



PROGRAM

The 30th Nordic Lipidforum Symposium

THE NORDIC LIPIDFORUM SYMPOSIUM
12 – 15 JUNE 2019, HORSSENS, DENMARK

The Organising committee warmly welcome you all to celebrate anniversary when we invite lipidfriends to the 30th Nordic Lipidforum Symposium.

- Future and broader perspective in lipid nutrition and technology



Welcome to The 30th Nordic Lipidforum Symposium

Horsens, Denmark June 12 – 15, 2019



Photo: Scandic Bygholm Park

Dear Lipidforum members and colleagues!

In 2019 we celebrate anniversary when we invite you all to the 30th Nordic Lipidforum Symposium, which will take place from the 12th to the 15th of June 2019, in Horsens, Denmark.

Horsens is a city in eastern [Jutland](#) with a population of around 55 000. Already during the Viking age, it was a settlement called Horsnes. The name probably referred to the breeding of large numbers of horses in the area.

Horsens is located at the end of a beautiful fjord which can be viewed from the harbour. The fjord is the typical Danish kind with rolling hills and forests that stretches all the way down to the water (*information taken from <https://wikitravel.org/en/Horsens>*).

The symposium is an important forum for researchers, scientists, engineers and others working in both academia and industry to exchange scientific and technological results in the area of lipids, fats and oils. The topics of the symposium will encompass marine lipids, analysis, skin care, industrial aspects of lipids, health and nutritional aspects and food safety and regulatory affairs.

The symposium will take place at the **Scandic Bygholm Park**. The hotel is a renovated manor house from 1775, and the hotel is surrounded by beautiful Bygholm Park. Scandic Bygholm Park is located close to attractions such as the prison museum [Fængslet](#) (The Prison) and Legoland. For more information about the hotel, visit their website [here](#).

The Symposium dinner on Friday will be held in the above mentioned The Prison.

The scientific program will close around lunchtime on Saturday 15th of June. This gives the opportunity to extend your stay in Denmark.

We are looking forward to seeing you all at the anniversary Nordic Lipidforum symposium in Horsens 2019.

More information see our [website](#).

Best regards from the organizing committee:

Karsten Nielsen karsten.nielsen@aak.com

Ann-Dorit Moltke Sørensen adms@food.dtu.dk

Robert Wolff secretary@lipidforum.info

Nordic Lipidforum

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PRACTICAL INFORMATION

Where: Horsens – Denmark
When: 12 - 15 June 2019
How to get there: Direct flights to Billund and train to Horsens.
Visitor Information: <https://visithorsens.dk/>
Seminar language: English

Seminar fee includes Conference materials, admission to the symposium, coffee and refreshment during breaks, lunches and Get-together:

Early-bird Symposium fee:	Before May 14 th :	After May 14 th :
Members of Euro Fed Lipid and Lipidforum:	EUR 480	EUR 570
Non-members:	EUR 560	EUR 640
Students, members:	EUR 330	EUR 400
Student, non-members:	EUR 400	EUR 500

Conference dinner at [Fængslet Resturant](#): EUR 100 Students: EUR 50

Registration: Fill in registration [here](#).
Payment: Upon registration.
Accommodation: Scandic Bygholm Park.
Sponsors: Please contact organising committee for more information.
Public transportation: Information available on website [here](#). Maps also available at the same website.



The 30th Nordic Lipidforum Symposium

12 – 15 June 2019

Horsens - DENMARK

- *Future and broader perspective in lipid nutrition and technology*

PROGRAM TOPICS

Under the sub-theme *Future and broader perspective in lipid nutrition and technology*, the Scientific Committee has decided the following topics will be covered at Symposium:

- Industrial aspects of lipids
- Health and nutritional aspects of lipids
- Analysis
- Lipid in skin care
- Marine lipids
- Food safety – regulatory affairs

See you all in Horsens!



Nordic Lipidforum

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PROGRAM

We call attention to any possible changes in the program.

Wednesday June 12th

- 1400 – 1630 The Nordic Lipidforum General Board meeting (board members only)
- 1600 - 1800 Registration at the Hotel Scandic Bygholm Park.
Poster preparation.
- 1800 – 1930 Get-together

Thursday June 13th

- 0830 – 0845 **WELCOME** - Opening by Karsten Nilsen, Chairman of the board of the Nordic Lipidforum and Organising committee.

Session I – Industrial Aspects of lipids – part I

Chair: Karsten Nilsen and Kasiu Riihinen

- 0845 – 0915 **KEY NOTE – New and Future Aspects of Industrial Oil Production**, *Kaisu Riihinen*, Avena Nordic Grain Oy (FIN) & *Karsten Nielsen*, AAK (DEN)
- 0915 – 0935 **Supercritical CO₂ extracted berry seed oils: Composition and health effects**, Prof. *Baoru Yang*, University of Turku (FIN)
- 0935 – 0955 **Latest technological developments for fish/marine oil refining and post-modifications**, Dr. *Véronique Gibon*, Desmet Ballestra (BEL)
- 0955 – 1015 **None palm opportunities for the food industry**, *Jeroen Demeurisse*, AAK (BEL)
- 1015 – 1045 **Coffee break - Poster session and exhibition**

Session II – Marine Lipids – part I

Chair: Ingrid Undeland and Iren Stoknes

- 1045 – 1105 **The Nordic Lipidforum Young Scientist Award Winner 2019: Characterizing and unravelling rare long chain lipids in microalgae**, *Anita Ljubic*, DTU (DEN)



- 1105 – 1125 **Acylglycerol based prodrugs possessing EPA and DHA**, Prof. *Gudmundur Haraldsson*, University of Iceland (ISL)
- 1125 – 1145 **The use of egg and soy phosphatidylcholines with attached caffeic acid enhances oxidative stability of high fat emulsions**, *Betül Yesiltas*, DTU (DEN)
- 1145 – 1205 **Bleaching of crude mackerel oil - effect on removal of volatile secondary lipid oxidation products**, *John-Erik Haugen*, NOFIMA (NOR)
- 1205 – 1300 **LUNCH - Poster session and exhibition**
- 1300 – 1320 **Interfacial properties of potato peptides affect physical and oxidative stability of fish oil-in-water emulsions**, Prof. *Charlotte Jacobsen*, DTU (DEN)
- 1320 – 1340 **The Nordic Lipidforum Young Scientist Award Winner 2019: Synthesis of various saturated, monounsaturated and polyunsaturated methoxylated ether lipids**, *Svanur Sigurjonsson*, University of Iceland (ISL)

Session III – Health and nutritional aspects of lipids – part I

Chair: *Guðrún Valgerður Skúladóttir* and *Astrid Nilsson*

- 1340 – 1400 **KEY NOTE – Are the benefits of the omega-3 fatty acids EPA and DHA supplement use for cardiovascular events as great as previously believed?** Prof. *Guðrún Valgerður Skúladóttir*, Department of Physiology, University of Iceland (ISL)
- 1400 – 1420 **Oxidative status and fatty acid concentrations of long chain omega-3-supplements on Finnish market**, *Eija Ahonen*, University of Turku (FIN)
- 1420 – 1440 **Bioavailability of docosahexaenoic acid 22:6(n-3) from enantiopure triacylglycerols and their regioisomeric counterpart in rats**, *Kaisa Linderborg*, University of Turku (FIN)
- 1440 – 1510 **Coffee break - Poster session and exhibition**



- 1510 – 1530 **Dietary Norwegian camelina oil high in ALA increases the level of EPA and DHA in rats**, Senior Researcher *Astrid Nilsson*, Nofima (NOR)
- 1530 – 1550 **Effect of the stereospecific location of DHA in dietary triacylglycerols to its level in rat brain and eyes**, *Amruta Kulkarni*, University of Turku (FIN)
- 1550 – 1610 **Sea buckthorn oil for wellbeing of mucous membranes**, *Petra Larmo*, Aromtech Ltd, Tornio (FIN)
- 1610 – 1700 **END OF DAY ONE** - Poster session and exhibition - mingling

Friday June 14th

- 0730 – 0830 **Morning Jog – our traditional, since the Reykjavik meeting, morning jog sponsored by Larodan.**

Session II – Marine lipids – part II

Chair: Ingrid Undeland and Iren Stoknes

- 0900 – 0930 **KEY NOTE – How to produce stable marine lipid emulsions without fishy smell and taste**, Prof. *Charlotte Jacobsen*, DTU (DEN)
- 0930 – 0950 **Extending the shelf life of herring by-products to increase the possibilities for value-adding**, *Haizhou Wu*, Chalmers University of Technology (SWE)
- 0950 – 1010 **Quality of omega3 in fish liver for sustainable utilization of fishing waste**, Senior Researcher *Ann-Dorit Moltke Sørensen*, DTU (DEN)
- 1010 – 1030 **Preventive measures to prohibit post mortem hemoglobin mediated lipid oxidation in herring and rainbow trout**, *Semhar Ghirmai*, Chalmers (SWE)
- 1030 – 1100 **Coffee break - Poster session and exhibition**
- 1100 – 1120 **Reduction of lipid oxidation in Baltic herring fish mass during frozen storage by additions of berry press cake**, *Annelie Damerau*, University of Turku (FIN)



- 1120 – 1140 **The Nordic Lipidforum Young Scientist Award Winner 2019: Lipid oxidation during ensilaging of herring by-products, *Mursalin Sajib*, Chalmers Technical University (SWE)**
- 1140 – 1200 **Oxidative stability of mackerel lipids: effect of composition and antioxidants, Researcher *Revilija Mozuraityte*, SINTEF (NOR)**
- 1200 – 1300 **LUNCH - Poster session and exhibition**
- 1300 – 1320 **Physical and oxidative stability of high-fat fish-oil emulsions added algae-based stabilizers from *Saccharina latissima*, *Ditte B. Hermund*, DTU (DEN)**

Session III – Health and nutritional aspects of lipids – part II

Chair: Guðrún Valgerður Skúladóttir and Astrid Nilsson

- 1320 – 1350 **KEY NOTE – Lipidomics: development and use of high-resolution mass spectrometry-based methods for systems biology studies, *Richard R. Sprenger*, University of Southern Denmark**
- 1350 – 1410 **Influence of pre-digestion with recombinant human gastric lipase during in vitro digestion of infant formula and o/w emulsion with pancreatic lipase, *Christine Heerup*, University of Copenhagen (DEN)**
- 1410 – 1500 **Members Meeting**
- 1500 **END OF DAY TWO**
- We take a short walk down to Fængslet – Guided tour*
- 1900 **Seven generations, values, consumer behaviour and ways of living – now and in the future – *Marianne Levinsen*, Fremforsk (DEN)**
- 2000 **The Nordic Lipidforum 30th Conference dinner at Fængslet Restaurant**



Saturday June 15th

Session IV - Lipid in skin care

Chair: Ingrid Undeland and Anna-Maija Lampi

- 0900 – 0930 **KEY NOTE – Formulations for skin care - from molecular properties to macroscopic barrier function**, *Sebastian Björklund*, University of Malmö (SWE)
- 0930 – 0950 **Omega-3 fatty acids and zinc affect robustness and function of skin in Atlantic salmon**, *Tone-Kari K. Østbye*, Nofima AS (NOR)
- 0950 – 1010 **Novel lipid-based technology of existing APIs and NCEs for opportunities in topical delivery**, *Vibhu Rinwa*, Lipidor AB (SWE)
- 1010 – 1030 **Lipids and skin – from inside out and outside in**, *Jari Alander*, AAK (SWE)
- 1030 – 1100 **Coffee break**

Session I – Industrial Aspects of lipids – part II

Chair: Arnar Haldórsson and Guðrún Valgerður Skúladóttir

- 1100 – 1120 **Case story - 3-MCPD and GE in the O&F industry, and what's next to expect**, *Karsten Nielsen*, AAK (DEN)
- 1120 – 1140 **Aspects of Analytical Quality for Determination of Contaminants in Food and Feed**, *Trude Sofie Guldberg*, SINTEF Industry (NOR)
- 1140 – 1200 **Low 3-MCPD and GE: the role of bleaching earth**, *Jorge Herrero Hernández*, Clariant (SPA)
- 1200 – 1210 **Closing remarks – Welcome to the 31th Nordic Lipidforum Symposium 2021 in Norway**
- 1215 – 1330 **FAREWELL LUNCH**

HAVE A SAFE JOURNEY HOME!



ABSTRACTS

The 30th Nordic Lipidforum Symposium

Horsens, Denmark

June 12 – 15, 2019

At the following pages you will find an overview of the abstracts presented at the Symposium.

Nordic Lipidforum

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Name: Kaisu Riihinen and Karsten Nielsen

Organisation: Avena Nordic Grain Oy and AAK

Topic covered: Industrial aspects of Lipids

Title: **The Past, Presence & Future of the Lipid Industry.**

Authors: Kaisu Riihinen and Karsten Nielsen

Industrial production of lipids, oils and fats, from vegetable, animal and marine sources has a long history, both in the food industry as an important raw material margarine, frying oils, shortenings or different oil-based sauces as mayonnaise, and in the chemical industry, for example for paints and other surface protections.

As industrial processing of lipids is a relative capital intensive industry it has during the years been concentrated – and a major part of the chemical applications has been replaced by synthetic polymers, based on mineral oil production. The high level of capital investments also slows down introduction of new technologies, unless they are very beneficial.

During recent years the impact of increased understanding of the nutritional impact of the intake of trans fatty acids cannot be underestimated, this has basically ended the application of hydrogenated vegetable and marine oils in the food industry. But the raw materials have gone to other applications, marine oils are today used in the feed business for farming or in the food business as a long chain omega 3 fatty acids source, and a large part of the vegetable oils today go to biofuel, whereas the need of solid fats in the food industry is to a large extent covered by palm oil and other exotic raw materials.

In the near future a number of new challenges and opportunities are arising.

The consumers increasing focus on environmental aspects increase the focus on green energy as biofuel, and on the sustainability of the production of the raw materials, most evident on the high focus on the production of palm oil in South East Asia, but also on soy bean oil production in South America and fish farming around the globe.

Food safety is another factor influencing the industry. Continuously improving analytical capabilities reveals process- and environmental contaminants, which the industry has to deal with.

New industrial oil products may also be newly developed, innovative lipids, and oil produced using new technologies and production processes. New type of products are also obtained in the sustainable utilization of oil press cakes as a human food. Not all these products but some of them may require authorization as a Novel Food prior commercialization in the EU market. Novel food is not only novel product but as a legal definition hasn't been consumed as food to a significant degree by humans before May 1997. Authorization requires a food safety evaluation. Novel Food may also be an oil plant which is or has been traditionally eaten outside of the EU.

This presentation will revise selected summaries of the lipid product applications currently under Novel Food assessment in the European Commission. Novel food approval is under process both for *Brassica napus* (Whole seeds) and Rapeseed powder from *Brassica rapa L.* and *Brassica napus L.* Rapeseed oil is considered as a traditional food product but these new products from the same source material require safety evaluations. Composition of rapeseed powder is presented further from the safety point based on the intake of antinutrients.



Name: Ditte B. Hermund

Organisation: DTU National Food Institute

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Topic covered: Marine Lipids

Title: Physical and oxidative stability of high-fat fish-oil emulsions added algae-based stabilizers from *Saccharina latissima*

Authors: Ditte Baun Hermund, Betül Yesiltas, Ioanna Anagnostara, Alyssa Marie Soria Caindec, Xiarou Hou, Randi Neerup, Yuhong Huang, George E. Anasontzis, Lene Lange, and Charlotte Jacobsen

The protection of long-chain (LC) omega-3 polyunsaturated fatty acids (PUFAs) against oxidation when added into food matrices could be achieved by the development of fish-oil delivery emulsions and by the addition of antioxidants.

Commercial alginate, a brown algae polysaccharide, in combination with sodium caseinate (NaCas), is widely used by the food industry to stabilize emulsions. Moreover, previous studies have reported that laminarin and fucoidans, both brown-algae polysaccharides, show antioxidant activity.

In this work, alginate (NaAlg), fucoidan, and laminarin were extracted from the brown alga *Saccharina latissima* and examined for their stabilizing properties. The potential of these polysaccharides in preventing lipid oxidation and in maintaining the physical stability of 70% (w/w) fish oil-in-water emulsions were studied. The polysaccharides were formulated in different concentration (0-0.63%, w/w) together with NaCas (0.23%, w/w) into the aqueous phase. The physical (e.g. creaming, droplet-size distribution, and apparent viscosity) and oxidative (peroxide value and secondary oxidation products) stability of the emulsions, were evaluated during 12 days of storage in the dark at 20°C.

Results showed that the antioxidant activity of fucoidan, laminarin and NaAlg derived from *S. latissima* in emulsion systems was only observed for laminarin and for some concentrations of NaAlg. It was found that laminarin was the most promising polysaccharide to enhance the oxidative stability of the emulsions. However, the physical stability of the emulsions added laminarin was poor at low concentrations. Hence, it can be recommended to use laminarin extracts for stabilizing 70% (w/w) fish oil-in-water emulsions both physically and oxidatively at a concentration of 0.30% (w/w) together with 0.23% (w/w) NaCas.



Name: Charlotte Jacobsen

Organisation: DTU National Food Institute

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Topic covered: Marine lipids

Title: Interfacial properties of potato peptides affect physical and oxidative stability of fish oil-in-water emulsions

Authors: Pedro J. García-Moreno, Elham Ranjbar, Tobias H. Olsen, Paolo Marcatili, Simon Gregersen, Nykola C. Jones, Søren V. Hoffmann, Michael T. Overgaard, Egon B. Hansen, Charlotte Jacobsen

Bioinformatics was used to identify emulsifying peptides embedded within the structure of potato protein. This reduced time and cost of extensive screening hydrolysis processes. Up to 40 synthetic peptides having between 10 and 29 amino acids, different net charge and potential different conformation at the interface (e.g. alpha-helix, beta-sheet and unordered) were tested in this study. First, interfacial tension measurements and evaluation of the physical stability of 5wt. % fish oil-in-water emulsions (e.g. zeta potential, droplet size during storage) were carried out in order to select the best performing peptides. Secondly, Synchrotron Radiation Circular Dichroism (SRCD) was used to study the conformation at the oil/water interface of the selected peptides. Finally, the oxidative stability of fish oil-in-water emulsions stabilized with the selected peptides was evaluated by using Electron Spin Resonance (ESR) and determination of hydroperoxides and secondary volatile oxidation products.

The results indicated that up to five peptides showed similar or superior emulsifying activity when compared to sodium caseinate (e.g. based on interfacial tension measurements and droplet size of the emulsions). Thus, this work shows the feasibility of using bioinformatics to identify plant-based emulsifiers embedded in potato protein, which could be used to obtain omega-3 delivery emulsions with high physical stability and acceptable oxidative stability.



Name: Betül Yesiltas

Organisation: Technical University of Denmark

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Topic covered: Marine lipids

Title: Identifying useful peptides synthesized from seaweed, potato and single cell protein with emulsifying properties

Authors: Betül Yesiltas, L. Lægsgaard, M.L. Brinch, E.B. Hansen, S. Gregersen, Charlotte Jacobsen, P. Marcatili, T.H. Olsen, and Pedro J. García-Moreno.

This study is part of a bigger project which aims for identifying and producing useful peptides from available protein sources. Bioinformatics tools have been developed to predict functional peptides, which are embedded in potato, seaweed, and single cell proteins. Main focus was on identifying these peptides' emulsifying activity.

In order to characterise the emulsifying activity of these peptides, their interfacial tension was measured using a drop tensiometer. Moreover, physical stability of the 5 % fish oil-in-water emulsions produced with peptides were followed during 6 days of storage. Droplet size, zeta potential and creaming of these emulsions were monitored during storage.

Four peptides from potato source, 12 peptides from seaweed source and 12 peptides from single cell source were analyzed. Results indicated that some of the peptides from different sources provided lower interfacial tension compared to sodium caseinate as a control. Moreover, some of the peptides from potato and seaweed sources showed better physical activity compared to emulsions produced with sodium caseinate. These results demonstrated that functional peptides from various sources can be good candidates for stabilizing oil-in-water emulsions due to their emulsifying properties.



Name: Betül Yesiltas

Organisation: Technical University of Denmark

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Topic covered: Marine lipids

Title: The use of egg and soy phosphatidylcholines with attached caffeic acid enhances oxidative stability of high fat emulsion

Authors: Betül Yesiltas, Pedro J. García-Moreno, Ann-Dorit M. Sørensen, Sampson Anankanbil, Chiranjib Banerjee, Guo Zheng, Peter R. Ogilby, Charlotte Jacobsen

This study was carried out to investigate the effects of combined use of sodium caseinate (CAS), commercial phosphatidylcholine (PC) and modified PCs on physical and oxidative stability of 70 % fish oil-in-water emulsions. Caffeic acid was covalently attached to both modified PCs (egg PC and soy PC; PCs originated from eggs and soy, respectively) in order to increase the antioxidant activity of PCs and investigate the advantage of bringing the antioxidant activity to the close proximity of oil-water interface. Results showed that the oxidative stability was improved when part of the PC was substituted with modified egg PC or soy PC. Emulsions containing a low concentration of modified PCs (10 % wt of total PC) resulted in a prooxidative effect on the formation of hydroperoxides (peroxide value) compared to emulsions with free caffeic acid added. On the other hand, a decrease in the formation of volatile oxidation products was observed for emulsions containing higher levels of modified PCs (10 % wt of total PC) compared to the emulsions with free caffeic acid added at its equivalent concentration. Increased concentration of modified PCs provided higher oxidative stability in high fat emulsions independently of the type of the modified PCs. Moreover, it was shown that the oxidation did not propagate from one droplet to another droplet by the use of microscopy. In this case, oxidation was initiated by singlet oxygen produced in a single droplet using a focused laser. Oxidation propagation was followed using the fluorescence of unoxidized and oxidized C₁₁-BODIPY.



Name: Anita Ljubic

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Topic covered: Marine lipids

Title: Characterizing and unraveling rare long chain lipids in microalgae

Authors: Anita Ljubic, Charlotte Jacobsen, Betsy Read

Alkenones are polyunsaturated ethyl and methyl (C₃₆-C₄₀) ketones with unusual trans double bonds. These very long chain lipids are produced by very few microalgae species from Haptophyte family. Geochemists and oceanographers have for a long time used alkenones as a tool to reconstruct paleoenvironments as unsaturation index of their trans double-bonds provides a proxy to estimate sea surface temperatures and atmospheric CO₂ levels. Apart from being one of the most studied classes of lipids in marine geochemistry, alkenones are a potentially fruitful yet relatively unexplored renewable source of petroleum, and may also have commercial value as heavy lubricants, bioplastics, cosmetics, and/or medical products including drug delivery systems. The nutritional benefits of alkenones and/or oil extracts from haptophytes in general are also uncharted considering their high levels of nutritionally important eicosapentaenoic and docosahexaenoic acid.

To realize the potential commercial applications of alkenones and oil extracts from these microalgae, biosynthesis and accumulation metabolism of these lipids was investigated. *Emiliana huxleyi*, *Gephyrocapsa oceanica* and *Isochrysis galbana* were cultivated under different conditions (light stress, nutrient starvation and sodium bicarbonate addition) and harvested at different growth stages. Total lipids were extracted, fractionated, purified and analyzed by GC/MS. In order to characterize alkenones, biophysical characteristics (crystallization, melting point, smoke point, rheology, density and color) were examined. Oil extracts and purified alkenones were tested for antimicrobial and antifungal effect, bioavailability and antioxidative activity.

Accumulation of alkenones in microalgal cells changes through the different growth stages and under different cultivation conditions, which allows us to define conditions that will favor alkenone production and its effect on synthesis of other lipid classes including polyunsaturated fatty acids. The results obtained by characterizing and quantifying microalgal lipids from selected species, focusing on alkenones, will allow us to determine whether microalgal oil extracted from these species have nutritional, industrial and/or pharmaceutical importance.



Name: Ann-Dorit Moltke Sørensen

Organisation: Technical University of Denmark

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Topic covered: Marine lipids

Title: **Quality of omega-3 in fish liver for sustainable utilization of fishing waste**

Authors: Ann-Dorit Moltke Sørensen, Simone Andrea Warncke, Sussie Hjorth Hansen, Nina Skall Nielsen and Charlotte Jacobsen

Long chain (LC) omega-3 polyunsaturated fatty acids (PUFAs), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have been associated with several health beneficial effects and the intake for the average consumer is generally too low in the diet. Therefore, products like fish oil high in omega-3 have become a popular dietary supplement. Thus, there is a demand for new methods to obtain high quality omega-3 rich oils and applications with omega-3 PUFAs to increase the population's intake of these healthy fatty acids. Alternative sources of fish oil may be able to reduce Denmark's import of more than 100,000 tons yearly.

In Denmark, most of the wild fish caught are slaughtered and rinsed immediately, when the fishing vessel is still at the sea. The fish livers are discarded in to the sea. This practice is now prohibited in the new EU legislation. The discarded fish livers can be categorized as unutilized fish raw material. Yearly, up to 44 million tons unutilized fish raw material is discarded. Fish livers have a high content of omega-3 LC PUFAs, i.e. EPA and DHA. This liver could be stored and used for production of oil rich in omega-3 and thus create value from waste material.

The aim of this study was to evaluate the effect of storage conditions (iced and -18°C) on board the fishing vessel on the oxidative quality of the livers obtained from five different cod species. Additionally, a systematic evaluation of seasonal variation in oil content, oxidation status and fatty acid composition was performed on the different cod species. Overall, the quality of the livers seems promising for marine oil production except when obtained from monkfish due to their low oil content and high FFA. Moreover, EPA and DHA content was lower in monkfish than in the other cod species evaluated.



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Topic covered: Health and nutritional aspects of lipids

Title: **Oxidative status and fatty acid concentrations of long chain omega-3-supplements on Finnish market**

Authors: Eija Ahonen, PhD Annelie Damerau, PhD Marko Tarvainen, Associate Professor
Kaisa Linderborg

Altogether 49 fish-, krill- and algae oil supplements purchased from local grocery stores, pharmacies and online were tested for oxidative status and fatty acids concentrations. Oxidative status was analyzed with peroxide value and para-anisidine value. Fatty acid concentrations were analyzed by gas chromatography (GC-FID) and quantified in relation to internal standard.

Approximately 22 % of the products exceeded the GOED recommended peroxide value (< 5 mEq/kg). In general the infringement was small, only three products exceeded value 7 and two value 14. Due to the presence of aldehyde structured flavor compounds the para-anisidine value could be reliably determined for only 25 products, none of which exceeded the recommended value (< 20). The amount of DHA exceeded the stated amount in 33 % of the products of which the amount was declared. For 56 % of the products the amount was between 80 – 100 % of the stated amount and for 12 % the amount was lower than 80 %. Similarly, for the total amount of omega-3 fatty acids the amount was smaller than 80 % for 12 % of the products.

Generally, the oxidative status of the products on Finnish market was quite good, although the unsuitability of the para-anisidine value analysis method for flavored oils and krill oils must be acknowledged when evaluating the results. With a few exceptions the fatty acid concentrations in the products corresponded well to the stated amount.



Name: Kaisa Linderborg

Organisation: University of Turku, Finland

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Topic covered: Health and nutritional aspects of lipids

Title: Bioavailability of docosahexaenoic acid 22:6(n-3) from enantiopure triacylglycerols and their regioisomeric counterpart in rats

Authors: Kaisa M Linderborg, Amruta Kulkarni, Ai Zhao, Jian Zhang, Heikki Kallio, Johann D Magnusson, Gudmundur G Haraldsson, Yumei Zhang, Baoru Yang

Triacylglycerols (TAGs) are to a large extent chiral and they are metabolized in the chiral physiological environment. However, our understanding of the impact of TAG structure on the absorption and metabolic fate of fatty acids (FAs) is limited. This gap in knowledge has been caused by the challenging synthesis of enantiospecifically structured TAGs in quantities required for animal studies and for clinical investigations in humans. The present study was conducted to determine if dietary TAGs possessing DHA either in sn-1, sn-2 or sn-3 position and two stearic acid residues in the remaining sn-positions, [sn-22:6(n-3)-18:0-18:0, sn-18:0-22:6(n-3)-18:0 or sn-18:0-18:0-22:6(n-3)], 1) would lead to different lipid content and composition of the feces 2) would lead to difference in FA content or composition of fasting plasma or 3) would have a different impact on the weights of the organs. The study was enabled by chemoenzymatic synthesis of enantiospecific TAGs. The five-day feeding trial was conducted in mildly (n-3) FA deficient rats, and by using both tristearin and normal feed as controls. Less secretion of fecal DHA was detected from the sn-2 position compared with the sn-1 and sn-3 positions, but no difference was found in DHA content of the fasting plasma or in the weight of the body or organs. 18:0 was lost to feces mainly as cleaved from the primary positions but also as glycerol-bound. The 5-day intervention in rats was long enough to modify the fatty acid profile of plasma phospholipids in rats. To our knowledge, this is the first study assessing the bioavailability and metabolic fate of DHA from the sn-1, sn-2 and sn-3 positions of TAGs with a feeding period of several days.



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Topic covered: Marine lipids

Title: **Preventive measures to prohibit post mortem hemoglobin mediated lipid oxidation in herring and rainbow trout**

Authors: Semhar Ghirmai, Haizhou Wu, Michael Axelsson and Ingrid Undeland

Introduction

Hemoglobin (Hb), the oxygen transporting protein in blood is known as the main lipid pro-oxidant in fish. In vivo the Hb molecules are encapsulated in high concentrations in the red blood cells (RBCs). However, post-mortem biochemical changes and processing factors cause the RBCs to hemolyze, thus Hb molecules leak out and contaminate the fish muscle. In today's processes small pelagic fish such as herring are often collected in large trawls and are commercially not actively bled to remove the blood. Later on, in the filleting process the fish muscle is rinsed with tap water, However, rinsing away the blood with tap water cause osmotic imbalance, thus the red blood cells (RBCs) rapidly hemolyze and the Hb content is released. We have studied the causes of hemolysis in rainbow trout and in herring to find conditions where the stability of RBCs is maximal, and deterioration of fish muscle minimal.

Results

Optimal process parameters was found when no mechanical stress was implied, RBCs was stored in 171 +/- 51 mM NaCl and in cold temperature 3 +/- 1 C. Furthermore, we have expanded and deepened our understanding of the protecting effects seen in blood plasma. This has been done by investigating the effect of individual substances naturally found in blood plasma, such as glucose, ATP, albumin and different antioxidants. We will also study the form of Hb released and how the distribution of these Hb-forms changes over time to understand their function in lipid-oxidation.

Method

The degree of hemolysis was measured spectrophotometrically by measuring the relative amount of Hb released under different conditions.

Conclusion

Small adjustments in the early handling of post-mortem fish could minimize hemolysis during fish processing, thus delay lipid oxidation, as less Hb will be free to oxidize and react with PUFAs.



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Topic covered: Marine lipids

Title: **Reduction of lipid oxidation in Baltic herring fish mass during frozen storage by additions of berry press cake**

Authors: Annelie Damerou, Tanja Seppälä, Saska Tuomasjukka, Baoru Yang

In Finland in 2018, 126 million kg of Baltic herring (*Clupea harengus membras*) were caught commercially, of which only 3% ends up on consumer's plates. Small size and small bones of Baltic herring make filleting difficult and costly, limiting its commercial use. Therefore, herring is more efficiently processed to fish mass which has potential to be used in different fish products like fish patties. However, availability of Baltic herring is limited to winter months and therefore to ensure production all year around the fish mass needs to be stored frozen up to six months. Previously, the use of frozen Baltic herring mass was unsuccessful since the produced products had poor sensory quality because of lipid oxidation, which occurred during storage. Baltic herring is prone to lipid oxidation based on its high content of polyunsaturated fatty acids.

The hypothesis of this study was that natural additions ("green label additions") like berry press cakes from lingonberry and sea buckthorn can reduce lipid oxidation in Baltic herring fish mass during frozen storage. The effect of the natural additions on the oxidation was compared to commercial antioxidants. The lipid oxidation during storage was studied by analysis of volatile secondary lipid oxidation products using solid phase micro extraction with gas chromatography and reduction of polyunsaturated fatty acids using gas chromatography at different time points, maximum 10 months. The results of volatile oxidation compounds like E,E-2,4-heptadienal or E,E-3,5-octadien-2-one showed reduced lipid oxidation in all products with natural addition up to six month of storage. The performance of natural additions was better or comparable to commercial antioxidants.

At this point, the hypotheses have been proven; berry press cakes can be used to reduce lipid oxidation of Baltic herring fish mass during frozen storage. Further research on suitable concentrations of the additions and on consumer acceptability is needed.



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Topic covered: Marine lipids

Title: Synthesis of various saturated, monounsaturated and polyunsaturated methoxylated ether lipids

Authors: Svanur Sigurjónsson, Einar Lúthersson, Carlos D. Magnússon, Lilja Kristinsdóttir, Haraldur G. Guðmundsson, Erika Das and Guðmundur G. Haraldsson

Non-polar diacylglycerol ethers (DAGEs) constituting two fatty acyl groups attached to a 1-O-alkyl-sn-glycerol framework are characteristic of the liver oil of various chondrichthyan fish species including ratfish, rays and sharks, where they commonly constitute up to 25% of the oil. These ether lipids are known to display various beneficial biological effects on human and animal health, such as stimulating the allergic system and immune control, reducing tumor growth and benefitting asthma, psoriasis and arthritis as well as being precursors for platelet activating factors and plasmalogens. Methoxylated ether lipids (MELs) are an interesting subclass of the 1-O-alkyl-sn-glycerols possessing a methoxyl group located at the 2-position on the alkyl moiety. In the shark liver oil, MELs commonly make up 2-4% of the 1-O-alkyl-sn-glycerols present in the oil. Most common of these MELs are the monounsaturated 16 and 18 carbon alkenyl chain types comprised of the cis double bond at the 4-position on the alkenyl chain. Polyunsaturated MELs have also been discovered including the remarkable DHA-like methoxylated alkylglycerol, an all-cis 1-O-(2-methoxydocosa-4,7,10,13,16,19-hexaenyl)-sn-glycerol. These MELs also offer interesting biological effects that include antibacterial, antifungal, anticancer and immune control stimulation. They are only present in trace amounts in mammals including humans and their bioactivity studies are seriously hampered by lack of pure individual compounds possessing the natural configuration.

We hereby present the total synthesis and characterization of 10 different MELs, including the remarkable polyunsaturated DHA-like ether lipid. High enantiopurity was achieved using the natural precursors R-solketal and S-epichlorohydrin to introduce the two chiral centers into the structure of all the compounds. For the polyunsaturated types, the all-cis framework was achieved by hydrogenation via Lindlar catalyst of the corresponding poly-yne precursors followed by the crucial silver ion chromatography to separate all over-hydrogenated products as well as trans-configured double bonds resulting in stereochemically pure compounds



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Topic covered: Health and nutritional aspects of lipids

Title: **Acylglycerol based prodrugs possessing EPA and DHA**

Authors: Lena Ros Jonsdottir and Gudmundur G. Haraldsson

The bioactive n-3 polyunsaturated fatty acids (PUFAs) EPA and DHA are regarded as anti-inflammatory prodrugs since they are precursors to the highly potent lipid mediators resolvins and protectins. We have designed and synthesized enantiostructured triacylglycerols (TAGs) labeled with pure saturated medium chain fatty acids (MCFAs), n-3 PUFAs and a potent drug, where the benign effects of the n-3 PUFAs, structured and possibly enantiostructured TAGs, and the drug are combined in a single molecule. Lipid based drug carriers and prodrugs offer various advantages and our approach is believed to offer a novel and interesting form of a prodrug. An obvious choice of potent drugs for such prodrugs are the non-steroidal anti-inflammatory drugs (NSAIDs) fulfilling the prerequisite of a carboxyl group to allow ester bond formation to the glycerol framework. Hence, it was decided to base our studies on (S)-ibuprofen and (S)-naproxen to demonstrate our synthetic goal. Two regioisomeric prodrug forms were synthesized by a highly efficient chemoenzymatic approach, starting from (R)- and (S)-solketals as chiral precursors. The first form had the active drug attached as an ester to the sn-2 position of the TAG with PUFA in the sn-3 (or sn-1) and MCFA in the sn-1 (or sn-3) positions. In the second form this was reversed with the drug in the sn-3 (or sn-1) position and PUFA in the sn-2 position. The immobilized *Candida antarctica* lipase (CAL-B) from Novozymes was observed to offer outstanding regiocontrol in these processes, both on the MCFAs activated as vinyl esters and the drugs activated as oxime esters. We anticipate that a prodrug design of the type described may offer good opportunities to control site-specific release of the drug as a combination of the presence of the MCFA, PUFA and drug, their location within the TAG glycerol backbone and the consequent timing of their release.



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Topic covered: Marine lipids

Title: **Lipid oxidation during ensilaging of herring by-products**

Authors: Mursalin Sajib and Ingrid Undeland

Ensilaging - preservation under acidic conditions, is an environment-friendly and cost-effective process option to valorize underutilized fish processing by-products to potential food/feed ingredients. However, to date, limited research has been done on the ensilaging process; and, very little is known about chemical/biochemical reactions taking place during ensilaging, not least the occurrence of lipid oxidation. The aim of this study was to understand the behavior of lipid oxidation during ensilaging of herring (*Clupea harengus*) by-products under various process settings.

Ensilaging for 0–7 days at different temperatures between 7 and 47°C, revealed an increasing peroxide value (PV) and 2-thiobarbituric acid reactive substances (TBARS) development rate up to 22°C followed by a decreasing trend. Investigation of specific aldehydes e.g. malondialdehyde (MDA) and its hydrolysis product acetaldehyde revealed that MDA did not accumulate at elevated temperature (e.g. 47°C), rather it underwent hydrolytic cleavage giving rise to the formation of acetaldehyde. Further investigation of lipid oxidation and non-enzymatic browning-derived volatile compounds revealed that there was a pronounced formation of saturated aldehydes (e.g. pentanal and hexanal) and non-enzymatic browning reactions products (e.g. 2-pentylfuran and phenylacetaldehyde) at 47°C, compared to 7°C and 22°C. The pronounced formation of 2-pentylfuran and phenylacetaldehyde at 47°C indicates that the interaction between lipid oxidation-derived aldehydes (including MDA) with proteins/peptides/amino acids is higher at elevated temperatures. In addition, the endogenous α -tocopherol content decreased at a faster rate at 47°C and 22°C compared to at 7°C, pointing at the higher degree of oxidation at, and above, ambient temperatures; but with another profile of oxidation products forming as a result of different reaction routes taking place. This, in turn, dictates that e.g. PV and TBARS should be accompanied by other markers when monitoring lipid oxidation in silage produced at ambient or higher temperatures.



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Topic covered: Health and nutritional aspects of lipids

Title: Dietary Norwegian camelina oil high in ALA increases the level of EPA and DHA in rats

Authors: Nilsson A., Østbye T.K., Bergum S.K., Meisland A., Gulbrandsen O.A., Drotningvik A., and Vogt G.

Camelina (*Camelina sativa*) is an underexploited, but promising, oilseed crop in Norway relevant for both edible oil and fish feed. Camelina seeds contain up to 45 % oil, and the oil is particularly high in the omega-3 fatty acid ALA (α -linolenic acid, 18:3,n-3) (35-45 % (w/w)). Within the omega-3 fatty acids, ALA, EPA (eicosapentaenoic acid, 20:5,n-3) and DHA (docosahexaenoic acid, 22:6,n-3) are the most important with strong evidence for potential health effects. The health benefits of EPA and DHA are well documented, but there is also a growing body of scientific data supporting the idea that ALA may exert beneficial effects by other mechanisms rather than simply acting as a precursor for EPA and DHA.

The aim of the project was to study the utilization of ALA, the main omega-3 fatty acid in vegetable oils, to the long chain omega-3 fatty acids EPA and DHA in rats after intake of cold pressed Norwegian Camelina oil.

Methods:

Zucker fa/fa rats (Crl:ZUC(Orl)-Lepr fa, from Charles River Laboratories, Italy) were assigned to experimental groups of six rats each with comparable mean body weight. The rats were fed a modified, semi-purified experimental diet based on AIN-93G recommendation for growing rats with 12 % (w/w) soybean oil (control group), 7 % (w/w) soybean oil and 5 % (w/w) sandeel oil (sandeel group) or 7 % (w/w) soybean oil and 5 % (w/w) camelina oil (camelina group) for four weeks. Samples of different organs were collected and frozen at -80°C until the analyses of fatty acid composition and/or gene expression were performed.

Results:

Intake of camelina oil with high level of ALA, increase the level of EPA and DHA in Zucker rats. This increase in EPA and DHA cannot be explained by a higher hepatic gene expression level of central enzymes of the omega-3 fatty acid pathway.

The animal experiment was approved in accordance with the Norwegian regulation on animal experimentation (approval no 11603).



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Topic covered: Health and nutritional aspects of lipids

Title: Effect of the stereospecific location of DHA in dietary triacylglycerols to its level in rat brain and eyes

Authors: Amruta Kulkarni, Ai Zhao, Gudmundur G Haraldsson, Yumei Zhang, Kaisa M Linderborg and Baoru Yang

Omega-3 long-chain polyunsaturated fatty acids (n-3 LC-PUFA) are integral part of cell membrane and are essential for normal growth and development. Docosahexaenoic acid (22:3n-3, DHA) is highly abundant in the brain and retina and it is important to ensure optimum neural and visual functions. Most dietary lipids are present in food as triacylglycerols (TAGs) and the positional specificity of fatty acids on TAG plays a major role in the uptake and absorption of particular fatty acid.

Our study involved synthesis of enantiopure TAGs, animal feeding trial, and lipid composition analysis of rat brain and eye tissues to study the bioavailability of n-3 LC-PUFA from lipids with different stereospecific structures in vivo. Enantiopure structured TAGs possessing DHA at sn-1 or sn-3 positions and stearic acid at the remaining positions were synthesised in five-steps from enantiopure (R)- and (S)-solketals, respectively. The symmetrically structured sn-2 TAG possessing DHA at 2-position and stearic acid at remaining positions was synthesized by two-step chemoenzymatic route from glycerol by using highly regioselective immobilized *Candida antarctica* lipase. Forty-eight healthy male Sprague-Dawley rats were kept on low omega-3 diet for 4 weeks after weaning and then randomly divided into four groups namely sn-1, sn-2, sn-3 and control (tristearin) groups. The experimental fat intervention was continued for 5 days. Thereafter, all the rats were sacrificed with exsanguination at day 6 in the fasting state and rat brain and eyes were collected. The lipids were extracted by chloroform-methanol (2:1) method and fatty acids were analyzed as methyl esters by gas chromatograph equipped with a flame ionization detector.

In this congress presentation, the effect of the stereospecific location of DHA in dietary triacylglycerols to its level in rat brain and eyes is investigated.



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Topic covered: Lipid in skin care

Title: Omega-3 fatty acids and zinc affect robustness and function of skin in Atlantic salmon

Authors: Tone-Kari K. Østbye, Elisabeth Ytteborg, Bente Ruyter, Aleksei Krasnov, Lene Sveen, Vibeke Høst, and Gerd Marit Berge

We have studied the effects of different levels of omega-3 fatty acids (EPA and DHA) and zinc (Zn) on function and robustness of skin in Atlantic salmon post-smolt produced in recirculation units (RAS). Five different dietary groups were studied, through smoltification in freshwater and 10 weeks into the seawater phase.

Results so far indicate significant effects of omega-3 and Zn on skin quality in Atlantic salmon. A high level of EPA and DHA provided fish with a thicker connective tissue and lipid layer, compared to fish given a low level of EPA and DHA. Fish given a high level of Zn had a smoother epidermis and higher number of mucus cells than the fish given a low level of Zn. These differences seemed to be important for fish robustness when the fish were transferred to seawater. A number of salmon were inflicted with standardized wounds using a punch biopsy, and the wound healing process was followed for three weeks. The quickest wound healing was seen in fish given high dietary level of Zn, while the slowest wound healing process was seen in fish given low level of EPA and DHA. The results indicate that omega-3 and Zn strengthen the skin in different ways, thus different levels may be used in different periods to increase robustness and barrier functions.

Results so far indicate that nutritional factors have a significant impact on both chemical composition, structure and function of skin in Atlantic salmon. Further studies are needed in order to find optimal nutrient levels for the different stages during smoltification and sea transfer.



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Topic covered: Marine lipids

Title: **Oxidative stability of mackerel lipids: effect of composition and antioxidants**

Authors: Revilija Mozuraityte, Inger Beate Standal and Ana Karina Carvajal

Rest raw materials obtained after filleting of pelagic fish such as mackerel can be processed into several valuable products such as fish oil, proteins or meal. Marine lipids are known as a source of bioactive long chain polyunsaturated omega-3 fatty acids (n-3 LC- PUFA), namely EPA and DHA, and for their promotion of human health. Therefore, lipids obtained from mackerel rest raw materials have great potential in the omega-3 supplement market. However, due to high unsaturation mackerel oil is also very prone to oxidation. In order to stabilise the lipids, the effective antioxidant should be added early in the process as oxidation is not reversible process.

This study discusses the oxidative stability of three different fractions:

- 1) heads, backbones and tails,
- 2) heads, backbones, tails, cut-offs and viscera and
- 3) viscera.

The model system developed at SINTEF Ocean and based on dissolved oxygen consumption measurement for quantification of lipid oxidation was used for screening of selected antioxidants. The most effective antioxidants were tested in the lab scale mackerel oil production. Oxidative quality and stability of the obtained oils and lipids in the sediment fraction and the effect of antioxidants will be discussed.



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Topic covered: Marine lipids

Title: **Bleaching of crude mackerel oil - effect on removal of volatile secondary lipid oxidation products.**

Authors: John-Erik Haugen, Ane Meisland and Åge Oterhals

Introduction

Bleaching adsorbents based on activated clay minerals are used in fish oil refining for removing of color components (carotenoids), oxidation products, trace minerals and soaps. Beside their effect on peroxide value (PV) and anisidine value (AV; i.e. aldehydes, principally 2-alkenals and 2,4-dienals), bleaching clays may also have a positive effect on the removal of other volatile organic compounds (VOCs) including secondary lipid oxidation products, which are odor active compounds contributing to off-flavors in marine oils.

Commercial bleaching clays have been tested on crude mackerel oil produced from mackerel byproducts. Initially, seven bleaching clays have been screened with regard to their effect on color reduction and removal of primary and secondary lipid oxidation products. In addition, VOCs have been analyzed using dynamic headspace gas-chromatography mass spectrometry (DHS-GC/MS). The bleaching clay that showed the best overall efficiency in the screening trial was further tested by use of a 3-factorial central composite design (CCD) based on amount of added adsorbent, activated carbon, and time to identify the optimal bleaching conditions.

Results

Bleaching clays showed a significant reduction in volatile organic compounds. Up to 80 % reduction of total VOCs in the crude oil was obtained. And 70 to 90 % of individual volatile secondary lipid oxidation products in the crude oil could be removed by the bleaching process. As example, a typical lipid oxidation product from n-3 fatty acids, 1-penten-3-ol was reduced by 90 %. The levels of volatile secondary lipid oxidation products also showed a high significant correlation with AV: 2-hexenal ($r=0.90$, $p<0.0001$), 1-penten-3-ol ($r=0.83$, $p<0.0001$) and 2-ethylfuran ($r=0.84$, $p<0.0001$).

Conclusions

Beside the reduction of PV, AV and color components, the bleaching of fish oil may have a significant additional positive effect with regard to the removal of other volatile secondary lipid oxidation products.



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Topic covered: Lipid in skin care

Title: **Novel lipid-based technology of existing APIs and NCEs for opportunities in topical delivery.**

Authors: Vibhu Rinwa, Jan Holmbäck and Hwanmi Lim

Introduction

AKVANO® lipid-based technology offers unique product opportunities in dermal drug delivery systems.

Technology

AKVANO® technology is based on water-free lipid formulations where selected lipids and elective active ingredient are dissolved in a volatile solvent. Different lipid combinations provide desired properties in order to optimize the incorporation and function of active components in the formulation.

Penetration and stability studies

A flow through diffusion cell system has been used for permeation of AKVANO® formulations to compare with commercial products, using artificial or pig ear skin membranes. Stability studies for all optimized formulations involved in house developed stability indicating methods. This is mostly followed by indicative accelerated stability tests.

Results

The resulting formulation is a sprayable liquid (other delivery options such as drop, solution, stick, medical wipe are available), suitable for topical administration. After evaporation of the solvent, a thin lipid layer is formed on the skin surface for effective deposition of the active ingredient which leads to highly efficient physicochemical interaction with the skin. Penetration studies are performed on several APIs in AKVANO® and results from experiments showed that AKVANO® formulations has much higher penetration when compared with marketed creams and ointments. The direct deposition of lipids and active compounds leads to highly efficient physicochemical interaction with the skin barrier, resulting in quicker, direct penetration into the stratum corneum and potentially a faster onset of action of active compounds. This is ideal for reformulation of established active substances, but also in finding the optimal formulation for New Chemical Entities. Accelerated physical and chemical stability studies result showed that there was no degradation products up to 12 months in most of optimized formulations.

Conclusion

The versatility of AKVANO delivery system has enabled the successful incorporation of more than 60 structurally different active pharmaceutical ingredients (APIs), used in products for different therapeutic applications such as: anti-psoriasis, antimicrobial, anti-inflammatory, antifungal, local anaesthetics, anti-acne, wound healing, anti-eczema, nonsteroidal anti-inflammatory and more.



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Topic covered: Health and nutritional aspects of lipids

Title: **Are the benefits of the omega-3 fatty acids EPA and DHA supplement use for cardiovascular events as great as previously believed?**

Authors: Guðrún Valgerður Skúladóttir

Early trials evaluating the effect of omega-3 fatty acids have reported benefits for cardiovascular events, but recent large study trials have variable findings. Cardiovascular disease (CVD) is a class of diseases that involve the heart or blood vessels, such as angina and myocardial infarction (known as a heart attack). Recently, European Medicines Agency (EMA) submitted press release confirming that omega-3 fatty acid medicines containing a combination of an ethyl ester of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) at a dose of 1 g per day are not effective in preventing further problems with the heart and blood vessels in patients who have had a heart attack.

In the human body, high levels of triglycerides (TG) in the bloodstream are a risk factor for CVD, and it is authorized that one of the most important and consistent effects of EPA and DHA is evident in their role in reducing blood TG levels. Many trials included in meta-analyses have tested an insufficient daily dose of omega-3 fatty acids of less than 1 g. The benefits of this omega-3 fatty acid intake in doses above 2 g daily on serum TG levels are well-documented and not a matter of debate. The effect of omega-3 fatty acids on TG synthesis in liver and thereby on the TG level in the bloodstream is beneficial against CV disease, but the scientific evidence on the mechanism involved in the liver is not clear.

The possible explanations for the observed controversies surrounding heart health benefits of EPA and DHA supplementation may be the disparity between cohort, baseline characteristics, pre-clinical and clinical studies, and the genetic variability among study participants on the effects analyzed.



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Topic covered: Health and nutritional aspects of lipids

Title: Sea buckthorn oil for wellbeing of mucous membranes

Authors: Petra Larmo (Aromtech Ltd, Tornio, Finland), Baoru Yang (University of Turku, Finland), Heikki Kallio (University of Turku, Finland)

Mucous membranes line the body canals and structures facing the environment, including the outer surface of eyes, respiratory, digestive, and urogenital tracts. Sea buckthorn oil manufactured by supercritical carbon dioxide extraction has shown beneficial effects on mucous membranes in clinical studies.

Dry eye is a multifactorial disease of the ocular surface, associated with inflammation and symptoms of dryness and grittiness. In dry eye, osmolarity of the tear film protecting the ocular surface is elevated, most commonly due to insufficient tear film lipid layer, allowing excess water evaporation.

Effects of a standardized combination of sea buckthorn berry and seed oil on dry eye were investigated in a randomized, double-blind, placebo-controlled study. One hundred women and men took 2 g of sea buckthorn or placebo oil daily for three months. Intake of sea buckthorn oil, compared to placebo, attenuated the rise of tear film osmolarity, and relieved the symptoms of burning and redness of eyes. In topical application, an eyelid spray containing sea buckthorn oil and hyaluronic acid relieved the symptoms of dry eye in a randomized, controlled study of 50 participants.

Up to more than 40% of postmenopausal women experience symptoms of vaginal atrophy, drying and thinning of vaginal mucosa due to decreased estrogen. Effects of sea buckthorn oil on vaginal atrophy were investigated in a randomized, double-blind, placebo-controlled study of 116 women. During the study period of three months the participants daily took 3 g of standardized sea buckthorn berry and seed oil or placebo. Intake of sea buckthorn oil compared to placebo improved the integrity of vaginal epithelium. In topical application, a cream containing sea buckthorn oil and hyaluronic acid had beneficial effects on condition of vaginal mucosa and symptoms in a study of 214 postmenopausal women.



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Topic covered: Marine lipids

Title: Extending the shelf life of herring by-products to increase the possibilities for value-adding

Authors: Haizhou Wu, Semhar Ghirmai, Ingrid Undeland

Introduction

Today, the majority of all by-products from the fish industry are targeted feed production, or even end up as waste. Globally, these raw materials are estimated to carry around 25 million tonnes of protein- and omega-3-rich-muscle, which instead could be used in food production. Techniques to separate food grade muscle, proteins and oil from complex bony raw materials exist, but applying such techniques on fish by-products is rendered difficult by their high susceptibility to lipid oxidation. Stabilizing strategies for fish-byproducts are thus needed. In Sweden, herring by-products dominate, but are particularly troublesome due to their high levels of hemoglobin (Hb), a strong catalyst of lipid oxidation. The aim of this study was to quantify Hb and investigate the effect of incubating, dipping or rinsing herring by-products in different solutions on the removal of Hb and the development of lipid oxidation during subsequent ice storage.

Results

Herring by-products had 3-5 times higher Hb-levels than the fillet, with most of the Hb being interior, i.e. not on the surface. Thereby, only 10-18 % Hb could be rinsed away with water or physiological salt (0.9 % NaCl), and the effect of such a rinsing on lipid oxidation development during subsequent storage was limited. Solutions with added antioxidants (rosemary extract, ascorbic acid, tocopherols and citric acid in 0.9 % NaCl) were therefore developed, and effects of dipping or incubating by-products in these solutions on lipid oxidation were remarkable; shelf life went from <1 day to >12 days.

Conclusion

Novel antioxidative strategies for protecting herring by-products from oxidation were developed which could significantly extend their shelf life and therefore would be powerful tools within industry to allow upgrading of fish by-products to food ingredients.



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Topic covered: Health and nutritional aspects of lipids

Title: Influence of pre-digestion with recombinant human gastric lipase during in vitro digestion of infant formula and o/w emulsion with pancreatic lipase

Authors: Christine Heerup, Sofie Falkenløve Madsen, Charlotte Jacobsen, Ragna Berthelsen and Anette Müllertz

Introduction

Lipids constitute around 50 % of the daily energy intake during the first six months after birth, where infants are fed mothers' milk or infant formula. Human gastric lipase (HGL) acts in the stomach and is responsible for 10-30 % of total digestion of dietary fat in infants. Recommendations for pediatric digestion models exist and the importance of gastric lipolysis by HGL is acknowledged; however, due to limited availability of HGL, the presently existing in vitro models use gastric lipase of animal or microbial origin.

Objective

The purpose of the study was to test the hypothesis that implementation of a gastric digestion step using recombinant HGL (rHGL) in pediatric in vitro digestion models is necessary to get a realistic estimation of lipid digestion in infants.

Methodology

A two-step in vitro lipolysis model using titration on a pH-STAT apparatus was developed, in which rHGL was used during a 50 min gastric step and porcine pancreatin was used as a source of pancreatic lipase during a 90 min intestinal step. NAN₁ and soy phosphatidylcholine – oil (SPCemul) emulsion was digested using 0, 3.75 or 7.5 TBU/mL rHGL in the gastric step, followed by 0 or 26.5 TBU/mL pancreatic lipase in the intestinal step (five combinations in total).

Main findings

Gastric digestion with 3.75 or 7.5 TBU/mL rHGL for 50 min was sufficient to achieve 10-30 % of the total digestion for both SPCemul and NAN₁. Similar levels of digestion was observed after 140 min of digestion of NAN₁ both with and without pre-digestion with rHGL, while a synergistic effect between rHGL and pancreatic lipase was observed for SPCemul.

Conclusions

Even low levels of in vitro pre-digestion with rHGL influence the impact of pancreatic lipase and gastric:total lipolysis ratio in a substrate-dependent manner. The underlying cause of this finding remains to be elucidated.



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Topic covered: Industrial aspects of lipids

Title: Low 3-MCPD and GE: the role of bleaching earth

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Since new Regulations in Europe are setting maximum limits, the reduction of 3-MCPD esters and glycidyl fatty acid esters (GE) has become a high priority for the oils and fats industry. Clariant as one of the leading suppliers to the industry and with more than 100 years of experience on bleaching earths under the brand name Tonsil® has adapted its portfolio to the new market demands.

Tonsil® bleaching earths produced under strict purity principles are satisfactory applied by the edible oil industry helping to keep the 3-MCPD and GE values under control.

Tonsil® bleaching earths are playing an important role by removing the 3-MCPD precursors and therefore avoiding the formation of 3-MCPD during processing. On the other hand, acid activated Tonsil® grades show very good results by catalyzing the decomposition of GE's formed during the process and maximizing the reduction after bleaching. Thus, selection of an appropriate bleaching earth together with optimized refining conditions are key parameters to keep the desired low 3-MCPD and GE values.

We understand the needs of our customers for successfully producing high-quality edible oils or biofuels. To that end, Clariant has increased their production capacity and technical abilities (new sites in France and Turkey, bigger technical team...) and enlarged the product portfolio, all to ensure we are closer to the customer and can better support evolving market and regional requirements, considering also further applications as oleochemicals, pharma, etc.

Innovation and R&D are key for Clariant and several projects are being developed to address the coming issues for the industry: MOSH/MOAH reduction, lower oil retention on the spent cake, etc.



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See you all in Norway 2021!



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