Occurrence of cyclic imines in European commercial seafood and consumers risk assessment

Cyclic imines constitute a quite recently discovered group of marine biotoxins that act on neural receptors and that bioaccumulate in seafood. They are grouped together due to the imino group functioning as their common pharmacore, responsible for acute neurotoxicity in mice. Cyclic imines (CIs) have not been linked yet to human poisoning and are not regulated in the European Union (EU), although the European Food Safety Authority (EFSA) requires more data to perform conclusive risk assessment for consumers. Several commercial samples of bivalves including raw and processed samples from eight countries (Italy, Portugal, Slovenia, Spain, Ireland, Norway, The Netherlands and Denmark) were obtained over 2 years. Emerging cyclic imine concentrations in all the samples were analysed on a LC-3200QTRAP and LC-HRMS QExactive mass spectrometer. In shellfish, two CIs, pinnatoxin G (PnTX-G) and 13-desmethylspirolide C (SPX-1) were found at low concentrations (0.1–12 µg/kg PnTX-G and 26–66 µg/kg SPX-1), while gymnodimines and pteriatoxins were not detected in commercial (raw and processed) samples. In summary, SPX-1 (n: 47) and PnTX-G (n: 96) were detected in 9.4% and 4.2% of the samples, respectively, at concentrations higher than the limit of quantification (LOQ), and in 7.3% and 31.2% of the samples at concentrations lower than the LOQ (25 µg/kg for SPX-1 and 3 µg/kg for PnTX-G), respectively. For the detected cyclic imines, the average exposure and the 95th percentile were calculated. The results obtained indicate that it is unlikely that a potential health risk exists through the seafood diet for CIs in the EU. However, further information about CIs is necessary in order to perform a conclusive risk assessment.

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Combined effects of microplastics and chemical contaminants on the organ toxicity of zebrafish (Danio rerio)

Microplastics contamination of the aquatic environment is considered a growing problem. The ingestion of microplastics has been documented for a variety of aquatic animals. Studies have shown the potential of microplastics to affect the bioavailability and uptake route of sorbed co-contaminants of different nature in living organisms. Persistent organic pollutants and metals have been the co-contaminants majorly investigated in this field. The combined effect of microplastics and sorbed co-contaminants in aquatic organisms still needs to be properly understood. To address this, we have subjected zebrafish to four different feeds: A) untreated feed; B) feed supplemented with microplastics (LD-PE 125–250 μm of diameter); C) feed supplemented with 2% microplastics to which a mixture of PCBs, BFRs, PFCs and methylmercury were sorbed; and D) feed supplemented with the mixture of contaminants only. After 3 weeks of exposure fish were dissected and liver, intestine, muscular tissue and brain were extracted. After visual observation, evaluation of differential gene expression of some selected biomarker genes in liver, intestine and brain were carried out. Additionally, quantification of perfluorinated compounds in liver, brain, muscular tissue and intestine of some selected samples were performed. The feed supplemented with microplastics with sorbed contaminants produced the most evident effects especially on the liver. The results indicate that microplastics alone does not produce relevant effects on zebrafish in the experimental conditions tested; on the contrary, the combined effect of microplastics and sorbed contaminants altered significantly their organs homeostasis in a greater manner than the contaminants alone.

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Effects of steaming on contaminants of emerging concern levels in seafood

Seafood consumption is a major route for human exposure to environmental contaminants of emerging concern (CeCs). However, toxicological information about the presence of CeCs in seafood is still insufficient, especially considering the effect of cooking procedures on contaminant levels. This study is one among a few who evaluated the effect of steaming on the levels of different CeCs (toxic elements, PFCs, PAHs, musk fragrances and UV-filters) in commercially relevant seafood in Europe, and estimate the potential risks associated with its consumption for consumers. In most cases, an increase in contaminant levels was observed after steaming, though varying according to contaminant and seafood species (e.g. iAs, perfluorobutanoate, dibenzo(ah)anthracene in Mytilus edulis, HHCB-Lactone in Solea sp., 2-Ethylhexyl salicylate in Lophius piscatorius). Furthermore, the increase in some CeCs, like Pb, MeHg, iAs, Cd and carcinogenic PAHs, in seafood after steaming reveals that adverse health effects can never be excluded, regardless contaminants concentration. However, the risk of adverse effects can vary. The drastic changes induced by steaming suggest that the effect of cooking should be integrated in food risk assessment, as well as accounted in CeCs regulations and recommendations issued by food safety authorities, in order to avoid over/underestimation of risks for consumer health.

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Environmental Toxicology: Plastics

Plastic is a general term for a diverse group of polymeric materials that are used in a plethora of products. They represent a major source of human exposure to endocrine disrupting chemicals, including phthalates, bisphenols and persistent organic pollutants (POPs). For humans, foods represent the main source of exposure, but common house dust can also be a significant source of exposure in small children.

Phthalates and bisphenol A can interfere with male reproductive development by inducing reproductive organ malformations and impaired sperm production. Also persistent halogenated chemicals may be intentionally or unintentionally present in plastics and migrate/leak to foods or the environment causing concern for male reproductive function.

Exploring the chemistry of complex samples by tentative identification and semi-quantification: a food contact material case

In fields such as food safety and environmental chemistry, ensuring safety is greatly challenged by large numbers of unknown substances occurring. Even with current state of the art mass spectrometers, dealing with non-identified substances is a very laborious process as it includes structure elucidation of a vast number of unknowns, of which only a fraction may be relevant. Here, we present an exploration and prioritization approach based on high resolution mass spectrometry. The method uses algorithm-based precursor/product-ion correlations on Quadrupole-Time of Flight (Q-TOF) MS/MS data to retrieve the most likely chemical match from a structure database. In addition, TOF-only data is used to estimate analyte concentration via semi-quantification. The method is demonstrated in recycled paper food contact material (FCM). Here, 585 chromatographic peaks were discovered, of which 117 were unique to the sample and could be tentatively elucidated via accurate mass, isotopic pattern, and precursor/product-ion correlations. Nearly 85% of these 117 peaks were matched with database entries, which provided varying certainty of information about the analyte structure. Semi-quantitative concentration ranges of investigated compounds were between 0.7 μg dm-2 and 1600 μg dm-2. With this data, a subgroup of chemicals was risk-categorized and prioritized using the most likely candidate structure(s) obtained. Prioritization based on expected health impact was possible using the tentatively assigned data. Overall, the described method is a valuable chemical exploration tool for non-identified substances, but also may be used as a preliminary prioritization tool for substances expected to have the highest health impact, for example in FCMs.
Prioritization before risk assessment: The viability of uncertain data on food contact materials

The shortage of data on non-intentionally added substances (NIAS) present in food contact material (FCM) limits the ability to ensure food safety. Recent strategies in analytical method development allow investigating NIAS by using chemical exploration; but this has not been sufficiently investigated in risk assessment context. Here, exploration is applied on two paperboard FCM samples followed by risk prioritization for chemicals that can potentially migrate to food. Concentration estimates from exploration are converted into a tentative exposure assessment, while predicted chemical structures are assessed using quantitative structure-activity relationships (QSAR) models for carcinogenicity, mutagenicity, and reproductive toxicity. A selection of 60 chemical compounds from two FCMs is assessed by four risk assessors to classify chemical compounds based on probable risk. For 60% of cases, the assessors classified compounds as either high priority or low priority. Unclassified compounds are due to disagreements between experts or due to a lack of data. Among the high priority substances were high concentration compounds, benzophenone derivatives, and dyes. The low priority compounds contained e.g. oligomers from plasticizers and linear alkane amides. The classification scheme was demonstrated to provide valuable information based on tentative data, able to prioritize discovered chemical compounds for pending risk assessment.

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The influence of microplastics and halogenated contaminants in feed on toxicokinetics and gene expression in European seabass (Dicentrarchus labrax)

When microplastics pollute fish habitats, it may be ingested by fish, thereby contaminating fish with sorbed contaminants. The present study investigates how combinations of halogenated contaminants and microplastics associated with feed are able to alter toxicokinetics in European seabass and affect the fish. Microplastic particles (2%) were added to the feed either with sorbed contaminants or as a mixture of clean microplastics and chemical contaminants, and compared to feed containing contaminants without microplastics. For the contaminated microplastic diet, the accumulation of polychlorinated biphenyls (PCBs) and brominated flame retardants (BFRs) in fish was significantly higher, increasing up to 40 days of accumulation and then reversing to values comparable to the other diets at the end of accumulation. The significant gene expression results of liver (cyp1a, il1β, gstα) after 40 days of exposure indicate that microplastics might indeed exacerbate the toxic effects (liver metabolism, immune system, oxidative stress) of some chemical contaminants sorbed to microplastics. Seabass quickly metabolised BDE99 to BDE47 by debromination, probably mediated by deiodinase enzymes, and unlike other contaminants, this metabolism was unaffected by the presence of microplastics. For the other PCBs and BFRs, the elimination coefficients were significantly lower in fish fed the diet with contaminants sorbed to microplastic compared to the other diets. The results indicate that microplastics affects liver detoxification and lipid distribution, both of which affect the concentration of contaminants.
UV-filters and musk fragrances in seafood commercialized in Europe Union: Occurrence, risk and exposure assessment

In the framework of the FP7 ECsafeSeafood project, 62 seafood samples commercialized in Europe Union from several representative species – mackerel, tuna, salmon, seabream, cod, monkfish, crab, shrimp, octopus, perch and plaice – were analysed for residues of 21 personal care products (PCPs), including 11 UV-filters (UV-Fs) and 10 musk fragrances (musk). PCPs analysis were performed by Quick, Easy, Cheap, Effective Rugged, Safe (QuEChERS), combined with liquid-liquid extraction (LLE) or dispersive solid-phase extraction (dSPE), followed by gas chromatography-tandem mass spectrometry (GC-MS/MS). The results showed the presence in a wide range of samples of nine out of eleven UV-Fs compounds analysed, namely 2-ethylhexyl salicylate (EHS), 2-ethylhexyl,4-methoxycinnamate (EHMC), 4-methylbenzylidene camphor (4-MBC), benzophenone-1 (BP1), benzophenone-3 (BP3), isoamyl-4-methoxycinnamate (IMC), 2,2′-dihydroxy-4,4′-dimethoxybenzophenone (DHMB), homosalate (HS), and octocrylene (OC), whereas galaxolide (HHCB), galaxolide lactone (HHCB-lactone), and tonalide (AHTN) were the most found musks. The potential risks to human health associated with the exposure to eight of the more prevalent PCPs – EHS, EHMC, 4-MBC, BP1, BP3, IMC, HHCB, and AHTN - through seafood consumption were assessed for consumers from five European countries (Belgium, Ireland, Italy, Portugal and Spain). Results showed that the human exposure to UV-Fs and musks estimated from the concentration values found in seafood and the daily consumption of concerned seafood species, were far below toxicological reference values.
Vurdering af metode til bestemmelse af total organisk fluor (TOF) i fødevarekontaktmaterialer og bestemmelse af baggrundsniveau for TOF i pap og papir

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A framework to estimate concentrations of potentially unknown substances by semi-quantification in liquid chromatography electrospray ionization mass spectrometry
Risk assessment of exposure to chemicals from food and other sources rely on quantitative information of the occurrence of these chemicals. As screening analysis is increasingly used, a strategy to semi-quantify unknown or untargeted analytes is required. A proof of concept strategy to semi-quantifying unknown substances in LC-MS was investigated by studying the responses of a chemically diverse marker set of 17 analytes using an experimental design study. Optimal conditions were established using two optimization parameters related to weak-responding compounds and to the overall response. All the 17 selected analytes were semi-quantified using a different analyte to assess the quantification performance under various conditions. It was found that source conditions had strong effects on the responses, with the range of low-response signals varying from −80% to over +300% compared to centerpoints. Positive electrospray (ESI+) was found to have more complex source interactions than negative electrospray (ESI−). Choice of quantification marker resulted in better quantification if the retention time difference was minimized (12 out of 12 cases error factor <4.0) rather than if the accurate mass difference was minimized (7 out of 12 cases error factor <4.0). Using optimal conditions and retention time selection, semi-quantification in ESI+ (70% quantified, average prediction error factor 2.08) and ESI- (100% quantified, average prediction error factor 1.74) yielded acceptable results for untargeted screening. The method was successfully applied to an extract of food contact material containing over 300 unknown substances. Without identification and authentic standards, the method was able to estimate the concentration of a virtually unlimited number of compounds thereby providing valuable data to prioritize compounds in risk assessment studies.

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An effect-directed strategy for characterizing emerging chemicals in food contact materials made from paper and board

Food contact materials (FCM) are any type of item intended to come into contact with foods and thus represent a potential source for human exposure to chemicals. Regarding FCMs made of paper and board, information pertaining to their chemical constituents and the potential impacts on human health remains scarce, which hampers safety evaluation. We describe an effect-directed strategy to identify and characterize emerging chemicals in paper and board FCMs. Twenty FCMs were tested in eight reporter gene assays, including assays for the AR, ER, AhR, PPARγ, Nrf2 and p53, as well as mutagenicity. All FCMs exhibited activities in at least one assay. As proof-of-principle, FCM samples obtained from a sandwich wrapper and a pizza box were carried through a complete step-by-step multi-tiered approach. The pizza box...
exhibited ER activity, likely caused by the presence of bisphenol A, dibutyl phthalate, and benzylbutyl phthalate. The
sandwich wrapper exhibited AR antagonism, likely caused by abietic acid and dehydroabietic acid. Migration studies
confirmed that the active chemicals can transfer from FCMs to food simulants. In conclusion, we report an effect-directed
strategy that can identify hazards posed by FCMs made from paper and board, including the identification of the
chemical(s) responsible for the observed activity.

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Authors: Rosenmai, A. K. (Intern), Bengtström, L. (Intern), Taxvig, C. (Intern), Trier, X. (Intern), Petersen, J. H. (Intern),
Svingen, T. (Intern), Binderup, M. (Intern), van Vugt-Lussenburg, B. M. A. (Ekstern), Dybdahl, M. (Intern), Granby, K.
(Intern), Vinggaard, A. M. (Intern)
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Contamination of food generally has a negative impact on the quality and may imply a risk to human health. Mercury (Hg) is one of the most hazardous compounds in our environment and is released from the earth’s crust by both natural and anthropogenic processes. The mercury species ‘methylmercury’ is highly toxic, because affects the function of enzymes, easily crosses the blood-brain and the placenta barriers and is toxic to the nervous system (especially the developing brain). It bioaccumulates and biomagnifies through the aquatic food chain. Methylmercury is the most common mercury species in fish and humans are also mainly exposed to methylmercury from consumption of fish and other seafood.

The aims of the present controlled fish feeding trials were to study the carryover from feed to fish fillets (at low spike levels (1x background level of methylmercury) and to determine toxicokinetic parameters. The study included Atlantic salmon (Salmo salar), which is one of the main farmed seafood product consumed in Europe and with production in Northern Europe as well as European seabass (Dicentrarchus labrax) produced in Southern Europe, where it is a highly consumed seafood product. The weight gain of the fish, their feed intake, feed and fish fillet contaminant level were determined to model the uptake and elimination of methylmercury. The toxicokinetics for feed with low levels of methylmercury (41-75 ng/g) showed high assimilation and low elimination.

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**Carryover of methylmercury from feed to seabass and salmon**

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**Cyclic imines identification and confirmation in European commercial shellfish and seaweed samples**

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**Effectiveness of a temperature control system in home induction hobs to reduce acrylamide formation during pan frying**

Three trials were conducted to determine the influence of the use of temperature control systems on physico-chemical characteristics and acrylamide formation in the domestic preparation of potatoes. French fries were pre-treated by soaking in water or acidified water, and then they were cooked using a range of home-cooking procedures. Soaking raw potatoes in acidified water (pH=3.17) before frying at a controlled temperature (180 °C) was the most efficient pretreatment for reducing acrylamide formation (76%). For the same temperature, roasted frozen par-fried potatoes contained less fat and acrylamide than similar pan-fried potatoes. Potatoes butter fried at 140 °C had an acrylamide concentration similar to that of potatoes fried in oil at 180 °C, but this value was reduced by 71% when the frying was carried out using a temperature control system. Controlling the frying temperature reduced acrylamide formation at all the temperatures studied.

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Effect of cooking on levels of contaminants of emerging concern in commercial seafood

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Effects of industrial processing on essential elements and regulated and emerging contaminant levels in seafood

Mitigation of contaminants in industrial processing was studied for prawns (cooked and peeled), Greenland halibut (cold smoked) and Atlantic salmon (cold smoked and trimmed). Raw prawns had significantly higher cadmium, chromium, iron, selenium and zinc content in autumn than in spring, while summer levels typically were intermediate. Peeling raw prawns increased mercury concentration but reduced the concentration of all other elements including inorganic arsenic, total arsenic, chromium, zinc, selenium but especially cadmium, copper and iron (p < 0.05), however interaction between seasons and processing was observed.

Non-toxic organic arsenic in raw Greenland halibut (N = 10) and salmon (N = 4) did not transform to carcinogenic inorganic arsenic during industrial cold smoking. Hence inorganic arsenic was low (<0.003 mg/kg wet weight) in both raw and smoked fillets rich in organic arsenic (up to 9.0 mg/kg for farmed salmon and 0.7 mg/kg for wild caught Greenland halibut per wet weight). Processing salmon did not significantly change any levels (calculated both per wet weight, dry weight or lipid content). Cold smoking decreased total arsenic (17%) and increased PCB congeners (10–22%) in Greenland halibut (wet weight). However PFOS, PCB and PBDE congeners were not different in processed Greenland halibut when corrected for water loss or lipid content.
Effects of industrial processing on regulated and emerging contaminant levels in seafood

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Occurrence of halogenated flame retardants in commercial seafood species available in European markets

PBDEs (congeners 28, 47, 99, 100, 153, 154, 183, 209), HBCD (α, β, γ), emerging brominated flame retardants (PBEB, HBB and DBDPE), dechloranes (Dec 602, 603, 604, syn- and anti-DP), TBBPA, 2,4,6-TBP and MeO-PBDEs (8 congeners) were analysed in commercial seafood samples from European countries. Levels were similar to literature and above the environmental quality standards (EQS) limit of the Directive 2013/39/EU for PBDEs. Contaminants were found in 90.5% of the seafood samples at n.d.-356 ng/g lw (n.d.-41.1 ng/g ww). DBDPE was not detected and 2,4,6-TBP was detected only in mussels, but at levels comparable to those of PBDEs. Mussel and seabream were the most contaminated species and the Mediterranean Sea (FAO Fishing Area 37) was the most contaminated location. The risk assessment revealed that there was no health risk related to the exposure to brominated flame retardants via seafood consumption. However, a refined risk assessment for BDE-99 is of interest in the future. Moreover, the cooking process concentrated PBDEs and HBB.

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Publication information
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Scopus rating (2017): CiteScore 3.99 SJR 1.144 SNIP 1.427
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.96 SJR 1.351 SNIP 1.58
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Pharmaceuticals and endocrine disruptors in raw and cooked seafood from European markets: human health risk assessment

General information
State: Published
Recycling of plastic waste: Screening for brominated flame retardants (BFRs)

Flame retardants are chemicals vital for reducing risks of fire and preventing human casualties and property losses. Due to the abundance, low cost and high performance of bromine, brominated flame retardants (BFRs) have had a significant share of the market for years. Physical stability on the other hand, has resulted in dispersion and accumulation of selected BFRs in the environment and receiving biota. A wide range of plastic products may contain BFRs. This affects the quality of waste plastics as secondary resource: material recycling may potentially reintroduce the BFRs into new plastic product cycles and lead to increased exposure levels, e.g. through use of plastic packaging materials. To provide quantitative and qualitative data on presence of BFRs in plastics, we analysed bromophenols (tetrabromobisphenol A (TBBPA), dibromophenols (2,4- and 2,6-DBP) and 2,4,6-tribromophenol (2,4,6-TBP)), hexabromocyclododecane stereoisomers (α-, β-, and γ-HBCD), as well as selected polybrominated diphenyl ethers (PBDEs) in samples of household waste plastics, virgin and recycled plastics. A considerable number of samples contained BFRs, with highest concentrations associated with acrylonitrile butadiene styrene (ABS, up to 26,000,000 ng TBBPA/g) and polystyrene (PS, up to 330,000 ng ∑HBCD/g). Abundancy in low concentrations of some BFRs in plastic samples suggested either unintended addition in plastic products or degradation of higher molecular weight BFRs. The presence of currently restricted flame retardants (PBDEs and HBCD) identified in the plastic samples illustrates that circular material flows may be contaminated for extended periods. The screening clearly showed a need for improved documentation and monitoring of the presence of BFRs in plastic waste routed to recycling.

General information
State: Published
Organisations: Department of Environmental Engineering, Residual Resource Engineering, National Food Institute, Research Group for Analytical Food Chemistry, Environmental Chemistry
Authors: Pivnenko, K. (Intern), Granby, K. (Intern), Eriksson, E. (Intern), Astrup, T. F. (Intern)
Number of pages: 9
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4 SJR 1.407 SNIP 2.159
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.732 SNIP 2.263 CiteScore 4.33
Web of Science (2015): Indexed yes
Safety assessment of contaminants of emerging concern in seafood: Contributions of the ECsafeSEAFOOD project

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Organisations: National Food Institute, Research Group for Analytical Food Chemistry
Authors: Marques, A. T. (Ekstern), Rodríguez-Mozaz, S. (Ekstern), Granby, K. (Intern)
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Main Research Area: Technical/natural sciences

Tetrabromobisphenol A (TBBPA), Hexabromocyclododecane (HBCD), Bromophenol, POPs, Additives

DOIs:
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Publication: Research - peer-review › Journal article – Annual report year: 2017
The influence of microplastic inclusion in feed on carryover of environmental pollutants from feed to seabass and salmon

General information
State: Published
Authors: Granby, K. (Intern), Rasmussen, R. R. (Intern), Kotterman, M. (Ekstern), Sloth, J. J. (Intern), Cederberg, T. L. (Intern), Marques, A. T. (Ekstern), Koelmans, A. (Ekstern), Larsen, B. K. (Intern)
Pages: 16-16
Publication date: 2017

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Electronic versions:
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Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2017

Toxicity of emerging chemical contaminants evaluated in vivo with classic and alternative approaches using the zebrafish animal model

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Aquaculture, National Food Institute, Research Group for Analytical Food Chemistry
Authors: Rainieri, S. (Ekstern), Conlledo, N. (Ekstern), Larsen, B. K. (Intern), Granby, K. (Intern), Barranco, A. (Ekstern)
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UV-filters and musk fragrances in European seafood: Occurrence and risk assessment

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Host publication information
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Place of publication: Brussels, Belgium
Acrylamide reduction in fried potato slices and strips by using asparaginase in combination with conventional blanching

In this research, acrylamide reduction in potato chips was investigated in relation to blanching and asparaginase immersion treatments before final frying. Potatoes slices (Verdi variety, diameter: 40 mm, thickness: 2.0 mm) were fried at 170 °C for 5 min (final moisture content of ∼2.0 g/100 g). Prior to frying, potato slices were treated in one of the following ways: (i) Rinsing in distilled water (control I); (ii) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min; (iii) Rinsing in distilled water plus immersion in an asparaginase solution (10000 ASNU/L) at 50 °C for 20 min; (iv) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min plus immersion in an asparaginase solution (10000 ASNU/L) at 50 °C for 20 min; (v) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min plus immersion in distilled water at 50 °C for 20 min (control II). Blanching in hot water (ii) was almost as effective as asparaginase potato immersion (iii) in order to diminish acrylamide formation in potato chips (acrylamide reduction was ∼17% of the initial acrylamide concentration). When potato slices were blanched before asparaginase immersion, the acrylamide content of the resultant potato chips was reduced considerably by almost 90%. We have demonstrated that blanching of potato slices plus asparaginase treatment is an effective combination for acrylamide mitigation during frying. It seems to be that blanching provokes changes in the microstructure of potato tissue leading to an easier and more effective diffusion of asparaginase.

On the other hand, par-fried potatoes of Bintje variety were prepared by cutting strips (0.8×0.8×5cm) which were blanched at 75°C for 10min. Unblanched strips were used as the control. Control or blanched strips were then dried at 85°C for 10 min and immediately partially fried at 175°C for 1min. Finally, frozen par-fried potatoes were fried at 175°C for 3min to obtain French fries. Pre-drying of raw or blanched potato strips did not generate acrylamide formation as expected. Partial frying of pre-dried control potato strips generated 370μg/kg of acrylamide and the final frying determined French fries with 2075μg/kg of acrylamide. When control potato strips were treated with a 10000 ASNU/L asparaginase solution at 40°C for 20min, the acrylamide formation in French fries was reduced by 30%. When blanched potato strips were treated in the same way, the produced French fries have 60% less acrylamide content than blanched strips without the enzyme treatment. Soaking of blanched potato strips (75°C, 10min) in an 10000 ASNU/L asparaginase solution at 40°C for 20min is an effective way to reduce acrylamide formation after frying by reducing the amount of one of its important precursors such as asparagine.

Burden of disease of dietary exposure to acrylamide in Denmark

Acrylamide (AA) is a process-contaminant that potentially increases the risk of developing cancer in humans. AA is formed during heat treatment of starchy foods and detected in a wide range of commonly consumed products. Increased focus on risk ranking and prioritization of major causes of disease makes it relevant to estimate the impact that exposure to chemical contaminants and other hazards in food have on health. In this study, we estimated the burden of disease (BoD) caused by dietary exposure to AA, using disability adjusted life years (DALY) as health metric. We applied an exposure-based approach and proposed a model of three components: an exposure, health-outcome, and DALY-module. We estimated BoD using two approaches for estimating cancer risk based on toxicological data and two approaches for estimating DALY. In Denmark, 1.8 healthy life years per 100,000 inhabitants are lost each year due to exposure to AA through foods, as estimated by the most conservative approach. This result should be used to inform risk management decisions and for comparison with BoD of other food-borne hazards for prioritizing policies. However, our study shows that careful evaluation of methodological choices and assumptions used in BoD studies is necessary before use in policy making.
Chemical Contaminants: Food monitoring 2012-2013

**General information**

**State:** Published  
**Organisations:** National Food Institute, Research Group for Analytical Food Chemistry, Division of Risk Assessment and Nutrition, Research Group for Nano-Bio Science, Research Group for Food Production Engineering  
**Authors:** Petersen, A. (Intern), Fromberg, A. (Intern), Andersen, J. H. (Intern), Sloth, J. J. (Intern), Granby, K. (Intern), Duedahl-Olesen, L. (Intern), Rasmussen, P. H. (Intern), Cederberg, T. L. (Intern)  
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Chemicals in Paper and Board Food Contact Material: Towards More Knowledge, Analytical and Prioritization Analysis

**General information**

**State:** Published  
**Organisations:** National Food Institute, Research Group for Analytical Food Chemistry, Research Group for Genomic Epidemiology  
**Authors:** Pieke, E. N. (Intern), Granby, K. (Intern), Boriani, E. (Intern)  
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**Main Research Area:** Technical/natural sciences  
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Chemicals in Paper and Board Food Contact Material: Towards More Knowledge, Analytical and Prioritization Analysis

**General information**

**State:** Published  
**Organisations:** National Food Institute, Research Group for Analytical Food Chemistry, Research Group for Genomic Epidemiology  
**Authors:** Pieke, E. N. (Intern), Granby, K. (Intern), Boriani, E. (Intern)
Cyclic imines evaluation in European commercial shellfish samples

Cyclic imines constitute a quite recently discovered group of marine biotoxins that act on neural receptors and that bioaccumulate in seafood. They are grouped together due to the imino group functioning as their common pharmacore, responsible for acute neurotoxicity in mice. Cyclic imines have not been linked yet to human poisoning and are not regulated in Europe, although the EFSA requires more data to perform conclusive risk assessment for consumers. Spirolides (SPXs) are produced by the dinoflagellate Alexandrium ostenfeldii, gymnodimines (GYMs) are also produced by A. ostenfeldii and by Karenia selliformis. The dinoflagellate Vulcanodinium rugosum produces pinnatoxins (PnTXs). In addition, not all cyclic imines are equally potent: SPX-1 showed about 300 fold more activity than GYM-A on equimolar basis in a in vivo study about neuromuscular excitability in mice. Oral toxicity of SPXs is much lower (10-100 times less toxic orally, depending on the toxin and how the toxins are administered). In contrast to spirolides, PnTXs have proven to be almost as toxic via oral dosing as they are by i.p. injection to mice. Levels of toxicity of spirolide C and pinnatoxin E+F in feed were 500 and 60 (LD50, mice, µg/kg), respectively, which is more relevant to protect consumers. Several commercial samples from eight different countries (Italy, Portugal, Slovenia, Spain, Ireland, Norway, Netherlands and Denmark) were obtained over 2 years. Emerging cyclic imine concentrations in all the samples were analysed on a LC-3000QTRAP and LC-HRMS QExactive mass spectrometer. All this data will be used in an European risk evaluation.
Evaluation of cyclic imines in commercial shellfish samples in Europe samples

General information
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Organisations: National Food Institute, Research Group for Analytical Food Chemistry
Authors: Rambla, M. (Ekstern), del Rio, V. (Ekstern), Miles, C. O. (Ekstern), Samdal, I. A. (Ekstern), Fernandez, M. (Ekstern), de la Iglesia, P. (Ekstern), Barbosa, V. (Ekstern), Tediosi, A. (Ekstern), Madorran, E. (Ekstern), Calis, T. (Ekstern), Kotterman, M. (Ekstern), Granby, K. (Intern), Diogène, J. (Ekstern)
Number of pages: 2
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Source: PublicationPreSubmission
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Publication: Research › Conference abstract in journal – Annual report year: 2016

Executive summary of the report on Joint FAO/WHO expert meeting on hazards associated with animal feed. (12-15 May 201, FAO, Rome)

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Authors: Joint FAO/WHO expert meeting
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Levels of pharmaceuticals and endocrine disruptors in commercially available seafood before and after cooking

General information
State: Published
Mitigation of the processing contaminant acrylamide in bread by reducing asparagine in the bread dough

Over the past few years there has been an increasing awareness regarding acrylamide (AAM) content of various foods. Although there are several relevant articles on AAM mitigation in industrially prepared products, the literature regarding homemade preparations is rather scarce. The objective of this study is to mitigate the AAM formation in baked buns made with 1:1 sifted wheat/wholegrain flour through the depletion of asparagine (ASN) in the bread dough. Using a full-factorial design, the effect of four factors (yeast amount, fermentation time, fermentation temperature and yeast types) was tested. Liquid chromatography-tandem mass spectrometry (LC-MS/MS) was used for AAM and its main precursor, ASN, determination. The resulting ASN depletion in the dough (68–89%) is significantly affected by fermentation time and yeast type, while AAM mitigation levels in the baked buns are significantly influenced by yeast amount, fermentation time and yeast type. The mean concentrations for each combination range between 5 and 15 \( \mu g\ kg^{-1} \).
Non-targeted screening for contaminants in paper and board food-contact materials using effect-directed analysis and accurate mass spectrometry

Due to large knowledge gaps in chemical composition and toxicological data for substances involved, paper and board food-contact materials (P&B FCM) have been emerging as a FCM type of particular concern for consumer safety. This study describes the development of a step-by-step strategy, including extraction, high-performance liquid chromatography (HPLC) fractionation, tentative identification of relevant substances and in vitro testing of selected tentatively identified substances. As a case study, we used two fractions from a recycled pizza box sample which exhibited aryl hydrocarbon receptor (AhR) activity. These fractions were analysed by gas chromatography (GC) and ultra-HPLC (UHPLC) coupled to quadrupole time-of-flight mass spectrometers (QTOF MS) in order tentatively to identify substances. The elemental composition was determined for peaks above a threshold, and compared with entries in a commercial mass spectral library for GC-MS (GC-EI-QTOF MS) analysis and an in-house built library of accurate masses for substances known to be used in P&B packaging for UHPLC-QTOF analysis. Of 75 tentatively identified substances, 15 were initially selected for further testing in vitro; however, only seven were commercially available and subsequently tested in vitro and quantified. Of these seven, the identities of three pigments found in printing inks were confirmed by UHPLC tandem mass spectrometry (QqQ MS/MS). Two pigments had entries in the database, meaning that a material relevant accurate mass database can provide a fast tentative identification. Pure standards of the seven tentatively identified substances were tested in vitro but could not explain a significant proportion of the AhR-response in the extract. Targeted analyses of dioxins and PCBs, both well-known AhR agonists, was performed. However, the dioxins could explain approximately 3% of the activity observed in the pizza box extract indicating that some very AhR active substance(s) still remain to be identified in recycled low quality P&B.
A critical view on microplastic quantification in aquatic organisms

Microplastics, plastic particles and fragments smaller than 5mm, are ubiquitous in the marine environment. Ingestion and accumulation of microplastics have previously been demonstrated for diverse marine species ranging from zooplankton to bivalves and fish, implying the potential for microplastics to accumulate in the marine food web. In this way, microplastics can potentially impact food safety and human health. Although a few methods to quantify microplastics in biota have been described, no comparison and/or intercalibration of these techniques have been performed. Here we conducted a literature review on all available extraction and quantification methods. Two of these methods, involving wet acid destruction, were used to evaluate the presence of microplastics in field-collected mussels (Mytilus galloprovincialis) from
three different "hotspot" locations in Europe (Po estuary, Italy; Tagus estuary, Portugal; Ebro estuary, Spain). An average of 0.18±0.14 total microplasticsg−1 w.w. for the Acid mix Method and 0.12±0.04 total microplasticsg−1 w.w. for the Nitric acid Method was established. Additionally, in a pilot study an average load of 0.13±0.14 total microplasticsg−1 w.w. was recorded in commercial mussels (Mytilus edulis and M. galloprovincialis) from five European countries (France, Italy, Denmark, Spain and The Netherlands). A detailed analysis and comparison of methods indicated the need for further research to develop a standardised operating protocol for microplastic quantification and monitoring.

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Web of Science (2017): Indexed yes
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Scopus rating (2015): SJR 1.424 SNIP 1.317 CiteScore 3.71
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.794 SNIP 1.76 CiteScore 4.32
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.569 SNIP 1.597 CiteScore 3.75
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BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.541 SNIP 1.362 CiteScore 3.31
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.703 SNIP 1.53 CiteScore 3.7
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BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.664 SNIP 1.474
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.506 SNIP 1.384
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.372 SNIP 1.39
Scopus rating (2007): SJR 1.318 SNIP 1.601
Scopus rating (2006): SJR 1.198 SNIP 1.506
Scopus rating (2005): SJR 1.094 SNIP 1.341
Scopus rating (2004): SJR 0.824 SNIP 0.973
Primary aromatic amines (PAA) are chemical compounds, of which some are carcinogenic and allergenic, while others of these compounds are suspected carcinogens. PAA may arise in materials intended for food contact as a result of the occurrence of impurities or degradation products of e.g. aromatic isocyanates used in lacquers and adhesives in azocoulourants.

According to the regulation on plastics EC 10/2011:

‘Plastic materials and articles shall not release primary aromatic amines, excluding those appearing in Table 1 of Annex I, in a detectable quantity into food or food simulant. The detection limit is 0.01 mg of substance per kg of food or food simulant. The detection limit applies to the sum of primary aromatic amines released’

Since July 1st 2011, an additional EU regulation has come into place, which states that each consignment of polyamide (nylon) kitchen utensils from China and Hong Kong shall be accompanied by appropriate documentation, including analytical results showing that it meets the requirements concerning the release of primary aromatic amines.

25 samples of black nylon kitchenware each of three articles were tested for migration of primary aromatic amines (PAA), using 3% acetic acid as food simulant at an exposure temperature of 100°C and time from ½-4 hours, depending on the foreseeable use of the utensil. The samples were collected by the Norwegian Food Safety Authority at importers and retail shops.

Of the 20 PAA analysed, four PAA were detected, being aniline (ANL) in 11 samples (0.6-2.3 μg/kg), 4,4'-Methylenedianiline (4,4'-MDA) in 11 samples (0.6-14μg/kg), 2,4-Toluenediamine (2,4-TDA) in one sample (2.3 μg/kg) and 2,4-Dimethylaniline (2,4-DMA) in one sample (0.45 μg/kg).

11 samples did not contain PAAs, 14 samples contained PAAs, where the sum (ΣPAA), however did not exceed the specific migration limit of 10 μg/kg food simulant after the expanded uncertainty is subtracted from the sum of PAA. The highest content of ΣPAA migrants was from a frying spatula originating from China containing ΣPAA of 16.0 μg/kg before correction for expanded uncertainty, however after correction the content of 9.7 μg/kg was compliant.
Dietary exposure to volatile and non-volatile N-nitrosamines from processed meat products in Denmark

Recent epidemiological studies show a positive association between cancer incidence and high intake of processed meat. N-nitrosamines (NAs) in these products have been suggested as one potential causative factor. Most volatile NAs (VNAs) are classified as probable human carcinogens, whereas the carcinogenicity for the majority of the non-volatile NA (NVNA) remains to be elucidated. Danish adults (15–75 years) and children (4–6 years) consume 20 g and 16 g of processed meat per day (95th percentile), respectively. The consumption is primarily accounted for by sausages, salami, pork flank (spiced and boiled) and ham. This consumption results in an exposure to NVNA of 33 and 90 ng kg bw⁻¹ day⁻¹ for adults and children, respectively. The exposure to VNA is significantly lower amounting to 0.34 and 1.1 ng kg bw⁻¹ day⁻¹ for adults and children, respectively. Based on a BMDL10 of 29 µg kg bw⁻¹ day⁻¹ a MOE value ≥17,000 was derived for the exposure to NA known to be carcinogenic (VNA including NSAR), indicating an exposure of low concern. The exposure to the NVNA is substantially higher and if found to be of toxicological significance the exposure may be of concern.

General information
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Organisations: Division of Food Chemistry, National Food Institute, Research Group for Analytical Food Chemistry, Research Group for Food Production Engineering, Division of Nutrition, Division of Risk Assessment and Nutrition, Division of Toxicology and Risk Assessment
Authors: Herrmann, S. S. (Intern), Duedahl-Olesen, L. (Intern), Christensen, T. (Intern), Olesen, P. T. (Intern), Granby, K. (Intern)
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Scopus rating (2016): CiteScore 3.96 SJR 1.351 SNIP 1.58
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.202 SNIP 1.415 CiteScore 3.44
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.038 SNIP 1.369 CiteScore 3.12
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.02 SNIP 1.506 CiteScore 3.26
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Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
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ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.124 SNIP 1.58 CiteScore 3.36
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.93 SNIP 1.221
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.833 SNIP 1.056
Formation and mitigation of N-nitrosamines in nitrite preserved cooked sausages

Literature on formation and mitigation of N-nitrosamine (NA) and especially non-volatile NA (NVNA) in meat products is scarce and the present study is therefore a relevant contribution to the field. We found positive correlation between the levels of N-nitrosopiperidine (NPIP), N-nitrosohydroxyproline (NHPRO), N-nitrosoproline (NPRO), N-nitrosothiazolidine-4-carboxylic acid (NTCA) and N-nitroso-2-methyl-thiazolidine-4-carboxylic acid (NMTCA) and the amount of nitrite added to cooked pork sausages. The levels studied were 0, 60, 100, 150, 250 and 350 mg kg⁻¹. The levels of N-nitrosodimethylamine (NDMA) and N-nitrosopyrrolidine (NPYR) remained at or below limit of quantification. Erythorbic acid inhibited the formation of NHPRO, NPRO, NPIP and NTCA. This inhibition was for NTCA and NMTCA counteracted by addition of free iron. Ascorbyl palmitate had less inhibitory effect than erythorbic acid and a combination of the two provided no further protection. Increasing the black pepper content increased the levels of NPIP and NMTCA. Only slight effects of increased fat content and addition of tripolyphosphate were observed.
Ascorbyl palmitate, Erythorbic acid, Factorial design, Haem, Iron, Carboxylic acids, Meats, Nitrosamines, Inhibitory effect, Limit of quantifications, N-nitrosodimethylamine, Positive correlations, Thiazolidine-4-carboxylic acid, Tripolyphosphates, Palmitic acid

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Heat toxicant contaminant mitigation in potato chips

Heating foods immersed in oil during frying provides many attractive sensorial attributes including taste, flavor and color. However, some toxic compounds formed during frying of potatoes such as furan and acrylamide may constitute an increased cancer risk for consumers. The objective of this work was to mitigate the furan and acrylamide formation in potato chips without increasing their oil uptake by optimizing the blanching treatment before final frying. Potato slices were blanched in order to simultaneously leach out ascorbic acid and reducing sugars, the most important precursors of furan and acrylamide generation in thermally treated starchy foods. A central composite design was implemented to optimize the temperature-time blanching conditions under which furan, acrylamide and oil content in potato chips were minimized. The optimum blanching conditions were 64 degrees C and 17 min in which significant reductions of furan, acrylamide and oil content (91%, 54% and 19% respectively) were reached. (C) 2014 Elsevier Ltd. All rights reserved.

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Occurrence of volatile and non-volatile N-nitrosamines in processed meat products and the role of heat treatment

Most of the available data on the occurrence of N-nitrosamines (NA) in processed meat products have been generated in the 1980s and 1990s and especially data on the occurrence of non-volatile NA (NVNA) are scarce. Therefore we have studied the levels of volatile nitrosamines (VNA) and NVNA in processed meat products on the Danish market (N = 70) and for comparison also products on the Belgian market (N = 20). The effect of heat treatment on the NA levels, in selected samples, was also studied, in order to enable an evaluation of how preparation before consumption affects the levels of NA. For the Danish products the mean levels of the VNA were generally low (≤0.8 μg kg−1), whereas the mean levels of the NVNA were considerably higher (≤118 μg kg−1). Slightly higher mean levels were indicated for the Belgian products (i.e. VNA ≤1.5 μg kg−1 and NVNA ≤270 μg kg−1). The sums of VNA were higher than 10 μg kg−1 for one Danish sample and two Belgian samples. Levels of up to 2000 and 4000 μg kg−1 of N-nitroso-thiazolidine-4-carboxylic acid (NTCA) an NVNA occurred in the Danish and the Belgian samples, respectively. The majority of the Danish processed meat products contain NVNA but also VNA occur. The levels of NA are comparable with those reported in previous and recent studies; however the frequency in which they are found may be lower and thereby also the mean contents. The levels of N-nitrosopiperidine (NPIP) increased by frying and baking, whereas varying impacts were observed for N-nitrosoproline (NPRO), N-nitrosodimethylamine (NDMA), N-nitrosopyrrolidine (NPYR), N-nitrosodiethylamine (NDEA) and N-nitrosomethylaniline (NMA) depending on the type of product and/or the heat treatment. The levels of the NVNA, NTCA and N-nitroso-2-methyl-thiazolidine 4-carboxylic acid (NMTCA) decreased after frying and baking.

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Chemical identification of contaminants in paper and board food contact materials

Paper and board are used for a variety of food contact materials, such as baking paper, microwave popcorn bags and packaging for cereals as well as fast foods. Despite this extensive use, there are currently large data gaps about the chemical composition of different paper and board food contact materials and the toxicological effects of these compounds. The aim of this study was to develop a rationalised interdisciplinary strategy for the screening and identification of compounds with potential adverse health effects in paper and board materials. The first step in the proposed strategy was to develop a comprehensive extraction process that is compatible with both chemical and toxicological analyses. For this purpose, a purge-and-trap method was developed for the collection of small volatile organic compounds; in addition semi- and nonvolatile compounds were extracted by a boiling ethanol reflux system. After an initial in vitro screening of 20 different paper and board samples for endocrine disruptive effects, mutagenicity and
effects on metabolism of foreign compounds, five samples with adverse effects were selected for fractionation. The fractions were tested in cell assays in a second screening. The fractionation was used to reduce the number of compounds to be identified as well as the matrix effect. Next, the fractions were analysed by gas chromatography and liquid chromatography coupled to high resolution mass spectrometry. These two techniques were designed to be as complimentary as possible and by them in combination increased the possibility to identify compounds with potential adverse health effects. Several steps in the tentative identification by gas chromatography can be automated, due to the standardisation of this technique that enables searches in vast mass spectral libraries. Such libraries are missing for liquid chromatography, and a large part of the tentative identification must be performed manually. To facilitate the tentative identification by liquid chromatography, an accurate mass database containing approximately 2100 entries of compounds with reported use in paper and board was built. The results from this study indicate that both isotope ratio and hits in the accurate mass database greatly increases the possibility of a correct tentative identification. After lists of tentatively identified compound had been produced for a certain toxicological assay, compound were selected for further testing based on previously reported effects, structural similarities to known ligands, and availability of analytical standards for identified compounds. Any positive annotation through databases should be regarded as tentative, and therefore analytical standards were used to confirm the identification. After confirmation, equivalence factors for the initially observed toxicological effect and from all the confirmed compounds tested in the same toxicological assay were calculated. The initially observed effects on the metabolism of xenobiotics could to a minor extent, though not fully, be attributed to dyes used in printing inks. In addition, it was concluded that the endocrine disruptive effects could largely be explained by monomers and plasticisers present in a recycled fibre sample and by sizing agents in virgin fibres.

Current issues in dietary acrylamide: formation, mitigation and risk assessment

Acrylamide (AA) is known as a neurotoxin in humans and it is classified as a probable human carcinogen by the International Agency of Research on Cancer. AA is produced as by-product of the Maillard reaction in starchy foods processed at high temperatures (>120 °C). This review includes the investigation of AA precursors, mechanisms of AA formation and AA mitigation technologies in potato, cereal and coffee products. Additionally, most relevant issues of AA risk assessment are discussed. New technologies tested from laboratory to industrial scale face, as a major challenge, the reduction of AA content of browned food, while still maintaining its attractive organoleptic properties. Reducing sugars such as glucose and fructose are the major contributors to AA in potato-based products. On the other hand, the limiting substrate of AA formation in cereals and coffee is the free amino acid asparagine. For some products the addition of glycine or asparaginase reduces AA formation during baking. Since, for potatoes, the limiting substrate is reducing sugars, increases in sugar content in potatoes during storage then introduce some difficulties and potentially quite large variations in the AA content of the final product. Sugars in potatoes may be reduced by blanching. Levels of AA in different foods show large variations and no general upper limit is easily applicable, since some formation will always occur. Current policy is that practical measures should be taken voluntarily to reduce AA formation in vulnerable foods since AA is considered a health risk at the concentrations found in foods. © 2013 Society of Chemical Industry.
Fractionation of extracts from paper and board food contact materials for in vitro screening of toxicity

Paper and board used as food contact materials (FCMs) are chemically complex matrices, partly due to the naturally occurring substances in paper and board, but also due to the chemical treatment of the paper used to make it suitable for food contact. In order to assure the safety of packaging materials, information on the exposure as well as on the toxicity of substances in the packaging must be obtained. This study describes a comprehensive method for the extraction and fractionation of substances present in paper and board FCMs for further investigation by in vitro testing and chemical analysis. The extraction efficiency and the fractionation process were validated by determining recoveries in extracts from paper and board fortified with five surrogates of known concentration. The recoveries for the five surrogates were between 20% and 104% in the raw extract and between 21% and 109% after extraction and fractionation. The fractionation both reduces the number of compounds to be identified and works as a sample clean-up by reducing matrix effects. Raw extracts and fractions from two paper and board FCMs were furthermore tested in the aryl hydrocarbon receptor (AhR) reporter gene assay. Both raw extracts and two of the fractions of the raw extracts gave a positive response in the AhR assay. The strategy of extraction followed by fractionation offers a powerful tool in order to make the workflow for screening FCMs for potentially adverse effects more efficient.

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Furan and Alkylated Furans in Heat Processed Food, Including Home Cooked Products

The occurrence of furan in home cooked food was studied. Cooking was found to reduce the level of furan in ready-to-eat foods, however on average around 50% of furan remain in the foods. The analysis of furan occurrence revealed that it is most commonly formed in foods with high levels of carbohydrates. Interestingly, breakfast cereals, dry bread products, and dried fruit products including raisins, plums and bananas contained furan at levels up to 387 μg/kg. Furan was also found in the dry ingredients of cookies and bread, and in snacks such as crisps and popcorn. The 2-alkylfurans, 2-methylfuran, 2,5-dimethylfuran, 2-ethylfuran, and 2-pentylfuran were present at levels in the same range as furan (885 μg/kg) and the level of 2-methylfuran (1328 μg/kg) exceeded this level in coffee.

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Levels and risk assessment of chemical contaminants in byproducts for animal feed in Denmark

With aim to provide information on chemical contaminants in byproducts in animal feed, the data from an official control by the Danish Plant Directorate during 1998-2009, were reviewed and several samples of citrus pulp and dried distillers grains with solubles (DDGS) were additionally collected for analysis and risk assessment. The levels of contaminants in the samples from the official control were below maximum limits from EU regulations with only a few exceptions in the following groups; dioxins and dioxin-like polychlorobiphenyls (PCBs) in fish-containing byproducts and dioxins in vegetable and animal fat, hydrogen cyanide in linseed, and cadmium in sunflowers. The levels of pesticides and mycotoxins in the additionally collected samples were below maximum limits. Enniatin B (ENN B) was present in all DDGS samples. The hypothetical cases of carry-over of contamination from these byproducts were designed assuming total absorption and accumulation of the ingested contaminant in meat and milk and high exposure (a byproduct formed 15-20% of the feed ration depending on the species). The risk assessment was refined based on literature data on metabolism in relevant animal species. Risk assessment of contaminants in byproducts is generally based on a worst-case approach, as data on carry-over of a contaminant are sparse. This may lead to erroneous estimation of health hazards. The presence of ENN B in all samples of DDGS indicates that potential impact of this emerging mycotoxin on feed and food safety deserves attention. A challenge for the future is to fill up gaps in toxicological databases and improve models for carry-over of contaminants.

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N-nitrosamines in processed meat products – analysis, occurrence, formation, mitigation and exposure

N-nitrosamines (NA) occur in sodium nitrite (nitrite) preserved meat products as bacon, sausages, ham and several types of luncheon meats. Several of these NA are carcinogenic and high intake of processed meat products has been associated with increased risk of cancer and other adverse health effects in some epidemiologic studies. Exposure to NA via meat products may be the underlying reason for this association. The levels of NA in processed meat products ought therefore to be as low as possible. There is a large amount of literature on the occurrence, formation and mitigation of NA in meat products already available, though several areas especially regarding non-volatile NA (NVNA) are relatively...
unexplored. Studies performed in actual meat products are also scarce. The more that is understood about which factors affect the formation of both volatile NA (VNA) and NVNA the more likely it is to identify strategies for the prevention of NA formation in general and not only for a few NA. The aim of the present thesis was therefore to study the role of ingoing amount of nitrite, factors relevant for industrial processing of meat, fat content and the effect of heat treatment on the formation of VNA and NVNA in meat. Secondly data on the occurrence of VNA and NVNA in processed meat products on the Danish market were to be generated and used for an evaluation of the exposure level resulting from consumption of processed meat products. A method allowing for the simultaneous determination of both VNA and NVNA has not been described in the literature. In order to meet the defined aims, a method based on acetonitrile extraction and liquid chromatography tandem mass spectrometry using both atmospheric pressure chemical ionisation and electrospray ionisation was developed and validated. Data on the occurrence of NA in processed meat products was obtained by analysing products taken from the Danish market. The mean levels of the individual VNA were generally found to be low (<500 μg kg⁻¹), whereas the mean levels of the individual NVNA were considerably higher (≤118 μg kg⁻¹). The most frequently detected VNA were N-nitrosodimethylamine (NDMA) and N-nitrosopyrrolidine (NPYR) and the most frequently detected NVNA were N-nitrosodihydrazine-2-carboxylic acid (NTCA) and N-nitroso-2-methylthiazolidine-4-carboxylic acid (NMTCA). NTCA occurred at high levels, i.e. up to 2000 μg kg⁻¹. Higher mean levels of both the VNA (≤1.5 μg kg⁻¹) and NVNA (≤270 μg kg⁻¹) were found in samples taken from the Belgian market, though the difference was not significant. Thus in spite of the National Provision that Denmark obtain allowing an ingoing amount of sodium nitrite of 60 mg kg⁻¹ instead of 150 mg kg⁻¹ according to EU regulation, no significant differences between the mean levels of NA in the Danish samples and the Belgian samples could be demonstrated. The relationship between the ingoing amount of nitrite and the levels of VNA and NVNA was studied in both minced meat and sausages. The levels of N-nitrosodihydroxylamine (NHP PRO), N-nitrosopropylene (NPRO), NTCA, NMTCA, N-nitrososarcosine (NSAR), and N-nitrosopiperidine (NPiP) were found to be positively related to the ingoing amount of nitrite. The same could not be demonstrated for the commonly assayd NDMA and NPYR of which the levels remained low even when 350 mg kg⁻¹ nitrite was added. This may indicate that the relevant precursors are not present. Studies by others have indicated especially the formation of NDMA to depend more on factors as meat quality including feeding and/or breeding conditions and processing factors as temperatures and duration of drying and storage than on the ingoing amount of nitrite. A range of studies were performed using both minced pork meat and sausages in order to evaluate the effects of sodium chloride, antioxidants (erythorbic acid and ascorbyl palmitate), sodium tripolyphosphate, dextrose, fat content, black pepper and time on the NA formation and their interactions with nitrite and each other. Factorial experiments were employed in order to gain as much information with a reasonable number of samples. The ingoing amount of nitrite and the presence of erythorbic acid affected the levels of NA most. The levels of NHP PRO, NPRO, NPIP, NTCA and NMTCA were inversely related to the amount of erythorbic acid (396–1104 mg kg⁻¹). The levels of the individual NA were reduced with up to 20 to 75%. No additional protection against NA formation was obtained by also adding ascorbyl palmitate, a fat soluble antioxidant. Sodium chloride was found to have minor effects on the NA levels compared to nitrite and erythorbic acid. The NA formation happened rapidly and was relatively unaffected by storage for up to 13 days. Black pepper significantly increased the levels of NPiP. Fe(III) increased the levels of NHPRO, NMTCA and NTCA, whereas haem had no effect on the NA levels. A clear positive effect of heat treatment on the levels of NPIP was demonstrated in all the heat treatment experiments performed. Depending on the temperature obtained in the meat different effects were found for the other NA. If the sausages produced with different levels of nitrite were fried until a centre temperature of 100°C also the levels of NSAR, NTCA and NMTCA increased. Though when products purchased at the local supermarkets and butcher stores were heated to a higher temperature (~250°C), the levels of NTCA and NMTCA decreased. Depending on the product and heat treatment the levels of NPRO, NPYR, N-nitrosodiethylamine (NDEA) and N-nitrosomethylamine (NMA) either increased or decreased. From the data acquired on the occurrence of NA in meat products on the Danish market it was estimated that consumption at the 95 th percentile of these products resulted in an exposure of 0.7 ng kg⁻¹ bw⁻¹ day⁻¹ for Danish adults and children, respectively. The calculated Margin Of Exposure (MOE) was well above 10,000 indicating that the exposure is of low concern. Though, it cannot be ruled out that the exposure to these VNA is accountable for the stronger association between adverse health effects and consumption of processed meat than for consumption of red meat. The 96 th percentile exposure to the NVNA was estimated to be considerably higher (47–129 ng kg⁻¹ bw⁻¹ day⁻¹), though this exposure level is not possible to risk assess because data concerning the toxicological relevance of these compounds are lacking. Overall the present thesis show that if nitrite is used for meat preservation and/or colouration the levels of NA generally increase. Because of the possible adverse health effects of NA the exposure level ought to be kept at a minimum. Based on the present knowledge it is evaluated that low levels of NA in processed meat products are best achieved by using as little nitrite as possible and use it in combination with erythorbic acid (~1000 mg kg⁻¹) or another C-vitamin compound. Furthermore by storing the processed meat products protected from oxygen, depletion of the erythorbic acid is prevented. The European Food Safety Authority has concluded that microbiological safe meat products generally may be produced by the addition of 50 mg kg⁻¹ of nitrite. Other means besides nitrite addition can insure the microbiological safety. However, the occurrence of the carcinogenic NDMA and perhaps NPYR seems neither to be related to the levels of nitrite or to the levels of erythorbic acid.

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Simultaneous determination of volatile and non-volatile nitrosamines in processed meat products by liquid chromatography tandem mass spectrometry using atmospheric pressure chemical ionisation and electrospray ionisation

A sensitive, selective and generic method has been developed for the simultaneous determination of the contents (μgkg−1 range) of both volatile nitrosamines (VNA) and non-volatile nitrosamines (NVNA) in processed meat products. The extraction procedure only requires basic laboratory equipment and a small volume of organic solvent. Separation and quantification were performed by the developed LC–(APCI/ESI)MS/MS method. The method was validated using spiked samples of three different processed meat products. Satisfactory recoveries (50–130%) and precisions (2–23%) were obtained for eight VNA and six NVNAs with LODs generally between 0.2 and 1μgkg−1, though for a few analyte/matrix combinations higher LODs were obtained (3 to 18μgkg−1). The validation results show that results obtained for one meat product is not always valid for other meat products. We were not able to obtain satisfactory results for N-nitrosohydroxyproline (NHPRO), N-nitrosodibenzylamine (NDBzA) and N-nitrosodiphenylamine (NDPhA). Application of the APCI interface improved the sensitivity of the method, because of less matrix interference, and gave the method a wider scope, as some NAs were ionisable only by APCI. However, it was only possible to ionize N-nitroso-thiazolidine-4-carboxylic acid (NTCA) and N-nitroso-2-methyl-thiazolidine-4-carboxylic acid (NMTCA) by ESI. The validated method was applied for the analysis of processed meat products and contents of N-nitrosodimethylamine (NDMA), N-nitrosopyrrolidine (NPYR), N-nitrosomethylaniline (NMA), N-nitrosoproline (NPRO), NTCA, and NMTCA were found in one or several nitrite cured meat products, whereas none were detected in non-nitrite cured bacon.

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Are Chileans exposed to dietary furan?

Chilean consumer preferences include foods that may contain considerable amounts of furan, a potential human carcinogen. However, there is no information regarding dietary exposure to furan in Chile. Thus, the objective of this work was to determine the Chilean exposure to dietary furan. To accomplish this objective, the furan concentration of 14 types of commercial foods processed at high temperature were analysed based on a modified headspace-GC/MS (HS-GC/MS) method in which the limits of detection for different food matrices ranged from 0.01 to 0.6 ng g−1. In addition, a risk assessment was made with exposure estimates based on dietary data from national studies on different age groups (9-monthold babies, school children, adults and elderly people). Of the food items surveyed “American”-type coffee (espresso coffee plus hot water) obtained from automatic coffee machine (936 ng g−1) and low moisture starchy products like crisps and “soda”-type crackers showed the highest furan concentrations (259 and 91 ng g−1, respectively). Furthermore, furan was also found in samples of breakfast cereals (approximately 20 ng g−1), jarred fruit baby foods (8.5 ng g−1) and orange juice (7.0 ng g−1). School children (aged 9–13 years) represented the highest intake of furan (about 500 ng kg−1 bw day−1), with margins of exposure of 2479 and 2411, respectively, which points to a possible public health risk.

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Furan: A critical heat induced dietary contaminant
The presence of furan in a broad range of heat processed foods (0-6000 μg kg⁻¹) has received considerable attention due to the fact that this heat induced contaminant is considered as a “possible carcinogenic compound to humans”. Since a genotoxic mode of action could be associated with furan-induced tumor formation, current human exposure levels to this contaminant may indicate a risk to human health and the necessity for its mitigation. This review summarizes and focuses on the main issues of furan toxicity, human dietary exposure to furan and mechanisms of furan formation. Additionally, the role of some critical factors such as heating conditions, pH and matrix microstructure are discussed in order to propose some potential methodologies for furan mitigation in a wide range of heated foods. © 2013 The Royal Society of Chemistry.

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Furan in food including homemade and ready-to-eat food products

Furan is formed in canned, jarred or browned food items. As furan is carcinogenic in animal experiments, attention has been drawn to the presence in commercial and home-cooked foods.

The formation of furan in home cooked foods were studied as well as the stability of furan during cooking, saving and reheating of meals. In addition the occurrence of furan in some commercially dried and browned food products were determined.

Several recipes of European homemade food were prepared but in most cases fortunately furan was not found. In few exceptions were e.g. apple pie (133 ng/g furan in the rasp) and tea buns with raisins (83 ng/g furan in the raisins).

The influence on heating and reheating of ready to eat foods like different soups, baked beans and vegetable meals known to contain furan, showed that heating roughly reduced the furan level to half the initial level and reheating reduced the level a bit further, hence furan is relatively stable in food products.

Of the food items surveyed relatively many sundried fruit and vegetable products like raisins, tomatoes, and dried bananas contained furan, for example a sample of raisins contained 83 ng/g and banana crisps 11ng/g furan. Furthermore one sample of breakfast cereals contained 387 ng/g furan while the others were below 87 ng/g (n=11). The Maillard browning reactions of carbohydrate rich foods are responsible for furan formation in heat treated foods as breakfast cereals, toasted bread, cookies and crisps/snacks. When preparing potato crisps (diameter 40 mm x width 2 mm) by deep frying in oil at 150°, 170° and 190°C to the same water content (crispiness) of ~ 2% simulating industrial conditions, the furan content increased from 12-15 ng/g up to 31-52 ng/g. A similar study on French fries (0.8 x 0.8 x 5 cm) showed furan contents of 11-21 ng/g.

General information

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Organisations: National Food Institute, Division of Food Chemistry, Pontifícia Universidade Católica
Authors: Fromberg, A. (Intern), Granby, K. (Intern), Mariotti Celis, M. (Ekstern), Pedreschi, F. (Ekstern)
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Furan occurrence, Foods, Ready to eat, Homemade, Browned
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Poster
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Influence of heating conditions and ascorbic acid concentration over furan formation in starchy model systems

Furan, a potential carcinogen, can be formed in foods processed at high temperatures such as coffee, baby foods, bread and snacks. Although there is still no clarity about the risks associated with the current intake levels of dietary furan, to limit the furan occurrence in foods may be considered as a challenge in the prevention of human diseases as cancer. Considering that heat processed starchy products are characterized by their high worldwide consumption, we decided to dig into the mechanisms that would define their final content of furan.

The present study explored the effect of heating conditions (frying and baking) and ascorbic acid concentration over furan occurrence in a starchy model system.

Two different formulations of wheat flour dough (WF: wheat flour and WF-AA: wheat flour and ascorbic acid) were
prepared with a 40 % of moisture (wb). Then, dough were cut in circle chips (40 mm of diameter ; 2.3 mm of thickness) which were fried and baked at 170°C and 200°C for 5, 7 and 9 minutes. Furan contents of heat processed products were quantified by GC-MS.

WF fried products contained higher furan levels than baked ones for all different processing times (e.g. 97 % higher furan in 5 minutes fried chips). For the case of WF-AA chips baking produced more furan compared to the frying (e.g. 58 % higher furan in 7 minutes baked chips). For all process conditions ascorbic acid addition produced an increase in furan levels (17%-58% in frying and 74-98 % in baking).

As for Maillard reactions in general, for all samples, an increase in furan level was observed when the moisture content decreased. Additionally, in fried products furan level was directly proportional to their oil uptake.

We conclude that for the present model conditions, ascorbic acid improves the furan generation, having a stronger effect in baked products.

We also propose that while lipid oxidation has been considered as one of main furan generation routes, for this particular case, it should not have a greater influence over furan formation; since frying experiments were realized with commercial sunflower oil with added antioxidant. Finally, considering that furan is an unpolar compound, for fried product the oil uptake may be responsible for the higher furan retention.
Optimization of a blanching process to reduce the furan level of potato crisps without increasing their oil uptake

Furan, a potential carcinogen, can be formed in foods processed at high temperatures such as coffee, baby foods, bread and crisps. Considering that crisps are characterized by their high worldwide consumption, we decided to improve the chemical food safety of these fried products.

Thus, the objective of this work was to reduce the level of furan in crisps without increasing their oil uptake. To accomplish this purpose a central composite design was used to study the effect of blanching time and temperature on the reduction of reducing sugars, one of furan precursors, in potato slices. After the pre-treatments, potatoes slices were fried at 170°C until reach a 2% of moisture (w.b.) and the impact of both factors (blanching time and temperature) over furan content and oil uptake were evaluated.

Although blanching pre-treatments performed at higher temperatures (80°C) resulted in the lowest levels of both reducing sugar and furan, crisps pre-treated under these conditions presented a significant increasing in their oil content. On the other hand, blanching at temperature of 65° for 10 min was a 30% more efficient (30 %) in the extraction of reducing sugars compared to blanching at lower temperatures (~50°C) which appeared more time consuming. Additionally, under these blanching conditions a significant furan reduction in crisps was obtained without increasing their oil uptake. This later, may be explained, since blanch at 65°C activate the pectin-methyl-esterase and the resulting reactions would decrease porosity and, therefore reduce oil absorption.

Perfluorinated compounds in fish and carryover from fishfeed to farmed rainbow trout

Perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) bioaccumulate in humans and the half-life is around 4-6 years. As fish for many people is the largest source of PFOS exposure, the occurrence and the exposure of PFOS from fish was estimated. Today a significant proportion of the fish consumption is from aquaculture produce (~40% of the world’s fisheries (FAO 2012)). Hence the carryover of PFOS and PFOA from aquaculture feed to fish was studied.

In 2011 and 2012 fish were collected from Danish catching areas in the Baltic Sea and the North Sea and from Danish aquaculture farms and analysed for PFOS and PFOA.

The impact of chemical exposure on the cause in a feeding trial with rainbow trout (Oncorhynchus mykiss) accumulation and elimination of PFOS and PFOA was studied. PFOS was added to the fish feed at a level of 3 µg/g and PFOA at 0.5 µg/g. The fish were fed with the contaminated fish feed in an accumulation period of 12 weeks following an 8 weeks elimination period where unspiked feed were used. The feeding trials were carried out in tanks and the experiment included a control study of fish which were exposed only to unspiked feed. All feeding trials were conducted in duplicates. Fish were sampled 5 times during accumulation and 6 times during elimination. Analysis of PFOS and PFOA were performed on trout filet and liver.
Analysis of migration of polyfluorinated compounds from paper packaging into food matrices

General information
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Number of pages: 1
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Event: Poster session presented at NordFluor Seminar on Per- and Polyfluoroalkyl Substances (PFAS), Åbo/Turku, Finland.
Main Research Area: Technical/natural sciences
Electronic versions:
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Publication: Research - peer-review › Poster – Annual report year: 2012

Determination of free and bound volatile and non-volatile nitrosamines in nitrite cured meat products

General information
State: Published
Organisations: National Food Institute, Division of Food Chemistry
Authors: Herrmann, S. S. (Intern), Duedahl-Olesen, L. (Intern), Granby, K. (Intern)
Number of pages: 1
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N-Nitrosamines, Nitrite, Curing, Processed meat, LC-MS/MS
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Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2012

Extraction method for the collection of volatile organic compounds in paper and cardboard food packaging materials

General information
State: Published
Organisations: National Food Institute, Division of Food Chemistry
Authors: Bengtström, L. (Intern), Trier, X. (Intern), Granby, K. (Intern), Petersen, J. H. (Intern)
Number of pages: 1
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Main Research Area: Technical/natural sciences
Furan content and non-enzymatic browning in starchy food model systems

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Organisations: National Food Institute, Division of Food Chemistry, Pontifícia Universidade Católica
Authors: Mariotti Celis, M. (Ekstern), Pedreschi, F. (Ekstern), Granby, K. (Intern), Fromberg, A. (Intern), Risum, J. (Intern)
Number of pages: 1
Publication date: 2012

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Furan formation, Non-enzymatic browning, Starchy food model system
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Oral presentation
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Furan in food including homemade and ready-to-eat food products

Furan is formed in canned, jarred or browned food items. As furan is carcinogenic in animal experiments, attention has been drawn to the presence in commercial and home-cooked foods. The formation of furan in home cooked foods were studied as well as the stability of furan during cooking, saving and reheating of meals. In addition the occurrence of furan in some commercially dried and browned food products were determined.

Several recipes of European homemade food were prepared but in most cases fortunately furan was not found. Few exceptions were e.g. apple pie (133 ng/g furan in the rasp) and tea buns with raisins (83 ng/g furan in the raisins). The influence on heating and reheating of ready to eat foods like different soups, baked beans and vegetable meals known to contain furan, showed that heating roughly reduced the furan level to half the initial level and reheating reduced the level a bit further, hence furan is relatively stable in food products.

Of the food items surveyed relatively many sundried fruit and vegetable products like raisins, tomatoes, and dried bananas contained furan, for example a sample of raisins contained 83 ng/g and banana crisps 11 ng/g furan. Furthermore one sample of breakfast cereals contained 387 ng/g furan while the others were below 87 ng/g (n=11). The Maillard browning reactions of carbohydrate rich foods are responsible for furan formation in heat treated foods as breakfast cereals, toasted bread, cookies and crisps/snacks. When preparing potato crisps (diameter 40 mm x width 2 mm) by deep frying in oil at 150°, 170° and 190°C to the same water content (crispiness) of ~ 2% simulating industrial conditions, the furan content increased from 12-15 ng/g up to 31-52 ng/g. A similar study on French fries (0.8 x 0.8 x 5 cm) showed furan contents of 11-21 ng/g.

General information
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Organisations: National Food Institute, Division of Food Chemistry, Pontifícia Universidade Católica
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Abstract
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Furan Occurrence in Starchy Food Model Systems Processed at High Temperatures: Effect of Ascorbic Acid and Heating Conditions

Furan, a potential carcinogen, has been detected in highly consumed starchy foods, such as bread and snacks; however, research on furan generation in these food matrixes has not been undertaken, thus far. The present study explored the effect of ascorbic acid addition and cooking methods (frying and baking) over furan occurrence and its relation with the non-enzymatic browning in a wheat flour starchy food model system. Results showed that furan generation significantly increased in the presence of ascorbic acid after 7 min of heating (p < 0.05). The strongest effect was observed for baked products. Additionally, the furan content in fried products increased with the increase of the oil uptake levels. As for Maillard reactions, in general, the furan level in all samples linearly correlated with their degree of non-enzymatic browning, represented by L* and a* color parameters (e.g., wheat flour baked samples showed a R² of 0.88 and 0.87 for L* and a*, respectively), when the sample moisture content decreased during heating.
Potential contamination issues arising from the use of biofuel and food industry by-products in animal feed: Animal Feed Contamination: Effects on Livestock and Food Safety

By-products are secondary or discarded products from manufacturing. Contamination of by-products used for feed may result in carryover to animal food products and hence have impact on either animal health or food safety. Feed by-products from bioethanol production include, for example, 'dried distillers grain' (DDG) and 'dried distillers grain with solubles' (DDGS) from generation bioethanol production, C5-molasses from generation bioethanol production and glycerol from biodiesel production. By-products from food industry may comprise discarded or downgraded food and food surplus or secondary products such as peels, pulpettes, molasses, whey, mask, oil cakes, etc. Contamination of by-products and possible impacts are presented.

General information
State: Published
Organisations: National Food Institute, Division of Food Chemistry, Division of Toxicology and Risk Assessment, Danish Plant Directorate
Authors: Granby, K. (Intern), Mortensen, A. (Intern), Broesboel-Jensen, B. (Ekstern)
Pages: 514-539
Publication date: 2012

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Series: Woodhead Publishing Series in Food Science, Technology and Nutrition
Number: 215
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animal feed, dried distillers grain, dried distillers grain with solubles, food industry by-product, food safety, health safety, bioethanol synthesis, biofuel, C5-molasses, glycerol 56-81-5, 10060, Biochemistry studies - General, 13202, Nutrition -
Acrylamide diminishing in potato chips by using commercial Asparaginase

In April 2002, Swedish researchers shocked the food safety world when they presented preliminary findings of acrylamide in some fried and baked foods, most notably potato chips and French fries. Asparagine is an aminoacid precursor of acrylamide formation through Maillard reaction. Asparaginase enzyme converts free asparagine into aspartic acid; another amino acid that does not form acrylamide and also maintains intact the food sensorial properties. The objective of this research was to compare the effect of different temperature-time asparaginase treatments over the acrylamide content of potato chips. Control and asparaginase treated potato slices (Verdi variety, diameter: 40 mm, width: 2.0 mm) were fried at 170 °C for 5 min. Potato slices were treated in one of the following ways: (i) Rinsing in distilled water (control A); (ii) Blanching in hot water at 85 °C for 3.5 min (control B); (iii) Immersing in a 10000 ASNU/l asparaginase solution at 40° C for 20 min; (iv) Immersing in a 10000 ASNU/l asparaginase solution at 50° C for 10 min; (v) Immersing in a 10000 ASNU/l asparaginase solution at 50° C for 20 min; (vi) Blanching in hot water at 85°C for 3.5 min plus immersing in a 10000 ASNU/l asparaginase solution at 40° C for 20 min; (vii) Blanching in hot water at 85°C for 3.5 min plus immersing in a 10000 ASNU/l asparaginase solution at 50° C for 10 min; (viii) Blanching in hot water at 85°C for 3.5 min plus immersing in 10000 ASNU/l asparaginase solution at 50° C for 20 min. Soaking blanched potato chips in a 10000 ASNU/l asparaginase solution for 20 min at 50°C was the most effective time-temperature combination asparaginase treatment in order to diminish the acrylamide content in potato chips in -90 %.

Acrylamide reduction in potato chips by using commercial asparaginase in combination with conventional blanching

In this research acrylamide reduction in potato chips was investigated in relation to blanching and asparaginase immersion treatments before final frying. Potatoes slices (Verdi variety, diameter: 40 mm, thickness: 2.0 mm) were fried at 170 °C for 5 min (final moisture content of ~2.0 g/100 g). Prior to frying, potato slices were treated in one of the following ways: (i) Rinsing in distilled water (control I); (ii) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min; (iii) Rinsing in distilled water plus immersion in an asparaginase solution (10000 ASNU/L) at 50 °C for 20 min; (iv) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min plus immersion in an asparaginase solution (10000 ASNU/L) at 50 °C for 20 min; (v) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min plus immersion in an asparaginase solution (10000 ASNU/L) at 50 °C for 20 min; (vi) Rinsing in distilled water plus blanching in hot water at 85 °C for 3.5 min plus immersion in distilled water at 50 °C for 20 min (control II). Blanching in hot water (ii) was almost as effective as asparaginase potato immersion (iii) in order to diminish acrylamide formation in potato chips (acrylamide reduction was ~17% of the initial acrylamide concentration). When potato slices were blanched before asparaginase immersion, the acrylamide content of the resultant potato chips was reduced considerably by almost 90%. We have demonstrated that blanching of potato slices plus asparaginase treatment is an effective combination for acrylamide mitigation during frying. It seems to be that blanching provokes changes in the microstructure of potato tissue leading to an easier and more effective diffusion of asparaginase.

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Organisations: National Food Institute, Division of Food Chemistry, Division of Industrial Food Research, Pontifícia Universidade Católica
Authors: Pedreschi, F. (Ekstern), Mariotti, S. (Ekstern), Granby, K. (Intern), Risum, J. (Intern)
Number of pages: 6
Publication date: 2011
Estimation of dietary intake of PCB and organochlorine pesticides for children and adults

Levels of organochlorine substances, including a number of organochlorine pesticides and PCB, are monitored in food, including meat, fish and dairy products. The substances are slowly degradable and therefore persist for long periods in the environment, where they accumulate in the fatty tissues of animals and humans. They are included, because of the potential health-hazardous effect of these compounds on humans. The highest average contents are found in cod liver and fatty fish. The Danish population’s average daily intake has been estimated at between 0.03 and 0.3 μg/day for organochlorine pesticides and 0.9 μg/day for the indicator PCB-sum. People with a relatively high intake of these substances (the 95th percentile) are estimated to consume approximately twice as much. In general, the highest contributions to the intake of the organochlorine environmental contaminants are from fish, meat and dairy products. However, children have a relatively higher intake from milk and milk products and a lower intake from fish compared to adults.

General information

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Organisations: Division of Food Chemistry, National Food Institute, Division of Nutrition, Division of Toxicology and Risk Assessment, Regional Veterinary and Food Administration Center
Authors: Fromberg, A. (Intern), Granby, K. (Intern), Højgård, A. (Ekstern), Fagt, S. (Intern), Larsen, J. C. (Intern)
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Main Research Area: Technical/natural sciences

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  Scopus rating (2017): CiteScore 5.19 SJR 1.793 SNIP 2.109
  Web of Science (2017): Indexed yes
  BFI (2016): BFI-level 2
  Scopus rating (2016): CiteScore 4.85 SJR 1.731 SNIP 2.095
  Web of Science (2016): Indexed yes
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  Scopus rating (2015): SJR 1.582 SNIP 1.946 CiteScore 4.31
  Web of Science (2015): Indexed yes
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  Scopus rating (2014): SJR 1.557 SNIP 2.01 CiteScore 3.92
  Web of Science (2014): Indexed yes
Patented Techniques for Acrylamide Mitigation in High-Temperature Processed Foods

Heating foods has many advantages since it adds taste, color, texture and minimizes harmful germs, among others. Flavor and aroma compounds are produced via the Maillard reaction, where various hazardous compounds may form as well, such as acrylamide. Maillard reaction is believed to be the main route for acrylamide formation between reducing sugars (glucose and fructose), sucrose, and the amino acid asparagine, and, consequently, a variety of technologies have been developed to reduce acrylamide concentration in thermally processed foods based either on: (i) Changing process parameters (e.g. time and temperature of cooking) which inhibits Maillard Reaction; (ii) Reducing acrylamide precursor levels in raw materials to be cooked at high temperatures (e.g. by using microorganisms, asparaginase, amino acids and saccharides, blanching, etc.). In this paper, most of the recent patents for acrylamide reduction in foods processed at high temperatures are mentioned and briefly analyzed in order to develop new mitigation techniques for acrylamide in different food matrices.
Polyfluorinated surfactants (PFS) in paper and board coatings for food packaging

A range of polyfluorinated surfactants (PFS) used for food contact materials, primarily to impart oil and water repellency on paper and board. PFS are of interest, as they can be precursors of poly- and perfluorinated alkyl substances (PFAS), of which several are persistent and are found worldwide in human blood and the environment. Materials and methods To determine the elemental composition of PFS, we combined information from patents, chemical suppliers and analyses of industrial blends using ultra performance liquid chromatography-negative electrospray ionisation quadrupole time-of-flight mass spectrometry. Results At a high pH of 9.7, both non-ionic and anionic PFS were ionised and were recognised by negative mass defects of exact masses, and neutral fragment losses of $n \times 20$ or $n \times 100$ Da. More than 115 molecular structures were found in industrial blends from the EU, US and China, belonging to the groups of polyfluoroalkyl-mono- and diester phosphates (monoPAPS, diPAPS and S-diPAPS), -ethoxylates, -acrylates, -amino acids, -sulfonamide phosphates and -thio acids, together with residuals and synthesis byproducts. In addition, a number of starting materials such as perfluorooctane sulfonamide N-alkyl esters were analysed. Di- and trialkylated PAPS and S-diPAPS were found in migrates from European food contact materials. Conclusion This study highlights the need to monitor for more types of PFS in order to map the sources of PFAS in humans and the environment.
**Processing Contaminants in Food Production**

Contaminants like acrylamide, furan or PAHs (polycyclic aromatic hydrocarbons) as e.g. Benz(a)pyrene may be formed during food processing. All of the substances are genotoxic carcinogens, and for that reason mitigation strategies to reduce the levels are needed. Examples of the formation of the processing contaminants and factors that influence the occurrence are given as well as suggestions for mitigation.

**General information**

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Organisations: National Food Institute, Division of Food Chemistry, Pontifícia Universidade Católica
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Publication date: 2011
Event: Abstract from XXV Interamerican Congress of Chemical Engineering, Santiago, Chile.
Main Research Area: Technical/natural sciences

**Tools to discover anionic and nonionic polyfluorinated alkyl surfactants by liquid chromatography electrospray ionisation mass spectrometry**

A tiered approach is proposed for the discovery of unknown anionic and nonionic polyfluorinated alkyl surfactants (PFASs) by reversed phase ultra high performance liquid chromatography (UHPLC) – negative electrospray ionisation – quadrupole time of flight mass spectrometry (UHPLC–ESI−–QTOF–MS). The chromatographic separation, ionisation and detection of PFASs mixtures, was achieved at high pH (pH=9.7) with NH4OH as additive. To distinguish PFASs from other chemicals we used the characteristic negative mass defects of PFASs, their specific losses of 20Da (HF) and the presence of series of chromatographic peaks, belonging to homologues series with m/z of n×50Da (CF2) or n×100Da (CF2CF2). The elemental composition of the precursor ions were deducted from the accurate m/z values of the deprotonated molecules [M−H]−. In case of in-source fragmentation, the presence of dimers, e.g. [M2−H]− and adduct ions such as [M−H+solvent]− and [(M−H)(M−H+Na)n]− were used to confirm the identity of the precursor ions. In relation to quantification of PFASs, we discuss how their surfactancy influence the ESI processes, challenge their handling in solution and choices of precursor-to-product ions for MSMS of e.g., structural PFAS isomers. The method has been used to discover PFASs in industrial blends and in extracts from food contact materials.

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Organisations: Division of Food Chemistry, National Food Institute, University of Copenhagen
Authors: Trier, X. (Intern), Granby, K. (Intern), Christensen, J. H. (Ekstern)
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Web of Science (2017): Indexed Yes
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BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.693 SNIP 1.398 CiteScore 4.03
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Acrylamide Mitigation in Potato Chips by Using NaCl

In April 2002, Swedish researchers shocked the world when they presented preliminary findings on the presence of acrylamide in fried and baked foods, most notably potato chips and French fries, at levels of 30–2,300 ppb. The objective of this research was to study the effect of immersing potato slices in a NaCl solution over the acrylamide formation in the resultant potato chips. Potato slices (Verdi variety, diameter 40 mm, width 2.0 mm) were fried at 170 °C for 5 min (final moisture content of ∼2.0%). Prior to frying, the potato slices were treated in one of the following ways: (1) control slices (unblanched or raw potato slices); (2) slices blanched at 90 °C for 5 min in water; (3) slices blanched at 90 °C for 5 min plus immersed in a 1 g/100 g NaCl solution at 25 °C for 5 min; (4) slices blanched at 90 °C for 5 min plus immersed in a 3 g/100 g NaCl solution at 25 °C for 5 min; (5) slices blanched at 90 °C for 5 min plus immersed in distilled water at 25 °C for...
5 min; and (6) slices blanched at 90 °C for 5 min in a 3 g/100 g NaCl solution. Blanching followed by the immersion of potato slices in 1 g/100 g NaCl solution was effective in reducing acrylamide content in ~62%; however, almost half of this percentage (~27%) could be attributed to the effect of NaCl and 35% to the effect of the slight heating treatment during salt immersion step (25 °C for 5 min). Blanching seems to make the NaCl diffusion in potato tissue easier leading to a significant acrylamide reduction in the potato slices after frying.

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- **Web of Science (2017):** Indexed yes
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- **Scopus rating (2016):** SJR 1.391 SNIP 1.392 CiteScore 3.03
- **Web of Science (2016):** Indexed yes
- **BFI (2015):** BFI-level 1
- **Scopus rating (2015):** SJR 1.329 SNIP 1.375 CiteScore 2.74
- **BFI (2014):** BFI-level 1
- **Scopus rating (2014):** SJR 1.426 SNIP 1.769 CiteScore 3.24
- **Web of Science (2014):** Indexed yes
- **BFI (2013):** BFI-level 1
- **Scopus rating (2013):** SJR 1.234 SNIP 1.701 CiteScore 2.97
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- **Web of Science (2013):** Indexed yes
- **Scopus rating (2012):** SJR 1.361 SNIP 2.346 CiteScore 3.42
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**Food sources of non dioxin-like PCBs (NDL-PCBs)**

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Organisations: Division of Food Chemistry, National Food Institute, Division of Nutrition, Danish Veterinary and Food Administration
Influence of smoking parameters on the concentration of polycyclic aromatic hydrocarbons (PAHs) in Danish smoked fish

A new method for the analysis of 25 polycyclic aromatic hydrocarbon (PAH) compounds in fish was developed, validated, and used for the quantification of PAHs in 180 industrially smoked fish products. The method included pressurized liquid extraction, gel-permeation chromatography (Bio-beads S-X3), solid-phase extraction (silica gel), and gas chromatography-mass spectrometry analysis. The sum concentration of 25 PAHs (Sigma PAH25) was highest in smoked herring (n = 3) and mackerel fillets (n = 13), with an average concentration of 320 and 235 μg kg⁻¹, respectively. Lowest average Sigma PAH25 concentrations were obtained for indirectly smoked trout (26 μg kg⁻¹). Principal component analysis was used to correlate processing parameters to PAH concentrations and to identify the effects of these parameters. The analysis showed that for salmon hot-smoking conditions lead to higher sigma PAH25 than cold smoking, and for other fish species direct smoking leads to higher sigma PAH25 than indirect smoking. Also, the usage of common alder increases the PAH contamination compared with beech. The effects of smoking time, combustion temperatures, and two types of smoke-generating material on the Sigma PAH25 were also tested in a pilot plant study with smoked trout as a model fish. In addition to confirming that increased combustion temperatures and usage of common alder in comparison with beech increased Sigma PAH25, it was also revealed that the PAH concentration decreased in the order fish skin >> outer layer of the fish muscle inner part of the fish muscle.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Duedahl-Olesen, L. (Intern), Christensen, J. H. (Ekstern), Højgård, A. (Ekstern), Granby, K. (Intern), Timm-Heinrich, M. (Ekstern)
Pages: 1294-1305
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Volume: 27
Issue number: 9
ISSN (Print): 1944-0049
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
Quantification of polyfluorinated compounds in food

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Kolind-Hansen, L. (Intern), Granby, K. (Intern), Trier, X. (Intern)
Publication date: 2010
Event: Poster session presented at DanSak 10: 10th Danish Symposium in Analytical Chemistry, University of Copenhagen, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 269848
Publication: Research - peer-review › Journal article – Annual report year: 2010

Acrylamide Mitigation In Potato Chips by Using NaCl

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Division of Food Chemistry, Pontificia Universidade Católica
Authors: Pedreschi, F. (Ekstern), Risum, J. (Intern), Granby, K. (Intern)
Pages: 1-7
Publication date: 2009

Host publication information
Title of host publication: International Symposium on Food Processing: Monitoring Technology in Bioprocesses and Food Quality Management
Acrylamide mitigation in potato chips by using NaCl

Acrylamide is known to cause cancer in laboratory animals but there is no direct evidence that this substance causes cancer in humans. In April 2002, Swedish researchers shocked the world when they presented preliminary findings on the presence of acrylamide in fried and baked foods, most notably potato chips and French fries, at levels of 30-2300 ppb.

The objective of this research was to study the effect of immersing potato slices in a NaCl solution in relation to acrylamide formation in the prepared potato chips. Potato slices (Verdi variety, diameter: 40 mm, width: 2.0 mm) were fried at 170 °C for 5 min (final moisture content of ~ 2.0 %). Prior to frying, the potato slices were treated in one of the following ways: (i) Blanching in hot water at 90 °C for 5 min; (H) Immersion in a 3% NaCl solution at 25 °C for 5 min; (Hi) Blching in hot water at 90 °C for 5 min plus immersion in a 3% NaCl solution at 25 °C for 5 min; (iv) Blanching in hot water at 90 °C for 5 min plus immersion in a distilled water at 25 °C for 5 min. Raw potato slices were used as control. Blanching reduced the acrylamide content of potato chips with 12 %. On the other hand, when potato slices were immersed in salt solution, the acrylamide only decreased with 3 %. Interestingly, when blanched potato slices were immersed in NaCl solution and then fried, the acrylamide concentrations of the potato chips decreased with 66 %. Blanching seems to make the NaCl diffusion in potato tissue easier leading to a significant acrylamide reduction in the potato slices after frying.

General information
State: Published
Organisations: National Food Institute, Division of Industrial Food Research, Division of Food Chemistry
Authors: Pedreschi, F. (Intern), Risum, J. (Intern), Granby, K. (Intern)
Pages: 63-68
Publication date: 2009

Host publication information
Title of host publication: 5th International Technical Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management
Main Research Area: Technical/natural sciences
Source: dtu
Source-ID: n::oai:DTIC-ART:compendex/140085955::24369
Publication: Research › Article in proceedings – Annual report year: 2009

Acrylamid i maden, Fødevaresikkerhedsaspekter og muligheder for at mindske niveauerne- i fødevareindustrien eller hjemme hos forbrugeren

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Hedegaard, R. S. V. (Intern)
Pages: 14-17
Publication date: 2009

Publication information
Journal: Dansk Kemi
Volume: 90
Issue number: 1
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: English
Source: orbit
Source-ID: 244301
Biomonitering og fødevarer

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Toxicology and Risk Assessment
Authors: Hedegaard, R. S. V. (Intern), Granby, K. (Intern), Fromberg, A. (Intern), Cederberg, T. L. (Intern), Frandsen, H. L. (Intern), Duedahl-Olesen, L. (Intern), Petersen, J. H. (Intern), Jakobsen, J. (Intern), Larsen, E. H. (Intern)
Pages: 18-32
Publication date: 2009

Host publication information
Title of host publication: Miljø og sundhed
Volume: 15
Place of publication: København
Publisher: Sundhedsstyrelsens Rådgivende Videnskabelige Udvalg for Miljø og Sundhed
Edition: supplement nr. 1
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 252340
Publication: Communication › Book chapter – Annual report year: 2009

Furan in heat processed food products including home cooked food products and ready-to-eat products

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Nutrition
Authors: Fromberg, A. (Intern), Fagt, S. (Intern), Granby, K. (Intern)
Number of pages: 47
Publication date: 2009

Publication information
Place of publication: Søborg, Denmark
Publisher: Technical University of Denmark (DTU)
ISBN (Print): 978-87-92158-32-1
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 246692
Publication: Research › Report – Annual report year: 2009

Mængden af PAH kan mindskes

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Toxicology and Risk Assessment, Section for Aquatic Lipids and Oxidation, National Institute of Aquatic Resources, Section for Aquatic Process and Product Technology
Pages: 24-25
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: Plus Proces
Volume: 5
ISSN (Print): 0902-5057
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
Acrylamide-asparagine relationship in baked/toasted wheat and rye breads

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Nutrition
Authors: Granby, K. (Intern), Nielsen, N. J. (Ekstern), Hedegaard, R. S. V. (Intern), Christensen, T. (Intern), Kann, M. (Ekstern), Skibsted, L. H. (Ekstern)
Pages: 921-929
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Food Additives and Contaminants
Volume: 25
Issue number: 8
ISSN (Print): 0265-203X
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.121 SNIP 3.86
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.941 SNIP 1.365
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.945 SNIP 1.63
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 0.782 SNIP 1.56
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.975 SNIP 1.213
Acrylamide generation in pre-treated potato chips

Acrylamide formation in potato slices fried at two different temperatures (170 and 190 degrees C) was investigated under different pre-processing conditions. Potato slices (Saturna variety, diameter: 37 mm, width: 2.2 mm) were either fried at 170 degrees C per 5 min or 190 degrees C per 3.5 min to reach a final moisture content of 1.8 g water/100g (wet basis). Prior to frying, potato slices were treated in one of the following ways: (i) Raw slices without any pre-treatment were considered as the control; (ii) Blanching: which was accomplished in 2 temperature-time combinations: 60 degrees C for 30 min and 90 degrees C for 5 min; (iii) Slices blanched treated such as in (ii) were then dried at 60 degrees C until a final moisture content of 60 g water/100 g (wet basis); (iv) Slices blanched such as in (ii) were then impregnated in a 3 g/100 g of NaCl solution for 5 min at 25 degrees C. Acrylamide content in potato chips was determined after frying at 170 or 190 degrees C. Frying at 190 degrees C increased by almost 130 percent the acrylamide content of all the pre-treated samples (average value) fried at 170 degrees C. Soaking of blanched potato slices in the 3 g/100 g of NaCl solution for 5 min at 25 degrees C, reduces acrylamide formation in potato chips by 11 percent after frying at 170 or 190 degrees C. However when the slices are blanched directly in the 3 g/100g of NaCl solution at 60 degrees C for 30 min, their acrylamide formation increased surprisingly by similar to 90 percent when frying at 170 degrees C.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Intern), Kaack, K. (Ekstern), Granby, K. (Intern)
Pages: 4-7
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Agro Food Industry Hi-Tech
Volume: 19
Issue number: 1
ISSN (Print): 1722-6996
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.174 SJR 0.159 CiteScore 0.29
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.33 SJR 0.203 SNIP 0.151
Acrylamide in bread. Effect of prooxidants and antioxidants

Addition of 1% aqueous rosemary extract with approximately 40 mg of gallic acid equivalents or comparable addition of rosemary oil or of dried rosemary leaves to wheat dough reduced the content of acrylamide in wheat buns by 62, 67 and 57%, respectively, compared to wheat buns without rosemary. Increasing the addition of aqueous rosemary extract to 10% did not decrease the acrylamide content further compared to the addition of a 1% extract. The spice dittany showed less effect in wheat buns compared to rosemary and even increased acrylamide formation slightly. The effect of antioxidants on acrylamide formation was confirmed by addition of 1.0 mM (but not 0.1 mM) of the green tea flavonoids epicatechin or epigallocatechin gallate to an aqueous food model. Free radicals were detected by ESR using the spin trap alpha-(4-Pyridyl 1-oxide)-N-tert-butyl-nitrone (POBN) in an aqueous model system of 0.060 M glucose and 0.060 M asparagine heated under conditions generating acrylamide, further confirming the impact of free radical intermediates in formation of acrylamide. A modest effect of the peroxides in oxidized oil on acrylamide elimination was observed pointing towards an oxidative induced polymerization of acrylamide. The impact of oxidative processes on acrylamide elimination should not be neglected, since oxidized vegetable oil seems to promote degradation of acrylamide.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Toxicology and Risk Assessment
Authors: Hedegaard, R. S. V. (Intern), Granby, K. (Intern), Frandsen, H. L. (Intern), Thygesen, J. (Ekstern), Skibsted, L. H. (Ekstern)
Acrylamide Mitigation Procedures in Fried Potatoes

Acrylamide diminishing in potato slices and strips was studied in relation to frying temperature and some pre-treatments. Potato slices (Tivoli variety, diameter 37 mm, width: 2.2 mm) were fried at 150, 170 and 190 degrees C until reaching moisture contents of similar to 1.8 percent. Prior to frying, potato slices were treated in one of the following ways: (i) blanched in hot water at six different time-temperature combinations (50 degrees C for 30 and 70 min; 70 degrees C for 8 and 40 min; 90 degrees C for 2 and 9 min); (ii) immersed in a citric acid solutions of 10 g/L for half an hour. Potato strips (0.8 x 0.8 x 5 cm) of Bintje variety were fried at 150, 170 and 190 degrees C until reaching moisture contents of similar to 40 percent. Prior to frying, potato strips were treated in similar ways to potato slices. Glucose and asparagine contents were determined in potato slices and strips before frying, whereas acrylamide content was determined in the fried potato chips and French fries. Blanching reduced in potato chips on average 76 percent and 68 percent of the glucose and asparagine content compared to the control. Potato slices blanched at 50 degrees C for 70 minutes surprisingly had a very low acrylamide content (28 µm/kg) even when they were fried at 190 degrees C. Potato immersion in citric acid solution of 10 g/L reduced acrylamide formation by almost 70% for slices fried at 150 degrees C. Color represented by the parameters L* and a* showed high correlations (r(2) of 0.79 and 0.83, respectively) with French fry acrylamide content.

General information
State: Published
Organisations: National Food Institute, Division of Food Chemistry
Authors: Pedreschi, F. (Intern), Kaack, K. (Ekstern), Granby, K. (Intern)
Pages: 32-36
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Agro Food Industry Hi-Tech
Volume: 19
Issue number: 2
ISSN (Print): 1722-6996
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.174 SJR 0.159 CiteScore 0.29
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.33 SJR 0.203 SNIP 0.151
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.167 SNIP 0.208 CiteScore 0.24
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.157 SNIP 0.162 CiteScore 0.22
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.177 SNIP 0.103 CiteScore 0.28
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.158 SNIP 0.094 CiteScore 0.19
Children's exposure to Σ DDT from different food categories

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Nutrition
Authors: Fromberg, A. (Intern), Granby, K. (Intern), Højgård, A. (Ekstern), Fagt, S. (Intern)
Pages: 1090-1093
Publication date: 2008
Conference: 28th International Symposium on Halogenated Persistent Organic Pollutants, Birmingham, United Kingdom, 17/08/2008 - 17/08/2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Organohalogen Compounds
Volume: 70
ISSN (Print): 1026-4892
Ratings:
Web of Science (2018): Indexed yes
Web of Science (2014): Indexed yes
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no
ISI indexed (2011): ISI indexed no
Web of Science (2006): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Original language: English
Electronic versions:
08_623.pdf
Links:
Dietary acrylamide intake from different foods for Danish consumer groups

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Hedegaard, R. S. V. (Intern), Christensen, T. (Ekstern)
Publication date: 2008
Event: Abstract from The final COST 927 symposium on thermally processed foods: possible health implications, Smolenice, Slovakiet.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 236727
Publication: Research › Conference abstract for conference – Annual report year: 2008

Fødevaresikkerhed og sundhed i relation til økologiske fødevarer

General information
State: Published
Organisations: Division of Microbiology and Risk Assessment, National Food Institute, Division of Food Chemistry, Division of Toxicology and Risk Assessment, University of Copenhagen
Authors: Baggesen, D. L. (Intern), Herrmann, S. S. (Intern), Granby, K. (Intern), Knuthsen, P. (Intern), Leth, T. (Intern), Christensen, L. S. (Intern), Wingstrand, A. (Intern), Andersen, J. K. (Intern), Sørensen, I. K. (Intern), Sandø, P. (Ekstern), Lassen, J. (Ekstern)
Pages: 395-428
Publication date: 2008

Host publication information
Title of host publication: Udvikling, vækst og integritet i den danske økologisektor
Publisher: Internationalt Center for Forskning i Økologisk Jordbrug og Fødevaresystemer
ISBN (Print): 978-87-991343-6-6
Series: ICROFS-rapport
Number: 1/2008
Main Research Area: Technical/natural sciences
Electronic versions: E11B4d01.pdf
Source: orbit
Source-ID: 235337
Publication: Research › Book chapter – Annual report year: 2008

Formation of acrylamide in cheese bread
Low addition of grated Mozzarella cheese (13.4 g/100 g dough) resulted after baking for 20 min at 200 degrees C in a moderate increase of acrylamide from 4 ppb in buns without cheese to 7 ppb in the cheese buns as analyzed by a LCMS/MS technique. The effect was strongly dependent on the amount of cheese added, and addition of 23.7 g cheese resulted in 958 ppb acrylamide. For an o/w rapeseed oil emulsion as a food model heated under conditions similar to those persisting inside bread during baking, it was further shown that acrylamide formation also occurred in absence of reducing sugars. In contrast, acrylamide was not observed in Pao de queijo a traditional Brazilian bread product made from fermented cassava flour, fresh eggs and a mixture of Brazilian Gouda type cheese and Mozzarella cheese pointing towards a role of eggs in protection against acrylamide formation.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Hedegaard, R. S. V. (Intern), Sobrinho, L. G. D. A. (Ekstern), Granby, K. (Intern), Skibsted, L. (Ekstern)
Pages: 168-170
Publication date: 2008
Main Research Area: Technical/natural sciences
Publication information
Journal: Milchwissenschaft
Levels of Pesticides in Food and Food Safety Aspects

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Petersen, A. (Intern), Herrmann, S. S. (Intern), Poulsen, M. E. (Intern)
Pages: 287-318
Publication date: 2008

Host publication information
Title of host publication: Analysis of Pesticides in Food and Environmental Samples
Publisher: CRC Press
Editor: Tadeo, J. L.
Robust modelling of heat-induced reactions in an industrial food production process exemplified by acrylamide generation in breakfast cereals

Data from an industrial case study of breakfast cereal production indicated that the generated amounts of acrylamide are greatly dependent upon the combined effects of temperature and heating time in a roasting step process. Two approaches to obtain process models for acrylamide generation were tested. The first applied a pathway-based model. The second developed a simpler more robust model based on the integrated effects of time and temperature, where the generation of acrylamide was crudely fitted to an exponentially rising function. The development of the two models highlighted a number of difficulties in applying multi-parameter models and emphasized the advantages of "classical" approaches to process modelling, especially for use in an industrial context. The study faced with a significant degree of variability in the data, due to fluctuations in the process, which also emphasized the importance of robustness in the developed models. The correlations obtained for predicting acrylamide generation in the case study present a useful tool for food processing industry to minimize acrylamide generation. In the present case it was possible by lowering process temperature and prolonging residence time to achieve an approximately 80% reduction in acrylamide content while maintaining the desired product quality. (C) 2007 The Institution of Chemical Engineers. Published by Elsevier B.V. All rights reserved.
Testing for migration of Poly Fluorinated Compounds (PFCs) from coated paper food contact materials

**General information**

State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Trier, X. T. (Intern), Hjorth, K. (Ekstern), Christensen, J. H. (Ekstern), Granby, K. (Intern)
Publication date: 2008
Event: Poster session presented at ILSI conference on Food Contact Materials, Pragh, .
Main Research Area: Technical/natural sciences

**Source**
Source: orbit
Source-ID: 234781
Publication: Research - peer-review › Journal article – Annual report year: 2008

**Testing for migration of Poly Fluorinated Compounds (PFCs) from coated paper food contact materials**

**General information**

State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Trier, X. T. (Intern), Hjorth, K. (Ekstern), Christensen, J. H. (Ekstern), Granby, K. (Intern)
Publication date: 2008
Event: Poster session presented at ILSI conference on Food Contact Materials, Pragh, .
Main Research Area: Technical/natural sciences

**Source**
Source: orbit
Source-ID: 234781
Publication: Research › Poster – Annual report year: 2008
The effect of asparaginase on acrylamide formation in French fries

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Pages: 386-392
Publication date: 2008
Main Research Area: Technical/natural sciences

Publication information
Journal: Food Chemistry
Volume: 109
Issue number: 2
ISSN (Print): 0308-8146
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.19 SJR 1.793 SNIP 2.109
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 4.85 SJR 1.731 SNIP 2.095
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.582 SNIP 1.946 CiteScore 4.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.557 SNIP 2.01 CiteScore 3.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.554 SNIP 2.056 CiteScore 3.87
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.762 SNIP 2.342 CiteScore 3.98
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 1.911 SNIP 2.383 CiteScore 4.17
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.981 SNIP 2.253
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.789 SNIP 2.023
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.47 SNIP 1.706
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.475 SNIP 2.087
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Acrylamide Precursors: Limiting substrates and in vivo effect

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Knutsen, S. V. (ed.) (Ekstern), EFSA Publication
Publication date: 2007

Publication information
Place of publication: Oslo, Norway
Publisher: Nordic Innovation Centre
Original language: English
Main Research Area: Technical/natural sciences
precursors, acrylamide precursors, acrylamide, glycine, Food safety, biomarkers, Nordic, cereal, food processing, asparagine, acrylamide, glucose, limiting substrates, fructose, potato, in vivo effects
Links:
http://www.nordicinnovation.net

Acrylamide precursors - Limiting substrates and in vivo effects (NORDACRYL)

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Knutsen, S. H. (Ekstern), Granby, K. (Intern)
Publication date: 2007

Publication information
Place of publication: Nordic Innovations Centre, Norway
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 247618
Publication: Research › Report – Annual report year: 2007

Acrylamide reduction under different pre-treatments in French fries
Acrylamide formation in French fries was investigated in relation under different processing conditions and the content of glucose and asparagine of the strips before frying. Potato strips (0.8 x 0.8 x 5 cm) of Bintje variety were fried at 150, 170 and 190 degrees C until reaching moisture contents of similar to 40 g water/100 g (total basis). Prior to frying, potato strips were treated in one of the following ways: (i) immersed in distilled water for 0 min (control), 60 min and 120 min; (ii) immersed in a citric acid solution of 10 g/L for an hour; (iii) immersed in a sodium pyrophosphate solution of 10 g/L for an
hour; (iii) blanched in hot water at six different time-temperature combinations (50 degrees C for 40 and 80 min; 70 degrees C for 10 and 45 min; 90 degrees C for 3 and 10 min). Acrylamide content was determined in French fries while the glucose and asparagine content in the potato strips before frying. Immersed strips in water for 120 min showed a reduction of acrylamide formation of 33%, 21% and 27% at 150, 170 and 190 degrees C, respectively, when they were compared against the control. Potato strips blanched at 50 degrees C for 80 min had the lowest acrylamide content when compared against strips blanched at different conditions and fried at the same temperature (135, 327 and 564 mu m acrylamide/kg for 150, 170 and 190 degrees C, respectively). Potato strip immersion in citric acid solution of 10 g/L reduced much more the acrylamide formation after frying than the strip immersion in sodium pyrophosphate solution of 10 g/L (53% vs. 17 %, respectively-average values for the three temperatures tested). Acrylamide formation decreased dramatically as the frying temperature decreased from 190 to 150 degrees C for all the pre-treatments tested. Color represented by the total color difference showed high correlation (r(2) of 0.854) with the acrylamide content of French fries.
An intercomparison study of the determination of glyphosate, chlormequat and mepiquat residues in wheat

An intercomparison study of the determinations of glyphosate, chlormequat and mepiquat residues in cereals was performed. Four samples comprising one blank, two incurred and one spiked sample were sent to six participating laboratories. For glyphosate, two laboratories reported considerably lower results than the other four. One of the two laboratories with low results also reported low recoveries. The results of a sample spiked with 0.80 mg kg\(^{-1}\) glyphosate and an incurred sample, ranged from 0.23-0.87 mg kg\(^{-1}\) and 0.11-0.25 mg kg\(^{-1}\) respectively. The strong correlation between the two samples \((r^2 = 0.95)\) indicates a systematic between-laboratory variation. Several different principles were used for the analysis of glyphosate using different clean-up techniques and GC/MS, HPLC-fluorescence or LC/MS for detection. The results of the chlormequat residues showed more consistency. All but one laboratory obtained comparable results. However the correlation between the results for the sample spiked with 0.38 mg kg\(^{-1}\) (range: 0.26-0.65 mg kg\(^{-1}\)) and the incurred samples (range: 0.19-0.45 and 0.15-0.23 mg kg\(^{-1}\), respectively) again showed a strong correlation \((r(2) = 0.99 and 0.88)\) indicating a systematic component. For mepiquat, results above the limit of quantification were only reported for the spiked sample. The results ranged from 0.29-0.92 mg kg\(^{-1}\) (spiked concentration= 0.38 mg kg\(^{-1}\)). Three laboratories had results that deviated less than 25% from the fortified concentration. Two laboratories reported results 38% and 141% above the fortified concentration, respectively.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Andersen, J. H. (Intern), Bille, R. (Intern), Granby, K. (Intern)
Pages: 140-148
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Food Additives and Contaminants
Volume: 24
Issue number: 2
ISSN (Print): 0265-203X
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
BFI (2016): BFI-level 1
BFI (2015): BFI-level 1
BFI (2014): BFI-level 1
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
The objective of this work was to study the development of color formation in pre-dried potato slices during frying and acrylamide formation in the final potato chips. Color measurement was done by using an inexpensive computer vision technique which allowed quantifying representatively and precisely the color of complex surfaces such as those of potato chips in L*a*b* units from RGB images. Prior to frying, potato slices (Desiree variety, diameter: 37 mm, width: 2.2 mm) were blanched in hot water at 85 degrees C for 3.5 min. Unblanched slices were considered as the control. Slices of the same dimensions were blanched as in the previous step, and then air-dried until reaching a moisture content of 60% (wet basis). These samples were called pre-dried potato slices. Potato slices were fried at 120 degrees C, 140 degrees C, 160 degrees C and 180 degrees C until reaching moisture contents of similar to 1.8% (total basis) for color quantification. Acrylamide concentration was determined only in final chips fried at 120 degrees C, 150 degrees C and 180 degrees C and compared with that of two brands of commercial chips produced in Chile (Moms and Frito Lay). Color values in L*a*b* units were recorded at different sampling times during frying at the four mentioned temperatures using the total color difference parameter (Delta E). Pre-drying did not affect the color of potato chips considerably when compared against blanched chips; however when fried at 180 degrees C, pre-dried potato chips present 44%, 22%, 44% lower acrylamide content than that of the control, Moms and Frito Lay chips, respectively.
Color kinetics and acrylamide formation in NaCl soaked potato chips

The objective of this work was to study the kinetics of color development in blanched and blanched-NaCl impregnated potato slices during frying by using the dynamic method and also to evaluate the effect of NaCl in reducing acrylamide formation in potato chips. The measurement of color was done by using an inexpensive computer vision technique which allowed quantifying in a more precise and representative way the color in L*a*b* units of complex surfaces such as those of potato slices during frying. The effect of potato slice soaking in NaCl was evaluated not only for color change but also for acrylamide formation. Prior to frying, potato slices (Desiree variety, diameter: 37 mm, width: 2.2 mm) were blanched in hot water at 85 degrees C for 3.5 min; these slices were considered as the control. Slices of the same dimensions were blanched as in the previous step, and soaked at 25 degrees C in a NaCl solution of 0.02 g/l 5 min at 200 rpm of agitation. These samples were considered as NaCl soaked potato chips. Blanched and soaked slices were fried at 120, 140, 160 and 180 degrees C until reaching moisture contents of similar to 1.8% (total basis) for color evaluation. Acrylamide content was evaluated only in final samples fried from 120 degrees C to 160 degrees C. Color values in L*a*b* units were recorded at different sampling times during frying at the four mentioned temperatures using the total color change parameter (Delta E). Experimental data of surface temperature, moisture content and color change in potato chips during frying were fitted to empirical relationships, with correlation coefficients greater than 90%. A first-order rate equation was used to model the kinetics of color change. In all cases, the Arrhenius activation energy decreases alongside with decreasing chip moisture content. Soaking in NaCl solution of potato slices before frying reduced dramatically acrylamide formation in potato chips in similar to 90% (average value) in comparison with control chips.
Influence of water activity on acrylamide formation from glucose and asparagine in aqueous glycerol

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Toxicology and Risk Assessment
Authors: Hedegaard, R. S. V. (Intern), Frandsen, H. L. (Intern), Granby, K. (Intern), Apostolopoulou, A. (Ekstern), Skibsted, L. H. (Ekstern)
Pages: 486-492
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 55
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.343 SJR 1.269 CiteScore 3.64
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2

Original language: English
frying, soaking, color, acrylamide, NaCl, potato slices, kinetics
DOIs:
10.1016/j.jfoodeng.2006.03.020
Source: orbit
Source-ID: 230008
Publication: Research - peer-review › Journal article – Annual report year: 2007
Kilder og niveauer af kemiske fødevareforureninger

General information
Kilder og niveauer af kemiske fødevareforureninger

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Cederberg, T. L. (Intern), Duedahl-Olesen, L. (Intern), Petersen, J. H. (Intern), Poulsen, M. E. (Intern), Sloth, J. J. (Intern)
Pages: 3-16
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Miljø og Sundhed
Volume: 35
ISSN (Print): 1395-5241
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: 239620
Publication: Communication › Journal article – Annual report year: 2007

Kræftfremkaldende stof i mad reduceres

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

Publication information
Journal: FoodDTU Midt i Ugen
Original language: Danish
Source: orbit
Source-ID: 258726
Publication: Communication › Journal article – Annual report year: 2007

LC-MS/MS analysis of Hexabromocyclododecane (HBCD) isomers and Tetrabromobisphenol: A (TBBPA) and levels in Danish fish for food consumption

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Cederberg, T. L. (Intern)
Publication date: 2007

Host publication information
Title of host publication: Proceedings of the 4th International Conference on Brominated Flame Retardants
Main Research Area: Technical/natural sciences
LC-MS/MS analysis of Hexabromocyclododecane (HBCD) isomers and Tetrabromobisphenol A (TBBPA) and levels in Danish fish for food consumption

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Cederberg, T. L. (Intern)
Publication date: 2007
Event: Abstract from The 4th International Workshop on Brominated Flame Retardants, Amsterdam, the Netherlands.
Main Research Area: Technical/natural sciences

Model studies on acrylamide generation from glucose/asparagine in aqueous glycerol
Acrylamide formation from asparagine and glucose in different ratios in neutral glycerol/water mixtures was found to increase with decreasing water activity (0.33)

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Toxicology and Risk Assessment
Authors: Hedegaard, R. S. V. (Intern), Frandsen, H. L. (Intern), Granby, K. (Intern), Apostolopoulou, A. (Ekstern), Skibsted, L. (Ekstern)
Pages: 486-492
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 55
Issue number: 2
ISSN (Print): 0021-8561
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.343 SJR 1.269 CiteScore 3.64
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.45 SJR 1.305 SNIP 1.343
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.224 SNIP 1.245 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.267 SNIP 1.413 CiteScore 3.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 1.43 SNIP 1.47 CiteScore 3.44
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 1.408 SNIP 1.464 CiteScore 3.2
ISI indexed (2012): ISI indexed yes
Smoking of trout in Denmark

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Section for Aquatic Process and Product Technology, National Institute of Aquatic Resources, Section for Aquatic Lipids and Oxidation
Authors: Duedahl-Olesen, L. (Intern), Fischer, K. (Intern), Timm Heinrich, M. (Intern), Granby, K. (Intern)
Publication date: 2007
Main Research Area: Technical/natural sciences

Bibliographical note
Poster præsenteret ved ISPAC 21 i Trondheim i perioden 5. til 10. august 2007

Source: orbit
Source-ID: 214393
Publication: Research - peer-review › Journal article – Annual report year: 2007

Source: orbit
Source-ID: 225345
Publication: Research › Poster – Annual report year: 2007

reaction mechanism, asparagine, acrylamide, glucose, water activity

DOIs:
10.1021/jf0624300
Acrylamide content and color development in fried potato strips

Acrylamide formation and changes in color of fried potato strips was investigated in relation to frying temperature and three treatments before frying. Potato strips (0.8 x 0.8 x 5 cm) of Bintje variety were fried at 150, 170 and 190 degrees C until reaching moisture contents of similar to 40 g water/100 g (total basis). Prior to frying, potato strips were treated in one of the following ways: (i) immersed in distilled water for 0 min (control), 60 min and 120 min; (ii) blanched in hot water at six different time-temperature combinations (50 degrees C for 40 and 80 min; 70 degrees C for 10 and 45 min; 90 degrees C for 3 and 10 min); (iii) immersed in a citric acid solution of 10 g/L for an hour; (iv) immersed in a sodium pyrophosphate solution of 10 g/L for an hour. Acrylamide content and color was determined in the potato strips after frying. Immersed strips in water for 120 min showed a reduction of acrylamide formation of 33%, 21% and 27% at 150, 170 and 190 T, respectively, when they were compared against the control. Potato strips blanched at 50 T for 80 min had the lowest acrylamide content when compared against strips blanched at different conditions and fried at the same temperature (13 5, 327 and 564 μm acrylamide/kg for 150, 170 and 190 degrees C, respectively). Potato strip immersion in citric acid solution of 10 g/L reduced much more the acrylamide formation after frying than the strip immersion in sodium pyrophosphate solution of 10 g/L (53% vs. 17%, respectively, average values for the three temperatures tested). Acrylamide formation decreased dramatically as the frying temperature decreased from 190 to 150 degrees C for all the pre-treatments tested. Color represented by the parameters L* and a* showed high correlations (r(2) of 0.79 and 0.83, respectively) with French fry acrylamide content.

General information

State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Pages: 40-46
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information

Journal: Food Research International
Volume: 39
Issue number: 1
ISSN (Print): 0963-9969
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SJR 1.472 SNIP 1.467 CiteScore 3.9
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.87 SJR 1.612 SNIP 1.675
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.508 SNIP 1.629 CiteScore 3.66
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.487 SNIP 1.751 CiteScore 3.52
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.526 SNIP 1.802 CiteScore 3.68
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.563 SNIP 1.775 CiteScore 3.31
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.521 SNIP 1.697 CiteScore 3.42
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Acrylamide formation from different ratios of glucose and asparagines in glycerol-water mixtures

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Hedegaard, R. S. V. (Intern), Apostolopoulou, A. (Ekstern), Frandsen, H. (Ekstern), Granby, K. (Intern), Skibsted, L. H. (Ekstern)
Publication date: 2006
Event: Abstract from COST/IMARS workshop on "Thermally processed foods", Napoli, Italy.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244374
Publication: Research › Conference abstract for conference – Annual report year: 2006

Acrylamide formation from different ratios of glucose and asparagines in glycerol-water mixtures

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Hedegaard, R. S. V. (Intern), Apostolopoulou, A. (Ekstern), Frandsen, H. (Ekstern), Granby, K. (Intern), Skibsted, L. H. (Ekstern)
Publication date: 2006
Event: Poster session presented at COST/IMARS workshop on "Thermally processed foods", Napoli, Italy.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244373
Publication: Research › Poster – Annual report year: 2006

A liquid chromatography-tandem mass spectrometry method for simultaneous analysis of acrylamide and the precursors, asparagaine and reducing sugars in bread

A LC-MS-MS method for simultaneous determination of acrylamide, asparagine, fructose, glucose and sucrose in bread was developed. The method is based on aqueous extraction by blending. After centrifugation the samples were cleaned up by solid phase extraction on C18 cartridges conditioned with 2 mL of methanol and 2 x 2 mL of water and subsequently flushed with sample solution before the actual analytical sample fractions were collected. Analytes were separated on a
Hypercarb column (100 mm x 2.1 mm, 5 μm) and detected by tandem MS with electrospray ionisation. Acrylamide and saccharides were ionised in positive mode. Asparagine in wheat bread was detectable at lower levels using negative ion mode. To compensate for matrix induced signal suppression D-3-acrylamide and N-15(2)-asparagine were used as internal standards for acrylamide and asparagine, respectively. Recoveries were in the range 93-112% for acrylamide spiked at 30, 250 μg kg(-1) and 97-101% for asparagine spiked at 70, 140 mg kg(-1). Sorbitol was used as internal standard for fructose and glucose. Samples were diluted to obtain acceptable recoveries in saccharide analyses. LODs were 13 μg kg(-1) for acrylamide and 2 mg kg(-1) for asparagine in wheat bread.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Nielsen, N. (Ekstern), Granby, K. (Intern), Hedegaard, R. S. V. (Intern), Skibsted, L. (Ekstern)
Pages: 211-220
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Analytica Chimica Acta
Volume: 557
Issue number: 1-2
ISSN (Print): 0003-2670
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.06
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.64
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.74
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.55
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 4.62
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Analysis and dietary exposure to acrylamide from coffee, cocoa and chocolate

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Nielsen, M. K. (Ekstern)
Publication date: 2006
Event: Poster session presented at COST/IMARS workshop on "Thermally processed foods", Napoli, Italy.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244361
Publication: Research › Poster – Annual report year: 2006

Effect of asparagine and sugar potato content on acrylamide formation in French fries

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Publication date: 2006
Event: Abstract from IFT meeting, Orlando, FL, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244369
Publication: Research › Conference abstract for conference – Annual report year: 2006

Effect of asparagine and sugar potato content on acrylamide formation in French fries

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Publication date: 2006
Event: Poster session presented at IFT meeting, Orlando, FL, United States.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244368
Publication: Research › Poster – Annual report year: 2006
Kartoflen - Sund delikatesse eller fedende fyld

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Bach, I. C. (Ekstern), Blennow, A. (Ekstern), Sloth, B. (Ekstern), Christiansen, J. (Ekstern), Larke, P. E. (Ekstern), Ulvskov, P. (Ekstern), Knuthsen, P. (Intern), Granby, K. (Intern), Poulsen, M. E. (Intern), Kirk, H. G. (Ekstern)
Pages: 1-7
Publication date: 2006
Main Research Area: Technical/natural sciences

Publication information
Journal: Planteforskning
ISSN (Print): 1903-0908
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: 247872
Publication: Research › Journal article – Annual report year: 2006

LC-MS/MS analysis of Hexabromocyclododecane (HBCD) and tetrabromobisphenolA (TBBPA) flame retardants in food

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Nielsen, M. K. (Ekstern)
Publication date: 2006
Event: Abstract from 26th International Symposium on Chromatography, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244360
Publication: Research › Conference abstract for conference – Annual report year: 2006

Chemical contaminants: Part 1

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Nutrition, Division of Toxicology and Risk Assessment
Number of pages: 150
Publication date: Apr 2005
Acrylamide in cereal products – from raw materials to industrial prospects

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern)
Publication date: 2005
Event: Abstract from Cerealienetværkets årsmøde 2005: Cereals for food and feed, Slagelse, Denmark, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244364
Publication: Research › Conference abstract for conference – Annual report year: 2005

Acrylamide occurrence and oil uptake in potato chips

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. W. (Ekstern), Moyano, P. C. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Publication date: 2005
Event: Poster session presented at Toxicology and Safety Evaluation Division : IFT annual meeting, New Orleans, Lousiana-US, .
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244366
Publication: Research › Poster – Annual report year: 2005

Analyse af acrylamid, asparagine og reducerende sukkere i hvedebrød

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Nielsen, N. J. (Ekstern), Granby, K. (Intern), Skibsted, L. H. (Ekstern), Hedegaard, R. S. V. (Intern)
Pages: 32-33
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
Volume: 86
Issue number: 5
Color changes and acrylamide formation in fried potato slices
The objective of this work was to study the kinetics of browning during deep-fat frying of blanched and unblanched potato chips by using the dynamic method and to find a relationship between browning development and acrylamide formation. Prior to frying, potato slices were blanched in hot water at 85°C for 3.5 min. Unblanched slices were used as the control. Control and blanched potato slices (Panda variety, diameter: 37 mm, width: 2.2 mm) were fried at 120, 150 and 180°C until reaching moisture contents of similar to 1.8% (total basis) and their acrylamide content and final color were measured. Color changes were recorded at different sampling times during frying at the three mentioned temperatures using the chromatic redness parameter a*. Experimental data of surface temperature, moisture content and color change in potato chips during frying were fit to empirical relationship with correlation coefficients greater than 90%. A first-order rate equation was used to model the kinetics of color change. In all case the Arrhenius activation energy decreases alongside with decreasing chip moisture content. Blanching reduced acrylamide formation in potato chips in similar to 64% (average value) in comparison with control chips at the three oil temperatures tested. For the two pre-treatments studied, average acrylamide content increased -58 times as the frying temperature increased from 120 to 180°C. There was a linear correlation between acrylamide content of potato chips and their color represented by the redness component a* in the range of the temperatures studied.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Intern), Moyano, P. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Pages: 1-9
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Food Research International
Volume: 38
Issue number: 1
ISSN (Print): 0963-9969
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SJR 1.472 SNIP 1.467 CiteScore 3.9
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.87 SJR 1.612 SNIP 1.675
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.508 SNIP 1.629 CiteScore 3.66
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.487 SNIP 1.751 CiteScore 3.52
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.526 SNIP 1.802 CiteScore 3.68
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Levels of PCB in Cod Liver from Danish Waters 1988-2004

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Fromberg, A. (Intern), Granby, K. (Intern), Højgård, A. (Ekstern)
Pages: 1247-1249
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Organohalogen Compounds
Volume: 67
ISSN (Print): 1026-4892
Ratings:
Web of Science (2018): Indexed yes
Web of Science (2014): Indexed yes
ISI indexed (2013): ISI indexed no
ISI indexed (2012): ISI indexed no

Source: orbit
Source-ID: 229495
Publication: Research - peer-review > Journal article – Annual report year: 2005

frying, browning, color, acrylamide, potato slices, kinetics
Procesmodellering af acrylamiddannelse

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Division of Food Chemistry
Authors: Jensen, B. B. B. (Ekstern), Adler-Nissen, J. (Intern), Granby, K. (Intern)
Pages: 29-32
Publication date: 2005
Main Research Area: Technical/natural sciences

Reduction of acrylamide occurrence in fried potato strips

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. (Ekstern), Granby, K. (Intern), Kaack, K. (Ekstern)
Publication date: 2005
Event: Abstract from International Conference on Fruit, Vegetable and Potato Processing, Brugge, Belgien
Main Research Area: Technical/natural sciences

Reduction of the occurrence of acrylamide in potato chips

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Pedreschi, F. W. (Ekstern), Kaack, K. (Ekstern), Granby, K. (Intern)
Publication date: 2005
Event: Poster session presented at Toxicology and Safety Evaluation Division : IFT annual meeting, New Orleans, Lousiana-US
Main Research Area: Technical/natural sciences
Samtidig analyse af akrylamid og udgangsstofferne for dets dannelse, asparagin og reducerende sukre, i hvedebrød

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Nielsen, N. J. (Ekstern), Granby, K. (Intern), Skibsted, L. (Ekstern), Hedegaard, R. S. V. (Intern)
Publication date: 2005
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
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: English
Source: orbit
Source-ID: 244302
Publication: Communication › Journal article – Annual report year: 2005

Acrylamid i fødevarer

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Food Biotechnology and Engineering Group, Department of Systems Biology
Authors: Granby, K. (Intern), Frandsen, H. (Ekstern), Kaack, K. (Ekstern), Jensen, B. B. B. (Intern), Adler-Nissen, J. (Intern)
Pages: 18-21
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Alimenta
Volume: 5
ISSN (Print): 1395-1718
Original language: Danish
Source: orbit
Source-ID: 155303
Publication: Communication › Journal article – Annual report year: 2004

Acrylamid i fødevarer kan mindskes

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern)
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Externt FORVM
Issue number: 6
Original language: Danish
Analysis of acrylamide in coffee and dietary exposure to acrylamide from coffee

An analytical method for analysing acrylamide in coffee was validated. The analysis of prepared coffee includes a comprehensive clean-up using multimode solid-phase extraction (SPE) by automatic SPE equipment and detection by liquid chromatography tandem mass spectrometry using electrospray in the positive mode. The recoveries of acrylamide in ready-to-drink coffee spiked with 5 and 10 mug l(-1) were 96 +/- 14% and 100 +/- 8%, respectively. Within laboratory reproducibility for the same spiking levels were 14% and 9%, respectively. Coffee samples (n = 25) prepared twice by coffee machines and twice by a French Press Cafetiere coffee maker contained 8 +/- 3 mug l(-1) and 9 +/- 3 mug l(-1) acrylamide. Five ready-to-drink instant coffee prepared twice contained 8 +/- 2 mug l(-1). Hence, the results do not show significant differences in the acrylamide contents in ready-to-drink coffee prepared by coffee machine, French Press or from instant coffee. Medium roasted coffee contained more acrylamide (similar to10 mug l(-1)) than dark roasted coffee (similar to5 mug l(-1)). Males aged 35-45 years, drinking on average 1.11 coffee per day are exposed to the highest doses of acrylamide from coffee. The dietary intake of acrylamide from coffee comprises, on an average, 10 mug day(-1) for males and 9 mug day(-1) for females aged 35-45 years. Probabilistic modelling of the exposure of Danish consumers (all adults) to acrylamide from coffee shows a mean exposure of 6.5 mug day(-1) and a 95 percentile of 18 mug day(-1). (C) 2004 Elsevier B.V. All rights reserved.
Analysis of pesticides in fruit, vegetables and cereals using methanolic extraction and detection by LC-MS/MS

Abstract: A method for analysing carbamates and other relatively polar pesticides by LC-MS-MS with electrospray ionisation has been developed. The method is based on extraction by ultrasonication using a methanolic ammonium acetate–acetic acid buffer. After centrifugation the samples are filtered in Miniprep filter HPLC vials and detected by LC–MS–MS. To compensate for variations in the MS response [13C6]-carbaryl was used as internal standard and matrix-matched pesticide solutions were used as external standards for the quantification. The method has been validated for the matrices apple, avocado, carrot, lettuce, orange, potato and wheat at the spiking levels—0.02; 0.04 and 0.20 mg kg⁻¹. Recoveries were generally in the range 70–120%. Results from participation in three intercomparisons proved the accuracy of the method. As the analytical procedure does not include any concentration or cleanup steps, it is easy and fast to perform, making it applicable for routine analysis in large pesticide monitoring programmes.

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Andersen, J. H. (Intern), Christensen, H. B. (Intern)
Pages: 165-176
Publication date: 2004
Main Research Area: Technical/natural sciences

Publication information
Journal: Analytica Chimica Acta
Volume: 520
Issue number: 1-2
ISSN (Print): 0003-2670
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.06
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.01
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.94
Web of Science (2015): Indexed yes
Reduction of acrylamide formation in potato slices during frying

Reduction of acrylamide formation in potato chips was investigated in relation to frying temperature and three treatments before frying. Potato slices (Tivoli variety, diameter: 37 mm, width: 2.2 mm) were fried at 150°C, 170°C and 190°C until reaching moisture contents of similar to 1.7 g water/100 g (total basis). Prior to frying, potato slices were treated in one of the following ways: (i) soaked in distilled water for 0 min (control), 40 min and 90 min; (ii) blanched in hot water at six different time-temperature combinations (50°C for 30 and 70 min; 70°C for 8 and 40 min; 90°C for 2 and 9 min); (iii) immersed in citric acid solutions of different concentrations (10 and 20 g/l) for half an hour. Glucose and asparagine concentration was determined in potato slices before frying, whereas acrylamide content was determined in the resultant fried potato chips. Glucose content decreased in similar to 32% in potato slices soaked 90 min in distilled water. Soaked slices showed on average a reduction of acrylamide formation of 27%, 38% and 20% at 150°C, 170°C and 190°C, respectively, when they were compared against the control. Blanching reduced on average 76% and 68% of the glucose and asparagine content compared to the control. Potato slices blanched at 50°C for 70 min surprisingly had a very low acrylamide content (28 μm/kg) even when they were fried at 190°C. Potato immersion in citric acid solutions of 10 and 20 g/l reduced acrylamide formation by almost 70% for slices fried at 150°C. For the three pre-treatments studied, acrylamide formation increased dramatically as the frying temperature increased from 150°C to 190°C. (C) 2004 Swiss Society of Food Science and Technology. Published by Elsevier Ltd. All rights reserved.

General information
State: Published
Organisations: National Food Institute, Division of Food Chemistry
Authors: Pedreschi, F. (Intern), Kaack, K. (Ekstern), Granby, K. (Intern)
Pages: 679-685
Analysis of glyphosate residues in cereals using liquid chromatography-mass spectrometry (LC-MS/MS)

A fast and specific method for the determination of glyphosate in cereals is described. The method is based on extraction with water by ultrasonication. The samples are cleaned up and separated by high-performance liquid chromatography on a polystyrene-based reverse-phase column (clean-up) in series with an ion chromatography column (separation) using NaHCO₃ as eluent. A micro-membrane suppressor was inserted after the separator column to remove the Na⁺ ions before detection by electrospray ionization mass spectrometry in the negative-ion mode. In MS/MS, mode the following transitions were monitored m/z 168--> 150 (glyphosate) and 170-->152 (internal standard 2- 13 (CN)-N-15-glyphosate) for
quantification. The mean recovery was 85% (n = 32) at spiking levels from 0.03 to 0.33 mg kg⁻¹. From 1998 to 2001, from the analysis of about 50 samples per annum, a reduction in the glyphosate residues was observed owing to a Danish trade decision not to use grain with glyphosate residues for milling or bread production.

**General information**
- **State:** Published
- **Organisations:** Division of Food Chemistry, National Food Institute
- **Authors:** Granby, K. (Intern), Johannesen, S. (Ekstern), Gabrielsen, M. V. (Intern)
- **Pages:** 692-698
- **Publication date:** 2003
- **Workshop:** 4th European Pesticide Residues Workshop, Rome, Italy, 28/05/2002 - 28/05/2002
- **Main Research Area:** Technical/natural sciences

**Publication information**
- **Journal:** Food Additives and Contaminants
- **Volume:** 20
- **Issue number:** 8
- **ISSN (Print):** 0265-203X
- **Ratings:**
  - BFI (2018): BFI-level 1
  - BFI (2017): BFI-level 1
  - BFI (2016): BFI-level 1
  - BFI (2015): BFI-level 1
  - BFI (2014): BFI-level 1
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 1
  - ISI indexed (2013): ISI indexed yes
  - BFI (2012): BFI-level 1
  - ISI indexed (2012): ISI indexed yes
  - BFI (2011): BFI-level 1
  - Scopus rating (2011): SJR 0.121 SNIP 3.86
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
  - BFI (2010): BFI-level 1
  - Scopus rating (2010): SJR 0.941 SNIP 1.365
  - Web of Science (2010): Indexed yes
  - BFI (2009): BFI-level 1
  - Scopus rating (2009): SJR 0.945 SNIP 1.63
  - Web of Science (2009): Indexed yes
  - BFI (2008): BFI-level 2
  - Scopus rating (2008): SJR 0.782 SNIP 1.56
  - Web of Science (2008): Indexed yes
  - Scopus rating (2007): SJR 0.975 SNIP 1.213
  - Web of Science (2007): Indexed yes
  - Scopus rating (2006): SJR 0.945 SNIP 1.298
  - Web of Science (2006): Indexed yes
  - Scopus rating (2005): SJR 0.907 SNIP 1.408
  - Web of Science (2005): Indexed yes
  - Scopus rating (2004): SJR 1.026 SNIP 1.076
  - Web of Science (2004): Indexed yes
  - Scopus rating (2003): SJR 0.946 SNIP 1.178
  - Web of Science (2003): Indexed yes
  - Scopus rating (2002): SJR 0.977 SNIP 1.362
  - Web of Science (2002): Indexed yes
  - Scopus rating (2001): SJR 0.603 SNIP 1.138
  - Web of Science (2001): Indexed yes
  - Scopus rating (2000): SJR 0.941 SNIP 1.231
Cumulative risk assessment of the intake of organophosphorus and carbamate pesticides in the Danish diet

The aim of the study is to evaluate the potential cumulative effects of organophosphorus and carbamate pesticides that act through a common mechanism of toxicity, and to assess the long- and short-term risks for the Danish population. The intake estimates are based on dietary intake data collected in the Danish nation-wide food consumption survey in 1995. The pesticide data are based on the Danish pesticide residue-monitoring programme from 1996-2001. The amount of 35 organophosphorus pesticides and carbamates were included in the cumulative risk assessment. Processing factors, such as reduction of pesticide levels by rinsing and peeling, were applied in the exposure assessment. The “Toxicity Equivalence Factor” (TEF) approach was used to normalise the toxicity of the different organophosphorus and carbamate pesticides. Cumulative chronic exposure of organophosphorus and carbamates pesticides via fruit, vegetables and cereals is for adults 0.8-2% of the Acceptable Daily Intake (ADI) in chlorpyrifos equivalents, and 0.03-11% of the ADI in methamidophos equivalents; and for children 2-5% of the ADI in the chlorpyrifos equivalents, and 0.07-27% of the ADI in methamidophos equivalents. Neither Acute Reference Dose (ARfD) nor ADI was exceeded for any of the compounds studied. The results indicate that the Danish population is neither exposed to any cumulative chronic risk, nor at risk of acute exposure, from consumption of organophosphorus and carbamate pesticides from fruit, vegetables and cereals.
Processing factors and variability of pyrimethanil, fenhexamid and tolylfluanid in strawberries

An HPLC-MS/MS method for the analysis of three pesticides in strawberries was developed and validated. Recoveries were measured at three spiking levels and ranged from 85 to 99% (mean recoveries). The effects of processing of strawberries ranging from rinsing to jam production were investigated for the three fungicides tolylfluanid, fenhexamid and pyrimethanil, which were applied under field conditions. Kresoxim-methyl was also applied in the field, but was not found in any of the samples investigated. The effect of parameters such as preharvest interval, dose, harvest time and observed pesticide concentration after harvest (initial concentration, mg kg\(^{-1}\)) were examined with respect to possible reduction of the pesticides. The results from rinsing showed that all three pesticides were reduced on average by 37% for tolylfluanid, by 34% for fenhexamid and by 19% for pyrimethanil. For tolylfluanid and fenhexamid, the initial concentration significantly affected the reduction. For fenhexamid, dose could also have a minor influence on reduction. For pyrimethanil, none of the parameters significantly influenced the reduction. For jam production, cooking significantly reduced tolylfluanid by an average of 91%. For fenhexamid and pyrimethanil, a smaller reduction was seen, 25% and
The reduction of tolyfluanid and pyrimethanil was affected by the preharvest interval, while fenhexamid was affected by the initial concentration. The unit-to-unit variability of fungicide contents was also investigated and the variability factors for the three fungicides were from 1.9 to 2.8.
Reduktion af acrylamid i fødevarer

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern)
Publication date: 2003
Main Research Area: Technical/natural sciences

Publication information
Journal: Plus Proces
Issue number: 3
Original language: Danish
Source: orbit
Source-ID: 240664
Publication: Communication › Journal article – Annual report year: 2003

Pesticide Residues in Fruits, Vegetables and Cereals in Denmark - 2001

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Andersen, J. H. (Intern), Poulsen, M. E. (Intern), Granby, K. (Intern)
Publication date: 2002

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244926
Publication: Research › Report – Annual report year: 2002

Pesticidrester i fødevarer 2001- resultater fra den danske pesticidkontrol

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Division of Toxicology and Risk Assessment
Authors: Andersen, J. H. (Intern), Poulsen, M. E. (Intern), Granby, K. (Intern), Christensen, H. B. (Intern), Bille, R. (Intern), Meyer, O. A. (Intern)
Publication date: 2002

Publication information
Original language: Danish
Series: FødevareRapport 2002
Number: 25
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 234211
Publication: Communication › Report – Annual report year: 2002

Investigation of the herbicide glyphosate and the plant growth regulators chlormequat and mepiquat in cereals produced in Denmark

An LC-MS/ MS method for analysing glyphosate and aminomethylphosphonic acid (AMPA) in cereals was developed. The method is based on extraction with water and detection of the ions from the fragmentation m/z 170 → 88 (glyphosate) and
m/z 112 → 30 (AMPA), using electrospray interface in the positive mode. Investigation from the harvests of 1998 and 1999 showed residues of glyphosate and/or its degradation product AMPA in more than half of the cereal samples produced in Denmark. The average concentration of glyphosate in 46 samples from the 1999 harvest was 0.11 mg/kg compared with 0.08 mg/kg for the 1998 harvest (n=49). Thus, the figures were well below the maximum residue limit (MRL) and no violations were observed. The plant growth regulators chlormequat and/or mepiquat were investigated in cereals from the Danish harvest of 1999 where 83% of the samples contained chlormequat (n=46) compared with 87% of the samples from the 1997 harvest (n=52). The average concentration of chlormequat in 1999 was 0.32 mg/kg compared with 0.23 mg/kg in 1997. At 2.9 mg/kg, one sample of wheat bran was exceeding the MRL of 2 mg/kg for wheat. The intakes of the pesticides through the diet of cereals were estimated to comprise 0.04% of the acceptable daily intake (ADI) for glyphosate and 1% of the ADI for chlormequat for an adult Dane.
Method validation for strobilurin fungicides in cereals and fruit
Strobilurins are a new class of fungicides that are active against a broad spectrum of fungi. In the present work a GC method for analysis of strobilurin fungicides was validated. The method was based on extraction with ethyl acetate/cyclohexane, clean-up by gel permeation chromatography (GPC) and determination of the content by gas chromatography (GC) with electron capture (EC-), nitrogen/phosphorous (NP-), and mass spectrometric (MS-) detection. Three strobilurins, azoxystrobin, kresoxim-methyl and trifloxystrobin were validated on three matrices, wheat, apple and grapes. The validation was based on recovery tests at three or four spiking levels, determined as double determinations and repeated three times (n=6). The mean recoveries for the three detectors were in the range of 70-114%, and the LODs were between 0.004 mg/kg and 0.014 mg/kg, for all three strobilurins. The values for repeatability and reproducibility were within the limits for repeatability and reproducibility given by the Horwitz equation. Validation was not accepted for azoxystrobin in grapes on all three detectors and for azoxystrobin in apple for the MS-detector. A comparison of matrix-matched standards versus standards in solvent showed varying differences between the two calibration curves.
Pesticide Residues in Fruits, Vegetables and Cereals in Denmark - 2000

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Andersen, J. H. (Intern), Granby, K. (Intern), Poulsen, M. E. (Intern)
Publication date: 2001

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244928
Publication: Research › Report – Annual report year: 2001

Undersøgelser for pesticidrester i dansk kvalitetshvede

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern)
Pages: 55-56
Publication date: 2001

Host publication information
Title of host publication: Produktion af kvalitetshvede i Danmark - En oversigt over problemer og muligheder : DJF rapport Markbrug nr. 53
Editors: Petersen, J. W., Petersen, J. B., Knudsen, L., Deneken, G., Jørgensen, J. R.
Main Research Area: Technical/natural sciences
Source: orbit
Analyse af glyphosat i korn vha LC-MS/MS: In: Berg T. Kemiske Forureninger i Fødevarer

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Vahl, M. (Intern)
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Dansk Kemi
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: 240662
Publication: Communication › Journal article – Annual report year: 2000

Ingen fald i indhold af glyphosat og stråforkortere i korn

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Vahl, M. (Intern)
Pages: 18-20
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Fødevarenyt
Issue number: 1
Original language: Danish
Source: orbit
Source-ID: 240659
Publication: Communication › Journal article – Annual report year: 2000

Overvågningssystem for levnedsmidler 1993-1997: Del III: Produktionshjælpemidler

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute, Communications and Management Secretariat
Authors: Ørntoft, I. (Ekstern), Rasmussen, A. (Ekstern), Granby, K. (Intern), Hansen, H. F. (Ekstern), Büchert, A. (Intern)
Publication date: 2000

Publication information
Publisher: Fødeveredirektoratet
Original language: Danish
Series: FødevareRapport
Number: 2000:03
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244307
Publication: Research › Report – Annual report year: 2000
Fluxes of soluble gases in the marine atmosphere surface layer

Fluxes of HNO3 and NH3 to the sea-surface have been obtained from measurements of vertical concentration profiles. The obtained fluxes have been compared to fluxes calculated by the use of the resistance method, and the fluxes calculated from measurements based on the extrapolation of a log-linear profile were found to be an order of a magnitude higher than the fluxes obtained from the resistance method. The difference between these two calculated fluxes is explained by scavenging of the gases by sea-spray and chemical reactions. A simple model is constructed to calculate the vertical profiles for HNO3 in the case of high chemical reactions. The high fluxes and the measured profiles are explained by the calculated profiles of HNO3 where chemical reactions are taken into account. Since both sink/sources and horizontal inhomogeneity are influencing the NH3 flux, it has not been possible to calculate profiles for this component by taking chemical reactions into account.
Gaseous and particulate oxidized and reduced nitrogen species in the atmospheric boundary layer in Scandinavia in spring

Observations of the concentration of several nitrogen containing compounds at five rural Scandinavian sites during March-June 1993 are reported. Total nitrate (NO$_3^-$ + HNO$_3$) and total ammonium (NH$_4^+$ + NH$_3$) were measured by denuder and filter pack. In general the methods agree well. At all sites the particulate fraction dominated, with the largest fraction of NO$_3^-$ and the lowest of NH$_4^+$ at the sites which were closest to the emission sources. The fraction of NO$_3^-$ of total nitrate increased with increasing NO$_2$ concentrations, indicating that the nighttime conversion of NO$_2$ to NO$_3^-$ is an important route of formation for NO$_3^-$. A positive correlation was found between HNO$_3$ and O$_3$ in June at all sites, while no correlation was found early in the spring. Model calculations were made with a lagrangian boundary layer photooxidant model for the whole period, and compared to the measured concentrations. The calculated ratio between mean observed and modelled daily maximum concentrations of ozone over the measurement period were within +/-10% at all sites. The models ability to describe the daily ozone maximum concentration was satisfactory with an average deviation of 19-22% from the observed concentrations. HNO$_3$ was underestimated by over 50% at all sites except the one closest to the emission sources. The correlation between modelled and observed concentrations was generally best for the sites with shortest transport distance from the sources of emission.
Measurements of inorganic ions, organic & inorganic acids in Malaysia during the 1997 Haze Episode

General information
State: Published
Organisations: Unknown
Authors: Granby, K. (Intern), Wåhlin, P. (Ekstern), Geernaert, G. (Ekstern), Jensen, F. P. (Ekstern), Leong, C. P. (Ekstern), Lim, S. F. (Ekstern)
Publication date: 1998

Host publication information
Title of host publication: Conference Proceedings of Environmental Strategies for the 21st Century : An Asia Pacific Conference
Main Research Area: Technical/natural sciences
Conference: An Asia Pacific Conference, Singapore, 01/01/1998
Source: orbit
Source-ID: 244402
Publication: Research › Article in proceedings – Annual report year: 1998

Pesticide Residues in Fruits, Vegetables and Cereals in Denmark - 1997

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Andersen, J. H. (Intern), Granby, K. (Intern), Poulsen, M. E. (Intern)
Publication date: 1998

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244933
Publication: Research › Report – Annual report year: 1998

Pesticidrester i danske levnedsmidler 1997

General information
State: Published
Organisations: Division of Food Chemistry, National Food Institute
Authors: Granby, K. (Intern), Poulsen, M. E. (Intern)
Publication date: 1998

Publication information
Publisher: Veterinær- og Fødevaredirektoratet
ISBN (Print): 87-90599-23-3
Carboxylic acids: Seasonal variation and relation to chemical and meteorological parameters
Formic and acetic acid measured as daily averages in 1993-1994 show equal and highly correlated concentrations up to 3 ppb in the summer (May-August). In the winter (October-March) the formic acid/acetate acid ratio was 0.6 and the formic acid concentrations were usually below 1 ppb. In winter the carboxylic acids correlate with O-3, NOy, SO2 and particulate sulphur. The main sources are suggested to be ozonolysis of anthropogenic alkenes and reactions between peroxyacetyl radicals and RO2 radicals. In spring-summer the carboxylic acids correlate with O-3, O-x, HNO3, PAN, NOy, SO2, particulate sulphur and temperature. In addition to the sources of the winter a contribution from ozonolysis of biogenic alkenes is likely. Quite similar formic acid/acetate acid ratios for all wind directions suggest that the source(s) are atmospheric oxidation processes distributed over large areas. The highest concentrations occurring for winds from east to south and the correlation with e.g., particulate sulphur indicate chemical production in polluted air masses during long range transport.

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Egelov, A. H. (Ekstern), Nielsen, T. (Ekstern), Lohse, C. (Ekstern)
Pages: 195-207
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Atmospheric Chemistry
Volume: 28
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ISSN (Print): 0167-7764
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 0.552 SJR 0.8 CiteScore 1.75
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.907 SNIP 0.646 CiteScore 1.66
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.73 SNIP 0.598 CiteScore 1.69
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.818 SNIP 0.733 CiteScore 1.58
Comparison of field measurements and a trajectory model

General information
State: Published
Organisations: Risø National Laboratory, National Environmental Research Institute
Authors: Nielsen, T. (Ekstern), Hertel, O. (Ekstern), Christensen, C. S. (Ekstern), Egeløv, A. H. (Ekstern), Granby, K. (Intern), Hansen, A. B. (Ekstern), Platz, J. (Ekstern), Skov, H. (Ekstern)
Pages: 1114-1115
Publication date: 1997
Conference: 1st Joint Nordic Symposium on Atmospheric Chemistry and Nordic Society of Aerosol Research
Symposium, Helsingør, Denmark, 15/11/1996 - 15/11/1996
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Aerosol Science
Volume: 28
Issue number: 6
ISSN (Print): 0021-8502
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.274 SJR 0.828 CiteScore 2.52
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.21 SJR 0.873 SNIP 1.24
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.071 SNIP 1.317 CiteScore 2.47
Exchange and Transport of Air Pollutants over Complex Terrain and the Sea: Field Measurements and numerical modelling; ship, ocean platform and laboratory measurements

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Asman, W. A. H. (Ekstern), Berkowicz, R. (Ekstern), Hertel, O. (Ekstern), Runge, E. H. (Ekstern), Sørensen, L. (Ekstern), Granby, K. (Intern), Gryning, S. (Ekstern), Sempreviva, A. M. (Ekstern), Larsen, S. E. (Ekstern), Kilde, N. A. (Ekstern), Madsen, H. (Ekstern), Allerup, P. (Ekstern), Overgård, S. (Ekstern), Jørgensen, J. (Ekstern), Vejen, F. (Ekstern), Hedegård, K. (Ekstern)
Publication date: 1997

Host publication information
Title of host publication: EUROTRAC 2. final Report, No. 9
Place of publication: Garmisch-Partenkirchen Germany
Publisher: EUROTRAC International Scientific Secretariat
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 245194
Publication: Research - peer-review › Book chapter – Annual report year: 1997

Indications of sources of atmospheric formic and acetic acid

General information
State: Published
Organisations: Risø National Laboratory, National Environmental Research Institute
Authors: Granby, K. (Intern), Nielsen, T. (Ekstern), Egelov, A. H. (Ekstern)
Pages: 1112-1112
Publication date: 1997
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Aerosol Science
Volume: 28
Issue number: 6
ISSN (Print): 0021-8502
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): SNIP 1.274 SJR 0.828 CiteScore 2.52
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.21 SJR 0.873 SNIP 1.24
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.071 SNIP 1.317 CiteScore 2.47
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.081 SNIP 1.561 CiteScore 2.72
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.187 SNIP 1.826 CiteScore 2.9
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.284 SNIP 1.611 CiteScore 2.64
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
On the spatial distribution and seasonal variation of lower-troposphere ozone over Europe

Surface ozone data from 25 European low-altitude sites and mountain sites located between 79 degrees N and 28 degrees N were studied. The analysis covered the time period March 1989-February 1993. Average summer and winter O-3 concentrations in the boundary layer over the continent gave rise to gradients that were strongest in the north-west to south-east direction and west-east direction, respectively. Wintertime O-3 ranged from 19 to 27 ppb over the continent, compared to about 32 ppb at the western border, while for summer the continental O-3 values ranged between 39 and 56 ppb and the oceanic mixing ratios were around 37 ppb. In the lower free troposphere average wintertime O-3 mixing ratios were around 38 ppb, with only an 8 ppb difference between 28 degrees N and 79 degrees N. For summer the average O-3 levels decreased from about 55 ppb over Central Europe to 32 ppb at 79 degrees N. In addition, O-3 and O-x (= O-3 + NO2) in polluted and clean air were compared. The amplitudes of the seasonal ozone variations increased in the north-
west to southeast direction, while the time of the annual maximum was shifted from spring (at the northerly sites) to late summer (at sites in Austria and Hungary), which reflected the contribution of photochemical ozone production in the lower parts of the troposphere.

**General information**

**State:** Published

**Organisations:** Forschungszentrum Jülich GmbH, Stockholm University, National Environmental Research Institute, Norwegian Institute for Air Research, Finnish Meteorological Institute, University of Ljubljana, University of Bristol, Université Paris XIII

**Authors:** Scheel, H. E. (Ekstern), Areskoug, H. (Ekstern), Geiss, H. (Ekstern), Gomiscek, B. (Ekstern), Granby, K. (Intern), Haszpra, L. (Ekstern), Klasinc, L. (Ekstern), Kley, D. (Ekstern), Laurila, T. (Ekstern), Lindskog, A. (Ekstern), Roemer, M. (Ekstern), Schmitt, R. (Ekstern), Simmonds, P. (Ekstern), Solberg, S. (Ekstern), Toupance, G. (Ekstern)

**Pages:** 11-28

**Publication date:** 1997

**Main Research Area:** Technical/natural sciences

**Publication information**

**Journal:** Journal of Atmospheric Chemistry

**Volume:** 28

**Issue number:** 1-3

**ISSN (Print):** 0167-7764

**Ratings:**

- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
- Scopus rating (2017): SNIP 0.552 SJR 0.8 CiteScore 1.75
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): SJR 0.907 SNIP 0.646 CiteScore 1.66
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 0.73 SNIP 0.598 CiteScore 1.69
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 0.818 SNIP 0.733 CiteScore 1.58
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 0.918 SNIP 0.502 CiteScore 1.37
- ISI indexed (2013): ISI indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 0.919 SNIP 0.656 CiteScore 1.51
- ISI indexed (2012): ISI indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 0.667 SNIP 0.554 CiteScore 1.26
- ISI indexed (2011): ISI indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 0.945 SNIP 0.873
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.025 SNIP 0.652
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 0.999 SNIP 0.777
- Scopus rating (2007): SJR 1.013 SNIP 0.878
- Scopus rating (2006): SJR 0.956 SNIP 0.806
- Scopus rating (2005): SJR 1.088 SNIP 0.805
- Scopus rating (2004): SJR 1.442 SNIP 1.063
- Scopus rating (2003): SJR 2.092 SNIP 1.453
- Scopus rating (2002): SJR 2.112 SNIP 1.152
- Scopus rating (2001): SJR 2.207 SNIP 1.238
- Scopus rating (2000): SJR 2.223 SNIP 1.036
- Scopus rating (1999): SJR 2.278 SNIP 0.969
Urban and semirural observations of carboxylic acids and carbonyls
In a busy street in Central Copenhagen winter mean concentrations (ppbv) were for formic acid, (0.7 ± 0.3); acetic acid, (1.2 ± 0.5); formaldehyde, (2.6 ± 0.7); acetaldehyde, (1.0 ± 0.7); and acetone, (1.0 ± 0.5). Simultaneous measurements at a semi-rural site 30 km west of Copenhagen showed mean concentrations (ppbv) of: formic acid, (0.6 ± 0.3); acetic acid, (1.0 ± 0.5); formaldehyde, (0.9 ± 0.5); acetaldehyde, (0.7 ± 0.4); and acetone, (0.9 ± 0.4). The similar concentrations of formic acid and acetic acid at the two sites in Denmark when NOy concentrations were one order of magnitude lower at the semi-rural site indicate that primary emission from automobiles was not an important source of the carboxylic acids. In a busy street in Brussels, Belgium summer mean concentrations (ppbv) were for formic acid, (3.6 ± 1.6) and acetic acid, (4.0 ± 2.0). Weaker diurnal variation of formic acid and acetic acid than of the directly emitted NOy and CO in both Copenhagen and Brussels further support sources of the carboxylic acids other than car traffic. For formaldehyde the strong correlations with gas NOy and CO indicate that direct emission from automobile is a source. Acetone shows similar concentrations at the urban and semirural sites and weak correlations with CO and gas NOy which indicate other sources than traffic emission. For acetone and the carboxylic acids the similar concentrations at the urban and semi-rural site may be explained by a regional photochemical source, i.e. oxidation of reactive hydrocarbons in polluted air masses carried to the region by long-range transport. Carboxylic acids; carbonyls; formic acid; acetic acid; formaldehyde; acetaldehyde; acetone; ambient air
Atmosfærens indhold af NOy forbindelser

General information
Comparison of measurements and modelling ozone, other photochemical oxidants, precursors and atmospheric oxidation products during a summer high pressure episode in Denmark

Evaluation of the Danish ACDEP model to simulate formation of Tropospheric ozone, other photochemical oxidants and atmospheric reaction products

Hydrocarbons and Organochlorines in the Common Mussels from the Kattegat and the Belts and their Relation to Condition Indexes
(SIGMA7 chlorobiphenyl) for polychlorinated biphenyls, 2.4-67 ng g⁻¹ wet wt for SIGMAADDT, 0.3-3.1 ng g⁻¹ wet wt for alpha-HCH, 0.6-7.4 ng g⁻¹ wet wt for gamma-HCH and 0.05-0.74 ng g⁻¹ wet wt for HCB. An interpretation of the physiological parameter, the condition index (measured as the ratio of dry weight of soft tissue to (shell length)³ and 'normalized' with respect to shell length) in relation to the lipid content showed a good correlation (r = 0.76, p = 0.0001). The condition index showed a significant negative correlation with the polycyclic aromatic hydrocarbons (SIGMA14 PAH, r = -0.48, p = 0.01) and a weaker negative correlation with the p-n-hydrocarbons (r = -0.36, p = 0.08).

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Spliid, N. H. (Ekstern)
Pages: 74-82
Publication date: 1995
Main Research Area: Technical/natural sciences

Publication information
Journal: Marine Pollution Bulletin
Volume: 30
Issue number: 1
ISSN (Print): 0025-326X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.228 SJR 1.147 CiteScore 3.4
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.46 SJR 1.332 SNIP 1.35
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.252 SNIP 1.276 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.303 SNIP 1.425 CiteScore 3.04
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.21 SNIP 1.533 CiteScore 2.89
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.235 SNIP 1.385 CiteScore 2.64
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 1.251 SNIP 1.35 CiteScore 2.57
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.292 SNIP 1.282
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 1.313 SNIP 1.209
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.379 SNIP 1.324
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.346 SNIP 1.37
Observations of Particulate Organic Nitrates and unidentified components of NOy

A method to determine the total content of particulate organic nitrates (PON) has been developed and ambient air measurements of PON, NO, NO2, HNO3, peroxyacetyl nitrate (PAN), peroxypropionyl nitrate (PPN), gas NOy and particulate inorganic nitrate have been performed in the spring and early summer at an agricultural site in Denmark and compared with measurements of ozone, H2O2, SO2, formic acid, acetic acid and methane sulfonic acid. The gas NOy detector determines the sum NO + NO2 + HNO2 + HNO3 + PAN + PPN + gas phase organic nitrates + 2 x N2O5 + NO3. The content of residual gas NOy (= gas NOy - NO - NO2 - HNO3 - PAN - PPN) was determined and a group of unidentified NOy compounds was found. The phenomenon was observed at a site with relatively high NOx/NOy ratios compared to previous observations in U.S.A. and Canada. The residual gas NOy made up 7 +/- 6% of total NOy (total NOy = gas NOy + particulate inorganic nitrate). Residual gas NOy was much higher than the particulate fraction of organic nitrates (PON). PON was only 0.25 +/- 0.11% of concentrations of photochemical oxidants in connection with high-pressure systems suggesting atmospheric processes being the major source. Clean marine air can be discarded as a source for PON and residual gas NOy.
Atmospheric Occurrence of Particulate Organic Nitrates

General information
State: Published
Organisations: Danmarks Miljøundersøgelser
Authors: Nielsen, T. (Ekstern), Egeløv, A. H. (Ekstern), Granby, K. (Intern), Skov, H. (Ekstern)
Pages: 1202-1205
Publication date: 1994

Host publication information
Title of host publication: Transport and Transformation of Pollutants in the Troposphere
Publisher: SPB Academic Publishing bv
Main Research Area: Technical/natural sciences
Conference: Transport and Transformation of Pollutants in the Troposphere, Garmisch Partenkirchen, Germany, 01/01/1994
Source: orbit
Source-ID: 244408
Background Ozone Contribution at a Non-remote TOR-site

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Egeløv, A. H. (Ekstern), Granby, K. (Intern), Nielsen, T. (Ekstern), Skov, H. (Ekstern)
Pages: 203-206
Publication date: 1994

Host publication information
Title of host publication: Transport and Transformation of Pollutants in the Troposphere
Publisher: SPB Academic Publishing bv
Main Research Area: Technical/natural sciences
Conference: Transport and Transformation of Pollutants in the Troposphere, Garmisch-Partenkirchen Germany, 01/01/1994
Source: orbit
Source-ID: 244315
Publication: Research › Article in proceedings – Annual report year: 1994

Deposition of Gases and Particles in the PBL: Evaluation of the Influence of a Vertical Resolution in Atmospheric Transport Models

General information
State: Published
Organisations: National Environmental Research Institute, University of Bergen
Authors: Hertel, O. (Ekstern), Christensen, J. (Ekstern), Runge, E. (Ekstern), Berkowicz, R. (Ekstern), Asman, W. A. H. (Ekstern), Granby, K. (Intern), Hovmand, M. F. (Ekstern), Hov, Ø. (Ekstern)
Publication date: 1994

Host publication information
Title of host publication: 20th International Technical Meeting on Air Pollution Modelling and its Application
Main Research Area: Technical/natural sciences
Conference: 20th International Technical Meeting on Air Pollution Modelling and its Application, Valencia Spain, 01/01/1993
Source: orbit
Source-ID: 244336
Publication: Research › Article in proceedings – Annual report year: 1994

Diffusion Scrubber: A Technique for Measuring Ammonia

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Sørensen, L. L. (Ekstern), Granby, K. (Intern), Asman, W. A. H. (Ekstern), Nielsen, H. (Ekstern)
Publication date: 1994

Publication information
Publisher: National Environmental Research Institute
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244438
Publication: Research › Report – Annual report year: 1994

Diffusion Scrubber Technique used for Measurements of Atmospheric Ammonia
A diffusion scrubber (DS) was developed to measure trace levels of gaseous ammonia in ambient air. The sampling resolution time for this method is 10 min and the detection limit is estimated to be 0.01 ppbv. The response to the NH3 concentrations is found to be dependent on the relative humidity in the ambient air and the temperature. The method is calibrated by using a diluted NH3 cylinder gas, and the concentrations of the calibration gas were in the range 0.02-2 ppbv during the test. Sampling performed with the DS-method is compared to sampling performed by a filter pack and a
The DS-method shows good agreement with the continuous flow denuder and the filter pack.

**General information**
State: Published
Organisations: National Environmental Research Institute
Authors: Sørensen, L. L. (Ekstern), Granby, K. (Intern), Nielsen, H. (Ekstern), Asman, W. A. H. (Ekstern)
Pages: 3637-3645
Publication date: 1994
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Atmospheric Environment
Volume: 28
Issue number: 22
ISSN (Print): 1352-2310
Ratings:
- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- Scopus rating (2017): SNIP 1.451 SJR 1.523 CiteScore 4.12
- Web of Science (2017): Indexed Yes
- BFI (2016): BFI-level 1
- Scopus rating (2016): CiteScore 4.01 SJR 1.495 SNIP 1.599
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 1
- Scopus rating (2015): SJR 1.754 SNIP 1.615 CiteScore 3.73
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 1
- Scopus rating (2014): SJR 1.612 SNIP 1.661 CiteScore 3.55
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): SJR 1.766 SNIP 1.62 CiteScore 3.52
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): SJR 1.981 SNIP 1.674 CiteScore 3.47
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): SJR 1.971 SNIP 1.78 CiteScore 3.84
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Scopus rating (2010): SJR 1.907 SNIP 1.485
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
- Scopus rating (2009): SJR 1.979 SNIP 1.46
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 1
- Scopus rating (2008): SJR 1.877 SNIP 1.579
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 1.999 SNIP 1.547
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 1.87 SNIP 1.571
- Web of Science (2006): Indexed yes
Dry Deposition Processes: (In Danish: Processer for Tørdeposition)

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Asman, W. A. H. (Ekstern), Sørensen, L. (Ekstern), Berkowicz, R. (Ekstern), Granby, K. (Intern), Nielsen, H. (Ekstern), Jensen, B. (Ekstern), Runge, E. (Ekstern), Lykkelund, C. (Ekstern), Gryning, S. (Ekstern), Sempreviva, A. M. (Ekstern)
Publication date: 1994

Publication information
Place of publication: Copenhagen, Denmark
Original language: English
Series: Marine Research from the Danish Environmental Protection Agency (EPA)
Number: Report No. 35
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 245191
Publication: Research - peer-review › Report – Annual report year: 1994

EUROTRAC Annual Report, Part 3, Air Sea Exchange (ASE): Deposition of Nitrogen compounds to Danish Coastal Waters (A Contribution to subproject ASE)

General information
State: Published
Organisations: National Environmental Research Institute
Publication date: 1994

Publication information
Place of publication: Garmisch-Partenkirchen Germany
Publisher: EUROTRAC International Scientific Secretariat
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 245180
Publication: Research - peer-review › Report – Annual report year: 1993
H2O2 Measurements at Northern Latitudes

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Hertel, O. (Ekstern), Egeløv, A. H. (Ekstern), Lohse, C. (Ekstern), Hummelshøj, P. (Ekstern)
Pages: 232-237
Publication date: 1994

Host publication information
Title of host publication: Physico-Chemical Behaviour of Atmospheric Pollutants: Proceedings of the 6th European Symposium
Editors: Angeletti, G., Restelli, G.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 244399
Publication: Research › Article in proceedings – Annual report year: 1994

H2O2 Measurements from Denmark and Northern Greenland

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Hertel, O. (Ekstern), Egeløv, A. H. (Ekstern), Lohse, C. (Ekstern), Hummelshøj, P. (Ekstern)
Pages: 115-118
Publication date: 1994

Host publication information
Title of host publication: Third Nordic Symposium on Atmospheric Chemistry: Proceedings of NORSAC '93
Editor: Nielsen, C. J.
Main Research Area: Technical/natural sciences
Conference: 3rd Nordic Symposium on Atmospheric Chemistry, Geilo, Norway, 03/12/1993 - 03/12/1993
Source: orbit
Source-ID: 244380
Publication: Research › Article in proceedings – Annual report year: 1994

Hydrogen Peroxide concentrations in relation to Mixing Heights at a Danish Sea Site and A Land Site: Comparison with a Trajectory Model

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Gryning, S. E. (Ekstern), Hertel, O. (Ekstern)
Pages: 651-654
Publication date: 1994

Host publication information
Title of host publication: Transport and Transformation of Pollutants in the Troposphere
Publisher: SPB Academic Publishing bv
Main Research Area: Technical/natural sciences
Conference: Transport and Transformation of Pollutants in the Troposphere, Garmisch-Partenkirchen Germany, 01/01/1994
Source: orbit
Source-ID: 244381
Publication: Research › Article in proceedings – Annual report year: 1994

Measurements of C1- C3 Carbonyls at the Danish TOR Station and in Central Copenhagen

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Christensen, C. (Ekstern), Lohse, C. (Ekstern), Granby, K. (Intern), Nielsen, T. (Ekstern), Egeløv, A. H. (Ekstern)
Organic Sulphur Compounds: Atmospheric Chemistry, Occurrence and Modelling

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Hertel, O. (Ekstern), Holcmann, J. (Ekstern), Nielsen, O. J. (Ekstern), Nielsen, T. (Ekstern), Sehested, K. (Ekstern), Egeløv, A. H. (Ekstern)
Pages: 163-166
Publication date: 1994

Tropospheric Ozone Research (TOR)-station, Lille Valby, Denmark

General information
State: Published
Organisations: Unknown
Authors: Nielsen, T. (Ekstern), Granby, K. (Intern), Egeløv, A. H. (Ekstern), Hummelshøj, P. (Ekstern), Palmgren, F. (Ekstern), Skov, H. (Ekstern)
Pages: 38-45
Publication date: 1994

Deposition of Nitrogen Compounds to Danish Coastal Waters

General information
State: Published
Organisations: National Environmental Research Institute, Risø National Laboratory, Danish Meterological Institute
Authors: Asman, W. A. H. (Ekstern), Berkowicz, R. (Ekstern), Hertel, O. (Ekstern), Sørensen, L. (Ekstern), Granby, K. (Intern), Nielsen, H. (Ekstern), Runge, E. H. (Ekstern), Jensen, P. K. (Ekstern), Gryning, S. E. (Ekstern), Kilde, N. A. (Ekstern), Madsen, H. (Ekstern), Allerup, P. (Ekstern), Overgård, S. (Ekstern), Jørgensen, J. (Ekstern), Vejen, F. (Ekstern), Hedegård, K. (Ekstern)
Pages: 779-782
Publication date: 1993
Measurements of H$_2$O$_2$ by a diffusion Scrubber Technique and by Collection on Ti(IV) -impregnated filters

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Hummelshøj, P. (Ekstern), Egeløv, A. H. (Ekstern)
Pages: 173-178
Publication date: 1993

Measurements of Hydrogen Peroxide by a Diffusion Scrubber and By a Filter Method

General information
State: Published
Organisations: National Environmental Research Institute
Authors: Granby, K. (Intern), Hummelshøj, P. (Ekstern), Egeløv, A. H. (Ekstern)
Pages: 119-125
Publication date: 1993

The DCAR TOR Station Lille Valby, Denmark

General information
State: Published
Organisations: Unknown
Authors: Nielsen, T. (Ekstern), Granby, K. (Intern), Egeløv, A. H. (Ekstern), Hilbert, G. (Ekstern), Hummelshøj, P. (Ekstern), Jensen, F. P. (Ekstern), Lohse, C. (Ekstern)
Publication date: 1992
Correlation between the Levels of PCBs and the Presence of Diseases in Common Dab

**General information**
State: Published
Organisations: Danish Institute for Fisheries and Marine Research
Authors: Granby, K. (Intern), Nielsen, E. (Ekstern), Mellergård, S. (Ekstern)
Publication date: 1991

**Host publication information**
Title of host publication: International Council for Exploration of the Sea (ICES)
Publisher: Marine Environmental Quality Committee
Main Research Area: Technical/natural sciences
Conference: International Council for Exploration of the Sea (ICES), 01/01/1991
Source: orbit
Source-ID: 244378
Publication: Research › Article in proceedings – Annual report year: 1991

**Organochlorines in Danish and West Greenland Harbor Porpoises**
Concentrations of organochlorines in the blubber of 27 harbour porpoises (Phocoena phocoena) collected from 1986 to 1988 in Danish North Sea and Baltic waters and two harbour porpoises collected in 1988 in West Greenland are reported. Comparisons with previous Danish findings reveal a lower contamination level than in the 1970s and early 1980s. The contamination level of two adult West Greenland animals was markedly lower than in Danish animals.

**General information**
State: Published
Organisations: Zoological Museum, National Environmental Research Institute
Authors: Granby, K. (Intern), Kinze, C. C. (Ekstern)
Pages: 458-462
Publication date: 1991
Main Research Area: Technical/natural sciences

**Publication information**
Journal: Marine Pollution Bulletin
Volume: 22
Issue number: 9
ISSN (Print): 0025-326X
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): SNIP 1.228 SJR 1.147 CiteScore 3.4
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.46 SJR 1.332 SNIP 1.35
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 1.252 SNIP 1.276 CiteScore 3.23
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 1.303 SNIP 1.425 CiteScore 3.04
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.21 SNIP 1.533 CiteScore 2.89
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.235 SNIP 1.385 CiteScore 2.64
ISI indexed (2012): ISI indexed yes
PCB i Danske Farvande

General information
State: Published
Organisations: Unknown
Authors: Granby, K. (Intern), Aamann, M. (Ekstern)
Publication date: 1988
Main Research Area: Technical/natural sciences

Publication information
Journal: Vand og Miljø
Volume: 2
Original language: English
Source: orbit
Source-ID: 244303
Publication: Communication › Journal article – Annual report year: 1988

Input of Petroleum Hydrocarbons to the Danish Sea Areas and Levels Occurring in the Environment

General information
State: Published
Organisations: Unknown
Authors: Granby, K. (Intern), Jensen, K. (Ekstern), Jørgensen, K. F. (Ekstern)
Publication date: 1987

Host publication information
Title of host publication: Baltic Sea Environment Proceedings No. 22
Main Research Area: Technical/natural sciences
Conference: Seminar on Oil Pollution Questions, The Helsinki Commission, Norkoeping, Sweden, 01/01/1986
Source: orbit

**General information**
State: Published
Organisations: Unknown
Authors: Granby, K. (Intern)
Publication date: 1987

**Publication information**
Original language: English
Main Research Area: Technical/natural sciences
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