A general overview of support materials for enzyme immobilization: Characteristics, properties, practical utility

In recent years, enzyme immobilization has been presented as a powerful tool for the improvement of enzyme properties such as stability and reusability. However, the type of support material used plays a crucial role in the immobilization process due to the strong effect of these materials on the properties of the produced catalytic system. A large variety of inorganic and organic as well as hybrid and composite materials may be used as stable and efficient supports for biocatalysts. This review provides a general overview of the characteristics and properties of the materials applied for enzyme immobilization. For the purposes of this literature study, support materials are divided into two main groups, called Classic and New materials. The review will be useful in selection of appropriate support materials with tailored properties for the production of highly effective biocatalytic systems for use in various processes.
Alcohol dehydrogenase on inorganic powders: Zeta potential and particle agglomeration as main factors determining activity during immobilization

Alcohol dehydrogenase from *Saccharomyces cerevisiae* was immobilized on different inorganic support materials, i.e., powders of Al₂O₃, SiC, TiO₂, and YSZ-8, by covalent bonding and physical adsorption. The raw powders were characterized by scanning electron microscopy, BET surface area, particle size distribution, and ζ-potential measurements. Enzyme activity retention, storage stability, and recyclability were evaluated on the basis of the measured support material properties. Preliminary experiments showed that the buffer selection was a critical factor. The properties of both the enzyme and the powders varied considerably between the buffers used; namely Tris-HCl (100 mM, pH 7) and MES (40 mM, pH 6.5) buffers. The enzyme activity was higher and more stable in the MES buffer, whereas the commonly used Tris buffer was problematic due to apparent incompatibility with formaldehyde. In MES, the order of decreasing activity of covalently bonded enzyme was on SiC > YSZ-8 > Al₂O₃ > TiO₂. The lower performance of TiO₂ was ascribed to the negative ζ-potential of the material, which impeded an efficient immobilization. Particle agglomeration, caused by low colloidal stability of the particles in MES buffer, hampered the storage stability of the immobilized systems. The results from this study show the advantages and limitations of using nanoparticles as immobilization supports, and highlight which properties of nanoparticles must be considered to ensure an efficient immobilization.

**General information**

State: Published
Organisations: Department of Chemical and Biochemical Engineering, Department of Energy Conversion and Storage
Contributors: Sigurdardóttir, S. B., Lehmann, J., Grivel, J., Zhang, W., Kaiser, A., Pinelo, M.
Pages: 136-142
Publication date: 2018
Peer-reviewed: Yes

**Publication information**

Journal: Colloids and Surfaces B: Biointerfaces
Volume: 175
ISSN (Print): 0927-7765
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 4.24 SJR 1.071 SNIP 1.101
Web of Science (2017): Impact factor 3.997
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 4.42 SJR 1.079 SNIP 1.322
Web of Science (2016): Impact factor 3.887
BFI (2015): BFI-level 1
Developments in support materials for immobilization of oxidoreductases: A comprehensive review

Bioresmediation, a biologically mediated transformation or degradation of persistent chemicals into nonhazardous or less-hazardous substances, has been recognized as a key strategy to control levels of pollutants in water and soils. The use of enzymes, notably oxidoreductases such as laccases, tyrosinases, various oxygenases, aromatic dioxygenases, and different peroxidases (all of EC class 1) is receiving significant research attention in this regard. It should be stated that
immobilization is emphasized as a powerful tool for enhancement of enzyme activity and stability as well as for protection of the enzyme proteins against negative effects of harsh reaction conditions. As proper selection of support materials for immobilization and their performance is overlooked when it comes to comparing performance of immobilized enzyme in academic studies, this review summarizes the current state of knowledge regarding the materials used for enzyme immobilization of these oxidoreductase enzymes for environmental applications. In the presented study, thorough physicochemical characteristics of the support materials was presented. Moreover, various types of reactions and notably operational modes of enzymatic processes for biodegradation of harmful pollutants are summarized, and future trends in use of immobilized oxidoreductases for environmental applications are discussed. Our goal is to provide an improved foundation on which new technological advancements can be made to achieve efficient enzyme-assisted bioremediation.
Directing filtration to narrow molecular weight distribution of oligodextran in an enzymatic membrane reactor

Oligodextrans with molecular weight (Mw) within the range of 5.0–8.0kDa have great commercial potential as precursors of iron-dextran for anemia treatment. Traditional oligodextran production consists of sucrose fermentation, acid hydrolysis and ethanol precipitation, which results in an uneven Mw product, hypersaline wastewater discharge and potential safety hazards. In this work, a novel enzymatic membrane reactor (EMR) system to produce oligodextran is proposed, whereby in-situ product recovery can be manipulated to control the Mw distribution of the resulting products. Results showed that the membrane material played an important role in the permeate flux and transmission of oligodextran. Among the tested membranes, a 20kDa polyethersulfone (PES) membrane was found to be optimal for building up the EMR, as it successfully controlled the oligodextran Mw within the desired range with a relatively narrow distribution and high productivity. Moreover, high transmembrane pressures (3 bars) and low stirring rates (160rpm) promoted yields beyond 50% in 120min. Higher permeate fluxes prevented further product hydrolysis and enhanced the yield. However, the resulting concentration polarization (CP) should be minimized to reduce accumulation of large oligodextran molecules on the membrane surface, which might diffuse through the membrane and thus broaden the Mw distribution of the products in the permeate. Both dextranase and dextran caused membrane irreversible fouling. The fouling caused by the enzymes not only favored the enzyme immobilization itself, but also contributed to narrow the membrane pore size distribution. As a result, a higher uniformity of oligodextran products compared with the pristine EMR was obtained, especially at the beginning of operation with EMR (which was improved by 22%). It was concluded that selecting the suitable membrane type and permeate flux, maximizing the shear rate, and narrowing the membrane pore size distribution were effective strategies to obtain high-quality oligodextran products by EMRs.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Chinese Academy of Sciences
Pages: 268-279
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Journal of Membrane Science
Volume: 555
ISSN (Print): 0376-7388
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
|------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|------------|---------------------|-----------------------|
Efficient ionic liquid-based platform for multi-enzymatic conversion of carbon dioxide to methanol

Low yields commonly obtained during enzymatic conversion of CO₂ to methanol are attributed to low CO₂ solubility in water. In this study, four selected ionic liquids with high CO₂ solubility were separately added to the multi-enzyme reaction mixture and the yields were compared to the pure aqueous system (control). In an aqueous 20% [CH][Glu] system, yield increased ca. 3.5-fold compared to the control (ca. 5-fold if NADH regeneration was incorporated). Molecular dynamics simulation revealed that CO₂ remains for longer in a productive conformation in the enzyme in the presence of [CH][Glu], which explains the marked increase of yield that was also confirmed by isothermal titration calorimetry – lower energy (ΔG) binding of CO₂ to FDH. The results suggest that the accessibility of CO₂ to the enzyme active site depends on the absence/presence and nature of the ionic liquid, and that the enzyme conformation determines CO₂ retention and hence final conversion.
Enzyme immobilization is an established method for the enhancement of enzyme stability and reusability, two factors that are of great importance for industrial biocatalytic applications. Immobilization can be achieved by different methods and on a variety of carrier materials, both organic and inorganic. Inorganic materials provide the advantage of high stability and long service life which, together with the prolonged service life of the immobilized enzyme, can benefit the process economy. However, enzyme immobilization and increased stability often come at the cost of decreased enzyme activity. The main challenges involved in the design of an efficient immobilized enzyme system is to obtain both retention of high enzyme activity, enhanced stability and reusability, which is a complicated task, given the many variables involved, and the large numbers of methods and materials available. Simultaneously, new carrier materials and morphologies are constantly being developed. An investigation of enzyme immobilization systems on inorganic materials, with special emphasis on inorganic membranes, has been conducted in order to evaluate the effects of the immobilization system on the enzyme properties upon immobilization, i.e., activity, stability and reusability. The material properties of the enzyme carriers (particles and membranes) and their effects on the success of immobilization are described here. Furthermore, the reuse of inorganic membranes as enzyme carriers has been investigated and the reported examples show high ability of regeneration. To the best of our knowledge, this is the first review on enzyme immobilization focusing on the three
fundamental aspects to consider when dealing with the topic: catalytic properties, enzyme leakage and reusability. Abbreviations: β-Gal: β-d-galactosidase; ADH: alcohol dehydrogenase; AFM: atomic force microscopy; APTES: 3-aminopropyltriethoxysilane; APTMS: 3-aminopropyltrimethoxysilane; BPA: bisphenol A; BSA: bovine serum albumin; CA: carbonic anhydrase; CALB: Candida antartica lipase B; CD: circular dichroism; CDI: carbonyldiimidazole; CLEA: cross-linked enzyme aggregates; CLSM: confocal laser scanning microscopy; CNT: carbon nanotube; CPG: controlled pore glass; CRL: Candida rugosa lipase; DMeDMOS: dimethyldimethoxysilane; DRIFT: diffuse reflectance Fourier transform infrared; E2: 17β-estradiol; EDC: N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide hydrochloride; EDS: electron dispersive spectroscopy; FDH: formate dehydrogenase; FESEM: field emission scanning microscopy; FT-IR: Fourier transform infrared spectroscopy; GA: glutaraldehyde; GCSZn: coal fly ashes glass-ceramic zinc sulfate; GOD: glucose oxidase; GPS: 3-(glycidyloxypropyl)trimethoxysilane; HDI: hexamethylene diisocyanate; IEP: isoelectric point; IPTES: (3-isocyanatopropyl)triethoxysilane; IR: infrared spectroscopy; LbL: layer-by-layer; MCP: metallic ceramic powder; MeTEOS: methyltriethoxysilane; MMZn: Mucor miehei lipase; MNP: magnetic nanoparticle; MPTMS: 3-mercaptopropyltrimethoxysilane; NH2: N-hydroxysuccinimidy; PAM: poly(allylamine hydrochloride); PEI: polyethyleneimine; PEG: polyethylene glycol; PES: polyether sulfone; PM-IRRAS: polarization modulation infrared reflection absorption spectroscopy; pNPA: para-nitrophenyl acetate; pNPP: para-nitrophenyl palmitate; PSS: polystyrene sulfonate; PTMS: phenyltrimethoxysilane; ROL: Rhizopus oryzae lipase; SCAD: Saccharomyces cerevisiae alcohol dehydrogenase; SDS: sodium dodecyl sulfate; SDS-2: sodium dodecyl sulfonate; SEM: scanning electron microscopy; TEM: transmission electron microscopy; TGA: thermogravimetric analysis; TLL: Thermomyces lanuginosa lipase; TTIP: titanium tetraisoproxide; TVL: Trametes versicolor laccase; UF: ultrafiltration; VTMS: vinyltrimethylsilane

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Department of Energy Conversion and Storage, Ceramic Engineering & Science, Electrofunctional materials
Contributors: Sigurdardóttir, S. B., Lehmann, J., Ovtar, S., Grivel, J., Della Negra, M., Kaiser, A., Pinelo, M.
Pages: 2578-2607
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Advanced Synthesis and Catalysis
Volume: 360
Issue number: 14
ISSN (Print): 1615-4150
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 5.01 SJR 2.079 SNIP 0.935
Web of Science (2017): Impact factor 5.123
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 5.36 SJR 2.416 SNIP 0.948
Web of Science (2016): Impact factor 5.646
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 6.07 SJR 2.59 SNIP 1.102
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 5.4 SJR 2.339 SNIP 1.106
Web of Science (2014): Impact factor 5.663
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 5.56 SJR 2.659 SNIP 1.106
Web of Science (2013): Impact factor 5.542
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 5.33 SJR 2.796 SNIP 1.146
Web of Science (2012): Impact factor 5.535
Immobilization of alcohol dehydrogenase on ceramic silicon carbide membranes for enzymatic CH₃ OH production

BACKGROUND Alcohol dehydrogenase (ADH; EC 1.1.1.1) catalyzes oxidation of CH₃OH to CHOH during NAD⁺ reduction to NADH. ADH can also accelerate the reverse reaction, which is studied as part of cascading enzymatic conversion of CO₂ to CH₃OH. In the present study, immobilization of ADH onto macroporous membranes of silicon carbide (SiC) was investigated for CHOH to CH₃OH conversion.

RESULTS Immobilization techniques included physical adsorption directly to the membrane and functionalization of the membrane with polyethylenimine (PEI) or (3-aminopropyl)triethoxysilane (APTES) followed by glutaraldehyde (GA) cross-linking. Enzyme loadings, flux, NADH conversion, and overall ADH reusability were assessed. Enzyme loadings were similar, but substrate conversion was approximately 2 and 2.5 times higher for APTES-GA and PEI-GA, respectively, and the relative activity retention was better than for physical adsorption. Membrane surface treatment with NaOH prior to APTES-GA immobilization resulted in significant improvement in enzyme loading and a doubling of ADH activity as well as higher activity during recycling as the ADH destabilization rate was unaffected.

CONCLUSIONS The results provided proof-of-concept for the use of NaOH-treated SiC membranes for covalent enzyme immobilization and biocatalytic efficiency improvement of ADH during multiple reaction cycles. These data have implications for the development of robust extended enzymatic reactions.
Ionic Liquids as Bifunctional Cosolvents Enhanced CO₂ Conversion Catalysed by NADH-Dependent Formate Dehydrogenase

Efficient CO₂ conversion by formate dehydrogenase is limited by the low CO₂ concentrations that can be reached in traditional buffers. The use of ionic liquids was proposed as a manner to increase CO₂ concentration in the reaction system. It has been found, however, that the required cofactor (NADH) heavily degraded during the enzymatic reaction and that acidity was the main reason. Acidity, indeed, resulted in reduction of the conversion of CO₂ into formic acid and contributed to overestimate the amount of formic acid produced when the progression of the reaction was followed by a decrease in NADH absorbance (method N). Stability of NADH and the mechanism of NADH degradation was investigated by UV, NMR and by DFT calculations. It was found that by selecting neutral–basic ionic liquids and by adjusting the concentration of the ionic liquid in the buffer, the concentration of NADH can be maintained in the reaction system with little loss. Conversion of CO₂ to methanol in BmimBF₄ (67.1%) was more than twice as compared with the conversion attained by the enzymatic reaction in phosphate buffer (24.3%).

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, CERE – Center for Energy Resources Engineering, Chinese Academy of Sciences
Number of pages: 13
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Catalysts
Volume: 8
Issue number: 8
Article number: 304
ISSN (Print): 2073-4344
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.23 SJR 0.855 SNIP 0.954
Web of Science (2017): Impact factor 3.465
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.44 SJR 0.928 SNIP 1.212
Web of Science (2016): Impact factor 3.082
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.45 SJR 1.054 SNIP 1.202
Web of Science (2015): Impact factor 2.964
Web of Science (2015): Indexed yes
Lignin from hydrothermally pretreated grass biomass retards enzymatic cellulose degradation by acting as a physical barrier rather than by inducing nonproductive adsorption of enzymes

Lignin is known to hinder efficient enzymatic conversion of lignocellulose in biorefining processes. In particular, nonproductive adsorption of cellulases onto lignin is considered a key mechanism to explain how lignin retards enzymatic cellulose conversion in extended reactions. Lignin-rich residues (LRRs) were prepared via extensive enzymatic cellulose degradation of corn stover (Zea mays subsp. mays L.), Miscanthus × giganteus stalks (MS) and wheat straw (Triticum aestivum L.) (WS) samples that each had been hydrothermally pretreated at three severity factors (log $R_0$) of 3.65, 3.83 and 3.97. The LRRs had different residual carbohydrate levels—the highest in MS; the lowest in WS. The residual carbohydrate was not traceable at the surface of the LRRs particles by ATR-FTIR analysis. The chemical properties of the lignin in the LRRs varied across the three types of biomass, but monolignols composition was not affected by the severity factor. When pure cellulose was added to a mixture of LRRs and a commercial cellulolytic enzyme preparation, the rate and extent of glucose release were unaffected by the presence of LRRs regardless of biomass type and severity factor, despite adsorption of the enzymes to the LRRs. Since the surface of the LRRs particles were covered by lignin, the data suggest that the retardation of enzymatic cellulose degradation during extended reaction on lignocellulosic substrates is due to physical blockage of the access of enzymes to the cellulose caused by the gradual accumulation of lignin at the surface of the biomass particles rather than by nonproductive enzyme adsorption. The study suggests that lignin from hydrothermally pretreated grass biomass retards enzymatic cellulose degradation by acting as a physical barrier blocking the access of enzymes to cellulose rather than by inducing retardation through nonproductive adsorption of enzymes.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Aarhus University, University of Copenhagen, Technical University of Denmark
Number of pages: 13
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Biotechnology for Biofuels
Volume: 11
Article number: 85
ISSN (Print): 1754-6834
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 5.93 SJR 1.899 SNIP 1.587
Web of Science (2017): Impact factor 5.497
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.89 SJR 2.119 SNIP 1.737
Membrane separation of enzyme-converted biomass compounds: Recovery of xylose and production of gluconic acid as a value-added product

The purpose of the present study was to assess the efficiency of enzyme-assisted nanofiltration for separation of xylose from glucose present in genuine biorefinery liquors obtained from hydrothermal pretreatment of wheat straw, corn stover and Miscanthus stalks. Glucose oxidase and catalase were used to convert the glucose contained in the liquors into gluconic acid, so xylose could be more easily recovered in the subsequent nanofiltration. Subjecting the biomass liquors to dilute acid treatment and centrifugation before the enzymatic reaction and filtration led to maximum biocatalytic performance of the membrane bioreactor (neglectable fouling and no enzyme activity loss) during five consecutive reaction-filtration cycles. The best separation factor of gluconic acid over xylose in the subsequent nanofiltration was 2.7, 2.5 and 2.2 for wheat straw, corn stover and Miscanthus stalks, respectively. All represented a significant improvement
compared to the benchmark separation of xylose and glucose, in which case the separation factor was only 1.4. However, the higher ionic strength of the biomass liquors compared to the pure model solution probably led to a less negative zeta potential of the nanofiltration membrane, which significantly reduced the xylose purification performance as compared to the model system, for which the separation factor was 34.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Pages: 73-80
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Separation and Purification Technology
Volume: 194
ISSN (Print): 1383-5866
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.25 SJR 1.093 SNIP 1.475
Web of Science (2017): Impact factor 3.927
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.024 SNIP 1.4
Web of Science (2016): Impact factor 3.359
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.75 SJR 1.07 SNIP 1.499
Web of Science (2015): Impact factor 3.299
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.5 SJR 1.261 SNIP 1.532
Web of Science (2014): Impact factor 3.091
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.62 SJR 1.327 SNIP 1.674
Web of Science (2013): Impact factor 3.065
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.2 SJR 1.394 SNIP 1.718
Web of Science (2012): Impact factor 2.894
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.48 SJR 1.352 SNIP 1.633
Web of Science (2011): Impact factor 2.921
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.386 SNIP 1.58
Web of Science (2010): Impact factor 2.775
BFI (2009): BFI-level 2
Simple preparation of thiol-ene particles in glycerol and surface functionalization by thiol-ene chemistry (TEC) and surface chain transfer free radical polymerization (SCT-FRP)

Thiol-ene (TE) based polymer particles have traditionally been prepared via emulsion polymerization in water (using surfactants, stabilizers and co-solvents). Here, we present a green and simple alternative with excellent control over particle size, while avoiding the addition of stabilizers. Glycerol is applied as a dispersing medium for the preparation of offstoichiometric TE (OSTE) microparticles, where sizes in the range of 40 to 400 µm are obtained solely by changing the mixing speed of the emulsions prior to cross-linking. Control over surface chemistry is achieved by surface functionalization of excess thiol groups via photochemical thiol-ene chemistry (TEC) resulting in a functional monolayer. In addition, surface chain transfer free radical polymerization (SCT-FRP) was used for the first time to introduce a thicker polymer layer on the particle surface. The application potential of the system is demonstrated by using functional particles as a support for immobilized enzymes in a continuous plug-flow reactor.

General information

State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Center for BioProcess Engineering, KT Consortium, PROSYS - Process and Systems Engineering Centre
Number of pages: 28
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Macromolecular Rapid Communications
Volume: 39
Issue number: 2
Article number: 1700394
ISSN (Print): 1022-1336
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 4.08 SJR 1.452 SNIP 0.94
Web of Science (2017): Impact factor 4.441
Surface modification of polysulfone membranes applied for a membrane reactor with immobilized alcohol dehydrogenase

Commercially available polysulfone (PSf) membranes with a polypropylene backing are used across a broad range of applications. However, the natural properties of the PSf surface sometimes limit their application. Here we present, how the surface of supported membranes can be heterogeneously activated by lithiation followed by functionalization with acid
chlorides at 0°C, permitting modification of commercial PSf membranes without compromising the mechanical integrity of the membrane. Post-functionalization polymer grafting was illustrated through both, a “grafting from” approach by surface initiated atom transfer radical polymerization (SI-ATRP) and by a “grafting to” approach exploiting Cu(i) catalyzed 1,3-cycloadditions of alkynes with azides (CuAAC) introducing hydrophilic polymers onto the membrane surface. Poly(1-vinyl imidazole) (pVim) grafted membranes were exploited as support for immobilization of alcohol dehydrogenase (ADH) in a biocatalytic membrane reactor (BMR) and demonstrated substantial improvements in terms of operational enzyme stability compared to immobilization onto pristine membranes.

### General information

State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, Center for BioProcess Engineering, KT Consortium, PROSYS - Process and Systems Engineering Centre
Pages: 160-168
Publication date: 2018
Peer-reviewed: Yes

### Publication information

Journal: Materials Today Communications
Volume: 14
ISSN (Print): 2352-4928
Ratings:
- Web of Science (2019): Indexed yes
- Web of Science (2018): Indexed yes
- Scopus rating (2017): CiteScore 1.86 SJR 0.512 SNIP 0.726
- Web of Science (2017): Indexed yes
- Scopus rating (2016): CiteScore 1.38 SJR 0.4 SNIP 0.749
- Scopus rating (2015): CiteScore 0.8 SJR 0.137 SNIP 0.14
Original language: English
Keywords: Materials Science (all), Mechanics of Materials, Materials Chemistry, Enzyme immobilization, Polysulfone membrane, Surface functionalization
DOIs:
- 10.1016/j.mtcomm.2017.12.019
Source: FindIt
Source-ID: 2398096507
Research output: Research - peer-review > Journal article – Annual report year: 2018

### Sustainable downstream routes for bio-manufacturing processes

Biorefinery is a promising concept that can contribute overcoming the petrol-era, especially with respect to sustainable fine chemical production, addressing at the same time several problems: the depletion of petroleum resources (with the associated consequences), human sustainability, waste management and political concerns 1,2. Production and separation of valuable products from biomass have indeed been successfully achieved and implemented at full scale3. However, the lack of cost-effective downstream processes is largely preventing biorefinery products to become economically competitive, and membranes are one of the fundamental technologies for separation of fermentation products such as succinic acid4 (SA). Therefore, key factors such as pH, pressure, steric effect etc. in downstream processes must be identified for a technological breakthrough. Data collection about different feedstocks, fermentation and downstream techniques for bio-SA production will highlight the most relevant for large-scale application. These, will be then study trough a techno-economical analysis, which will be focused on membrane separation techniques. Thus, a computer-aided framework will be used to assess and rank the critical parameters in downstream technologies, which will be subsequently tested trough an experimental validation of bio-SA production. The interest for bio-SA production have been constantly increasing3,5, since more than 30 commercially valuable products can be currently synthetized from it, including solvents and lubricants, synthetic resins and biodegradable polymers such as PBS and polyamides, cosmetics, food and pharmaceuticals 3,5. Finally, a defined and interactive operation range for each studied variable is intended to be provided, which can be virtually extrapolated to other similar separation processes. The feasibility of potential alternatives will be evaluated experimentally on other similar processes.

1
Systematic Decision-Support Methodology for Resource Recovery

The promise of recovering valuable resources from waste and process streams of bio-based production processes makes resource recovery one of the pillar technologies in achieving circular economy. From a decision-making point of view, there are large numbers of technologies that can be potentially employed in the recovery of target resources in a given waste stream, while this decision is further complicated due to the large variation in chemical, physical and biological properties of waste streams that can be encountered. This decision-making process is further complicated by the multi-faceted optimisation and constraints such as technology readiness, process economics and life cycle analysis that can act as roadblocks in achieving a successful implementation.

Process systems engineering (PSE) is one promising domain of research that can systematically and efficiently handle these types of large-scale problems. To this end, this presentation will focus on the role of process synthesis can play in efficiently defining and ordering the search space for this type of a large combinatorial problem and introduce a hierarchical, gated multi-disciplinary framework that can be employed to systematically assess the interplay between Technology readiness level, Economics and Environmental sustainability.

The application of the framework is demonstrated through resource recovery examples from bio-based production processes.

Upgrading of biomass monosaccharides by immobilized glucose dehydrogenase and xylose dehydrogenase

Direct upgrading and separation of the monosaccharides from biomass liquors is an overlooked area. In this work we demonstrate enzymatic production of gluconic acid and xylonic acid from glucose and xylose present in pretreated birchwood liquor by glucose dehydrogenase (GDH, EC 1.1.1.118) and xylose dehydrogenase (XDH, EC 1.1.1.175), respectively. The biocatalytic conversions were compared using two different kinds of silica support materials (silica nanoparticles (nanoSiO2) and porous silica particles with hexagonal pores (SBA silica) for enzyme immobilization. Upon immobilization, both enzymes showed significant improvement in their thermal stability and robustness at alkaline pH and exhibited over 50% activity even at pH 10 and 60°C on both immobilization matrices. When compared to free enzymes at 45°C, GDH immobilized on nanoSiO2 and SBA silica displayed a 4.5 and 7.25 fold increase in half-life, respectively, whilst XDH immobilized on nanoSiO2 and SBA showed a 4.7 and 9.5 fold improvement in half-life, respectively. Additionally, after five reaction cycles both nanoSiO2GDH and nanoSiO2XDH retained more than 40% activity and GDH and XDH immobilized on SBA silica maintained around 50% of their initial activity resulting in about 1.5-1.6 fold increase in biocatalytic productivity compared to the free enzymes.
Advanced fabrication of porous ceramic multilayers for membrane applications

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Ceramic Engineering & Science, Proton conductors, Department of Biotechnology and Biomedicine, Department of Chemical and Biochemical Engineering
Development of a thiol-ene based screening platform for enzyme immobilization demonstrated using horseradish peroxidase

Efficient immobilization of enzymes on support surfaces requires an exact match between the surface chemistry and the specific enzyme. A successful match would normally be identified through time consuming screening of conventional resins in multiple experiments testing individual immobilization strategies. In this study we present a versatile strategy that largely expands the number of possible surface functionalities for enzyme immobilization in a single, generic platform. The combination of many individual surface chemistries and thus immobilization methods in one modular system permits faster and more efficient screening, which we believe will result in a higher chance of discovery of optimal surface/enzyme interactions. The proposed system consists of a thiol-functional microplate prepared through fast photochemical curing of an off-stoichiometric thiol-ene (OSTE) mixture. Surface functionalization by thiol-ene chemistry (TEC) resulted in the formation of a functional monolayer in each well, whereas, polymer surface grafts were introduced through surface chain transfer free radical polymerization (SCT-FRP). Enzyme immobilization on the modified surfaces was evaluated by using a rhodamine labeled horseradish peroxidase (Rho-HRP) as a model enzyme, and the amount of immobilized enzyme was qualitatively assessed by fluorescence intensity (FI) measurements. Subsequently, Rho-HRP activity was measured directly on the surface. The broad range of utilized surface chemistries permits direct correlation of enzymatic activity to the surface functionality and improves the determination of promising enzyme-surface candidates. The results underline the high potential of this system as a screening platform for synergistic immobilization of enzymes onto thiol-ene polymer surfaces. This article is protected by copyright. All rights reserved.
Enzymatic conversion of CO2 to CH3OH via reverse dehydrogenase cascade biocatalysis: Quantitative comparison of efficiencies of immobilized enzyme systems

A designed biocatalytic cascade system based on reverse enzymatic catalysis by formate dehydrogenase (EC 1.2.1.2), formaldehyde dehydrogenase (EC 1.2.1.46), and alcohol dehydrogenase (EC 1.1.1.1) can convert carbon dioxide (CO2) to methanol (CH3OH) via formation of fomic acid (CHOOH) and formaldehyde (CHOH) during equimolar cofactor oxidation of NADH to NAD+. This reaction is appealing because it represents a double gain: (1) reduction of CO2 and (2) an alternative to fossil fuel based production of CH3OH. The present review evaluates the efficiency of different immobilized enzyme systems and reaction designs that have been explored for optimizing this sequential enzymatic conversion of CO2 to CH3OH, including multilayer microcapsules, bead scaffolds, cationic nanofibers, and membrane systems. The recent progress within efficient cofactor regeneration, protein engineering of the enzymes for robustness, and advanced uses of membrane systems for enzyme reuse and product separation are assessed for large scale implementation of this biocatalytic reaction cascade. Industrial realization of enzymatic CO2 to CH3OH conversion including the option for reaping of formaldehyde and formate during the reaction warrants innovative development. There is a particular need for development of i) better enzymes; ii) improved understanding of enzyme structure function aspects of reverse catalysis by dehydrogenases, iii) quantitative kinetic models of the enzymatic cascade reaction during simultaneous cofactor regeneration, iv) robust systems for regeneration of reducing equivalents.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Marpani, F. B., Pinelo, M., Meyer, A. S.
Pages: 217-228
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Biochemical Engineering Journal
Volume: 127
ISSN (Print): 1369-703X
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.18
Web of Science (2017): Impact factor 6.735
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.16
Web of Science (2016): Impact factor 6.216
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.75
Web of Science (2015): Impact factor 5.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.72
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.03
Web of Science (2013): Impact factor 4.058
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.15
Web of Science (2012): Impact factor 3.473
ISI indexed (2012): ISI indexed yes
Enzyme recycling in lignocellulosic biorefineries

Commercial production of ethanol from lignocellulosic biomass is becoming a reality, but the next step is to diversify the process and produce chemicals and materials. These lignocellulosic biorefineries will in many cases rely on hydrolysis of biomass carbohydrates into monosaccharides – the sugar platform. Cellulases are the most important enzymes required in this process, but the complex nature of lignocellulose requires several other enzymes (hemicellulases and auxiliary enzymes) for efficient hydrolysis. Enzyme recycling increases the catalytic productivity of the enzymes by reusing them for several batches of hydrolysis, and thereby reduces the overall cost associated with the hydrolysis. Research on this subject has been ongoing for many years and several promising technologies and methods have been developed and demonstrated. But only in a very few cases have these technologies been upscaled and tested in industrial settings, mainly because of many difficulties with recycling of enzymes from the complex lignocellulose hydrolyzate at industrially relevant conditions, i.e., high solids loadings. The challenges are associated with the large number of different enzymes required for efficient hydrolysis, enzyme stability, and the detrimental interaction between enzyme and lignin. This review provides a comprehensive overview of the various methods for enzyme recovery and recycling, for example recycling of free enzymes, readsorption to fresh material, recycling of solids, membrane filtration, and immobilization. Lignin is a major obstacle for successful hydrolysis and enzyme recycling. A thorough understanding of this subject and possibilities to minimize adsorption or methods to desorb the enzymes are important in order to develop the technology.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Jørgensen, H., Pinelo, M.
Pages: 150-167
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Biofuels, Bioproducts and Biorefining
Volume: 11
ISSN (Print): 1932-104X
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 2.67 SJR 1.156 SNIP 1.28
Experimental and computational evaluation of area selectively immobilized horseradish peroxidase in a microfluidic device

A microreactor with a square shaped reactor chamber was developed with the aim to correlate enzyme positioning with biocatalytic activity. The enzyme position as an important parameter to improve the contribution of the individual enzymes towards the overall reactor efficacy was therefore evaluated experimentally and by computational fluid dynamics (CFD) simulations. Ultimately, such a correlation would lead to faster development through computational pre-screening and optimized experimental design. In this proof-of-concept study, microreactors were prepared in a 2-step curing process of an off-stoichiometric thiol-ene-epoxy (OSTE+) mixture employing both a thiol-ene (TEC) and a thiol-epoxy curing reaction. Subsequent surface functionalization of the remaining thiol groups on the reactor surface through stenciled photoinitiated TEC enabled the preparation of specific surface patterns in the reactor. Patterns were visualized using an allyl-functional disperse red dye, illustrating the successful preparation of a fully reacted surface, a half covered surface and 2 checkerboard patterns. Similarly, allyl glycidyl ether was exploited to functionalize the microreactor surface with epoxide groups, which were used for covalent immobilization of horseradish peroxidase (HRP) in the same patterns. Biocatalytic activity measurements confirmed a clear dependency of the overall reactor performance depending on the spatial distribution of the immobilized enzymes, where specifically the two checkerboard motifs were identified as being particularly effective compared to enzymes covering homogeneously the entire reactor surface. The performance of the same configurations was additionally determined by 3-dimensional CFD simulations. The computational model predicted the same tendencies for the overall reactor performance as obtained from experimental determination. This good agreement between the obtained experimental and computational results confirmed the high potential of CFD models for
predicting and optimizing the biocatalytic performance of such a reactor.

**General information**

State: Published
Organisations: Department of Chemical and Biochemical Engineering, The Danish Polymer Centre, CAPEC-PROCESS, CHEC Research Centre, KT Consortium, Center for BioProcess Engineering
Pages: 16-23
Publication date: 2017
Peer-reviewed: Yes

**Publication information**

Journal: Chemical Engineering Journal
Volume: 332
ISSN (Print): 1385-8947
Ratings:
- BFI (2019): BFI-level 2
- Web of Science (2019): Indexed yes
- BFI (2018): BFI-level 2
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 2
- Scopus rating (2017): CiteScore 7.01
- Web of Science (2017): Impact factor 6.735
- Web of Science (2017): Indexed yes
- BFI (2016): BFI-level 2
- Scopus rating (2016): CiteScore 6.34
- Web of Science (2016): Impact factor 6.216
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): CiteScore 5.68
- Web of Science (2015): Impact factor 5.31
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): CiteScore 4.92
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 1
- Scopus rating (2013): CiteScore 4.59
- Web of Science (2013): Impact factor 4.058
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 1
- Scopus rating (2012): CiteScore 3.92
- Web of Science (2012): Impact factor 3.473
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 1
- Scopus rating (2011): CiteScore 3.96
- Web of Science (2011): Impact factor 3.461
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 1
- Web of Science (2010): Impact factor 3.074
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 1
High-performance removal of acids and furans from wheat straw pretreatment liquid by diananofiltration

Two model solutions and a real stream from the hydrothermal pretreatment of wheat straw were subjected to nanofiltration, and permeate flux, retention and resistance to fouling were evaluated. Three commercial NF membranes were tested, and a pressure of 4 bars (range: 1–20 bars) and a temperature of 20°C (range: 20–50°C) were found to provide the best results in terms of retention. A subsequent nanodiafiltration consisting of five cycles enabled one to recover 90% of the monosaccharides (purity >99%). This result showed that diananofiltration could be a promising strategy for the recovery of high-purity streams of monosaccharides from pretreatment liquids.
In order to maximize enzymatic xylan depolymerization while simultaneously purifying the resulting monosaccharide (xylose), different ultrafiltration (UF) membrane reactor configurations were evaluated. Initial results showed that the two hydrolytic enzymes required for complete depolymerization of xylan, endo-1,4-β-xylanase and β-xylosidase, promoted different types of fouling, which had a direct impact on the extent of xylan hydrolysis achieved during reaction. Endo-1,4-β-xylanase generated DP 1-6 xylo-oligomers. These products contributed to partial pore blocking of the 1 kDa polysulfone membrane and caused irreversible flux loss (~20%). The presence of β-xylosidase could not prevent deposition of xylan and xylooligosaccharide deposition formed a cake layer on the membrane which hindered enzymatic attack in addition to fouling. Reaction with both enzymes followed by UF was found to be the optimal configuration, providing at least 40% higher xylan hydrolysis than the cascade configuration (involving sequential reaction with each of the enzymes separately) and the simultaneous reaction-filtration with both enzymes, respectively. This study thus confirmed that the reactor configuration has a crucial impact on the performance of both the reaction and the separation process of xylose during enzymatic xylan degradation, and that the type of fouling mechanism varies in response to the type of enzyme treatment.
Kinetics based reaction optimization of enzyme catalysed reduction of formaldehyde to methanol with synchronous cofactor regeneration

Enzymatic reduction of carbon dioxide (CO\textsubscript{2}) to methanol (CH\textsubscript{3}OH) can be accomplished using a designed set-up of three oxidoreductases utilizing reduced pyridine nucleotide (NADH) as cofactor for the reducing equivalents electron supply. For this enzyme system to function efficiently a balanced regeneration of the reducing equivalents during reaction is required. Herein, we report the optimization of the enzymatic conversion of formaldehyde (CHOH) to CH\textsubscript{3}OH by alcohol dehydrogenase, the final step of the enzymatic redox reaction of CO\textsubscript{2} to CH\textsubscript{3}OH, with kinetically synchronous enzymatic cofactor regeneration using either glucose dehydrogenase (System I) or xylose dehydrogenase (System II). A mathematical model of the enzyme kinetics was employed to identify the best reaction set-up for attaining optimal cofactor recycling rate and enzyme utilization efficiency. Targeted process optimization experiments were conducted to verify the kinetically modelled results. Repetitive reaction cycles were shown to enhance the yield of CH\textsubscript{3}OH, increase the total turnover number (TTN) and the biocatalytic productivity rate (BPR) value for both system I and II whilst minimizing the exposure of the enzymes to high concentrations of CHOH. System II was found to be superior to System I with a yield of 8 mM CH\textsubscript{3}OH, a TTN of 160 and BPR of 24 μmol CH\textsubscript{3}OH/U·h during 6 hours of reaction. The study demonstrates that an optimal reaction set-up could be designed from rational kinetics modelling to maximize the yield of CH\textsubscript{3}OH, whilst simultaneously optimizing cofactor recycling and enzyme utilization efficiency. This article is protected by copyright. All rights reserved.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, CHEC Research Centre
Contributors: Marpani, F. B., Sárossy, Z., Pinelo, M., Meyer, A. S.
Pages: 2762-2770
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Biotechnology and Bioengineering
Volume: 114
Issue number: 12
ISSN (Print): 0006-3592
Ratings:
- BFI (2019): BFI-level 1
- Web of Science (2019): Indexed yes
- BFI (2018): BFI-level 1
- Web of Science (2018): Indexed yes
- BFI (2017): BFI-level 1
Separation of xylose and glucose using an integrated membrane system for enzymatic cofactor regeneration and downstream purification

Mixtures of xylose, glucose and pyruvate were fed to a membrane bioreactor equipped with a charged NF membrane (NTR 7450). Value-added products were obtained in the reactor via enzymatic cofactor-dependent catalysis of glucose to gluconic acid and pyruvate to lactic acid, respectively. The initial cofactor (NADH) concentration could be decreased to 10% of the stoichiometric value (relative to glucose) without compromising process time and substrate conversion via i) efficient cofactor regeneration and ii) high retention of cofactor (R=0.98) in the membrane bioreactor. Furthermore, accumulation of xylose (R

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Pages: 327-335
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Journal of Membrane Science
Volume: 523
ISSN (Print): 0376-7388
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.93 SJR 2.4 SNIP 1.898
Web of Science (2017): Impact factor 6.578
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.13 SJR 2.087 SNIP 1.731
Web of Science (2016): Impact factor 6.035
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.89 SJR 1.978 SNIP 1.763
Web of Science (2015): Impact factor 5.557
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.42 SJR 2.436 SNIP 1.924
Web of Science (2014): Impact factor 5.056
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.38 SJR 2.451 SNIP 1.994
Significance of membrane bioreactor design on the biocatalytic performance of glucose oxidase and catalase: Free vs. immobilized enzyme systems

Membrane separation of xylose and glucose can be accomplished via oxidation of glucose to gluconic acid by enzymatic glucose oxidase catalysis. Oxygen for this reaction can be supplied via decomposition of hydrogen peroxide by enzymatic catalase catalysis. In order to maximize the biocatalytic productivity of glucose oxidase and catalase (gluconic acid yield per total amount of enzyme) the following system set-ups were compared: immobilization of glucose oxidase alone; co-immobilization of glucose oxidase and catalase; glucose oxidase and catalase free in the membrane bioreactor. Fouling-induced enzyme immobilization in the porous support of an ultrafiltration membrane was used as strategy for entrapment of glucose oxidase and catalase. The biocatalytic productivity of the membrane reactor was found to be highly related to the oxygen availability, which in turn depended on the reactor configuration, hydrogen peroxide concentration and catalase origin. When glucose oxidase and catalase (from Aspergillus niger) were free in the membrane bioreactor a total biocatalytic productivity of 122 mg gluconic acid/mg enzyme was obtained after five consecutive reaction cycles. The free...
enzymes showed superior performance compared to the immobilized systems as a result of limited substrate and product diffusion in the latter case.

**General information**
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Morthensen, S. T., Meyer, A. S., Jørgensen, H., Pinelo, M.
Pages: 41-47
Publication date: 2017
Peer-reviewed: Yes

**Publication information**
Journal: Biochemical Engineering Journal
Volume: 117
ISSN (Print): 1369-703x
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.18
Web of Science (2017): Impact factor 6.735
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.16
Web of Science (2016): Impact factor 6.216
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.75
Web of Science (2015): Impact factor 5.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.72
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.03
Web of Science (2013): Impact factor 4.058
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.15
Web of Science (2012): Impact factor 3.473
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.95
Web of Science (2011): Impact factor 3.461
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Impact factor 3.074
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
Surface properties correlate to the digestibility of hydrothermally pretreated lignocellulosic Poaceae biomass feedstocks

Background: Understanding factors that govern lignocellulosic biomass recalcitrance is a prerequisite for designing efficient 2nd generation biorefining processes. However, the reasons and mechanisms responsible for quantitative differences in enzymatic digestibility of various biomass feedstocks in response to hydrothermal pretreatment at different severities are still not sufficiently understood.

Results: Potentially important lignocellulosic feedstocks for biorefining, corn stover (Zea mays subsp. mays L.), stalks of Miscanthus × giganteus and wheat straw (Triticum aestivum L.) were systematically hydrothermally pretreated; each at three different severities of 3.65, 3.83, and 3.97, respectively, and the enzymatic digestibility was assessed. Pretreated samples of Miscanthus × giganteus stalks were the least digestible among the biomass feedstocks producing ~24 to 66.6% lower glucose yields than the other feedstocks depending on pretreatment severity and enzymedosage. Bulk biomass composition analyses, 2D nuclear magnetic resonance, and comprehensive microarray polymer profiling were not able to explain the observed differences in recalcitrance among the pretreated feedstocks. However, methods characterizing physical and chemical features of the biomass surfaces, specifically contact angle measurements (wettability) and attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy (surfacebiopolymer composition) produced data correlating pretreatment severity and enzymatic digestibility, and they also revealed differences that correlated to enzymatic glucose yield responses among the three different biomass types.

Conclusion: The study revealed that to a large extent, factors related to physico-chemical surface properties, namely surface wettability as assessed by contact angle measurements and surface content of hemicellulose, lignin, and waxas assessed by ATR-FTIR rather than bulk biomass chemical composition correlated to the recalcitrance of the testedbiomass types. The data provide new insight into how hydrothermal pretreatment severity affects surface properties of key Poaceae lignocellulosic biomass and may help design new approaches to overcome biomass recalcitrance.
Cascade catalysis in membranes with enzyme immobilization for multienzymatic conversion of CO₂ to methanol

Facile co-immobilization of enzymes is highly desirable for bioconversion methods involving multienzymatic cascade reactions. Here we show for the first time that three enzymes can be immobilized in flat-sheet polymeric membranes simultaneously or separately by simple pressure-driven filtration (i.e. by directing membrane fouling formation), without any addition of organic solvent. Such coimmobilization and sequential immobilization systems were examined for the production of methanol from CO₂ with formate dehydrogenase (FDH), formaldehyde dehydrogenase (FaldDH) and alcohol dehydrogenase (ADH). Enzyme activity was fully retained by this non-covalent immobilization strategy. The two immobilization systems had similar catalytic efficiencies because the second reaction (formic acid → formaldehyde) catalyzed by FaldDH was found to be the cascade bottleneck (a threshold substrate concentration was required).
Moreover, the trade-off between the mitigation of product inhibition and low substrate concentration for the adjacent enzymes probably made the coimmobilization meaningless. Thus, sequential immobilization could be used for multi-enzymatic cascade reactions, as it allowed the operational conditions for each single step to be optimized, not only during the enzyme immobilization but also during the reaction process, and the pressure-driven mass transfer (flow-through mode) could overcome the diffusion resistance between enzymes. This study not only offers a green and facile immobilization method for multi-enzymatic cascade systems, but also reveals the reaction bottleneck and provides possible solutions for the bioconversion of CO2 to methanol.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Center for Electron Nanoscopy
Contributors: Luo, J., Meyer, A. S., Mateiu, R. V., Pinelo, M.
Pages: 319-327
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: New Biotechnology
Volume: 32
Issue number: 3
ISSN (Print): 1871-6784
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.66 SJR 0.967 SNIP 1.14
Web of Science (2017): Impact factor 3.733
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.67 SJR 1.08 SNIP 1.262
Web of Science (2016): Impact factor 3.813
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.07 SJR 1.073 SNIP 1.055
Web of Science (2015): Impact factor 3.199
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.77 SJR 0.994 SNIP 1.237
Web of Science (2014): Impact factor 2.898
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.5 SJR 0.822 SNIP 0.966
Web of Science (2013): Impact factor 2.106
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.12 SJR 0.784 SNIP 0.85
Web of Science (2012): Impact factor 1.706
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.13 SJR 0.947 SNIP 0.955
Web of Science (2011): Impact factor 2.756
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Fractionation and enzymatic processing of biomass for biorefinery applications

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Tristan Djajadi, D., Meyer, A., Pinelo, M., Jørgensen, H.
Number of pages: 1
Publication date: 2015

Host publication information
Title of host publication: Book of Abstracts. DTU's Sustain Conference 2015
Place of publication: Lyngby
Publisher: Technical University of Denmark (DTU)
Article number: R-17
Electronic versions:
R17_DTU_Sustain_2015.pdf

Bibliographical note
Poster presentation
Research output: Research - peer-review › Conference abstract in proceedings – Annual report year: 2015

In Situ Formation of a Bilocatalytic Alginate Membrane by Enhanced Concentration Polarization
A thin alginate layer induced on the surface of a commercial polysulfone membrane was used as a matrix for noncovalent immobilization of enzymes. Despite the expected decrease of flux across the membrane resulting from the coating, the initial hypothesis was that such a system should allow high immobilized enzyme loadings, which would benefit from the decreased flux in terms of increased enzyme/substrate contact time. The study was performed in a sequential fashion: first, the most suitable types of alginate able to induce a very thin, sustainable gel layer by pressure-driven membrane filtration were selected and evaluated. Then, an efficient method to make the gel layer adhere to the surface of the membrane was developed. Finally, and after confirming that the enzyme loading could remarkably be enhanced by using this method, several strategies to increase the permeate flux were evaluated. Alcohol dehydrogenase (EC 1.1.1.1), able to catalyze the conversion of formaldehyde into methanol, was selected as the model enzyme. An enzyme loading of 71.4% (44.8 μg/cm²) was attained under the optimal immobilization conditions, which resulted in a 40% conversion to methanol as compared to the control setup (without alginate) where only 10.8% (6.9 μg/cm²) enzyme was loaded, with less than 5% conversion. Such conversion increased to 60% when polyethylene glycol (PEG) was added during the construction of the gel layer, as a strategy to increase flux. No enzyme leakage was observed for both cases (with/without PEG addition). Modeling results showed that the dominant fouling mechanism during gel layer induction (involving enzyme entrapment) was cake layer formation in the initial and intermediate phases, while pore blocking was the dominant mechanism in the final phase. Such mechanisms had a direct consequence on the type of immobilization promoted in each phase. The results suggested that the strategy proposed could be efficiently used to enhance the enzyme loading on polymer membranes.
Production of prebiotic oligosaccharides by novel enzymatic catalysis

A group of prebiotic oligosaccharides known as human milk oligo-saccharides (HMOs) are currently receiving a lot of attention due to the prospect of their addition to infant formula. Whereas prebiotics in general are used as mediators for modulating the gut microbiome in human individuals, HMOs play an important role in development of this organ, where it contributes to the selective growth stimulation of the beneficial microorganism Bifidobacterium infantis. The effects of HMOs are not only prebiotic and a range of beneficial effects have been postulated, with varying amounts of scientific evidence backing them up.

Since chemical synthesis of carbohydrates is extremely cumbersome, it is generally accepted that HMOs must be produced biochemically and enzymatic in vitro production is a popular strategy. Thus, the purpose of this PhD project was to encompass as many of the aspects of the enzymatic production of HMOs as possible, and identify opportunities to improve the enzymes, reaction efficiencies and processes involved.

For enzymatic in vitro production of HMOs, industrial side stream products are often used as substrates to reduce the final product price. However, to use these substrates it is generally necessary to identify glycosyl hydrolases with trans-glycosidase activity or ideally rare trans-glycosidases. The BioEng group has previously developed a state of the art engineered trans-sialidase used for the synthesis of sialylated HMOs. Thus, synthesis of the simple genuine mono-sialylated HMO, 3’sialyllactose(3’S), received particular attention in this PhD project. The BioEng state of the art trans-sialidase was, during this PhD project, further mutated, raising the bar for competing enzymes. For further improvement of the current leading enzyme, it was concluded that new knowledge would be required and that such knowledge could be provided by identification of novel trans-sialidases, which have, however, only been identified in a single genus. Never the less, as part of this PhD project a novel trans-sialidase was identified which was capable of producing 3’S and a novel trans-sialylation product, 3SL, the properties of which are unknown.

With the goal to further improve 3’S production, the process strategy underwent scrutiny and weak points were identified and improved upon. At the start of the PhD project, 3’S was purified in a three step process including ultrafiltration, with subsequent column chromatography and removal of eluent. As part of this PhD project, an innovative nanofiltration approach eliminated the necessity for column chromatography and eluent removal. Furthermore, by moving the HMO enzymatic synthesis to a membrane reactor, an integrated membrane system strategy was constructed and proof of concept was demonstrated.

From the beginning of the PhD project, it was known that future endeavors would include the synthesis of larger HMO structures, for which enzymes and substrates for HMO backbone synthesis would be required. Progress in this aspect of HMO production was also achieved during this PhD project, as two novel β-N-acetylhexosaminidases were identified through screening of metagenomic libraries. Both enzymes were successfully used to produce HMO backbone precursors, which have previously been used for HMO backbone synthesis.

General information

State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Nordvang, R. T., Mikkelsen, J. D., Pinelo, M., Jers, C.
Number of pages: 141
Publication date: 2015

Publication information

Publisher: Technical University of Denmark, Department of Chemical and Biochemical Engineering
Original language: English
Electronic versions:
Production_of_prebiotic_oligosaccharides.pdf
Source: PublicationPreSubmission
Source-ID: 127441979

An integrated membrane system for the biocatalytic production of 3'-sialyllactose from dairy by-products

An integrated membrane system was investigated for the production of 30-sialyllactose by an engineered sialidase using casein glycomacropeptide (CGMP) and lactose as substrates. CGMP was purified by ultrafiltration (UF) to remove any small molecules present and then an enzymatic membrane reactor (EMR) was used to separate the product and reuse the enzyme. A PLCC regenerated cellulose membrane was found to be the most suitable for both UF purification and EMR. Subsequently, nanofiltration (NF) was conducted to increase the purity of the 30-sialyllactose by removing the excess lactose present. The NTR7450 membrane outperformed others in NF due to its high retention of 30-sialyllactose (98%) and relatively low rejection of lactose (40%). The lactose in the permeate could be concentrated by the NF45 membrane and recycled into the EMR. The described integrated membrane system enables a more economic and efficient enzymatic production of 30-sialyllactose.
Assessing Effects and interactions among key variables affecting the growth of mixotrophic microalgae: pH, inoculum volume, and growth medium composition.

A 2(3) + 3 full factorial experimental design was used to evaluate growth rate and biomass productivity of four selected, high-biomass-yielding microalgae species, namely, Chlorella vulgaris (CV), Scenedesmus acutus (SA), Chlamydomonas reinhardtii (CR), and Chlamydomonas debaryana (CD), in mixtures of growth medium (MWC) and wastewater at different proportions (from 20 to 50% of MWC) and at different pH (from 7 to 9). Multilinear regression analysis of the biomass productivity data showed that for SA and CD the biomass productivity was independent of the proportion of medium (MWC), while the growth of CV and CR slowed down in mixtures with high proportions of wastewater. However, the biomass productivity of SA was dependent on pH, while the growth of the other microalgae was independent of pH (7-9). When evaluating the influence of pH and proportion of medium, CD appeared most robust among the algae species, despite its lower biomass productivity. All the four species reduced 80-90% of the nitrate [Formula: see text] and 60-70% of the ammonia [Formula: see text] initially present in the wastewater:medium mixture, although the extent of the reduction was dependent on the initial [Formula: see text] ratio. Both SA and CV reduced ~20-25% of the chemical oxygen demand (COD) contained in the wastewater. This study shows the remarkable influence of certain variables that are often ignored in the search for optimal conditions of microalgal growth and also reveals the importance of considering interactions among growth variables in potential applications at large scale, particularly in the field of bioremediation.
Directing filtration to optimize enzyme immobilization in reactive membranes

In this work, fouling principles in force in ultrafiltration were deployed to understand the role of selected variables-applied pressure (1-3bar), enzyme concentration (0.05-0.2gL⁻¹), pH (5-9) and membrane properties-on fouling-induced enzyme immobilization. The immobilization and subsequent enzymatic reaction efficiency were evaluated in terms of enzyme loading, conversion rate and biocatalytic stability. Alcohol dehydrogenase (ADH) was selected as a model enzyme. Lower pressure, higher enzyme concentration and lower pH resulted in higher irreversible fouling resistance and lower permeate flux. High pH during immobilization produced increased permeate flux but declines in conversion rates, likely because of the weak immobilization resulting from strong electrostatic repulsion between enzymes and membrane. The results showed that pore blocking as a fouling mechanism permitted a higher enzyme loading but generated more permeability loss, while cake layer formation increased enzyme stability but resulted in low loading rate. Low pH (near isoelectric point) favored hydrophobic and electrostatic adsorption of enzymes on the membrane, which reduced the enzyme stability. Neutral pH, however, promoted entrapment and hydrogen bonding of enzymes on the membrane, which improved the enzyme stability. This study suggests that a compromise between different fouling/immobilization mechanisms must be found in order to maximize the immobilization performance, both in terms of enzyme loading and also of enzyme activity.

© 2014 Elsevier B.V.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Technical University of Denmark
Pages: 1-11
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Membrane Science
Volume: 459
ISSN (Print): 0376-7388
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.93 SJR 2.4 SNIP 1.898
Web of Science (2017): Impact factor 6.578
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.13 SJR 2.087 SNIP 1.731
Web of Science (2016): Impact factor 6.035
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.89 SJR 1.978 SNIP 1.763
Web of Science (2015): Impact factor 5.557
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.42 SJR 2.436 SNIP 1.924
Web of Science (2014): Impact factor 5.056
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.38 SJR 2.451 SNIP 1.994
Web of Science (2013): Impact factor 4.908
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 4.37 SJR 2.185 SNIP 1.962
Web of Science (2012): Impact factor 4.093
ISI indexed (2012): ISI indexed yes
Enzymatic production and purification of prebiotic oligosaccharides by chromatography and membrane systems

Enzymatic treatment of biomass is an environmentally friendly method to obtain a range of products, such as biofuels, animal feed or food ingredients. The objective of this PhD study was to produce functional food ingredients – oligosaccharides and polysaccharides by means of enzymatic catalysis from biomass: casein glycomacropeptide (cGMP) and potato pulp. These saccharides should possess prebiotic properties, i.e., they should be non-digestable, selectively fermented and allow specific changes, both in the composition and/or activity of the gastrointestinal microbiota that confers benefits upon host well-being. Therefore the obtained compounds were incubated with single bacterial cultures to examine their prebiotic potential.

Different types of oligosaccharides were produced in the present study. The first group of compounds was human milk oligosaccharides (HMOs) containing sialic acid in their structures. These were synthesized from cGMP (a donor of sialic acid) and appropriate glycan in trans-glycosylation reaction catalysed by mutant sialidase from Trypanosoma rangeli expressed in Pichia pastoris, Tr6. Production of the model HMO, sialyllactose was enlarged to 5 L scale.

The second type of sialylated oligosaccharides was obtained with the same donor of sialic acid – cGMP and different glycans with a new Trypanosoma rangeli transsialidase, Tr13. Well-documented prebiotics galactooligosaccharides (GOS), isomaltooligosaccharides (IMO) and lactulose, and three other compounds, i.e., melibiose, maltose, and fucose were sialylated with this enzyme resulting in creating novel human milk-like oligosaccharides. Both HMO and human milk-like oligosaccharides were purified by filtration and chromatography.

The last compounds produced during this study were GOS and some galactooligosaccharides. They were generated from isolated galactan and galactan contained in solubilised potato pulp polysaccharides (SPPP). An endo-1,4-ß-galactanase from Emericella nidulans was produced in a recombinant P. pastoris strain to catalyse hydrolysis of galactan and SPPP. This enzyme was purified, characterized and its crystal structure was determined. The products of enzymatic hydrolysis were fractionated according to their molecular weight using membrane filtration.
The results of this work pave the way for development of new functional food ingredients from industrial side-streams and generate value-added products with valuable biological properties and great market potential.

**General information**
State: Published
Organisations: Department of Chemical and Biochemical Engineering
Contributors: Michalak, M., Mikkelsen, J. D., Jonsson, G. E., Pinelo, M.
Number of pages: 125
Publication date: 2014

**Publication information**
Publisher: Technical University of Denmark, Department of Chemical and Biochemical Engineering
Original language: English
Electronic versions:
Malwina_Michalak_Afhandling.pdf

**Filtration behavior of casein glycomacropeptide (CGMP) in an enzymatic membrane reactor: fouling control by membrane selection and threshold flux operation**
Sialylated human milk oligosaccharides (HMOs) can be produced by enzymatic trans-sialidation using casein glycomacropeptide (CGMP) as the substrate. By performing the reaction in an enzymatic membrane reactor (EMR), simultaneous separation of the HMOs from CGMP and enzyme reuse can be achieved. In this study, the filtration performance and fouling behavior during ultrafiltration (UF) of CGMP for the enzymatic production of 3′-sialyllactose were investigated. A 5kDa regenerated cellulose membrane with high anti-fouling performance, could retain CGMP well, permeate 3′-sialyllactose, and was found to be the most suitable membrane for this application. Low pH increased CGMP retention but produced more fouling. Higher agitation and lower CGMP concentration induced larger permeate flux and higher CGMP retention. Adsorption fouling and pore blocking by CGMP in/on membranes could be controlled by selecting a highly hydrophilic membrane with appropriate pore size. Operating under threshold flux could minimize the concentration polarization and cake/gel/scaling layers, but might not avoid irreversible fouling caused by adsorption and pore blocking. The effects of membrane properties, pH, agitation and CGMP concentration on the threshold flux were studied based on the resistance-in-series model. Higher hydrophilicity of the membrane, elevated pH and agitation, and lower CGMP concentration were found to increase the threshold flux and decrease membrane fouling.

**General information**
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Luo, J., Morthensen, S. T., Meyer, A. S., Pinelo, M.
Pages: 127-139
Publication date: 2014
Peer-reviewed: Yes

**Publication information**
Journal: Journal of Membrane Science
Volume: 469
ISSN (Print): 0376-7388
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
Scopus rating (2017): CiteScore 6.93 SJR 2.4 SNIP 1.898
Web of Science (2017): Impact factor 6.578
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Web of Science (2016): Impact factor 6.035
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.89 SJR 1.978 SNIP 1.763
Web of Science (2015): Impact factor 5.557
Functionalization of a Membrane Sublayer Using Reverse Filtration of Enzymes and Dopamine Coating

High permeability, high enzyme loading, and strong antifouling ability are the desired features for a biocatalytic membrane to be used in an enzymatic membrane reactor (EMR). To achieve these goals, the membrane sublayer was enriched with...
Laccase by reverse filtration in this case, and the resulting enzyme-loaded sublayer was covered with a dopamine coating. After membrane reversal, the virgin membrane skin layer was facing the feed and the enzymes were entrapped by a polydopamine network in the membrane sublayer. Thus, the membrane sublayer was functionalized as a catalytically active layer. The effects of the original membrane properties (i.e., materials, pore size, and structure), enzyme type (i.e., laccase and alcohol dehydrogenase), and coating conditions (i.e., time and pH) on the resulting biocatalytic membrane permeability, enzyme loading, and activity were investigated. Using a RC10 kDa membrane with sponge-like sublayer to immobilize laccase with dopamine coating, the trade-off between permeability and enzyme loading was broken, and enzyme loading reached 44.5% without any permeability loss. After 85 days of storage and reuse 14 times, more than 80% of the immobilized laccase activity was retained for the membrane with a dopamine coating, while the relative activity was less than 40% without the coating. The resistance to high temperature and acidic/alkaline pH was also improved by the dopamine coating for the immobilized laccase. Moreover, this biocatalytic membrane could resist mild hydrodynamic cleaning (e.g., back-flushing), but the catalytic ability was reduced by chemical cleaning at extreme pH (e.g., 1.5 and 11.5). Since the immobilized enzyme is not directly facing the bulk of EMRs and the substrate can be specifically selected by the separation skin layer, this biocatalytic membrane is promising for cascade catalytic reactions.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Center for Electron Nanoscopy
Contributors: Luo, J., Meyer, A. S., Mateiu, R. V., Kalyani, D., Pinelo, M.
Number of pages: 11
Pages: 22894–22904
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: A C S Applied Materials and Interfaces
Volume: 6
Issue number: 24
ISSN (Print): 1944-8244
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 8.15 SJR 2.784 SNIP 1.543
Web of Science (2017): Impact factor 8.097
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 7.6 SJR 2.561 SNIP 1.536
Web of Science (2016): Impact factor 7.504
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 7.38 SJR 2.262 SNIP 1.555
Web of Science (2015): Impact factor 7.145
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 6.88 SJR 2.125 SNIP 1.636
Web of Science (2014): Impact factor 6.723
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 6.05 SJR 1.992 SNIP 1.548
Web of Science (2013): Impact factor 5.9
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 4.94 SJR 2.199 SNIP 1.327
Web of Science (2012): Impact factor 5.008
Predicting optimal back-shock times in ultrafiltration hollow fibre modules through path-lines

This paper presents a two dimensional mathematical model of back-shocking in ultrafiltration. The model investigates the effect of back-shocking on concentration polarization. The model shows a positive effect on both the volumetric flux and the observed rejection when back-shocking is applied as compared to the steady-state solution. Furthermore, the effect of changing different parameters such as inlet velocity, forward and backwards pressure on the back-shock time, the increase in volumetric flux and observed rejection, is presented. Moreover, two analytical estimates for the optimal back-shock time derived from calculating the path-lines during a back-shock cycle are presented. Both of these expressions are in good agreement with the results obtained from the mathematical model and data collected from the literature. Based on this, a simple expression for an optimal back-shock time in a multi-parameter problem is provided.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Mathematics
Contributors: Vinther, F., Pinelo, M., Brøns, M., Jonsson, G. E., Meyer, A. S.
Pages: 275-293
Publication date: 2014
Peer-reviewed: Yes

Publication information
Journal: Journal of Membrane Science
Volume: 470
ISSN (Print): 0376-7388
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.93 SJR 2.4 SNIP 1.898
Web of Science (2017): Impact factor 6.578
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.13 SJR 2.087 SNIP 1.731
Web of Science (2016): Impact factor 6.035
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.89 SJR 1.978 SNIP 1.763
Web of Science (2015): Impact factor 5.557
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Reactive membrane technology: Two case studies

Enzymatic processes are generally sustainable processes that use mild conditions and natural substrates. Membrane technology can be employed for enzyme immobilization as well as for recycling free enzymes. Using alcohol dehydrogenase (ADH) as part of a process to recycle CO2 to methanol, we investigated the effect of applied pressure, enzyme concentration, pH, and membrane properties on fouling-induced enzyme immobilization. In another study, the production of the human milk oligosaccharide 3’-sialyllactose by an engineered sialidase from *Trypanosoma rangeli* (Tr6)
was significantly improved in an enzymatic membrane reactor. The entire process can be improved by employing a series of ultra- and nanofiltrations.

Mechanisms controlling retention during ultrafiltration of charged saccharides: Molecular conformation and electrostatic forces

Separation of different biomass components in solution, including charged saccharides, is one of the key challenges in biorefining of plant biomass. Ultrafiltration is one of the potential processes that could cope with such separation. Electrostatic interactions between solute molecules and between solute molecules and membrane material are amongst the key factors determining the separation efficiency during ultrafiltration of charged saccharides. Our hypothesis is that the manipulation of pH in addition to the classic pressure control should enhance the ultrafiltration performance for charged saccharides in terms of permeate flux and observed retention of the target molecules. Series of batch ultrafiltrations with carboxy-methyl-cellulose (CMC) showed that an increase of transmembrane pressure (from 2 to 4 bars) resulted in higher permeate fluxes and lower observed retentions. These results were explained by the cake-layer model. An increase of pH from 2.0 to 7.4 caused an increase in flux and we propose that this effect was due to a conformation change in the CMC molecules from an entangled, globular shape to a more linear one in response to repulsion amongst the negative charges on the molecules at higher pH. The results obtained in this work demonstrate that it is possible to control the observed retention of charged saccharides during ultrafiltration by manipulating pH and transmembrane pressure. Therefore, beyond operational conditions, specific molecular mechanisms must be taken into account when it comes to optimizing ultrafiltration of such species.
Production of lipids and docosahexaenoic acid (DHA) by a native Thraustochytrium strain

Production of docosahexaenoic acid (DHA) by a native Labyrinthulomycetes strain, Thraustochytriidae sp. TN5, whose growth characteristics present some differences to related strains, was scaled from shaken flask to a laboratory fermentor. The effect of the growth medium composition and growth conditions for (i) biomass production, (ii) lipid content of the biomass, and (iii) DHA content in the lipids was determined. Taguchi's design of experiments was used to study the influence of two discrete – carbon and nitrogen sources – and six continuous – concentrations of the carbon and nitrogen
sources, yeast extract and artificial seawater, incubation temperature, and time- factors on the three mentioned variables. In the flask experiments the lipidic content in the biomass (25.2% w/w) and DHA concentration (0.48 g/L) were the highest at the following conditions: maltose 20 g/L, sodium glutamate 2.4 g/L, yeast extract 6 g/L, 72 h, 25°C, and artificial seawater 30% v/v; under these conditions biomass concentration was 5.1 g/L. Fed-batch allowed to increase biomass concentration to 14 g/L. The lipidic fraction of Thraustochytriidae sp. TN5 biomass in the repeated batches was found between 16.2 and 34.8% w/w. Under this growth condition lipids and DHA productivities were 50 and 23 mg/(L h), respectively. Practical applications: Consumption of long chain-polyunsaturated fatty acids (LC-PUFA) belonging to the omega-3 family such as DHA has several positive effects on human and animal health. However, natural sources are restricted to cold-water fish and their oils. Marine protists are also good candidates for the production of microbial DHA. For evaluating the potential of new strains the effect of the growth medium composition, growth conditions, and cultivation mode on DHA productivity has to be determined. In this work the production of DHA by a native Labyrinthulomycetes strain was scaled from shaken flask to a laboratory fermentor with the aid of Taguchi's methodology, process in which biomass concentration, lipid content in the biomass, and DHA content in the lipids were increased.

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Universidad de la Frontera
Contributors: Shene, C., Leyton, A., Rubilar, M., Pinelo, M., Acevedo, F., Morales, E.
Pages: 890-900
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: European Journal of Lipid Science and Technology
Volume: 115
Issue number: 8
ISSN (Print): 1438-7697
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 2.22 SJR 0.776 SNIP 1.05
Web of Science (2017): Impact factor 2.2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.06 SJR 0.712 SNIP 1.042
Web of Science (2016): Impact factor 2.145
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.85 SJR 0.643 SNIP 0.878
Web of Science (2015): Impact factor 1.953
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.98 SJR 0.742 SNIP 1.052
Web of Science (2014): Impact factor 1.812
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.16 SJR 0.863 SNIP 1.122
Web of Science (2013): Impact factor 2.033
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.06 SJR 0.864 SNIP 1.221
Web of Science (2012): Impact factor 2.266
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Controlling the rejection of protein during membrane filtration by adding selected polyelectrolytes

Electrostatic interactions among the charged groups on proteins and/or between proteins and other solutes significantly affect the aggregation/deposition phenomena that induce fouling and decrease permeate flux during membrane purification of proteins. Such interactions can be turned into an advantage by e.g. addition of new charged species that are able to destabilize the interactions causing aggregation or by controlling the charges via pH. The present study examined the effect of (1) addition of polyelectrolytes-polystyrene-co-acrylic acid (PS-co-AA) and pectin-, respectively, and (2) changing the pH, on the permeate flux and membrane transmission of bovin serum albumina (BSA) through a PVDF membrane. The addition of PS-co-AA to the feed solution resulted in significant increases of the BSA transmission at pH 7.4 as compared to the transmission of a pure BSA solution (1g/L). The addition of pectin to BSA at pH 7.4 also resulted in higher permeate fluxes and improved BSA transmission, as compared to the individual solution of pectin or BSA. The BSA transmission decreased at lower pHs i.e. at 4.7 (isoelectric point of BSA) and 2 with each polyelectrolyte as the apparent interactions between the BSA and the polyelectrolyte favoured deposition and aggregation phenomena, resulting in higher fouling. The results suggest that the addition of a polyelectrolyte to a protein solution at a certain pH can dramatically modify the profile of electrostatic interactions causing fouling, and can help enhance the performance of membrane filtration for fractionation/purification of a target protein by significantly reducing fouling and modifying rejection/selectivity.

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, Membrane Technology group
**In vitro activity on human gut bacteria of murta leaf extracts (Ugni molinae Turcz.), a native plant from southern Chile.**

Despite the fact that murta infusions have been used to treat gut/urinary infections by native Chileans for centuries, the mechanisms promoting such effects still remain unclear. As a first attempt to unravel these mechanisms, human fecal samples were incubated in a medium containing water extract of murta leaves (ML) and the growth of different bacterial groups was evaluated. Control incubations were made in media containing fructooligosaccharides (FOS) and glucose as a carbon source. Phenolic compounds in the ML extract, likely promoters of bioactivity, were identified by HPLC–DAD–MSn. Concentrations (log10 CFU/mL) of bifidobacteria and lactobacilli in media containing the extract and FOS were 7.33 ± 0.05/4.95 ± 0.20 and 6.44 ± 0.22/6.05 ± 0.06, respectively. Clostridia, anaerobes and Enterobacteriaceae grew to a similar extent in media containing murta extract and FOS. In vitro tests (disk diffusion) showed that Gram-positive (Bacillus and Paenibacillaceae) and Gram-negative (Enterobacteriaceae) bacteria isolated from fecal samples were sensitive to both water and 50/50 ethanol/water extracts of ML (28.4 μg gallic acid equivalents). At this concentration, the antimicrobial activity of ML extracts was significantly (P <0.05) lower than that of penicillin (10 U), whereas the difference between activity of ML extracts and gentamicin (10 μg) was not significant (P > 0.05). No evidence of dependency between the antimicrobial activity of ML extracts and the enzymatic capability of the sensitive strains was found. © 2012 Institute of Food Technologists®.

**General information**

**State:** Published  
**Organisations:** Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Universidad de la Frontera, Universidad de Concepcion  
**Contributors:** Shene, C., Canquil, N., Jorquera, M., Pinelo, M., Rubilar, M., Acevedo, F., Vergara, C., Baer, D. V., Mardones, C.  
**Pages:** M323-M329  
**Publication date:** 2012  
**Peer-reviewed:** Yes

**Publication information**

**Journal:** Journal of Food Science  
**Volume:** 77  
**Issue number:** 6  
**ISSN (Print):** 0022-1147  
**Ratings:**  
**BFI (2019):** BFI-level 1  
**Web of Science (2019):** Indexed yes  
**BFI (2018):** BFI-level 1  
**Web of Science (2018):** Indexed yes  
**BFI (2017):** BFI-level 1  
**Scopus rating (2017):** CiteScore 2.06 SJR 0.827 SNIP 0.978  
**Web of Science (2017):** Impact factor 2.018  
**Web of Science (2017):** Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.92 SJR 0.796 SNIP 0.992
Web of Science (2016): Impact factor 1.815
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.97 SJR 0.829 SNIP 0.982
Web of Science (2015): Impact factor 1.649
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.07 SJR 0.93 SNIP 1.112
Web of Science (2014): Impact factor 1.696
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.24 SJR 1.019 SNIP 1.077
Web of Science (2013): Impact factor 1.791
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.98 SJR 0.961 SNIP 1.08
Web of Science (2012): Impact factor 1.775
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.9 SJR 0.936 SNIP 1.051
Web of Science (2011): Impact factor 1.658
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.055 SNIP 1.114
Web of Science (2010): Impact factor 1.733
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.982 SNIP 1.012
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.884 SNIP 0.922
Scopus rating (2007): SJR 0.703 SNIP 0.968
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.734 SNIP 0.897
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.685 SNIP 1.016
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.761 SNIP 1.021
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 0.703 SNIP 1.017
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 0.921 SNIP 1.407
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 0.826 SNIP 1.142
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 1.159 SNIP 1.353
Scopus rating (1999): SJR 1.072 SNIP 1.303

Original language: English
Keywords: Antimicrobial activity, Human gut microbiota, Murta leaf, Phenolic compounds, Prebiotics
DOIs: 10.1111/j.1750-3841.2012.02692.x
Statistical modelling of the interplay between solute shape and rejection in porous membranes

The structural conformation of complex molecules, e.g., polymers and proteins, is determined by several factors like composition of the basic structural units, charge, and properties of the surrounding solvent. In absence of any chemical or physical interaction solute–solute and/or solute–membrane, it can be expected that the possibility for a solute particle to enter the membrane pore will only depend upon the relation between such molecular conformation and pore size. The objective of the present study is to use geometric and statistical modelling to determine the effect of particle elongation – from spherical to being increasingly prolate ellipsoidal – on the possibility of entering the pore, and, in turn, on the macroscopic distribution coefficient, $K$, and overall retention during filtration. The model showed that the value of $K$ was maximal when the longer of the radii in the prolate ellipsoid was approximately equal to the radius of the pores, in case the spherical size of the particle was smaller than the membrane pore. Furthermore, for spherical particles larger than the pore, such a maximum was found to occur after the smaller of the radii was smaller than the pore radius. Either for spherical particles bigger or smaller than the pore radius, $K$ was monotonically decreasing towards zero as the particles became more elongated. When relating the values of $K$ to the friction model, the maximal rejection coefficient was found to reach a characteristic minimum when changing shape. The results suggested that the retention during porous membrane filtration can be manipulated when working with solute particles prone to alter conformation via, e.g., adding proper functional groups to the molecule, or modifying charge density/distribution by varying pH.

General information
State: Published
Organisations: Department of Mathematics, Applied functional analysis, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Dynamical systems, Computer Aided Process Engineering Center, Membrane Technology group
Contributors: Vinther, F., Pinelo, M., Brøns, M., Jonsson, G., Meyer, A. S.
Pages: 261-269
Publication date: 2012
Peer-reviewed: Yes

Publication information
Journal: Separation and Purification Technology
Volume: 89
ISSN (Print): 1383-5866
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.25 SJR 1.093 SNIP 1.475
Web of Science (2017): Impact factor 3.927
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.024 SNIP 1.4
Web of Science (2016): Impact factor 3.359
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.75 SJR 1.07 SNIP 1.499
Web of Science (2015): Impact factor 3.299
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.5 SJR 1.261 SNIP 1.532
Web of Science (2014): Impact factor 3.091
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.62 SJR 1.327 SNIP 1.674
Web of Science (2013): Impact factor 3.065
A continuous membrane microbioreactor system for development of integrated pectin modification and separation processes

Evaluation of novel enzyme reactions and reactor systems is often hampered by costs related to obtaining sufficient amounts of enzymes. In this respect, it will be advantageous to assess new enzymatic processes in microbioreactors designed to resemble genuine reactor systems. In this work, we present a continuous membrane microbioreactor prototype for development of enzyme catalyzed degradation of pectin. Membrane reactors are becoming increasingly important for the novel “biorefining” type of processes that either require product removal to avoid product inhibition or rest on partial hydrolysis of the substrate to obtain e.g. value-added oligosaccharides from complex biopolymers. The microbioreactor prototype was fabricated from poly(methylmethacrylate) (PMMA) and poly(dimethylsiloxane) (PDMS) and designed as a loop reactor (working volume approximately 190μL) integrated with a regenerated cellulose membrane for separation of low molecular weight products. The main technical considerations and challenges related to establishing the continuous membrane microbioreactor are discussed. The workability of the prototype was validated by comparing the process data at microscale to those obtained using a lab-scale membrane reactor system. The prototype presented here is easy to handle, has a low complexity – thus a relatively simple fabrication process – and can be used to study extended
enzymatic reactions.

**General information**

State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Membrane Technology group
Pages: 418-426
Publication date: 2011
Peer-reviewed: Yes

**Publication information**

Journal: Chemical Engineering Journal
Volume: 167
Issue number: 2-3 special issue
ISSN (Print): 1385-8947
Ratings:

BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 7.01
Web of Science (2017): Impact factor 6.735
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 6.34
Web of Science (2016): Impact factor 6.216
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.68
Web of Science (2015): Impact factor 5.31
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 4.92
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 4.59
Web of Science (2013): Impact factor 4.058
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 3.92
Web of Science (2012): Impact factor 3.473
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 3.96
Web of Science (2011): Impact factor 3.461
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Impact factor 3.074
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
A Laboratory Exercise To Understand the Importance of Enzyme Technology in the Fruit-Processing Industry: Viscosity Decrease and Phenols Release from Apple Mash

In a 4-h laboratory exercise, students accomplish a series of enzymatic macerations of apple mash, assess the viscosity of the mash during the maceration, extract the juice by centrifugation, and measure the levels of antioxidant phenols extracted into the juice after different enzyme treatments. The exercise shows the impact of enzyme-catalyzed plant cell-wall degradation on the viscosity of apple fruit mash and on the extraction of antioxidant phenols into experimentally prepared apple juice. The exercise also demonstrates that pectinolytic and cellulolytic enzymes have different effects on the viscosity of apple mash. Depending on the academic skills and background of the students, various aspects of quantitative enzyme activity assessment and advanced data analysis of decay curves can be included in the postexercise discussions and reporting of the data.

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, BioChemical Engineering
Contributors: Pinelo, M., Nielsen, M. K., Meyer, A. S.
Pages: 499-502
Publication date: 2011
Peer-reviewed: Yes

Publication information
Journal: Journal of Chemical Education
Volume: 88
Issue number: 4
ISSN (Print): 0021-9584
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.52 SJR 0.466 SNIP 0.944
Web of Science (2017): Impact factor 1.758
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.39 SJR 0.415 SNIP 0.934
Web of Science (2016): Impact factor 1.419
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.24 SJR 0.383 SNIP 0.967
Web of Science (2015): Impact factor 1.225
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.13 SJR 0.381 SNIP 1.004

The objective of this paper is to assess if a membrane microbioreactor system could potentially be used to diagnose consequences of different process design and reactor operation options relevant for larger-scale enzymatic degradation of pectin reactions. The membrane microbioreactor prototype was fabricated from poly(methylmethacrylate) (PMMA) and poly(dimethylsiloxane) (PDMS) with a working volume of ~190 μL. The prototype also contained the necessary sensors and actuators, i.e., pressure transducer, mixing via magnetic stirrer bar and a temperature controller. The functionality of the prototype was demonstrated by performing a continuous enzymatic degradation of pectin experiment for a range of reactor conditions: different membrane molecular weight cutoff (MWCO) values, enzyme-to-substrate ratios (E/S), and substrate feeding rates (F) were assessed. Based on the experimental data, it was found that the apparent reaction rate increased from 0.11 μmol/h to 0.13 μmol/h when the E/S ratio was doubled from 0.2% (g/g) to 0.4% (g/g). In contrast, when the substrate feeding rate was reduced from 200 μL/h to 100 μL/h (i.e., longer residence time), a higher yield was achieved (producing a pectin fragment concentration of 0.82 mM in the permeate) and the apparent reaction rate increased by ~50% (i.e., from 0.11 μmol/h to 0.17 μmol/h). Clearly, this signifies that the substrate feeding rate is a critical variable that influences the conversion rate and the process yield. The data also showed that the process design affected the membrane rejection profile. The results obtained thus underlined the suitability of a miniature membrane reactor system for evaluating different process design options that are relevant for larger-scale reactions of enzymatic pectin degradation.
Enzymatisk udvinding af RG-II fra sukkerroepektin i membranreaktor

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Contributors: Zeuner, B., Pinelo, M., Meyer, A. S.
Pages: 28-30
Publication date: 2011
Peer-reviewed: Unknown

Publication information
Journal: Dansk Kemi
Volume: 92
Issue number: 9
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
Electronic versions:
BIZ_Dansk_Kemi_Nr._9_2011.pdf
Source: PublicationPreSubmission
Source-ID: 147925764
Research output: Communication › Journal article – Annual report year: 2011
Recovery of volatile fruit juice aroma compounds by membrane technology: Sweeping gas versus vacuum membrane distillation

The influence of temperature (10–45°C), feed flow rate (300–500L/h) and sweeping gas flow rate (1.2–2m³/h) on the recovery of berry fruit juice aroma compounds by sweeping gas membrane distillation (SGMD) was examined on an aroma model solution and on black currant juice in a lab scale membrane distillation set up. The data were compared to recovery of the aroma compounds by vacuum membrane distillation (VMD). The flux of SGMD increased with an increase in temperature, feed flow rate or sweeping gas flow rate. Increased temperature and feed flow rate also increased the concentration factors (Cpermeate/Cfeed) of the aroma compounds. At 45°C the most volatile and hydrophobic aroma compounds obtained the highest concentration factors: 12.1–9.3 (black currant juice) and 17.2–12.8 (model solution). With black currant juice a volume reduction of 13.7% (vol.%), at 45°C, 400L/h, resulted in an aroma recovery of 73–84vol.% for the most volatile compounds. Compared to VMD, the aroma recovery with SGMD was less influenced by the feed flow rate but more influenced by the temperature. Higher fluxes were achieved during concentration by VMD and this reduced the operation time, which in turn reduced the degradation of anthocyanins and polyphenolic compounds in the juice.

Industrial relevance

High temperature evaporation is the most widely used industrial technique for aroma recovery and concentration of juices, but membrane distillation (MD) may provide for gentler aroma stripping and lower energy consumption. This study gives important clues about the fate of berry juice aroma compounds and polyphenols during concentration by MD, and identifies the main factors influencing the aroma recovery efficiency with MD. Both SGMD and VMD are promising techniques for gentle stripping of berry juice aroma compounds and deserve further consideration as alternative techniques for gentle aroma stripping in industrial fruit juice processing.

General information

State: Published
Organisations: Department of Chemistry, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, Membrane Technology group, University of Copenhagen
Pages: 388-397
Publication date: 2011
Peer-reviewed: Yes

Publication information

Journal: Innovative Food Science and Emerging Technologies
Volume: 12
Issue number: 3
ISSN (Print): 1466-8564
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.24 SJR 1.201 SNIP 1.194
Web of Science (2017): Impact factor 3.116
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.54 SJR 1.431 SNIP 1.386
Web of Science (2016): Impact factor 2.573
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.48 SJR 1.675 SNIP 1.495
Web of Science (2015): Impact factor 2.997
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.67 SJR 1.583 SNIP 1.672
Web of Science (2014): Impact factor 3.273
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.16 SJR 1.374 SNIP 1.649
Web of Science (2013): Impact factor 2.248
ISI indexed (2013): ISI indexed yes
Juice clarification by protease and pectinase treatments indicates new roles of pectin and protein in cherry juice turbidity

Industrial juice clarification is accomplished by a combination of enzymatic depectinization, gelatin–silica sol, and/or bentonite treatment. The gelatin–silica sol treatment step is particularly slow, mischievous, and requires comprehensive downstream processing to obtain clarified juice. In this work, alternative, enzymatic clarification strategies of industrially pressed cherry juice were evaluated in a 24−1 factorial design set-up with addition of a pectinase, Pectinex Smash®, a protease, Enzeco, both enzyme preparations derived from Aspergillus spp., gallic acid, and tannic acid as factors, and determination of turbidity, protein, pectin, and phenolics as responses. The effects of the alternative clarification treatments were assessed immediately after the particular clarification treatment (immediate turbidity) and during 14 days of cold storage (turbidity development). The protease treatment resulted in significant reduction of immediate turbidity, but had low clarification impact during the subsequent cold storage. In contrast, pectinase addition exerted a weak effect on immediate turbidity reduction, but effectively decreased the turbidity development during storage. The phenolic acid additions contributed to reduce turbidity when added together with the pectinase or the protease. However, when gallic acid and tannic acid were added together they induced enhanced turbidity formation. Conventionally, immediate turbidity is presumed to be caused by pectin, while turbidity development during cold storage (haze formation) is assumed to be due to protein–phenol interactions. Our results suggest that proteins play a decisive role in the formation of immediate turbidity in cherry juice, and point to that pectin may contribute to turbidity development during cold storage of cherry juice. The data may thus pave the way for development of improved, alternative procedures for cherry juice clarification.

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Contributors: Meyer, A. S., Zeuner, B., Pinelo-Jiménez, M.
Pages: 259-265
Publication date: 2010
Membrane microbioreactor prototype for enzyme-catalyzed degradation of pectin

General information
State: Published
Organisations: Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering, Computer Aided Process Engineering Center
Publication date: 2010
Peer-reviewed: Yes
Event: Abstract from 8th European Symposium on Biochemical Engineering, Bologna, Italy.
Source: orbit
Source-ID: 275515
Research output: Research - peer-review › Conference abstract for conference – Annual report year: 2010

Membrane technology for purification of enzymatically produced oligosaccharides: Molecular and operational features affecting performance

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, Computer Aided Process Engineering Center
Pages: 1-11
Publication date: 2009
Peer-reviewed: Yes

Publication Information
Journal: Separation and Purification Technology
Volume: 70
Issue number: 1
ISSN (Print): 1383-5866
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.25 SJR 1.093 SNIP 1.475
Web of Science (2017): Impact factor 3.927
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.024 SNIP 1.4
Web of Science (2016): Impact factor 3.359
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Plant location and extraction procedure strongly alter the antimicrobial activity of murta extracts

Leaves and fruits of Murta (Ugni Molinae Turcz.) growing in three locations of Chile with diverse climatic conditions were extracted by using ethanol/water mixtures at different ratios and the antimicrobial activity was assessed. Extracts containing the highest polyphenolic content were from murta plants grown nearer to the mountain (58 mg GAE/g murta),
subjected to extreme summer/winter-day/night temperature changes and rainy regime. Extracts from leaves collected in the valley and coast contained 46 and 40 mg GAE/g murta, respectively. A mixture of 50% ethanol/water was the most efficient in extracting polyphenols, showing pure solvents-both water and ethanol-a lower extraction capacity. No correlation between antioxidant capacity and polyphenolic content was found. Extracts from Murta leaves provoked a decrease in the growing of Pseudomonas aeruginosa, Klebsiella pneumoniae and Staphylococcus aureus, and showed no activity against the beneficial, probiotic bacteria. A significant correlation between polyphenol content and antimicrobial activity on harmful bacteria was found. Myricetin glucoside and quercetin glucoside/glucuronide/dirhamnoside presumably contributed to the antimicrobial activity of the extract. The higher antimicrobial activity of leaves extracts compared to the fruits could be attributed to flavan-3-ols and other flavonol glycosides. Quercetin glucuronide, myricetin xyloside and flavan-3-ols in polymeric form were tentatively identified for the first time in murta extracts. Both extracts showed an antimicrobial activity similar to some commercial antibiotics, suggesting their suitability to replace synthetic antimicrobials in food.

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Contributors: Shene, C., Reyes, A. K., Villarroel, M., Sineiro, J., Pinelo-Jiménez, M., Rubilar, M.
Pages: 467-475
Publication date: 2009
Peer-reviewed: Yes

Publication information
Journal: European Food Research and Technology
Volume: 228
Issue number: 3
ISSN (Print): 1438-2377
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 1.9 SJR 0.737 SNIP 0.846
Web of Science (2017): Impact factor 1.919
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 1.81 SJR 0.763 SNIP 0.881
Web of Science (2016): Impact factor 1.664
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 1.55 SJR 0.728 SNIP 0.82
Web of Science (2015): Impact factor 1.433
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 1.71 SJR 0.816 SNIP 0.911
Web of Science (2014): Impact factor 1.559
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 1.71 SJR 0.797 SNIP 0.906
Web of Science (2013): Impact factor 1.387
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 1.68 SJR 0.862 SNIP 1.039
Web of Science (2012): Impact factor 1.436
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 1.87 SJR 1.015 SNIP 1.095
Web of Science (2011): Impact factor 1.566
ISI indexed (2011): ISI indexed yes
Enzyme-assisted extraction of antioxidants: Release of phenols from vegetal matrixes

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Contributors: Pinelo-Jiménez, M., Meyer, A. S.
Pages: 3217-3220
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Electronic Journal of Environmental, Agricultural and Food Chemistry
Volume: 7
Issue number: 8
ISSN (Print): 1579-4377
Ratings:
Scopus rating (2015): SJR 0.141 SNIP 0.636
Scopus rating (2014): SJR 0.162 SNIP 0.462
Scopus rating (2013): SJR 0.174 SNIP 0.521
ISI indexed (2013): ISI indexed no

Keywords: Food supplements, Antimicrobial activity, HPLC-DAD-MS, Polyphenols, Flavonol glycosides, Murta (Ugni molinae Turcz.)
Personlige netværk giver succes for globaliseringen

General information
State: Published
Organisations: Division of Food Production Engineering, National Food Institute, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Contributors: Jørgensen, S. B. (ed.), Pinelo-Jiménez, M.
Publication date: 2008
Peer-reviewed: Unknown

Publication information
Journal: FoodDTU Midt i Ugen
Original language: Danish
Source: orbit
Source-ID: 258518
Research output: Communication › Journal article – Annual report year: 2008

Selective release of phenols from apple skin: Mass transfer kinetics during solvent and enzyme extraction

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Contributors: Pinelo-Jiménez, M., Zornoza Encabo, B., Meyer, A. S.
Pages: 620-627
Publication date: 2008
Peer-reviewed: Yes

Publication information
Journal: Separation and Purification Technology
Volume: 63
Issue number: 3
ISSN (Print): 1383-5866
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.25 SJR 1.093 SNIP 1.475
Web of Science (2017): Impact factor 3.927
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.024 SNIP 1.4
Web of Science (2016): Impact factor 3.359
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.75 SJR 1.07 SNIP 1.499
Supercritical Fluid and Solid-Liquid Extraction of Bioactive Substances from Grape Pomace: a Comparative Study

General information
State: Published
Organisations: Autonomous University of Madrid, University of Santiago de Compostela, Unknown
Effect of Cellulases, Solvent Type and Particle Size Distribution on the Extraction of Chlorogenic Acid and Other Phenols from Spent Coffee Grounds

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, Technical University of Denmark
Pages: 641-651
Publication date: 2007
Peer-reviewed: Yes

Publication information
Journal: American Journal of Food Technology
Volume: 2
Issue number: 7
ISSN (Print): 1557-4571
Ratings:
Scopus rating (2017): SJR 0.176 SNIP 0.348
Scopus rating (2016): SJR 0.247 SNIP 0.55
Scopus rating (2015): CiteScore 0.52 SJR 0.215 SNIP 0.541
Scopus rating (2014): CiteScore 0.99 SJR 0.512 SNIP 1.064
Scopus rating (2013): CiteScore 0.86 SJR 0.353 SNIP 0.858
ISI indexed (2013): ISI indexed no
Scopus rating (2012): CiteScore 1.55 SJR 0.527 SNIP 1.219
ISI indexed (2012): ISI indexed no
Scopus rating (2011): CiteScore 1.38 SJR 0.377 SNIP 1.203
ISI indexed (2011): ISI indexed no
Scopus rating (2010): SJR 0.233 SNIP 0.497
Scopus rating (2009): SJR 0.189 SNIP 0.256
Scopus rating (2008): SJR 0.159 SNIP 0.201
Original language: English
Source: orbit
Source-ID: 220876
Research output: Research - peer-review › Journal article – Annual report year: 2007

Ethanolic Extraction of Rosa rubiginosa Soluble Substances: Oil Solubility Equilibrium and Kinetic Studies
Processing of Rosa rubiginosa: Extraction of oil and antioxidant substances

General information
State: Published
Organisations: University of Santiago de Compostela, University of Santiago de Compostela
Contributors: Franco, D., Pinelo, M., Sineiro, J., Núñez, M. J.
Pages: 3506-3512
Publication date: 2007
Peer-reviewed: Yes

Publication information
Journal: Bioresource Technology
Volume: 98
Issue number: 18
ISSN (Print): 0960-8524
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 6.28 SJR 2.029 SNIP 1.799
Web of Science (2017): Impact factor 5.807
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 5.94 SJR 2.215 SNIP 1.932
Web of Science (2016): Impact factor 5.651
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 5.47 SJR 2.243 SNIP 1.897
Web of Science (2015): Impact factor 4.917
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 5.3 SJR 2.399 SNIP 2.087
Web of Science (2014): Impact factor 4.494
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 5.97 SJR 2.405 SNIP 2.477
Web of Science (2013): Impact factor 5.039
Applicability of NIR spectroscopy to determine oil and other physicochemical parameters in Rosa mosqueta and Chilean hazelnut

Due to the increasing interest in certain components, specially the oil, from non-conventional seeds as Rosa mosqueta (Rosa rubiginosa) and Chilean hazelnut (Gevuina avellana), quick determinations of oil and other parameters were carried out by using near-infrared (NIR) spectroscopy. Moisture, oil, fiber (as acid detergent fiber) and protein from solid samples of the seeds as mentioned, along with those of soybean (Glycine max), already analyzed by NIR and for serving as control for the variability of the method, were studied. Sample interactions to NIR radiations were processed using the multivariate regression algorithm Partial Least Squared (PLS) to build a calibration model. Standard error of cross-validation (SECV) was used to estimate the prediction error. Moisture of Rosa mosqueta, Chilean hazelnut presscake and soybean meal (in the ranges 10–15, 10–15, 8–10%, respectively), acid detergent fiber (60–68, 12–16, 10–15%, respectively), oil (1–4, 14–20, 5–13%, respectively) and protein (1–5, 8–15, 27–45%, respectively) were previously determined by wet analysis using standard methods, so creating a library. The possibility to analyze parameters from very different oilseeds with an acceptable uncertainty was also established. Standard errors of cross-validation were between 1.25 and 2.99%, being the oil content the best predicted parameter.
A Simple Method to Separate Red Wine Nonpolymeric Phenols and Tannins by Solid-Phase Extraction

Simple polyphenols and tannins differ in the way that they contribute to the organoleptic profile of wine and their effects on human health. Very few straightforward techniques to separate red wine nonpolymeric phenols from the polymeric fraction are available in the literature. In general, they are complex, time-consuming, and generate large amounts of waste. In this procedure, the separation of these compounds was achieved using C18 cartridges, three solvents with different elution strengths, and pH adjustments of the experimental matrices. Two full factorial 2² experimental designs were performed to find the optimal critical variables and their values, allowing for the maximization of tannin recovery and separation efficiency (SE). Nonpolymeric phenols such as phenolic acids, monomers, and oligomers of flavonol and flavan-3-ols and anthocyanins were removed from the column by means of an aqueous solvent followed by ethyl acetate. The polymeric fraction was then eluted with a combination of methanol/acetone/water. The best results were attained with 1 mL of wine sample, a 10% methanol/water solution (first eluant), ethyl acetate (second eluant), and 66% acetone/water as the polymeric phenols-eluting solution (third eluant), obtaining a SE of ca. 90%. Trials with this method on fruit juices also showed high separation efficiency. Hence, this solid-phase extraction method has been shown to be a simple and efficient alternative for the separation of nonpolymeric phenolic fractions and the polymeric ones, and this method could have important applications to sample purification prior to biological testing due to the nonspecific binding of polymeric phenolics to nearly all enzymes and receptor sites.

General information
State: Published
Organisations: Universidad de Talca, University of California
Contributors: Pinelo-Jiménez, M., Laurie, F., Waterhouse, A. L.
Pages: 2839-2844
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 54
Issue number: 8
ISSN (Print): 0021-8561
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
Effect of bubbling nitrogen and pulsed flow on the antiradical activity of grape residues

General information
State: Published
Organisations: University of Santiago de Compostela
Contributors: Pinelo-Jiménez, M., Rubilar, M., Sineiro, J., Núñez, M. J.
Pages: 269-275
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Journal of Food Engineering
Volume: 73
Issue number: 3
ISSN (Print): 0260-8774
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Scopus rating (2017): CiteScore 3.54 SJR 1.279 SNIP 1.671
Web of Science (2017): Impact factor 3.197
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.71 SJR 1.476 SNIP 1.837
Web of Science (2016): Impact factor 3.099
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 3.58 SJR 1.475 SNIP 1.858
Web of Science (2015): Impact factor 3.199
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 3.44 SJR 1.496 SNIP 1.96
Web of Science (2014): Impact factor 2.771
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 3.1 SJR 1.348 SNIP 1.891
Web of Science (2013): Impact factor 2.576
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.84 SJR 1.36 SNIP 1.978
Effect of enzymatic clarification and rat intestinal extracts incubation on phenolic composition and antioxidant activity of black currant juice

General information
State: Published
Organisations: Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering, Department of Chemistry
Pages: 6564-6571
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 54
Issue number: 18
ISSN (Print): 0021-8561
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.64 SJR 1.269 SNIP 1.343
Web of Science (2017): Impact factor 3.412
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): Impact factor 3.154
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.23 SJR 1.224 SNIP 1.245
Web of Science (2015): Impact factor 2.857
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.25 SJR 1.267 SNIP 1.413
Web of Science (2014): Impact factor 2.912
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.44 SJR 1.43 SNIP 1.47
Web of Science (2013): Impact factor 3.107
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.2 SJR 1.408 SNIP 1.464
Web of Science (2012): Impact factor 2.906
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 3.1 SJR 1.389 SNIP 1.441
Web of Science (2011): Impact factor 2.823
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.42 SNIP 1.391
Web of Science (2010): Impact factor 2.816
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.33 SNIP 1.306
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 1.327 SNIP 1.338
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.252 SNIP 1.44
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 1.367 SNIP 1.418
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.298 SNIP 1.517
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 1.353 SNIP 1.489
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 1.152 SNIP 1.469
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 1.219 SNIP 1.532
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 1.044 SNIP 1.239
Web of Science (2001): Indexed yes
Influence of extraction conditions on phenolic yields from pine bark: assessment of procyanidins polymerization degree by thiolysis

General information
State: Published
Organisations: University of Santiago de Compostela
Contributors: Jerez, M., Pinelo, M., Sineiro, J., Núñez, M. J.
Pages: 406-414
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Food Chemistry
Volume: 94
Issue number: 3
ISSN (Print): 0308-8146
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
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): Impact factor 4.946
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): Impact factor 4.529
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 4.31 SJR 1.582 SNIP 1.946
Web of Science (2015): Impact factor 4.052
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.92 SJR 1.557 SNIP 2.01
Web of Science (2014): Impact factor 3.391
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.87 SJR 1.554 SNIP 2.056
Web of Science (2013): Impact factor 3.259
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.98 SJR 1.762 SNIP 2.342
Web of Science (2012): Impact factor 3.334
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 4.17 SJR 1.911 SNIP 2.383
Mass Transfer during Continuous Solid-Liquid Extraction: Obtaining Antioxidants from Grape Byproducts

General information
State: Published
Organisations: University of Santiago de Compostela
Contributors: Pinelo-Jiménez, M., Sineiro, J., Núñez, M. J.
Pages: 57-63
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Journal of Food Engineering
Volume: 77
Issue number: 1
Original language: English
Source: orbit
Source-ID: 220889
Research output: Research - peer-review › Journal article – Annual report year: 2006

Murta Leaves (Ugni molinae Turcz) as a Source of Antioxidant Polyphenols

General information
State: Published
Organisations: University of Santiago de Compostela, Universidad de la Frontera
Protease assisted clarification of black currant juice

General information
State: Published
Organisations: Department of Systems Biology, Department of Chemistry
Pages: 6554-6563
Publication date: 2006
Peer-reviewed: Yes

Publication information
Journal: Journal of Agricultural and Food Chemistry
Volume: 54
ISSN (Print): 0021-8561
Ratings:
BFI (2019): BFI-level 2
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.64 SJR 1.269 SNIP 1.343
Web of Science (2017): Impact factor 3.412
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): Impact factor 3.154
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.23 SJR 1.224 SNIP 1.245
Web of Science (2015): Impact factor 2.857
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.25 SJR 1.267 SNIP 1.413
Upgrading of grape skins: Significance of plant cell-wall structural components and extraction techniques for phenol release

General information
State: Published
Organisations: Department of Systems Biology, Center for BioProcess Engineering, Department of Chemical and Biochemical Engineering
Projects:

Membrane reactors for industrial applications
Su, Z., PhD Student, Department of Chemical and Biochemical Engineering
Pinelo, M., Main Supervisor, Department of Chemical and Biochemical Engineering
Kaiser, A., Supervisor, Department of Energy Conversion and Storage
Luo, J., Supervisor, Department of Chemical and Biochemical Engineering
Zhang, W. (.), Supervisor, Department of Energy Conversion and Storage
01/12/2018 → 30/11/2021
Project: PhD

Developing Novel Systematic Strategies for Downstream Bioprocess Design
Mancini, E., PhD Student, Department of Chemical and Biochemical Engineering
Pinelo, M., Main Supervisor, Department of Chemical and Biochemical Engineering
Gernaey, K. V., Supervisor, Department of Chemical and Biochemical Engineering
Mansouri, S. S., Supervisor, Department of Chemical and Biochemical Engineering
Samfinansieret - Andet
01/06/2018 → 31/05/2021
Award relations: Developing Novel Systematic Strategies for Downstream Bioprocess Design
Project: PhD

Modification of ultrafiltration membranes to create high performance filtration/reaction matrixes
Ji, M., PhD Student, Department of Chemical and Biochemical Engineering
Pinelo, M., Main Supervisor, Department of Chemical and Biochemical Engineering
Daugaard, A. E., Supervisor, Department of Chemical and Biochemical Engineering
Luo, J., Supervisor, Department of Chemical and Biochemical Engineering
Woodley, J., Supervisor, Department of Chemical and Biochemical Engineering
Stipendie fra udlandet
01/02/2018 → 31/01/2021
Award relations: Modification of ultrafiltration membranes to create high performance filtration/reaction matrixes
Project: PhD

Tubular membrane reactions for immobilization of enzymes
Zverina, L., PhD Student, Department of Chemical and Biochemical Engineering
Daugaard, A. E., Main Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering
Woodley, J., Supervisor, Department of Chemical and Biochemical Engineering
Forskningsrådsfinansiering
01/03/2018 → 28/02/2021
Award relations: Tubular membrane reactions for immobilization of enzymes
Project: PhD

Membrane-based in-situ product removal
Jaksland, A., PhD Student, Department of Chemical and Biochemical Engineering
Woodley, J., Main Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering
Wan, Y., Supervisor
**Offentlig finansiering**  
01/09/2017 → 31/08/2020  
Award relations: Membrane-based in-situ product removal  
Project: PhD

**High performance immobilization of enzymes in inorganic membranes**  
Sigurdardóttir, S. B., PhD Student, Department of Chemical and Biochemical Engineering  
Della Negra, M., Supervisor, Department of Energy Conversion and Storage  
Kaiser, A., Supervisor, Department of Energy Conversion and Storage  

**Forskningsrådsfinansiering**  
01/06/2017 → 31/05/2020  
Award relations: High performance immobilization of enzymes in inorganic membranes  
Project: PhD

**New Concepts for Efficient Immobilization of Enzymes in Inorganic Membrane Reactors**  
Lehmann, J., PhD Student, Department of Energy Conversion and Storage  
Kaiser, A., Main Supervisor, Department of Energy Conversion and Storage  
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering  
Zhang, W., Supervisor, Department of Energy Conversion and Storage  

**Grundforskningsfonden**  
01/06/2017 → 31/05/2020  
Award relations: New Concepts for Efficient Immobilization of Enzymes in Inorganic Membrane Reactors  
Project: PhD

**CFD Modelling of dynamic microfiltration for application in biotechnology processes**  
Marke, H. S., PhD Student, Department of Chemical and Biochemical Engineering  
Krühne, U., Main Supervisor, Department of Chemical and Biochemical Engineering  
Hansen, E., Supervisor, Department of Chemical and Biochemical Engineering  
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering  

**Industrial PhD**  
01/02/2017 → 31/01/2020  
Award relations: CFD Modelling of dynamic microfiltration for application in biotechnology processes  
Project: PhD

**Use of Ionic Liquids and Support Materials for High Performance Enzymatic Conversion of CO2 into Formic Acid and Formaldehyd**  
Zhang, Z., PhD Student, Department of Chemical and Biochemical Engineering  
Zhang, S., Supervisor  
von Solms, N., Supervisor, Department of Chemical and Biochemical Engineering  

**Stipendie fra udlandet**  
01/12/2015 → 28/02/2019  
Award relations: Use of Ionic Liquids and Support Materials for High Performance Enzymatic Conversion of CO2 into Formic Acid and Formaldehyd  
Project: PhD

**Development of Large-Scale Processes Using Alcohol Oxidases**  
Dias Gomes, M., PhD Student, Department of Chemical and Biochemical Engineering  
Woodley, J., Main Supervisor, Department of Chemical and Biochemical Engineering  
Krühne, U., Supervisor, Department of Chemical and Biochemical Engineering  
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering  
Bommarius, A. S., Examiner  
Grosser, S. T., Examiner  

**Anden EU-finansiering**  
01/09/2015 → 14/01/2019  
Award relations: Development of Large-Scale Processes Using Alcohol Oxidases  
Project: PhD
Application of forward osmosis for water recovery and effluent up-concentration: the case of fermentative butanol production from crude glycerol
Kalafatakis, S., PhD Student, Department of Chemical and Biochemical Engineering
Gavala, H. N., Main Supervisor, Department of Chemical and Biochemical Engineering
Skiadas, I. V., Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Christensen, M. L., Examiner
Venus, J., Examiner
Venus, J., Examiner
Samfinansieret - Andet
01/06/2015 → 30/09/2017
Award relations: Application of forward osmosis for water recovery and effluent up-concentration: the case of fermentative butanol production from crude glycerol
Project: PhD

Aqueous Ammonia Soaking as a pretreatment of lignocellulosic biomasses for improving manurebafor enhancing biogas yield from lignocellulosic biomasses sed anaerobiv digestion
Lymperatou, A., PhD Student, Department of Chemical and Biochemical Engineering
Gavala, H. N., Supervisor, Department of Chemical and Biochemical Engineering
Skiadas, I. V., Main Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Carrere, H., Examiner
Holm-Nielsen, J. B., Examiner, Risø National Laboratory for Sustainable Energy
Carrere, H., Examiner
Carrere, H., Examiner
Offentlig finansiering
01/06/2015 → 13/11/2017
Award relations: Aqueous Ammonia Soaking as a pretreatment of lignocellulosic biomasses for improving manurebafor enhancing biogas yield from lignocellulosic biomasses sed anaerobiv digestion
Project: PhD

Fractionation and enzymatic processing of biomass for biorefinery applications
Djajadi, D. T., PhD Student, Department of Chemical and Biochemical Engineering
Meyer, A. S., Main Supervisor, Department of Biotechnology and Biomedicine
Jørgensen, H., Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering
Thomsen, K., Examiner, Department of Chemical and Biochemical Engineering
Barsberg, S. T., Examiner
Gras, S. L., Examiner
Gras, S. L., Examiner
Samfinansieret - Andet
01/02/2015 → 12/11/2018
Award relations: Fractionation and enzymatic processing of biomass for biorefinery applications
Project: PhD

Modification of polymer surfaces to enhance enzyme activity and stability
Hoffmann, C., PhD Student, Department of Chemical and Biochemical Engineering
Daugaard, A. E., Main Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering
Woodley, J., Supervisor, Department of Chemical and Biochemical Engineering
Szabo, P., Examiner, Department of Chemical and Biochemical Engineering
Gardossi, L., Examiner
Malkoch, M., Examiner
Gardossi, L., Examiner
Samfinansieret - Andet
01/08/2014 → 13/12/2017
Award relations: Modification of polymer surfaces to enhance enzyme activity and stability
Project: PhD

Developments in enzyme immobilization with downstream renewable energy applications
Mohd Sueb, M. S. B., PhD Student, Department of Chemical and Biochemical Engineering
Pinelo, M., Main Supervisor, Department of Chemical and Biochemical Engineering
Meyer, A. S., Supervisor, Department of Biotechnology and Biomedicine
Gavala, H. N., Examiner, Department of Chemical and Biochemical Engineering
Kádár, Z., Examiner, Department of Chemical and Biochemical Engineering
Kroff, P., Examiner, Department of Chemical and Biochemical Engineering
Stipendie fra udlandet
15/12/2013 → 25/08/2017
Award relations: Developments in enzyme immobilization with downstream renewable energy applications
Project: PhD

Forward osmosis biomimetic membranes for sensor and separation applications
Bajraktari, N., PhD Student, Department of Environmental Engineering
Hélix-Nielsen, C., Main Supervisor, Department of Environmental Engineering
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Christensen, M. L., Examiner
Jönsson, A., Examiner
Offentlig finansiering
01/01/2014 → 15/03/2017
Award relations: Forward osmosis biomimetic membranes for sensor and separation applications
Project: PhD

Experimental evaluation of carbonic anhydrase as a biocatalyst for implementation in CO2 removal from flue gas
Deslauriers, M. G., PhD Student, Department of Chemical and Biochemical Engineering
Woodley, J., Main Supervisor, Department of Chemical and Biochemical Engineering
von Solms, N., Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Liese, A., Examiner
Wentzel, A., Examiner
Samfinansieret - Andet
15/09/2013 → 24/01/2018
Award relations: Experimental evaluation of carbonic anhydrase as a biocatalyst for implementation in CO2 removal from flue gas
Project: PhD

Substrate-based selection of enzymes
Dominiak, M. M., PhD Student, Center for BioProcess Engineering
Mikkelsen, J. D., Main Supervisor, Department of Chemical and Biochemical Engineering
Sworm, G., Supervisor
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Schols, H., Examiner
Ulvskov, P., Examiner
Schols, H., Examiner
Ulvskov, P., Examiner
Stipendie fra udlandet
15/08/2010 → 23/04/2014
Award relations: Substrate-based selection of enzymes
Project: PhD

SILP enzyme catalysis technology for upgrading of biomass C5 monomers
Zeuner, B., PhD Student, Technical Information Center of Denmark
Meyer, A. S., Main Supervisor, Department of Biotechnology and Biomedicine
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering
Risager, A., Supervisor, Department of Chemistry
Jørgensen, H., Examiner, Risø National Laboratory for Sustainable Energy
Christakopoulos, P., Examiner, Department of Biotechnology and Biomedicine
Christensen, M. W., Examiner
Christakopoulos, P., Examiner
Christensen, M. W., Examiner
1/3 FUU, 1/3 inst 1/3 Andet
15/12/2009 → 23/04/2014
Award relations: SILP enzyme catalysis technology for upgrading of biomass C5 monomers
Project: PhD
Enzymatic Production of Human Milk Oligosaccharides
Guo, Y., PhD Student, Department of Chemical and Biochemical Engineering
Mikkelsen, J. D., Main Supervisor, Department of Chemical and Biochemical Engineering
Willer, M., Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Rasmusson, S. K., Examiner, Rise National Laboratory for Sustainable Energy
Schols, H., Examiner
Rasmusson, S. K., Examiner
Schols, H., Examiner
Forskningsrådsfinansiering
15/08/2010 → 24/09/2014
Award relations: Enzymatic Production of Human Milk Oligosaccharides
Project: PhD

Structural characterizaion and enzymatic modification of soy polysaccharides
Pierce, B., PhD Student, Department of Chemical and Biochemical Engineering
Meyer, A. S., Main Supervisor, Department of Biotechnology and Biomedicine
Mikkelsen, J. D., Supervisor, Department of Chemical and Biochemical Engineering
Wichmann, J., Supervisor
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Kabel, M. A., Examiner
Pedersen, L. H., Examiner
Kabel, M. A., Examiner
Pedersen, L. H., Examiner
Industrial PhD
15/11/2013 → 25/08/2017
Award relations: Structural characterizaion and enzymatic modification of soy polysaccharides
Project: PhD

Production and purification of prebotic oligosaccharides by chromatography and membrane systems
Michalak, M., PhD Student, Department of Chemical and Biochemical Engineering
Mikkelsen, J. D., Main Supervisor, Department of Chemical and Biochemical Engineering
Jonsson, G. E., Supervisor, Department of Chemical and Biochemical Engineering
Pinelo, M., Supervisor, Department of Chemical and Biochemical Engineering
Jørgensen, H., Examiner, Department of Systems Biology
Sabesan, S., Examiner
Wejse, P. L., Examiner
Globaliseringsmidler
01/11/2008 → 28/05/2014
Award relations: Production and purification of prebotic oligosaccharides by chromatography and membrane systems
Project: PhD

Discovery, Characterization and Design of a thermostable RGI Lyase for production of Bio-Functional Fibers
da Silva, I. I. C. R., PhD Student, Department of Chemical and Biochemical Engineering
Mikkelsen, J. D., Main Supervisor, Department of Chemical and Biochemical Engineering
Meyer, A. S., Supervisor, Department of Biotechnology and Biomedicine
Pinelo, M., Examiner, Department of Chemical and Biochemical Engineering
Kragh, K. M., Examiner
Visser, J. (.), Examiner
Globaliseringsmidler
01/02/2009 → 18/12/2013
Award relations: Discovery, Characterization and Design of a thermostable RGI Lyase for production of Bio-Functional Fibers
Project: PhD

Integration between enzyme technology and membrane separation in biorefinery processes
Morthensen, S. T., PhD Student, Department of Chemical and Biochemical Engineering
Pinelo, M., Main Supervisor, Department of Chemical and Biochemical Engineering
Meyer, A. S., Supervisor, Department of Biotechnology and Biomedicine
Helix-Nielsen, C., Examiner, Department of Environmental Engineering
Christensen, M. L., Examiner
Wallberg, O., Examiner
Samfinansieret - Andet
Chemical Bioreaction Engineering methods for Plant Seed Upgrading: Literature review and introductory experimental work
To study different cellular structure and composition (e.g. Protein, amino acid and carbohydrates) of different plant seed materials. To explore different extraction methods (experimental and industrial scale) for the production of protein from different plant seed materials.
Ale, M. T., Main Supervisor, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Meyer, A. S., Supervisor, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Pinelo, M., Project Participant, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
06/01/2014 → 24/01/2014
Project: Research

Extraction of protein and amino acid from hemp seed meal
Ale, M. T., Project Participant, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Meyer, A. S., Project Participant, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
Pinelo, M., Project Participant, Department of Chemical and Biochemical Engineering, Center for BioProcess Engineering
GUDP projects
01/06/2012 → 30/06/2014
Award relations: Extraction of protein and amino acid from hemp seed meal
Project: Research

Enzymatic catalysis for increased extraction and positive modulation of phenolic antioxidants in functional juice and wine production
Purpose: The objective of this project is the development of an enzymatic pre-press treatment for enhancing the profile and content of polyphenols in juices and wines and thereby increasing the beneficial health properties of these (functional drinks). The objective includes to study and model the enzyme kinetics for the complex degradation of the fruit skin and to use enzymes to change the glycosydative state of the phenolic compounds in order to enhance their antioxidant power.
Background: The addition of pectin decomposing enzymes before pressing of fruits is a common practice in the production of fruit juices as well as in the production of wines. The addition of enzymes helps the breakdown of cell structure of the fruits, and the main purpose of this treatment is to enhance juice yields without compromising the taste of the resulting products. By optimizing the enzyme treatment before extraction the level of polyphenolic antioxidants can be increased in the extracted juices. Thereby an enhancement of the potential health benefits of the juices and wines can be achieved.
Collaboration partners: This project is a post doc project and correlates with other projects in the research area 'Plant food and beverage processing'
Pinelo, M., Project Manager, Department of Systems Biology
Meyer, A. S., Contact Person, Department of Systems Biology
[Ordinær drift UK 10]: DKK700,000.00
01/10/2005 → 30/09/2007
Award relations: Enzymatic catalysis for increased extraction and positive modulation of phenolic antioxidants in functional juice and wine production
Project: Research

Activities:

Advanced fabrication of porous ceramic multilayers for membrane applications
Period: 2 Oct 2017
Andreas Kaiser (Keynote speaker)
Wenjing (Angela) Zhang (Invited speaker)
Manuel Pinelo (Invited speaker)
Michela Della Negra (Other)
Department of Energy Conversion and Storage
Ceramic Engineering & Science
Proton conductors
Department of Chemical and Biochemical Engineering
Related organisation

Advanced fabrication of porous ceramic multilayers for membrane applications
Kaiser, A. (Keynote speaker), Zhang, W. (Invited speaker), Pinelo, M. (Invited speaker), Della Negra, M. (Other)
2 Oct 2017
Activity: Talks and presentations › Conference presentations

Surface properties and chemistry correlate to the digestibility of biomass following hydrothermal pretreatment at different severities
Period: 1 May 2017 → 4 May 2017
Demi Tristan Djajadi (Guest lecturer)
Aleksander R. Hansen (Guest lecturer)
Anders Jensen (Guest lecturer)
Lisbeth G. Thygesen (Guest lecturer)
Manuel Pinelo (Guest lecturer)
Anne S. Meyer (Guest lecturer)
Henning Jørgensen (Guest lecturer)
Department of Chemical and Biochemical Engineering
Center for BioProcess Engineering

Description
Poster presentation
Degree of recognition: International

Related event

39th Symposium on Biotechnology for Fuels and Chemicals
01/05/2017 → 04/05/2017
San Francisco, United States
Activity: Talks and presentations › Conference presentations