Structure dependent antioxidant capacity of phlorotannins from Icelandic Fucus vesiculosus by UHPLC-DAD-ECD-QTOFMS

Brown algae are rich in polyphenolic compounds, phlorotannins, which have been found to possess high in vitro antioxidant capacity, especially DPPH radical scavenging activity, due to the high number of hydroxyl groups. Whereas, the overall antioxidant capacity of brown algae extracts has been widely studied, the antioxidant capacity of individual phlorotannins has been rarely explored. The aim of this study was to determine the structure dependant antioxidant capacity of phlorotannins from Icelandic brown algae, Fucus vesiculosus. The antioxidant capacity of individual phlorotannins was determined by an on-line method using liquid chromatography and an electrochemical detector followed by quadrupole Time of Flight mass spectrometry (UHPLC-DAD-ECD-QTOFMS). Tentative structural elucidation of 13 phlorotannin isomers from EAF was obtained by LC-DAD-QTOFMS, ranging from 374 to 870 Da. On-line determination of antioxidant capacity of the individual phlorotannins generally showed that low molecular phlorotannins exhibited higher antioxidant capacity and that the capacity decreased with polymerisation.
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BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.595 SNIP 2.027 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.548 SNIP 2.069 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
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BFI (2011): BFI-level 2
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Scopus rating (2008): SJR 1.488 SNIP 1.703
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Scopus rating (2006): SJR 1.383 SNIP 1.848
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.017 SNIP 1.543
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.057 SNIP 1.449
Scopus rating (2003): SJR 0.893 SNIP 1.258
Web of Science (2003): Indexed yes
Alkyl caffeates as antioxidants in O/W emulsions: Impact of emulsifier type and endogenous tocopherols

Antioxidant addition can be one strategy to limit lipid oxidation in emulsions. Research has proven that an important factor regarding the efficacy of antioxidants is their localization in the emulsion; however, other factors such as interactions with other components can also have an impact. Thus, the aim was to evaluate the impact of emulsifiers (Citrem and Tween80) and presence of endogenous tocopherols on the efficacies of caffeic acid and caffeates (C1–C20) as antioxidants in emulsions. Lipid oxidation was evaluated during storage and partitioning of caffeic acid and caffeates was estimated by measuring their concentrations in the aqueous phase. Partitioning of caffeic acid and caffeates was influenced by emulsifier type and the presence of endogenous tocopherols. Caffeic acid was the most efficient antioxidant in Citrem and Tween stabilized emulsions in the presence of endogenous tocopherol. In contrast, for Tween stabilized emulsions, caffeic acid acted as a prooxidant and the evaluated caffeates acted as strong antioxidants in the absence of endogenous tocopherol. Thus, when endogenous tocopherol was present lipophilization of caffeic acid did not increase its efficacy as an antioxidant. It is suggested that the differences observed in antioxidant efficiency with different emulsifiers and with and without endogenous tocopherols is due to emulsifier–antioxidant interactions and antioxidant–antioxidant interactions in the emulsions.

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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Antioxidant effect of water and acetone extracts of Fucus vesiculosus on oxidative stability of skin care emulsions

A water and an acetone extract of the Icelandic brown algae Fucus vesiculosus were evaluated as potential natural sources of antioxidant compounds in skin care emulsions. To assess their efficacy in inhibiting lipid oxidation caused by photo- or thermoxidation, they were stored in darkness and room temperature as control conditions, and compared to samples stored under accelerated conditions (light and room temperature, or darkness and 40°C). The presence of extracts in the skin care emulsions induced remarkable colour changes when the emulsions were exposed to light, and more extensively under high temperature. High temperature also caused greater increments in the droplet size of the emulsions. The analysis of the tocopherol content, peroxide value and volatile compounds during the storage revealed that, whereas both water and acetone extracts showed (at 2mg/g of emulsion) protective effect against thermooxidation, only the water extract showed antioxidant activity against photooxidation.

General information
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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, University of Navarra, Matís Ltd.
Antioxidant Efficacies of Rutin and Rutin Esters in Bulk Oil and Oil-in-Water Emulsion

The use of flavonoids as antioxidants in food formulations is limited due to their solubility and thereby their localization in the food products. However, enzymatic alkylation of flavonoids with lipophilic moieties alters their lipophilicity and thereby partitioning within different phases in a food product. This study aimed to evaluate the antioxidative efficiency of two derivatives of rutin, namely rutin laurate (C12:0) and rutin palmitate (C16:0) compared with their parent compound rutin and with butylated hydroxytoluene (BHT). Their efficiency as antioxidants at two different concentrations (25 and 200µM) was assessed in bulk oil and in an o/w emulsion system without and with iron addition. All evaluated compounds revealed antioxidative effects. However, rutin and BHT were the most efficient antioxidants in bulk oil followed by rutin palmitate, whereas rutin laurate acted as either an antioxidant or a prooxidant at low and high concentrations (25 and 200µM), respectively. In emulsions, rutin and BHT in high concentration (200µM) were more efficient than rutin esters. Thus, alkylation of rutin with medium chain fatty acids did not improve the antioxidant ability, neither in bulk oil nor in o/w emulsion. Interestingly, rutin had stronger antioxidative effect than BHT upon iron addition to the emulsion.

Practical application: According to the antioxidant hypothesis the polar paradox more amphiphilic antioxidants should perform as better antioxidants in emulsions than more polar antioxidants. The finding in this study revealed that lipophilization of rutin did not improve its antioxidant capacity in emulsions compared to untreated rutin. This stresses the importance of evaluating the antioxidant in each emulsion systems before selecting appropriate antioxidants for optimal protection against lipid oxidation.
Biomass composition of Arthrospira platensis during cultivation on industrial process water and harvesting

Microalgae have the ability to utilize nutrients from wastewater and use it for biomass production. The effluent from a biogas process was tested as a nutrient source for blue-green microalga Arthrospira platensis cultivation and compared with conventional synthetic medium. Cultivation was carried out in four different concentrations of industrial process water (25, 50, 75, and 100%). The biomass was then harvested by microfiltration, and centrifugation followed by freeze drying. Variations in biomass composition were studied, in order to investigate effects of industrial process water on A. platensis over 30 days of cultivation. Applied harvesting techniques were evaluated for their effect on physiochemical properties of the biomass. Arthrospira platensis was able to grow in all tested wastewater concentrations except 100%, however, increase of wastewater concentration in medium resulted in a decreased growth rate. Partial substitution of synthetic Zarrouk medium with 25% of wastewater showed no adverse effect on chemical composition of the biomass including high protein content (45%–58% dry weight) and favorable fatty acid composition (42%–45% PUFAs of total fatty acids). Evaluation by optical microscopy showed that microfiltration caused cell rupture at the moderate level while centrifugation had more severe effect on A. platensis. Effect of centrifugal forces and shear stress on A. platensis cells was confirmed by detecting lower lipid content in samples after applying both microfiltration and centrifugation due to cell content leakage.
Development of carbohydrate-based nano-microstructures loaded with fish oil by using electrohydrodynamic processing

The encapsulation of fish oil in carbohydrate-based nanomicrostructures obtained by electrohydrodynamic processing was investigated. Solutions of pullulan 200 kDa (15 wt%) and dextran 70 kDa (25 wt%) presented appropriate properties (viscosity, surface tension and conductivity) to allow the formation of nano-microfibers and nano-microcapsules, respectively. Although dextran 70 kDa exhibited antioxidant properties in solution, their capsules produced at lab and pilot-plant scales showed a low oxidative stability both with emulsified and neat oil. Phase separation of solution and opened capsules indicated a poor interaction between dextran and fish oil, which suggested that further optimization of the electrospaying solution is necessary. On the contrary, pullulan solutions were optimized to work even at pilot-plant scale. In this case, in spite of the prooxidant effect of pullulan in solution, oxidatively stable pullulan fibers (PV = 12.3 ± 0.9 meq O₂/kg and 15.5 ± 5.1 ng/g of 1-penten-3-ol) were obtained when oil was incorporated as neat oil and when producing batches during short time (30 or 10 min). This superior oxidative stability when compared to fibers with emulsified oil is mainly attributed to a higher fish oil entrapment and to the location of the oil in large bead-structures with a reduced specific surface area. These results indicated the feasibility of producing omega-3 nanodelivery systems by encapsulating fish oil in pullulan nano-microfibers using electrospinning processing.

General information

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Scopus rating (2011): SJR 1.615 SNIP 1.921 CiteScore 3.57
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Scopus rating (2010): SJR 1.743 SNIP 1.513
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.728 SNIP 1.781
Effects of Different Lipophilized Ferulate Esters in Fish Oil-Enriched Milk: Partitioning, Interaction, Protein, and Lipid Oxidation

Antioxidant effects of ferulic acid and lipophilized ferulate esters were investigated in fish oil-enriched milk. Methyl ferulate (C1) and ethyl ferulate (C2) more efficiently prevented lipid oxidation than dodecyl ferulate (C12) did, followed by ferulic acid (C0). The combination of C1 or C2 with C12 could have a "synergistic" effect indicated by peroxide value, hexanal, and 1-penten-3-ol analysis results. These antioxidants also showed protein oxidation inhibition effects. The most effective antioxidants (C1 and C2) had the highest concentration in the precipitate phase but the lowest concentration in the aqueous phase, which was the opposite of the partitioning of C0. C12 had the highest concentration in the oil and emulsion phase. In particular, the interaction between ferulates esterified with short and medium alkyl chain lengths could lead to their "synergistic" effects in fish oil-enriched milk, which could be caused by the change in their partitioning or localization at the interface.
Extraction of unsaturated fatty acid-rich oil from common carp (Cyprinus carpio) roe and production of defatted roe hydrolysates with functional, antioxidant, and antibacterial properties

Common carp roe is a rich protein and oil source, which is usually discarded with no specific use. The aims of this study were to extract oil from the discarded roe and examine functional, antioxidant, and antibacterial properties of defatted roe hydrolysates (CDRHs) at various degrees of hydrolysis (DH). Gas chromatography (GC) of fatty acid methyl esters (FAMEs) revealed that common carp roe oil contained high level of unsaturated fatty acids. The results of high-performance liquid chromatography-mass spectrometry (HPLC-MS) indicated that enzymatic hydrolysis of defatted roe yielded higher content of essential amino acids. CDRHs displayed higher solubility than untreated defatted roe, which increased with DH. Better emulsifying and foaming properties were observed at lower DH and non-isoelectric points. Furthermore, water and oil binding capacity decreased with DH. CDRHs exhibited antioxidant activity both in vitro and in 5% roe oil-in-water emulsions and inhibited the growth of certain bacterial strains. Common carp roe could be a promising source of unsaturated fatty acids and functional bioactive agents. Unsaturated fatty acid-rich oil extracted from common carp roe can be delivered into food systems by roe oil-in-water emulsions fortified by functional, antioxidant, and antibacterial hydrolysates from the defatted roe.

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Authors: Ghelichi, S. (Ekstern), Shabanpour, B. (Ekstern), Pourashouri, P. (Ekstern), Hajfathalian, M. (Ekstern), Jacobsen, C. (Intern)
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.813 SNIP 1.088 CiteScore 2.11
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.819 SNIP 1.153 CiteScore 2.1
Web of Science (2014): Indexed yes
Improving oxidative stability of liquid fish oil supplements for pets

Omega-3 polyunsaturated fatty acids have produced beneficial health effects in animals and are recommended by veterinarians to pet patients suffering from osteoarthritis. However, these oils are highly susceptible to lipid oxidation. The objectives of this study were to improve oxidative stability of fish oil by adding vegetable oils, mixed tocopherols and rosemary extract, and to formulate a commercial product according to the results obtained. The formulated product was evaluated against commercial fish oil products. An initial screening for antioxidative effect was performed by using OxiPlex equipment. The effect of antioxidant and vegetable oil blends was examined in oils stored at 30 and 40°C by measuring peroxide value, volatile compounds with GC-MS and tocopherol content. Addition of vegetable oil and rosemary extract at high level (4000–6000 ppm) plus 600 ppm of mixed tocopherols increased oxidative stability to the same extent as 2000 ppm mixed tocopherols in OxiPlexes. Overall, oxidative stability of fish oil or fish oil + vegetable oil blends was improved the most by addition of 5000 ppm rosemary extract and 500 ppm mixed tocopherols. A commercial oil blend with composition optimized based on the results of this study performed better than other commercial marine oils tested.
Practical applications: In some commercial oil blends for pets, a high level of vegetable oils is included in order to increase oxidative stability. In this study, vegetable oils are included at 30% level. At this level of vegetable oil inclusion, the omega-3 EPA and DHA content of the blends is at least 21% of total fatty acids for both fish and tuna oil based blends. In this study we wanted to examine, whether we could reduce the level of vegetable oil inclusion without compromising oxidative stability. This study demonstrates how the oxidative stability of omega-3 PUFA formulations for pets can be improved by combining fish oil with vegetable oils and by adding an antioxidant blend consisting of high concentrations of rosemary extract and tocopherol. The results are also of relevance to the manufacturers of dietary supplements.

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Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
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Scopus rating (2011): SJR 0.732 SNIP 0.945 CiteScore 1.75
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Scopus rating (2010): SJR 0.791 SNIP 1.049
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BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.838 SNIP 1.077
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.606 SNIP 0.815
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.598 SNIP 0.801
Investigation of Lipid Oxidation in High- and Low-Lipid-Containing Topical Skin Formulations

Abstract: Lipid oxidation can impact the odour of skin care products during storage. A study was conducted to identify and monitor representative markers for lipid oxidation in skin care products over time. Four lip care formulations and three skin care formulations with different lipid contents were stored at various cosmetic industry-relevant conditions for 84 days. The skin care products were analysed for lipid hydroperoxides and secondary volatile oxidation products. A trained sensory panel performed an odour difference (triangle) test and odour-profiled the products to detect and describe odour changes during storage. Several potential markers for lipid oxidation were identified. In skin care formulations, peroxide value (PV) analysis was a useful marker for lipid oxidation if the product was exposed to light during storage, but no clear changes were observed for PV in samples stored under other conditions. Furthermore, concentrations of several secondary volatile oxidation products increased during storage, and the highest increase was observed for products exposed to light. Pentanal and heptanal were found to be reliable markers for secondary volatile oxidation products in the skin care formulations (especially during exposure to light), whereas in the lip care formulations the best candidates were pentanal (especially during exposure to light and iron), 2-methyl furan and 3-methyl-3-buten-2-one (especially during exposure to light, iron and high temperatures). Graphical Abstract: [Figure not available: see fulltext.]
Marine phospholipids: The current understanding of their oxidation mechanisms and potential uses for food fortification

There is a growing interest in using marine phospholipids (PL) as ingredient for food fortification due to their numerous health benefits. However, the use of marine PL for food fortification is a challenge due to the complex nature of the degradation products that are formed during the handling and storage of marine PL. For example, nonenzymatic browning
reactions may occur between lipid oxidation products and primary amine group from phosphatidylethanolamine or amino acid residues that are present in marine PL. Therefore, marine PL contain products from nonenzymatic browning and lipid oxidation reactions, namely, Strecker aldehydes, pyrroles, oxypolymers, and other impurities that may positively or negatively affect the oxidative stability and quality of marine PL. This review was undertaken to provide the industry and academia with an overview of the current understanding of the quality changes taking place in PL during their production and their storage as well as with regards to their utilization for food fortification.

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Scopus rating (2014): SJR 2.052 SNIP 2.403 CiteScore 5.97
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Scopus rating (2011): SJR 1.874 SNIP 2.29 CiteScore 5.49
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.018 SNIP 2.307
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.795 SNIP 2.276
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.975 SNIP 2.346
Scopus rating (2007): SJR 1.877 SNIP 2.474
Scopus rating (2006): SJR 1.739 SNIP 2.271
Scopus rating (2005): SJR 1.344 SNIP 2.223
Scopus rating (2004): SJR 0.959 SNIP 1.637
Scopus rating (2003): SJR 0.729 SNIP 1.802
Scopus rating (2002): SJR 0.789 SNIP 1.993
Scopus rating (2001): SJR 1.1 SNIP 1.953
Micro-algae biomass as an alternative resource for fishmeal and fish oil in the production of fish feed

In recent years, intense efforts have been made to find new, alternate and sustainable aquatic feed ingredients, primarily in anticipation of an increasing world population and predicted insufficient fishmeal supply which is a critical component of aquaculture feed. Now it is becoming increasingly evident that the continued exploitation of industrial fish as a resource fish feed will ultimately become both environmentally and economically unsustainable. Microalgae are at the base of the entire aquatic food chain and play a major role in the diet of aquatic animals such as fish. Microalgae’s main application for aquaculture is related to nutrition, being used as a sole fresh feed or an additive, e.g. source of pigment. Algae produce almost all nutritious compounds which are required for fish. The diverse biochemical composition of microalgae represents them as a promising candidate for the formulation of fish feed. The nutritional composition of microalgae depends on the species, environmental conditions and growth medium composition. Microalgae for use in aquaculture should be non-toxic and possess the essential nutritive constituents, in a reasonable price. Photosynthetic production of algae either in outdoor or indoor photobioreactor systems is costly since cultures must be maintained at low densities. Consequently, large volumes of media must be processed to recover small quantities of algae, and since most algal cells are minuscule, unspecific expensive harvesting processes must be employed. Strategies such as cultivation of microalgae on low price growth media, selection of microalgae capable of growing on such media and produce biomass with desired chemical composition and development of specific harvest and downstream processing represent basic solutions to improve the applicability of microalgae biomass as a fish feed ingredient. Moreover, storage of the algae biomass at optimum conditions minimise the deterioration of valuable compounds. This project has employed the strategies mentioned above to provide a clear concept for the cultivation, processing and the storage of microalgae biomass intended to be used as a fish feed ingredient. A pre-gasified industrial process water with high concentration of ammonia and free from toxic compounds, representing effluent from a local biogas plant was used as a low price growth medium. Therefore, the biomass production benefits from low cultivation price and also from valorization of the nutrients. Screening of various microalgae species has been extensively done to find proper microalgae capable of growing on industrial process water and producing a biomass containing high levels of protein, long-chain polyunsaturated fatty acids (LC PUFA), and bioactive compounds such as natural antioxidants. Effects of growth media composition/concentration and cultivation time on the nutritional composition of the biomass, variations in proteins, lipid, fatty acid composition, amino acids, tocopherols, and pigments were evaluated. Among all studied species including Nannochloropsis salina, nannochloropsis limnetica, Chlorella sorokiniana, Chlorella vulgaris, Chlorella pyrenoidosa, Desmodesmus sp. and Arthrospira platensis, the microalgae Chlorella pyrenoidosa grew well on the industrial process water, efficiently valorized the compounds in the growth medium (ammonia and phosphorous) and produced reasonable amounts of the biomass (6.1 g/L). The resulting biomass included very high levels of protein (65.2±1.30% DW) as well as promising amino acid and carotenoid compositions. Chlorella pyrenoidosa was selected as a source of proteins and amino acids while lacking LC PUFA’s. The microalgae Nannochloropsis salina which was grown on a mixture of standard growth medium and industrial process water produced a biomass containing high eicosapentaenoic acid (C20.5 n-3, as 44.2% ± 2.30% of total fatty acids), representing a rich source of LC PUFA. Data from laboratory scale experiments were translated to large scale and both of these species have been successfully cultivated in flat panel photobioreactor systems. Chromatographic methods were developed and employed for characterising algal biomass at both pre- and post-harvest stages and were based on the analysis of fatty acids (gas-liquid chromatography) and pigments (high-performance liquid chromatography). These methods represented rapid, routine and reliable control measures to verify the variations in the purity of the biomass the microalgae biomass during cultivation, and its quality during the processing and storage. In this study, a new downstream process set up, which included cross flow microfiltration by SiC (0.1µm) ceramic membranes, heat treatment (75°C&15 seconds) for inactivation of enzymes, up concentration by bowl centrifuge at 6500×500 g and finally drying by the novel swirl/spin flash dryer was developed. This processing concept was specifically designed and tested on microalgae samples as a fish feed ingredient. The process aimed at reducing the energy consumption and minimizing deterioration of value-added bioactive compounds such as carotenoids, and LC PUFA. The method has been tested in the laboratory and large scales. Energy consumption per kg of the product was evaluated as 2.2 KWh, which was estimated as 28% lower than known current processing technologies which are being applied to microalgae. The swirl flash dryer was specifically designed to handle microalgae paste like feeds. Analysis of the pigment and fatty acid composition also revealed that the drying technique had profound adverse effects on the quality of microalgae biomass. As the final part of the study, effects of the storage time (0-56 days), storage temperature (5°C, 20°C and 40°C) and the packaging conditions (under vacuum or ambient pressure) on a high LC PUFA biomass from Nannochloropsis salina was investigated. The storage time and temperature strongly influenced the oxidation reactions, which resulted in deterioration of bioactive compounds such as carotenoids, tocopherols and LC PUFA. The study revealed that the oxidation reactions, which led to the creation of primary and secondary products, occurred mainly during the first days of storage. The storage of freeze-dried microalgae at a low temperature (e.g. 5°C) was found to be more efficient than in oxygen-reduced storage conditions such as vacuum.
packaging. This project provides imperative data covering all aspects of utilisation of algae biomass as a fish feed ingredient. These findings reveal new opportunities and open new doors toward research, processing and quality control in the microalgae industry.

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Natural antioxidants derived from seaweed materiale

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Oxidative stability and microstructure of 5% fish-oil-enriched granola bars added natural antioxidants derived from brown alga Fucus vesiculosus

The aims of this study were to: 1) investigate the ability of Icelandic brown algae Fucus vesiculosus extracts to inhibit lipid oxidation in granola bars fortified with fish oil-in-water emulsion; 2) investigate whether addition of the seaweed extracts affected the physical microstructure of the oil droplets in granola bars.

The oxidative stability of the bars at 20°C was evaluated over a period of 10 weeks by measuring the development of peroxides and volatile compounds using dynamic headspace gas chromatography mass spectrometry (DHS GC-MS). The physical microstructure was determined using microscopy.

All extracts - except water extract in low concentration - reduced lipid oxidation during 10 weeks of storage when added in a concentration of 0.5 or 1 g extract/100 g emulsion. EE and AE (in the lowest concentration) were found to be most efficient as antioxidants in the bars. The antioxidant efficacy of these two extracts was among other related to an improved incorporation of the fish oil-in-water emulsions in the bars, high total phenolic content, high radical scavenging activity together with high interfacial affinity of phenolic compounds and probably regeneration of tocopherol.

Practical applications: The work showed the application potential of Fucus vesiculosus extracts as a natural antioxidant in low-moisture foods such as granola bars. These findings implied that the multi-functional nature of these extracts provides not only oxidative stability of the food but also a physical stability.
Oxidative stability of pullulan electrospun fibers containing fish oil: Effect of oil content and natural antioxidants addition

The effect of oil content and addition of natural antioxidants on the morphology and oxidative stability of pullulan ultra-thin fibers loaded with fish oil was investigated. Pullulan sub-micron fibers containing 10 and 30wt% fish oil were prepared and both presented beads where the oil accumulated. The number of beads was significantly higher in 30wt% oil-loaded fibers. Moreover, fibers containing 30wt% fish oil had a higher oxidative stability when compared to 10wt% oil-loaded fibers, despite its lower encapsulation efficiency (EE) value (67.1±3.1%). The oxidative stability of fibers loaded with 10wt% fish oil (EE=88.5±0.7%) was significantly improved when adding δ-tocopherol (500ppm) and rosemary extract (500ppm) as antioxidants. However, higher concentration of antioxidants (2000ppm δ-tocopherol and 1000ppm rosemary extract) did not further improve the oxidative stability of 10wt% oil-loaded fibers, but had a pro-oxidant effect. Finally, the production of pullulan fibers containing 10wt% fish oil from formic acid solutions increased the oxidative stability of the fibers when compared to the same type of fibers obtained from water solutions. The latter was observed for fibers without and with antioxidants (500ppm of δ-tocopherol and 500ppm of rosemary extract). Practical applications: Encapsulation of omega-3 polyunsaturated fatty acids and addition of antioxidants are the most efficient strategies to protect these lipids against oxidation when incorporating them into food matrices. These results show the feasibility to encapsulate fish oil in pullulan ultra-thin fibers and to improve their oxidative stability by adding natural antioxidants such as δ-tocopherol and rosemary extract. Therefore, this study might open up new opportunities for further technological development in the production of omega-3 nanodelivery systems, which have potential applications in different types of fortified foods. Encapsulation of fish oil in electrospun pullulan fibers stabilized by natural antioxidants.

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BFI (2016): BFI-level 1
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Production of peptides with various effects from proteins of different sources continues to receive academic attention. Researchers of different disciplines are putting increasing efforts to produce bioactive and functional peptides from different sources such as plants, animals, and food industry by-products. The aim of this review is to introduce production
methods of hydrolysates and peptides and provide a comprehensive overview of their bioactivity in terms of their effects on immune, cardiovascular, nervous, and gastrointestinal systems. Moreover, functional and antioxidant properties of hydrolysates and isolated peptides are reviewed. Finally, industrial and commercial applications of bioactive peptides including their use in nutrition and production of pharmaceuticals and nutraceuticals are discussed.

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Scopus rating (2014): SJR 2.052 SNIP 2.403 CiteScore 5.97  
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BFI (2010): BFI-level 2  
Scopus rating (2010): SJR 2.018 SNIP 2.307  
BFI (2009): BFI-level 2  
Scopus rating (2009): SJR 1.795 SNIP 2.276  
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Scopus rating (2008): SJR 1.975 SNIP 2.346  
Scopus rating (2007): SJR 1.877 SNIP 2.474  
Scopus rating (2006): SJR 1.739 SNIP 2.271  
Scopus rating (2005): SJR 1.344 SNIP 2.223  
Scopus rating (2004): SJR 0.959 SNIP 1.637  
Scopus rating (2003): SJR 0.729 SNIP 1.802  
Scopus rating (2002): SJR 0.789 SNIP 1.993  
Scopus rating (2001): SJR 1.1 SNIP 1.953  
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Physical and oxidative stability of fish oil-in-water emulsions fortified with enzymatic hydrolysates from common carp (Cyprinus carpio) roe

Physical and oxidative stability of 5% (by weight) cod liver oil-in-water emulsions fortified with common carp (C. carpio) roe protein hydrolysate (CRPH) were examined. CRPH was obtained by enzymatic hydrolysis of discarded roe by using Alcalase 2.4 L for 30, 60, 90, and 120 min to yield different degrees of hydrolysis (DH). All the hydrolysates showed in vitro antioxidant activity in terms of radical scavenging and chelating properties. CRPH-containing emulsions had significantly smaller droplets than control (p

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BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.909 SNIP 2.395 CiteScore 4.17
ISI indexed (2011): ISI indexed yes
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Physical and oxidative stability of high fat fish oil-in-water emulsions stabilized with combinations of sodium caseinate and sodium alginate

A systematic study was carried out in order to evaluate the physical and oxidative stability of high fat omega-3 delivery fish oil-in-water emulsions stabilized with combinations of sodium caseinate (NaCas) and sodium alginate (NaAlg). The influence of 3 factors related to emulsion composition (fish oil content: 50, 60 and 70%; total amount of NaCas and NaAlg: 1.4, 2.1 and 2.8%; and ratio NaCas:NaAlg: 0.4, 1.2 and 2) on physical (droplet size, viscosity and zeta potential) and oxidative (primary and secondary oxidation products) parameters was evaluated. It was possible to produce emulsions with a combination of NaCas and NaAlg, except when the ratio between NaAlg and aqueous phase was high (0.047 or 0.054). Viscosity of the emulsions significantly increased with increasing fish oil and total stabilizer content. Zeta potential was significantly affected by total stabilizer content. The content of primary oxidation products in the emulsions was very low (0.93 meq peroxides/kg oil). Secondary oxidation products were detected in small amounts (<60 ng/g emulsion). Even though the optimum formulation concerning physical parameters was suggested as 61.8% fish oil content, 1.4% total stabilizer and 1.2 ratio NaCas:NaAlg by Box-Behnken’s design, the formulae 70%-1.4%-1.2 was decided due to high fish oil content's decreasing effect on droplet size and peroxide value. Practical applications: Physically and oxidatively stable high fat (50-70%) omega-3 delivery fish oil-in-water emulsions are of high interest to food industry for the production of omega-3 fortified products. Our results show the feasibility to stabilize high fat delivery fish oil-in-water emulsions using combinations of NaCas and NaAlg. As these emulsions had high amount of fish oil, food products can be enriched with smaller amounts of high fat emulsions when compared to low fat delivery emulsions. This results in minor changes of the product's original structure. Examples for enrichment of food products with omega-3 are dressings, cream cheese, yoghurt and mayonnaise.
Protein-polysaccharide Mixtures as Wall Material in Fish Oil-loaded Nano-microcapsules Obtained by Electrospraying

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PROVIDE a project aiming at protein valorization through informatics, hydrolysis, and separation

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Organisations: National Food Institute, Research Group for Gut Microbiology and Immunology, Research Group for Bioactives – Analysis and Application, Department of Bio and Health Informatics, Immunoinformatics and Machine Learning, Technical University of Denmark
Authors: Hansen, E. B. (Intern), Jacobsen, C. (Intern), Lund, O. (Ekstern), Marcatili, P. (Intern), García Moreno, P. J. (Intern)
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ABSTRACT BOOK
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Quality changes of Antarctic krill powder during long term storage

Krill is a valuable sustainable resource of omega-3 fatty acids and protein, which may be processed into a krill powder for human consumption. The objective of this study was to investigate the stability of krill powder when stored for up to 12 months at room temperature. In addition, the effect of packaging in vacuum was observed. The stability was assessed by changes in concentrations of lipid classes, antioxidants, pyrroles and lipid, and Strecker-derived volatiles. Some degradation occurred during storage at room temperature. Thus, a minor increase in volatiles, an increase in free fatty acids and a concomitant decrease in antioxidants, tocopherol, and astaxanthin was observed. In addition, there was a minor decrease in phospholipids and n-3 fatty acids; however, storage at vacuum improved the oxidative stability of krill powder.

Practical applications: For the use of krill powder in human nutrition, it is important, that the quality and stability is sufficiently high to retain the nutritional value during storage. This study contributes with information about the stability during storage up to 12 months at room temperature and the effect of packaging the powder in vacuum.

Antarctic krill (Euphausia superba) is a shrimp-like marine crustacean. It is rich in omega-3 fatty acids, primarily bound in phospholipids in the sn-2 position of the molecule, making it highly bioavailable. Krill may be processed into powder also rich in protein and astaxanthin. Stability of krill powder, stored for up to 12 months at room temperature, showed slight lipid oxidation.

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Authors: Nielsen, N. S. (Intern), Lu, H. F. S. (Intern), Bruheim, I. (Ekstern), Jacobsen, C. (Intern)
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BFI (2011): BFI-level 1
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ISI indexed (2011): ISI indexed yes
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BFI (2010): BFI-level 1
Storage conditions affect oxidative stability and nutritional composition of freeze-dried Nannochloropsis salina: Oxidation of dried Nannochloropsis salina during storage

Microalgae biomass is known as a promising sustainable source of bioactive compounds. Application of microalgae biomass in food and feed products requires information regarding storage stability and optimized storage conditions to minimize unwanted deterioration which downgrades the bioactive composition of microalgae biomass. In order to investigate the worsening of the nutritional quality of freeze dried biomass, a multifactorial storage experiment was conducted on a high EPA (eicosapentaenoic acid) Nannochloropsis salina biomass. The storage time (0–56 days), storage temperature (5, 20, and 40 °C) and packaging conditions (under vacuum and ambient pressure) were used as main factors. During the 56 days of storage, both time and temperature strongly influenced the oxidation reactions which result in deterioration of bioactive compounds such as carotenoids, tocopherols, and EPA. Lipid deterioration occurred both due to enzyme-induced lipolysis and autoxidation. Carotenoids and α-tocopherol contents decreased during storage, but may still have prevented EPA from higher oxidative deteriorations due to their powerful antioxidant properties. Oxidation reactions, which resulted in the creation of primary and secondary volatile oxidation products, occurred mainly at the first days of storage. The resulting volatile compounds (measured by headspace gas chromatography-mass spectrometry) declined further until day 56, probably due to reaction with amino acids, or decomposition to low molecular weight tertiary oxidation compounds. Storage of microalgae at low temperature is more effective than vacuum packaging.

Practical Applications: Microalgae are known as a sustainable source of bioactive compounds, and their industrial scale application is growing very fast. Application of microalgae biomass in food, feed, or cosmetics requires the knowledge of the optimum storage conditions to prevent the value-added compounds from deterioration. Results of this study improve our understanding of the chemical deterioration under different storage conditions and can help the producers/customers to extend the shelf life of microalgae biomass by choosing correct storage conditions.

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Supplementation of docosahexaenoic acid (DHA), vitamin D₃ and uridine in combination with six weeks of cognitive and motor training in prepubescent children: a pilot study

Background Learning and memory have been shown to be influenced by combination of dietary supplements and exercise in animal models, but there is little available evidence from human subjects. The aim of this pilot study was to investigate the effect of combining a motor- and cognitive exercise program with dietary supplementation consisting of 500 mg docosahexaenoic acid (DHA), 10 μg vitamin D₃ and 1000 mg uridine (DDU-supplement) in 16 prepubescent children (age 8–11 years). Methods We designed a randomized, placebo-controlled, double-blinded study lasting 6 weeks in which DDU-supplement or placebo was ingested daily. During the intervention period, all children trained approximately 30 min 3 days/week using an internet-based cognitive and motor training program (Mitii). Prior to and post the intervention period dietary record, blood sampling, physical exercise tests and motor and cognitive tests were performed. Results Fourteen of the 16 children completed the intervention and ingested the supplement as required. 6 weeks DDU-supplementation resulted in a significant increase in the blood concentration of vitamin D₂+₃ and DHA (p = 0.023 and p < 0.001, respectively). Power calculation based on one of the cognitive tasks revealed a proper sample size of 26 children. Conclusion All children showed improved performance in the trained motor- and cognitive tasks, but it was not possible to demonstrate any significant effects on the cognitive tests from the dietary supplementation. However, DDU-supplementation did result in increased blood concentration of DHA and vitamin D₂+₃. Trial registration Clinical registration ID: NCT02426554 (clinical Trial.gov). January 2015 retrospectively registered.

Value utilization of discarded fish livers for production of omega-3 rich oil
Variation in growth, yield and protein concentration in Saccharina latissima (Laminariales, Phaeophyceae) cultivated with different wave and current exposures in the Faroe Islands

Ropes seeded directly with Saccharina latissima were deployed at different exposures (sheltered, current exposed and wave exposed) in a Faroese sound and characteristics of growth and quality of the biomass and surroundings were evaluated during the growth season from March to August 2015. Saccharina latissima individuals cultivated at the current exposed location were heavier compared to the individuals cultivated at the other locations; however, the total biomass yield was significantly lower at the current exposed location. The protein and nutritional value of the biomass varied with season but showed no correlation with exposure. The highest protein levels and EAA (essential amino acid) score were measured in the spring (April and May) samples. The amino acid composition was dominated by glutamate followed by aspartic acid; however, this was replaced by methionine in the July samples. Total Kjeldahl nitrogen was significantly higher in May and August compared to July, and the nitrate concentration in the biomass was significantly lower in May and August compared to July. Nitrate was most available in the seawater at the time of deployment (3rd of March) and decreased during spring and summer. Saccharina latissima was cultivated successfully at the sheltered, current exposed and wave exposed locations using a direct seeding method. However, our results indicate that the lower biomass yield at the current exposed cultivation location compared to the sheltered and wave exposed are due to the direct seeding method, and possible limitations using this method need further testing and optimization.
Antioxidant activity of cod (Gadus morhua) protein hydrolysates: Fractionation and characterisation of peptide fractions

This study aimed to characterise peptide fractions (>5 kDa, 3–5 kDa and <3 kDa) with antioxidative activity obtained from a cod protein hydrolysate. The free amino acids in all fractions were dominated by Ala, Gly, Glu and Ser. The total amino acid composition had high proportions of Lys, Ala and Glu. The 3–5 kDa and <3 kDa fractions were further fractionated by size exclusion chromatography. All sub-fractions showed high Fe²⁺ chelating activity. The DPPH radical-scavenging activity of the 3–5 kDa fraction was exerted mainly by one sub-fraction dominated by peptides with masses below 600 Da. The DPPH radical-scavenging activity of the <3 kDa fraction was exerted by sub-fractions with low molecular weight. The highest reducing power was found in a sub-fraction containing peptides rich in Arg, Tyr and Phe. Both free amino acids and low molecular weight peptides thus seemed to contribute to the antioxidative activity of the peptide fractions, and Tyr seemed to play a major role in the antioxidant activity.

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Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
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Web of Science (2005): Indexed yes
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Antioxidant Activity of Protein Hydrolysates Obtained from Common Carp (Cyprinus carpio) Discarded Roe

Lipid oxidation represents a severe challenge in food engineering because it deteriorates quality of foods, especially those containing high contents of polyunsaturated fatty acids (PUFAs). One way to overcome this barrier is application of synthetic antioxidants such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), propyl gallate (PG), and tertiary butylhydroquinone (TBHQ) in PUFA-rich foods. However, recently there have been concerns over health-related risks posed by these synthetic agents. Therefore, obtaining safe antioxidants from natural sources, especially those which are discarded with no use, with potency to retard lipid oxidation has gained sizable attention. Therefore, the present study aimed at obtaining “green” antioxidants from discarded common carp roe via the so-called hydrolysis process by using alcalase and determining their antioxidant activity both in vitro and in food model systems. Four common carp roe protein hydrolysates (CRPH) obtained at different reaction times (i.e. 30, 60, 90, and 120 min) were assayed. In vitro antioxidant activity of the hydrolysates was measured through three different assays (i.e. DPPH radical scavenging, metal ion chelating, and reducing power). Furthermore, the oxidative stability of 5% fish oil-in-water emulsions containing or not the hydrolysates was investigated by monitoring their content of hydroperoxides and volatiles markers. The hydrolysates exhibited high DPPH radical scavenging activity and reducing power when compared to positive controls, i.e. BHT and ascorbic acid, respectively. However, Fe2+ chelating capacity of the hydrolysates was relatively lower than that of Ethylenediaminetetraacetic acid (EDTA), applied as positive control. The antioxidant activity of hydrolysates changed with DH and increased in a dose dependent manner. Unlike CRPH-fortified emulsions, the emulsions without CRPH exhibited significantly increased peroxide value (PV) during the storage period (p<0.05), reaching from 4.7±0.1 at day 0 to 79.2±11.3 at day 7. Moreover, all CRPH-containing emulsions showed negligible amounts of most secondary oxidation products (e.g. 1-penten-3-one and (E,E)-2,4-heptadienal) when compared to the emulsion control at day 7. These results indicate that common carp roe protein hydrolysates exert antioxidant activity both in vitro and in fish oil-in-water emulsions, and can thus be considered as alternative antioxidants to the synthetic ones.

General information
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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Gorgan University of Agricultural Sciences and Natural Resources
Authors: Ghelichi, S. (Ekstern), Sørensen, A. M. (Intern), García Moreno, P. J. (Intern), Jacobsen, C. (Intern)
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Main Research Area: Technical/natural sciences
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Bibliographical note
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Antioxidative Effect of Seaweed Extracts in Chilled Storage of Minced Atlantic Mackerel (Scomber scombrus): Effect on Lipid and Protein Oxidation

In this study, antioxidant activity of absolute ethanol, 50 % ethanol and water extracts of two species of seaweeds namely, Fucus serratus and Polysiphonia fucoides were evaluated for their ability to retard lipid and protein oxidation in minced mackerel. Mackerel mince added with 0.5 g/kg of extracts was prepared. For comparison, BHT at 0.2 g/kg and a control with no added extracts were also prepared. The samples were stored at 5 °C for 8 days, and sampling was done at time 0, 1, 2, 4, 5 and 8 days. The 50 % ethanolic extracts of P. fucoides were found to be very effective in retarding lipid and protein oxidation, as it resulted in low levels of peroxide value, volatiles and carbonyl compounds and protected against the loss of α-tocopherol and tryptophan residues. In spite of the higher phenolic content, the absolute ethanol extracts of both species showed a pro-oxidative tendency in minced mackerel. Water extract with lowest phenolic content showed no antioxidant effect in minced mackerel. In conclusion, the 50 % ethanolic extracts of P. fucoides can be a potential source of natural antioxidants, as these extracts have antioxidant activities similar to synthetic antioxidants such as BHT. However, the extent of protection offered by these extracts against protein oxidation was not clear and further studies are needed to understand the nature of the interaction between proteins and these extracts.

General information
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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, University of Guilan
Authors: Babakhani, A. (Ekstern), Farvin, K. H. S. (Ekstern), Jacobsen, C. (Intern)
Number of pages: 13
Pages: 352-364
Publication date: 2016
Main Research Area: Technical/natural sciences
Bioactive compounds in industrial red seaweed used in carrageenan production

The main seaweed species used in industrial scale for carrageenan production are Kappaphycus alvarezii, Eucheuma denticulatum, Chondrus crispus, Gigartina sp. and also Furcellaria lumbricalis as a source of furcellaran (Danish Agar) is also classified together with carrageenan. The chemical compositions of these five industrial red seaweeds were evaluated. Protein, lipid and total phenolic content, total amino acid and composition, fatty acid profile, tocopherol content and pigment composition were analyzed. The results demonstrate that there is potential possibility to develop a method to extracts most of the bioactive compounds, before the main process for carrageenan extraction, leading to a future multiproduct extraction (biorefinery) approach, instead of the traditional single-extraction procedure.
Comparison of Three Methods for Extraction of Volatile Lipid Oxidation Products from Food Matrices for GC–MS Analysis

The aim of this study was to compare three different collection methods; purge and trap, solid phase micro extraction and automated dynamic headspace/thermal desorption, all followed by GC–MS analysis used for the measurements of concentrations of volatile oxidation products in three different food matrices, namely oil, emulsion and milk. The linearity ranges of calibration curves obtained by the three different methods were compared for oil samples. Overall, the results showed that the three collection methods were comparable, although there were large differences in the linearity range of the calibration curves depending on the collection method. However, some challenges were observed for solid phase micro extraction and automated dynamic headspace/thermal desorption, namely, competition problems and overestimation of concentration by calibration curves, respectively. Based on the results, we suggest mainly to apply solid phase micro extraction on simple matrices and to be cautious with more complex matrices such as enriched milk and highly oxidized oils. Thereby, the study confirmed some challenges observed by other authors regarding competition problems on the fiber when using solid phase micro extraction. Furthermore, we observed that purge and trap, and automated dynamic headspace/thermal desorption were excellent for extraction of volatile compounds in all three matrices. However, automated dynamic headspace/thermal desorption calibration curves did provide an overestimation for oil samples so results must be interpreted with caution.
Development of a broodstock diet to improve developmental competence of embryos in European eel, Anguilla anguilla

We examined the effect of dietary arachidonic acid (ARA) and eicosapentaenoic acid (EPA) on the production of embryos and hatched larvae in the European eel, Anguilla anguilla. Two diets with high and intermediate levels of ARA and low and intermediate levels of EPA (Feed 1: ARA 1.9%, EPA 4.2%; Feed 2: ARA 1.2%, EPA 5.1% of total fatty acids) were tested against a commercial diet (DE: ARA: 0.5%, EPA: 8.2% of total fatty acids). After 24 weeks of feeding, ARA levels in the muscles and ovaries increased to 0.9% and 1.3% of total fatty acids, respectively, in Feed 1 and were significantly higher than in Feed 2 and DE. Female broodstock was not fed during hormonal treatment to induce vitellogenesis and ovulation. EPA levels in females fed the test diets decreased in the both muscle and ovary and were significantly lower in eggs from females fed Feed 1. The highest percentage of stripped females, producing viable eggs and larvae, were those females fed the highest dietary ARA levels (Feed 1). The level of lipid peroxidation products in eggs was similar among treatment, indicating that the lowest dietary levels of vitamin C and vitamin E were sufficient. In the unfertilized eggs, ARA levels were also highest (1.1% of total fatty acids) in the diet with highest ARA levels (Feed 1).

General information
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Effekten af støgetid og -temperatur på kvaliteten af spiseolier

General information
State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, National Veterinary Institute, Section for Bacteriology, Pathology and Parasitology, Division of Risk Assessment and Nutrition, Technical University of Denmark
Authors: Jacobsen, C. (Intern), Holmer, I. (Intern), Simony Jensen, J. (Ekstern), Stampe Madsen, S. (Ekstern), Lund-Larsen, M. (Ekstern), Mejborn, H. (Intern)
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Encapsulation of fish oil in nanofibers by emulsion electrospinning: Physical characterization and oxidative stability

The encapsulation of fish oil in poly(vinyl alcohol) (PVA) nanofibers by emulsion electrospinning was investigated. Independently of the emulsifier used, whey protein isolate (WPI) or fish protein hydrolysate (FPH), PVA concentration had a high influence on fiber morphology. Fibers without bead defects were only produced for solutions with 10.5% (w/w) PVA, which presented sufficient number of polymer chain entanglements. On the other hand, increasing oil load from 1.5 to 3% (w/w) resulted in fibers with larger diameters containing spindle-like enlargements interspersed. High omega-3 encapsulation efficiency (92.4 ± 2.3%) was obtained for fibers produced from 10.5% (w/w) PVA-5% (w/w) emulsion blend stabilized with WPI, resulting in an oil load capacity of 11.3 ± 0.3%. Moreover, the encapsulated oil was randomly distributed as small droplets inside the fibers. However, the electrospun fibers presented a higher content of hydroperoxides and secondary oxidation products (e.g. 1-penten-3-ol, hexanal, octanal and nonanal) compared to emulsified and unprotected fish oil.

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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Research Group for Nano-Bio Science, Technical University of Denmark, University of Granada
Authors: Garcia Moreno, P. J. (Intern), Boutrup Stephansen, K. (Intern), van der Kruis J., (Ekstern), Guadix, A. (Ekstern), Guadix, E. M. (Ekstern), Chronakis, I. S. (Intern), Jacobsen, C. (Intern)
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Enhancement of Protein and Pigment Content in Two Chlorella Species Cultivated on Industrial Process Water

Chlorella pyrenoidosa and Chlorella vulgaris were cultivated in pre-gasified industrial process water with high concentration of ammonia representing effluent from a local biogas plant. The study aimed to investigate the effects of growth media and cultivation duration on the nutritional composition of biomass. Variations in proteins, lipid, fatty acid composition, amino acids, tocopherols, and pigments were studied. Both species grew well in industrial process water. The contents of proteins were affected significantly by the growth media and cultivation duration. Microalgae Chlorella pyrenoidosa produced the highest concentrations of protein (65.2% ± 1.30% DW) while Chlorella vulgaris accumulated extremely high concentrations of lutein and chlorophylls (7.14 ± 0.66 mg/g DW and 32.4 ± 1.77 mg/g DW, respectively). Cultivation of Chlorella species in industrial process water is an environmentally friendly, sustainable bioremediation method with added value biomass production and resource valorization, since the resulting biomass also presented a good source of proteins, amino acids, and carotenoids for potential use in aquaculture feed industry.
Evaluation of the antioxidant activity in food model system of fish peptides released during simulated gastrointestinal digestion

In the last decade, increasing evidences of the occurrence of lipid oxidation during digestion have been reported, in either in vivo or in vitro studies (1,2,3). As a result, the nutritional quality and safety of foodstuffs could be affected by the decrease of certain lipidic compounds of interest and the generation of potentially toxic oxidation products. Regarding fish composition, the high content in polyunsaturated ω-3 acyl groups renders its lipids especially prone to oxidation. However, fish is also a major source of protein, which could greatly influence the extent of oxidation reactions taking place in the gastrointestinal tract. In fact, several studies have reported antioxidant activity of fish protein hydrolysates, coming from fish industry waste by-products (3,4). Thus, the potential release of peptides showing antioxidant properties during fish digestion cannot be ruled out. In order to shed light on these aspects, in vitro digestates of European sea bass were submitted to ultrafiltration using membranes with different cut off size. Afterwards, the potential antioxidant activity of the peptide fractions obtained was evaluated by comparing the oxidative stability of fish oil-in-water emulsions (5%), containing or not the isolated fractions (2 mg/ml final protein concentration). For this purpose, the occurrence of volatile markers of lipid oxidation, the tocopherol content, and the lipid composition of the emulsions during storage were studied. At day 12 of storage, emulsions made with digested protein fractions showed a higher content of docosahexanoic acyl groups and tocopherol than the emulsion control (without fractions), and also a lower content of volatile oxidation markers.

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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Technical University of Denmark
Authors: Safafar, H. (Intern), Uldall Nørregaard, P. (Ekstern), Ljubic, A. (Ekstern), Møller, P. (Ekstern), Holdt, S. L. (Intern), Jacobsen, C. (Intern)
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Publication: Research - peer-review › Journal article – Annual report year: 2016
Extraction, characterization and application of antioxidants from the Nordic brown alga Fucus vesiculosus

Marine algae are a huge underutilized resource in the Nordic countries with a potential to be used in the development of new natural ingredients for the food, cosmetics and pharmaceutical industry. Such ingredients can act as natural preservatives and prevent product deterioration during storage, in particular in the form of rancidity due to oxidation of unsaturated fatty acids in the products.

A characteristic feature of Fucus vesiculosus, also known as bladder wrack, is a high content of phlorotannins – a particular type of polyphenol group. Previous studies have shown positive correlations between the phlorotannin content and radical scavenging capacity of extracts derived from Nordic F. vesiculosus. Radical scavenging capacity is an important antioxidant property in terms of preventing the oxidation of unsaturated fatty acids. The high content of antioxidative phlorotannins in F. vesiculosus therefore makes this alga particularly attractive for the development of new natural antioxidants. While the in vitro antioxidant properties of F. vesiculosus extracts are widely studied, studies evaluating the antioxidant efficacy of such extracts in food and skin care products are scarce.

This PhD study investigated the possibilities of using extracts from Nordic F. vesiculosus as natural antioxidants in food and skin care products. All tested food products were fortified with fish oil rich in polyunsaturated omega-3 fatty acids. The fish oil was added specifically in order to examine the effectiveness of the antioxidants in systems which are more likely to oxidize compared with conventional products. The products tested were all oil-in-water emulsions except for granola bars, which were instead added 70% fish oil-in-water emulsions. Tests were made on a selections of extracts made from water, acetone, and ethanol, as well as a fraction of purified phlorotannins. Investigations also highlighted the influence of the extraction medium on the antioxidant properties, the phlorotannin content as well as other co-extracted substances. Moreover, it was examined which phlorotannins were present in each of the extracts, and how each specific phlorotannin contributed to the overall antioxidant activity.

All extracts examined and also the phlorotannin-rich fraction were somewhat able to improve the oxidative stability of the food and skin care products. The effectiveness of these extracts was to a large degree dependant on their antioxidant properties and composition, which in turn depended on the extraction medium used. In general, water was efficient in extracting iron chelating compounds. However, it was also found that water was not effective in extracting phlorotannins, and that the iron chelating ability, according to our results, to a greater extent was due to the presence of the pigment 19-hex-fucoxanthin. It has also been discussed whether algal sugars with iron chelating ability may be extracted with water and hence affect the antioxidant properties of the water extract. However, this aspect was not investigated. The high iron chelating ability of the water extract proved particularly effective in FO-enriched mayonnaise. Previous studies have also shown that iron chelating ability is an important property of antioxidants to work efficiently in this particular food. Acetone and ethanol were highly effective in extracting phlorotannins, which were found to have good radical scavenging capacity as well as reducing power. In addition, these phlorotannins exhibited a high affinity to the interface between the hydrophilic and the hydrophobic phase, compared to phlorotannins extracted with water. The more amphiphilic phlorotannins were also found to be effective antioxidants in FO-enriched granola bars. It was examined from microscopy how the emulsified fish oil added seaweed extracts localized when added to the granola bars. Emulsions added extracts with more amphiphilic phlorotannins clearly improved incorporation of the fish oil emulsions into the granola bars, which in turn had a major impact on the oxidative stability of these products. It was concluded that the surface active phlorotannins were important radical scavengers in granola bars. These phlorotannins are chain-breaking antioxidants that deactivate lipid radicals formed in the first part of lipid oxidation. In addition, it was discussed whether some of these phlorotannins also regenerated antioxidative tocopherols from the oil phase.

A structural characterization and on-line detection of phlorotannins in the purified fraction was carried out in support of a further characterisation of phlorotannins and how they each contribute to the overall antioxidant activity. By mass spectrometry 13 phlorotannin isomers were identified with molecular weights between 374 and 870 Da (3 to 7 phloroglucinol units). It was found that the antioxidant activity is decreasing with increased molecular weight and hence with increased polymerization of the phlorotannins.

This PhD work has contributed basic knowledge of relevance to future large scale development of natural antioxidants from seaweeds to the benefit of the food, cosmetic and pharmaceutical industrial sectors. It is clearly demonstrated that it is possible to produce antioxidants from seaweed thallus, and also that it is possible to use alternative environment-friendly extraction methods. In addition, the studies highlight examples of application possibilities of seaweed extracts as natural antioxidants, e.g. in the formulation of functional foods enriched with fish oil.

General information
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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Department of Systems Biology, Metabolomics Platform
Authors: Hermund, D. B. (Intern), Jacobsen, C. (Intern), Nielsen, K. F. (Intern)
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Original language: English
Main Research Area: Technical/natural sciences
Fish oil extracted from fish-fillet by-products is weakly linked to the extraction temperatures but strongly linked to the omega-3 content of the raw material

Rainbow trout (Oncorhynchus mykiss) is the main species produced in Danish fresh water farming. Therefore, a large amount of filleting by-products like heads, bones, and tails (HBT) and intestines are available and can be used to produce high quality fish oil. The main aim in this study was to investigate whether different extraction temperatures (70 and 90°C) during production of crude fish oil from two fractions (HBT and intestines) separately or together affected the quality of the oil. The quality of the oil was measured by determination of peroxide value, anisidine value, volatile oxidation products, % free fatty acids as well as content of omega-3 PUFA. Furthermore, an experiment was carried out to elucidate the effect of extraction temperature on oil produced from raw materials with a different content of omega-3 fatty acids. For this purpose filleting by-products from conventional (low omega-3 PUFA content) and organic (high omega-3 PUFA content) fish farming were used. Findings showed that the natural variation between production days influenced the quality of the produced oil to a high extent. The temperature was found to play a minor role regarding oxidative quality of the produced oil. However, the omega-3 fatty acid content of the raw material influenced the oil quality.
Nannochloropsis salina was grown on a mixture of standard growth media and pre-gasified industrial process water representing effluent from a local biogas plant. The study aimed to investigate the effects of enriched growth media and cultivation time on nutritional composition of Nannochloropsis salina biomass, with a focus on eicosapentaenoic acid (EPA). Variations in fatty acid composition, lipids, protein, amino acids, tocopherols and pigments were studied and results compared to algae cultivated on F/2 media as reference. Mixed growth media and process water enhanced the nutritional quality of Nannochloropsis salina in laboratory scale when compared to algae cultivated in standard F/2 medium. Data from laboratory scale translated to the large scale using a 4000 L flat panel photo-bioreactor system. The algae growth rate in winter conditions in Denmark was slow, but results revealed that large-scale cultivation of Nannochloropsis salina at these conditions could improve the nutritional properties such as EPA, tocopherol, protein and carotenoids compared to laboratory-scale cultivated microalgae. EPA reached 44.2% ± 2.30% of total fatty acids, and α-tocopherol reached 431 ± 28 µg/g of biomass dry weight after 21 days of cultivation. Variations in chemical compositions of Nannochloropsis salina were studied during the course of cultivation. Nannochloropsis salina can be presented as a good candidate for winter time cultivation in Denmark. The resulting biomass is a rich source of EPA and also a good source of protein (amino acids), tocopherols and carotenoids for potential use in aquaculture feed industry.
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.777 SNIP 1.205 CiteScore 3.66
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.781 SNIP 1.356 CiteScore 3.59
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 0.934 SNIP 1.766 CiteScore 4.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.888 SNIP 1.605 CiteScore 4.16
ISI indexed (2012): ISI indexed yes
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Scopus rating (2009): SJR 0.439 SNIP 0.836
Scopus rating (2008): SJR 0.433 SNIP 0.329
Scopus rating (2007): SJR 0.501 SNIP 0.448
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Scopus rating (2005): SJR 0.173 SNIP 0.543

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EPA, Nannochloropsis salina, Industrial process water, Microalgae, Carotenoids, Amino acid, Tocopherol, Large scale, Flat panel photo-bioreactor

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Marine ecosystem connectivity mediated by migrant–resident interactions and the concomitant cross-system flux of lipids

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Publication date: 2016
Main Research Area: Technical/natural sciences
Oxidative Stability and Shelf Life of Food Emulsions

Lipid oxidation and antioxidant effects in food emulsions are influenced by many different factors, such as the composition of the aqueous phase and interface, the partitioning of the antioxidants between the different phases of the emulsion system, the antioxidant properties, and others. This chapter will give an overview of the most important factors influencing lipid oxidation in such systems. This will be followed by a summary of the effects of some of these factors including antioxidant addition in real food emulsions such as mayonnaise, dressing, dairy products, margarine, and spreads.
Oxidative Stability and Shelf Life of Foods Containing Oils and Fats

Oxidative Stability and Shelf Life of Foods Containing Oils and Fats focuses on food stability and shelf life, both important factors in the improvement and development of food products. This book, relevant for professionals in the food and pet food industries, presents an evaluation of methods for studies on the oxidative stability and shelf life of bulk oils/fats, fried oils and foods, food emulsions, dried foods, meat and meat products, and seafood in food and pet food. Focuses on the application of various evaluation methods to studies of oxidative stability and shelf life in oils and fats and oils and fats-containing foods in the food and pet food industries. Discusses oxidative stability and shelf life of low-moisture (dry) food, including dry pet food. Discusses lipid co-oxidation with protein because a number of food products contain both lipids and proteins. Directed mainly toward readers working in the food and pet food industries.

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Oxidative stability during storage of fish oil from filleting by-products of rainbow trout (Oncorhynchus mykiss) is largely independent of the processing and production temperature

Rainbow trout (Oncorhynchus mykiss) is the main fish species produced in Danish fresh water farming. Large amounts of filleting by-products like heads, bones, tails (HBT), and intestines are produced when rainbow trout is processed to smoked rainbow trout filets. The filleting by-products can be used to produce high quality fish oil. In this study, the oxidative stability of fish oil produced from filleting by-products was evaluated. The oil was produced from conventional or organic fish (low and high omega-3 fatty acid content) at different temperatures (70 and 90°C). The oxidative stability of the oil was tested during storage at two different temperatures (20 and 40°C). Results showed that omega-3 content of the fish oil influenced the oxidative stability, whereas the processing temperature during oil production played a minor role.

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Authors: Honold, P. (Intern), Nouard, M. (Intern), Jacobsen, C. (Intern)
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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Oxidative Stability of Granola Bars Enriched with Multilayered Fish Oil Emulsion in the Presence of Novel Brown Seaweed Based Antioxidants

Fucus vesiculosus extracts that have both radical scavenging activity and metal chelating ability in vitro were used as natural antioxidant in granola bars enriched with fish oil emulsion by using primary and secondary emulsion systems stabilized by sodium caseinate alone and sodium caseinate-chitosan. The bars were stored at 20 °C for 10 weeks and evaluated for the development of primary and secondary oxidation products. The samples prepared with secondary emulsion system developed less oxidation products probably due to increased interfacial layer thickness that would act as a barrier to the penetration and diffusion of molecular species that promote oxidation. The positive
charge of oil droplets in the secondary emulsion may also inhibit iron-lipid interaction through electrostatic repulsion. Additional protection against lipid oxidation was obtained when fish oil emulsions were added to the granola bars especially in combination with acetone and ethanol extracts of Fucus vesiculosus.

**General information**

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**Organisations:** National Food Institute, Research Group for Bioactives – Analysis and Application, TÜBİTAK Marmara Research Center, Arla Foods, Matís ltd.

**Authors:** Hermund, D. B. (Intern), Karadağ, A. (Ekstern), Andersen, U. (Ekstern), Jónsdóttir, R. (Ekstern), Kristinsson, H. G. (Ekstern), Alasalvar, C. (Ekstern), Jacobsen, C. (Intern)

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- BFI (2016): BFI-level 2
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
- Web of Science (2016): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 1.236 SNIP 1.253 CiteScore 3.23
- Web of Science (2015): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 1.384 SNIP 1.446 CiteScore 3.1
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 1.408 SNIP 1.392
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 1.317 SNIP 1.303
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 1.361 SNIP 1.324
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.249 SNIP 1.439
- Web of Science (2007): Indexed yes
Oxidative Stability of Nano-Microstructures containing fish oil
Electrohydrodynamic processing is a straightforward and versatile encapsulation technique suitable for the production of nano-microstructures (NMS) (e.g. fibers and capsules) containing bioactive compounds. The process is very gentle and does not require the use of heat, avoiding deterioration of thermolabile active compounds such as fish oil. Moreover, encapsulates produced present a decreased size, which allows their incorporation into food systems without affecting product sensory qualities.

In this work, electrohydrodynamic processing and oxidative stability of NMS containing fish oil were investigated. For that purpose, three different biopolymers namely pullulan, dextran and whey protein concentrate (WPC) were evaluated as encapsulating materials. First, the influence of biopolymer concentration on the physical properties (e.g. viscosity, conductivity and surface tension) of the biopolymer solutions and on the morphology of NMS was assayed. Secondly, the oxidative stability of the biopolymer solutions containing emulsified fish oil during storage (14 days at 40 °C) and of NMS loaded with fish oil (e.g. pullulan fibers and dextran and WPC capsules) was determined. Finally, to improve the oxidative status of the NMS, pullulan fibers, dextran capsules and WPC capsules were produced by adding neat fish oil instead of emulsified fish oil to the biopolymer solutions. These latter NMS presented a higher oxidative stability, which may be due to a better entrapment of the fish oil into biopolymer encapsulates.
Oxidative stability of pullulan nanofibers loaded with fish oil: effect of oil content and antioxidants addition

Electrospinning processing is a promising technique for the encapsulation of thermostable bioactive compounds (e.g. fish oil) since it does not require the use of heat. Furthermore, the nano-microfibers (NMF) obtained present a reduced size, which makes them easier to disperse in food matrices compared to traditional encapsulates (e.g. microcapsules produced by spray-drying). Biopolymers such as proteins and polysaccharides are required for the production of food-grade NMF. In this sense, pullulan, which is a food-approved polysaccharide, is an interesting encapsulating material due to its high electrospinnability and low oxygen permeability.

In light of the above, the aim of this work was to investigate the oxidative stability of omega-3 enriched pullulan NMF. First, the influence of fish oil content (10-20-30 %) on the properties of the electrospinning solutions (e.g. viscosity, conductivity and surface tension) as well as on the morphology of NFM and oxidative stability of NMF during storage (20 days at 20 °C and relative humidity of 33%) was studied. Secondly, the effect on the oxidative stability of the NMS of incorporating hydrophilic antioxidants (e.g. EDTA) to pullulan solutions and/or lipophilic antioxidants (e.g. tocopherols) to fish oil was evaluated. Preliminary results show that neat fish oil can be incorporated into pullulan NMS by adding 30% Tween20 (by weight to respect to fish oil content), leading to NMS not containing antioxidants with a peroxide value lower that 20 meq O2/kg oil at day 0.

Physical and Oxidative Stability of Fish Oil-In-Water Emulsions Stabilized with Fish Protein Hydrolysates

The emulsifying and antioxidant properties of fish protein hydrolysates (FPH) for the physical and oxidative stabilization of 5% (by weight) fish oil-in-water emulsions were investigated. Muscle proteins from sardine (Sardina pilchardus) and small-spotted catshark (Scyliorhinus canicula) were hydrolyzed to degrees of hydrolysis (DH) of 3-4-5-6% with subtilisin. Sardine hydrolysates with low DH, 3% and 4%, presented the most effective peptides to physically stabilize emulsions with smaller droplet size. This implied more protein adsorbed at the interface to act as physical barrier against prooxidants. This fact might also be responsible for the higher oxidative stability of these emulsions, as shown by their lowest peroxide value and concentration of volatiles such as 1-penten-3-one and 1-penten-3-ol. Among the hydrolysates prepared from small-spotted catshark only the hydrolysate with DH 3% yielded a physically stable emulsion with low concentration of unsaturated aldehydes. These results show the potential of FPH as alternative protein emulsifiers for the production of oxidatively stable fish oil-in-water emulsions.
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.85 SJR 1.706 SNIP 2.091
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.597 SNIP 1.962 CiteScore 4.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.595 SNIP 2.027 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.548 SNIP 2.069 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.805 SNIP 2.357 CiteScore 3.98
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.909 SNIP 2.395 CiteScore 4.17
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.965 SNIP 2.261
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.776 SNIP 2.024
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.488 SNIP 1.703
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.467 SNIP 2.095
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.383 SNIP 1.848
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.017 SNIP 1.543
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.057 SNIP 1.449
Scopus rating (2003): SJR 0.893 SNIP 1.258
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.957 SNIP 1.238
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.805 SNIP 0.99
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.728 SNIP 0.979
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.661 SNIP 0.937

Original language: English

Omega-3, Fish protein hydrolysates, Oil-in-water emulsions, Physical stability, Oxidative stability

DOIs:
Potential seaweed-based food ingredients to inhibit lipid oxidation in fish-oil-enriched mayonnaise

Brown seaweed Fucus vesiculosus has a high potential as a source of natural antioxidants due to a high diversity of bioactive compounds in its composition. In this study, four extracts were characterized with respect to composition of bioactive compounds, in vitro antioxidant properties and their partitioning between water and octanol. Additionally, the antioxidant activity of the extracts was evaluated in a fish-oil-enriched mayonnaise. Acetone and ethanol were found to extract the highest amount of phenolic compounds and carotenoids. Water used as extraction solvent, extracted some phenolic compounds but also higher amount of metals and chlorophyll derivates. It was proposed that extracts with high phenolic content and low iron content, such as the acetone and ethanol extract, would have the highest potential as antioxidants in foods. This was confirmed in the storage trial, where these extracts showed higher antioxidant activity.

General information
State: Published
Organisations: National Food Institute, Division of Industrial Food Research, Research Group for Bioactives – Analysis and Application, Matís ltd.
Pages: 571-584
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: European Food Research and Technology
Volume: 242
Issue number: 4
ISSN (Print): 1438-2377
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.742 SNIP 0.882 CiteScore 1.81
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.732 SNIP 0.822 CiteScore 1.55
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.828 SNIP 0.908 CiteScore 1.71
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.791 SNIP 0.901 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.872 SNIP 1.038 CiteScore 1.68
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.009 SNIP 1.097 CiteScore 1.87
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.931 SNIP 0.901
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.917 SNIP 0.845
Macroalgal cultivation is a developing industry in the western part of the world, and in the Faroe Islands experimental cultivation including Alaria esculenta, Laminaria hyperborea and Saccharina latissima, has been carried out since 2005. The cultivation experiments with A. esculenta and S. latissima have shown promising results with regard to growth and yield, but the quality and composition of the cultivated biomass has not been investigated. Protein level and amino acid composition are essential factors when estimating the quality of the produced biomass for food and/or feed, but how does e.g. seasonality, exposure and nutrient levels affect these factors. Current work investigated growth and yield in cultivated S. latissima in a sound in the Faroe Islands, and studied the variation in total Kjeldal nitrogen, nitrate and protein content and changes in amino acid composition with regard to season (spring and summer), and exposure (current exposed, wave exposed and sheltered). To enable comparison we also investigated the variation in total Kjeldal nitrogen, nitrate and protein content and changes in amino acid compositional in wild S. latissima populations. In the cultivated biomass there was a significantly lower yield at the current exposed site (5.2 ± 0.4 kg m⁻¹) compared to the sheltered (9.9 ± 1.3 kg m⁻¹) and the wave exposed (8.0 ± 1.5 kg m⁻¹). The growth rate (SGR) did not differ with regard to exposure, however the weight of the individuals at the current exposed site was significantly higher compared to the individuals at the sheltered and wave exposed sites through out the cultivation period. In both the cultivated biomass and the natural populations a significant seasonal differences was observed in the total Kjeldal nitrogen, nitrate and protein levels and amino acid composition. A significant difference related to exposure degree was observed in total Kjeldal nitrogen and nitrogen, but this was not observed for protein and amino acid composition.

**General information**

State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Fiskaaling/Tari-Faroe Seaweed, Faroese Food- and veterinary agency
Authors: Mols-Mortensen, A. (Ekstern), Ortind, E. (Ekstern), Holdt, S. L. (Intern), Jacobsen, C. (Intern)
Number of pages: 1
Publication date: 2016
Event: Abstract from 22nd International Seaweed Symposium, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

**Bibliographical note**

OR-28-03
Alkyl chain length impacts the antioxidative effect of lipophilized ferulic acid in fish oil enriched milk
Lipophilization of phenolics by esterification with fatty alcohols may alter their localization in an emulsion and thereby their antioxidative efficacy. In this study, synthesized unbranched alkyl ferulates were evaluated as antioxidants in fish oil enriched milk. Lipid oxidation was determined by peroxide values and concentration of volatile oxidation products. A cut-off effect in the antioxidant efficacy in relation to the alkyl chain length was observed. The most efficient alkyl ferulate was methyl ferulate followed by ferulic acid and butyl ferulate, whereas octyl ferulate was prooxidative and the prooxidative effect increased further with an increment in the alkyl chain length from C8 to C12. Further elongation of the alkyl chain length to C16 and C20 resulted in weak prooxidative effects to weak antioxidative effects depending on the different volatile oxidation compounds developed.

General information
State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Centre de cooperation Internationale en Recherche Agronomique pour le Développement
Authors: Sørensen, A. M. (Intern), Lyneborg, K. S. (Intern), Villeneuve, P. (Ekstern), Jacobsen, C. (Intern)
Number of pages: 9
Pages: 190-196
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Functional Foods
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Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.49 SJR 1.178 SNIP 1.255
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.582 CiteScore 4.31
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.305 SNIP 1.652 CiteScore 3.94
Scopus rating (2013): SJR 1.51 SNIP 2.139 CiteScore 5.12
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 1.176 SNIP 1.435 CiteScore 2.91
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 0.957 SNIP 1.389 CiteScore 2.45
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.67 SNIP 0.831
Original language: English
Ferulic acid, Ferulates, Lipid oxidation, Fish oil enrichment, Cut-off effects, Antioxidants
DOIs:
10.1016/j.jff.2014.04.008
Source: Findit
Source-ID: 267088100
Publication: Research - peer-review › Journal article – Annual report year: 2015

Antioxidant Activity of Seaweed Extracts: In Vitro Assays, Evaluation in 5 % Fish Oil-in-Water Emulsions and Characterization
In this study the antioxidant activity of absolute ethanol, 50 % ethanol and water extracts of two species of seaweeds, namely Fucus serratus and Polysiphonia fucoides, were evaluated both in in vitro assays and in 5 % fish oil-in-water (o/w) emulsions. The 50 % ethanolic extracts of P. fucoides showed higher antioxidant activity both in in vitro assays and in 5 % oil-in-water emulsion in the presence or absence of iron. In spite of the higher phenolic content and very good antioxidant activity in some of the in vitro assays, the absolute ethanol extracts of both the species showed a pro-oxidative tendency in 5 % fish oil-in-water emulsion in the presence or absence of iron. In order to investigate the reason for the higher antioxidant activity of 50 % ethanolic extracts of P. fucoides, these extracts were further fractionated into polyphenol-rich,
protein-rich, polysaccharide-rich and low-molecular-weight fractions. These fractions were tested both in in vitro and in 5 % oil-in-water emulsions. The results of the present study showed that the main effect was due to the phenolic compounds. In conclusion, the 50 % ethanolic extracts of P. fucoides can be a potential source of natural antioxidants as these extracts have antioxidant activities similar to those of synthetic antioxidants such as BHT.

General information
State: Published
Organisations: National Food Institute, Division of Industrial Food Research
Authors: Farvin Habebullah, S. (Intern), Jacobsen, C. (Intern)
Number of pages: 17
Pages: 571-587
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the American Oil Chemists' Society
Volume: 92
Issue number: 4
ISSN (Print): 0003-021X
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.64 SJR 0.696 SNIP 0.905
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.682 SNIP 0.997 CiteScore 1.66
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.767 SNIP 1.043 CiteScore 1.68
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.809 SNIP 1.074 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.871 SNIP 1.236 CiteScore 1.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.833 SNIP 1.292 CiteScore 1.98
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.763 SNIP 1.056
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.863 SNIP 1.183
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.667 SNIP 1.037
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.663 SNIP 0.891
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.658 SNIP 0.851
Web of Science (2006): Indexed yes
Antioxidative effect of lipophilized caffeic acid in fish oil enriched mayonnaise and milk

The antioxidative effect of lipophilized caffeic acid was assessed in two different fish oil enriched food products: mayonnaise and milk. In both emulsion systems, caffeic acid esterified with fatty alcohols of different chain lengths (C1–C20) were better antioxidants than the original phenolic compound. The optimal chain length with respect to protection against oxidation was, however, different for the two food systems. Fish oil enriched mayonnaise with caffeates of medium alkyl chain length (butyl, octyl and dodecyl) added resulted in a better oxidative stability than caffeates with shorter (methyl) or longer (octadecyl) alkyl chains. Whereas in fish oil enriched milk emulsions the most effective caffeates were those with shorter alkyl chains (methyl and butyl) rather than the ones with medium and long chains (octyl, dodecyl, hexadecyl and eicosyl). These results demonstrate that there might be an optimum alkyl chain length for each phenolipid in each type of emulsion systems.

General information

State: Published
Organisations: Division of Industrial Food Research, National Food Institute, Centre de cooperation Internationale en Recherche Agronomique pour le Développement, University of Barcelona
Authors: Alemán, M. (Ekstern), Bou, R. (Ekstern), Guardiola, F. (Ekstern), Durand, E. (Ekstern), Villeneuve, P. (Ekstern), Jacobsen, C. (Intern), Sørensen, A. M. (Intern)
Number of pages: 9
Pages: 236-244
Publication date: 2015
Main Research Area: Technical/natural sciences

Publication information
Journal: Food Chemistry
Volume: 167
ISSN (Print): 0308-8146
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.85 SJR 1.706 SNIP 2.091
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.597 SNIP 1.962 CiteScore 4.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
This study aimed at investigating the potential of microalgae species grown on industrial wastewater as a new source of natural antioxidants. Six microalgae from different classes, including Phaeodactylum sp. (Bacillariophyceae), Nannochloropsis sp. (Eustigmatophyceae), Chlorella sp., Dunaliella sp., and Desmodesmus sp. (Chlorophyta), were screened for their antioxidant properties using different in vitro assays. Natural antioxidants, including pigments, phenolics, and tocopherols, were measured in methanolic extracts of microalgae biomass. Highest and lowest concentrations of pigments, phenolic compounds, and tocopherols were found in Desmodesmus sp. and Phaeodactylum tricornutum microalgae species, respectively. The results of each assay were correlated to the content of natural antioxidants in microalgae biomass. Phenolic compounds were found as major contributors to the antioxidant activity in all antioxidant tests while carotenoids were found to contribute to the 1,1-diphenyl-2-picryl-hydrazil (DPPH) radical scavenging activity, ferrous reduction power (FRAP), and ABTS-radical scavenging capacity activity. Desmodesmus sp. biomass represented...
a potentially rich source of natural antioxidants, such as carotenoids (lutein), tocopherols, and phenolic compounds when cultivated on industrial waste water as the main nutrient source.

**General information**
State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Department of Environmental Engineering, Residual Resource Engineering, Kalundborg Municipality
Authors: Safafar, H. (Intern), van Wagenen, J. M. (Intern), Møller, P. (Ekstern), Jacobsen, C. (Intern)
Pages: 7339-7356
Publication date: 2015
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Marine Drugs
Volume: 13
Issue number: 12
ISSN (Print): 1660-3397
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.83 SJR 0.87 SNIP 1.304
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.777 SNIP 1.205 CiteScore 3.66
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 0.781 SNIP 1.356 CiteScore 3.59
Web of Science (2014): Indexed yes
Scopus rating (2013): SJR 0.934 SNIP 1.766 CiteScore 4.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): SJR 0.888 SNIP 1.605 CiteScore 4.16
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): SJR 0.975 SNIP 1.448 CiteScore 4.06
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
Scopus rating (2010): SJR 0.745 SNIP 1.277
Web of Science (2010): Indexed yes
Scopus rating (2009): SJR 0.439 SNIP 0.836
Scopus rating (2008): SJR 0.433 SNIP 0.329
Scopus rating (2007): SJR 0.501 SNIP 0.448
Scopus rating (2006): SJR 0.586 SNIP 0.931
Scopus rating (2005): SJR 0.173 SNIP 0.543
Original language: English
Electronic versions: marinedrugs_13_07069.pdf
DOIs: 10.3390/md13127069
Links: http://www.mdpi.com/1660-3397/13/12/7069
Source: PublicationPreSubmission
Source-ID: 118784864
Publication: Research - peer-review › Journal article – Annual report year: 2015
Characterisation and antioxidant evaluation of Icelandic F. vesiculosus extracts in vitro and in fish-oil-enriched milk and mayonnaise

Bioactive compounds from Fucus vesiculosus were extracted and their antioxidant efficacy in fish-oil-enriched foods was evaluated. Water extract (WE) and ethyl acetate fraction (EAF) were obtained and characterised. Furthermore, WE and EAF were added to fish-oil-enriched milk or mayonnaise. Oxidation during storage was evaluated. EAF showed highest phenolic and pigment contents compared with WE. Antioxidant efficacy was found to be dependent on the concentration in the foods. Furthermore, high antioxidant activity in the foods was related to high radical scavenging, high or moderate metal chelating ability, as well as high phenolic and carotenoid contents.

General information
State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Matís ltd.
Pages: 828-841
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Main Research Area: Technical/natural sciences

Publication information
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Volume: 19
Issue number: Part B
ISSN (Print): 1756-4646
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.49 SJR 1.178 SNIP 1.255
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.34 SNIP 1.582 CiteScore 4.31
Web of Science (2015): Indexed yes
Scopus rating (2014): SJR 1.305 SNIP 1.652 CiteScore 3.94
Scopus rating (2013): SJR 1.51 SNIP 2.139 CiteScore 5.12
ISI indexed (2013): ISI indexed yes
Scopus rating (2012): SJR 1.176 SNIP 1.435 CiteScore 2.91
ISI indexed (2012): ISI indexed yes
Scopus rating (2011): SJR 0.957 SNIP 1.389 CiteScore 2.45
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.67 SNIP 0.831
Original language: English
Brown algae, Phlorotannin, Fortification, Omega-3, Lipid oxidation, Food emulsions
DOIs:
10.1016/j.jff.2015.02.020
Source: FindIt
Source-ID: 2263975311
Publication: Research - peer-review › Journal article – Annual report year: 2015

Determination of toxic elements (Pb, Hg, Cd, As) and fatty acids in muscles and cephalothoraxes in a Mediterranean and a northern rose shrimp: a comparative study of Parapenaeus longirostris and Pandalus borealis

General information
State: Published
Organisations: National Food Institute, Research Group for Nano-Bio Science, Research Group for Bioactives – Analysis and Application, Technical University of Denmark, National Kapodistrian University of Athens
Authors: Soultani, G. (Ekstern), Stathopoulou, E. (Ekstern), Rasmussen, R. R. (Intern), Herbst, B. K. (Intern), Jacobsen, C. (Intern)
Number of pages: 1
Pages: 13-13
Publication date: 2015
Determination of toxic elements (Pb, Hg, Cd, As) and fatty acids in muscles and cephalothoraxes in a Mediterranean and a northern rose shrimp: a comparative study of *Parapenaeus longirostris* and *Pandalus borealis*

General information
State: Published
Organisations: National Food Institute, Research Group for Nano-Bio Science, Research Group for Bioactives – Analysis and Application, Technical University of Denmark, National Kapodistrian University of Athens
Authors: Soultani, G. (Ekstern), Stathopoulou, E. (Ekstern), Rasmussen, R. R. (Intern), Herbst, B. K. (Intern), Jacobsen, C. (Intern)
Number of pages: 1
Publication date: 2015
Event: Poster session presented at CEMEPE - 5th international conference on environmental management, engineering, planning and economics, Athens, Greece.
Main Research Area: Technical/natural sciences
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poster_CEMEPE_2.pdf
Publication: Research - peer-review › Poster – Annual report year: 2015

Emulsifying and antioxidant properties of fish protein hydrolysates obtained from discarded species: evaluation on fish oil-in-water emulsions

General information
State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Research Group for Nano-Bio Science, University of Granada
Authors: García Moreno, P. J. (Intern), Guadix, A. (Ekstern), Guadix, E. M. (Ekstern), Jacobsen, C. (Intern)
Number of pages: 1
Publication date: 2015

Impact of dietary fatty acids on muscle composition, liver lipids, milt composition and sperm performance in European eel

In order for European eel aquaculture to be sustainable, the life cycle should be completed in captivity. Development of broodstock diets may improve the species' reproductive success in captivity, through the production of high-quality gametes. Here, our aim was to evaluate the influence of dietary regime on muscle composition, and liver lipids prior to induced maturation, and the resulting sperm composition and performance. To accomplish this fish were reared on three "enhanced" diets and one commercial diet, each with different levels of fatty acids, arachidonic acid (ARA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). Neutral lipids from the muscle and liver incorporated the majority of the fatty acid profile, while phospholipids incorporated only certain fatty acids. Diet had an effect on the majority of sperm fatty acids, on the total volume of extractable milt, and on the percentage of motile sperm. Here, our results suggest that the total volume of extractable milt is a DHA-dependent process, as we found the diets with the highest DHA
levels induced the most milt while the diet with the lowest DHA level induced the least amount of milt. The diet with the highest level of ARA induced medium milt volumes but had the highest sperm motility. EPA also seems important for sperm quality parameters since diets with higher EPA percentages had a higher volume of milt and higher sperm motility. In conclusion, dietary fatty acids had an influence on fatty acids in the tissues of male eel and this impacted sperm performance.
Isolation of glycoproteins from brown algae.
The present invention relates to a novel process for the isolation of unique anti-oxidative glycoproteins from the pH precipitated fractions of enzymatic extracts of brown algae. Two brown seaweeds viz, Fucus serratus and Fucus vesiculosus were hydrolysed by using 3 enzymes viz, Alcalase, Viscozyme and Termamyl and the glycoproteins were isolated from these enzyme extracts.

General information
State: Published
Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Institute of Food and Dairy Technology
Authors: Surendraraj, A. (Ekstern), Farvin Koduvayur Habeebullah , S. (Ekstern), Jacobsen, C. (Intern)
Publication date: 2015

Publication information
IPC: A23L1/305; A61K38/02; C07K1/36; C12P21/00
Patent number: WO2015004255
Date: 15/01/2015
Priority date: 12/07/2013
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Lipids and Composition of Fatty Acids of Saccharina latissima Cultivated Year-round in Integrated Multi-trophic Aquaculture
This study is evaluating the seasonal lipid and fatty acid composition of the brown seaweed Saccharina latissima. Biomass was sampled throughout the year (bi-monthly) at the commercial cultivation site near a fish farm in an integrated multi-trophic aquaculture (IMTA) and at a reference site in Denmark (2013-2014). Generally, there was no difference in the biomass composition between sites; however, significant seasonal changes were found. The lipid concentration varied from 0.62%-0.88% dry weight (DW) in July to 3.33%-3.35% DW in November (p < 0.05) in both sites. The fatty acid composition in January was significantly different from all the other sampling months. The dissimilarities were mainly explained by changes in the relative abundance of 20:5n-3 (13.12%-33.35%), 14:0 (11.07%-29.37%) and 18:1n-9 (10.15%-16.94%). Polyunsaturated fatty acids (PUFA’s) made up more than half of the fatty acids with a maximum in July (52.3%-54.0% fatty acid methyl esters; FAME). This including the most appreciated health beneficial PUFA’s, eicosapentaenoic (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3), but also arachidonic (ARA) and stearidonic acid (SDA), which are not found in land vegetables such as cabbage and lettuce. Compared to fat (salmon) and lean fish (cod) this seaweed species contains higher proportions of ARA and SDA, but lower EPA (only cod) and DHA.
Conclusively, the season of harvest is important for the choice of lipid quantity and quality, but the marine vegetables provide better sources of EPA, DHA and long-chain (LC)-PUFA’s in general compared to traditional vegetables.

General information
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Organisations: Department of Environmental Engineering, Residual Resource Engineering, National Food Institute, Research Group for Bioactives – Analysis and Application
Authors: Silva Marinho, G. (Intern), Holdt, S. L. (Intern), Jacobsen, C. (Intern), Angelidaki, I. (Intern)
Microalgal bioremediation of nutrients in wastewater and production of food/feed ingredients

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Authors: Safafar, H. (Intern), Møller, P. (Ekstern), Holdt, S. L. (Intern), Jacobsen, C. (Intern)
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New parameters for evaluating the quality of commercial krill oil capsules from the aspect of lipid oxidation and non-enzymatic browning reactions

Classical techniques such as Peroxide Value and Anisidine Value are not useful to evaluate the quality of krill oil. These techniques may underestimate lipid oxidation and other degradative reactions in krill oil. Therefore, the main objective of this study was to evaluate the quality of eight different commercial krill oil capsules through parameters such as: investigation of chemical compositions (bioactive compounds such as phospholipids, n-3 polyunsaturated fatty acids, antioxidants), hydrophobic pyrroles, and volatile profiles (lipid and Strecker-derived volatiles, pyridines, pyrazines, and their alkyl derivatives, sulphur and amino compounds). The data of chemical composition of krill oil were correlated well with those from volatile measurement. Through investigating volatile profile, new insights into the lipid oxidation and non-enzymatic browning reactions in krill oil were obtained, and the quality among different commercial krill oil products was differentiated. Practical applications: Different from fish oil, krill oil has a much more complex matrix. Therefore, classical techniques, which are useful to differentiate the quality of fish oil are not applicable to krill oil. This work provides new parameters to differentiate the quality of krill oil through the measurement of bioactive compounds and hydrophobic pyrroles in krill oil, and investigation of volatile profiles of krill oil from the aspect of lipid oxidation and non-enzymatic browning reactions.

General information

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Authors: Lu, H. F. S. (Intern), Bruheim, I. (Ekstern), Jacobsen, C. (Intern)
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Authors: Safafar, H. (Intern), Jacobsen, C. (Intern), Møller, P. (Ekstern)
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Oxidative stability of electrospun nanofibers loaded with fish oil

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Authors: García Moreno, P. J. (Intern), Boutrup Stephansen, K. (Intern), Guadix, A. (Ekstern), Guadix, E. M. (Ekstern), Chronakis, I. S. (Intern), Jacobsen, C. (Intern)
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Physical and oxidative stability of fish oil-in-water emulsions stabilized with fish protein hydrolysates

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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, University of Granada
Authors: García Moreno, P. J. (Intern), Guadix, A. (Ekstern), Guadix, E. M. (Ekstern), Jacobsen, C. (Intern)
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Production of omega-3 nanodelivery systems by emulsion electrospinning

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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application, Research Group for Nano-Bio Science
Authors: García Moreno, P. J. (Intern), van der Kruijs, J. (Ekstern), Boutrup Stephansen, K. (Intern), Chronakis, I. S. (Intern), Jacobsen, C. (Intern)
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Production of omega-3 rich fish oil from by-products of Danish trout farms

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Organisations: National Food Institute, Research Group for Bioactives – Analysis and Application
Authors: Honold, P. J. (Intern), Nouard, M. (Intern), Jacobsen, C. (Intern)
Some strategies for the stabilization of long chain n-3 PUFA-enriched foods: A review

Oil-in-water (o/w) and water-in-oil (w/o) emulsions are important colloid structures in food products, as many foods exist as emulsions. O/w emulsions, such as milk, mayonnaise, and salad dressing constitute a particularly large—and widely consumed—group of such complex, heterophasic food systems. Lipid oxidation is one of the major quality deteriorating problems in such foods. This is due to the fact that lipid oxidation is an interfacial phenomenon and since emulsions have a large interfacial area they are particularly susceptible to oxidation. Lipid oxidation is induced by transition metals, light, temperature, oxygen, and is also affected by pH, droplet size, and numerous other factors related to the composition of the emulsion. During the last decade, marine polyunsaturated n-3 polyunsaturated fatty acids (PUFA) have increasingly been incorporated into emulsified foods in order to address recent nutritional recommendations. The increased use of n-3 PUFA has resulted in new challenges for the food industry with respect to avoiding lipid oxidation. This review provides an overview of results obtained primarily in the author's own lab on the use of the following different strategies to reduce or inhibit lipid oxidation by: (1) optimizing the processing conditions; (2) utilizing n-3 PUFA delivery systems; and (3) addition of antioxidants.

Practical applications: This review provides an overview of how food producers can inhibit or reduce lipid oxidation in various real foods enriched with n-3 PUFA. Particular emphasis are not only on emulsified foods, such as mayonnaise, dressing, milk, and yoghurt drink, but solid foods, such as energy bars, fish paté, and cakes are also touched upon. For emulsified foods, it is possible to reduce lipid oxidation by optimizing homogenization conditions (pressure and temperature) and the type of homogenization equipment can also affect lipid oxidation. The use of fish-oil-in-water emulsions as an n-3 PUFA delivery system can reduce lipid oxidation in some cases, but the delivery system must be optimized for the food system in question. Finally, lipid oxidation can also be reduced by antioxidants. The review suggests that multi-component antioxidants with multi-function properties in many cases may provide better efficacy than mono-compound antioxidants.
The effect of thermal treatment on the quality changes of Antarctic krill meal during the manufacturing process: High processing temperatures decrease product quality

The quality of krill products is influenced by their manufacturing process and could be evaluated by their degradation products from lipid oxidation and non-enzymatic browning reactions. The main objectives of this study were: (i) to investigate the effect of thermal treatment on these two reactions in krill products during their manufacturing process; and (ii) to understand and postulate the possible mechanisms for non-enzymatic browning reactions in krill products. Characterisation of krill products at different stages was obtained by determination of their lipid composition (lipid classes and phospholipids), antioxidant (α-tocopherol and astaxanthin esters) and volatile profiles (degradation products from lipid
oxidation and Strecker degradation). The use of thermal treatment resulted in lipid oxidation and subsequently led to the development of non-enzymatic browning reactions in krill products during their manufacturing process. It is hypothesized that non-enzymatic browning reactions in krill products might occur through Maillard reaction or lipid peroxidation pathways. Practical applications: The quality of krill products is influenced by the temperature used during their manufacturing process, and the occurrence of their degradative reactions is influenced by the chemical composition and matrix of krill products. This work provides information about the possible mechanisms of the two most commonly found reactions in the food system namely, lipid oxidation and non-enzymatic browning reactions. This information is not only applicable to krill products but also to other food matrices containing lipid, protein, sugar, etc.

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Organisations: Division of Industrial Food Research, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, National Food Institute, Research Group for Bioactives – Analysis and Application, Olympic Seafood AS
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In the present study proteins isolated from herring brine, which is a by-product of marinated herring production were evaluated for their functional properties and antioxidant activity. Herring brine was collected from the local herring industry and proteins were precipitated by adjusting the pH to 4.5 and the obtained supernatant was further fractionated by using ultrafiltration membranes with molecular weight cut offs of 50, 10 and 1kDa. The obtained >50kDa, 50–10kDa, 10–1kDa fractions and pH precipitated fraction were studied for their functional properties and antioxidant activity. Functional properties revealed that >50kDa polypeptides showed good emulsion activity index when compared to the other fractions. However all fractions had low emulsion stability index. The pH precipitated fraction showed the highest foaming capacity and stability at pH 10. The 50–10kDa and 10–1kDa peptide fractions showed good radical scavenging activity and reducing power at a concentration of 0.5mg protein/ml. All the fractions demonstrated low iron chelating activity and did not inhibit oxidation in a soybean phosphatidylcholine liposome model system. However all the fractions were to some extent able to delay iron catalyzed lipid oxidation in 5% fish oil in water emulsions and the 10–50kDa fraction was the best. These results show the potential of proteins and peptide fractions recovered from waste water from the herring industry as source of natural antioxidants for use in food products.
Antioxidant activity of Cod (Gadus morhua) protein hydrolysates: In vitro assays and evaluation in 5% fish oil-in-water emulsion

Cod protein hydrolysates were fractionated according to the molecular mass into three fractions of >5kDa, 3–5kDa and...
Antioxidant properties and efficacies of synthesized alkyl caffeates, ferulates, and coumarates

Caffeic, ferulic, and coumaric acids were lipophilized with saturated fatty alcohols (C1-C20). The antioxidant properties of these hydroxycinnamic acids and their alkyl esters were evaluated in various assays. Furthermore, the antioxidant efficiency of the compounds was evaluated in a simple o/w microemulsion using the conjugated autoxidizable triene (CAT) assay. All evaluated phenolipids had radical scavenging, reducing power, and metal chelating properties. Only caffeic acid and caffeates were able to form a complex with iron via their catechol group in the phenolic ring. In the o/w emulsion, the medium chain phenolipids of the three homologues series were most efficient. The antioxidant properties and efficacies were dependent upon functional groups substituted to the ring structure and were in the following order: caffeic acid and caffeates > ferulic acid and ferulates > coumaric acid and coumarates. Moreover, the results demonstrated that the test system has an impact on the antioxidative properties measured.

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Authors: Sørensen, A. M. (Intern), Durand, E. (Ekstern), Laguerre, M. (Ekstern), Bayrasy, C. (Ekstern), Lecomte, J. (Ekstern), Villeneuve, P. (Ekstern), Jacobsen, C. (Intern)
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Antioxidative properties of some phototropic microalgae grown in waste water

Microalgae can be a new source of oil and protein in the aquaculture industry while their potential as natural sources of antioxidants has gained recent attention. Not only the fatty acid and amino acid composition but also the antioxidative properties of the micro algae biomass is important when selecting the species to be used for fish feed. The present study is part of a project which aims at developing new processing technologies, so that microalgae-biomass can be used as an alternative valuable resource in fish feed. Lipid and protein composition as well as antioxidative properties were used for the screening and selection of the species. In this study, the potential antioxidant activities of 12 micro algal sample from Chlorella, Spirulina, Euglena, Scenedesmus and Haematococcus species grown in waste water in Kalundborg micro algal facilities were evaluated using three antioxidant assays, including the trolox equivalent antioxidant capacity, superoxide anion radical scavenging activity and 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging capacity. Total phenolic contents (Folin-Ciocalteau), tochols (HPLC), carotenoids (HPLC), flavones and ubiquinone (HPLC) contents also were measured. Antioxidant activity in micro algae varied strongly between species.
Development of harvesting and up concentration technologies for microalgae as an ingredient in fish feed

The European Union has recently adopted an ambitious strategy for developing the Bio economy in Europe based on the innovative use of sustainable biological resources to cover the growing demand of the food, energy and industrial sectors. Despite their excellent nutritional quality of digestible protein, LC PUFAs and vitamins/minerals, fish meal and fish oil are limited resources in aquaculture and alternatives are needed to support the fast growing aquaculture demand for high quality fish feed. Microalgae represent an interesting reliable resource of great potential as an alternative to fish meal and fish oil. In applications of algae in fish feed, it is essential to produce a product comparable to fish protein and fish oil both in terms of quality and costs. Downstream processing of microalgae includes harvest, dewatering, cell rupture, fractionation and drying. The dewatering and drying which involve separation of water from the algal suspension, account for the majority of total production costs. This project investigate the effects of harvesting, dewatering, thermal treatments and drying on microalgae biomass composition and quality and suggests a set up suited for the production of algae ingredients for fish feed. Further we evaluate the chemical composition of six different microalgae species including; Nanochloropsis limnethica, Chlorella sorokiniana, Phaeodactylum tinctorum, Dunaliella salina, Nannochloropsis salina and Nannochloropsis occulata.

Development of healthy marine ingredients from waste products from smoked rainbow trout

There is an increasing demand for healthy marine omega-3 oils as well as new functional proteins for human consumption. At the same time there is an increasing demand for fish oil as an ingredient in fish feed due to the growth in production of farmed fish. The aquaculture industry currently uses approx. 850,000 tons of fish oil per year, which is expected to increase significantly in the coming years. The demand for fish oil for human consumption has been estimated to 425,000 tons by 2017. The present production of fish oil from wild fish is 1 mio. tons/year. Due to sustainability issues it is not possible to increase the production of fish oil from wild fish further. A possible source of omega-3 oils for human consumption is waste products from the fish industry. At present only approximately 40 % of the fish is used for human consumption and the rest is turned into waste products. Rainbow trout is the main species produced in Danish fresh water farming. By-products from the filleting process (head, bones, tail and intestine) are at present turned into ensilage and sold to the mink industry with low revenue. The aim of the DANFOMEGA project is therefore to use these waste products for the development of new high quality omega-3 oils and protein products and to evaluate the potential of these ingredients in a number of food applications. One of the challenges when producing and using fish oils is to obtain good sensory properties and high oxidative stability. Therefore, the process for extracting the fish oil as well as the addition of antioxidants to prevent oxidation must be optimized. This presentation will include results from our work on these challenges.
Development of volatile compounds during storage of different skin care products at various conditions

Many skin care products contain various lipids to care and soften the skin. These lipids are either saturated or unsaturated. In the case of even small amounts of unsaturated lipids, these are at risk of oxidizing when exposed to heat, light or other conditions with a pro-oxidative effect. When stored in the homes of consumers skin care products may be exposed to relatively high temperatures and light. Hence, especially skin care products sold in countries with a warm climate can undergo lipid oxidation and develop volatile compounds with off-odours.

This presentation will include results from a storage experiment on three cleansing milks stored between 14 and 84 days, under different conditions. The samples were exposed to heat (20°C, 40°C and 50°C), light (samples at 20°C) and iron (samples at 40°C). Samples were analysed for their development of volatile compounds by dynamic headspace gas chromatography-mass spectrometry and peroxide value, and compared to samples stored at 2°C in the dark. In addition, sensory analyses were carried out to assess the off-odours developed in the samples.

Effect of temperature towards lipid oxidation and non-enzymatic browning reactions in krill oil upon storage

The main objective of this study was to investigate the effect of temperature towards lipid oxidation and non-enzymatic browning reactions in krill oil upon storage. Krill oil was incubated at two different temperatures (20 and 40°C) for 28 or 42 days. The oxidative stability of krill oil was assessed by peroxide value and anisidine value, measurement of lipid derived volatiles, lipid classes and antioxidants. The non-enzymatic browning reactions were assessed through the measurement of pyrroles, free amino acids content and Strecker-derived volatiles. The increase of incubation temperature firstly increased the lipid oxidation in krill oil and subsequently the non-enzymatic browning reactions. The occurrence of these reactions was most likely due to the reaction between α-dicarbonyl or carbonyl compounds with amino acids or ammonia. In addition to tocopherol and astaxanthin esters, the formation of pyrroles might help to protect the krill oil against lipid oxidation. © 2014 Elsevier Ltd. All rights reserved.
Effects of dietary fatty acids on the production and quality of eggs and larvae of Atlantic cod (Gadus morhua L.)

Cultivated Atlantic cod (Gadus morhua) entering their first year of gamete maturation were fed diets with different levels of arachidonic acid (ARA) and eicosapentaenoic acid (EPA) for 6.5 months prior to commencement of spawning. Gravid females were stripped three times: at the beginning, peak and end of spawning. Lipid composition and egg and larval quality of 34 family crosses were investigated. Results indicated that ARA uptake into eggs from broodstock diet was highly efficient achieving proportions of ARA up to 84% higher in eggs than in the diet. EPA was 42–76% higher, and DHA was 155–173% higher in eggs than in diets. Cod fed the diet with the lowest EPA/ARA ratio had the greatest egg production. Eggs from fish on a diet with high ARA level had significantly higher fertilization and hatching success than those fed low levels of ARA. This diet produced on average 71 viable eggs g–1 female compared with 32.5 and 4 eggs in diet B and C, respectively. Furthermore, larval survival until 8 days posthatch was higher in diets with lower ARA levels. The combined results showed that ARA dietary supplementation and low EPA/ARA ratio yielded a greater number of viable larvae kg–1 female.

General information

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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, National Food Institute, Division of Industrial Food Research, Section for Marine Ecology and Oceanography, Section for Marine Living Resources, Fisheries and Oceans Canada
Authors: Røjbek, M. (Intern), Støttrup, J. (Intern), Jacobsen, C. (Intern), Tomkiewicz, J. (Intern), Nielsen, A. (Intern), Trippel, E. (Ekstern)
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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.159 SNIP 1.285 CiteScore 1.8
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Scopus rating (2013): SJR 1.205 SNIP 1.207 CiteScore 2.16
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Scopus rating (2012): SJR 1.343 SNIP 1.158 CiteScore 1.9
ISI indexed (2012): ISI indexed yes
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ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
The objective of this study was to investigate the influence of casein (0.3% w/w) and phospholipid (0.5% w/w) emulsifier combinations on the physical and oxidative stability of 10% fish oil-in-water emulsions at pH 7. For that purpose, three phospholipids were evaluated, namely, lecithin (LC), phosphatidylcholine (PC), and phosphatidylethanolamine (PE). The emulsion stabilized with LC showed the best physical stability having the most negative zeta potential and the lowest mean droplet size. In addition, this emulsion was also the least oxidized in terms of peroxide value and concentration of the volatile oxidation product 1-penten-3-ol. This finding is not explained by the antioxidant activity of LC because it showed similar DPPH scavenging activity and lower metal chelating activity than the other phospholipids. Therefore, these results suggested that other factors such as the combination of casein and lecithin, which could result in a favorable structure and thickness of the interfacial layer, prevented lipid oxidation in this emulsion.
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Influence of dietary lipid and protein sources on the sensory quality of organic rainbow trout (Oncorhynchus mykiss) after ice storage

The influence of dietary protein and lipid sources on the quality of organic rainbow trout (Oncorhynchus mykiss) was studied. The protein and oil sources were fishmeal, fish oil, and organic vegetable protein and oils. Sensory profiling was performed during 3 to 14 days of ice storage along with lipid analyses of the fillet. Overall, the results showed that the sensory characteristics of the trout were affected in different ways during ice storage. The source of lipid seemed to affect the sensory quality at the beginning of the storage period, while the protein source seemed to have a more pronounced impact at the end of the storage period.

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Web of Science (2017): Indexed Yes
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Scopus rating (2016): CiteScore 0.59 SJR 0.268 SNIP 0.582
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.298 SNIP 0.623 CiteScore 0.65
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.275 SNIP 0.632 CiteScore 0.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.281 SNIP 0.558 CiteScore 0.59
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.429 SNIP 0.545 CiteScore 0.64
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.385 SNIP 0.621 CiteScore 0.68
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.282 SNIP 0.34
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.197 SNIP 0
Web of Science (2009): Indexed yes
Lipid oxidation during instrumented dynamic in vitro digestion of marine oil-enriched milk

General information
State: Published
Organisations: National Food Institute, Division of Industrial Food Research
Authors: Meynier, A. (Ekstern), Jacobsen, C. (Intern), Thomsen, B. R. (Intern), Brestaz, P. (Ekstern), Ribourg, L. (Ekstern), Viau, M. (Ekstern), Genot, C. (Ekstern)
Number of pages: 1
Publication date: 2014
Main Research Area: Technical/natural sciences
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Lipid profiling of some autotrophic microalgae grown on waste water

Microalgae can be a new source of lipids for the aquaculture industry. Moreover, their potential as natural sources of antioxidants has gained recent attention. About 40 species of microalgae are used in aquaculture worldwide. A full characterization of lipid components is critical for selecting the most suitable microalgae and downstream processing for food and feed production. The present study is part of a big project funded by GUDP (green development and demonstration program of ministry of agriculture and fisheries of Denmark) which aims at developing new processing technologies, so that microalgae-biomass can be used as an alternative valuable resource in fish feed. In this work, 10 fresh water and marine microalgae from Chlorella, Scenedesmus, Haematococcus, Nannochloropsis, Nannochloropsis and Dunaliella species grown in waste water in Kalundborg micro algal facility were harvested by membrane microfiltration and analyzed for fatty acid (GC), triacylglycerol (HPLC), sterol (GC) and tochol (HPLC) composition and also for amounts of phospholipids. Lipid composition in micro algae varied strongly between species.

General information
State: Published
Organisations: National Food Institute, Division of Industrial Food Research, Ecolipids A/S
Authors: Safafar, H. (Intern), Jacobsen, C. (Intern), Møller, P. (Ekstern)
Number of pages: 1
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Event: Abstract from 2nd International Conference on Algal Biorefinery, Lyngby, Denmark.
Oxidative stability and non-enzymatic browning reactions in Antarctic krill oil (Euphausia superba)

Antarctic krill oil has gained much consideration recently due to its rich content of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in the form of phospholipids and its powerful antioxidant known as astaxanthin. To secure these valuable bioactive nutrients in krill oil, a gentle and immediate on-board processing of freshly captured krill is recommended. Compared to fish oil, krill oil has a more complex matrix, which leads to the formation of additional compounds from non-enzymatic browning reactions. Lipid oxidation occurs through different pathways in krill oil and cannot be detected through classical analytical techniques such as determination of peroxide and anisidine value. Therefore selection of appropriate methods to evaluate the oxidative stability of krill oil is of high importance.

Quality changes in krill and krill products during their manufacturing process: the effect of temperature

The main objective of this study is to a) investigate the effect of temperature towards the non-enzymatic browning reactions and lipid oxidation in krill products sampled at different stages during their manufacturing process. In order to further investigate this, a simple model system comprising amino acids (leucine, isoleucine, valine, methionine and lysine) was prepared with addition of lipid (saturated and α, β-unsaturated aldehydes) or non-enzymatic (Strecker aldehydes and pyrazine) derived volatiles. Therefore, the secondary objective is to investigate if the occurrence of non-enzymatic browning reactions in krill products was due to the presence of carbonyl compounds degraded from lipid oxidation, and if the presence of a high level of non-enzymatic products would affect the formation of pyrroles. Characterisation of krill products sampled at different stages was made by determining the lipid composition, antioxidant content and volatile profile. Non-enzymatic browning development in model system was investigated through the measurement of volatile, pyrroles, free amino acid content and browning development (YI). The use of thermal treatment could cause the development of non-enzymatic browning reactions and lipid oxidation in krill products during their manufacturing process. The occurrence of these reactions could be observed in krill meal and this was ascribed to the presence of carbonyl compounds derived lipid oxidation products. The presence of a high level of non-enzymatic degradation products in krill products could enhance the pyrrolisation.
The degree of lipophilization affects antioxidative efficacy of ferulates in omega-3 enriched milk

Antioxidant Effect of Seaweed Extracts in Vitro and in Food Emulsion Systems Enriched With Fish Oil

A review on broodstock nutrition of marine pelagic spawners: the curious case of the freshwater eels (Anguilla spp.)
the Japanese eel, although high levels of 18:2n-6 in the eggs of farmed eels were not detrimental. The total free amino acid amount and profile of eel eggs appears much different from other marine pelagic spawners. Nutritional intervention to influence egg composition seems feasible, but responsiveness of farmed eels to induced maturation might also require environmental manipulation. The challenge remains to succeed in raising European eel broodstock with formulated feeds and to enable the procurement of viable eggs and larvae, once adequate protocols for induced maturation have been developed.

General information
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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, National Food Institute, Division of Industrial Food Research, Section for Marine Ecology and Oceanography, National Institute of Sciences and Technologies of the Sea, BioMar A/S, Wageningen IMARES, National Institute for Agronomic Research
Authors: Heinsbroek, L. (Ekstern), Støttrup, J. (Intern), Jacobsen, C. (Intern), Corraze, G. (Ekstern), Kraiem, M. (Ekstern), Holst, L. (Ekstern), Tomkiewicz, J. (Intern), Kaushik, S. (Ekstern)
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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.957 SNIP 1.448 CiteScore 1.96
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.005 SNIP 1.216 CiteScore 1.86
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.159 SNIP 1.285 CiteScore 1.8
Web of Science (2014): Indexed yes
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Scopus rating (2013): SJR 1.205 SNIP 1.207 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
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BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.343 SNIP 1.158 CiteScore 1.9
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Scopus rating (2011): SJR 1.216 SNIP 1.654 CiteScore 2.15
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.089 SNIP 1.161
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.894 SNIP 0.916
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.125 SNIP 1.095
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.192 SNIP 1.257
Scopus rating (2006): SJR 1.04 SNIP 1.201
Scopus rating (2005): SJR 1.038 SNIP 0.94
Web of Science (2005): Indexed yes
Caffeates as antioxidants in emulsions and the effect of tocopherols

Lipid oxidation is a major issue in foods containing LC PUFA. To protect these food products antioxidant addition can be a solution. Many food products are emulsions. According to the "polar paradox" hypothesis, polar compounds are more efficient as antioxidants in bulk oil, whereas lipophilic compounds are more efficient antioxidants in emulsions. Lately, extensive work has been performed on phenolipids and their antioxidant efficacy in emulsions. It was found that the "polar paradox" hypothesis was too simple to explain the observed efficacy of the phenolipids. The antioxidant efficacy increased with increasing length of the alkyl chain up to a certain length after which the efficacy decreased. Therefore, a new term, "cut-off effect", was introduced to describe this behavior.

The aim of this study was to evaluate the antioxidative effect of caffeic acid and its ester C1 – C20, caffeates, in two different emulsion systems. In the first system we used stripped fish-rapeseed oil (50:50) and for the second system we used non-stripped fish-rapeseed oil (50:50) and for both systems Tween80 was used as emulsifier. Hence, the first system was without tocopherol and the second system was with tocopherols from the oil. Lipid oxidation was evaluated from three parameters measured over time: peroxide value (PV), secondary volatile oxidation products and tocopherol concentrations. The results demonstrate the efficacy of caffeates in simple emulsions. Furthermore, the two different emulsion systems reveal possible interactions between caffeates and tocopherols in simple emulsions.

Characterization of Oxidative Stability of Fish Oil- and Plant Oil-Enriched Skimmed Milk

The objective of this research was to determine the oxidative stability of fish oil blended with crude plant oils rich in naturally occurring antioxidants, cameline oil and oat oil, respectively, in bulk and after supplementation of 1 wt% of oil blends to skimmed milk emulsions. Ability of crude oat oil and cameline oil to protect fish oil in bulk and as fish oil-enriched skimmed milk emulsions was evaluated. Results of oxidative stability of bulk oils and blends assessed by the Schaal oven weight gain test and by the rancimat method showed significant increase in oxidative stability when oat oil was added to fish oil in only 5 and 10 %, whereas no protective effect of cameline oil was observed when evaluated by these methods. Moreover, fish oil blended with oat oil conferred the lowest PV and lower amounts of volatile compounds during the storage period of 14 days at 4 °C. Surprisingly, skimmed milk supplemented with fish-oat oil blend gave the highest scores for off-flavors in the sensory evaluation, demonstrating that several methods, including sensory analysis, should be combined to illustrate the complete picture of lipid oxidation in emulsions.
Comparison of Three Methods for Extraction of Volatile Lipid Oxidation Products from Food Matrices for GC-MS Analysis
GC based methods are often used for determination of volatile oxidation products such as pentanal and hexanal. Different extraction methods for extracting volatiles before GC analysis can be used, e.g. static headspace, dynamic headspace and solid phase microextraction (SPME). Traditionally, dynamic headspace extraction has been performed manually. Recently, automated dynamic headspace methods have become available. This presentation will summarize the principles of the different extraction methods. Moreover, results from fish oil, oil-in-water emulsion and milk obtained with SPME, manual dynamic headspace or automated dynamic headspace (TDU/DHS) extraction followed by GC-MS analysis will be compared. In all cases, concentrations of volatiles were quantified by calibration curves by addition of selected standards to oil, emulsion or milk. The results show that the linearity of calibration curves differs between the different extraction methods. Furthermore, in some cases the concentrations of volatiles obtained in the samples with the different methods were similar whereas in other cases very different concentrations were obtained. Finally, the findings indicated that when samples contained high concentration of volatiles the use of SPME can be problematic due to the fact that volatiles are competing for space on the SPME fiber. Thereby, the concentration of some volatiles may be under estimated.

General information
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Organisations: National Food Institute, Division of Industrial Food Research, Technical University of Denmark
Authors: Jacobsen, C. (Intern), Yesiltas, B. (Ekstern), Berner, L. (Intern), Thomsen, B. R. (Intern)
Publication date: 2013
Event: Abstract from 27th Nordic Lipidforum Symposium, Helsinki, Finland.
Main Research Area: Technical/natural sciences

Comparison of two methods for extraction of volatiles from marine PL emulsions: Short Communication
The dynamic headspace (DHS) thermal desorption principle using Tenax GR tube, as well as the solid phase micro-extraction (SPME) tool with carboxen/polydimethylsiloxane 50/30 µm CAR/PDMS SPME fiber, both coupled to GC/MS were implemented for the isolation and identification of both lipid and Strecker derived volatiles in marine phospholipids (PL) emulsions. Comparison of volatile extraction efficiency was made between the methods. For marine PL emulsions with a highly complex composition of volatiles headspace, a fiber saturation problem was encountered when using CAR/PDMS-SPME for volatiles analysis. However, the CAR/PDMS-SPME technique was efficient for lipid oxidation analysis in emulsions of less complex headspace. The SPME method extracted volatiles of lower molecular weights more efficient than the DHS method. On the other hand, DHS Tenax GR appeared to be more efficient in extracting volatiles of higher molecular weights and it provided a broader volatile spectrum for marine PL emulsion than the CAR/PDMS-SPME method.

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Authors: Lu, H. F. S. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
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Main Research Area: Technical/natural sciences
Effect of emulsifier type, pH and iron on oxidative stability of 5% fish oil-in-water emulsions

The effect of using different emulsifiers on lipid oxidation in 5% w/w fish oil-in-water emulsions was investigated. Emulsifiers included two of milk protein origin (whey protein isolate (Whey) or sodium caseinate (Cas)), soy lecithin (Lec) or emulsifiers high in milk phospholipid (20 or 75%). Forty different emulsions were produced with the five different emulsifiers. For each emulsifier, emulsions were prepared at two concentrations (0.2 and 0.75 wt%) at pH 3 or 7 and with or without added iron. Emulsions were stored in closed bottles in the dark at RT (20°C) for up to 7 days (with added iron) or 42 days (without added iron). Physical parameters and oxidative stability of the emulsions were investigated by analysis of particle size, zeta potential, primary and secondary oxidation products. Increase in emulsifier concentration generally increased the oxidative stability. Type of emulsifier and physical conditions affected the physical and oxidative stability of the emulsions. A general observation was that emulsions produced with the milk protein based emulsifiers were more oxidatively stable compared with the other emulsions. Practical applications: The overall conclusion from this study was that the oxidative stability of 5% o/w emulsions depended on both emulsifier type, concentration, pH and iron content. An analogous conclusion is most likely also valid in more complex food emulsions with similar or higher lipid contents such as milk drink, dressing, etc. Hence, in such foods the emulsifier and the emulsifier concentration should be carefully chosen in order to minimise lipid oxidation. However, milk protein-based emulsifiers could be a better choice than emulsifiers with higher content of phospholipids independent of emulsifier concentration, pH and iron content.

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Organisations: National Food Institute, Division of Industrial Food Research
Authors: Nielsen, N. S. (Intern), Horn, A. F. (Intern), Jacobsen, C. (Intern)
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
The objective of this study was to investigate the influence of pH on lipid oxidation and protein partitioning in 10% fish oil-in-water emulsions prepared with different whey protein isolates with varying ratios of α-lactalbumin and β-lactoglobulin. Results showed that an increase in pH increased lipid oxidation irrespective of the emulsifier used. At pH 4, lipid oxidation was not affected by the type of whey protein emulsifier used or the partitioning of proteins between the interface and the water phase. However, at pH 7 the emulsifier with the highest concentration of β-lactoglobulin protected more effectively against oxidation during emulsion production, whereas the emulsions with the highest concentration of α-lactalbumin were
most stable to oxidation during storage. These differences were explained by differences in the pressure and adsorption induced unfolding of the individual protein components.

**General information**
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Organisations: National Food Institute, Division of Industrial Food Research
Authors: Horn, A. F. (Intern), Wulff, T. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
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Scopus rating (2016): CiteScore 4.85 SJR 1.706 SNIP 2.091
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.597 SNIP 1.962 CiteScore 4.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.595 SNIP 2.027 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.548 SNIP 2.069 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.805 SNIP 2.357 CiteScore 3.98
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.909 SNIP 2.395 CiteScore 4.17
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.965 SNIP 2.261
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.776 SNIP 2.024
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.488 SNIP 1.703
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.467 SNIP 2.095
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.383 SNIP 1.848
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.017 SNIP 1.543
Effects of organic plant oils and role of oxidation on nutrient utilization in juvenile rainbow trout (Oncorhynchus mykiss)

Producing organic fish diets requires that the use of both fishmeal and fish oil (FO) be minimized and replaced by sustainable, organic sources. The purpose of the present study was to replace FO with organic oils and evaluate the effects on feed intake, feed conversion ratio (FCR), daily specific growth rate (SGR) and nutrient digestibility in diets in which fishmeal protein was partly substituted by organic plant protein concentrates. It is prohibited to add antioxidants to organic oils, and therefore the effects of force-oxidizing the oils (including FO) on feed intake and nutrient digestibility was furthermore examined. Four organic oils with either a relatively high or low content of polyunsaturated fatty acids were considered: linseed oil, rapeseed oil, sunflower oil and grapeseed oil. Substituting FO with organic oils did not affect feed intake (P>0.05), FCR or SGR (P>0.05) despite very different dietary fatty acid profiles. All organic plant oils had a positive effect on apparent lipid digestibility compared with the FO diet (P<0.05), whereas there were no effects on the apparent digestibility of other macronutrients when compared with the FO diet (P>0.05). Organic vegetable oils did not undergo auto-oxidation as opposed to the FO, and the FO diet consequently had a significantly negative effect on the apparent lipid digestibility. Feed intake was not affected by oxidation of any oils. In conclusion, the study demonstrated that it is possible to fully substitute FO with plant-based organic oils without negatively affecting nutrient digestibility and growth performance. Furthermore, plant-based organic oils are less likely to oxidize than FOs, prolonging the shelf life of such organic diets.

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Organizations: National Institute of Aquatic Resources, Section for Aquaculture, National Food Institute, Division of Industrial Food Research, Danish Technological Institute, BioMar A/S
Authors: Lund, I. (Intern), Dalsgaard, A. J. T. (Intern), Jacobsen, C. (Intern), Hansen, J. (Ekstern), Holm, J. (Ekstern), Jokumsen, A. (Intern)
Pages: 394-403
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Main Research Area: Technical/natural sciences

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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.94 SNIP 1.18 CiteScore 1.94
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.076 SNIP 1.124 CiteScore 1.7
Forage fish quality: seasonal lipid dynamics of herring (Clupea harengus L.) and sprat (Sprattus sprattus L.) in the Baltic Sea

This study investigates lipid content and fatty acid composition of two important forage fish, sprat (Sprattus sprattus) and herring (Clupea harengus) in the Baltic Sea ecosystem. Seasonal variation in lipids was studied during three periods following the annual reproductive cycle considering potential differences relating to fish size, sex, and reproductive status. The isopod Saduria entomon, being at times an important prey for predatory fish, was included for comparison. In both sprat and herring, lipid content and absolute contents of essential polyunsaturated fatty acids (PUFAs) varied seasonally with high levels towards the end of the annual zooplankton production cycle, succeeded by a decline. Lipid content and fatty acid composition differed significantly between sprat and herring. Sprat lipid content was higher than herring, increasing with fish size and characterized by large proportions of monounsaturated fatty acids. Herring lipid content was related to the reproductive cycle and proportions of PUFAs were high compared with sprat. Levels of essential PUFAs were high in S. entomon compared with clupeids rendering it a valuable alternative prey species in the Baltic Sea ecosystem. The lipid dynamics of forage fish and benthos, combined with changes in availability and abundance, will affect growth and reproduction of their predators.

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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, National Food Institute, Division of Industrial Food Research
Authors: Røjbek, M. (Intern), Tomkiewicz, J. (Intern), Jacobsen, C. (Intern), Støttrup, J. (Intern)
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
The oxidative stability of 10% fish oil-in-water emulsions was investigated for emulsions prepared under different homogenization conditions. Homogenization was conducted at two different pressures (5 or 22.5 MPa), and at two different temperatures (22 and 72 °C). Milk proteins were used as the emulsifier. Hence, emulsions were prepared with either a combination of α-lactalbumin and β-lactoglobulin or with a combination of sodium caseinate and β-lactoglobulin. Results showed that an increase in pressure increased the oxidative stability of emulsions with caseinate and β-lactoglobulin, whereas it decreased the oxidative stability of emulsions with α-lactalbumin and β-lactoglobulin. For both types of emulsions the partitioning of proteins between the interface and the aqueous phase appeared to be important for the oxidative stability. The effect of pre-heating the aqueous phase with the milk proteins prior to homogenization did not have any clear effect on lipid oxidation in either of the two types of emulsions.
Impact of endogenous canola phenolics on the oxidative stability of oil-in-water emulsions

The aim of this study was to evaluate the antioxidative effect of phenolics naturally present in canola seeds and meal. Individual phenolics were extracted from ground, defatted canola seeds, and meal. Fractionated extracts rich in sinapic acid, sinapine, or canolol as well as a non-fractionated extract were used. These extracts (100 and 350 µM) were evaluated as antioxidants in stripped canola oil-in-water (o/w) emulsion. For comparison, the antioxidative effect of phenolic standards for sinapic acid and sinapine (as sinapine thiocyanate) and butylated hydroxytoluene (BTH) as a positive control were also evaluated. The concentration of lipid hydroperoxides and selected volatiles measured at different time points was used to evaluate the antioxidative effect. Moreover, the properties of extracts and corresponding phenolic standards were evaluated in three different in vitro antioxidant assays. All extracts and standard antioxidants had radical scavenging activity and reducing power. The antioxidant standards and extracts inhibited lipid oxidation in the emulsions compared to no antioxidant added. At 100 µM the effectiveness of the extracts was as follows: sinapine > whole extract > sinapic acid > canolol > Con2 (no antioxidant). At 350 µM the ranking was as follows: canolol ≥ sinapine ≥ whole extract ≥ sinapic acid > Con2. Sinapine and sinapic acid extracts were more efficient antioxidants than the corresponding pure standards. However, the most efficient antioxidant in this study was BHT. The differences in effectiveness may be ascribed to mainly the different chain attached to the phenolic ring, which results in different polarity and thus different location in the emulsions. Practical applications: The result showed stronger antioxidant activity of canola extracts than phenolic standards. Therefore, these canola extracts can be used for protecting canola oil emulsion or other emulsions against lipid oxidation. However, the results indicate that the antioxidant activity of the extracts rich in sinapine and canolol had a concentration-sensitive effect. In order to get the best antioxidative effect, optimization of the concentration to be used for each specific application is necessary.
Antioxidant activity, Canolol, Lipid oxidation, Sinapic acid, Sinapine

Impact of primary amine group from aminophospholipids and amino acids on marine phospholipids stability: Non-enzymatic browning and lipid oxidation

The main objective of this study was to investigate the oxidative stability and non-enzymatic browning reactions of marine PL in the presence or in the absence of primary amine group from aminophospholipids and amino acids. Marine phospholipids liposomal dispersions were prepared from two authentic standards (phosphatidylcholine and phosphatidylethanolamine) and two purified PL from marine sources with and without addition of amino acids (leucine, methionine and lysine). Samples were incubated at 60 °C for 0, 2, 4 and 6 days. Non-enzymatic browning reactions were investigated through measurement of (i) Strecker derived volatiles, (ii) yellowness index (YI), (iii) hydrophobic and (iv) hydrophilic pyrroles content. The oxidative stability of the samples was assessed through measurement of secondary lipid derived volatile oxidation products. The result showed that the presence of PE and amino acids caused the formation of pyrroles, generated Strecker derived volatiles, decreased the YI development and lowered lipid oxidation. The lower
degree of lipid oxidation in liposomal dispersions containing amino acids might be attributed to antioxidative properties of pyrroles or amino acids.

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Organisations: National Food Institute, Division of Industrial Food Research, Spectral Service AG
Authors: Lu, H. F. S. (Intern), Nielsen, N. S. (Intern), Baron, C. P. (Intern), Diehl, B. W. K. (Ekstern), Jacobsen, C. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.597 SNIP 1.962 CiteScore 4.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.595 SNIP 2.027 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.548 SNIP 2.069 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.805 SNIP 2.357 CiteScore 3.98
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BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.909 SNIP 2.395 CiteScore 4.17
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.965 SNIP 2.261
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.776 SNIP 2.024
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.488 SNIP 1.703
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.467 SNIP 2.095
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.383 SNIP 1.848
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.017 SNIP 1.543
Investigation of oxidative degradation and non-enzymatic browning reactions in krill and fish oils

The aim of this research was to investigate the oxidation progress and pathways of krill and fish oil during 21 days of incubation at 40°C. The oxidative stability of the oils was investigated through: (i) classical methods such as peroxide value (PV), anisidine value (AV), thiobarbituric reactive substance (TBARS), conjugated dienes and trienes, and antioxidant content, and (ii) advanced methods such as determination of volatiles content by dynamic headspace (DHS)-GC/MS, lipid classes, and pyrrole content. In addition, the oxidative stability of the oils was evaluated under accelerated oxidation conditions using the Oxipres™ at 90°C. The results from analysis of PV, AV, TBARS, conjugated dienes and trienes, and the antioxidant content suggested that krill oil was more oxidatively stable than fish oil. However, the color or other constituents of the krill oil might affect the result of these classical methods. Nevertheless, the conclusion was supported by the results of the Oxipres™ measurements, which showed that the oxygen consumption was higher for fish oil. Furthermore, the level of most volatile lipid oxidation products was higher for fish oil. The development of Strecker degradation products and pyrroles formed as a result of non-enzymatic browning reactions could only be observed in krill oil. The presence of pyrroles might have contributed to the higher oxidative stability of krill oil. Krill oil also contained a higher level of tocopherol, astaxanthin and phospholipids than fish oil, which could have resulted in better protection against oxidation. The results demonstrated that the classical methods for measuring oxidative deterioration of lipids were not useful for krill oil.

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Web of Science (2017): Indexed yes
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Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Methods to assess secondary volatile lipid oxidation products in complex food matrices

A range of different methods are available to determine secondary volatile lipid oxidation products. These methods include e.g. spectrophotometric determination of anisidine values and TBARS as well as GC based methods for determination of specific volatile oxidation products such as pentanal and hexanal. Different extraction methods for extracting volatiles before GC analysis can be used, e.g static headspace, dynamic headspace and solid phase microextraction. Traditionally, dynamic headspace extraction has been performed manually. However, recently automated dynamic headspace methods have become available. This presentation will briefly discuss advantages and disadvantages of spectrophotometric methods versus GC-based methods. Moreover, the different extraction methods used for GC-based analysis will be discussed and examples on results obtained with SPME, the traditional and the automated dynamic headspace methods
Modification of essential fatty acid composition in broodstock of cultured European eel Anguilla anguilla L.

Farmed eels had lower levels of arachidonic acid (20:4 n-6) (ARA) and higher ratios of eicosapentaenoic acid (20:5 n-3) (EPA):ARA compared to wild European eels collected from the Baltic Sea and southern Norwegian coast. Eels fed a formulated feed (JD) with a distribution of essential fatty acids (EFA) resembling wild European eel were sampled after 0, 5, 10, 14 and 44 weeks of feeding to examine changes in fatty acid composition (FAC) in ovaries, visceral fat and muscle. The results showed a slow but steady incorporation of EFA. Lipids are incorporated in the oocytes early in oogenesis, and the leading cohort of oocytes is rich in lipid droplets before the onset of vitellogenesis. This indicates that feeding with optimized broodstock feeds should start early to allow the incorporation of EFA in the first cohort of oocytes. At least 14 weeks of feeding is required to change lipid EFA in broodstock eel to resemble EFA in the diet or in wild fish. After 44 weeks of feeding, ARA was significantly higher in the neutral lipids of ovaries (1.9%) compared to visceral fat (1.2%) or muscle (1.0%). EPA:ARA ratios decreased two- to threefold in all tissues examined during that time. ARA and docosahexaenoic acid (22:6 n-3) (DHA) had accumulated in ovarian polar lipids.

General information
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Organisations: Section for Coastal Ecology, National Institute of Aquatic Resources, National Food Institute, Section for Population Ecology and Genetics, Division of Industrial Food Research
Authors: Støttrup, J. (Intern), Jacobsen, C. (Intern), Tomkiewicz, J. (Intern), Jarlbæk, H. (Intern)
Pages: 172-185
Publication date: 2013
Main Research Area: Technical/natural sciences
Organic plant ingredients in the diet of Rainbow trout (Oncorhynchus mykiss): Impact on fish muscle composition and oxidative stability

Rainbow trout were fed diets containing either fish meal and fish oil (FM-FO) (control) or diets in which 40% of the fishmeal was substituted with a mixture of ingredients grown organically including plant protein concentrate (PP) in combination with either fish oil (FO) as lipid source, or one of the following organic plant oils; rapeseed (RO), linseed/flaxseed (LO), grape seed (GO), or sunflower (SO). The impact of these substitutions was investigated by measuring fish muscle fatty acid profile as well as oxidative and color stability of the fillet during 14 days ice storage. The inclusion of plant protein concentrate did not affect the fatty acid profile significantly but resulted in a slightly improved oxidative stability of the fish fillets as compared to the control diet. The fatty acid profile of the oil used was in general well reflected in the fish muscle fatty acid profile. Fish fed PP-RO were the most oxidatively stable during ice storage but the omega-3 fatty acid content was reduced by 40% compared to fish fed the FM-FO control diet. Replacing FO by LO was not suitable as it induced oxidation and the fillet contained 40–50% less of long chain omega-3 fatty acids.
Oxidative changes during ice storage of rainbow trout (Oncorhynchus mykiss) fed different ratios of marine and vegetable feed ingredients

Recently fish meal and oil have increasingly been replaced with proteins and oils from vegetable sources in the diets of farmed salmonids, but the consequences for the oxidative stability of the resulting fish products have not been investigated. The aim of the present study was to evaluate the influence of feeding regime on composition of rainbow trout fillets, as well as on lipid and protein oxidation during storage on ice. Rainbow trout were fed six different diets, which differed in their levels of marine oil and proteins vs. vegetable oil and protein. Fish fillets were characterised by measurement of fatty acid and amino acid composition, primary and secondary lipid oxidation products, astaxanthin and tocopherol content. Protein oxidation was assessed by measuring protein carbonyl content, oxidised amino acids, sulfhydryl groups and immuno-blotting against carbonyl groups. Feeding regimes significantly influenced fatty acid composition. Replacement of fish oil with vegetable oil reduced formation of primary oxidation products, but the effect on secondary oxidation products differed between different types of volatiles. The differences in protein and amino acid composition were not significant, and there were no clear effects of diets on protein oxidation, but data indicated that compounds present in the marine ingredients might have had an effect on protein oxidation.

General information
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Organisations: National Food Institute, Division of Industrial Food Research, Val-de-Marne Territorial Division
Authors: Timm Heinrich, M. (Intern), Eymard, S. (Ekstern), Baron, C. P. (Intern), Nielsen, H. H. (Intern), Jacobsen, C. (Intern)
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BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.548 SNIP 2.069 CiteScore 3.87
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Oxidative Stability and Sensory Attributes of Fermented Milk Product Fortified with Fish Oil and Marine Phospholipids

Marine phospholipids (PL) are potential ingredients for food fortification due to its numerous advantages. The main objective of this study was to investigate whether a fermented milk product fortified with a mixture of marine PL and fish oil had better oxidative stability than a fermented milk product fortified with fish oil alone. Fortification of a fermented milk product with marine PL was performed by incorporating 1 % w/w lipids, either in the form of neat oil or in the form of a pre-emulsion. Lipid oxidation was investigated in the neat emulsions and fortified products by the measurements of primary, secondary volatile oxidation products and tocopherol content upon 32 days storage at 2 °C and 28 days storage at 5 °C, respectively. Analyses of particle size distribution, viscosity and microbial growth were also performed. In addition, sensory attributes such as sour, fishy and rancid flavor/odor were evaluated in fortified products by a trained panel. The results obtained showed that incorporation of a mixture of marine PL and fish oil into fermented milk products decreased the oxidative stability and sensory quality of fortified products. The pH-dependent behavior of iron seemed to be the main factor that influenced the lipid oxidation in the marine PL emulsion and fermented milk system. In addition, both oxidative stability and sensory acceptability of fortified products varied depending on the quality of the marine PL used for fortification.

General information
Oxidative stability of krill oil (Euphausia superba)

Krill oil has been reported in many studies to have high oxidative stability when evaluated by peroxide value (PV) and anisidine value (AV). However, recent studies have shown that other compounds than primary and secondary oxidation products are formed when krill oil is exposed to oxidative conditions. These compounds include Strecker degradation compounds and pyrroles. Some of these compounds may have antioxidative effect. Commercial scale processing of krill prior to extraction may affect the oxidative stability of krill oil. Therefore, the main objective of this study was to compare lipid oxidation in krill oil produced in a commercial process and krill oil carefully extracted from frozen krill in the laboratory.

Krill oil was incubated at different temperatures (20, 30 and 40 °C) for 1, 2, 3, 4 and 6 weeks, under conditions of constant stirring while being exposed to air. The oxidative stability of both oils was assessed by simple chemical analyses such as PV, AV, spectrophotometric determination at 400 nm, and also advanced determination methods such as a) measurement of secondary volatile oxidation products and Strecker degradation products by DHS-GC/MS, b) measurement of lipid classes especially phosphatidylcholine and phosphatidylethanolamine, c) measurement of antioxidants level such as tocopherols, rosemary, ascorbyl palmitate and astaxanthin upon storage. In addition, the effect of residues or impurities present in krill oil contributing to its oxidative stability were investigated by d) the determination of amino acids composition and transition metals such as Cu²⁺ and Fe²⁺.

General information

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Phenolic compounds and in vitro antioxidant activity of selected species of seaweeds from Danish coast

Water and ethanolic extracts of 16 species of seaweeds collected along the Danish coasts were screened for antioxidant activities using four in vitro antioxidant assays (2,2-diphenyl-1-picrylhydrazyl radical scavenging activity, reducing power, ferrous ion-chelating and liposome model system). Furthermore their effectiveness in retarding lipid peroxidation in fish oil was evaluated by an accelerated stability test. Significant differences were observed in total and individual phenolic content and the antioxidant activities of seaweed species evaluated. Ethanol was more efficient for polyphenol extraction than water. Polysiphonia fucoides and all the Fucus species tested showed highest radical scavenging activity, reducing power, inhibition of oxidation in liposome model system and in fish oil and were high in phenolic content. These seaweeds could be potential rich sources of natural antioxidants for protection of foods against oxidation. In general, the various antioxidative assays correlated well with the total phenolic content, indicating that algal polyphenols are active components in these extracts. However, in some of the antioxidative assays some species with low total phenolic content also showed good antioxidative effects indicating that some other co-extracted active compounds such as pigments and tocopherols in ethanolic extracts and sulphated polysaccharides, proteins or peptides in water extracts may also contribute to the overall antioxidant properties and this needs further investigation.
Phenolipids as antioxidants in omega-3 enriched food products

Foods containing omega-3 PUFA are highly susceptible to oxidation. This causes formation of undesirable flavors and loss of health-beneficial fatty acids. To protect these food products, antioxidant addition may be a solution. Lately, extensive work has been performed on phenolipids and their efficacy in model emulsion systems. Since the polar paradox hypothesis was a simplified statement of the antioxidant efficacy in emulsions, a new term, “cut-off effect”, was introduced. The cut-off effect describes the efficacy of phenolipids in simple emulsions. However, most food products consist of a complex matrix where several factors may influence the oxidative stability, e.g. type and concentration of emulsifier. Thus, a better understanding of the antioxidative effect of phenolipids in complex foods is of great interest.

The aim of this study was to evaluate the antioxidative effect of caffeic acid and its esters, caffeates, in two different fish-oil-enriched food products: mayonnaise and milk. Lipid oxidation was evaluated from 3 parameters measured over storage time: peroxide value, volatiles and tocopherol concentrations. The results demonstrate the influence of the complex emulsions on the antioxidant efficacy.

Physico-chemical properties, oxidative stability and non-enzymatic browning in marine phospholipid emulsions and their use in food applications

Marine phospholipids (PL) contain a high level of eicosapentaenoic acids (EPA) and docosahexaenoic acids (DHA), which have documented beneficial effect on human health. In addition, marine PL are more advantageous than crude or refined fish oils. Marine PL are more resistant to oxidation, provide better bioavailability and ability to form liposomes. All these unique properties of marine PL make them an attractive choice as ingredients for food fortification. Nowadays, a wide range of food products fortified with n-3 triglycerides (TAG) are available worldwide. However, the feasibility of using marine PL for food fortification has not been explored. The main objective of the present Ph.D. study was to explore the feasibility of using marine PL for food fortification. The secondary objective was to study the physical and oxidative stability of marine PL emulsions while identifying the important factors affecting their stability.

Marine PL contain a high level of phosphatidycholine (PC), which has amphiphilic properties. Therefore it is feasible to prepare marine PL emulsions without addition of other emulsifiers. Emulsions containing solely marine PL with a high physical stability could be prepared by using 2-10 % marine PL. The high physical stability of these emulsions was most likely due to the coexistence of micelles, liposomes and emulsified oil droplets. However, there was a requirement for at least 3 % of marine PL (equivalent to 0.8 - 1.3 % of PC depending on the marine PL sources) to avoid phase separation and to form physically stable emulsions containing both marine PL and fish oil.
Emulsions with high oxidative stability could be prepared by using marine PL of high quality with a high content of PL, cholesterol, antioxidants and a low content of prooxidants such as transition metals and initial hydroperoxides. In addition, the presence of other antioxidative compounds such as residues of free amino acids and pyrroles (formed via nonenzymatic browning reactions) in marine PL most likely have improved the oxidative stability of marine PL emulsions. In addition, hydrolysis of PL in marine PL emulsions was minimal at pH 7. In general, both physical and oxidative stability of marine PL emulsions varied in relation to the chemical composition of the marine PL used for emulsion preparation. Therefore, marine PL were purified through acetone precipitation in order to eliminate the effect of other factors such as the content of TAG, antioxidant or other minor components on lipid oxidation in marine PL. The oxidative stability of emulsions prepared from different levels of purified marine PL was investigated. Results obtained seem to suggest that the oxidative stability of purified marine PL emulsions was greatly improved by the addition of α-tocopherol.

Non-enzymatic browning reactions were observed in marine PL emulsions through the a) measurements of Strecker degradation (SD) products of amino acid residues, and b) measurements of hydrophobic and hydrophilic pyrroles (which are pyrrolisation products of phosphatidylethanolamine (PE) and amino acids), respectively. Several mechanisms were proposed for non-enzymatic browning reactions in marine PL. It is speculated that these reactions might have occurred in marine PL mainly during their manufacturing process due to the interactions between lipid oxidation products with the primary amine groups from PE and residues of amino acids/protein that are present in marine PL. In addition, the content of pyrroles, SD products and the degree of browning in marine PL might be influenced by chemical compositions of marine PL and their manufacturing processes. In order to further investigate if the presence of pyrroles or degradation products of amino acids have any influence on oxidative stability of marine PL, liposomal dispersions were prepared from pure PC and PE compounds and purified marine PL with and without addition of amino acids. The obtained result from this model study confirmed the proposed mechanisms of non-enzymatic browning reactions in marine PL. The presence of PE and amino acids led to formation of pyrroles, generation of SD products and decreases in both browning development and lipid oxidation in liposomal dispersions. The low lipid oxidation in dispersions containing amino acids might be attributed to the antioxidative properties of pyrroles or amino acids. In addition, it is speculated that PE and amino acids pyrrolisation or oxypolymerisation of lipid oxidation products in marine PL might be the cause of browning development.

Incorporation of marine PL into fermented milk product adversely affected the oxidative stability and sensory quality of fortified products despite the use of a low percentage of marine PL in combination with fish oil for fortification. This unexpected result was mainly due to the quality of current marine PL that was used for emulsion preparation and food application. In addition, the oxidative stability and sensory quality of marine PL fortified products varied depending on the quality and source of marine PL used for fortification. Although the attempts to incorporate marine PL into food system did not produce the expected results, the findings from the present Ph.D. study provide food industries and academia with new insights into the oxidative stability of marine PL and further inspirations for improving the quality of current marine PL.

General information
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Authors: Lu, H. F. S. (Intern), Jacobsen, C. (Intern), Baron, C. P. (Intern), Nielsen, N. S. (Intern)
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Physico-chemical properties, oxidative stability and non-enzymatic browning reactions in marine phospholipids emulsions and their applications for food enrichment

Marine phospholipids (PL) are more advantageous than fish oil. They seem to have better bioavailability, better resistance and higher content of eicosapentaenoic acids and docosahexaenoic acids than fish oil. The main objective of this study was to explore the possibilities of using marine PL for food enrichment. The secondary objective was to investigate the different aspects of marine PL emulsions including: physico-chemical properties, oxidative stability and non-enzymatic browning reactions while identifying the important factors affecting their stability. The physical and oxidative stability of marine PL emulsions was significantly influenced by the chemical composition of marine PL used. Emulsions with a high oxidative stability could be obtained when using marine PL of high purity with a high content of PL, cholesterol and α-tocopherol. Non-enzymatic browning reactions (Strecker degradation and pyrrolization) seemed to influence the oxidative...
stability of marine PL emulsions. Similar to marine PL emulsions, the oxidative stability and sensory acceptability of marine PL enriched products varied depending on the quality and chemical composition of marine PL used. Overall, this study provided new insights into the oxidative stability of marine PL and preliminary knowledge on the quality of marine PL fortified foods.

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Recent advances in the field of omega-3-lipids
During the last 15-20 years the use of fish and algae oils for human applications has received increasing attention from academia, industry and consumers. This is due to the fact that a growing body of evidence supports that marine omega-3 lipids have a wide range of health beneficial effects, and at the same time the intake of these healthy lipids is far below the recommendable level in many parts of the world. This presentation will provide a brief overview of recent advances in the body of knowledge about the health benefits of omega-3 lipids.
For many years fish oil produced from wild fish has been the most important source of marine omega-3 fatty acids. However, the production of fish oil has been stable during the last decade. Therefore, to meet the increased demand for omega-3 lipids new sources are available. The presentation will discuss possible future sources of omega-3 lipids for human consumption.

Due to their polyunsaturated nature omega-3 lipids are highly susceptible to lipid oxidation. The last part of the presentation will discuss possible means to prevent or reduce lipid oxidation in omega-3 lipids in dietary supplements and in foods enriched with these healthy lipids. Possible means to prevent oxidation include antioxidant addition, optimisation of food processing conditions and the use of delivery systems for omega-3 lipids (e.g. emulsions and microencapsulated omega-3 powders).

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Organisations: National Food Institute, Division of Industrial Food Research
Authors: Jacobsen, C. (Intern)
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Retardation Of Lipid Oxidation In Fish Oil-Enriched Fish Pâté- Combination Effects
The oxidative stability during storage of fish pâté made from cod and enriched with 5% oil was investigated. Pâtés were produced with neat fish oil, pre-emulsified fish oil, microencapsulated fish oil, inert medium chain triacylglycerol (MCT) oil or a fish/rapeseed oil mixture. Addition of fish oil decreased the oxidative stability. Fish pâté with microencapsulated fish oil or MCT oil did not oxidize, whereas oxidation was slower in fish pâté with pre-emulsified oil compared with fish pâté with neat oil. Packaging in vacuum did not decrease oxidation. Fish pâtés with emulsified oil stored at 2 or 10°C were equally stable. Mixing fish oil with rapeseed oil before emulsification slightly increased the stability of the fish pâtés. Addition of antimicrobial agents, sodium benzoate and potassium sorbate increased oxidative stability. It is recommended to produce enriched fish pâté by adding pre-emulsified fish oil or microencapsulated fish oil and store at preferentially 2-10°C. Practical Applications: The results from this study can directly be transferred to practical applications in the food industry. Thus, the study showed that fish oil-enriched fish pâté with an acceptable shelf life and good sensory properties can be produced if one or more of the following strategies are used: Use microencapsulated or pre-emulsified fish oil or pre-emulsified fish oil/rapeseed oil mixture as the fish oil delivery system and add antimicrobial agents to increase both microbial and oxidative stability. The fish pâté can be stored at temperatures up to 10°C. © 2011 Wiley Periodicals, Inc.
Role of hydrophobicity on antioxidant activity in lipid dispersions, From the polar paradox to the cut-off theory

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Organisations: National Food Institute, Division of Industrial Food Research, University of Massachusetts, Centre de cooperation Internationale en Recherche Agronomique pour le Développement
Authors: Laguerre, M. (Ekstern), Sørensen, A. M. (Intern), Bayrasy, C. (Ekstern), Lecomte, J. (Ekstern), Jacobsen, C. (Ekstern), Decker, E. A. (Ekstern), Villeneuve, P. (Ekstern)
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Chapter: 8
Main Research Area: Technical/natural sciences

Ultra structure of oil-in-water emulsions - a comparison of different microscopy- and preparation methods

We compare chemical fixation/ room temperature embedding in resin, cryofixation/ freeze substitution, and cryofixation/cryo imaging (freeze-fracture cryo-SEM) on several oil-in-water food emulsions. This is for visualization of the structure and thickness of the emulsifying layers consisting of food grade emulsifiers such as whey protein, sodium caseinate and milk phospholipids; layers that are expected to be in the range of only a few nm. Furthermore, the liquid nature and high water content of the samples further complicates the preparation process; especially since water is a major component of the samples. Concerning chemical fixation we adapted conventional protocols for preserving the emulsions by developing agar pockets for encapsulation or embedding in capillary tubes. Indeed, to use chemical fixation with these samples is challenging because we need to minimize alterations of the samples while ensuring at the same time that the samples are stabilized so they do not collapse when the water is removed. These protocols give an interesting view of the emulsions and the organisation of the interface layer surrounding the oil droplets. With cryofixation we could image more details of this interface and even the protein in the water phase. We observed that freeze substituted material seems to correspond very well to images of freeze fractured frozen samples in cryo-SEM where protein aggregates seems to be visible in the water phase.

With this work, we want to demonstrate the importance of combining different microscopic approaches to access the ultra structure of the oil-in-water emulsions due to their complexity and instability.

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Organisations: Center for Electron Nanoscopy, Department of Mechanical Engineering, Materials and Surface Engineering, National Food Institute, Division of Industrial Food Research, Université de Lausanne
Authors: Jensen, L. H. S. (Intern), Loussert, C. (Ekstern), Humbel, B. (Ekstern), Horn, A. F. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern), Horsewell, A. (Intern)
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Main Research Area: Technical/natural sciences

Ultra structure of oil-in-water emulsions - a comparison of different microscopy- and preparation methods

General information
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Organisations: Center for Electron Nanoscopy, National Food Institute, Division of Industrial Food Research, Department of Mechanical Engineering, Materials and Surface Engineering, Université de Lausanne
Activity of caffeic acid in different fish lipid matrices: A review

Caffeic acid, a hydroxybenzene acid commonly found in various vegetable sources, has been employed as a natural antioxidant for inhibiting oxidation of fish lipids present in different food matrices. The aim of this review is to discuss the mechanisms involved in the antioxidative and prooxidative effects of caffeic acid found in different model systems containing fish lipids. These model systems include bulk fish oils, liposomes from cod roe phospholipids, fish oil emulsions, washed cod mince, regular horse mackerel mince and a fish oil fortified fitness bar. The data reported show that the antioxidant activity depends on the physical state of the lipids and the composition of the intrinsic matrix in which they are situated. Caffeic acid significantly prevented rancidity in both unwashed and washed fish mince, the latter which was fortified with haemoglobin. In the unwashed mince, the activity was however clearly dependent on the lipid to antioxidant ratio. In these systems, an important redox cycle between caffeic acid and the endogenous reducing agents ascorbic acid and tocopherol were further thought to play an important role for the protective effects. The effect of caffeic acid was also highly dependent on the storage temperature, showing higher effectiveness above than below 0°C. Caffeic acid was not able to inhibit oxidation of bulk fish oils, fish oil in water emulsions and the fish-oil enriched fitness bar. In the liposome system, caffeic acid inhibited haemoglobin (Hb)-promoted oxidation but strongly mediated Fe2+ mediated oxidation. In conclusion, caffeic acid can significantly prevent Hb-mediated oxidation in fish muscle foods but its activity in food emulsions and liposomes is highly dependent on the pH, the emulsifier used and the prooxidants present.

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Organisations: National Food Institute, CSIC Instituto de Investigaciones Marín, Chalmers University of Technology, SINTEF, Norwegian University of Science and Technology
Authors: Medina, I. (Ekstern), Undeland, I. (Ekstern), Larsson, K. (Ekstern), Storrø, I. (Ekstern), Rustad, T. (Ekstern), Jacobsen, C. (Intern), Kristinová, V. (Ekstern), Gallardo, J. M. (Ekstern)
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Addition of Fish Oil to Cream Cheese Affects Lipid Oxidation, Sensory Stability and Microstructure

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Antioxidant effect of seaweed extracts in food emulsion systems enriched with fish oil

Natural antioxidants derived from marine algae have a high content of bioactive components with potential for improving oxidative stability of lipids in food systems. In this presentation we will discuss results from our ongoing work on the brown algae *Fucus vesiculosus*. This seaweed contains a wide range of polyphenols with potential antioxidant activity. Thus, in vitro antioxidant properties of *F. vesiculosus* extracts have been found to be related to the total polyphenolic content. It has been suggested that the primary antioxidant activity comes from secondary metabolites such as phlorotannins, a dominant polyphenolic compound. However, studies on the effectiveness of seaweed extracts in food model systems are sparse, therefore there is a need to look further into this area. Results obtained in our lab with different extracts of *F. Vesiculosus* in a range of different food models will be presented.

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Antioxidative effect of seaweed extracts in 5% fish oil-in-water emulsion

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Authors: Farvin, S. (Intern), Jacobsen, C. (Intern)
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Composition and health benefits of potato peels

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Organisations: National Food Institute, Division of Industrial Food Research
Authors: Farvin, S. (Intern), Surendraraj, A. (Ekstern), Jacobsen, C. (Intern)
Publication date: 2012
Effect of Replacement of Marine Ingredients with Vegetable Oil and Protein on Oxidative Changes during Ice Storage of Rainbow Trout (Oncorhynchus mykiss)

Recently, fish meal and fish oil have increasingly been replaced with proteins and oils from vegetable sources in the diets of farmed salmonids, but the consequences for the oxidative stability of the resulting fish products have only been investigated to a limited extent. This presentation will discuss results from two recent studies from our laboratory on this topic. In the first study, rainbow trout were fed six different diets, which differed in the ratio between marine oil and proteins vs. vegetable oil and protein. Rapeseed oil was used as the oil source and the vegetable proteins were a mix based on pea, wheat, sunflower and beans. In the second study, one group of rainbow trout was fed a traditional diet based on fish meal and fish oil, whereas the other five groups were fed diets in which 40% of the fish meal was replaced with plant proteins from peas, horse bean and rapeseed. The oil source was either fish oil, linseed oil, sunflower oil, rapeseed oil or grapeseed oil. Rainbow trout was stored on ice for up to 14 days. In both studies, the effect of the feeding regime on the fatty acid composition and lipid oxidation in the fish fillet was determined. In the first study, the effect of the diet on protein oxidation in fish fillets was also determined. In both studies, feeding regimes significantly influenced fatty acid composition. Moreover concentration of primary oxidation products at the end of the storage period was highest in fish fed lipids with the highest unsaturation index and lowest in fish fed with lipids with low unsaturation index. The effect of the diet on secondary oxidation products differed between different types of volatiles. There were no clear effects of diets on protein oxidation, but data indicated that compounds present in the marine ingredients might have had an effect on protein oxidation.

Emulsification technique affects oxidative stability of fish oil-in-water emulsions

In oil-in-water emulsions, lipid oxidation is expected to be initiated at the oil-water interface. The properties of the emulsifier used, and the structure at the interface is therefore expected to be of great importance for lipid oxidation in emulsions. Previous studies have shown that e.g. homogenization pressure can affect how proteins locate themselves at the interface of an emulsion. The hypothesis is therefore that emulsions produced with different emulsification equipments differ in their oxidative stability due to differences in the behaviour of the proteins at the interface.

The aim of this study was to compare lipid oxidation in 10% fish oil-in-water emulsions prepared by two different kinds of high pressure homogenizers i.e. a microfluidizer and a two valve high pressure homogenizer. Emulsions were made with equal droplet sizes, and with either 1% sodium caseinate or 1% whey protein isolate. Emulsions were characterised and investigated by microscopy. Lipid oxidation was assessed by PV and the formation of secondary volatile oxidation products. Results showed that the different emulsification techniques had an influence on lipid oxidation and that the effect of the emulsification technique depended on the type of protein used as an emulsifier.
Factors affecting the oxidative stability of omega-3 emulsions prepared with milk proteins

Omega-3 fatty acids are prone to lipid oxidation due to their unsaturated nature. In oil-in-water emulsions, lipid oxidation is expected to be initiated at the oil-water interface. The properties of the emulsifier used and the structure at the interface are therefore expected to be of great importance for the resulting oxidation.

This presentation will give an overview of parameters that are expected to change the properties and structure of milk protein components at the interface of 10% fish oil-in-water emulsions. Results from three different studies will be included. The first study compared the effect of two different high pressure homogenizers on oxidation in caseinate and whey protein isolate emulsions. The second study evaluated the effect of homogenization pressure and temperature on emulsions prepared either with whey proteins or a combination of caseinate and β-lactoglobulin. Finally, the third study investigated the influence of pH on emulsions prepared with α-lactalbumin, β-lactoglobulin or a combination of the two. In all three studies the adsorption of individual protein components were shown to be of great importance to lipid oxidation. Thus, the effect of various conditions for emulsion production will be discussed in relation to protein adsorption and their structure at the interface.

Factors Influencing the Effect of Milk-based Emulsifiers on Lipid Oxidation in Omega-3 Emulsions

Intake of fish oil, and in particular the long chained polyunsaturated omega-3 fatty acids, has over the last centuries been associated with a wide range of health beneficial effects. Nevertheless, the intake of these healthy lipids is still lower than recommended in most Western populations. An interest in omega-3 enriched foods has therefore developed. The challenge when the polyunsaturated omega-3 fatty acids are added to foods is their sensitivity towards heating, metal ions and oxygen, as these factors can lead to lipid oxidation. To avoid this, a possible approach is to incorporate and thereby protect the fatty acids in an emulsion before they are added to the food product. However, the use of these so-called delivery emulsions in different food products has shown contradictory results.

On this background, the overall goal of the present PhD work was to increase our knowledge about factors related to the choice of emulsifier, homogenization equipment and emulsification conditions that could influence lipid oxidation in simple fish oil-in-water emulsion systems. The main focus was on the use of milk proteins alone or in combination with phospholipids as emulsifiers. In addition, the aim was to utilize this knowledge for designing delivery emulsions for the addition of fish oil to foods, and thereby achieve oxidatively stable fish oil enriched products. In simple emulsions, sodium caseinate, whey protein isolate, soy lecithin and combinations of milk proteins and milk phospholipids were investigated as emulsifiers in both 5% and 70% fish oil-in-water emulsions. The effects of the individual emulsifiers were evaluated at different pH values, emulsifier concentrations and with or without the addition of iron. Generally, protein stabilized 5% oil-in-water emulsions were more oxidatively stable at low pH than at neutral pH, whereas the opposite was observed for 70% oil-in-water emulsions. It was shown that emulsions prepared with the highly flexible milk protein casein were the least oxidized at the varying conditions, followed by emulsions with whey protein isolate. The use of soy lecithin or a combination of milk protein and milk phospholipids as emulsifier in these 5% and 70% emulsions was shown only to be advantageous in 70% emulsions at low pH. Moreover, a good quality of the emulsifier was shown to be crucial for obtaining a better oxidative stability of emulsions prepared with phospholipids than with milk proteins.
proteins. The oxidative stability of 10% oil-in-water emulsions prepared with varying ratios of individual whey protein components, α-lactalbumin and β-lactoglobulin, was furthermore investigated at different pH values. Similarly to the 5% emulsions, the oxidative stability of these 10% emulsions was better at low pH than at neutral pH, independent of the type of emulsifier. No difference was observed in the antioxidative effect of the whey protein components when emulsions were prepared at pH 4. Nevertheless, at neutral pH the highest antioxidative effect during the emulsification process was achieved when using the emulsifier with the highest concentration of β-lactoglobulin, whereas during storage the best oxidative stability was observed in the emulsions with the highest concentration of α-lactalbumin. These differences were ascribed to the partitioning of α-lactalbumin and β-lactoglobulin between the interface and the aqueous phase in the emulsion.

It was demonstrated that the use of different high pressure homogenizers influenced lipid oxidation in emulsions prepared with whey protein isolate as emulsifier, but not emulsions prepared with sodium caseinate. Moreover, it was shown that the applied pressure during high pressure homogenization influenced the resulting oxidative stability of the emulsion dependent on the emulsifier used. Overall, it was concluded, that the partitioning of proteins between the interface and the aqueous phase, and the composition of protein components at the interfacial layer played an important role for the oxidative stability of emulsions prepared on different equipments and under various conditions.

In two case studies, fish oil-in-water emulsions prepared with different milk-based emulsifiers were used as delivery emulsions in milk and cream cheese. Unexpectedly, results showed that a better oxidative stability was achieved when the fish oil was added as neat oil to the milk than as a 10% delivery emulsion. Furthermore, no difference was observed on the oxidative status of the milks dependent on the type of emulsifier used for preparing the delivery emulsions. Independent of the introduction method of fish oil to cream cheese (neat oil vs a 70% delivery emulsion), the fish oil enriched cream cheese oxidized during a 20 weeks storage period to a degree where the sensory quality of the product was significantly impacted. However, in contrast to the fish oil enriched milks, differences in the oxidative stability were observed between cream cheeses containing delivery emulsions prepared with different emulsifiers. The use of a combination of milk proteins and milk phospholipids for preparing the delivery emulsion was shown to change the macrostructure of the cream cheese. Furthermore, this cream cheese was less oxidized than the cream cheeses added delivery emulsions with whey protein isolate or sodium caseinate but similarly oxidized as the cream cheese added neat fish oil. Interestingly, the use of sodium caseinate as emulsifier in the delivery emulsions was shown to result in the least oxidatively stable fish oil enriched cream cheese.

Overall, this PhD work showed that factors related to both the choice of emulsifier, homogenization equipment and emulsification conditions influence the oxidative stability of simple fish oil-in-water emulsions. These factors include the oil concentration, the type of milk protein or phospholipid used as emulsifier, the pH, the addition of iron, preheating of the protein prior to homogenization, the equipment used for homogenization and the pressure applied during high pressure homogenization. In addition, lipid oxidation in simple fish oil-in-water emulsions was shown to depend on combinations of these factors, and not any one of them alone. Moreover, it was shown that despite an attempt to optimize the above-mentioned and thereby create an oxidatively stable fish oil-in-water delivery emulsion, this was not enough to ensure a protection of the fish oil when the delivery emulsion was added to milk or cream cheese.
Individual whey protein components influence lipid oxidation dependent on pH

In emulsions, lipid oxidation is expected to be initiated at the oil-water interface. The properties of the emulsifier used and the composition at the interface is therefore expected to be of great importance for the resulting oxidation. Previous studies have shown that individual whey protein components (α-lactalbumin and β-lactoglobulin) adsorb differently to the interface depending on pH. In addition, differences have been shown to exist between the oxidative stability provided by α-lactalbumin and β-lactoglobulin. The hypothesis is that pH influences the oxidative stability of emulsions by affecting the preferential adsorption of whey protein components at the interface.

The aim of the study was to compare lipid oxidation in 10% fish oil-in-water emulsions prepared with 1% whey protein having either a high concentration of α-lactalbumin, a high concentration of β-lactoglobulin or equal amounts of the two. Emulsions were prepared at pH4 and pH7. Emulsions were characterized by their droplet sizes, viscosities, and contents of proteins in the water phase. Lipid oxidation was assessed by PV and secondary volatile oxidation products. Results showed that pH greatly influenced the oxidative stability of emulsions. At high pH β-lactoglobulin emulsions were more stable than α-lactalbumin emulsions, whereas at low pH the opposite was the case.

Investigation of lipid oxidation and non-enzymatic browning reactions in marine PL emulsions

Marine phospholipids (PL) have received much attention recently due to their numerous advantages. One of these advantages is their better resistance towards oxidation as compared to fish oil. In addition to the antioxidative properties of α-tocopherol and phospholipids, the better oxidative stability of marine PL might be attributed to antioxidative properties of pyrroles formed between oxidised lipids with amine groups from phosphatidylethanolamine (PE) or residues amino acids that are present in marine PL. The main objective of this study was to investigate if the presence of amine group from PE or amino acids affected the oxidative stability of purified marine PL emulsions. The secondary objective was to study the non-enzymatic browning reactions in the emulsions which included both Strecker degradation (SD) and pyrroles formation. Emulsions were prepared with and without addition of amino acids (leucine, methionine and lysine) from 2 authentic standards (PC and PE) and 2 purified marine PL (LC and MPL) through sonication method. Emulsions were incubated at 60 °C for 0, 2, 4 and 6 days. Non-enzymatic browning reactions were investigated through measurement of i) Strecker aldehydes, ii) yellowness index (YI), iii) hydrophobic and hydrophilic pyrroles content. On the other hand, the oxidative...
stability of emulsion was measured through secondary lipid derived volatiles. The result showed that the presence of PE and amino acids caused the formation of pyrroles, generated the Strecker aldehydes, decreased the YI development and lowered the lipid oxidation. The lower lipid oxidation in emulsions containing amino acids might be attributed to antioxidative properties of pyrroles or amino acids.

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Organisations: National Food Institute, Division of Industrial Food Research, National Food Institute
Authors: Lu, H. F. S. (Intern), Nielsen, N. S. (Intern), Baron, C. P. (Intern), Bernd, D. (Ekstern), Jacobsen, C. (Intern)
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Main Research Area: Technical/natural sciences

**Iron-mediated lipid oxidation in 70% fish oil-in-ater emulsions: effect of emulsifier type and pH**
The objective of this study was to investigate the protective effect of five different emulsifiers on iron-mediated lipid oxidation in 70% fish oil-in-water emulsions. The emulsifiers were either based on protein (whey protein isolate and sodium caseinate) or based on phospholipid (soy lecithin and two milk phospholipids with different phospholipid contents, MPL20 and MPL75). Lipid oxidation was studied at pH 4.5 and 7.0, and results were compared to lipid oxidation in neat fish oil. Results showed that all emulsions oxidised more than neat oil. Furthermore, emulsions prepared with proteins oxidised more at low pH than at high pH, and casein emulsions oxidised the least (Peroxide value (PV) at day 7 was 0.5–0.7 meq kg⁻¹). Among emulsions prepared with phospholipids, emulsions with MPL75 were the most oxidised followed by emulsions prepared with lecithin and MPL20. Thus, PV in MPL75 emulsions was 5.0–5.5 meq kg⁻¹ at day 7 compared with 0.9–1.9 meq kg⁻¹ in MPL20 emulsions.

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Is Solid Phase Microextraction (SPME) an appropriate method for extraction of volatile oxidation products from complex food systems.

Volatile secondary lipid oxidation products can be identified and quantified by GC-FID or GC-MS. An extraction step is, however, needed before GC analysis. A range of different extraction methods are available such as static headspace, dynamic headspace and SPME. Each of these methods has its advantages and drawbacks. Among the advantages of the SPME method are its high sensitivity compared to static headspace and that it is less laborious than the dynamic headspace method. For these reasons, the use of SPME has increased in both academia and industry during the last decade.

The extraction efficiency obtained with the SPME method can be affected by different factors such as fiber type, stirring of sample versus not stirring, extraction temperature and time. These factors can easily be controlled and optimized to obtain the highest possible extraction efficiency. However, extraction efficiency can also be affected by uncontrollable factors such as batch to batch variation between fibers of the same type and presence of compounds in the sample matrix, which competes with the compounds of interest for adsorption to the SPME fiber. The latter factor is particularly a problem when SPME is used for analysis of lipid oxidation during storage of complex food matrices. Examples on how uncontrollable factors have affected results obtained with the SPME method in the authors' lab will be given and the appropriateness of the SPME method for the analysis of volatile oxidation products in selected food systems will be discussed.

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Linking lipid dynamics with the reproductive cycle in Baltic cod Gadus morhua
This study describes lipid composition and antioxidants of Baltic cod Gadus morhua L. during the reproductive cycle, and investigates whether they reflect its dominant prey and whether levels of fatty acids important for reproductive performance were low. Reasons for a shift in peak spawning time of Baltic cod from spring/early summer to midsummer since the early 1990s remain unresolved and may partly be diet related. This study demonstrated that a substantial amount of lipid was invested in cod ovarian development, and that lipid composition varied substantially with the reproductive cycle. Selective retention of the essential fatty acids docosahexaenoic acid (DHA) and arachidonic acid (ARA) in ovaries during maturation was evident, but despite mobilization from the liver, ARA levels were low in ovaries during late maturation and spawning. Astaxanthin and a-tocopherol accumulated in cod ovaries and decreased in late maturing and spawning fish, most likely due to their antioxidant protection activity. The fatty acid composition of cod liver reflected its clupeid prey. The ratio of 18:1n-9 to DHA was almost twice as high in sprat as in herring and indicated the ratio of sprat and herring in cod diet, while the level of 16:1n-7 and astaxanthin indicated the presence of the isopod Saduria entomon in cod diet. It is likely that food web alterations in the Baltic ecosystem related to environmental and hydrographic changes caused a decrease in ARA availability. Low ARA content coincides with cod ovarian development in the central Baltic Sea, and may be associated with the delay in spawning and affect egg and larval survival; however, this needs further verification in experimental studies.

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Organisations: National Institute of Aquatic Resources, Section for Coastal Ecology, National Food Institute, Division of Industrial Food Research, Section for Population Ecology and Genetics
Authors: Røjbek, M. (Intern), Jacobsen, C. (Intern), Tomkiewicz, J. (Intern), Støttrup, J. (Intern)
Lipid dynamics of herring (Clupea harengus L.) and sprat (Sprattus sprattus) as major prey species in the Baltic Sea

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Coastal Ecology, Section for Population Ecology and Genetics, National Food Institute, Division of Industrial Food Research
Authors: Røjbek, M. (Intern), Tomkiewicz, J. (Intern), Jacobsen, C. (Intern), Støttrup, J. (Intern)
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Main Research Area: Technical/natural sciences
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Lipid oxidation in fish oil enriched oil-in-water emulsions and cream cheese with pre-emulsified fish oil is affected differently by the emulsifier used
It is well-documented that a high intake of long chain omega-3 polyunsaturated fatty acids has several health beneficial effects in humans. Consequently, the interest in food products enriched with marine oils has increased during recent years. However, addition of these highly unsaturated fatty acids to foods invariably increases the risk of lipid oxidation. A possible strategy to avoid lipid oxidation and the consecutive development of unpleasant off-flavours is to protect the oil in a delivery emulsion in which the oil droplets are shielded from its possible pro-oxidative surroundings by an emulsifier. The antioxidative properties of milk proteins make them an obvious choice as emulsifiers in delivery emulsions. Previous studies have furthermore shown that a combination of proteins and phospholipids may increase the thickness of the interfacial layer in an emulsion.

This presentation will include results from studies on lipid oxidation in simple oil-in-water emulsions prepared with milk proteins alone or combinations of milk proteins and phospholipids. In addition, a study on fish oil enriched cream cheese will be presented. In this study, the cream cheese was enriched with either neat fish oil or a fish oil-in-water delivery emulsion prepared with whey protein isolate, sodium caseinate or a commercially available emulsifier that consisted of ~20% milk phospholipids and ~50% milk proteins. Results showed that simple emulsions prepared with a combination of milk proteins and phospholipids as emulsifier had lower oxidative stability compared with emulsions prepared with milk proteins only. In cream cheese the opposite was the case. Furthermore, delivery emulsions prepared with milk proteins only were even found to increase oxidation compared to cream cheese prepared with neat fish oil. The findings in cream cheese could to some extent be explained by differences in the microstructure as observed from confocal laser scanning microscopy.

Lipophilization of dihydrocaffeic acid affects its antioxidative properties in fish-oil-enriched emulsions
The aim of the present study was to evaluate the antioxidative effect of lipophilized dihydrocaffeic acid, i.e., octyl dihydrocaffeate and oleyl dihydrocaffeate. Furthermore, the relationship between the measured efficacy of the antioxidants in emulsions, their partitioning into different phases of an emulsion system and their in vitro antioxidative properties was also evaluated. Lipid oxidation in the emulsions was affected by the antioxidants applied. Thus, despite a reduced antioxidant activity of lipophilized dihydrocaffeic acid in the antioxidant assays, lipophilized dihydrocaffeic acid was more efficient than caffeic and dihydrocaffeic acids. Octyl dihydrocaffeate had a significantly higher antioxidative effect than oleyl dihydrocaffeate in emulsions. The results partly supported the polar paradox hypothesis, since lipophilized compounds resulted in increased oxidative stability. However, the decreased antioxidative efficacy with increasing alkyl chain length esterified to dihydrocaffeic acid supported a newly suggested cut-off effect hypothesis. This hypothesis suggests that when a certain level of hydrophobicity is obtained for lipophilized phenolic acids, the ester forms micelles in the aqueous phase rather than being located at the interface or oil phase. This phenomenon is suggested to explain the reduced antioxidant activity of oleyl dihydrocaffeate compared with octyl dihydrocaffeate. Practical application: The finding that
lipophilization of phenolic compounds increase their efficacy opens up new possibilities for producing new and more efficient antioxidants for food systems. However, the results also show that optimization of the chain length for each type of phenolic compound may be necessary. Since these compounds may have a much higher efficacy against lipid oxidation a lower amount of antioxidant will be necessary to obtain the same effect. This would decrease the costs. In addition, the use of synthetic antioxidants, that might have toxic effect in vivo, can be avoided. The raw materials used for the lipophilized compounds are natural compounds, however the fate of the lipophilized compounds in vivo should eventually be evaluated.

General information
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Authors: Sørensen, A. M. (Intern), Nielsen, N. S. (Intern), Yang, Z. (Ekstern), Xu, X. (Ekstern), Jacobsen, C. (Intern)
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ISI indexed (2011): ISI indexed yes
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Web of Science (2010): Indexed yes
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Web of Science (2007): Indexed yes
New natural antioxidants for protecting omega-3 rich products.

The long-chain (LC) highly unsaturated omega-3 fatty acids, EPA (eicosapentaenoic acid, 20:5) and DHA (docosahexaenoic acid, 22:6) are vital for a wide range of biological functions and are implicated in the prevention of numerous diseases. However, these fatty acids are highly susceptible to oxidation because of their unsaturated nature. Addition of antioxidants is one method to prevent lipid oxidation. As synthetic antioxidants may have carcinogenic effects at higher levels, the replacement of synthetic antioxidants with natural antioxidants is now in demand. We have isolated natural antioxidants from yoghurt, potato peel, fish protein hydrolysates and seaweed, which were able to protect highly unsaturated fish oil from oxidation. These antioxidant extracts may have potential for commercial exploitation. Copyright © 2012 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

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Scopus rating (2013): SJR 0.264 SNIP 0.311 CiteScore 0.43
ISI indexed (2013): ISI indexed no
Scopus rating (2012): SJR 0.323 SNIP 0.499 CiteScore 0.4
ISI indexed (2012): ISI indexed no
Scopus rating (2011): SJR 0.323 SNIP 0.368 CiteScore 0.39
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.197 SNIP 0.258
Web of Science (2002): Indexed yes
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ANTIOXIDANT COMPOUNDS, ANTIOXIDANTS, ANTIOXIDATIVE ACTIVITY, FISH OILS, NATURAL ANTIOXIDANTS, OILS FISH, OXIDATION
Oxidative degradation and non-enzymatic browning due to the interaction between oxidised lipids and primary amine groups in different marine PL emulsions

Due to the beneficial health effects of marine phospholipids (PL) there is an increasing industrial interest in using them for nutritional applications including emulsified foods. This study was undertaken to investigate both oxidative and hydrolytic stability of marine PL emulsions in relation to the chemical composition of the marine PL used. Moreover, non-enzymatic browning reactions were also investigated. Emulsions were prepared by high pressure homogenizer using different concentrations and sources of marine PL. In some formulations, fish oil was added in order to study the effect of increasing levels of triglycerides in the emulsions. The oxidative and hydrolytic stability of emulsions was investigated through measurement of peroxide value, free fatty acids, and 31P NMR during storage at 2°C for up to 32 days. The oxidative stability of marine PL emulsions during storage was further investigated through the measurement of secondary volatile compounds by solid-phase microextraction (SPME) and dynamic headspace (DHS) connected to gas chromatography (GC–MS). Non-enzymatic browning reactions were investigated through the measurement of Strecker derived volatiles, colour changes and pyrrole content. The results suggested that the oxidative stability of marine PL emulsions was significantly influenced by the chemical composition and the concentration of marine PL used to prepare them. Emulsions with good oxidative stability could be prepared from marine PL of high purity and high content of PL and antioxidant and low TAG content. © 2012 Elsevier Ltd. All rights reserved.
Oxidative Stability of Dispersions Prepared from Purified Marine Phospholipid and the Role of α-Tocopherol

The objective of this study was to investigate the oxidative stability of dispersions prepared from different levels of purified marine phospholipid (PL) obtained by acetone precipitation, with particular focus on the interaction between α-tocopherol and PL in dispersions. This also included the investigation of nonenzymatic browning in purified marine PL dispersions. Dispersions were prepared by high-pressure homogenizer. The oxidative and hydrolytic stabilities of dispersions were investigated by determination of hydroperoxides, secondary volatile oxidation products, and free fatty acids, respectively, during 32 days of storage at 2 °C. Nonenzymatic browning was investigated through measurement of Strecker aldehydes, color changes, and pyrrole content. Dispersions containing α-tocopherol or higher levels of purified marine PL showed a lower increment of volatiles after 32 days storage. The results suggested that tocopherol is an efficient antioxidant in PL dispersions or that the presence of α-tocopherol and pyroles may be the main reason for the high oxidative stability of purified marine PL dispersions.
Ratings:

BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
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Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
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Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
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ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.384 SNIP 1.446 CiteScore 3.1
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.408 SNIP 1.392
Web of Science (2010): Indexed yes
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Phenolipids as antioxidants in emulsified systems
Lipid oxidation is a major issue in foods containing LC PUFA and substantial efforts have been made to protect lipids against oxidation. Recent studies carried out with phenolipids (lipophilized phenolics) in emulsified systems have shown that increased lipophilicity did not necessarily lead to an increase of the antioxidative effect. When the phenolic compound reaches a certain point of lipophilicity its antioxidative effect decreases. Thus, the polar paradox hypothesis is not valid when the alkyl chain length is above a certain length. Furthermore, the length of the alkyl chain for optimal antioxidant effect has been shown to be influenced by the specific phenolic compound and the type of emulsion. The overall aim for our work was to evaluate phenolipids with different lipophilicity as antioxidants in emulsified food. In the study presented here caffeic, ferulic and coumaric acid were selected along with their corresponding alkyl esters (C4-C20). The methods used to evaluate the antioxidative effect of the different phenolipids were the CAT assay (o/w emulsion), antioxidant assays (DPPH, Iron chelating and reducing power) and partitioning studies. Moreover, the results from the CAT assay on caffeates were compared to results (PV and volatiles) from a storage experiment with an o/w emulsion.

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Phenolipids as antioxidants in emulsified systems and the effect of alkyl chain length

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Physico-chemical Properties of Marine Phospholipid Emulsions
Many studies have shown that marine phospholipids (PL) have better bioavailability, better resistance towards oxidation and contain higher polyunsaturated fatty acids such as eicosapentaenoic (EPA) and docosahexaenoic acids (DHA) than triglycerides (TAG) present in fish oil. The objective of this study was to investigate the emulsifying properties of various commercial marine PL and the feasibility of using them to prepare stable emulsions prepared with or without addition of fish oil. In addition, this study also investigated the relationship between chemical composition of marine PL and the stability of their emulsions. Physical stability was investigated through particle size distribution (PSD), zeta potential, microscopy inspection and emulsion separation (ES); while the oxidative and hydrolytic stability of emulsions were investigated through peroxide value (PV) and free fatty acids value (FFA) after 32 days storage at room temperature and at 2 °C. In conclusion, marine PL showed good emulsifying properties and it was possible to prepare marine PL emulsions
with and without addition of fish oil. Emulsion with both good oxidative stability and physical stability could be prepared by using marine PL of high purity, less TAG, more PL, cholesterol and higher antioxidant content.

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The present work was undertaken to examine the utilisation of potato peel, a waste material, as a source of natural antioxidants for retarding lipid and protein oxidation in minced mackerel. Mackerel mince with two different concentrations (2.4 or 4.8g/kg) of water or ethanol extracts of potato peel and a control with no added extracts were prepared. The samples were stored at 5°C for 96h and the sampling was done at time points 0, 24, 48 and 96h. The ethanol extracts, which contained high amounts of phenolic compounds, was found to be very effective in retarding lipid and protein oxidation as it resulted in low levels of peroxide value, volatiles, carbonyl compounds and protected against the loss of α-tocopherol and tryptophan and tyrosine residues. Water extracts was less efficient especially at higher concentrations, which might be due to lower phenolic content or due to the pro-oxidative nature of some of the phenolic acids/co-extracted compounds.
Reproduction of European Eel in Aquaculture (REEL): Consolidation and new production methods

Project aim: Enhance methods and technology applied to produce and culture European eel larvae as basis for the development of a future self-sustained eel aquaculture.

Background: The severe decline of the European eel stock calls for conservation measures including national eel management plans and establishment of a self-sustained eel aquaculture. In 2005, the National Institute of Aquatic Resources at the Technical University of Denmark (DTU Aqua), the Faculty of Life Sciences at Copenhagen University (KU-Life) and the eel aquaculture industry started to build up a research and technology platform for the development of methods to reproduce European eel in aquaculture. Two major projects: Artificial Reproduction of Eels II and III (ROE II and III) succeeded during 2005-2008 to produce viable eggs and larvae that lived up to 12 days. The larvae thereby accomplished the yolk-sac stage and became ready to start feeding. The results were in particular promising because they evidenced that methods successfully applied to Japanese eel has a potential for application also to the European eel. ROE II and III were supported by the Ministry of Food, Agriculture and Fisheries and the European Commission through the Financial Instrument for Fisheries Guidance (FIFG) and the Danish Food Research Program 2006, respectively.
Results: The REEL project accomplished through three series of experiments to consolidate previous results. The longevity of larvae was extended from 12 to 20 days after hatch in first feeding experiments thereby entering the leptocephalus phase. Maturation potential and methods to induce maturation were further tested, and farmed and wild eel broodstocks as well as different treatments were compared. In particular, fertilisation procedures to produce fertilised eggs and embryos and monitoring techniques were enhanced. The technology needed to culture embryos and larvae was substantially improved. The potential for new hormonal treatments was explored and recombinant eel hormones have been produced. New broodstock diets were developed with focus on the lipid composition essential for development and survival of fish larvae. In addition, the experimental facility established by DTU Aqua at Lyksvad Fish Farm was enhanced by improving the experimental and laboratory facilities. The REEL project provided the basis for the establishment of an EU collaborative research project: Reproduction of European Eel: Towards a Self-sustained Aquaculture (PRO-EEL) coordinated by DTU Aqua. REEL included the partners DTU Aqua, KU-Life, Danish Eel Farmers Association (DEFA), Billund Aquaculture Service (BA), BioMar, and Bioneer of which four are integrated in the PRO-EEL project that in total has 15 international partners.
Solid phase microextraction (SPME) for extraction of volatile oxidation products from complex food systems – Pros and cons

Volatile secondary lipid oxidation products can be identified and quantified by GC-FID or GC-MS. An extraction step is, however, needed before GC analysis. A range of different extraction methods are available such as static headspace, dynamic headspace and SPME. Each of these methods has its advantages and drawbacks. Among the advantages of the SPME method are its high sensitivity compared to static headspace and that it is less laborious than the dynamic headspace method. For these reasons, the use of SPME has increased in both academia and industry during the last decade.

The extraction efficiency obtained with the SPME method can be affected by different factors such as fiber type, stirring of sample versus not stirring, extraction temperature and time. These factors can easily be controlled and optimized to obtain the highest possible extraction efficiency. However, extraction efficiency can also be affected by uncontrollable factors such as batch to batch variation between fibers of the same type and presence of compounds in the sample matrix, which competes with the compounds of interest for adsorption to the SPME fiber. The latter factor is particularly a problem when SPME is used for analysis of lipid oxidation during storage of complex food matrices. Examples on how uncontrollable factors have affected results obtained with the SPME method in the authors’ lab will be given and the appropriateness of the SPME method for the analysis of volatile oxidation products in selected food systems will be discussed.

Stability and Stabilization of Omega-3 Oils as such and in Selected Foods

The application of omega-3 polyunsaturated fatty acids (PUFA) in foods has increased dramatically during the last decade due to the increasing awareness about the health beneficial effects of these fatty acids. Due to their polyunsaturated nature omega-3 PUFA are highly susceptible to lipid oxidation, which will lead to formation of undesirable fishy and rancid off-flavours. Such off-flavours can lead to consumer rejection of omega-3 enriched foods. Important issues to address in order to avoid lipid oxidation are 1) processing conditions and product composition, 2) omega-3 PUFA source and delivery system, and 3) addition of antioxidants. This presentation will summarize our current knowledge about these issues in a range of different omega-3 enriched foods.
System Development from Organic Solvents to Ionic Liquids for Synthesiz-ing Ascorbyl Esters with Conjugated Linoleic Acids

The aim of this paper is to screen suitable reaction systems for the modification of antioxidants through enzymatic synthesis. Enzymatic esterification of ascorbic acid with conjugated linoleic acid (CLA) was investigated as a model. Four organic solvents and five different enzymes were evaluated. Results show that only Novozym® 435 turned out to be a useful enzymatic preparation for the production of ascorbyl-CLA ester. The optimum reaction conditions in the organic solvent system were 4 h at 55°C and at a molar ratio of 5 (CLA/ascorbic acid). The esterification reaction was transferred to an ionic liquid system for the purpose of improving solubility of the polar substrate and avoiding the application of organic solvents. From screening experiments, it was evident that only methyltrioctylammonium triflouroacetate (tO-MA-TFA) could provide a proper reaction environment for production of ascorbyl-CLA ester when using Novozym® 435 as biocatalyst. It was possible to significantly increase the productivity (150 g/l) through the increase of ascorbic acid solubility in ionic liquids by super saturation together with the increase of reaction temperature to 70°C, far beyond than that in organic solvents (35 g/l) after preliminary optimizations for both systems.

The antioxidative effect of lipophilized rutin and dihydrocaffeic acid in fish oil enriched milk

The antioxidative effect of phenolipids was evaluated in fish oil enriched milk emulsions as a model for a complex food system. Two different phenolipids modified from dihydrocaffeic acid (with C8 or C18:1) and rutin (with C12 or C16) were evaluated. Both dihydrocaffeate esters and rutin laurate showed significantly better antioxidant properties in milk emulsion compared with the original phenolics. However, rutin palmitate only performed slightly better as antioxidant than rutin. The results with rutin indicated that a cut-off effect exists in relation to the alkyl chain length with respect to optimal antioxidative activity in milk emulsions. Thus, the optimal alkyl chain length is at least below 16 carbon atoms, and maybe even less for rutin esters. For dihydrocaffeate esters it was not possible to conclude on a cut-off effect in relation to alkyl chain length and antioxidative effect due to the almost similar antioxidant effect of the two phenolipids. However, there was a tendency
towards octyl dihydrocaffeate being slightly more efficient than oleyl dihydrocaffeate. Practical application: The finding that phenolipids are better antioxidants in milk emulsions than the original phenolic acid provides new knowledge that can be used to develop new antioxidant strategies to protect foods against lipid oxidation. However, the results indicate that both optimization of alkyl chain length for each type of phenolic, and optimization for each type of emulsion will be necessary in order to get the best oxidative stability of an emulsion with these phenolipids. Use of efficient antioxidants may lower the amount of antioxidant needed to protect against lipid oxidation and may in addition decrease the costs.

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The choice of homogenisation equipment affects lipid oxidation in emulsions

Milk proteins are often used by the food industry because of their good emulsifying properties. In addition, they can also provide oxidative stability to foods. However, different milk proteins or protein components have been shown to differ in their antioxidative properties, and their localisation in emulsions has been shown to be affected by the emulsification conditions. The objective of this study was to investigate the influence of homogenisation equipment (microfluidizer vs. two-stage valve homogeniser) on lipid oxidation in 10% fish oil-in-water emulsions prepared with two different milk proteins. Emulsions were prepared at pH 7 with similar droplet sizes. Results showed that the oxidative stability of emulsions prepared with sodium caseinate was not influenced by the type of homogeniser used. In contrast, the type of homogenisation equipment significantly influenced lipid oxidation when whey protein was used as emulsifier, with the microfluidizer resulting in lower levels of oxidation.

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Organisations: National Food Institute, Division of Industrial Food Research, Materials and Surface Engineering, Center for Electron Nanoscopy, Department of Mechanical Engineering
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The effect of protein and lipid source in organic feed for (organic) rainbow trout on sensory quality

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The structure of omega3 food emulsions

Fish oil is rich in polyunsaturated omega-3 fatty acids (omega-3 PUFAs) which are generally recognized as being beneficial to the health [1]. The addition of fish oil to food products is attractive to both the consumers and the food industry. Indeed, these components will improve nutritional value and add product value. Omega-3 PUFAs are rich in double bonds in their fatty acid chains and this attribute renders them highly susceptible to lipid oxidation. Omega-3 PUFAs can be added to food products as neat oil or as a delivery system such as oil-in-water emulsions. In this last configuration, the oil is surrounded by an emulsifier e.g. proteins, phospholipids or hydro-colloids. This emulsifier layer is important and may protect the oil inside the droplets against prooxidants in the surrounding water phase; the emulsifier should act as a physical barrier between the omega-3 PUFAs and the prooxidants. But this protective aspect is a really complex process and it is dependent on the food matrix to which the oil is added [2]. Oxidation is presumed to be initiated at the emulsifier layer, i.e. the interface layer between the oil and water where the oil is most likely to come into contact with the prooxidants in the water phase. Hence the structure, thickness and composition of the interface layer is expected to have a great impact on the oxidative stability of the emulsion. These layers are consisting of food grade emulsifiers such as milk phospholipids, casein and whey protein and are estimated to be in the range of a few nm which is why we used several electron microscopy techniques to visualize and characterize them.

For this work we compare chemical fixation/ room temperature embedding in resin, cryofixation/ freeze substitution and cryofixation/cryo imaging (freeze-fracture cryo-SEM) on several oil-in-water emulsions. Concerning chemical fixation, we adapted conventional protocols for preserving the emulsions, by developing agar pockets for encapsulation or embedding in capillary tubes (figure 1). Indeed to use chemical fixation with these samples is challenging because we need to minimize alterations of the samples while ensuring at the same time that the samples are stabilized so they do not collapse when the water is removed, e.g. milk encapsulated in agar capsules [3]. These new protocols give an interesting view of the emulsions and the organisation of the interface layer surrounding the oil droplets. With cryofixation we could image more details of this interface and we observed that cryo substituted material seems to correspond very well to images of freeze fractured frozen samples in cryo-SEM where protein aggregates seems to be visible in the water phase, see figure 2.

With this work, we want to demonstrate the importance of combining different microscopic approaches to access the ultrastructure of the oil-in-water emulsions due to their complexity and instability [5].

Antioxidant Activity of Fish Protein Hydrolysates in in vitro Assays and in Oil-in-Water Emulsions.

The aim of this study was to screen different protein hydrolysates with respect to their antioxidative properties in order to select the most promising extracts for further evaluation in oil-in-water emulsions. Three fractions of protein hydrolysates (Crude, >5kDa and 5kDa, 3-5kDa and 5kDa and 1-3kDa) were compared. The hydrolysates were added to oil-in-water emulsions at 0.5%, 1% and 2% w/w and their antioxidative activities were measured using the 1,1-diphenyl- 2-picrylhydrazyl (DPPH) radical scavenging assay and the 2-thiobarbituric acid (TBARs) method. The results showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity. The hydrolysates were also tested in oil-in-water emulsions and the results showed that the hydrolysates had a significant antioxidant activity in the emulsions as well. The study showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity. The hydrolysates were also tested in oil-in-water emulsions and the results showed that the hydrolysates had a significant antioxidant activity in the emulsions as well. The study showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity. The hydrolysates were also tested in oil-in-water emulsions and the results showed that the hydrolysates had a significant antioxidant activity in the emulsions as well. The study showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity. The hydrolysates were also tested in oil-in-water emulsions and the results showed that the hydrolysates had a significant antioxidant activity in the emulsions as well. The study showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity. The hydrolysates were also tested in oil-in-water emulsions and the results showed that the hydrolysates had a significant antioxidant activity in the emulsions as well. The study showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity. The hydrolysates were also tested in oil-in-water emulsions and the results showed that the hydrolysates had a significant antioxidant activity in the emulsions as well. The study showed that the hydrolysates had a significant antioxidant activity and that the crude hydrolysates had the highest antioxidant activity.
The addition of fish oil to food products is appealing both to the food industry and consumers for reasons such as health benefits and the extra commercial value. Fish oil is rich in long chain omega-3 fatty acids, which contain a large number of double bonds. This feature causes the omega-3 fatty acids to be highly susceptible to oxidation, thus their incorporation into foods is limited by the development of unpleasant off-flavours. Strategies for limiting oxidation which implies increasing the shelf-life of potential products are necessary for commercial production. One such strategy is to add the oil as an emulsion rather than as neat oil. Studies so far have indicated that emulsification of the fish oil changes the oxidative stability of the product but whether emulsification is an advantage seems to be dependent on the food matrix to which the emulsion is added [1, 2]. It is therefore of interest to look at the emulsions to assess what determines the oxidation. It has been proposed that oxidation is to some extent dependent on the structure of the emulsion; including oil droplet sizes, size distribution and the thickness of the interface between oil and water. This interface can be stabilized by food grade emulsifiers such as proteins and phospholipids from milk. The main objective of this study is to characterize fish oil in water emulsions with respect to oil droplet size, size distribution, and ultimately to view the thickness, structure and morphology of the interface layers. The emulsion fractures are random and impossible to control when using freeze-fracture cryo-SEM. We have previously shown that some types of emulsifiers tend to break along the interface layer, while others cause the fractures to be perpendicular to the interface layer [3]. To control the field of view more specifically and to ensure the access to the desired part of the sample, we propose now the use of cryo-FIB SEM. This method allows us to access the interface layers as needed, see figure 1.

Emulsions with high oil content, i.e. 70%, and relatively large oil droplets, i.e. μm range, have been frozen in slush nitrogen, fractured and ice has been sublimated from the surface in a Quorum Polar Prep 2000 Cryo Transfer System. Platinum has been sputtered onto the sample prior to sectioning. The sample is imaged in a Quanta 3D FEG (FEI) with a with ETD, 15 kV and WD 10 mm. Figure 1 shows a sectioned oil droplet from an emulsion, which is emulsified with phospholipids from milk. On the micrograph it can be observed a contrast on the surface of the oil droplet that faces the interior below the original fracture plane, which has not been covered in platinum. The contrast is seen as a lighter line on the bottom side and the sliced oil droplet, visualised in figure 2. This could possibly be attributed to the phosphorous in the emulsifier.

Cryo-SEM for Characterization of the Structure of Fish Oil Emulsions

Addition of fish oil to food products to improve nutritional quality by the addition of omega-3 fatty acids is attractive both to the consumers and the food industry for reasons such as health benefits and added product value. The long chain omega-3 fatty acids contain a large number of double bonds which causes the fish oil to be susceptible to oxidation. The shelf lives of fish oil enriched products are thus limited by fast oxidation rates of the fish oil which causes development of off-flavours as well as degeneration of the beneficial health effects of the fish oil. At the present moment this is a barrier for...
their access to the market and it is necessary to develop techniques to protect the oil against oxidation. Emulsification of the oil has been put forward as a strategy for protection against oxidation, but whether that is beneficial seems to depend on the food matrix to which the oil is added [1,2]; see figure 1. It is thus interesting to investigate the pure emulsions to gain knowledge about the oxidation without the effects of an external food matrix. It has been seen that some factors that influence the oxidation in pure emulsions are the type of emulsifier, the oil droplet size and the pH [3]. This dependence has led to the belief that the oxidation is initiated at the interface between oil and water and that the thickness or composition of the interface can be controlled to ensure optimum stability of the emulsions.

Deodorization optimization of Camelina sativa oil: Oxidative and sensory studies
Camelina sativa oil (CO) is characterized by a high content (up to 40 wt %) of essential α-linolenic acid and characteristic odour and flavour. Deodorization of highly unsaturated oils requires great attention as the refining process involves thermal treatment which affects oil integrity. In the present study RSM and principal component analysis (PCA) were used to optimize bench-scale deodorization of CO. Mathematical models were generated through multiple regressions with backward elimination, describing the effects of process parameters (temperature, steam flow, time) on oil quality indicators [peroxide value (PV), p-anisidine value (p-AV), γ-tocopherol (γ-T) and oxidative stability (OS)]. Additionally, sensory evaluation was performed. RSM analysis showed a significant effect of deodorization temperature and to a lesser extent, deodorization steam flow and time on removal of oxidative compounds, flavour and odour. PCA of chemical and sensory results showed that deodorization temperature affected the sensory properties in the samples. The best conditions for removing undesirable flavour and odour were achieved by using a deodorization temperature of 195–210°C.
Emulsification technique affects oxidative stability of fish oil-in-water emulsion

In oil-in-water emulsions, lipid oxidation is expected to be initiated at the oil-water interface. The properties of the emulsifier used, and the structure at the interface is therefore expected to be of great importance for lipid oxidation in emulsions. Previous studies have shown that e.g. homogenization pressure can affect how proteins locate themselves at the interface of an emulsion. The hypothesis is therefore that emulsions produced with different emulsification equipments differ in their oxidative stability due to differences in the behaviour of the proteins at the interface. The aim of this study was therefore to compare lipid oxidation in 10% fish oil-in-water emulsions prepared by two different kinds of high pressure homogenizers i.e. a microfluidizer and a two valve high pressure homogenizer. Emulsions were made with equal droplet sizes, and with either 1% sodium caseinate or 1% whey protein isolate. Emulsions were characterised and investigated by microscopy. Lipid oxidation was assessed by PV and the formation of secondary volatile oxidation products. Results showed that the different emulsification techniques had an influence on lipid oxidation and that the effect of the emulsification technique depended on the type of protein used as an emulsifier.

General information
Impact of Endogenous Phenolics in Canola Oil on the Oxidative Stability of Oil-in-Water Emulsions

Canola oil is low in saturated fat, high in monounsaturated fat and has a favourable omega-6:omega-3 ratio. Therefore, canola oil has a healthier fatty acid profile compared to other plant oils such as soy oil. Therefore, canola oil is also an ingredient in many food products. However, the content of unsaturated lipid makes canola oil susceptible towards lipid oxidation. Many food products are lipid containing emulsions and a lot of efforts have been put into developing methods to protect the lipids against oxidation. Since lipid oxidation has a negative influence on the shelf life of the foods, efficient antioxidants will result in increased shelf life and thereby increased quality of the food products. Besides tocopherols, Canola oil contains different compounds with antioxidative properties. These compounds are Sinapic acid, Sinapine and Canolol; all belonging to the group of phenolic compounds. However, the effect of these endogenous antioxidants on lipid oxidation in o/w emulsion is yet unknown. Hence, the aim of this study was to evaluate the effect of the endogenous phenolics in Canola oil on lipid oxidation in o/w emulsion. For this purpose individual phenolics were extracted from defatted ground canola seeds. Fractionated extracts of Sinapic acid, Sinapine and Canolol was used as well as a non fractionated extract. These extracts was added (100 and 350 μM) to 10% o/w emulsion with stripped canola oil in order to evaluate their effect on lipid oxidation in emulsions. For comparison, the antioxidative effect of phenolic standards for Sinapic acid and Sinapine (as Sinapine thiocyanate) were also evaluated in the emulsions, and BHT was used as a positive control. Emulsions were stored at 3°C and sample was taken at different time point. Evaluation of the antioxidative effect was based on Peroxide Value (PV) and secondary volatile oxidation products by headspace GC supported by evaluation of the properties of the extracts and corresponding phenolic standards in 3 different in vitro antioxidant assays.

Lipid oxidation in omega-3 emulsions prepared with milk proteins

An increasing body of evidence supports the health beneficial effects of omega-3 polyunsaturated fatty acids. Therefore, incorporation of marine oils into foods has also gained an increasing interest. However, the highly unsaturated lipids present in marine oils are prone to lipid oxidation, and their addition to foods is therefore limited by the development of unpleasant off-flavors. Hence, efficient strategies are necessary to protect the lipids and thereby make fish oil-enriched food products successful in the marketplace. In an attempt to increase the oxidative stability of fish oil-enriched food products several studies have been carried out where fish oil has been introduced to different foods through delivery emulsions instead of as neat oil. However, contradicting results have been obtained between individual foods on whether the neat oil or the delivery emulsion gave the most oxidatively stable product. Thus, a better understanding of factors influencing lipid oxidation in delivery emulsions themselves is therefore needed to understand the differences observed between food systems. In oil-in-water emulsions, lipid oxidation is expected to be initiated at the oil-water interface. The properties of the emulsifier used and the structure at the interface are therefore expected to be of great importance for oxidation in emulsions. This presentation will include results from mainly three different studies of lipid oxidation in omega-3 emulsions prepared with milk proteins and protein components. In these three studies different parameters that are expected to change the properties and structure of the proteins at the interface were investigated. The first study compares 70% emulsions with either sodium caseinate or whey protein isolate at two pH values with and without iron addition. The second study evaluates the effect of two different high pressure homogenizers on oxidation in 10% emulsions with the same emulsifiers as in the first study. Finally, the third study considers the effect of changing pH on oxidation in emulsions prepared with different whey protein components. Results on lipid oxidation as affected by the different parameters will be discussed and related to the differences between the proteins and their structure at the
interfacial layer. Results will be complimented by micrographs of the emulsions.

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Moderate exercise of rainbow trout induces only minor differences in fatty acid profile, texture, white muscle fibres and proximate chemical composition of fillets
These experiments studied how moderate water velocities (0.9 body length second−1 (bl s−1)) may influence different quality characteristics of rainbow trout when compared to fish kept in standing water (b0.1 bl s−1). Fish fed at 1.3% of their body weight per day were slaughtered at a weight of 350 g after nine weeks of experiment at 15.0 °C. The fatty acid composition in fillets differed only marginally between exercised fish (excF) and control fish (ctrlF) kept in standing water. ExcF fillets had a significantly lower content of fatty acids 16:0 (P<0.05) and 18:1 (n−7) (P<0.01) and a higher content of 20:2 (n−6) (Pb0.05) compared to ctrlF fish, but all differences were small (b7%). The percentage of n−3 fatty acids was not significantly affected by the applied training regime and neither was the n−3 : n−6−1 ratio. The percentage of n−3 fatty acids, however, decreased linearly in both groups when the lipid content in the fillet increased (R2≥0.85, Pb1·10−6). Fillet texture measured instrumentally as shear force (g) after 72 h of ice storage did not differ between the two experimental groups, and neither did the content of lipid, protein or dry matter in the fillet. Muscle fibre sizes have a possible role in textural characteristics and were determined by histological analyses of white, glycolytic muscle tissue. These data showed that although differences in average fibre diameters were small (excF: 75.04 (s.d.=48.96)μm; ctrlF: 74.50 (46.21)μm) the general fibre size distribution differed significantly among the two groups (Pb0.01). Moreover, moderate exercise induced small but significant changes in fibre circularity (excF: circ.=0.724; ctrlF:=0.720, Pb0.05) but neither muscle fibre diameter nor circularity was significantly related to fillet texture. Altogether, the results suggest that moderate water velocities have limited impact on quality of pan-sized rainbow trout but subtle changes in the fillets indicate that other training strategies may induce stronger responses.

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The objective of this study was to evaluate the protective effects of five different emulsifiers on lipid oxidation in 70% fish oil-in-water emulsions to be used as delivery systems for long chain polyunsaturated omega-3 fatty acids to foods. The emulsifiers were either phospholipid (PL) based or protein based. The PL-based emulsifiers were soy lecithin and two milk PL concentrates (with either 20 or 75% PL). The protein-based emulsifiers were whey protein isolate and sodium...
caseinate. Lipid oxidation was studied at two pH values (pH 4.5 and 7.0) and results were compared to lipid oxidation in neat fish oil. Lipid oxidation was followed by determination of peroxide values and volatile oxidation products. Emulsions were furthermore imaged by confocal and cryo-scanning electron microscopy. Results showed that emulsions prepared at high pH with proteins oxidized less than or equally to neat oil, whereas, all other emulsions oxidized more. In addition, there was a tendency toward a faster progression in lipid oxidation at low pH compared to high pH for emulsions prepared with protein-based emulsifiers. The opposite was observed for emulsions prepared with PL-based emulsifiers. Hence, at low pH PL-based emulsions may be more suitable as delivery systems than protein-based emulsions. Moreover, the quality of the PL-based emulsifiers seemed to affect lipid oxidation. Practical applications: Results from the present study give an insight into the physical and oxidative stability of 70% fish oil-in-water emulsions prepared with whey protein isolate, sodium caseinate, milk phospholipids, or soy lecithin. The emulsions can be used as delivery systems for fish oil to foods. However, only emulsions prepared with proteins at high pH offered advantages with respect to better oxidative stability during storage compared to neat fish oil. Thus, when fish oil is added to a food product in a delivery emulsion, the type of emulsion used should be carefully considered.
Oxidative Stability of Marine Phospholipids

Many studies have shown that marine phospholipids (MPL) provide more advantages than fish oil. They have better bioavailability, better resistance towards oxidation and higher content of eicosapentaenoic acids (EPA) and docosahexaenoic acids (DHA) than oily triglycerides (fish oil). The objective of this study is to investigate the oxidative and hydrolytic stability of MPL. In addition, this study also investigates the effect of chemical composition of MPL and Maillard reaction (interaction between lipids oxidation products with the residue of amino acids) on MPL emulsions’ stability. Firstly, MPL were prepared in the form of emulsions by high pressure homogenizer. Then, the oxidative and hydrolytic stability of phospholipids was investigated by measurement of simple chemical analyses such as Peroxide Value and Free Fatty Acids, and 31PNMR after 32 days storage at 2°C. The oxidative stability of MPL was further investigated through measurement of secondary volatile compounds by Solid Phase Microextraction at several time intervals. On the other hand, the Maillard reaction was investigated through the measurement of color changes and pyrrole content before and after 32 days storage. Preliminary result suggested that MPL emulsions have good hydrolytic stability and relatively good oxidative stability as compared to fish oil containing emulsions. As a conclusion, MPL with different chemical compositions have affected emulsions’ stability differently.
stable liposomes which are attractive ingredients for food or feed applications. However, MPL are still susceptible to oxidation as they contain large amounts polyunsaturated fatty acids and application of MPL in food and aquaculture industries is therefore a great challenge for researchers. Hence, knowledge on the oxidative stability of MPL and the behavior of MPL in food and feed systems is an important issue. For this reason, this review was undertaken to provide the industry and academia with an overview of (1) the stability of MPL in different forms and their potential as liposomal material, and (2) the current applications and future prospects of MPL in both food and aquaculture industries with special emphasis on MPL in the liposomal form.

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Phenolics and Lipophilized Phenolics as Antioxidants in Fish Oil Enriched Emulsions,

Emulsions containing omega-3 LC PUFA are highly susceptible to oxidation. This causes formation of undesirable flavors and loss of health beneficial fatty acids. Many omega-3 enriched food products on the market are oil-in-water emulsions. According to the so called “polar paradox”, polar compounds work better as antioxidants in bulk oil, whereas lipophilic compounds are better antioxidants in emulsions. This presentation is an overview of our previous work in the area of fish oil enriched emulsions with antioxidants. Our studies have shown that the lipophilicity of the compounds is not the only factor determining their efficacy as antioxidants in simple model systems. Interactions between the antioxidants, emulsifier and pH also influence the antioxidant behavior. Moreover, studies with lipophilized phenolics in a food emulsion showed that there is no linear increase of antioxidant activity with increased lipophilicity. Instead a cut-off effect was observed in relation to the alkyl chain length lipophilized to the phenolic compound. Furthermore, the efficacy of lipophilic antioxidants is influenced by the type of food system. Thus, our results show that the antioxidant behavior may not be as simple as stated by the “polar paradox” hypothesis. According to our research results in this area, this hypothesis deserves reconsideration.

Prevention of lipid oxidation in omega-3 enriched oofds by antioxidants and the use of delivery systems.

Due to the health beneficial effects of marine omega-3 fatty acids there is an increasing interest in developing functional foods containing these healthy fatty acids. However, such foods are very susceptible to lipid oxidation, which will give rise to undesirable off-flavours and unhealthy oxidation products. Efficient strategies to prevent lipid oxidation are therefore required. Such strategies include addition of antioxidants or the use of omega-3 delivery emulsions. However, antioxidant efficacy in complex omega-3 enriched foods are influenced by many factors including the lipophilicity of the antioxidants. Selection of the optimal antioxidant system is therefore a major challenge. Likewise, a range of factors can influence the ability of omega-3 delivery systems to protect the omega-3 fatty acids against oxidation after addition to food systems. These challenges will be discussed in this presentation and examples from the authors own research on antioxidants and omega-3 delivery systems will be given.
Storage stability of marine phospholipids emulsions

Marine phospholipids (MPL) are believed to provide more advantages than fish oil from the same source. They are considered to have a better bioavailability, a better resistance towards oxidation and a higher content of polyunsaturated fatty acids such as eicosapentaenoic (EPA) and docosahexaenoic acids (DHA) than oily triglycerides (fish oil). Therefore, the objective of this study is to explore the feasibility of using marine phospholipids emulsions as delivery system through investigation of the physical, oxidative and hydrolytic stability of MPL emulsions with or without addition of fish oil. The effect of initial Peroxide Value, total lipids, phospholipids and antioxidants content on stability of MPL emulsions were studied. The physical stability was investigated through measurement of particle size distribution and creaming stability, which involve measurement of changes (%) in emulsion volume. In addition, preliminary investigation of the oxidative and hydrolytic stability was carried out through determination of Peroxide Value and Free Fatty Acids Value after 32 days storage at room temperature and 2°C, respectively. Oxidative stability of MPL emulsions were also investigated through measurement of secondary volatile compounds by Solid Phase Microextraction at several time intervals at 2°C storage. Preliminary results showed that marine phospholipids emulsion has a good oxidative stability.

The effect of protein and lipid source in organic feed for (organic) rainbow trout on sensory quality

The aim of this work was to study which effects protein and lipid source in feed for organic rainbow trout (Oncorhynchus mykiss) may have on the sensory quality of the final product after up to 14 days of storage in ice. The protein sources used in the experiment were fishmeal and a mixture of vegetable protein. While the lipid sources were fish, linseed, sunflower, rapeseed and grape seed oil. After slaughtering all fish were frozen (-40°C) until the sensory experiment was performed, for which the trout were thawed and stored for 3, 5, 7 and 14 days in ice respectively. The sensory experiment included objective sensory profiling, of samples which were heat treated in a convention oven at 100°C until the core temperature was 70°C. The sensory panel consisted of 11 assessors which all were tested and trained. The sensory analysis included descriptors related to the odour, appearance, flavour and texture. After 3 days of storage in ice an impact of lipid source is seen. Inclusion of linseed oil resulted in a sensory profile comparable to the use of fish oil in the feed. While some of the other vegetable oils, especially grape seed oil results in a sensory profile rather different from the trout that had fish oil. However, this difference observed after 3 days of storage did not appear after a longer storage time, and consequently no differences in the sensory characteristics is observed after the 5 days of storage in ice. Nevertheless after 7 days in ice some differences are appearing again. Here the trout which have had rapeseed and grape seed oil in the feed has a more neutral flavour and odour compared to the other ones. After 14 days of storage the protein source had an effect, and the trout which received fishmeal in the feed were more tainted. Therefore, it is seen that the shelf-life is increased by feeding the fish with vegetable protein compared to fish meal. The conclusion of the experiment therefore was that both dietary vegetable protein and lipid sources can influence on sensory characteristics of trout stored in ice.
The effects of feed composition on the sensory quality of organic rainbow trout during ice storage

The focus of this work was to study which effects the type of protein and lipid source in the feed for organic Rainbow trout influences had on the sensory quality of final product. Two and four different protein and lipid sources were used in the experiment respectively. The protein sources were fishmeal and a mixture of protein from organic vegetable, while the lipid sources were fish oil and organic oil from linseed, sunflower, rapeseed and grape seed. Sensory analysis was performed after 3, 5, 7 and 14 days of storage in ice. The results showed that both protein and lipid source in the feed can influence sensory characteristics of the trout. After 3 and 7 days of storage in ice differences in the sensory characteristics between rainbow trout’s which have had different lipid sources in the feed were observed. While a difference between the trout fed with different protein sources were observed after 14 days of storage, indicating that vegetable protein in the feed increases the self-life of organic rainbow trout.

The efficacy of compounds with different polarities as antioxidant in emulsions with omega-3 lipids

According to the so-called polar paradox hypothesis, the efficacy of an antioxidant in emulsions is highly affected by its polarity and thereby location in the different phases. However, other factors also affect the efficacy of antioxidants in multiphase systems. The aim of this study was to evaluate the efficacy of antioxidants [ascorbic acid, ascorbyl palmitate, ascorbyl CLA and CLA (conjugated linoleic acid)] with different polarities in two different emulsion systems: o/w emulsion (5% oil) and w/o emulsion (98% oil) stabilized with citrem and PGPR, respectively. The efficacy of the antioxidants was compared to their partitioning in an o/w emulsion system and to results obtained from different antioxidant assays: iron reducing power, chelating activity and radical scavenging activity. For the w/o emulsions the efficacy of the antioxidants followed the polar paradox hypothesis: ascorbyl palmitate = ascorbyl CLA > ascorbic acid ≥ CLA > reference. For the o/w emulsion the antioxidative effects were not in accordance with the polar paradox. In the beginning of the storage, ascorbyl palmitate and ascorbic acid were most efficient, however in the end they acted as prooxidants. Ascorbyl CLA was located at the interface but was inactive as an antioxidant. This may be due to impurities or interaction with citrem.
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Antioxidant Activity of Potato Peel Extracts in a Fish-Rapeseed Oil Mixture and in Oil-in-Water Emulsions
The objectives of the present work were (a) to extract the phenolic fraction from the peels of two Danish varieties of potatoes, viz. Sava and Bintje, and examine their antioxidant capacity in in-vitro systems (b) to evaluate the effect of these extracts on the storage stability of a fish- rapeseed oil mixture and oil-in-water emulsions. Multiple antioxidant activity of the potato peel extracts was evident from in-vitro systems as they showed strong reducing power, radical scavenging ability, ferrous ion chelating activity and prevented oxidation in a liposome model system. The Sava variety, which showed strong antioxidant activity in in-vitro systems, was tested in oil and oil-in-water emulsions. Ethanolic extracts of Sava (C1,600 mg/kg) prevented lipid oxidation in emulsions and in oil. Water extracts showed no antioxidant activity in oil whereas it showed pro-oxidant activity in emulsions. Thus, the results of the present study show the possibility of utilizing waste potato peel as a promising source of natural antioxidants for retarding lipid oxidation.

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The aim of the present study was to elucidate previous findings showing that peptide fractions isolated from yoghurt had antioxidant effects. Therefore, peptides and free amino acids released during fermentation of milk were characterised. Yoghurt samples were stripped from sugars and lactic acid and subsequently fractionated by ultra filtration using membranes with cut off sizes of 30, 10 and 3 kDa. The peptides in these fractions were identified by LC–MS/MS. The identified peptides comprised a few N-terminal fragments of αs1-, αs2-, and β-casein, and several fragments from β-casein. Almost all the peptides identified contained at least one proline residue. Some of the identified peptides included the hydrophobic amino acid residues Val or Leu at the N-terminus and Pro, His or Tyr in the amino acid sequence, which is
characteristic of antioxidant peptides. In addition, the yoghurt contained a considerable amount of free amino acids such as His, Tyr, Thr and Lys, which have been reported to have antioxidant properties. Thus, our findings confirm that the antioxidant effects of the peptide fractions from yoghurt are due to the presence of certain peptides and free amino acids with recognised antioxidant activity in these fractions.
Antioxidant properties of modified rutin esters by DPPH, reducing power, iron chelation and human low density lipoprotein assays

Practical limitations exist regarding the effectiveness of flavonoids as antioxidants in many food systems, possibly due to their poor solubility and miscibility in lipidic environments. Current strategies to improve these properties include enzymatically acylating flavonoids with lipophilic moieties. Herein, two derivatives of rutin (possessing C12:0 or C16:0 acyl groups) were assessed for their antioxidant properties, and compared with their parent compound, rutin and with butylated hydroxytoluene (BHT). While all compounds exhibited relatively strong radical scavenging abilities, modified rutin compounds exhibited decreased reducing power and metal chelating abilities as compared to rutin. Conversely, investigations on the oxidation of human low density lipoprotein (LDL) revealed that rutin laurate was most effective in inhibiting oxidation by prolonging LDL lag time for an in vitro system. With regards to in vivo considerations, a pre-treatment step confirmed that the ester bond linking rutin and acyl moieties was most susceptible to hydrolysis by digestive enzymes, while rutin itself was not degraded. Thus, acylation of rutin with medium or long chain fatty acids may result in improved antioxidant abilities in more complex systems, including LDL-oxidation assays. Likely reasons may include improved lipophilic solubility and partitioning properties allowing for better accessibility to the actual site of oxidation. (C) 2010 Elsevier Ltd. All rights reserved.
Assessment of Washing with Antioxidant on the Oxidative Stability of Fatty Fish Mince during Processing and Storage

Fatty fish have been recognized as potential raw material for the production of surimi; however, they can easily oxidize. The ability of antioxidants added in the washing water to reduce oxidation during the washing and subsequent storage needs to be evaluated. Horse mackerel (Trachurus trachurus) mince was washed three times with 3 volumes of cold water (W) or the antioxidant solutions caffeic acid (CA) or propyl gallate (PG), at concentrations of 100 mg/kg, or spermine (SP), at a concentration of 400 mg/kg. Accumulation of antioxidant in the mince at each washing step was evaluated. The obtained washed minces were characterized and stored for 5 days at 5 degrees C. Lipid oxidation was followed by
measuring primary and secondary lipid oxidation products (peroxides and volatiles, respectively). Characterizations of the physicochemical properties of protein and protein oxidation were also performed. Results indicated that the antioxidants were accumulated differently, but all antioxidants tested were able to prevent lipid oxidation in fatty fish mince during washing and subsequent storage. The ranking in terms of oxidative stability of the washed minces was CA = PG > SP > W. The antioxidants tested also showed some protection of the protein during processing and storage., however, the results were more difficult to explain and indicated complex interactions between protein and antioxidant. The chemical structures of the antioxidant and its functional groups, its properties, and its interaction with the protein matrix are important parameters that need to be carefully evaluated to reveal to what extent antioxidants are able to protect protein from oxidative damage.
Challenges when developing omega-3 enriched foods

Due to the polyunsaturated nature of omega-3 fatty acids, lipid oxidation is a major challenge when developing omega-3 enriched foods. In multiphase food systems, several factors can affect lipid oxidation and efficacy of antioxidants, added to prevent lipid oxidation. This review discusses the influence of important factors such as oil quality, delivery systems for omega-3 fatty acids, processing conditions, composition of the food matrix on lipid oxidation in different omega-3 enriched foods (milk, yoghurt, mayonnaise and mayonnaise-based salads, dressing, energy bar and fish paté). Moreover, the effect of different antioxidants (tocopherol, EDTA, lactoferrin, caffeic acid, ascorbic acid, ascorbyl palmitate, propyl gallate, gallic acid, as well as lipophilized antioxidants) is compared in different food systems.

Characterization of Emulsions of Fish Oil and Water by Cryo Scanning Electron Microscopy

Addition of fish oil to industrially prepared food products is attractive to the food industry because of the well-documented health effects of the omega 3 fatty acids in the fish oil [1]. Polynsaturated Fatty Acids including omega 3 fatty acids are highly susceptible to lipid oxidation due to the many double bonds. Emulsions of fish oil in water are potential candidates for a delivery system of fish oil to food products. It has been suggested that oxidation of oil-in-water emulsions is initiated at the interface between oil and water. It has also been proposed that oxidation is to some extent dependent on the ultra structure of the emulsion; including the size of oil droplets, their distribution and the thickness of the interface between oil...
and water. This interface is stabilized by macromolecules such as proteins, phospholipids and hydrocolloids. The main objective of this study is to characterize fish oil in water emulsions with respect to oil droplet size, distribution, and ultimately to view the structure and thickness of the interface layer.

A freeze-fractured surface viewed at low temperatures under the scanning electron microscope is a promising strategy to reveal variations in the microstructures of the emulsions. Freeze-fractured emulsions tend to break along the oil and water interface which provides direct access to the surface of the interface layer. The interface layer can be either viewed directly or water can be sublimated from the surface to reveal more of the oil droplets. A second option is to view droplets that are broken across the interface. This will display the actual interface layer, which can be seen after etching for a short period of time.

We have found this method to show promising results for characterization of emulsions with oil droplet sizes ranging from 100 nm - 20 µm, various distribution of droplets and diverse amounts and types of emulsifiers. Here we present results for emulsions with different amounts of fish oil and different protein or milk phospholipid based emulsifiers.

We aim to refine the technique further in order to enable us to derive a correlation between the oil/water interface thickness and microstructure and the stability against oxidation of the fish oil.

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State: Published
Organisations: Center for Electron Nanoscopy, National Food Institute, Division of Industrial Food Research, Department of Mechanical Engineering, Materials and Surface Engineering
Authors: Jensen, L. H. S. (Intern), Horn, A. F. (Intern), Jacobsen, C. (Intern), Nielsen, N. S. (Intern), Horsewell, A. (Intern)
Number of pages: 2
Publication date: 2010
Event: Abstract from 17th International Microscopy Congress, Rio De Janeiro, Brazil.
Main Research Area: Technical/natural sciences
Electronic versions:
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Bibliographical note
Poster presentation.
Source: dtu
Source-ID: u::7003
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2010

Chemical processes responsible for quality deterioration in fish

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Protein Biochemistry, Section for Aquatic Process and Product Technology
Authors: Jacobsen, C. (Intern), Nielsen, H. H. (Intern), Jørgensen, B. (Intern), Nielsen, J. (Intern)
Number of pages: 824
Pages: 439-465
Publication date: 2010

Host publication information
Title of host publication: Chemical deterioration and physical instability of food and beverages
Volume: Part 2
Publisher: British Welding Research Association
Editors: Andersen, M., Skibsted, L.
ISBN (Print): 9781845694951
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253226
Publication: Research - peer-review › Book chapter – Annual report year: 2010

Effect of emulsifiers and physical structure on lipid oxidation in omega-3 emulsions
The body of evidence supporting health beneficial effects of long-chain omega-3 polyunsaturated fatty acids has increased over the last decades. Consequently, the interest in fish oil-enriched foods has also increased. However, addition of these highly unsaturated fatty acids to foods also adds the challenge of lipid oxidation. In order to limit lipid oxidation and the consecutive development of unpleasant off-flavours, the manner in which the fish oil is introduced to the food product should be carefully considered, e.g. an emulsion could be used as delivery system for the omega-3s. The aim of this study was therefore to compare lipid oxidation in fish oil-in-water emulsions made by the use of different emulsifiers. Results showed that emulsions made with phospholipid based emulsifiers oxidised more than neat oil, whereas emulsions made
with protein based emulsifiers generally oxidised less than neat oil. The protective effect of proteins might be caused by several factors such as the physical structure of the interface and a possible metal chelating effect. Moreover, due to the much lower lipid content, the protein based emulsifiers, may be less susceptible to lipid oxidation compared to the phospholipid based.

**General information**
State: Published
Organisations: Division of Seafood Research, National Food Institute
Authors: Horn, A. F. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2010
Event: Abstract from 101st AOCS Annual Meeting, Phoenix, AZ, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 272399
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2010

**Effect of lipophilization of dihydrocaffeic acid on its antioxidative properties in fish oil enriched emulsion**
The relative low intake of fish and the health beneficial n-3 polyunsaturated fatty acids (PUFA) in the Western countries has created a growing market for food products enriched with eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Since EPA and DHA are more susceptible to lipid oxidation than PUFAs from vegetable oils due to their highly polyunsaturated nature, it is necessary to develop methods to protect these PUFAs. Many food systems are emulsions. Due to the so-called polar paradox phenomenon, hydrophilic antioxidants may in many cases be better antioxidants in bulk oil than lipophilic compounds, whereas lipophilic antioxidants are more efficient than hydrophilic antioxidants in emulsions. This phenomenon has been explained by the affinity of the compounds towards the different phases in bulk oil and emulsions. The hydrophilic character of many naturally occurring antioxidants may cause a low efficacy in inhibiting lipid oxidation in food emulsions. However, lipophilization of the antioxidants with a fatty alcohol may alter their location in the emulsion matrix and thereby improve their efficacy. Evaluation of the effect of lipophilisation of selected antioxidants revealed that generally, lipophilized dihydrocaffeic acid and rutin increased the oxidative stability of o/w emulsions and fish oil enriched milk compared with their parent compound. The results supported a cut-off effect in relation to the acyl chain length esterified to the phenolic compound. Octyl dihydrocaffeate (C8 acyl chain) was a stronger antioxidant than oleyl dihydrocaffeate (C18 acyl chain) and rutin laurate (C12 acyl chain) was a stronger antioxidant than rutin palmitate (C16 acyl chain). Interestingly, it seemed that the cut-off effect not only is specific for the individual lipophilized phenolic compounds, but that it also depends on the emulsion system, i.e. the optimal chain length seems to vary between different emulsion systems.

**General information**
State: Published
Organisations: National Food Institute, University of Burgos, Technical University of Denmark, Aarhus University
Authors: Sørensen, A. M. (Intern), de Diego, S. (Ekstern), Petersen, L. K. (Ekstern), Nielsen, N. S. (Intern), Yang, Z. (Ekstern), Xu, X. (Ekstern), Jacobsen, C. (Intern)
Publication date: 2010
Event: Abstract from 8th Euro Fed Lipid, Munich, Germany, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 272417
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2010

**Enrichment of foods with omega-3 fatty acids: A multidisciplinary challenge**
Enrichment of foods with marine omega-3 polyunsaturated fatty acids (PUFA) poses a multidisciplinary challenge to food industry and academia. Although our knowledge about possible health effects of omega-3 PUFA has increased tremendously during the last 30 years, there is still a lot to be learned about these healthy fatty acids. Moreover, consumer acceptance and lipid oxidation of omega-3 PUFA-enriched food are other major challenges that the food industry meet when developing omega-3-enriched foods. Two examples on multidisciplinary research projects to overcome some of these challenges are given in this article together with cases studies illustrating how lipid oxidation can be prevented in a range of different omega-3-enriched foods.

**General information**
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 141-150
Publication date: 2010

**Host publication information**
Title of host publication: The Annals of the New York Academy of Sciences
Human milk fat substitute from butterfat: production by enzymatic interesterification and evaluation of oxidative stability

Recent data have suggested that the fatty acid composition and molecular structure of fats in infant formulas should be as similar to human milk fat as possible to obtain optimal fat and calcium absorption from the infant formula. This work investigated the possibilities of using enzyme technology and butterfat as a material to produce a fat similar to human milk fat with respect to the above parameters. Moreover, the oxidative stability of the enzyme modified human milk fat substitute (HMFS) was compared to the fat blend used for the production of HMFS. Using a combination of enzyme technology, fractionation and batch deodorization and with butterfat in combination with soybean oil and rapeseed oil as raw materials it was possible to produce HMFS with a molecular structure and fatty acid composition that was very similar to that of human milk fat. The oxidative stability of the HMFS oil was lower than that of the reference oil with the same fatty acid composition. However, oxidation did not lead to a severe increase in rancidity scores during storage. Rather, the panel gave high intensity scores for other off-flavors such as burnt and bitter. Further optimization of the deodorization process is therefore necessary to remove these off-flavors.

General information
State: Published
Organisations: Division of Seafood Research, National Institute of Aquatic Resources, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, National Food Institute, Aarhus University, Novozymes A/S
Authors: Sørensen, A. M. (Intern), Xu, X. (Ekstern), Zhang, L. (Intern), Kristensen, J. B. (Ekstern), Jacobsen, C. (Intern)
Pages: 185-194
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
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Volume: 87
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.64 SJR 0.696 SNIP 0.905
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.682 SNIP 0.997 CiteScore 1.66
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.767 SNIP 1.043 CiteScore 1.68
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.809 SNIP 1.074 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.871 SNIP 1.236 CiteScore 1.81
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.833 SNIP 1.292 CiteScore 1.98
ISI indexed (2011): ISI indexed yes
Influence of lipids and fatty acid composition on Baltic cod (Gadus morhua L.) maturation and timing of spawning

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources, Section for Coastal Ecology, Section for Aquatic Lipids and Oxidation, Institute Management
Authors: Tomkiewicz, J. (Intern), Støttrup, J. (Intern), Jacobsen, C. (Intern), Røjbek, M. (Intern), Köster, F. (Intern)
Publication date: 2010
Main Research Area: Technical/natural sciences
Electronic versions:
ICES CM 2009 C10.pdf
Links:
http://www.ices.dk/products/cmdocsindex.asp

Bibliographical note
Extended abstract
Source: orbit
Source-ID: 256650
Publication: Research › Conference abstract for conference – Annual report year: 2010
Inhibition of haemoglobin-mediated lipid oxidation in washed cod muscle and cod protein isolates by Fucus vesiculosus extract and fraction

The effects of Fucus vesiculosus extract and fractions towards haemoglobin- (Hb-) catalysed lipid oxidation in washed cod muscle system and cod protein isolates during ice storage were examined. The extract and fractions were characterised in terms of total phlorotannin content (TPC), 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, ferrous ion-chelating ability and reducing power. Progression of oxidation was followed by determining rancid odour, thiobarbituric acid reactive substances (TBARS), redness and volatile oxidation compounds by gas chromatography (GC). In both washed cod muscle and protein isolates, phlorotannin-enriched ethyl acetate (EtOAc) fraction showed higher inhibitory effect than crude 80% ethanol (EtOH) extract. The addition of oligomeric phlorotannin-rich subfraction (LH-2) separated by Sephadex LH-20 chromatography, completely inhibited the initiation of lipid peroxidation in both systems throughout the entire study period (8 days). Its effectiveness at 300 mg/kg level was comparable to that of 100 mg/kg propyl gallate (PG), a highly effective synthetic antioxidant in muscle foods. Although polymeric phlorotannin-rich subfraction (LH-5) had similar level of TPC and chemical antioxidant activities as oligomeric subfraction LH-2, it was far less efficient in model systems. These results suggest that other factors rather than the intrinsic reactivity toward radicals could be responsible for the inhibitory effect of phlorotannins on lipid oxidation in fish muscle. This study highlights the great potential of oligomeric phlorotannins as novel natural antioxidants in fish and fish products.

General information
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Organisations: Division of Seafood Research, National Food Institute, University of Iceland, Icelandic Food Research
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Main Research Area: Technical/natural sciences

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Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.85 SJR 1.706 SNIP 2.091
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.597 SNIP 1.962 CiteScore 4.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.595 SNIP 2.027 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.548 SNIP 2.069 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.805 SNIP 2.357 CiteScore 3.98
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.909 SNIP 2.395 CiteScore 4.17
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.965 SNIP 2.261
Lipophilized phenolics as antioxidants in fish oil enriched food systems

Food products containing long chain omega-3 PUFA are highly susceptible to oxidation, which causes undesirable flavors and loss of health beneficial fatty acids. Many omega-3 enriched food products on the market are oil-in-water emulsions. According to the so called “polar paradox”, polar compounds work better as antioxidants in bulk oil, whereas lipophilic compounds are better antioxidants in emulsions. Phenolics have in general shown to posses antioxidative properties, which depend upon their structure i.e. number and location of –OH groups. However, many of these compounds are polar. Our hypothesis is that lipophilization of such polar phenolic compounds may improve their efficacy in fish oil enriched food systems. Our study aimed at evaluating rutin and dihydrocaffeic acid and their esters as antioxidants in o/w emulsion model system and milk enriched with fish oil. Moreover, the effect of the chain length of the fatty acid was investigated. The effect of the compounds was evaluated by determination of primary and secondary oxidation products. Further, these findings were combined with antioxidant assay and partitioning studies. Preliminary data showed that the lipophilization improve the antioxidative effect depending on the system, and that the chain length influenced the efficacy of the lipophilized compounds.

General information
State: Published
Organisations: Division of Seafood Research, National Food Institute
Authors: Sørensen, A. M. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2010
Event: Abstract from 101st AOCS Annual Meeting, Phoenix, AZ, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 266809
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2010

Oxidative stability of fish oil-enriched mayonnaise-based salads

The oxidative stability of fish oil-enriched mayonnaise-based salads and the influence of different vegetables in shrimp and tuna salads were evaluated. Moreover, the lipid oxidation in the presence of 1% oregano, rosemary, or thyme in fish oil-enriched tuna salad was assessed. The results obtained showed that the mayonnaise itself was more oxidatively stable without vegetables and tuna or shrimp, in spite of the higher oil content in mayonnaise (63 and 6.3% fish oil, respectively)
compared to salads (~24 and 2.4% fish oil, respectively). Surprisingly, the fish oil-enriched mayonnaise was only significantly different from the standard mayonnaise in the volatile concentration during the end of storage. In fish oil-enriched shrimp salad, asparagus had an anti-oxidative effect and shrimp a pro-oxidative effect, where the anti-oxidative effect of asparagus was strong enough to prevent the pro-oxidative effect of shrimp. The effect of ingredients in tuna salads was inconclusive, possibly due to a high content of volatiles in the vegetables themselves. However, the addition of spices increased the oxidative stability of tuna salad (oregano>rosemary>thyme).
The effect of farmed trout on cardiovascular risk markers in healthy men

Increased intake of marine long-chain n-3 PUFA (n-3 LCPUFA) may decrease the risk of CVD and reduce mortality by lowering serum TAG and blood pressure (BP). Furthermore, n-3 LCPUFA may affect novel CVD risk markers related to inflammation and vascular function. The objective of the present study was to examine the effect of farmed trout on novel and traditional CVD risk markers in healthy men, and to evaluate whether this was affected by the aquacultural feed regime. We performed a parallel, 8-week intervention study in which sixty-eight healthy male volunteers were randomised to consume either a daily meal with 150 g farmed trout raised on either marine or vegetable-based feed, or a reference meal containing 150 g chicken. Twenty-four hour BP, pulse wave velocity, augmentation index, fatty acid composition of erythrocyte (RBC), and concentrations of TAG, HDL-cholesterol, LDL-cholesterol, glucose, insulin, C-reactive protein (CRP) and other markers of inflammation were measured at weeks 0 and 8. RBC content of total n-3 LCPUFA, both EPA and DHA, was significantly higher among men consuming trout raised on marine feed compared with men consuming the vegetable-fed trout or chicken. The three intervention groups did not differ significantly with respect to any of the other outcome variables, although there were trends towards associations between the changes in RBC n-3 LCPUFA and those in BP and CRP. In the present study, we conclude that we could not confirm the fish oil-induced reduction in CVD risk markers after daily consumption of trout with high or low n-3 LCPUFA content. However, trout raised on vegetable-based
feed had less pronounced impact on RBC n-3 LCPUFA status.

**General information**

State: Published
Organisations: Division of Seafood Research, National Food Institute, Division of Food Chemistry, National Institute of Aquatic Resources, University of Copenhagen, Aalborg University Hospital, BioMar A/S
Authors: Hallund, J. (Ekstern), Madsen, B. O. (Ekstern), Bügel, S. H. (Ekstern), Jacobsen, C. (Intern), Jakobsen, J. (Intern), Krarup, H. (Ekstern), Holm, J. (Ekstern), Nielsen, H. H. (Intern), Lauritzen, L. (Ekstern)
Publication date: 2010
Main Research Area: Technical/natural sciences

**Publication information**

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Volume: 104
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BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.46 SJR 1.983 SNIP 1.533
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.583 SNIP 1.446 CiteScore 3.52
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.468 SNIP 1.278 CiteScore 3.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 2.72 SNIP 2.521 CiteScore 3.61
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 2.263 SNIP 2.484 CiteScore 3.12
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.079 SNIP 1.661 CiteScore 3.13
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.248 SNIP 1.277
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.62 SNIP 0.581
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.956 SNIP 1.199
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.941 SNIP 1.192
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.71 SNIP 0.924
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.513 SNIP 1.152
The influence of emulsifier type on lipid oxidation in fish-oil-enriched light mayonnaise

The oxidative stability of fish oil-enriched light mayonnaise (40% oil) and the influence of two different emulsifiers, egg yolk and milk protein-based emulsifier, were evaluated. Moreover, the effects of different fish oil concentrations (4, 10 and 14%) and storage temperatures (2 and 20 degrees C) were investigated. As expected, the results showed that lipid oxidation increased with storage temperature, and at 20 degrees C with increasing fish oil concentrations. On the basis of the findings in this study, a storage temperature of 20 degrees C for 4 months cannot be recommended for light mayonnaise due to significant lipid oxidation even in mayonnaises without fish oil. However, enrichment of light mayonnaises with 4% fish oil without adding antioxidant did not result in increased oxidation when stored at 2 degrees C, and thus seems feasible; however, this has to be confirmed by sensory analysis. Surprisingly, our hypothesis that substitution of egg yolk with a less iron-containing emulsifier (milk protein-based emulsifier) could increase the oxidative stability of fish oil-enriched mayonnaises was not confirmed. These findings suggest that the initial quality of the emulsifiers was more important than its iron content in terms of lipid oxidation.
Additions of caffeic acid, ascorbyl palmitate or gamma-tocopherol to fish oil-enriched energy bars affect lipid oxidation differently

The objectives of the study were to investigate the effects of caffeic acid, ascorbyl palmitate and gamma-tocopherol on protection of fish oil-enriched energy bars against lipid oxidation during storage for 10 weeks at room temperature. The lipophilic gamma-tocopherol reduced lipid oxidation during storage when added at a concentration above 440 μg/g fish oil. However, the best antioxidative effect was observed when it was added at a concentration of 660 μg/g fish oil. In contrast, prooxidative effects were observed when using either gamma-tocopherol at concentrations below 220 μg/g fish oil, or the hydrophilic caffeic acid, or the amphiphilic ascorbyl palmitate at concentrations of 75, 150 and 300 μg/g fish oil. Prooxidative effects were observed as an increase in the formation of lipid hydroperoxides and volatile secondary oxidation products, as well as the development of rancid off-flavours. The differences in the efficacies of the three antioxidants examined are expected to be related to their different localisations and mechanisms of action. (C) 2008 Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Antioxidant activities and phenolic content of some of the selected species of seaweeds from Danish coast

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Farvin, S. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 3rd Joint Trans-Atlantic Fisheries Technology Conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 225795
Publication: Research - peer-review › Journal article – Annual report year: 2009

Antioxidant properties of modified rutin esters following lipase-catalyzed esterification

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, National Food Institute
Authors: Lue, B. (Intern), Jacobsen, C. (Intern), Nielsen, N. S. (Intern), Guo, Z. (Intern), Xu, X. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
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Publication: Research › Conference abstract for conference – Annual report year: 2009

Antioxidant strategies to prevent lipid oxidation in omega-3 enriched food emulsions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Nielsen, N. S. (Intern), Sørensen, A. M. (Intern), Timm Heinrich, M. (Intern), Bruni Let, M. (Intern)
Publication date: 2009
Event: Abstract from 3rd Joint Trans-Atlantic Fisheries Technology Conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 252994
Publication: Research › Conference abstract for conference – Annual report year: 2009

Application of omega-3 oils in foods and emulsified products

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from International Forum and Short Course on Nutraceuticals and Functional Foods, Skiathos, Greece.
Can increased water velocities improve quality of farmed rainbow trout

General information
State: Published
Organisations: Section for Aquaculture, National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Section for Aquatic Process and Product Technology
Publication date: 2009
Event: Abstract from 3rd Joint Trans-Atlantic Fisheries Technology Conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253232
Publication: Research › Conference abstract for conference – Annual report year: 2009

Challenges when developing omega-3 enriched foods

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 252268
Publication: Research › Conference abstract for conference – Annual report year: 2009

Does feed composition affect oxidation of rainbow trout (Oncorhynchus mykiss) during frozen storage?
Rainbow trout (Oncorhynchus mykiss) were fed a diet containing either fish oil or rapeseed oil and with or without 200 mg/kg carotenoid (either astaxanthin or canthaxanthin). A total of six diets were obtained: (1) fish oil/astaxanthin; (2) vegetable oil/astaxanthin; (3) fish oil/canthaxanthin; (4) vegetable oil/canthaxanthin; (5) fish oil/no pigment; and (6) vegetable oil/no pigment. The fish were slaughtered and stored in polyethylene bags individually as butterfly fillets for up to 22 months at -20°C. The composition of the fish muscle at slaughter and during frozen storage was evaluated by sampling after 4, 8, 13, 18, and 22 months. The carotenoid content in the muscle was found to be approximately 9-10 mg/kg of fish for both carotenoids. Primary oxidation lipid products (peroxides) as well as secondary oxidation products (volatiles) were measured. In addition, the level of protein carbonyl groups and the content of tocopherols and carotenoids in the muscle were also measured. To estimate the overall changes in sensory properties of the different samples during storage, a trained sensory panel also evaluated the samples. Both the sensory panel and the chemical analysis revealed that in this investigation fish fed fish oil were slightly more oxidized than fish fed vegetable oil. Results showed that canthaxanthin effectively protected both protein and lipid against oxidation during frozen storage. In contrast, astaxanthin did not seem to have a clear and systematic effect. Results indicated that the feed composition influenced the fish muscle composition and subsequently the oxidative stability of the fish during frozen storage. Besides, other constituents in the feed might influence deposition of antioxidants in the tissue and consequently affect the oxidative stability of the muscle.

General information
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Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Process and Product Technology
Authors: Baron, C. (Intern), Hyldig, G. (Intern), Jacobsen, C. (Intern)
Pages: 4185-4194
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Main Research Area: Technical/natural sciences
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Volume: 57
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BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.384 SNIP 1.446 CiteScore 3.1
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.408 SNIP 1.392
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.317 SNIP 1.303
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.361 SNIP 1.324
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.249 SNIP 1.439
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.358 SNIP 1.418
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.286 SNIP 1.521
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.316 SNIP 1.496
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.158 SNIP 1.479
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.236 SNIP 1.537
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.066 SNIP 1.255
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.091 SNIP 1.312
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.859 SNIP 1.256
Original language: English
Trout, Frozen storage, Lipid oxidation, Protein oxidation, Feed composition
Effect of emulsifier type, iron and pH on the oxidative stability of 5% fish oil-in-water emulsions

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Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Nielsen, N. S. (Intern), Horn, A. F. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 7th Euro Fed Lipid Conference. Lipids, Fats and Oils. From knowledge to application, Graz, Austria, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244458
Publication: Research › Journal article – Annual report year: 2009

Effect of fish oil concentration and emulsifier on lipid oxidation in fish oil enriched mayonnaise

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Sørensen, A. M. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 100th Annual AOCS meeting, Orlando, Florida, May 2009, Orlando, FL. USA, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253090
Publication: Research › Conference abstract for conference – Annual report year: 2009

Effect of ingredients on oxidative stability of fish oil-enriched drinking yoghurt

The oxidative stabilities of fish oil-enriched milk and fish oil-enriched drinking yoghurt were compared by following the development of lipid oxidation in plain milk, plain yoghurt and yoghurt to which ingredients present in drinking yoghurt were added one by one. All samples were enriched with 1 wt-% fish oil. After 3 weeks of storage, development of peroxide values, volatile secondary oxidation products and fishy offflavors were much more pronounced in the milk compared to any of the yoghurt samples, irrespective of any added ingredients used to prepare flavored drinking yoghurt. Thus, pectin, citric acid or glucono delta-lactone did not affect the oxidative stability of fish oil-enriched yoghurt emulsions. Furthermore, the fruit preparation and added sugar did not lead to increased antioxidative activity. It is concluded that yoghurt as the dairy component in the fish oil-enriched emulsion was responsible for the remarkably high oxidative stability and was able to protect the n-3 PUFA against oxidative deterioration. It should be considered that this strong antioxidative effect of yoghurt might mask potential antioxidative effects of the other ingredients in the drinking yoghurt.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Division of Seafood Research
Authors: Nielsen, N. S. (Intern), Klein, A. (Ekstern), Jacobsen, C. (Intern)
Pages: 337-345
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 111
Issue number: 4
ISSN (Print): 1438-7697
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.873 SNIP 1.207 CiteScore 2.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.732 SNIP 0.945 CiteScore 1.75
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.791 SNIP 1.049
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.838 SNIP 1.077
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.606 SNIP 0.815
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.598 SNIP 0.801
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.704 SNIP 0.9
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.674 SNIP 0.98
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.585 SNIP 0.946
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.479 SNIP 0.758
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.458 SNIP 0.71
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.331 SNIP 0.645
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
Volatile, Sensory evaluation, Oxidation, Peroxide value
DOIs:
10.1002/ejlt.200800162
Links:
http://www3.interscience.wiley.com.globalproxy.cvt.dk/journal/69502350/home?CRETRY=1&SRETRY=0
Source: orbit
Source-ID: 241915
Fødevarer beriget med fiskeolie: Stabilitet - ernæring - forbrugernes accept

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 1
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: SeafoodCircle Faktablad
Issue number: 3
Original language: Danish
Source: orbit
Source-ID: 240184
Publication: Communication › Journal article – Annual report year: 2009

Fødevarer med fiskeolier undervejs

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Division of Seafood Research
Authors: Jørgensen, S. B. (ed.) (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: FoodDTU Midt i Ugen
Issue number: 83
Original language: Danish
Source: orbit
Source-ID: 257978
Publication: Communication › Journal article – Annual report year: 2009

Foods enriched with fish oil: Stability – nutrition – consumer acceptance

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for Biological Sequence Analysis, Department of Systems Biology
Publication date: 2009
Event: Abstract from Presentation at 25th LipidForum Symposium, Elsinore, Denmark
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253092
Publication: Research › Conference abstract for conference – Annual report year: 2009

Influence of feeding regimes on composition and oxidative stability of rainbow trout (Oncorhynchus mykiss)

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Timm Heinrich, M. (Intern), Jacobsen, C. (Intern), Eymard, S. (Intern), Holm, J. (Ekstern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Influence of feeding regimes on fish composition and oxidative stability

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Publication date: 2009
Event: Abstract from 38th Annual WEFTA Meeting: Seafood from Catch and Aquaculture for a Sustainable Supply, Florence, Italy, September.
Main Research Area: Technical/natural sciences
Source: orbit

Lipid oxidation in fish oil enriched energy bars is affected by means of oil addition and addition of antioxidants

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Nielsen, N. S. (Intern), Horn, A. F. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit

Marifunc: Hvorfor er fisk så sundt?

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 1
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: SeafoodCircle Faktablad 9
Issue number: 9
Original language: Danish
Links:
Source: orbit
Source-ID: 249690
Publication: Communication › Journal article – Annual report year: 2009

Methods for reducing lipid oxidation in fish-oil-enriched energy bars

Methods for reducing lipid oxidation in fish-oil-enriched energy bars

Fish oil (FO) enrichment of foods is relevant owing to the beneficial effects of omega-3 polyunsaturated fatty acids on health. However, the susceptibility of FO to oxidation necessitates careful control to avoid this oxidation. In this study, energy bars were successfully supplemented with 5% FO. Heating of bars during baking did, apparently, not increase oxidation. Energy bars produced with neat FO were oxidatively unstable as measured by peroxide value, secondary volatile oxidation products and sensory analysis. Pre-emulsification of the FO with sodium caseinate in water offered similar protection towards oxidation as packaging the energy bars in modified atmosphere. These protection methods were although not as efficient as addition of FO as micro-encapsulated powder. Addition of the metal chelator ethylene diamine tetra-acetic acid (EDTA) (100-2000 ppm) to emulsified FO decreased the oxidative stability of the energy bars compared with the energy bars with emulsified FO but without EDTA.

General information
Optimization of fatty acid composition in the diet for female broodstock eels

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Population- and Ecosystem Dynamics, Section for Coastal Ecology
Oxidation challenges in functional foods and nutraceuticals

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from International Forum and Short Course on Nutraceuticals and Functional Foods, Skiathos, Greece.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253233
Publication: Research › Conference abstract for conference – Annual report year: 2009

Oxidation challenges in functional omega-3 oils and products there of: Preservation and protection techniques

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Horn, A. F. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from ISNFF Short Course Series International Forum and Practical Short Course on Omega-3 and Beyond: San Francisco, CA October 31 and November 1, 2009, San Francisco, CA, USA.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253246
Publication: Research › Conference abstract for conference – Annual report year: 2009

Oxidation of lipid and protein in horse mackerel (Trachurus trachurus) mince and washed minces during processing and storage

Protein and lipid oxidation was followed during processing and storage of mince and washed minces prepared from horse mackerel (Trachurus trachunts). Briefly horse mackerel mince (MO) was washed with three volumes of water, mimicking the surimi production and different washed products were obtained: M1, M2 and M3, with one, two and three washing steps, respectively. The different products were characterised (i.e. lipid content, protein, water, iron, fatty acid profile and tocopherol content) and analysed for protein and lipid oxidation in order to investigate the impact of the washing steps on oxidation. Subsequently the different products were stored for up to 96 h at 5 degrees C and samples were taken out regularly for analysis. Lipid oxidation was investigated by measuring primary oxidation products (lipid hydroperoxides) and secondary oxidation products (volatiles). Protein oxidation was followed by determination of protein solubility, protein thiol groups and protein carbonyl groups using colorimetric methods as well as western blotting for protein carbonyl groups. Lipid and protein oxidation markers indicated that both lipid and protein oxidation took place during processing and the ranking for oxidation was as follows M0 < M1 < M2 = M3. Lipid and protein oxidation developed simultaneously in different minces during storage, but it was not possible to determine at which level these two reactions were coupled.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Eymard, S. (Intern), Baron, C. (Intern), Jacobsen, C. (Intern)
Pages: 57-65
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Food Chemistry
Volume: 114
Issue number: 1
ISSN (Print): 0308-8146
Ratings:
Washed fish mince, Omega-3, Lipid oxidation, Surimi, Protein oxidation

DOIs:
10.1016/j.foodchem.2008.09.030
Oxidative stability of fish fillets depending on feeding regime

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Process and Product Technology
Publication date: 2009
Event: Abstract from 25th Nordic Lipid Symposium, Elsinore, Denmark, June, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 252997
Publication: Research › Conference abstract for conference – Annual report year: 2009

Potato peel extract - A natural antioxidant for retarding lipid oxidation in bulk fish oil and oil in water emulsions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Farvin, S. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 25th lipid symposium, 15-17 June, Elsinore, Denmark, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253110
Publication: Research › Conference abstract for conference – Annual report year: 2009

Preventing lipid oxidation in foods enriched with fish oil

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Nielsen, N. S. (Intern), Horn, A. F. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 3rd Joint Trans-Atlantic Fisheries Technology Conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253094
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2009

Processing of marine lipids and factors affecting their quality when used for functional foods

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Rustad, T. (Ekstern), Nielsen, N. S. (Intern), Falch, E. (Ekstern), Jansson, S. (Ekstern), Storr, I. (Ekstern)
Number of pages: 176
Pages: 89-114
Publication date: 2009

Host publication information
Title of host publication: Marine functional food
Volume: 2
Place of publication: Wageningen
Publisher: Wageningen Academic Publishers
Editor: Luten, J.
ISBN (Print): 90-86-86078-8
Main Research Area: Technical/natural sciences
Retaining nutritional and sensory quality of seafood products by antioxidant protection: Challenges and pitfalls

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 3rd Joint Trans-Atlantic Fisheries Technology Conference, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253235
Publication: Research › Conference abstract for conference – Annual report year: 2009

Seasonal lipid dynamics of herring and sprat in the Baltic Sea and possible implications for cod reproduction
The Baltic Sea experienced a regime shift in the 1980ies with major changes in food web dynamics. These ecosystem alterations were related to climatic driven changes in hydrographic conditions affecting phyto- and zooplankton assemblage and hence the food availability for clupeids. Sprat abundance increased dramatically in the early 1990ies. The changes in plankton communities in combination with increased competition resulted in declined condition of clupeids. Polyunsaturated fatty acids originate from phytoplankton and are transmitted through the food web. The present study investigates if the seasonal variation in lipid composition of herring and sprat reflects the changes in plankton. Fish were sampled five times over a year and the lipid composition of different size groups was analyzed. Significant seasonal variation in average lipid content in sprat was found: 14.00% in November, 11.26% in January, 7.47% in March and 9.60% in June. The lipid content in herring also varied within season but was lower than sprat: 7.42% in November, 6.71% in January and 4.70% in March. The seasonal lipid dynamic was reflected in variation of specific fatty acids. Clupeids are the major prey of Baltic cod so deficiencies of essential fatty acids could be a limiting factor for cod reproduction

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Section for Marine Ecology and Oceanography, National Food Institute, Division of Industrial Food Research, Institute Management
Authors: Røjbek, M. (Intern), Tomkiewicz, J. (Intern), Støttrup, J. (Intern), Jacobsen, C. (Intern), Köster, F. (Intern)
Publication date: 2009
Event: Poster session presented at ICES/PICES/UNCOVER Symposium 2009 on Rebuilding Depleted Fish Stocks, Warnemünde/Rostock, Germany.
Main Research Area: Technical/natural sciences
Publication: Research › Poster – Annual report year: 2009

Sensory impact of volatile oxidation products in omega-3 enriched foods and prevention of off-flavours

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Publication date: 2009
Event: Abstract from 12th International flavour conference. Recent advances in food and flavour chemistry. Skiathos, Greece, May, Skiathos, Greece.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253234
Publication: Research › Conference abstract for conference – Annual report year: 2009

The effect of different fish feeds on the sensory quality in farmed trout after frozen storage

General information
State: Published
Organisations: Section for Aquatic Process and Product Technology, National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Hyldig, G. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
The efficacy of compounds with different polarities as antioxidant in fish oil enriched emulsions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Sørensen, A. M. (Intern), Nielsen, N. S. (Intern), Decker, E. (Ekstern), Jacobsen, C. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253096
Publication: Research › Conference abstract for conference – Annual report year: 2009

The protective effect of emulsifiers on 70% oil-in-water emulsions, to be used as delivery system of omega-3s to food

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Horn, A. F. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2009
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253095
Publication: Research › Poster – Annual report year: 2009

A molecular approach to pre-harvest impact on post-harvest quality of trout

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Protein Biochemistry, Section for Aquatic Process and Product Technology
Publication date: 2008
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 242449
Publication: Research › Paper – Annual report year: 2008

Antioxidant activity of potato peel extracts in bulk fish oil and oil in water emulsions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Farvin, S. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2008
Event: Abstract from 38th Annual WEFTA meeting-Seafood from catch and aquaculture for a sustainable supply, 16-19 September, Florence, Italy.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253109
Publication: Research › Conference abstract for conference – Annual report year: 2008
Antioxidant strategies for preventing oxidative flavour deterioration of foods enriched with n-3 polyunsaturated lipids: a comparative evaluation

The aim of this review is to provide a better base for predicting the ability of antioxidants to prevent lipid oxidation in food emulsions in general and in functional food systems enriched with n-3 PUFA in particular. Therefore, the antioxidant efficacies of a range of commercially available antioxidants in a number of fish oil enriched real food emulsions (milk, milk drink, salad dressing, mayonnaise and selected model emulsions) are compared. This comparison clearly shows that the same antioxidant exerts different effects in different systems. EDTA is a very efficient antioxidant in salad dressing and mayonnaise, but not in milk, while ascorbyl palmitate efficiently reduces oxidation in milk. Furthermore, the comparative data evaluation confirms that the same antioxidant in some cases may exert opposite effects on peroxide levels and on formation of individual volatiles and fishy odour and flavours. Therefore, antioxidant effects should always be evaluated by more than one method.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Jacobsen, C. (Intern), Let, M. (Ekstern), Nielsen, N. S. (Intern), Meyer, A. S. (Intern)
Pages: 76-93
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Trends in Food Science & Technology
Volume: 19
Issue number: 2
ISSN (Print): 0924-2244
Ratings:
  BFI (2018): BFI-level 2
  Web of Science (2018): Indexed yes
  BFI (2017): BFI-level 2
  Web of Science (2017): Indexed Yes
  BFI (2016): BFI-level 2
  Scopus rating (2016): CiteScore 6 SJR 2.279 SNIP 2.694
  BFI (2015): BFI-level 2
  Scopus rating (2015): SJR 2.218 SNIP 2.6 CiteScore 5.51
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 2
  Scopus rating (2014): SJR 2.183 SNIP 2.789 CiteScore 5.17
  BFI (2013): BFI-level 2
  Scopus rating (2013): SJR 2.195 SNIP 2.679 CiteScore 4.83
  ISI indexed (2013): ISI indexed yes
  Web of Science (2013): Indexed yes
  BFI (2012): BFI-level 2
  Scopus rating (2012): SJR 2.098 SNIP 2.428 CiteScore 3.91
  ISI indexed (2012): ISI indexed yes
  Web of Science (2012): Indexed yes
  BFI (2011): BFI-level 2
  Scopus rating (2011): SJR 1.877 SNIP 2.623 CiteScore 3.81
  ISI indexed (2011): ISI indexed yes
  Web of Science (2011): Indexed yes
  BFI (2010): BFI-level 2
  Scopus rating (2010): SJR 1.729 SNIP 2.488
  Web of Science (2010): Indexed yes
  BFI (2009): BFI-level 2
  Scopus rating (2009): SJR 2.153 SNIP 2.574
  BFI (2008): BFI-level 2
  Scopus rating (2008): SJR 1.794 SNIP 2.316
  Web of Science (2008): Indexed yes
Application of structured lipids in food

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Timm Heinrich, M. (Intern), Nielsen, N. S. (Intern)
Publication date: 2008
Event: Poster session presented at 99th AOCS Annual Meeting & Expo, Seattle, WA, United States.
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract and oral presentation at the 99th Annual AOCS meeting Seattle, USA May 2008
Source: orbit
Source-ID: 238832
Publication: Research › Poster – Annual report year: 2008

Applications of natural antioxidants in omega-3-enriched foods

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Bruni Let, M. (Intern), Sørensen, A. M. (Intern), Horn, A. F. (Intern), Timm Heinrich, M. (Intern), Nielsen, N. S. (Intern)
Pages: 3288-3295
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Electronic Journal of Environmental, Agricultural and Food Chemistry
Volume: 7
Issue number: 8
ISSN (Print): 1579-4377
Ratings:
Scopus rating (2015): SJR 0.141 SNIP 0.644
Scopus rating (2014): SJR 0.16 SNIP 0.466
Scopus rating (2013): SJR 0.172 SNIP 0.523
ISI indexed (2013): ISI indexed no
Emulsifier type, metal chelation and pH affect oxidative stability of n-3-enriched emulsions

Recent research has shown that the oxidative stability of oil-in-water emulsions is affected by the type of surfactant used as emulsifier. The aim of this study was to evaluate the effect of real food emulsifiers as well as metal chelation by EDTA and pH on the oxidative stability of a 10% n-3-enriched oil-in-water emulsion. The selected food emulsifiers were Tween 80, Citrem, sodium caseinate and lecithin. Lipid oxidation was evaluated by determination of peroxide values and secondary volatile oxidation products. Moreover, the zeta potential and the droplet sizes were determined. Tween resulted in the least oxidatively stable emulsions, followed by Citrem. When iron was present, caseinate-stabilized emulsions oxidized slower than lecithin emulsions at pH 3, whereas the opposite was the case at pH 7. Oxidation generally progressed faster at pH 3 than at pH 7, irrespective of the addition of iron. EDTA generally reduced oxidation, as evaluated by volatiles formation in all emulsions, irrespective of pH and emulsifier type, except in the lecithin and caseinate emulsions where a pro-oxidative effect was observed for some volatiles. The different effects of the emulsifier types could be related to their ability to chelate iron, scavenge free radicals, interfere with interactions between the lipid hydroperoxides and iron as well as to form a physical barrier around the oil droplets.
Enrichment of foods with omega-3 fatty acids

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229020
Publication: Research - peer-review → Journal article – Annual report year: 2008

Healthy polyunsaturated fatty acids (PUFAs) for food enrichment

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Bruni Let, M. (Intern)
Impact of emulsifiers on the oxidative stability of 70% fish oil-in-water emulsions

The behavior of antioxidants in emulsions is influenced by several factors such as pH and emulsifier type. This study aimed to evaluate the interaction between selected food emulsifiers, phenolic compounds, iron, and pH and their effect on the oxidative stability of n-3 polyunsaturated lipids in a 10% oil-in-water emulsion. The emulsifiers tested were Tween 80 and Citrem, and the phenolic compounds were naringenin, rutin, caffeic acid, and coumaric acid. Lipid oxidation was evaluated at all levels, that is, formation of radicals (ESR), hydroperoxides (PV), and secondary volatile oxidation products. When iron was present, the pH was crucial for the formation of lipid oxidation products. At pH 3 some phenolic compounds, especially caffeic acid, reduced Fe3+ to Fe2+, and Fe2+ increased lipid oxidation at this pH compared to pH 6. Among the evaluated phenols, caffeic acid had the most significant effects, as caffeic acid was found to be prooxidative irrespective of pH, emulsifier type, and presence of iron, although the degrees of lipid oxidation were different at the different experimental conditions. The other evaluated phenols were prooxidative at pH 3 in Citrem-stabilized emulsions and had no significant effect at pH 6 in Citrem- or Tween-stabilized emulsions on the basis of the formation of volatiles. The results indicated that phenol-iron complexes/nanoparticles were formed at pH 6.

Interactions between iron, phenolic compounds, emulsifiers, and pH in omega-3-enriched oil-in-water emulsions

The behavior of antioxidants in emulsions is influenced by several factors such as pH and emulsifier type. This study aimed to evaluate the interaction between selected food emulsifiers, phenolic compounds, iron, and pH and their effect on the oxidative stability of n-3 polyunsaturated lipids in a 10% oil-in-water emulsion. The emulsifiers tested were Tween 80 and Citrem, and the phenolic compounds were naringenin, rutin, caffeic acid, and coumaric acid. Lipid oxidation was evaluated at all levels, that is, formation of radicals (ESR), hydroperoxides (PV), and secondary volatile oxidation products. When iron was present, the pH was crucial for the formation of lipid oxidation products. At pH 3 some phenolic compounds, especially caffeic acid, reduced Fe3+ to Fe2+, and Fe2+ increased lipid oxidation at this pH compared to pH 6. Among the evaluated phenols, caffeic acid had the most significant effects, as caffeic acid was found to be prooxidative irrespective of pH, emulsifier type, and presence of iron, although the degrees of lipid oxidation were different at the different experimental conditions. The other evaluated phenols were prooxidative at pH 3 in Citrem-stabilized emulsions and had no significant effect at pH 6 in Citrem- or Tween-stabilized emulsions on the basis of the formation of volatiles. The results indicated that phenol-iron complexes/nanoparticles were formed at pH 6.
Interactions between phenolic compounds, emulsifiers and Ph in Omega-3 enriched emulsions

General information
Investigation of dairy components responsible for resistance of omega-3 enriched yoghurt to lipid oxidation

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Farvin, S. (Intern), Baron, C. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract and oral presentation at 6th EuroFedLipid Congress, Athens, Greece, Sept 2008
Source: orbit
Source-ID: 253108
Publication: Research › Conference abstract for conference – Annual report year: 2008

Investigation of dairy components responsible for resistance of omega-3 enriched yoghurt to lipid oxidation

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Farvin, S. (Intern), Baron, C. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 253108
Publication: Research › Conference abstract for conference – Annual report year: 2008

Measuring oxidative stability in functional lipids

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Number of pages: 700
Publication date: 2008

Host publication information
Title of host publication: Handbook of lipid enzymology
Place of publication: Boca Raton
Publisher: C R C Press LLC
Editor: Xu, X.
Edition: 1
ISBN (Print): 978-1574444698
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 225897
Publication: Research - peer-review › Book chapter – Annual report year: 2008
Omega-3s in food emulsions: overview and case studies

There is an increasing interest in the use of healthy long chain omega-3 oils in foods. Incorporation of omega-3 oils into foods decreases their oxidative stability and therefore precautions need to be taken to avoid lipid oxidation. This review summarises the major factors to take into consideration when developing food emulsions enriched with omega-3 oils and examples on how oxidation can be reduced in products such as mayonnaise, spreads, milk, yoghurt are also given.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 9-13
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Agro Food Industry Hi-Tech
Volume: 19
Issue number: 5
ISSN (Print): 1722-6996
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.33 SJR 0.193 SNIP 0.137
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.161 SNIP 0.176 CiteScore 0.24
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.152 SNIP 0.147 CiteScore 0.22
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.174 SNIP 0.102 CiteScore 0.28
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.159 SNIP 0.096 CiteScore 0.19
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.161 SNIP 0.132 CiteScore 0.21
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.147 SNIP 0.091
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.158 SNIP 0.088
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.133 SNIP 0.084
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.123 SNIP 0.094
Scopus rating (2006): SJR 0.123 SNIP 0.044
Scopus rating (2005): SJR 0.121 SNIP 0.085
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.124 SNIP 0.138
Scopus rating (2003): SJR 0.137 SNIP 0.159
Oxidative stability of mayonnaise based salads enriched with fish oil

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Sørensen, A. M. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2008
Event: Poster session presented at 99th AOCS Annual Meeting & Expo, Seattle, WA, United States.
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract and oral presentation at the 99th Annual AOCS meeting Seattle, USA May 2008
Source: orbit
Source-ID: 238842
Publication: Research › Poster – Annual report year: 2008

Preventing lipid oxidation in seafood

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Undeland, I. (Ekstern), Storrø, I. (Ekstern), Rustad, T. (Ekstern), Hedges, N. (Ekstern), Medina, I. (Ekstern)
Pages: 426-460
Publication date: 2008

Host publication information
Title of host publication: Improving seafood products for the consumer
Place of publication: Cambridge
Publisher: British Welding Research Association
Editor: Børresen, T.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 225912
Publication: Research - peer-review › Book chapter – Annual report year: 2008

Protein and lipid oxidation in frozen rainbow trout

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Protein Biochemistry
Authors: Baron, C. (Intern), Kjærgård, I. V. H. (Intern), Jessen, F. (Intern), Jacobsen, C. (Intern)
Publication date: 2008
Event: Poster session presented at 99th AOCS Annual Meeting & Expo, Seattle, WA, United States.
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract and poster presentation at the 99th Annual AOCS meeting Seattle, USA May 2008
Source: orbit
Source-ID: 238841
Publication: Research › Poster – Annual report year: 2008
Sådan ændres produktionsål til moderfisk

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Population- and Ecosystem Dynamics, Section for Coastal Ecology
Authors: Jacobsen, C. (Intern), Tomkiewicz, J. (Intern), Støttrup, J. (Intern)
Publication date: 2008
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 239104
Publication: Research › Conference abstract for conference – Annual report year: 2008

Successful production of viable eggs and larvae of european eel (anguilla anguilla)

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Ocean Ecology and Climate, Section for Coastal Ecology, Section for Aquatic Lipids and Oxidation
Authors: Tomkiewicz, J. (Intern), Munk, P. (Intern), Støttrup, J. (Intern), Jacobsen, C. (Intern), Lauesen, P. (Ekstern), Graver, C. (Ekstern)
Publication date: 2008
Event: Abstract from Aquaculture Europe 08, Krakow, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 239103
Publication: Research › Conference abstract for conference – Annual report year: 2008

Production of oxidatively stable fish oil enriched food emulsions
Purpose: The objective of the project is to determine how a number of selected fish oil enriched foods can be protected against oxidation by the right choice of antioxidants, emulsifiers and optimal process conditions. Furthermore the influence of antioxidant addition to the fish oil it-self on the effect of antioxidants added to the foods will also be investigated.
Background: Fish oils are rich sources of the long-chain polyunsaturated fatty acids EPA and DHA of which DHA is a vital component of the phospholipids of human cellular membranes, especially those in the brain and retina. Fish oils have many other health benefiting properties such as preventing heart diseases. Addition of fish oils to foods is therefore of interest. The many double bonds in the fatty acids are however susceptible to oxidation. Collaboration partners: The project is a collaborative project between DFU-FF, BioCentrum-DTU, Arla Foods and Maritex A/S.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Department of Chemical and Biochemical Engineering
Authors: Bruni Let, M. (Intern), Meyer, A. S. (Intern), Jacobsen, C. (Intern)
Number of pages: 83
Publication date: May 2007

Publication information
Publisher: DIFRES, DTU
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 226441
Publication: Research › Ph.D. thesis – Annual report year: 2007

Application of antioxidants during short-path distillation of structured lipids
A specific structured lipid was produced from sunflower oil and caprylic acid. The antioxidative effect of adding alpha-tocopherol, ascorbyl palmitate or citric acid (each in three different concentrations) was investigated before and after the purification process (short-path distillation), and was compared with a control without addition of antioxidant. The oxidative status and stability were characterized by peroxide and anisidine values, secondary volatile oxidation products and induction period. The antioxidants affected the oxidative status compared with the control: citric acid was prooxidative at low concentrations, but antioxidative at high concentrations. Addition of ascorbyl palmitate had an antioxidative effect at all concentrations employed. alpha-Tocopherol showed less antioxidative activity compared with ascorbyl palmitate and citric acid, and its efficacy was slightly decreased with increasing concentration. Combinations of citric acid with ascorbyl palmitate were tested in a later part of the study. No additive or synergistic effect was found between citric acid and ascorbyl palmitate.
Ascorbyl palmitate, gamma-tocopherol, and EDTA affect lipid oxidation in fish oil enriched salad dressing differently

The aim of the study was to investigate the ability of γ-tocopherol, ethylenediaminetetraacetate (EDTA), and ascorbyl palmitate to protect fish oil enriched salad dressing against oxidation during a 6 week storage period at room temperature. The lipid-soluble γ-tocopherol (220 and 880 µg g-1 of fish oil) reduced lipid oxidation during storage by partly retarding the formation of lipid hydroperoxides (PV) and by decreasing the concentrations of individual volatile oxidation products by 34-39 and 42-66%, respectively. EDTA (10 and 50 µg g-1 of dressing) was the most efficient single antioxidant, and overall peroxide values and volatiles were reduced by approximately 70 and 77-86%, respectively. Conversely, prooxidant effects were observed with a high concentration of ascorbyl palmitate (300 µg g-1 of fish oil), whereas a low concentration was slightly antioxidative (50 µg/g of fish oil). Finally, a combination of all three antioxidants completely inhibited oxidation during storage, indicating that the prooxidant effects of ascorbyl palmitate were reverted or overshadowed by EDTA and γ-tocopherol.

General information
State: Published
Organisations: National Food Institute, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology
Authors: Timm-Heinrich, M. (Ekstern), Xu, X. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Pages: 244-262
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Food Lipids
Volume: 14
Issue number: 3
ISSN (Print): 1065-7258
Ratings:
Scopus rating (2012): SJR 0.43 SNIP 0.918
Scopus rating (2011): SJR 0.609 SNIP 1.029
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.45 SNIP 0.812
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.715 SNIP 0.722
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.362 SNIP 0.553
Scopus rating (2007): SJR 0.39 SNIP 0.498
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.375 SNIP 0.739
Scopus rating (2005): SJR 0.284 SNIP 0.496
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.261 SNIP 0.497
Scopus rating (2003): SJR 0.238 SNIP 0.266
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.277 SNIP 0.565
Scopus rating (2001): SJR 0.348 SNIP 0.511
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.408 SNIP 0.438
Scopus rating (1999): SJR 0.37 SNIP 0.586
Original language: English
DOIs:
10.1111/j.1745-4522.2007.00083.x
Source: orbit
Source-ID: 219794
Publication: Research - peer-review › Journal article – Annual report year: 2007
Comparison of methods to reduce dioxin and polychlorinated biphenyls contents in fishmeal: Extraction and enzymatic treatments

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, FF secretariat
Authors: Baron, C. (Intern), Børresen, T. (Intern), Jacobsen, C. (Intern)
Pages: 1620-1626
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 55
Issue number: 4
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.384 SNIP 1.446 CiteScore 3.1
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Comparison of oxidative stability in omega-3 PUFA enriched dairy products

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Klein, A. (Ekstern), Horn, A. F. (Intern), Bruni Let, M. (Intern), Nielsen, N. S. (Intern)
Publication date: 2007
Event: Abstract from 98th AOCS Annual Meeting & Expo, Quebec, Canada.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229307
Publication: Research › Conference abstract for conference – Annual report year: 2007

Enzymatic structural modification of antioxidants for omega-3 oil protection

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Department of Systems Biology
Authors: Bruni Let, M. (Intern), Schultz, L. (Ekstern), Zhang, H. (Ekstern), Guo, Z. (Ekstern), Jacobsen, C. (Intern), Xu, X. (Intern)
Publication date: 2007
Event: Abstract from European Congress of Chemical Engineering - 6, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229359
Enzymatic structural modification of antioxidants for omega-3 oil protection

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Department of Systems Biology
Authors: Bruni Let, M. (Intern), Schultz, L. (Ekstern), Zhang, H. (Ekstern), Guo, L. (Ekstern), Jacobsen, C. (Intern), Xu, X. (Intern)
Publication date: 2007
Event: Abstract from 98th AOCS Annual Meeting & Expo, Quebec, Canada.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229358
Publication: Research › Conference abstract for conference – Annual report year: 2007

Evaluation of lipid and protein oxidation during processing and storage of fatty fish mince

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Eymard, S. (Intern), Baron, C. (Intern), Jacobsen, C. (Intern)
Publication date: 2007
Event: Abstract from European Congress of Chemical Engineering - 6, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229208
Publication: Research › Conference abstract for conference – Annual report year: 2007

Evaluation of lipid and protein oxidation during processing and storage of fatty fish mince

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Eymard, S. (Intern), Baron, C. (Intern), Jacobsen, C. (Intern)
Publication date: 2007
Event: Abstract from 99th AOCS Annual Meeting & Expo, Seattle, WA, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229209
Publication: Research › Conference abstract for conference – Annual report year: 2007

Fatty acid composition of herring (Clupea harengus L.): influence of time and place of catch on n-3 PUFA content

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Section for Aquatic Protein Biochemistry
Authors: Jensen, K. N. (Intern), Jacobsen, C. (Intern), Nielsen, H. H. (Intern)
Pages: 710-718
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of the Science of Food and Agriculture
Volume: 87
Issue number: 4
ISSN (Print): 0022-5142
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Flere omega 3-fettsyre til forbrugerne

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Division of Seafood Research
Authors: Jørgensen, S. B. (ed.) (Intern), Jacobsen, C. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: FoodDTU Midt i Ugen
Original language: Danish
Source: orbit
Source-ID: 258752
Publication: Communication › Journal article – Annual report year: 2007

Healthy, nutritious and tasty fish for the future

General information
State: Published
Organisations: Section for Aquatic Protein Biochemistry, National Institute of Aquatic Resources, Section for Aquatic Process and Product Technology, Section for Aquatic Lipids and Oxidation
Authors: Nielsen, H. H. (Intern), Rentsch, M. L. (Intern), Jessen, F. (Intern), Hyldig, G. (Intern), Jacobsen, C. (Intern), Eymard, S. (Intern), Hallund, J. (Ekstern), Lauritzen, L. (Ekstern), Bügel, S. (Ekstern), Lametsch, R. (Ekstern), Holm, J. (Ekstern)
Publication date: 2007

Host publication information
Title of host publication: 23rd NJF-congress, Copenhagen, 27th-29 June
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract and Poster
Source: orbit
Source-ID: 226853
Publication: Research › Conference abstract in proceedings – Annual report year: 2007

Homogenization conditions affect the oxidative stability of fish oil enriched milk emulsions: Lipid oxidation

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Sørensen, A. M. (Intern), Meyer, A. S. (Intern)
Pages: 1773-1780
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 55
Issue number: 5
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Homogenization conditions affect the oxidative stability of fish oil enriched milk emulsions: Oxidation linked to changes in protein composition at the oil-water interface.
Lipid oxidation in milk, yoghurt, and salad dressing enriched with neat fish oil or pre-emulsified fish oil

Abstract: This study compared the oxidative stabilities of fish-oil-enriched milk, yoghurt, and salad dressing and investigated the effects on oxidation of adding either neat fish oil or a fish-oil-in-water emulsion to these products. Milk emulsions had higher levels of a fishy off-flavor and oxidized faster, as determined by the peroxide value and volatile oxidation products, than fish-oil-enriched yoghurt and dressing, despite the fact that dressings had a higher fish oil content and were stored at room temperature. Additionally, fish-oil-enriched yoghurt generally had higher oxidative stability than fish-oil-enriched dressings, irrespective of the mode of fish oil addition. Yoghurt thus seemed to be a good delivery system of lipids containing n-3 polyunsaturated fatty acids. Different effects of adding fish oil either as neat fish oil or as a fish-oil-in-water emulsion were observed for milk, yoghurt, and dressing. Yoghurt and dressing enriched with neat fish oil were more stable than those enriched with a fish-oil-in-water emulsion, whereas milk enriched with neat fish oil was less stable than milk enriched with the fish-oil-in-water emulsion. Overall, it seemed that application of neat fish oil was a good option for preserving the final quality in yoghurt and dressings, but a pre-emulsion may still be considered for the fish oil enrichment of certain food products, for example, milk. Keywords: Fish oil; lipid oxidation; oil-in-water emulsion; n-3 PUFA; milk; yoghurt; salad dressing.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Meyer, A. S. (Intern)
Pages: 7802-7809
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 55
Issue number: 19
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Multivariate analysis of 2-DE protein patterns - Practical approaches

Practical approaches to the use of multivariate data analysis of 2-DE protein patterns are demonstrated by three independent strategies for the image analysis and the multivariate analysis on the same set of 2-DE data. Four wheat varieties were selected on the basis of their baking quality. Two of the varieties were of strong baking quality and hard wheat kernel and two were of weak baking quality and soft kernel. Gliadins at different stages of grain development were analyzed by the application of multivariate data analysis on images of 2-DEs. Patterns related to the wheat varieties, harvest times and quality were detected on images of 2-DE protein patterns for all the three strategies. The use of the multivariate methods was evaluated in the alignment and matching procedures of 2-DE gels. All the three strategies were able to discriminate the samples according to quality, harvest time and variety, although different subsets of protein spots...
were selected. The explorative approach of using multivariate data analysis and variable selection in the analyses of 2-DEs seems to be promising as a fast, reliable and convenient way of screening and transforming many gel images into spot quantities.

**General information**

State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Enzyme and Protein Chemistry, Department of Systems Biology, Section for Aquatic Protein Biochemistry, Section for Aquatic Process and Product Technology, Center for Microbial Biotechnology, Norwegian Food Research Institute
Pages: 1289-1299
Publication date: 2007
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Electrophoresis
Volume: 28
Issue number: 8
ISSN (Print): 0173-0835
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.64 SJR 0.85 SNIP 0.777
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.851 SNIP 0.825 CiteScore 2.53
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.056 SNIP 0.892 CiteScore 2.88
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.154 SNIP 0.992 CiteScore 3.13
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.368 SNIP 0.983 CiteScore 3.24
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.525 SNIP 0.923 CiteScore 3.17
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.591 SNIP 0.932
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.481 SNIP 1.014
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.692 SNIP 0.991
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.817 SNIP 1.109
Scopus rating (2006): SJR 2.142 SNIP 1.243
Web of Science (2006): Indexed yes
Optimisation of oxidative stability of omega-3 enriched milk

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Jacobsen, C. (Intern), Bruni Let, M. (Intern), Meyer, A. S. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences

Optimization of oxidative stability of omega-3 enriched foods

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Nielsen, N. S. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences

Oxidative stability in a variety of omega-3 PUFA enriched products

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences
Oxidative stability of fish oil enriched drinking yoghurt

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology
Authors: Nielsen, N. S. (Intern), Debnath, D. (Ekstern), Jacobsen, C. (Intern)
Pages: 1478-1485
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: International Dairy Journal
Volume: 17
Issue number: 12
ISSN (Print): 0958-6946
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.34 SJR 1.125 SNIP 1.255
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.978 SNIP 1.17 CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.061 SNIP 1.175 CiteScore 2.24
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.238 SNIP 1.408 CiteScore 2.79
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.282 SNIP 1.467 CiteScore 2.55
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.269 SNIP 1.499 CiteScore 2.73
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.323 SNIP 1.471
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.622 SNIP 1.751
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.457 SNIP 1.519
Scopus rating (2007): SJR 1.223 SNIP 1.633
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.362 SNIP 1.774
Scopus rating (2005): SJR 1.2 SNIP 1.507
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.427 SNIP 1.715
Scopus rating (2003): SJR 1.199 SNIP 1.354
Scopus rating (2002): SJR 0.906 SNIP 1.173
Oxidative stability of mayonnaise based salads enriched with fish oil

Oxidative stability of mayonnaise based salads enriched with fish oil

Protection of lipid and protein fractions during processing and storage of horse mackerel paste

Protein and lipid oxidation during frozen storage of rainbow trout (Oncorhynchus mykiss)

Publication information
Protein and lipid oxidation in frozen rainbow trout

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Protein Biochemistry
Authors: Baron, C. (Intern), Kjærsgård, I. V. H. (Intern), Jessen, F. (Intern), Jacobsen, C. (Intern)
Publication date: 2007

Host publication information
Title of host publication: European Congress of Chemical Engineering (ECCE-6), Copenhagen, 16-20 September 2007
Main Research Area: Technical/natural sciences
Conference: European Congress of Chemical Engineering - 6, Copenhagen, Denmark, 16/09/2007 - 16/09/2007

Bibliographical note
Abstract and Poster
Source: orbit
Source-ID: 224859
Publication: Research › Conference abstract in proceedings – Annual report year: 2007

Successful production of European eel larvae

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Coastal Ecology, Section for Ocean Ecology and Climate, Research Secretariat, Section for Aquatic Lipids and Oxidation
Authors: Tomkiewicz, J. (Intern), Støttrup, J. (Intern), Munk, P. (Intern), Lauesen, P. (Intern), Graver, C. (Intern), Jarlbæk, H. (Intern), Jacobsen, C. (Intern), McEvoy, F. (Ekstern), Svalastoga, E. (Ekstern)
Publication date: 2007
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract and oral presentation ved European Aquaculture Symposium, Istanbul, October, 2007
Source: orbit
Source-ID: 232873
Publication: Research › Conference abstract for conference – Annual report year: 2007

The effect of different feeds on the sensory quality in farmed trout after frozen storage

General information
State: Published
Organisations: Section for Aquatic Process and Product Technology, National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Hyldig, G. (Intern), Jacobsen, C. (Intern)
Publication date: 2007

Host publication information
Title of host publication: 23rd NJF-congress, Copenhagen, 27th-29 June
Main Research Area: Technical/natural sciences

Bibliographical note
Abstract
Source: orbit
Production and Nutritional Aspects of Butter Enriched with Diacylglycerols

General information
State: Published
Organisations: Department of Systems Biology, Center for Biological Sequence Analysis
Authors: Kristensen, J. B. (Intern), Xu, X. (Intern), Mu, H. (Intern), Jacobsen, C. (Intern)
Publication date: Mar 2006

Publication information
Place of publication: Kgs. Lyngby, Denmark
Publisher: Technical University of Denmark (DTU)
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 269192
Publication: Research › Ph.D. thesis – Annual report year: 2006

Application of functional lipids in foods

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Timm Heinrich, M. (Intern), Nielsen, N. S. (Intern)
Pages: 341-364
Publication date: 2006

Host publication information
Title of host publication: Nutraceutical and speciality lipids and their co-products
Place of publication: Boca Raton
Publisher: CRC Press
Editor: Shahidi, F.
Main Research Area: Technical/natural sciences

Bibliographical note
I følge forlaget udgives denne 15. marts 2006
Source: orbit
Source-ID: 225885
Publication: Research - peer-review › Book chapter – Annual report year: 2006

Deodorization of lipase-interesterified butterfat and rapeseed oil blends in a pilot deodorizer

A mixture of butterfat and rapeseed oil (7:3, wt/wt) was interesterified using immobilized lipase from Thermomyces lanuginosus at 50øC. The interesterified mixture was then deodorized at five temperatures (60-180øC) and three samples were withdrawn at 1, 2, and 3h. The operation was monitored by free fatty acid (FFA) content, peroxide value (PV), volatiles, and the sensory evaluation of the samples with respect to flavor and odor (most importantly the butter flavor and odor and the off-flavor and odor from butyric acid). ANOVA partial least squares regression analysis showed that deodorization time, and especially deodorization temperature, significantly affected the sensory properties and levels of volatiles, FFA and peroxides in the samples. The best compromise between removing undesirable off-flavors while maintaining the desirable butter flavor seemed to be obtained by using a deodorization temperature of 120øC for 2h. Response surface methodology analysis showed a significant effect of deodorization temperature and, to a lesser extent, deodorization time. The butter flavor and odor had an optimum at a deodorization temperature of approximately 100-120øC for 1-2h. These conditions are therefore recommended in order to remove the off-flavor and odor, while maintaining as much as possible of the attractive butter flavor and odor.

General information
State: Published
Organisations: Department of Systems Biology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Rønne, T. H. (Intern), Jacobsen, C. (Intern), Xu, X. (Intern)
Pages: 182-192
Publication date: 2006
Main Research Area: Technical/natural sciences
Effect of homogenisations condition on the composition on the fat globule membrane and oxidative stability in omega-3 enriched milk

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Sørensen, A. M. (Intern), Baron, C. (Intern), Bruni Let, M. (Intern), Jacobsen, C. (Intern)
Publication date: 2006

Host publication information
Title of host publication: AOCS annual meeting, St. Louis, Ohio, Missouri, May 2006.
Main Research Area: Technical/natural sciences
Conference: AOCS annual meeting, St. Louis, Ohio, Missouri, May 2006., 01/01/2006

Bibliographical note
Poster and abstract
Source: orbit
Source-ID: 227316
Publication: Research - peer-review › Journal article – Annual report year: 2006

Evaluation of oxidative stability during processing and storage of fatty fish mince

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Eymard, S. (Intern), Baron, C. (Intern), Jacobsen, C. (Intern)
Publication date: 2006

Host publication information
Title of host publication: 4th Euro Fed Lipid Congress, Madrid, Spain, Oktober 2006
Main Research Area: Technical/natural sciences

Bibliographical note
Poster and abstract
Source: orbit
Source-ID: 225397
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

Interaction between antioxidants, emulsifiers and pH in omega-3 enriched oil-in-water emulsions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Sørensen, A. M. (Intern), Haahr, A. (Intern), Berner, L. (Intern), Jacobsen, C. (Intern)
Publication date: 2006

Host publication information
Title of host publication: AOCS annual meeting, St. Louis, Ohio, Missouri, May 2006 and: 2nd meeting on developing functional foods with omega-3 fatty acids, Helsingør, Denmark, June 2006
Main Research Area: Technical/natural sciences
Conference: AOCS annual meeting, St. Louis, Ohio, Missouri, May 2006 and: 2nd meeting on developing functional foods with omega-3 fatty acids, Helsingør, Denmark, June 2006, 01/01/2006

Bibliographical note
Poster and abstract
Source: orbit
Oxidation of sarcoplasmic proteins from rainbow trout fed different diets

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Baron, C. (Intern), Pham, K. (Ekstern), Jacobsen, C. (Intern)
Publication date: 2006

Host publication information
Title of host publication: IFT annual meeting, Orlando, USA, June 2006
Main Research Area: Technical/natural sciences
Conference: IFT meeting, Orlando, FL, United States, 24/06/2006 - 24/06/2006

Bibliographical note
Poster and abstract
Source: orbit
Source-ID: 224856
Publication: Research › Conference abstract in proceedings – Annual report year: 2006

Oxidative stability of diacylglycerol oil and butter blends containing diacylglycerols
Diacylglycerol (DAG) oils produced from sunflower oil and traditional sunflower oil were stored for 20 wk at 38 degrees C, and their oxidative stability was measured. Moreover, two butter blends were produced containing 40 wt-% DAG oil made from sunflower oil or rapeseed oil, respectively, as well as two control butter blends with sunflower oil or rapeseed oil. Their oxidative stability during storage at 5 degrees C for up to 12 wk was examined by similar means as for the pure oils. The storage study of the oils indicated that the DAG oil was oxidatively less stable as compared to sunflower oil, but that they had similar sensory quality. Storage of the butter blends revealed that blends with the two types of rapeseed oil (triacylglycerol (TAG) or DAG oil) were oxidatively more stable than the blends containing oils from sunflower. There was no unambiguous indication of DAG butter blends having a different stability than their respective control TAG blends. However, they had a significantly less salty and buttery flavour, which was ascribed to a much smaller water droplet size causing a delayed sensory perception in the mouth. The butter blend with DAG oil from rapeseed had a very neutral flavour. On the contrary, the butter blend with DAG oil from sunflower had a more rancid aroma and flavour than its control blend with sunflower oil

General information
State: Published
Organisations: Department of Systems Biology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for Biological Sequence Analysis
Authors: Kristensen, J. B. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern), Mu, H. (Intern)
Pages: 336-350
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 108
Issue number: 4
ISSN (Print): 1438-7697
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Oxidative stability of fish oil enriched yoghurts

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Jacobsen, C. (Intern), Bruni Let, M. (Intern), Andersen, G. (Ekstern), Meyer, A. S. (Intern)
Pages: 71-86
Publication date: 2006

Host publication information
Title of host publication: Seafood research from fish to dish, quality, safety and processing of wild and farmed fish
Preventing oxidation in milk enriched with omega-3 fatty acids

General information
State: Published
Organisations: Department of Systems Biology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Meyer, A. S. (Intern)
Pages: 77-81
Publication date: 2006
Main Research Area: Technical/natural sciences

Production and oxidative stability of a human milk fat substitute produced from lard by enzyme technology in a pilot packed-bed reactor

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology
Authors: Nielsen, N. S. (Intern), Yang, T. (Intern), Xu, X. (Intern), Jacobsen, C. (Intern)
Pages: 53-60
Publication date: 2006
Main Research Area: Technical/natural sciences
Protein and lipid oxidation during frozen storage of rainbow trout

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Protein Biochemistry
Authors: Baron, C. (Intern), Kjærsgård, I. V. H. (Intern), Jessen, F. (Intern), Jacobsen, C. (Intern)
Publication date: 2006
Main Research Area: Technical/natural sciences

Bibliographical note
Poster
Source: orbit
Source-ID: 224857
Publication: Research › Poster – Annual report year: 2006

Seafood research from fish to dish: Quality, safety and processing of wild and farmed fish

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Number of pages: 568
Publication date: 2006

Publication information
Place of publication: Wageningen
Publisher: Wageningen Academic Publishers
ISBN (Print): 90-86-86005-2
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 226485
Publication: Research - peer-review › Book – Annual report year: 2006

Storage stability of margarines produced from enzymatically interesterified fats compared to those prepared by conventional methods - Chemical properties

In this study, four margarine hardstocks were produced, two from enzymatically interesterified fats at 80 and 100% conversion, one from chemically randomized fat and one from physically mixed fat. These four hardstocks, blended with 50% sunflower oil, were mainly used for the production of table margarines in a pilot plant. Storage stability studies were carried out at storage temperatures of 5 and 25°C for 12wk. Margarines from the enzymatically interesterified fats were compared to the margarines produced by the conventional methods (chemical interesterification and physical blending) and to selected commercial margarines. The changes in the chemical properties of the products, including peroxide values (PV), tocopherols, free fatty acids, volatile oxidation products, and sensory evaluation, were examined during storage. It was observed that the margarine produced from the chemically interesterified fat had higher PV in weeks 4, 8 and 10 than the margarines produced from the enzymatically interesterified fats and the physically blended fat. These differences were not caused by different contents of tocopherols in the hardstocks. The differences between the processes for chemical and enzymatic interesterification, including further treatment stages, might be responsible for the development of a high PV in the margarine produced from the chemically interesterified fat. However, the contents of volatiles did not show the same tendency as observed for PV for the margarines stored at 25°C during 12wk. Storage at 25°C accelerated oxidation compared to storage at 5°C. The content of α- and β-tocopherols decreased faster than the content of γ- and δ-tocopherols during storage. This phenomenon was only affected by storage time, not by storage temperature. Sensory analysis did not show consistent differences between the produced margarines and commercial margarines, and no hydrolysis occurred for these four margarines during storage. The margarines produced from the enzymatically interesterified fats had low PV and a similar taste and smell compared to the margarine produced from the chemically interesterified fat.

General information
State: Published
Organisations: Food Production Engineering, Department of Systems Biology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Novozymes A/S
Using polyunsaturated fatty acids (PUFA) as functional ingredients

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern), Bruni Let, M. (Intern)
Pages: 341-364
Publication date: 2006

Effect of structured lipids based on fish oil on the growth and fatty acid composition in Rainbow Trout (Oncorhynchus mykiss)
The aim of the study was to investigate whether it was possible a) to increase the relative incorporation of n-3 very long chain polyunsaturated fatty acids (VLCPUFA) in a low VLCPUFA diet by feeding trout structured triacylglycerols and b) to reduce fat accumulation by feeding trout a diet containing DAG. A feeding experiment where groups of rainbow trout were fed six diets containing different types of oils for 61 days was performed. The lipid fraction of the six diets was as follows: 1) Fish oil and rapeseed oil (FO diet), 2) Specific structured lipid and rapeseed oil (SL diet), 3) Randomised structured lipids and rapeseed oil (RL diet), 4) Medium chain triglyceride and fish oil (MCT diet), 5) Diacylglycerol and fish oil (DAG diet), 6) Fish oil (FOmax diet). Five of the diets (1-5) contained mixed oils blended to contain the same amount of EPA and DHA. Three of these diets (2,3 and 4) contained medium chain fatty acids incorporated in TAG to be positioned either intentionally as specific (SL), by chance as randomised (RL) or added as medium chain TAG (MCT). Diet 1 contained fish oil (FO) in order to investigate the effect of MCFA and diet 4 contained diacylglycerol (DAG). Diet 6) was a reference diet containing pure fish oil (FOmax). After the feeding period, FO and FOmax fed fish were significantly larger than SL fed fish. Digestibility, measured by adding yttrium oxide as inert marker was significantly lowest for the MCT diet. Fish on the RL and MCT diets had significantly higher protein contents than fish fed FO and FOmax diets. The total fatty acid compositions of the fillet, liver, carcass and viscera were similar and reflected closely that of the diet, also in the sn-2 position. In conclusion, addition of MCT to the diet increased protein content of the fish. There was no additional effect of incorporating the medium chain fatty acids in specific positions and no weight reducing effect of adding DAG to the diets. (C) 2005 Elsevier B.V. All rights reserved.
Ratings:

BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.75 SJR 1.101 SNIP 1.524
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.103 SNIP 1.254 CiteScore 2.12
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.002 SNIP 1.34 CiteScore 2.16
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.136 SNIP 1.3 CiteScore 2.18
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.212 SNIP 1.487 CiteScore 2.32
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.294 SNIP 1.542 CiteScore 2.39
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.151 SNIP 1.394
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.941 SNIP 1.263
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.909 SNIP 1.173
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.019 SNIP 1.318
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.008 SNIP 1.689
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.915 SNIP 1.236
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.016 SNIP 1.627
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.121 SNIP 1.926
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.992 SNIP 1.418
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.049 SNIP 1.317
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.908 SNIP 1.113
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 1.049 SNIP 1.251

Original language: English
Effects of antioxidants on the lipase-catalyzed acidolysis during production of structured lipids

In the production process of structured lipids, the influence of the addition of antioxidants before enzymatic acidolysis was investigated. Eight different antioxidants were screened: butylated hydroxyanisole, butylated hydroxytoluene, propyl gallate, ascorbyl palmitate, citric acid, EDTA, a tocopherol blend and lecithin. As substrates, oils with different degrees of unsaturation (rapeseed, safflower or fish oil) as well as caprylic and capric acids were used. Enzyme activity (measured as percent incorporation of caprylic/capric acid into the oils) was not significantly influenced by the addition of antioxidants, neither in a batch process nor in a packed-bed reactor operation. α-Tocopherol concentrations remained stable for those mixtures where tocopherols were added. Primary oxidation products (measured as peroxide values) were reduced after acidolysis in the packed-bed reactor, likely due to the adsorption in the enzyme bed. The study shows that the addition of antioxidants before enzymatic reactions has no negative effects on the reaction progress. None of the antioxidants chosen had a significant positive effect on either the reaction process or the oxidative status of the structured lipid produced.

General information
State: Published
Organisations: Department of Biotechnology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology
Pages: 464-468
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 107
Issue number: 7-8
ISSN (Print): 1438-7697
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.873 SNIP 1.207 CiteScore 2.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.732 SNIP 0.945 CiteScore 1.75
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.791 SNIP 1.049
Enzymatic interesterification of butterfat with rapeseed oil in a continuous packed bed reactor

Lipase-catalyzed interesterification of butterfat blended with rapeseed oil (70/30, w/w) was investigated both in batch and in continuous reactions. Six commercially available immobilized lipases were screened in batch experiments, and the lipases, Lipozyme TL IM and Lipozyme RM IM, were chosen for further studies in a continuous packed bed reactor. TL IM gave a fast reaction and had almost reached equilibrium with a residence time of 30 min, whereas RM IM required 60 min. The effect of reaction temperature was more pronounced for RM IM. TL IM showed little effect on the interesterification degree when the temperature was raised from 60 degrees C to 90 degrees C, whereas RM IM had a positive effect when the temperature was increased from 40 degrees C to 80 degrees C. Even though TL IM is an sn-1,3 specific lipase, small changes in the sn-2 position of the triacylglycerol could be seen. The tendency was toward a reduction of the saturated fatty acid C14:0 and C16:0 and an increase of the long-chain saturated and unsaturated fatty acids (C18:0 and C18:1), especially at longer residence times (90 min). In prolonged continuous operation the activity of TL IM was high for the first 5 days, whereafter it dramatically decreased over the next 10 days to an activity level of 40%. In general, the study shows no significant difference for butterfat interesterification in terms of enzyme behavior from normal vegetable oils and fats even though it contains short-chain fatty acids and cholesterol. However, the release of short-chain fatty acids from enzymatic reactions makes the sensory quality unacceptable for direct edible applications.

General information
State: Published
Organisations: Department of Systems Biology, Center for Biological Sequence Analysis, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Rønne, T. H. (Intern), Yang, T. (Intern), Mu, H. (Intern), Jacobsen, C. (Intern), Xu, X. (Intern)
Pages: 5617-5624
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 53
Issue number: 14
ISSN (Print): 0021-8561
Ratings:
Protection against oxidation of fish-oil-enriched milk emulsions through addition of rapeseed oil or antioxidants

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Center for BioProcess Engineering, Department of Biotechnology
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Pham, K. A. (Ekstern), Meyer, A. S. (Intern)
Pages: 5429-5437
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 53
Issue number: 13
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.384 SNIP 1.446 CiteScore 3.1
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.408 SNIP 1.392
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.317 SNIP 1.303
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.361 SNIP 1.324
Web of Science (2008): Indexed yes
Sensory stability and oxidation of fish oil enriched milk is affected by milk storage temperature and oil quality

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Center for BioProcess Engineering, Department of Biotecnology
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Meyer, A. S. (Intern)
Pages: 173-182
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: International Dairy Journal
Volume: 15
Issue number: 2
ISSN (Print): 0958-6946
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 2.34 SJR 1.125 SNIP 1.255
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 0.978 SNIP 1.17 CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.061 SNIP 1.175 CiteScore 2.24
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.238 SNIP 1.408 CiteScore 2.79
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Storage stability study for margarines produced by enzymatically interesterified fats compared to the margarines by the conventional methods I. Physical properties

In this study, margarine hardstocks were produced from two enzymatically interesterified fats at conversion degrees of 80 and 100%, a chemically randomized fat and a physically mixed fat, respectively. These four hardstocks blended with 50% of sunflower oil were mainly used for the production of table margarines in a pilot plant. Storage stability studies were carried out at storage temperatures of 5 and 25 °C during 12 wk. Margarines from the enzymatically interesterified fats were compared to the margarines produced by conventional methods and to selected commercial products. The changes in the physical properties of margarines, including hardness, dropping point, crystal form, and sensory evaluation, were examined during storage. It was observed that margarine storage stability increased with increasing conversion degree. The color of margarines made from the enzymatically interesterified fats was more similar to that of the physically mixed fat than that of the margarine from the chemically randomized fat, which had less color. Crystal transformation was accelerated at high storage temperature. Crystal size was not only related to the types of crystals, but also to the driving force of temperature difference. A larger crystal size was observed at 5 °C than at 25 °C for the margarine made from the blend. Margarines produced from interesterified fats had better physical properties than the blend. Overall, the margarine produced from the enzymatically fully converted fat had physical properties similar to the margarine produced from the chemically interesterified fat.

General information
State: Published
Organisations: Department of Biotechnology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Zhang, H. (Intern), Jacobsen, C. (Intern), Adler-Nissen, J. (Intern)
Pages: 530-539
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 107
Issue number: 7-8
ISSN (Print): 1438-7697
UV treatment of fishmeal: A method to remove dioxins?

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, FF secretariat
Authors: Baron, C. (Intern), Børresen, T. (Intern), Jacobsen, C. (Intern)
Pages: 7091-7097
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 53
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Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.384 SNIP 1.446 CiteScore 3.1
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.408 SNIP 1.392
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.317 SNIP 1.303
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.361 SNIP 1.324
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.249 SNIP 1.439
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.358 SNIP 1.418
Web of Science (2006): Indexed yes
Apparatus for emulsion production in small scale and under controlled shear conditions

In this article, a rotor-stator apparatus for the production of 5 g batches of emulsion is introduced. Special attention was paid to the design of the apparatus and its construction, ensuring close tolerances in all machined parts. The size of the dispersing gap was 500 µm. The need to prepare small quantities of homogeneous emulsion formulations containing costly ingredients formed the impetus for this work. We present a set of emulsion production experiments using a model mayonnaise recipe with a weight percentage of dispersed oil of 80%, and illustrate the effect of rotor speed on the average size and size distributions of the resulting oil droplets. These size distributions were within the same range as a commercial mayonnaise. The maximum shear rates and corresponding shear stresses existing in the apparatus at different rotational speeds were estimated. A stabilization time related to rotor speed and geometry was also calculated. We discuss the scale-up of emulsion production, giving consideration to the length of time the shear stress is applied as well as to the magnitude of the shear stress.

General information
State: Published
Organisations: Food Biotechnology and Engineering Group, Department of Systems Biology
Authors: Adler-Nissen, J. (Intern), Mason, S. (Intern), Jacobsen, C. (Intern)
Pages: 311-319
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Food and Bioproducts Processing
Volume: 82
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  BFI (2018): BFI-level 1
  Web of Science (2018): Indexed yes
  BFI (2017): BFI-level 1
  Web of Science (2017): Indexed yes
  BFI (2016): BFI-level 1
  Scopus rating (2016): SJR 0.881 SNIP 1.178 CiteScore 2.59
  BFI (2015): BFI-level 1
  Scopus rating (2015): SJR 1.182 SNIP 1.87 CiteScore 3.44
  Web of Science (2015): Indexed yes
  BFI (2014): BFI-level 1
  Scopus rating (2014): SJR 1.236 SNIP 2.098 CiteScore 3.24
  BFI (2013): BFI-level 1
  Scopus rating (2013): SJR 0.932 SNIP 1.951 CiteScore 2.92
Chemical and olfactometric characterization of volatile flavor compounds in a fish oil enriched milk emulsion

Development of objectionable fishy off-flavors is an obstacle in the development of fish oil enriched foods. Only little is known about the sensory impact of specific volatile fish oil oxidation products in food emulsions. This study examined the volatiles profiles of fish oil enriched milk during cold storage (2 degreesC) for 14 days by dynamic headspace sampling followed by gas chromatography-mass spectrometry analyses. Different volatiles (n = 60) comprising alkenals, alkadienals, alkatrienals, and vinyl ketones were identified in the fish oil enriched milk. The potent odorants identified by gas chromatography-olfactometry were 1-penten-3-one, (Z)-4-heptenal, 1-octen-3-one, (Z)-1,5-octadien-3-one, (E,E)-2,4-heptadienal, and (E,Z)-2,6-nonadienal, but despite their potency, none of the separated volatiles imparted a fishy or metallic odor. Two isomers, (E,Z,Z) and (E,E,Z) of 2,4,7-decatrienal were identified in fish oil enriched milk emulsions with peroxide values 0.8 and 3.4 meq/kg, respectively. To our knowledge, this is the first report on appearance of these decatrienals in food emulsions having a relatively low peroxide value.
Developing polyunsaturated fatty acids as functional ingredients

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 307-332
Publication date: 2004

Host publication information
Title of host publication: Functional foods, diet, cardiovascular disease and diabetes
Place of publication: Cambridge
Publisher: Woodhead
Editor: Arnoldi, A.
Main Research Area: Technical/natural sciences

Effects of fish oil type, lipid antioxidants and presence of rapeseed oil on oxidative flavour stability of fish oil enriched milk

General information
State: Published
Organisations: Department of Systems Biology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Meyer, A. S. (Intern)
Pages: 170-182
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 106
Issue number: 3
ISSN (Print): 1438-7697
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.873 SNIP 1.207 CiteScore 2.06
Effects of lactoferrin, phytic acid, and EDTA on oxidation in two food emulsions enriched with long-chain polyunsaturated fatty acids

The influence of the addition of metal chelators on oxidative stability was studied in a milk drink and in a mayonnaise system containing highly polyunsaturated lipids. Milk drinks containing 5% (w/w) of specific structured lipid were supplemented with lactoferrin (6-24 M) and stored at 2°C for up to 9 weeks. Mayonnaise samples with 16% fish oil and 64% rapeseed oil (w/w) were supplemented with either lactoferrin (8-32 M), phytic acid (16-124 M), or EDTA (16-64 M) and were stored at 20°C for up to 4 weeks. The effect of the metal chelators was evaluated by determination of peroxide values, secondary volatile oxidation products, and sensory analysis. Lactoferrin reduced the oxidation when added in concentrations of 12 M in the milk drink and 8 M in the mayonnaise, whereas it was a prooxidant at higher concentrations in both systems. In mayonnaise, EDTA was an effective metal chelator even at 16 M, whereas phytic acid did not exert a distinct protective effect against oxidation. The differences in the equimolar effects of the metal chelators are proposed to be due to differences in their binding constants to iron and their different stabilities toward heat and low pH.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Pages: 7690-7699
Publication date: 2004
Main Research Area: Technical/natural sciences
Forbedrede smørbare fedtprodukter via enzymatisk modifikation af smørfet

**General information**
State: Published
Organisations: Food Biotechnology and Engineering Group, Department of Systems Biology, Enzyme and Protein Chemistry
Authors: Xu, X. (Intern), Jacobsen, C. (Intern), Mu, H. (Intern), Adler-Nissen, J. (Intern)
Pages: 408-411
Publication date: 2004
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Mælkefærdighedene
Volume: 17
Original language: Danish
Source: orbit
Source-ID: 155325
Publication: Research › Journal article – Annual report year: 2004

Modeling the sensory impact of defined combinations of volatile lipid oxidation products on fishy and metallic off-flavors
The volatiles (EZ)-2,6-nonadienal, 1-penten-3-one, (Z)-4-heptenal, and (EE)-2,4-heptadienal were added to milk containing 1.5% fat according to a central composite design, to evaluate the individual and combinatorial effects of these volatiles on sensory properties. The milk samples with added volatiles were subjected to sensory descriptive analysis for fishy and metallic off-flavors. The data were analyzed using partial least-squares regression and multiple linear regression to develop mathematical models. The models revealed significant main effects of (EZ)-2,6-nonadienal and 1-penten-3-one and highlighted the importance of two-factor interactions for contribution toward off-flavors. The results suggest that (EZ)-2,6-nonadienal and 1-penten-3-one could be useful markers for fishy and metallic off-flavors in fish oil and fish oil enriched foods. Within the addition levels of the volatiles there was a curvature effect of (EZ)-2,6-nonadienal, a compensatory effect of (Z)-4-heptenal and (EE)-2,4-heptadienal, and a synergistic effect of (EZ)-2,6-nonadienal and (Z)-4-heptenal in the development of fishy off-flavors

**General information**
State: Published
Organisations: Department of Systems Biology, National Institute of Aquatic Resources, Department of Biotechnology, Section for Aquatic Lipids and Oxidation
Pages: 1635-1641
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Oxidative stability during storage of structured lipids produced from fish oil and caprylic acid

**General information**

**State:** Published

**Organisations:** Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biochemistry and Nutrition

**Authors:** Nielsen, N. S. (Intern), Xu, X. (Intern), Timm Heinrich, M. (Intern), Jacobsen, C. (Intern)
Oxidative stability of mayonnaise and milk drink produced with structured lipids based on fish oil and caprylic acid

The oxidative stabilities of traditional fish oil (FO), randomized lipids (RFO), or specific structured lipids (SFO) produced from fish oil were compared when incorporated into either milk drink or mayonnaise. Furthermore, the effect of adding the potential antioxidants EDTA (240 mg/kg) or lactoferrin (1000 mg/kg) to the milk drink based on SFO was investigated. The lipid type significantly affected the oxidative stability of both mayonnaises and milk drinks: The oxidative stability decreased in the order RFO>FO>SFO. The reduced oxidative stability in the SFO food emulsions could not be ascribed to a single factor, but was most likely influenced by the structure of the lipids and differences in the processes used to produce and purify the lipids. In milk drinks based on SFO, EDTA slightly reduced oxidation, while lactoferrin did not exert a distinct antioxidative effect.
Oxidative stability of structured lipids containing C18:0, C18:1, C18:2, C18:3 or CLA in sn 2-position - as bulk lipids and in milk drinks

In this study, we compared the oxidative stability of a specific structured lipid (SL) containing conjugated linoleic acid (CLA) in the sn2-position with SL containing other C18 fatty acids of different degree of unsaturation (stearic, oleic, linoleic or linolenic acid). SL was produced by enzymatic interesterification with caprylic acid. Oxidative stability was compared in the five lipids themselves and in milk drinks containing 5% of the different SL. During storage, samples were taken for chemical and physical analyses. Moreover, sensory assessments were performed on milk drinks. The oxidative stability of our SL was very different when comparing (a) bulk lipids and milk drink and (b) the five different batches of each product. SL based on oleic acid was the most unstable as bulk lipid, while SL based on linoleic acid was the most unstable in milk drink. SL based on CLA was the second most unstable in both products.
Comparison of wet-chemical methods for determination of lipid hydroperoxides

Five methods for determination of lipid hydroperoxides were evaluated, including two iodometric procedures involving a titration and a spectrophotometric micro method, and three other spectrophotometric methods namely the ferro, International Dairy Federation (IDF) and FOX2 (ferrous oxidation in xylenol orange). Peroxide values determined in a range of food products by these five methods gave different results. The ferro method required large amounts of solvent (50 mL/sample); the FOX2 method had a low range (0.005-0.04 mumol hydroperoxide); the end point detection of the titration method was subjective and required a large amount of sample (1 g); and the micro method was sensitive to interruptions during execution. Therefore, only the modified IDF method was chosen for further testing and validation. Stability tests of the standard curve showed a variation coefficient of 4% and within runs the highest variation was 5.9% (for blank) and a maximum of 9.6% between runs variation for the lowest concentration. Among the antioxidants tested, only ethylenediaminetetraacetic acid (EDTA) affected the peroxide determinations.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology
Correlation between sensory analysis and dynamic headspace GC analysis in stored marinated herring

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology, Section for Aquatic Process and Product Technology, Section for Aquatic Protein Biochemistry
Authors: Jacobsen, C. (Intern), Nielsen, D. (Intern), Hyldig, G. (Intern), Nielsen, H. H. (Intern)
Number of pages: 400
Publication date: 2003

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Title of host publication: TAFT 2003: First joint trans Atlantic fisheries technology conference, 10-14 June 2003 Reykjavik, Iceland: 33rd WEFTA meeting
Place of publication: Reykjavik
Publisher: The Icelandic Fisheries Laboratories
ISBN (Print): 9979-74-005-1
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Source: orbit
Source-ID: 229308
Publication: Research » Conference abstract in proceedings – Annual report year: 2003
Effect of astaxanthin and canthaxanthin on lipid and protein oxidation of fish feed exposed to UVA

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Baron, C. (Intern), Berner, L. (Intern), Jacobsen, C. (Intern)
Pages: 61-61
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Main Research Area: Technical/natural sciences

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Journal: Free Radical Research
Volume: 37
ISSN (Print): 1071-5762
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.23 SJR 1.102 SNIP 1.025
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.172 SNIP 1.002 CiteScore 3.15
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.991 SNIP 0.937 CiteScore 2.87
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.106 SNIP 1.056 CiteScore 3.32
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.992 SNIP 0.948 CiteScore 3.14
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.924 SNIP 0.851 CiteScore 2.79
ISI indexed (2011): ISI indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.828 SNIP 0.817
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.913 SNIP 0.947
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.074 SNIP 1.046
Scopus rating (2007): SJR 1.051 SNIP 1.014
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.897 SNIP 0.989
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.875 SNIP 1.046
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.901 SNIP 1.038
Scopus rating (2003): SJR 1.025 SNIP 1.038
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.008 SNIP 1.007
Scopus rating (2001): SJR 0.993 SNIP 0.916
Scopus rating (2000): SJR 0.903 SNIP 0.99
Scopus rating (1999): SJR 0.933 SNIP 0.83
Fremstilling af et nyt smørprodukt med forbedrede ernæringsmæssige egenskaber

General information
State: Published
Organisations: Center for Biological Sequence Analysis, Department of Systems Biology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Pages: 206-208
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Mælketidende
Volume: 8
ISSN (Print): 0024-9645
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: Danish
Source: orbit
Source-ID: 226704
Publication: Research › Journal article – Annual report year: 2003

Levnedsmidler med fiskeolie - hvorfor og hvordan?

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 11-18
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Fisk og Hav
Issue number: 55
ISSN (Print): 0105-9211
Ratings:
ISI indexed (2013): ISI indexed no
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ISI indexed (2011): ISI indexed no
Original language: Danish
Links:
Source: orbit
Source-ID: 225895
Publication: Research › Journal article – Annual report year: 2003

Oxidative flavour deterioration of fish oil enriched milk
The oxidative deterioration of milk emulsions supplemented with 1.5 wt-% fish oil was investigated by sensory evaluation and by determining the peroxide value and volatile oxidation products after cold storage. Two types of milk emulsions were produced, one with a highly unsaturated tuna oil (38 wt-% of n-3 fatty acids) and one with cod liver oil (26 wt-% of n-3 fatty acids). The effect of added calcium disodium ethylenediaminetetraacetate (EDTA) on oxidation was also investigated. Emulsions based on cod liver oil with a slightly elevated peroxide value (1.5 meq/kg) oxidised significantly faster than the tuna oil emulsions, having a lower initial peroxide value (0.1 meq/kg). In the tuna oil emulsions the fishy off-flavour could not be detected throughout the storage period. Addition of 5-50 ppm EDTA significantly reduced the development of volatile oxidation products in the cod liver oil emulsions, indicating that metal chelation with EDTA could inhibit the
decomposition of lipid hydroperoxides in these emulsions. This study showed that an oxidatively stable milk emulsion containing highly polyunsaturated tuna fish oil could be prepared without significant fishy off-flavour development upon storage, provided that the initial peroxide value was sufficiently low.

**General information**
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Center for BioProcess Engineering, Department of Biotechnology
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Frankel, E. (Ekstern), Meyer, A. S. (Intern)
Pages: 518-528
Publication date: 2003
Main Research Area: Technical/natural sciences

**Publication information**
Journal: European Journal of Lipid Science and Technology
Volume: 105
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.873 SNIP 1.207 CiteScore 2.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.732 SNIP 0.945 CiteScore 1.75
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.791 SNIP 1.049
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.838 SNIP 1.077
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.606 SNIP 0.815
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.598 SNIP 0.801
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.704 SNIP 0.9
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.674 SNIP 0.98
Web of Science (2005): Indexed yes
Oxidative stability of mayonnaise containing structured lipids produced from sunflower oil and caprylic acid

Mayonnaise based on enzymatically produced specific structured lipid (SL) from sunflower oil and caprylic acid was compared with mayonnaise based on traditional sunflower oil (SO) or chemically randomized lipid (RL) with respect to their oxidative stability, sensory and rheological properties. Furthermore, the potential antioxidative effect of adding lactoferrin, propyl gallate or EDTA to the mayonnaise with SL was also investigated. Mayonnaise based on SL oxidized faster than mayonnaise based on RL or SO. The reduced oxidative stability in the SL mayonnaise could not be ascribed to a single factor, but was most likely influenced by the structure of the lipid, the lower tocopherol content and the higher initial levels of lipid hydroperoxides and secondary volatile oxidation compounds in the SL itself compared with the RL and traditional sunflower oil employed. EDTA was a strong antioxidant, while propyl gallate and lactoferrin did not exert any antioxidative effect in the SL mayonnaise.
Oxidative stability of milk drinks containing structured lipids produced from sunflower oil and caprylic acid

Milk drinks containing 5% traditional sunflower oil (SO), randomized lipid (RL) or specific structured lipid (SL) (both produced from SO and tricaprylin/caprylic acid) were compared with respect to their particle size, viscosity and oxidative stability during storage. Furthermore, the effect of adding potential antioxidants EDTA or gallic acid to the milk drink based on SL was investigated. The lipid type significantly affected the oxidative stability of the milk drinks: Milk drink based on SL oxidized faster than milk drink based on RL or SO. The reduced oxidative stability in the SL milk drink could not be ascribed was most likely influenced by the structure of the lipid and to a single factor, differences in the process applied to produce and purify the lipids. EDTA was a strong antioxidant, while gallic acid did not exert a distinct antioxidative effect in the milk drink based on SL.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Systems Biology
Authors: Timm Heinrich, M. (Intern), Xu, X. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
Pages: 459-470
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: European journal of lipid science and technology
Volume: 105
Issue number: 8
Oxidative stability of structured lipids produced from sunflower oil and caprylic acid

Traditional sunflower oil (SO), randomized lipid (RL) and specific structured lipid (SL), both produced from SO and tricaprylin/caprylic acid, respectively, were stored for up to 12 wk to compare their oxidative stabilities by chemical and sensory analyses. Furthermore, the effect of adding a commercial antioxidant blend Grindox 117 (propyl gallate/citric acid/ascorbil palmitate) or gallic acid to the SL was investigated. The lipid type affected the oxidative stability: SL was less stable than SO and RL. The reduced stability was most likely caused by both the structure of the lipid and differences in production/purification, which caused lower tocopherol content and higher initial levels of primary and secondary oxidation products in SL compared with RL and SO. Grindox 117 and gallic acid did not exert a distinct antioxidative effect in the SL oil samples during storage.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Timm Heinrich, M. (Intern), Xu, X. (Intern), Nielsen, N. S. (Intern), Jacobsen, C. (Intern)
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BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.873 SNIP 1.207 CiteScore 2.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.732 SNIP 0.945 CiteScore 1.75
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.791 SNIP 1.049
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.838 SNIP 1.077
Progress of lipid oxidation in different fish oil enriched milk emulsions supplemented with EDTA

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State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation, Department of Biotechnology
Authors: Bruni Let, M. (Intern), Jacobsen, C. (Intern), Frankel, E. (Ekstern), Meyer, A. S. (Intern)
Number of pages: 400
Publication date: 2003

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Title of host publication: TAFT 2003 : First joint trans Atlantic fisheries technology conference, 10-14 June 2003 Reykjavik, Iceland : 33rd WEFTA meeting
Place of publication: Reykjavik
Publisher: The Icelandic Fisheries Laboratories
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 229360
Publication: Research » Article in proceedings – Annual report year: 2003

Evaluation of oil quality during production and purification of structured lipids

General information
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Organisations: Department of Biotechnology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Xu, X. (Intern), Timm Heinrich, M. (Intern), Jacobsen, C. (Intern)
Pages: 030-AGFD, Part 1
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: Abstracts of Papers of the American Chemical Society
Volume: 223
Purification and deodorization of structured lipids by short path distillation

Purification of structured lipids (SL), produced from lipase-catalyzed acidolysis of rapeseed oil and capric acid, and deodorization of randomized SL, produced from chemical randomization of fish oil and tricaprin, were studied in a bench-scale short path distillation (SPD). SL obtained from enzymatic acidolysis usually contain a large proportion of medium-chain and long-chain free fatty acids. Two SPD steps have been applied for the removal of free fatty acids. Parameters such as evaporator temperature, feeding flow rate, stirring roller speed, and the content of free fatty acids (FFA) added to the starting materials were optimized with respect to FFA left in the product residuals and to tocopherol loss from the starting oil. Evaporator temperature and flow rate were optimized using response surface methodology and two models were obtained for the FFA content left and loss of tocopherols. An applicable parameter zone was created to obtain a certain FFA (0.5% for example) content. In general, conditions that result in a lower FFA content will lead to a higher loss of tocopherols. In most parts of the parameter zone, 50% loss of tocopherols will be expected. The deodorization study of randomized SL from fish oils and tricaprin indicated that SPD in comparison with batch deodorization gave a product of a poorer sensoric quality.

General information
State: Published
Organisations: Department of Biotechnology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Pages: 745-755
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 104
Volatile oxidation products formed in crude herring oil under accelerated oxidative conditions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Aidos, I. (Ekstern), Jacobsen, C. (Intern), Jensen, B. (Ekstern), Luten, J. (Ekstern), van der Padt, A. (Ekstern), Boom, R. (Ekstern)
Pages: 808-818
Publication date: 2002
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 104
Issue number: 12
ISSN (Print): 1438-7697
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.71 SNIP 1.024
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.642 SNIP 0.881 CiteScore 1.85
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.737 SNIP 1.051 CiteScore 1.98
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.852 SNIP 1.124 CiteScore 2.16
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.873 SNIP 1.207 CiteScore 2.06
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.732 SNIP 0.945 CiteScore 1.75
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.791 SNIP 1.049
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.838 SNIP 1.077
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.606 SNIP 0.815
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.598 SNIP 0.801
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.704 SNIP 0.9
Web of Science (2006): Indexed yes
Harskning i levnedsmidler med fiskeolie : Hvordan er det muligt at fremstille oxidationsstabile levnedsmidler beriget med fiskeolie?

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 36-41
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk kemi
Volume: 82
Issue number: 10
ISSN (Print): 0011-6335
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2007): Indexed yes
Web of Science (2004): Indexed yes
Original language: Danish
Source: orbit
Source-ID: 225892
Publication: Research › Journal article – Annual report year: 2001

Lipid oxidation in fish oil enriched mayonnaise : Calcium disodium ethylenediaminetetraacetate, but not gallic acid, strongly inhibited oxidative deterioration

The antioxidative effects of gallic acid, EDTA, and extra emulsifier Panodan DATEM TR in mayonnaise enriched with 16% fish oil were investigated. EDTA reduced the formation of free radicals, lipid hydroperoxides, volatiles, and fishy and rancid off-flavors. The antioxidative effect of EDTA was attributed to its ability to chelate free metal ions and iron from egg yolk located at the oil-water interface. Gallic acid reduced the levels of both free radicals and lipid hydroperoxides but promoted slightly the oxidative flavor deterioration in mayonnaise and influenced the profile of volatiles. Gallic acid may therefore promote the decomposition of lipid hydroperoxides to volatile oxidation products. Addition of extra emulsifier reduced the lipid hydroperoxide levels but did not influence the level of free radicals or the oxidative flavor deterioration in mayonnaise; however, it appeared to alter the profile of volatiles. The effect of the emulsifier on the physical structure and rheological properties depended on the presence of antioxidants

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology, Department of Systems Biology, Department of Biochemistry and Nutrition
Authors: Jacobsen, C. (Intern), Hartvigsen, K. (Intern), Thomsen, M. H. (Ekstern), Hansen, L. (Ekstern), Lund, P. (Intern), Skibsted, L. (Ekstern), Helmer, G. K. (Intern), Adler-Nissen, J. (Intern), Meyer, A. S. (Intern)
Oxidation in fish oil-enriched mayonnaise 4: Effect of tocopherol concentration on oxidative deterioration

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology, Department of Systems Biology, Department of Biochemistry and Nutrition
Authors: Jacobsen, C. (Intern), Hartvigsen, K. (Intern), Lund, P. (Intern), Thomsen, M. (Ekstern), Skibsted, L. (Ekstern), Hølmer, G. K. (Intern), Adler-Nissen, J. (Intern), Meyer, A. S. (Intern)
Pages: 308-318
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: European Food Research and Technology
Volume: 212
Issue number: 3
ISSN (Print): 1438-2377
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.742 SNIP 0.882 CiteScore 1.81
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.732 SNIP 0.822 CiteScore 1.55
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.828 SNIP 0.908 CiteScore 1.71
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.791 SNIP 0.901 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.872 SNIP 1.038 CiteScore 1.68
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.009 SNIP 1.097 CiteScore 1.87
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.931 SNIP 0.901
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Oxidation in fish oil enriched mayonnaise: Ascorbic acid and low pH increase oxidative deterioration

The effect of ascorbic acid (0-4000 ppm) and pH (3.8-6.2) on oxidation and levels of iron and copper in various fractions of mayonnaise enriched with 16% fish oil was investigated. Ascorbic acid induced release of iron from the assumed oil-water interface into the aqueous phase at all pH levels, but this effect of ascorbic acid was strongest at low pH (pH 3.8-4.2). Ascorbic acid generally promoted formation of volatile oxidation compounds and reduced the peroxide value in mayonnaises. Peroxide values and total volatiles generally increased with decreasing pH values, suggesting that low pH promoted oxidation. It is proposed that iron bridges between the egg yolk proteins low-density lipoproteins, lipovitellin, and phosphovit in the oil-water interface are broken at low pH values, whereby iron ions become accessible as oxidation initiators. In the presence of ascorbic acid, oxidation is further enhanced due to the reduction of Fe3+ to Fe2+ that rapidly catalyzes lipid oxidation via lipid hydroperoxide decomposition at the oil-water interface in mayonnaise.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Jacobsen, C. (Intern), Timm Heinrich, M. (Intern), Meyer, A. S. (Intern)
Pages: 3947-3956
Publication date: 2001
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 49
Issue number: 8
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
A check list for multi-instrument projects

General information
Effect of ascorbic acid on iron release from the emulsifier interface and on the oxidative flavor deterioration in fish oil enriched mayonnaise

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, Department of Biotechnology
Authors: Jacobsen, C. (Intern), Meyer, A. S. (Intern), Adler-Nissen, J. (Intern)
Pages: 4917-4926
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 47
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Mechanism of initiation of oxidation in mayonnaise enriched with fish oil as studied by electron spin resonance spectroscopy

Electron spin resonance spectroscopy (spin trapping technique) has been used to identify the most important single factor for initiation of lipid oxidation in mayonnaise enriched with fish oil. Low pH increases the formation of radicals during incubation under mildly accelerated conditions at 37 degrees C as quantified using 12-doxylstearic acid. Sugar, NaCl and potassium sorbate have no effect on radical formation while EDTA (down to 50 mug/g) has an antioxidative effect. Iron bound to phosvitin in egg yolk, inactive at pH similar to 6, is considered to be exposed to the solvent (the aqueous phase) at low pH and capable of initiating peroxide cleavage reactions when not protected by EDTA in a mixed complex.
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Oxidation in fish-oil-enriched mayonnaise 2: Assessment of the efficacy of different tocopherol antioxidant systems by discriminant partial least squares regression analysis
Oxidative protection of mayonnaises with 16% fish oil was studied during cold storage (5 degrees C) after supplementation with different tocopherol systems: the ternary antioxidant system ascorbic acid, lecithin and tocopherol (A/L/T), and two commercial mixtures, an oil-soluble (Toco 70) preparation and a water-soluble (Grindox 1032) preparation. The physical structure of the fish-oil-enriched mayonnaise was manipulated by adding extra emulsifier (Panodan TR) with the purpose of investigating whether or not this affected the antioxidative activity of the tocopherol mixtures. A number of different analytical techniques HPLC (high-performance liquid chromatography), gas chromatography mass spectrometry (GC-MS), sensory analysis, confocal laser scanning microscopy and rheological measurements were employed to elucidate the chemical, sensory, structural and rheological aspects of the oxidation process. Discriminant partial least squares regression was used to analyse the data obtained. The three tocopherol preparations not only affected the oxidative stability of the mayonnaises differently they also influenced the rheological and structural properties of the mayonnaises in different ways. The rheological and structural properties of the mayonnaise were also affected by the addition of extra emulsifier, but this did not influence the formation of fishy and rancid off-flavours. Addition of the A system caused the immediate formation of distinct fish; and rancid off-flavours in the fresh mayonnaises. The volatile compounds trans-2-heptenal, 3-octen-3-one, 1-octen-3-ol, trans,cis-2, 4-heptadienal, trans,trans-2,4-heptadienal, trans-2-octenal, nonanal and trans,cis-3,6-nonadienal were thought to contribute to the fishy and rancid flavours. Addition of Toco 70 did not affect the sensory perception of mayonnaise nor the development of volatile of flavour compounds as evaluated by GC-MS, but the peroxide values were slightly increased in mayonnaise containing Toco 70 as compared to the other mayonnaises. Mayonnaise with Grindox 1032 seemed to have fewer fishy and rancid off-flavours than mayonnaises without antioxidant. This flavour-protective effect of Grindox 1032 was correlated to an increase in the size of the droplet diameter of mayonnaises supplemented with Grindox 1032.

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology, Department of Systems Biology, Department of Biochemistry and Nutrition
Pages: 242-257
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: European Food Research and Technology
Volume: 210
Issue number: 4
ISSN (Print): 1438-2377
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.742 SNIP 0.882 CiteScore 1.81
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.732 SNIP 0.822 CiteScore 1.55
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.828 SNIP 0.908 CiteScore 1.71
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.791 SNIP 0.901 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.872 SNIP 1.038 CiteScore 1.68
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.009 SNIP 1.097 CiteScore 1.87
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Oxidation in fish oil-enriched mayonnaise: Assessment of the influence of the emulsion structure on oxidation by discriminant partial least squares regression analysis

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology, Department of Systems Biology, Department of Biochemistry and Nutrition, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Authors: Jacobsen, C. (Intern), Hartvigsen, K. (Intern), Lund, P. (Intern), Thomsen, M. (Ekstern), Skibsted, L. (Ekstern), Adler-Nissen, J. (Intern), Hølmer, G. K. (Intern), Meyer, A. S. (Intern)
Pages: 86-98
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: European Food Research and Technology
Volume: 211
ISSN (Print): 1438-2377
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.742 SNIP 0.882 CiteScore 1.81
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1

Original language: English
Source: orbit
Source-ID: 225900
Publication: Research - peer-review › Journal article – Annual report year: 2000
Oxidation mechanisms in mayonnaise enriched with fish oil

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Number of pages: 448
Publication date: 2000

Host publication information
Title of host publication: Proceedings of 29th WEFTA Meeting, 10 - 14 October, 1999 - Leptocarya - Pieria, Greece
Multivariate data analysis for more effective R&D and better quality control in the laboratory

General information
State: Published
Organisations: Department of Biotechnology, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Martens, H. (Intern), Martens, M. (Ekstern), Jacobsen, C. (Intern)
Pages: 9-17
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Managing the Modern Laboratory
Volume: 4
ISSN (Print): 1082-5878
Ratings:
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Original language: English
Source: orbit
Source-ID: 226606
Publication: Research › Journal article – Annual report year: 1999

Oxidation in fish-oil-enriched mayonnaise 1: Assessment of propyl gallate as an antioxidant by discriminant partial least squares regression analysis

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology, Department of Systems Biology, Department of Biochemistry and Nutrition
Authors: Jacobsen, C. (Intern), Hartvigsen, K. (Intern), Lund, P. (Intern), Meyer, A. S. (Intern), Adler-Nissen, J. (Intern), Holstborg, J. (Ekstern), Hølmer, G. K. (Intern)
Pages: 13-20
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: European Food Research and Technology
Volume: 210
ISSN (Print): 1438-2377
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.742 SNIP 0.882 CiteScore 1.81
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.732 SNIP 0.822 CiteScore 1.55
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.828 SNIP 0.908 CiteScore 1.71
Oxidation mechanisms in fish oil enriched emulsions

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Number of pages: 95
Publication date: 1999

Publication information
Publisher: DIFRES
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit

Oxidation mechanisms in fish oil enriched emulsions
Oxidation mechanisms in real food emulsions: Oil-water partition coefficients of selected volatile off-flavor compounds in mayonnaise

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Jacobsen, C. (Intern), Meyer, A. S. (Intern), Adler-Nissen, J. (Intern)
Pages: 317-327
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: European Food Research and Technology: international journal of food research and technology
Volume: 208
ISSN (Print): 1438-2377
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.742 SNIP 0.882 CiteScore 1.81
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.732 SNIP 0.822 CiteScore 1.55
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.828 SNIP 0.908 CiteScore 1.71
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.791 SNIP 0.901 CiteScore 1.71
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.872 SNIP 1.038 CiteScore 1.68
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.009 SNIP 1.097 CiteScore 1.87
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.931 SNIP 0.901
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.917 SNIP 0.845
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.852 SNIP 0.849
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.707 SNIP 0.842
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.749 SNIP 0.824
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.723 SNIP 0.789
Partitioning of selected antioxidants in mayonnaise

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Jacobsen, C. (Intern), Schwarz, K. (Ekstern), Stockmann, H. (Ekstern), Meyer, A. S. (Intern), Adler-Nissen, J. (Intern)
Pages: 3601-3610
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 47
Issue number: 9
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.291 SNIP 1.344
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.236 SNIP 1.253 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.278 SNIP 1.421 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.423 SNIP 1.479 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.43 SNIP 1.471 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Sensory impact of lipid oxidation in complex food systems

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources
Authors: Jacobsen, C. (Intern)
Pages: 484-492
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 101
ISSN (Print): 1438-7697
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Interactions between functional ingredients, antioxidants and off-flavour compounds in mayonnaise with fish oil

General information
State: Published
Oxidation mechanisms in real food emulsions: Method for separation of mayonnaise by ultracentrifugation

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Department of Biotechnology
Authors: Jacobsen, C. (Intern), Meyer, A. S. (Intern), Adler-Nissen, J. (Intern)
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Food Lipids
Volume: 5
Issue number: 2
ISSN (Print): 1065-7258
Ratings:
Scopus rating (2012): SJR 0.43 SNIP 0.918
Scopus rating (2011): SJR 0.609 SNIP 1.029
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.45 SNIP 0.812
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.715 SNIP 0.722
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.362 SNIP 0.553
Scopus rating (2007): SJR 0.39 SNIP 0.498
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.375 SNIP 0.739
Scopus rating (2005): SJR 0.284 SNIP 0.496
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.261 SNIP 0.497
Scopus rating (2003): SJR 0.238 SNIP 0.266
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.277 SNIP 0.565
Scopus rating (2001): SJR 0.348 SNIP 0.511
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.408 SNIP 0.438
Scopus rating (1999): SJR 0.37 SNIP 0.586
Original language: English

Bibliographical note
J English Article JUL 106GF Jacobsen C Tech Univ Denmark, Dept Seafood Res, Danish Inst Fisheries Res, Bldg 221, DK-2800 Lyngby, Denmark J FOOD LIPIDS
Source: orbit
Source-ID: 225906
Publication: Research - peer-review » Journal article – Annual report year: 1998

Fate of the synergistic antioxidant system ascorbic acid, lecithin, and tocopherol in mayonnaise: Partition of ascorbic acid

General information
Formulation of fish diets with reduced phosphorus content

General information
State: Published
Organisations: Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, FF secretariat
Authors: Jacobsen, C. (Intern), Børresen, T. (Intern)
Pages: 167-173
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: Water Science and Technology
Volume: 31
Issue number: 10
ISSN (Print): 0273-1223
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.3 SJR 0.394 SNIP 0.621
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.466 SNIP 0.599 CiteScore 1.19
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.587 SNIP 0.685 CiteScore 1.14
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.568 SNIP 0.7 CiteScore 1.3
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.601 SNIP 0.669 CiteScore 1.13
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.591 SNIP 0.626 CiteScore 1.25
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.522 SNIP 0.602
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.589 SNIP 0.686
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.579 SNIP 0.697
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.749 SNIP 0.781
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.693 SNIP 0.796
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.763 SNIP 0.85
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.877 SNIP 0.904
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.882 SNIP 0.902
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.903 SNIP 0.888
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.759 SNIP 0.967
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 0.76 SNIP 0.885
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.889 SNIP 0.936

Original language: English
Source: orbit
Source-ID: 225891
Publication: Research - peer-review › Journal article – Annual report year: 1995

Projects:
Novel microalgae based ingredients
National Food Institute
Period: 01/12/2017 → 30/11/2020
Number of participants: 5
Phd Student:
Ljubic, Anita (Intern)
Supervisor:
Bysted, Anette (Intern)
Holdt, Susan Løvstad (Intern)
Jakobsen, Jette (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)
Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Protein valorization through informatics, hydrolysis, and separation
WP leader on the industrialization part of proteins from seaweed
National Food Institute
Research Group for Bioactives – Analysis and Application
Research Group for Gut Microbiology and Immunology
Period: 01/09/2017 → 31/08/2021
Number of participants: 4
Acronym: PROVIDE
Project participant:
Holdt, Susan Løvstad (Intern)
Jacobsen, Charlotte (Intern)
Hansen, Egon Bech (Intern)
Garcia Moreno, Pedro Jesús (Intern)

Greenland seaweeds for human consumption
PhD project
National Food Institute
Research Group for Analytical and Predictive Microbiology
Research Group for Bioactives – Analysis and Application
Department of Civil Engineering
ARTEK, Section for Arctic Engineering and Sustainable Solutions
Period: 01/05/2017 → 30/04/2020
Number of participants: 5
Number of related Ph.D. students: 1
Phd Student:
Kreissig, Katharina Johanna (Intern)
Supervisor:
Jensen, Pernille Erland (Intern)
Holdt, Susan Løvstad (Intern)
Jacobsen, Charlotte (Intern)
Main Supervisor:
Hansen, Lisbeth Truelstrup (Intern)
Project
Experimental project in physics and nanotechnology: Cryo SEM Characterization of Food NMS Containing PUFA

Center for Electron Nanoscopy

DTU Danchip

National Food Institute

Research Group for Bioactives – Analysis and Application

Research Group for Nano-Bio Science

Period: 09/09/2016 → 01/12/2016
Number of participants: 5
Acronym: 33525
Project participant:
Haaning, Katrine (Ekstern)

Supervisor:
García Moreno, Pedro Jesús (Intern)
Jacobsen, Charlotte (Intern)
Chronakis, Ioannis S. (Intern)
Main Supervisor:
Mateiu, Ramona Valentina (Intern)

Valorization of red seaweed biomasses towards future sustainability (VALSEA), Multiextraction of Bioactive Compounds from Macroalgae

National Food Institute
Period: 01/02/2016 → 21/03/2019
Number of participants: 3
Phd Student:
Naseri, Alireza (Intern)

Supervisor:
Holdt, Susan Løvstad (Intern)
Jacobsen, Charlotte (Intern)

Main Supervisor:

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Optimization of processes, yield and biomass composition in large scale macroalgal cultivation in open ocean environments

National Food Institute
Period: 15/01/2016 → 14/01/2019
Number of participants: 4
Phd Student:
Grandorf Bak, Urd (Intern)

Supervisor:
Gregersen, Olavur (Ekstern)
Jacobsen, Charlotte (Ekstern)
Main Supervisor:
Holdt, Susan Løvstad (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Industrial PhD
Project: PhD

Valorization of red seaweed biomasses towards future sustainability (VALSEA), Multiextraction of Bioactive Compounds from Macroalgae
The aim of this applied research project is to better utilize the valuable compounds in seaweed and thereby achieve a higher return, since at present, Danish and international companies only extract specific stabilizing agents/ingredients from seaweed for use in various food and consumer products, and several valuable compounds go to waste. In this project the National Food Institute will use its expertise within seaweed research in cooperation with four Danish companies; CP Kelco, GEA Niro, Third Wave Nutrition and Nordisk Tang by Endelave. Not only carrageenan or furcellaran as single extraction, but a future multi-extraction of valuable proteins, natural food colours and antioxidants will turn waste into value, to be used in e.g. protein shakes. The research include the entire value chain from the extraction, drying of the extracted products such as protein, testing and application for ready products, and includes red seaweed species to be researched such as: Eucheuma spinosum, Furcellaria lumbricalis and Palmaria palmata for their different compositions and applications. DTU Food partners are Charlotte Jacobsen, Susan L. Holtd and Alireza Naseri

National Food Institute
Research Group for Bioactives – Analysis and Application
Period: 01/01/2016 → 31/12/2019
Number of participants: 3
Acronym: VALSEA
Project participant:
Naseri, Alireza (Intern)
Project Manager, academic:
Jacobsen, Charlotte (Intern)
Project Coordinator:
Holdt, Susan Løvstad (Intern)

Relations
Related projects:
Valorization of red seaweed biomasses towards future sustainability (VALSEA), Multiextraction of Bioactive Compounds from Macroalgae

Lipid Oxidation In High Fat Omega-3 Delivery Emulsions

National Food Institute
Period: 01/12/2015 → 30/11/2018
Number of participants: 3
Phd Student:
Yesiltas, Betül (Intern)
Supervisor:
Serensen, Ann-Dorit Moltke (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Development of omega-3 nanodelivery systems using electrospinning processing
Functional foods containing omega-3 lipids, which have approved health claims by EFSA, have resulted in one of the fastest-growing food product categories in Europe. However, to successfully develop foods enriched with omega-3 PUFA, lipid oxidation of these highly unsaturated fatty acids must be prevented in order to avoid both the loss of nutritional value and the formation of unpleasant off-flavors. Omega-3 PUFA can be added to foods as neat oils or as a “delivery system” such as microencapsulated oil powders and oil-in-water emulsions. Nevertheless, delivery of omega-3 lipids in the form of emulsions reduces the oxidative stability of omega-3 PUFA in some products. Furthermore, microencapsulates are less suitable for liquid or semi-liquid foods than emulsified omega-3 oils due to handling/mixing issues. Therefore, the development of alternative omega-3 PUFA delivery systems, which are easy to disperse and which will lead to improved oxidative stability of omega-3 enriched food products, is urgently required. One of the more promising delivery systems can be functional nanomicrostructures obtained by electrospinning technology, which is possible to up-scale.
In light of the above, the aim of this research project is to develop advanced omega-3 delivery systems such as electrospun nano-microstructures.

To this end, the specific objectives are:
1) Development of physically and oxidatively stable nano-microstructures with omega-3 PUFA and natural antioxidants using electrospinning processing.
2) Production of food enriched with the nano-microstructures having appropriate structural-functional properties and being oxidatively stable.

The success of the research proposed will lead to an important advance in the protection of omega-3 PUFA against oxidation when incorporated into food. Thus, the knowledge generated by this study has the potential to being exploited by companies devoted to the production of functional foods containing omega-3 lipids.

National Food Institute
Research Group for Bioactives – Analysis and Application
Research Group for Nano-Bio Science
Division of Industrial Food Research
Period: 24/08/2015 → 24/08/2017
Number of participants: 3
Acronym: ELECTRONANOMEGA
Project participant:
García Moreno, Pedro Jesús (Intern)
Supervisor:
Chronakis, Ioannis S. (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)

Related projects:
- Experimental project in physics and nanotechnology: Cryo SEM Characterization of Food NMS Containing PUFA
- Biological Sample Preparation for Electron Microscopy

Publications:
- Oxidative Stability of Nano-Microstructures containing fish oil
- Development of fish oil-loaded nano-microcapsules by co-axial electrospraying: physical characterization and oxidative stability
- Production of omega-3 nanodelivery systems by emulsion electrospinning
- Development of carbohydrate-based nano-microstructures loaded with fish oil by using electrohydrodynamic processing
- Oxidative stability of electrospun nanofibers loaded with fish oil
- Oxidative stability of pullulan electrospun fibers containing fish oil
- Encapsulation of fish oil in nanofibers by emulsion electrospinning: Physical characterization and oxidative stability
- Oxidative stability of pullulan nanofibers loaded with fish oil: effect of oil content and antioxidants addition
- Protein-polysaccharide Mixtures as Wall Material in Fish Oil-loaded Nano-microcapsules Obtained by Electrospraying Project

High value protein products in seaweed

The overall aim of the project is to develop new technologies that will ensure full utilization of the seaweed raw materials used for carrageenan production. More specifically, the aim is to develop new technologies to extract proteins from the seaweed either before or after extraction of carrageenan. Different mechanical and enzymatic technologies will be evaluated. The protein composition and the quality of the carrageenan fraction after extraction of proteins will be determined. The process will be scaled up to pilot scale if promising results are obtained in lab scale.

National Food Institute
Research Group for Food Production Engineering
Period: 20/10/2014 → 31/01/2016
Number of participants: 5
Acronym: HIT
Project participant:
Ekstraktion af glycoprotein fra tang
The project is based on a patent application regarding a new technology for extraction of glycoproteins with antioxidative properties from brown seaweed. The aim of the project is to upscale the technology and to evaluate whether it can be used on red seaweed, too. Furthermore, the antioxidative activity of the glycoprotein will be evaluated in selected food and skin care products.

National Food Institute
Research Group for Bioactives – Analysis and Application
Period: 15/08/2014 → 15/02/2015
Number of participants: 3
Acronym: Glycoprotein
Project participant:
Farvin Habeullah, Sabeena (Intern)
Jacobsen, Charlotte (Intern)
Kryger, Karsten (Intern)

Financing sources
Source: Public research council
Name of research programme: GAP
Amount: 543,000.00 Danish Kroner
Project

Udvikling af bæredygtige innovative fødevareingredienser på basis af ørredrestprodukter
National Food Institute
Division of Industrial Food Research
Division of Food Chemistry
Period: 01/01/2014 → 31/12/2015
Number of participants: 11
Acronym: DANFomega
Project participant:
Nouard, Marie-Louise (Intern)
Nielsen, Henrik Hauch (Intern)
Sloth, Jens Jørgen (Intern)
Rasmussen, Rie Romme (Intern)
Berner, Lis (Intern)
Vu, Thi Thu Trang (Intern)
Hansen, Erik D. (Ekstern)
Ørum, Poul (Ekstern)
Barlach, Anders (Ekstern)
Project Manager, organisational:
Honoré, Lone (Ekstern)
Project Manager, academic:
Jacobsen, Charlotte (Intern)

Financing sources
Source: Public research programme (public)
Udvikling af bæredygtige innovative fødevareingredienser på basis af ørredrestprodukter

National Food Institute
Research Group for Bioactives – Analysis and Application
Research Group for Food Production Engineering
Research Group for Nano-Bio Science

Period: 01/01/2014 → 31/12/2015
Number of participants: 12
Acronym: DANFOMEGA
Project participant:
Barlach, Anders (Ekstern)
Honold, Philipp (Intern)
Sørensen, Ann-Dorit Moltke (Intern)
Nouard, Marie-Louise (Intern)
Jessen, Flemming (Intern)
Sloth, Jens Jørgen (Intern)
Rasmussen, Rie Romme (Intern)
Berner, Lis (Intern)
Vu, Thi Thu Trang (Intern)
D. Hansen, Erik (Ekstern)

Financing sources
Source: Public research programme (public)

Lipid oxidation in skin care products
National Food Institute
Period: 01/01/2014 → 08/03/2018
Number of participants: 2
Phd Student:
Thomsen, Birgitte Raagaard (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)

Financing sources
Source: Internal funding (public)

Micro-algae biomass as an alternative resource for fishmeal and fish oil in the production of fish feed
National Food Institute
Period: 01/11/2013 → 15/03/2017
Number of participants: 6
Phd Student:
Safafar, Hamed (Intern)
Supervisor:
Møller, Per (Intern)
Main Supervisor: Jacobsen, Charlotte (Intern)
Examiner: Jørgensen, Bo Munk (Intern)
Barbosa, Maria (Ekstern)
Hansen, Per Juel (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet

Relations
Publications:
Micro-algae biomass as an alternative resource for fishmeal and fish oil in the production of fish feed
Project: PhD

Metabolic mechanisms behind the type 2 diabetes susceptible phenotype in low birth weight individuals
Department of Systems Biology
Period: 01/10/2013 → 27/10/2017
Number of participants: 6
Phd Student: Ribel-Madsen, Amalie (Intern)
Supervisor: Nielsen, Kristian Fog (Intern)
Main Supervisor: Brix, Susanne (Ekstern)
Examiner: Jacobsen, Charlotte (Intern)
Jessen, Niels (Ekstern)
Ozanne, Susan (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Quality improvement of krill oil and other krill products
National Food Institute
Division of Industrial Food Research
Period: 01/02/2013 → 31/12/2015
Number of participants: 2
Project participant: Lu, Henna Fung Sieng (Intern)
Jacobsen, Charlotte (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Muscle-specific stability of pork packaged in modified atmosphere during refrigerated storage
National Food Institute
Period: 01/11/2012 → 21/04/2016
Number of participants: 8
Phd Student: Spanos, Dimitrios (Intern)
Supervisor: Baron, Caroline P. (Intern)
Christensen, Mette (Ekstern)
Tørngren, Mari Ann (Ekstern)
Main Supervisor:
Jacobsen, Charlotte (Intern)
Examiner:
Jessen, Flemming (Intern)
Ertbjerg, Per (Ekstern)
Lund, Marianne Nissen (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

**Prediktiv modellering af kvalitetstab af laks gennem værdikæden**

National Food Institute
Period: 01/10/2012 → 26/04/2017
Number of participants: 7
Phd Student:
Johansson, Gine Ørnholt (Intern)
Supervisor:
Frosch, Stina (Intern)
Guðjónsdóttir, María (Intern)
Main Supervisor:
Jørgensen, Bo Munk (Intern)
Examiner:
Jacobsen, Charlotte (Intern)
Thorarinsdottir, Kristin Anna (Ekstern)
Ólafsdóttir, Gudrun (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.

**Relations**
Publications:
Process analysis and data driven optimization in the salmon industry
Project: PhD

**Extraction and characterisation of highly bioactive ingredients from Nordic marine algae**

National Food Institute
Period: 01/06/2012 → 21/04/2016
Number of participants: 6
Phd Student:
Hermund, Ditte Baun (Intern)
Supervisor:
Nielsen, Kristian Fog (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)
Examiner:
Sloth, Jens Jørgen (Intern)
Andersen, Mogens Larsen (Ekstern)
Hotchkiss, Sarah (Ekstern)

**Financing sources**
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

**Novel bioactive seaweed based ingredients and products**
The goal of this project is to develop technologies to process novel highly bioactive ingredients from bladderwrack and develop innovative products containing them with active collaboration of target consumers/users. The products include (a)
food supplements, (b) cosmetics and (c) food antioxidants. Within this programme DTU Food has defined a PhD project, which is cofinanced by DTU Food. The overall aim of the PhD study is to investigate the possibilities for developing novel natural antioxidants from highly unutilized Nordic seaweed resources. This will be achieved by exploring the potential application of polyphenolic secondary metabolites from Icelandic Fucus vesiculosus and Danish Fucus vesiculosus, Fucus serratus and Polysiphonia fucoides as novel natural antioxidants to control lipid oxidation and quality deterioration in lipid rich food systems. The focus will be to extract polyphenolic compounds by different extraction methods. The extracts will be screened for antioxidant activity by in vitro antioxidant assays such as radical scavenging and Fe2+ chelating activity. Analytical methods based on advanced high resolution MS techniques will be developed to characterize the polyphenolic compounds. The antioxidant activity will furthermore be evaluated in food systems.

National Food Institute
Research Group for Bioactives – Analysis and Application
Period: 01/01/2012 → 31/01/2016
Number of participants: 7
Acronym: Seaweed
Project participant:
Jacobsen, Charlotte (Intern)
Larsen, Ditte (Ekstern)
Torp, Eddy (Ekstern)
Sigurðsson, Guðbrandur (Ekstern)
Tómasson, Gunnar (Ekstern)
Folland, Sigbjørn (Ekstern)
Project Manager, academic:
G. Kristinsson, Hörður (Ekstern)

Financing sources
Source: Private funding (private)
Name of research programme: Nordic Innovation Center
Amount: 911,000.00 Norwegian Krone

Effects of emulging dietary fat with dairy phospholipids on establishment of the gut microbiota
Department of Systems Biology
Period: 01/12/2011 → 02/09/2015
Number of participants: 6
Phd Student:
Bennike, Rikke Mette Guldhammer (Intern)
Supervisor:
Licht, Tine Rask (Intern)
Main Supervisor:
Hellgren, Lars (Intern)
Examiner:
Jacobsen, Charlotte (Intern)
Ahrné, Siv (Ekstern)
Lauridsen, Charlotte (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Sensory factors in food satisfaction
National Food Institute
Period: 01/11/2011 → 01/04/2015
Number of participants: 6
Phd Student:
Andersen, Barbara Vad (Intern)
Supervisor:
Phenolipids as antioxidants in omega-3 model and real food systems - Effect of alkyl chain length and concentration

Fish oil contain omega-3 PUFAs due to the content of unsaturated lipids, the fish oil is easily oxidized. The oxidation and development of rancidity in fish oil can be inhibited or delayed by the addition of antioxidants. Phenolics are compounds present in plants and are known to have good antioxidant properties. However, phenolics are primary water soluble antioxidants, and will in many food products (emulsions) be located in the water phase and not close to the interface where the oxidation is initiated.

The lipophilicity of the phenolics can be modified by attaching a fatty acid to the phenolic compound (phenolipids). This modification will change the location of the new phenolipid emulsions, which may increase their antioxidant activity due to the location.

The aim of the project are to evaluate the optimum chain length of the fatty acid attached to different phenolic in order to give optimale antioxidant activity in different food emulsion systems. Second aim of the project is to develop mathematically models, these can be used by the industry to predict the efficacy of the new synthesized phenolipids.

Activities

Research stay at UMR IATE, CIRAD, Montpellier, France - Producing Phenolipids, September 2011 – March 2012
103rd AOCS Annual Meeting & Expo, Long Beach, California, USA, April 29 – May 2, 2012 - Phenolipids as antioxidants in emulsified systems and the effect of alkyl chain length (Ann-Dorit Moltke Sørensen, Christelle Bayrasy, Mickael Laguerre, Jerome Lecomte, Pierre Villeneuve and Charlotte Jacobsen)
See AOCS 2012 abstract ADMS in the right column
Research stay at SINTEF, Trondheim, Norway - Introduction to Oxygraph, June 2012
10th Euro Fed Lipid Congress, Cracow, Poland, September 23-26, 2012 - Phenolipids as antioxidants in emulsified systems (Ann-Dorit Moltke Sørensen, Christelle Bayrasy, Mickael Laguerre, Jerome Lecomte, Pierre Villeneuve and Charlotte Jacobsen)
See EFL 2012 abstract ADMS in the right column
104th AOCS Annual Meeting & Expo, Montreal, Quebec, Canada, April 28 – May 1, 2013.
See AOCS 2013 abstract ADMS in the right column
Phenolipids as antioxidant in omega-3 enriched food products (Ann-Dorit Moltke Sørensen, Mercedes Alemán, Erwann Durand, Pierre Villeneuve, Ricard Bou, Francesc Guardiola & Charlotte Jacobsen)
See ACS 2013 abstract ADMS in the right column
See EFL 2013 abstract ADMS in the right column
See AOCS 2014 abstract ADMS in the right column

Publications


National Food Institute

Division of Industrial Food Research
Period: 01/07/2011 → 30/06/2014
Number of participants: 4
Project participant:
Jacobsen, Charlotte (Intern)
Villeneuve, Pierre (Ekstern)
Storrø, Ivar (Ekstern)
Project Manager, academic:
Sørensen, Ann-Dorit Moltke (Intern)

Financing sources
Source: Public research council
Name of research programme: Danish Agency for Science Technology and Innovation Danish Council of Independent Research (DFF), Technology and Production
Amount: 3,479,916.00 Danish Kroner

Documents:
ACS 2013 Abstract ADMS
AOCS 2012 Abstract ADMS
AOCS 2013 Abstract ADMS
AOCS 2014 Abstract ADMS
EFL 2012 Abstract ADMS
EFL 2013 Abstract ADMS

Project

Phenolipids as antioxidants in omega-3 model and real food systems - Effect of alkyl chain length and concentration
Fish oil contain omega-3 PUFA due to the content of unsaturated lipids, the fish oil is easily oxidized. The oxidation and development of rancidity in fish oil can be inhibited or delayed by the addition of antioxidants. Phenolics are compounds present in plants and are known to have good antioxidative properties. However, phenolics are primary water soluble antioxidants, and will in many food products (emulsions) be located in the water phase and not close to the interface where the oxidation is initiated. The lipophilicity of the phenolics can be modified by attaching a fatty acid to the phenolic compound (Phenolipids). This modification will change the location of the new phenolipid in emulsions, which may increase their antioxidant activity due to the location. The aim of the project are to evaluate the optimale chain length of the fatty acid attached to different phenolic in order to give optimale antioxidant activity in different food emulsion systems. Second aim of the project is to develope mathematically models, there can be use by the industry to predict the efficacy of the new synthesized phenolipids.

Activities Research stay at UMR IATE, CIRAD, Montpellier, France - Producing Phenolipids, September 2011 – March 2012 103rd AOCS Annual Meeting & Expo, Long Beach, California, USA April 29 – May 2, 2012 - Phenolipids as antioxidants in emulsified systems and the effect of alkyl chain length (Ann-Dorit Moltke Sørensen, Christelle Bayrasy, Mickael Laguerre, Jérôme Lecomte, Pierre Villeneuve and Charlotte Jacobsen); Conference abstractResearch stay at SINTEF, Trondheim, Norway - Intoduction to Oxygraph, June 2012 0th Euro Fed Lipid Congress, Cracow, Poland, September 23 -26, 2012 - Phenolipids as antioxidants in emulsified systems (Ann-Dorit Moltke Sørensen, Christelle Bayrasy, Mickael Laguerre, Jérôme Lecomte, Pierre Villeneuve and Charlotte Jacobsen).

National Food Institute

Division of Industrial Food Research
Period: 01/07/2011 → 01/06/2014
Number of participants: 4
Acronym: Phenolipids as antioxidants
Contact person:
Jacobsen, Charlotte (Intern)
Project participant:
Villeneuve, Pierre (Ekstern)
Storrø, Ivar (Ekstern)
Project Manager, organisational:
Aquatic Resources as a Source of Potential Natural Antioxidants for Food Industry

It is well documented that long-chain polyunsaturated omega-3 fatty acids (omega-3 PUFA) have a range of beneficial health effects such as reducing atherosclerosis, prevention and treatment of numerous disorders like cardiovascular disease, cancer, diabetics, mental illness etc.

At the same time they are very susceptible to lipid oxidation that not only causes deterioration of food sensory quality, but also contributes to carcinogenesis, atherosclerosis and aging processes in humans. Hence, the oxidative instability of omega-3 fatty acids often limits their use as nutritionally beneficial lipids in fish oil enriched foods. Addition of antioxidants that scavenge free radicals and control pro-oxidative metals is used to retard lipid oxidation.

Many of the most commonly used antioxidants are synthetic compounds, which have been reported to possess carcinogenic effect in humans and there is, therefore a need to find potent and safer natural antioxidants.

Many living organisms in the marine environment are rich in omega-3 PUFA. Our hypothesis is therefore that these marine organisms are rich in natural antioxidants that are able to protect them against lipid oxidation and that these antioxidants can be used to protect foods against oxidation.

Objectives

The overall goal of the project is to identify natural compounds with antioxidant activity from aquatic resources such as marine algae, bacteria, fungi, peptides isolated from fish waste and to evaluate potential applications of these novel compounds to enhance oxidative stability, flavor quality and nutritional value of foods enriched with omega-3 fatty acids and seafood based products.

This will be achieved by:

Screening extracts from aquatic resources like marine algae, bacteria, fungi and peptides isolated from fish waste for their antioxidative mechanisms and properties and identifying the most promising sources of antioxidants.

Evaluating the antioxidant properties of the most promising antioxidant sources in different foods systems enriched with omega-3 fatty acids such as milk, dressing and seafood.

Project financing:

Danish research council for Technology and production (FTP)

National Food Institute
Division of Industrial Food Research
Department of Systems Biology
Bacterial Ecophysiology and Biotechnology

Metabolomics Platform
Period: 01/01/2009 → 31/12/2012
Number of participants: 6
Acronym: Potential natural antioxidants
Contact person:
Jacobsen, Charlotte (Intern)
Project participant:
Gram, Lone (Intern)
Jessen, Flemming (Intern)
Nielsen, Henrik Hauch (Intern)
Nielsen, Kristian Fog (Intern)
Project Manager, organisational:
Farvin Habeullah, Sabeena (Intern)

Reproductive Ecology: Effect of dietary fatty acids on ovarian maturation, spawning time and quality of eggs and larvae in Eastern Baltic cod
National Institute of Aquatic Resources
Period: 01/10/2008 → 27/06/2012
Number of participants: 6
Phd Student:
Røjbek, Maria (Intern)
Supervisor:
Jacobsen, Charlotte (Intern)
Tomkiewicz, Jonna (Intern)
Main Supervisor:
Støttrup, Josianne Gatt (Intern)
Examiner:
Grønkjær, Peter (Ekstern)
Kraus, Gerd (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD

Omega-3 food emulsions: Control and Investigation of Molecular Structure in Relation to Lipid Oxidation
National Food Institute
Period: 01/04/2008 → 28/03/2012
Number of participants: 7
Phd Student:
Horn, Anna Frisenfeldt (Intern)
Supervisor:
Nielsen, Nina Skall (Intern)
Szabo, Peter (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)
Examiner:
Hellgren, Lars (Intern)
Andersen, Mogens Larsen (Ekstern)
Genot, Claude (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.
Project: PhD
**Nutritional Immunology**

This project runs under the FoodDTU umbrella, and one of its purposes is to create new collaborations between different DTU institutes with ongoing research related to food science. The participating institutes are DTU-Food, DTU-Biosys and DTU-Aqua. The purpose is to elucidate the impact of specific dietary components including e.g. fish oil on the intestinal microbiota and thereby on the development of the immune system in early life. The results are expected to create a basis for better nutritional advice for pregnant women.

National Food Institute

Department of Systems Biology

University of Copenhagen


Number of participants: 14

Project participant:

Kristensen, Matilde Bylov (Intern)

Wilcks, Andrea (Intern)

Bergström, Anders (Intern)

Nellemann, Christine (Intern)

Kølln, Charlotte (Intern)

Jacobsen, Charlotte (Intern)

Nielsen, Nina Skall (Intern)

Horn, Anna Frisenfeldt (Intern)

Mathiassen, Jakob Hovalt (Intern)

Hellgren, Lars (Intern)

Fink, Lisbeth Nielsen (Intern)

Frøkjær, Hanne (Ekstern)

Broeng Metzdorff, Stine (Ekstern)

Project Manager, organisational:

Licht, Tine Rask (Intern)

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**Nutritional Immunology**

This project runs under the FoodDTU umbrella, and one of its purposes is to create new collaborations between different DTU institutes with ongoing research related to food science. The participating institutes are DTU-Food, DTU-Biosys and DTU-Aqua. The purpose is to elucidate the impact of specific dietary components including e.g. fish oil on the intestinal microbiota and thereby on the development of the immune system in early life. The results are expected to create a basis for better nutritional advice for pregnant women.

National Food Institute

Department of Systems Biology

University of Copenhagen

Period: 01/08/2007 → 31/12/2011

Number of participants: 13

Project participant:

Kristensen, Matilde Bylov (Intern)

Wilcks, Andrea (Intern)

Bergström, Anders (Intern)

Andersen, Jens Bo (Intern)

Nellemann, Christine (Intern)

Kølln, Charlotte (Intern)

Jacobsen, Charlotte (Intern)

Nielsen, Nina Skall (Intern)

Horn, Anna Frisenfeldt (Intern)

Mathiassen, Jakob Hovalt (Intern)

Hellgren, Lars (Intern)

Fink, Lisbeth Nielsen (Intern)

Project Manager, organisational:

Licht, Tine Rask (Intern)
Nutritional Immunology
National Food Institute
Department of Systems Biology
National Institute of Aquatic Resources
Period: 04/01/2007 → 31/12/2011
Number of participants: 10
Project participant:
Wilcks, Andrea (Intern)
Bergström, Anders (Intern)
Andersen, Jens Bo (Intern)
Metzdorff, Stine Broeng (Intern)
Fink, Lisbeth Nielsen (Intern)
Nielsen, Nina Skall (Intern)
Project Manager, organisational:
Licht, Tine Rask (Intern)
Frøkiær, Hanne (Intern)
Hellgren, Lars (Intern)
Jacobsen, Charlotte (Intern)

Financing sources
Source: [Ordinær drift UK 10]
Name of research programme: [Ordinær drift UK 10]
Amount: 3,250,000.00 Danish Kroner

Improvement of Oxidative Stability of Fish Oil Enriched Foods - Ingredients Interactions and Antioxidant Effects
National Food Institute
Period: 01/08/2006 → 23/06/2010
Number of participants: 6
Phd Student:
Sørensen, Ann-Dorit Moltke (Intern)
Supervisor:
Nielsen, Nina Skall (Intern)
Main Supervisor:
Jacobsen, Charlotte (Intern)
Examiner:
Hellgren, Lars (Intern)
Olsen, Karsten (Ekstern)
Villeneuve, Pierre (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Ansat eksternt

Enzymatic Lipophilisation of Bioactive Compounds
National Food Institute
Period: 01/04/2006 → 30/06/2008
Number of participants: 7
Phd Student:
Lue, Bena-Marie (Intern)
Supervisor:
Jacobsen, Charlotte (Intern)
Jørgensen, Bo Munk (Intern)
Nutritious and tasty omega-3 rich foods for a slim and healthy population
The increased prevalence of obesity represents the greatest challenge of public health today. Even slight modifications in the energy content of foodstuffs may facilitate the prevention of obesity. This could be achieved by replacing dietary fat with low-calorie fat (LCF). Moreover, new research results suggest that also omega-3 fatty acids from fish oil may have a preventive effect on obesity. Furthermore, it has been shown that omega-3 fatty acids from fish oil may prevent the development of other risk factors for heart disease. A new strategy to prevent obesity and risk factors for heart disease could be to substitute traditional fats with a combination of LCF and omega-3 fatty acids from fish oil. However, new technologies to incorporate these fatty acids into tasty foods with an acceptable shelf life are needed. It is also necessary to investigate consumer perception of these products. Finally, the potential health economic effects of such products should also be investigated. The aim of the project is therefore to determine the potential of omega-3 fatty acids and LCF to improve the health of the Danish population. This will be investigated in three sub-projects. Sub-project 1. Health promoting and weight reducing effects of omega-3 fatty acids and low calory fats. The aim of sub-project 1 is to answer the following questions: Do omega-3 fatty acids from fish oil affect weight, insulin-resistance and markers of cardiovascular disease in overweight adolescents? Do LCF influence appetite? What are the mechanisms behind the effects of omega-3 fatty acids from fish oil? Do omega-3 fatty acids and LCF have any synergistic effects on weight loss and prevention of metabolic syndrome? Sub-project 2. Protection against oxidation in fish oil enriched foods. The aim of sub-project 2 is to investigate how new technologies such as enzyme technology can be utilised to prevent oxidation in foods enriched with omega-3 fatty acids. Enzyme technology will be employed to produce new antioxidants with optimised physico-chemical properties. The antioxidants will be evaluated in selected fish oil enriched foods. Moreover, investigations on how oxidation can be prevented in fish oil enriched mayonnaise salads, bread and liver paté will be carried out, e.g. by determining the effect of the different ingredients on the oxidative stability of these foods. Sub-project 3. Consumer perception and health economic effects. The aim of sub-project 3 is to answer the following questions: Does labelling of the product influence the sensory perception of omega-3 enriched food products? What are the potential economical benefits to the Danish society of an increased intake of omega-3 fatty acids from fish oil? Participants: Project leader: Charlotte Jacobsen (Danish Institute for Fisheries Research, DTU (DIFRES) Sub-project 1: Sub-project leader: Lotte Lauritzen (Department of Human Nutrition, Faculty of Life Science, University of Copenhagen) (HN) Lars Hellgren (BioCentrum-DTU) Majken Højgaard Pedersen (HN & BioCentrum-DTU) Christian Melgaard (HN) Lone B. Sørensen (HN) Arne Astrup (HN) Jesper T. Andersen (Kohberg A/S) Flemming Vang Sparsæ (Danisco) Sub-project 2: Sub-project 2 leader: Xuebing Xu (BioCentrum-DTU) Mette Bruni Let (BioCentrum-DTU) Ann-Dorit Moltke Sørensen (DIFRES) Nina Skall Nielsen (DIFRES) Charlotte Jacobsen (DIFRES) Margit Olsen (Stryhns) Flemming Vang Sparsæ (Danisco) Jesper T. Andersen (Kohberg A/S) Frank Minck (Association for the Danish Fish Meal and Fish Oil Industry) Camilla Bang (Gråsten Salater A/S) Sub-project 3: Sub-project 3 leader: Joachim Scholderer (MAPP Center, Århus University) Jan Sørensen (CAST, Syddansk University) Grethe Hyldig (DIFRES) Jesper T. Andersen (Kohberg A/S) Camilla Bang (Gråsten Salater A/S) Project financing: Strategic Research Council (FØSU) and The Directorate for Food, Fisheries and Agri Business.

National Food Institute
Division of Industrial Food Research
Period: 01/01/2006 → 31/12/2009
Number of participants: 1
Acronym: Nu3Health
Contact person: Jacobsen, Charlotte (Intern)

Fish oil enrichments
An increasing amount of evidence suggests that omega-3 fatty acids have a number of positive nutritional benefits in the human body (cardioprotective effect, prevention of inflammatory and various neurological diseases etc.). Increased attention from the media on these issues has lead to an increased consumer knowledge about omega-3 fatty acids, which in turn has lead to a growing intake of fish oil capsules. An alternative way of increasing the consumption of omega-3 fatty acids could be by adding fish oil to foods. Recently, several fish oil enriched foods have been launched in other European countries. This is not the case in Denmark. This may be due to different reasons. At the consumer side a barrier could be a lack of confidence in the taste of the product. In the food industry a barrier could be the uncertain situation w.r.t. health claims as well as problems related to the susceptibility of fish oil enriched foods to lipid oxidation. Finally, more studies are...
needed to determine whether the bioavailability of omega-3 fatty acids from fish oil enriched foods is similar to that of fish oil capsules.

National Food Institute
Division of Industrial Food Research
Communications and Management Secretariat

Period: 01/01/2005 → 31/12/2008
Number of participants: 15
Project participant:
Nielsen, Nina Skall (Intern)
Jørgensen, Jane (Ekstern)
Mu, Huiling (Ekstern)
Porsgaard, Trine (Ekstern)
Jensen, Karen (Ekstern)
Scholderer, Joachim (Ekstern)
Hagemann, Kit (Ekstern)
Krutulyte, Rasa (Ekstern)
Elgaard, Peter (Ekstern)
Nielsen, Brian (Ekstern)
Graverholt, Jens Peter (Ekstern)
Affertsholt, Tage (Ekstern)
Pedersen, Pierre (Ekstern)
Brønner, Kirsti Wettre (Ekstern)
Project Manager, organisational:
Jacobsen, Charlotte (Intern)

Structured lipids for fish feed for rainbow trouts

Intake of n-3 polyunsaturated fatty acids (PUFA) from fish is important for human health, due to the positive health effects of these PUFA. Feed for farmed fish has traditionally contained ingredients of marine origin high in n-3 fatty acids. However, marine resources might be in shortage for future feed production due to an increasing aquaculture production and stable or declining catches for fish-meal and -oil production.

Alternative sources of oil for fish feed have been investigated. Substitution of fish oil with vegetable oil may not affect the growth of fish, but will be reflected in the tissue of the fish by a reduced content of n-3 PUFA such as EPA and DHA. A major challenge is to influence fatty acid metabolism to save EPA and DHA for storage.

Medium chain fatty acids may preferably be oxidised to provide energy especially when positioned in the sn-1 and -3 positions as demonstrated in mammals. Due to the high fat content in the diets fat accumulation in trout is sometimes too high. In mammals, addition of diacylglycerols to the diet has been shown to reduce fat accumulation.

Objectives:

To determine the specificity of lipase in trout
To investigate whether it is possible to increase the relative incorporation of EPA in a low n-3 PUFA diet by feeding trout specific structured triacylglycerols with n-3 PUFA in the sn-2 position and medium chain fatty acids in the sn-1,3 positions
To investigate whether addition of diacylglycerols (DAG) in a fish diet could reduce fat accumulation in trout.

National Food Institute
Division of Industrial Food Research
Communications and Management Secretariat

Period: 01/01/2004 → …
Number of participants: 8
Acronym: Lipids for fish feed
Project participant:
Nielsen, Nina Skall (Intern)
Nielsen, Henrik Hauch (Intern)
Jørgensen, Jane (Ekstern)
Mu, Huiling, (Ekstern)
Production and Nutritional Aspects of Butter Enriched with Diacylglycerols

Department of Systems Biology
Period: 15/10/2002 → 27/03/2006
Number of participants: 8
Phd Student:
Kristensen, Janni Brogaard (Intern)
Supervisor:
Jacobsen, Charlotte (Intern)
Nielsen, Nina Skall (Intern)
Xu, Xuebing (Intern)
Main Supervisor:
Mu, Huiling (Intern)
Examiner:
Hellgren, Lars (Intern)
Adlercreutz, Patrick (Ekstern)
Jensen, Merete Myrup (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Offentlig finansiering
Project: PhD

Production of magarine fats by lipase-catalysed interesterification: a process, quality, and nutritional study for industrial application

Department of Systems Biology
Period: 01/10/2001 → ...
Number of participants: 8
Phd Student:
Zhang, Hong (Intern)
Supervisor:
Jacobsen, Charlotte (Intern)
Nilsson, Jörgen (Ekstern)
Pedersen, Lars Saaby (Ekstern)

Main Supervisor:
Adler-Nissen, Jens (Intern)
Examiner:
Hellgren, Lars (Intern)
Adlercreutz, Patrick (Ekstern)
Mortensen, Børge (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Erhvervsforskerordningen
Project: PhD

FAO Fish Oil
The purpose of the project is to obtain preliminary data on the storage stability of a fish oil-enriched, vegetable-based product intended as a supplement to the staple diet in sub-Saharan populations. FAO Fisheries Utilization Division is in the process of setting up a project which involves supplying families in certain African regions with fish oil, rich in docosahexaenoic acid. The role of this pre-project is to follow the development of possible oxidation products during the storage at ambient temperature of the fish oil-enriched tomato-and-onion sauce. The storage stability is assessed through sensory evaluation and chemical measurements of oxidation indices.

National Institute of Aquatic Resources
Period: 01/07/1999 → 01/07/2000
Number of participants: 3
Project participant:
Jacobsen, Charlotte (Intern)
Vu, Thi Thu Trang (Intern)

Project Manager, organisational:
Jensen, Benny (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 100,000.00 Danish Kroner
Project

Oxidationsmekanismer i fiskeolieholdige
Department of Systems Biology
Period: 01/11/1996 → …
Number of participants: 4
Phd Student:
Jacobsen, Charlotte (Intern)
Supervisor:
Børresen, Torger (Intern)
Meyer, Anne S. (Intern)

Main Supervisor:
Adler-Nissen, Jens (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Kandidatstipendium ansat på DT
Project: PhD

Oxidation mechanisms in fish oil enriched emulsions
The purpose of the project is to study the oxidation mechanisms in fish oil enriched emulsions in order to develop combined emulsifier and antioxidant systems which are more efficient in protecting fish oil enriched foods against oxidation than existing antioxidant systems. Results obtained in 1999 have shown that the low pH in mayonnaise is a very important factor for the initiation of the oxidation processes in mayonnaise. This is due to the fact that iron ions are released/loosened from the egg yolk components at the oil/water interface when pH is decreased to 4, which is the normal
pH in mayonnaise. The released iron promotes decomposition of peroxides to volatiles, which are responsible for the off-flavour formation in mayonnaise. The metal chelator EDTA was observed to be a very efficient antioxidant in mayonnaise due to its ability to chelate iron. A HPLC method for determination of lipid peroxides has been further optimised and is now fully operational. By the aid of GC-MS a large number of volatiles that correlate to the fishy and rancid off-flavours in oxidised mayonnaise have been identified.

National Institute of Aquatic Resources
Department of Biochemistry and Nutrition
Department of Biotechnology
Danisco Ingredients
Association of Danish Fish Meal and Fish Oil Manufacturers

Royal Veterinary and Agricultural University
Period: 01/05/1996 → 31/12/1999
Number of participants: 11
Project participant:
Vu, Thi Thu Trang (Intern)
Jacobsen, Charlotte (Intern)
Hartvigsen, Karsten (Intern)
Lund, Pia (Intern)
Datta, Suvra (Intern)
Helmer, Gunhild Kofoed (Intern)
Meyer, Anne S. (Intern)
Green, Else (Intern)
Reitz, Suzie (Intern)
Adler-Nissen, Jens (Intern)

Project Manager, organisational:
Børresen, Torger (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 1,050,000.00 Danish Kroner
Source: Unknown
Name of research programme: Ukendt
Amount: 6,178,065.00 Danish Kroner

Activities:

Danish Fish Levy Fond (External organisation)
Period: 2017
Charlotte Jacobsen (Participant)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Board member

Related external organisation
Danish Fish Levy Fond
Denmark
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Internation Seaweed Symposium (External organisation)
Period: Jun 2016
Charlotte Jacobsen (Participant)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Member of National Organising Committee of the Internation Seaweed Symposium, Copenhagen, Denmark

Related external organisation
Internation Seaweed Symposium
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

EuroFedLipid seminar on lipid oxidation and antioxidant
Period: 5 Jun 2016 → 7 Jun 2016
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-organiser

Related event
EuroFedLipid seminar on lipid oxidation and antioxidant
05/06/2016 → 07/06/2016
Porto, Portugal
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Lipid Oxidation and Antioxidant Division under EuroFedLipid (External organisation)
Period: 2015 → …
Charlotte Jacobsen (Chairman)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-chairman

Related external organisation
Lipid Oxidation and Antioxidant Division under EuroFedLipid
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

European Journal of Lipid Science and Technology (Journal)
Period: 2014
Charlotte Jacobsen (Editor)
National Food Institute
Division of Industrial Food Research

Description
Assistant editor

Related journal
European Journal of Lipid Science and Technology
1438-7697
Central database
Microalgae workshop
Period: 26 Nov 2014
Charlotte Jacobsen (Organizer)
Division of Industrial Food Research
National Food Institute

Description
Organizer of seminar

Related event
Microalgae workshop
Kalundborg, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

11th EuroFedLipid Conference
Period: 14 Sep 2014
Charlotte Jacobsen (Chairman)
Division of Industrial Food Research
National Food Institute

Description
11th EuroFedLipid Conference
Session chair, scientific committee, reviewer

Related event
11th EuroFedLipid Conference
14/09/2014 → 17/09/2014
Montpellier, France
Activity: Attending an event › Participating in or organising a conference

Temadag om fiskeolie
Period: 25 Jun 2014
Charlotte Jacobsen (Invited speaker)
National Food Institute
Division of Industrial Food Research

Related event
Temadag om fiskeolie
25/06/2014 → …
Århus, Denmark
Activity: Talks and presentations › Conference presentations

105th AOCS Annual Meeting & Expo (Event)
Period: 4 May 2014
Charlotte Jacobsen (Reviewer)
National Food Institute
Division of Industrial Food Research

Description
105th AOCS Annual Meeting & Expo
Session Chair

Related event

105th AOCS Annual Meeting & Expo
04/05/2014 → 07/12/2014
San Antonio, TX, United States
Activity: Research › Peer review of manuscripts

EuroFedLipid and Nordic Lipidforum on: Novel sources of omega-3 fatty acids for food, feed and pharma
Period: 14 Nov 2012 → 15 Nov 2012
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-organiser of seminar

Related event

EuroFedLipid and Nordic Lipidforum on: Novel sources of omega-3 fatty acids for food, feed and pharma
14/11/2012 → 15/11/2012
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Journal of American Oil Chemist's Society (Journal)
Period: 2011 → 2016
Charlotte Jacobsen (Editor)
National Food Institute
Division of Industrial Food Research

Description
Receiving editor

Related journal

Journal of American Oil Chemist's Society
Local database
Activity: Research › Journal editor

Journal of Aquatic Food Products (Journal)
Period: 2011
Charlotte Jacobsen (Editor)
National Food Institute
Division of Industrial Food Research

Description
Receiving editor

Related journal

Journal of Aquatic Food Products
Local database
Activity: Research › Journal editor

10th ILPS congress: Phospholipids – Sources, processing and applications
Period: 16 Sep 2011 → 18 Sep 2011
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-organiser of congress

Related event

10th ILPS congress: Phospholipids – Sources, processing and applications
01/09/2011 → …
Rotterdam, Netherlands
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

Biohazard Panel (External organisation)
Period: 2010
Charlotte Jacobsen (Member)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Appointed by EFSA as an expert in the Fish Oil working group under the Biohazard Panel

Related external organisation

Biohazard Panel
Activity: Membership › Membership of research networks or expert groups

National Food Institute (Organisational unit)
Period: 2010 → 2012
Charlotte Jacobsen (Member)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Head of FOOD Denmark PhD research school

Related organisation

National Food Institute (Organisational unit)
Jacobsen, C. (Member)
2010 → 2012
Activity: Membership › Membership of research networks or expert groups

Nu3Health and HEFI projects
Period: 2 Nov 2010
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-organiser of final seminar

Related event

Nu3Health and HEFI projects
02/11/2010 → …
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.
Kan fiskes sundhedspotentiale udnyttet til innovativ produktudvikling?

Period: 28 Jan 2010

Charlotte Jacobsen (Speaker)

National Food Institute
Division of Seafood Research

Description
Place: Konferencen "Hvordan udvikles Nordatlantens Fiskeressourcer", arrangeret af Dansk Fødevare Forum, Grønlands Arbejdsgiverforening og DTU Fødevareinstituttet, Ålborg

Related external organisation

Unknown external organisation
Activity: Talks and presentations › Conference presentations

Period: 2009 → …

Charlotte Jacobsen (Participant)

National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Member

Related external organisation

Activity: Membership › Membership of commitees, commissions, boards, councils, associations, organisations, or similar

Marine Lipid Division under EuroFedLipid (External organisation)
Period: 2009 → 2015

Charlotte Jacobsen (Chairman)

National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-chairman

Related external organisation

Marine Lipid Division under EuroFedLipid
Activity: Membership › Membership of commitees, commissions, boards, councils, associations, organisations, or similar

National Food Institute (Organisational unit)
Period: 2009 → 2010

Charlotte Jacobsen (Member)

National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Deputy head of FOOD Denmark PhD research school

Related organisation

National Food Institute (Organisational unit)
Jacobsen, C. (Member)
2009 → 2010
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**American Oil Chemists Society (External organisation)**
Period: 2008 → 2010
Charlotte Jacobsen (Member)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
President European Section of American Oil Chemists Society

**Related external organisation**

**American Oil Chemists Society**
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

**Seminar on phospholipids**
Period: 19 Dec 2008
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Organizer, main responsible

**Related event**

**Seminar on phospholipids**
19/12/2008 → …
Copenhagen, Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**The opening seminar of the "Lipid Cluster at DTU"**
Period: 30 Apr 2008
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Organizer, main responsible

**Related event**

**The opening seminar of the "Lipid Cluster at DTU"**
30/04/2008 → …
Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Omega-3 enrichment of foods for Danish SME's**
Period: 13 Apr 2007 → 19 Apr 2007
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Co-organiser for 2 Workshops
Related event

**Omega-3 enrichment of foods for Danish SME's**
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Phospholipid network under the Øresund Food Network**
Period: 2006 → 2009
Charlotte Jacobsen (Other)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Coordinator
Activity: Other

**The good fat – the technology behind new products**
Period: 2006
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Seminar on “The good fat – the technology behind new products”

Co-organiser

**Related event**

**The good fat – the technology behind new products**
01/01/2006 → 01/01/2006
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Omega-3 fatty acids in functional foods**
Period: 16 Jun 2006
Charlotte Jacobsen (Organizer)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Organiser of the 2nd meeting

**Related event**

**Omega-3 fatty acids in functional foods**
15/06/2006 → 16/06/2006
Helsingør , Denmark
Activity: Attending an event › Participating in or organising workshops, courses, seminars etc.

**Lipid Oxidation board under The American Oil Chemists Society (External organisation)**
Period: 2005 → 2017
Charlotte Jacobsen (Chairman)
National Food Institute
Research Group for Bioactives – Analysis and Application

**Description**
Chairman
Responsible for organising 9 sessions
Related external organisation

Lipid Oxidation board under The American Oil Chemists Society
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Meeting between West European Fish Technology Association and the European Section of the American Oil Chemists Society, Ghent, Belgium
Period: 2005
Charlotte Jacobsen (Participant)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Co-organiser
Activity: Other

Officially appointed examiner at the University of Copenhagen, Denmark
Period: 2002
Charlotte Jacobsen (External examiner)
National Food Institute
Research Group for Bioactives – Analysis and Application
Activity: Examinations and supervision › External examination

Description
Assisting
Activity: Other

Organisation of opening seminar for the Food Biotechnology Center, SISIR
Period: 1991
Charlotte Jacobsen (Lecturer)
National Food Institute
Research Group for Bioactives – Analysis and Application

Description
Assisting
Activity: Other

Prizes:

Danisco Award, 2003 (250,000 DKK)
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
Awarded date: 2003
Prize: Prizes, scholarships, distinctions

Edwin Frankel Best Paper Award (The American Oil Chemist Society), 2010
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
Awarded date: 2010
Prize: Prizes, scholarships, distinctions

Edwin Frankel Best Paper Award (The American Oil Chemist Society), 2011
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
La Médaille Chevreul 2010, Association Française pour l’étude des Corps Gras
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
Awarded date: 2010
Prize: Prizes, scholarships, distinctions

Marcuse Lecturer grant (Lipidforum), 1999
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
Awarded date: 1999
Prize: Prizes, scholarships, distinctions

Outstanding paper presentation award (The American Oil Chemist Society), 1999
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
Awarded date: 1999
Prize: Prizes, scholarships, distinctions

Ph.D. student conference grant (Lipidforum) 1998
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Details
Awarded date: 1998
Prize: Prizes, scholarships, distinctions

Winner of Agro Business Park’s Innovation competition 2014
Charlotte Jacobsen (Recipient)
National Food Institute, Division of Industrial Food Research

Details
Awarded date: Nov 2014
Granting Organisations: AgroPark, Denmark
Prize: Prizes, scholarships, distinctions

Winner of Copenhagen Congress and Event Award 2017
Charlotte Jacobsen (Recipient)
National Food Institute, Research Group for Bioactives – Analysis and Application

Description
Winner as the best congress host for congresses below 1000 participants for the 22nd International Seaweed Symposium, Copenhagen, June 2016.

Details
Awarded date: Jun 2016
Granting Organisations: International Seaweed Symposium
Prize: Prizes, scholarships, distinctions

Press clippings:
Sundhedsværdi af dansk makrel på dåse
Charlotte Jacobsen
06/10/2017
National Food Institute, Research Group for Bioactives – Analysis and Application

Media coverage (1)

Test af makrel på dåse
06/10/2017
Politiken (National), Denmark, Print
Katrine Nadia Jørgensen
Charlotte Jacobsen
National Food Institute, Research Group for Bioactives – Analysis and Application

Sundhedseffekter af rødvin og fiskeolie
Charlotte Jacobsen
12/05/2016
National Food Institute, Research Group for Bioactives – Analysis and Application

Media contribution (1)

Sundhedseffekter af rødvin og fiskeolie
12/05/2016
Jyllandsposten JP Premium net, Web
Majbritt Schultze
Charlotte Jacobsen
National Food Institute, Research Group for Bioactives – Analysis and Application

Artikel Kosttilskud med antioxidanter
Charlotte Jacobsen
04/02/2016

Subject
Artikel Kosttilskud med antioxidanter
National Food Institute, Research Group for Bioactives – Analysis and Application

Media contribution (1)

Artikel Kosttilskud med antioxidanter
04/02/2016
Kristeligt Dagblad, Print
Louise Graa Christensen
Charlotte Jacobsen
National Food Institute, Research Group for Bioactives – Analysis and Application

Laks’ indhold af omega-3 fedtsyrer
Charlotte Jacobsen
12/09/2013
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Laks’ indhold af omega-3 fedtsyrer
12/09/2013
DR1, Television
Amalie Kaldan
Charlotte Jacobsen
National Food Institute, Division of Industrial Food Research
Ingredienskonference
Charlotte Jacobsen
09/09/2013
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Ingredienskonference
09/09/2013
FoodCulture, Print
Clavs Sylvest
Charlotte Jacobsen
National Food Institute, Division of Industrial Food Research

Æg's indhold af næringsstoffer i sammenhæng med produktionsform
Charlotte Jacobsen
12/06/2013
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Æg's indhold af næringsstoffer i sammenhæng med produktionsform
12/06/2013
DR1, Television
Tine Borresø
Charlotte Jacobsen
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Flødeskum
Charlotte Jacobsen
18/04/2013
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Flødeskum
18/04/2013
DR P3, Radio
Tilde Bang-Hansen
Charlotte Jacobsen
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Fisk og fiskeolie
Charlotte Jacobsen
23/01/2013
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Fisk og fiskeolie
23/01/2013
DR Kontant, Television
Charlotte Jacobsen
National Food Institute, Division of Industrial Food Research

Media contribution (1)

Harske fiskeoliekapsler
Charlotte Jacobsen
02/11/2012
National Food Institute, Division of Industrial Food Research
Media contribution (1)

**Harske fiskeoliekapsler**
02/11/2012
DR "Kontant", Television
Marian Midé
Charlotte Jacobsen
National Food Institute, Division of Industrial Food Research
Press / Media

**Omega-3 indhold og kvalitet af fiskeoliekapsler fra Helsecare**
Charlotte Jacobsen
31/08/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

**Omega-3 indhold og kvalitet af fiskeoliekapsler fra Helsecare**
31/08/2010
Radio
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

**Filmen "Food Inc"**
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

**Filmen "Food Inc"**
01/01/2010
Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

**Nu3Health**
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

**Nu3Health**
01/01/2010
Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

**Coaching**
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

**Coaching**
01/01/2010
Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Nu3Health
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

Nu3Health
01/01/2010
Børsen, Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

Omega-3 indhold i opdrættede fisk
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

Omega-3 indhold i opdrættede fisk
01/01/2010
Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

Omega-3 indhold i fisk
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

Omega-3 indhold i fisk
01/01/2010
Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

Prisforskelle på fiskeoliekapsler
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research

Media contribution (1)

Prisforskelle på fiskeoliekapsler
01/01/2010
Print
Charlotte Jacobsen
National Food Institute, Division of Seafood Research
Press / Media

Omega-3 indhold i fisk
Charlotte Jacobsen
01/01/2010
National Food Institute, Division of Seafood Research