

48th Conference of the West European Fish Technologists' Association

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Lisbon - Portugal, 15-18th October, 2018

ABSTRACT BOOK

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ORAL COMMUNICATIONS

OC01 - Functional aptitude of hake minces with added TMAO-demethylase inhibitors during frozen storage

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Denaturation and aggregation of myofibrillar proteins during frozen storage is the main cause of loss of fish muscle quality and functional aptitude. In hake muscle, the activity of the TMAO-demethylase enzyme has been reported to be among the main factors responsible for cold-induced protein denaturation. This enzyme degrades Trimethylamine-N-oxide (TMAO) to DMA, producing equimolar amounts of formaldehyde (FA), which is a well-known protein denaturing agent. The *in vitro* TMAO-demethylase inhibitory capacity of various tea aqueous extracts (green, white, red and black), as well as sodium citrate and phytic acid, has been compared. Based on its greater activity, phytic acid, sodium citrate and black tea extract were selected to be incorporated into hake mince, and the quality and thermal gelation capacity during five months of frozen storage at – 12 °C was evaluated. Phytic acid showed greater enzyme inhibitory activity in the mince and less FA accumulation during storage; however it caused *per se* a significant decrease in water holding capacity (WHC) and soluble protein. These results correlated well with the structural analysis of mince water by nuclear magnetic resonance (LF-NMR) and the size distribution of the soluble protein fraction aggregates by Dynamic light scattering (DLS). The gelling capacity of frozen hake mince with the different additives was evaluated along the storage period. At the rheological level, phytic acid produced more unstable batters (salt-ground muscle) and hindered thermal gelation after three months of storage. Black tea and citrate produced a significant decrease in FA content after five months in the frozen state, at which time they exhibited little difference in WHC, soluble protein and rheological behaviour with respect to the control (without additive). Despite showing a clear inhibitory effect of the enzyme TMAO-demethylase *in vitro*, the compounds studied showed a limited protective capacity regarding the hake mince functional aptitude.

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OC02 - Measures to prohibit post mortem hemoglobin mediated lipid oxidation in herring and rainbow trout

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Hemoglobin (Hb), the oxygen transporting protein in erythrocytes is known as the main lipid pro-oxidant in fish. Exsanguination after slaughter has been proven to be an effective way to minimize oxidation of polyunsaturated fatty acids (PUFA) in fish. However, studies have shown that this technique eliminate less than 50 % of the total blood, and there are evidence that the remaining blood contribute to rapid lipid oxidation of the fish muscle. Furthermore, small pelagic fish such as herring are often collected in large trawls and are commercially not actively bled, beyond the small amounts of blood that are lost, due to injuries, while the herring is incubated in the round in refrigerated sea water (RSW) tanks, and later on in the filleting process where the fish muscle is rinsed with tap water. Preliminary observations in our group have indicated that incubating erythrocytes in salt concentrations far from the physiological, e.g. 0% (tap water) or 3% (sea water), cause rapid hemolysis. Our hypothesis is that minimal hemolysis during fish processing should delay lipid oxidation, as less Hb will be free to oxidize and react with PUFAs.

The aim of this project is to further explore causes of hemolysis in herring and rainbow trout blood to find conditions where stability of erythrocytes is maximal, and deterioration of fish muscle minimal. We will expand and deepen our understanding of the effects of salinity of the rinsing solution, and also investigate the role of pH, antioxidants and other additives. The degree of hemolysis is measured spectrophotometrically by measuring the relative amount of Hb released under different conditions. We will also study the form of Hb released and how the distribution of these Hb-forms change over time to understand their function in lipid-oxidation.

OC05 - Effect of clove water extracts pre-treatment on lipid oxidation in sun dried sardines (*Rastrineobola argentea*) from Lake Victoria, Tanzania

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Lake Victoria sardines (*Rastrineobola argentea*), are fatty fish species attracting great attention as they are good source of health promoting omega-3 polyunsaturated fatty acids. While nutritionally valued, omega-3 fatty acids are susceptible to oxidative damage during fish processing and subsequent storage. The traditional low-cost, low-technology and weather-dependant open sun drying is the common sardine preservation method around the Lake. However, the process promotes lipid oxidation reactions which result in loss of omega-3 fatty acids and production of undesired flavours and odours in products. This study investigated the effect of clove water extracts pre-treatment on lipid oxidation in sun dried sardines. Lipid oxidation was assessed by peroxide value (PV), volatile components by GC-MS and fatty acid analysis by GC-FID. Results showed that soaking of sardines in 5, 10 and 20 g L⁻¹ clove water extracts for 40 min prior to sun drying reduced peroxide values in dry sardine by 38.7, 54.6 and 56 % respectively. Retention of DHA, EPA and DPA in sardines treated with 20 g L⁻¹ clove water extract was improved by 34.9, 36.6 and 34.4 % respectively. Significantly lower amounts of representative volatile compounds namely; 1-penten-3-ol, t, t-2, 4-heptadienal, t-2-penten-1-ol, 4-heptanal and Hexanal were produced in sardines pre-treated with clove extracts indicating protection of DHA and EPA from oxidative decomposition during sun drying process.

OC06 - Recovery of valuable aroma profile from fishery industry by-products streams

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Natural aromas, directly isolated from natural sources, are used as additives in the food industry and have a market value 20-50 times higher than the same compounds produced chemically. Food-processing gaseous and some liquid effluents are rich in volatile organic compounds and their direct discharge has a negative environmental impact. However, food effluents contain natural aroma compounds with high organoleptic value, which may be recovered. The aim of this work is the recovery and fractionation of volatile compounds from fishery by-products to obtain aroma concentrates, with good organoleptic properties and free from off-flavours, to be used as food additives. The selected case-study was a sardine cooking wastewater.

Due to the heterogeneity of the raw material, the need for its pretreatment was assessed through a comparison of the aroma compounds recovered from the raw material and from pre-treated raw material. The pre-treatment consisted of a centrifugation followed by a membrane processing step of the fraction of centrifugation more concentrated in aroma compounds. The recovery of the volatile compounds from the sardine effluent was performed using vacuum distillation and pervaporation. The condensates obtained were (semi-quantitatively) characterised in terms of their aroma profile by GC-MS/SPME. The condensates produced comprise the key desirable sardine aroma compounds (e.g. 1-penten-3-ol) and characteristic off-flavours (e.g. sulphur compounds) resultant from the raw material oxidation. Then, vacuum distillation and pervaporation were studied and compared under similar operating conditions.

The optimisation of the most efficient process was performed by assessing the different operating conditions involved, aiming maximised selectivities of aroma with good organoleptic properties in relation to off-flavours (using an aroma fractionation step). This study used a model solution, defined from previous data, which allowed a quantitative characterisation of the different samples in terms of their aroma compounds by GC-MS/SPME.

OC07 - Effect of different stabilization methods on structural and functional properties of protein recovered from brown seaweed, *Saccharina latissima*

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Effect of different post-harvest stabilization methods; freezing at -20°C/-80°C, oven-drying, sun-drying, freeze-drying and ensilaging on the protein yield, structural properties (molecular weight distribution and secondary structure) and functional properties (solubility and emulsion capacity) of protein recovered from brown seaweed, *S. latissima*, using alkaline solubilization/isoelectric precipitation was studied. Also, the efficacy of freeze-thawing in improving the isoelectric protein precipitation of the process was evaluated. The freeze-dried, oven-dried, and -20°C frozen seaweed resulted in a protein extraction yield significantly higher than the -80 frozen, sun-dried and ensilaged biomasses. Interestingly, freeze-thawing increased protein precipitation and the total protein yield of the process up to 2 times, reaching 20% and 26% for the oven-dried and freeze-dried seaweed, respectively. Sun-drying and -20°C freezing caused high degree of protein degradation as reflected in the polypeptide pattern of the seaweeds, while oven-drying caused highest alteration in the seaweed protein structure with less α -helical structure. High performance size-exclusion chromatography also revealed substantially higher proportion of high molecular weight proteins in protein recovered from freeze-dried seaweed. Proteins from all seaweeds had high water solubility ($\geq 80\%$) at neutral and alkaline pH's while only the proteins from sun-dried biomass showed high solubility in acidic pH's. Proteins from the sun-dried and -20°C frozen seaweed had considerably higher emulsion activity than those from the freeze-dried and oven-dried seaweed. To conclude, to recover seaweed proteins more efficiently in a biorefinery approach, the post-harvest stabilization method must be carefully chosen based on the final application of the proteins as well as economic and environmental aspects.

OC12 - Processing suitability of side streams from pelagic processing plants

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Self-sustainability and zero waste policies are becoming increasingly important in today's world as society is increasingly becoming aware of what part it plays in climate change. Decreasing the amount of unutilized raw materials in fish processing plants would be a step towards achieving these policies and could be achieved by turning underutilized side streams into highly sought-after products through innovative processing, such as extractions of enzymes, valuable omega-3 fatty acids, chitin, carotenoids, and other biologically active compounds.

The purpose of the study was to determine the effect of several different variables on the quality of side streams of pelagic fishing. These variables included the amount of fish caught, time until landing, amount of belly-filling, as well as location and timing of catch. Samples were also collected during July-September in a fish processing plant in East-Iceland. The side stream was broken down into four different phases which were acquired using centrifugation and the suitability of each phase for further processing was determined using proximate analysis.

Preliminary results indicate that significant value can be added to the side streams through innovative processing, producing high value products instead of traditional processing, which yields fish meal and oil.

By looking at innovative means to utilize side streams in fish processing plants it might be possible to produce valuable products intended directly for human consumption.

OC13 - Mussels as feed for organic husbandry

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The need for organic protein sources for animal feed for Danish organic livestock production is expected to see a further increase, when EU requirements from 2018 stipulate that all feed for organic livestock production must be 100 per cent organic.

The MuMiPro (Mussel farming, Mitigation and Protein Source for organic husbandry) project aims at developing a new way of growing mussels with a dual purpose: To create a new business area in Denmark by producing animal protein feed ingredients for organic husbandry and at the same time improve the marine environment by mitigating eutrophication effects through harvest of mussels. Researchers and the mussel farming industry join forces to develop a basis for Danish mussel farming, which will both improve the environment in coastal Danish waters and deliver sustainable feed protein, which is a scarce resource for organic pig, and poultry farming. At DTU we have set up a new process method for producing a protein rich meal from mussels, avoiding the expensive cooking and deshelling process, which is used in the conventional process for mussel production for consumption. By chopping of whole mussels with shells and byssus and a subsequent separation by a filter press a protein rich juice is produced, which is further spray dried to a meal ready as feed for organic poultry. A mussel meal produced through the conventional process is also produced, which is made with cooked and deshelled mussels which are subsequently dried to a meal. The two meals are analyzed for their nutritional value and feed formulations have been prepared for organic poultry. A total of 210 egg laying hens in an organic farm are receiving the diets.

The novel production method used for the production of the mussel meal will be presented along with the preliminary results from the feeding test.

OC14 - Innovative technologies for extraction of valuable components from salmon rest raw materials

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More than 1.3 million tonnes of marine rest raw materials (MRRM) are generated in Europe each year. Some countries have traditionally been utilising significant parts of the MRRM, mainly as silage, which is often processed into animal feed. Only a small fraction of the MRRM is used for human consumption or other value added applications. In other countries, due to the lack of specialised infrastructure, the MRRM are wasted or sent directly for animal feed without any attempt to recover the valuable components. Traditional processing technologies (e.g. thermal extraction, hydrolysis, silage) for MRRM that contain significant amounts of oils, usually aims at high amounts of oil or maximised solubilisation of proteins, with either the proteins or the oil considered as secondary products. Salmon RRM like skins, backbones and viscera contained significant amounts of both lipids and proteins, which could be extracted and used as valuable ingredients in several applications. A new approach for traditional hydrolysis of MRRM containing significant amounts of oils will be presented. The basis of several stage processing is the mild thermal separation of oil prior to hydrolysis and further processing of the de-fatted RRM. The oil obtained by thermal separation shows significantly higher quality compared to oil separated during hydrolysis with addition of commercial enzymes. The protein changes during the thermal separation step does not affect the hydrolysis of the proteins by the added proteases. The third stage of the processing covers further extraction of valuable components like gelatine, phospholipids and nucleic acids. Therefore, the three stage processing where oil is separated using mild heating during the first step look very promising both with regard to economical (up till 85% of oil from raw material is separated before hydrolysis) and quality aspects (oil contained low amount of free fatty acids and were not oxidised).

OC15 - Possibility of using a low molecular weight fraction from shrimp boiling water as microalgae growth media

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Throughout seafood processing, large volumes of water are being used which after contact with the fish/shellfish carry significant amounts of nutrients. Today not only the nutrients are lost without any proper treatment but also discharge of these process waters impose cost to the companies. This work is part of the Nordic project “*Extracting Novel Values from Aqueous Seafood Side Streams –NoVAqua*” introducing innovative ways to recover nutrients from shrimp process waters, and investigate using a low-molecular weight (LMW) fraction of shrimp boiling water (SBW) as nutrient containing media for microalgae growth.

LMW fractions from SBW were obtained by subjecting the SBW to flocculation using different food grade flocculants for the recovery of protein. These waters were evaluated as nutrient containing media for the cultivation of freshwater microalgae (*Chlorella sorokiniana* (CS) and *Auxenochlorella protothecoidsis* (AP)). Flocculants were selected from natural and synthetic ones.

Batch growth curves were conducted and growth measured, along with analysis of key nutrients, such as, NH₄, PO₄ and amino acids to identify potential limiting nutrients. Results showed that both species had the highest growth rates and final optical density in chitosan and alginate flocculated SPW. Growth in carrageenan flocculated media was found to be intermediate, whereas there was no growth in media from SBW flocculated with a synthetic flocculant. The AP species had approximately the same growth rate as CS, but had a greater final density in both LMW fractions from natural flocculated SBW. We will additionally present insights on the uptake of key nutrients and the results of scaled experiments with more detailed screening of amino acid uptake.

OC20 - Stress of becoming food – Timing of euthanising fish to secure good fillet quality

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In order to secure a high quality fish product, it is important to drain blood from the muscle. Proper exsanguination can be challenging on board fishing vessels as catches are large and the fish are alive and vigorous. It is therefore common practice in trawl and Danish seine fisheries to expose the fish to air prior to bleeding and gutting so that the fish become moribund and easier to handle. Previously, it has been recommended that Atlantic cod (*Gadus morhua*) should be bled within 30 minutes after euthanasia. However, the effects of stress prior to harvest, that can negatively affect fillet quality, has not been taken into account.

In the present study, we investigated the effects of crowding and air exposure time before and after euthanasia, on blood parameters and fillet quality of Atlantic cod. Directly or after 4h of crowding, fish were exposed to air for 0, 15 or 30 minutes prior to or after euthanasia. Blood clotting time, pH, lactate, glucose and muscle pH were measured as indication of stress. Also, muscle haemoglobin concentrations, to indicate residual blood in the muscle, were measured using VIS/NIR hyperspectral imaging.

We found that blood clotting time was lower after 15 minutes of air exposure, and crowding appeared to have an additional reducing effect. Blood and muscle pH, as well as lactate levels were mainly affected by air exposure time. The present results indicate that fillet quality can be improved by euthanising the fish prior to air exposure as this prevents an increase in amount of residual blood in the muscle.

OC21 - Addition of pea-flour and pea-protein concentrate in surimi gels.

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The objective is to study the influence over protein gelation of the addition of commercial pea flour (PF) and pea protein concentrate (PPI) on Alaska Pollock surimi (Grade KA).

The main interest of fortify surimi with the PF and PPI is because of peas are a good source of nutrients and phytochemicals (galactosides, phytates, phenols, lectins or protease inhibitors), that have been associated to health promoting functions.

Surimi samples were prepared by adding 2%NaCl (control) and different concentration of PF (5%, 8%) and 1.41% PPI (same total protein concentration than samples with 5% PF). Gelation process consisted of 40 °C/1hour +5 °C/overnight and then 90 °C/30 min. SDS-PAGE showed no chemical interaction between surimi and pea proteins, so looks like that the pea protein could form a dispersed phase (binder) apart from the main myofibril protein matrix. Breaking force (BF) and deformation (BD) significantly diminished with the PF addition. Samples with PPI exhibited higher values than samples with PF. It seems that the starch and PF fiber induced the formation of a heterogeneous myofibrillar network which reduced the water binding capacity.

Stress sweeps provided the limit values of the linear viscoelastic range in terms of the stress (σ_{\max}) and strain (γ_{\max}) amplitudes. Both parameters were significantly higher in sample with PPI compared with surimi gel. So, PPI could act as a dispersed phase in the multi-component composite, improving the structural stability (high σ_{\max}) and the conformational flexibility (high γ_{\max}) in the gel matrix, maintaining similar firmness and solid-like nature than surimi gel. Conversely, gels with PF showed lower values of σ_{\max} and γ_{\max} reflecting some structural damage produced by new dispersed phases (starch and fiber) in the myosin matrix, in line with BF and BD values.

OC27 - Characterization and analysis of the biotechnological potential of a *Chlorococcum* sp. strain isolated at the microalgae production unit – ALGAFARM

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Allmicroalgae is a Portuguese company that produces microalgae at Algafarm, the industrial microalgae plant located in Pataias, Leiria. The produced microalgal biomass is intended for food, feed and for other industrial applications. Microalgae produced by Allmicroalgae are cultivated in closed systems, either in photobioreactors or fermentation vessels. Together with a strict biochemical analysis plan, these technologies enable the delivery of pure, high quality and safe microalgal products. The production plant is certified for food safety, quality, health and environmental systems, and has recently obtained the European Organic Certification for the *Chlorella vulgaris* biomass.

Microalgae can efficiently use CO₂, being responsible for more than 40 % of global carbon fixation. At Algafarm, a novel *Chlorococcum* sp. strain 0030CN has been isolated and well characterized. Preliminary phylogenetic analysis suggests that *Chlorococcum* sp. 0030CN is a novel species related to *C. minutum* and *C. aquaticum*. The best areal productivities, maximum and global, were reached at industrial scale 10-m³ PBRs with 36.559 g.m⁻².day⁻¹ and 17.419 g.m⁻².day⁻¹, respectively. This strain was shown to be rich in protein (> 55%), carotenoids (4-5%; mainly lutein and β-carotene) and 18.35 % of the total lipids content, containing a high proportion of PUFAs (74.70% of total fatty acids). The potential of this strain to be used in animal feed and in cosmetics is evident, but more data is needed concerning the growth rates in heterotrophic and mixotrophic growth conditions.

OC28 - Biomass of Novel Microalgae (*Tetraselmis* sp. IMP3, *Tetraselmis* sp. CTP4, and *Skeletonema* sp.) is a Rich Source of Bioactives and Potentially Beneficial to Health

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Recently isolated microalgae *Tetraselmis* sp. IMP3, *Tetraselmis* sp. CTP4, and *Skeletonema* sp. were bioprospected. Relevant bioactive compounds (polyphenols, carotenoids, vitamin E, coenzyme Q10, beta-glucans) and key bioactivities (cytotoxicity, anti-inflammatory, anti-hypercholesterolemic, and antidiabetic) were analysed. The ethanolic extracts attained from the biomass of *Skeletonema* sp. displayed the highest total polyphenol content, reaching 300-400 mg/100 g dw. Moreover, this microalga also exhibited a substantial level of beta-glucans with 2.7 % w/dw. The richness in this important bioactive with immune-modulating properties is consentaneous with literature on diatoms, being its content a function of nutrient composition of the growing medium. Other studied bioactives were also detected and may warrant further research. With respect to bioactivities with particular health significance, anti-inflammatory activity deserves to be highlighted. Indeed, ethanolic extracts of *Skeletonema* sp. exhibited the highest inhibitory capacity of cyclooxygenase-2 (COX-2), 82 ± 2 %, which compares to 36 ± 9 % in *Tetraselmis* sp. CTP4 and 45 ± 5 % in *Tetraselmis* sp. IMP3. Aqueous extracts had always a lower anti-inflammatory capacity. Other bioactivities were detected, being particularly worth of future investigation a possible link between carotenoid presence in the biomass and antidiabetic activity. All in all, the biomass of these novel microalgae strains seems promising for the development of products for the promotion of human health (nutraceuticals or for pharmaceutical use) through either its direct incorporation or the preparation of extracts to be used as additives.

OC33 - Lipidomics approaches to disclose seaweeds phenotype and for bioprospection

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The growing interest in macroalgae for food, feed and pharma in Western countries demands a new knowledge on their constituents and new tools for traceability. Macroalgae are, nowadays, important sources of food, feed for humanity and livestock since they are rich in fibers, proteins, and contain lipids with high nutritional value, such as omega-6 and omega-3 fatty acids. Beside, macroalgae's polar lipids, including glycolipids and phospholipids, are recognized as important phytochemicals that have nutritional, health benefits, and bioactive properties, contributing to the valorisation of these marine plants. Lack of knowledge on their polar lipidome hinders their full biotechnological potential. Polar lipids, strictly dependent on macroalgae phylogeny, life stage and environment, geographical origin and can be tools for their traceability. However the potential of these lipids is yet to be fully uncovered as macroalgae's lipidome is still poorly studied. This is due to its complexity once macroalgae's lipidome may comprise more than two hundred different molecular species. Advances in liquid chromatography-mass spectrometry (LC-MS/MS) based lipidomics opened new perspectives in understanding lipid chemo- phenotyping and contribute to algae valorisation. In the last years, mass spectrometry based approaches new perspectives to disclose the lipidome of seaweeds such as *Chondrus crispus*, *Codium tomentosum*, and *Gracilaria* fostering their bioactive properties. In this communication we will give an overview of the modern analytical strategies based on mass spectrometry in macroalgae lipidomics and how they can be exploited to assess variation in the lipidome with phyla, growth phase or season. Overall, lipidomics can contribute to add value to seaweeds as renewable natural sources of health-promoting lipids and as functional foods, thus promoting the development of innovative seaweed-based products.

OC34 - Commercialising seafood by-products in the BlueShell project

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About 70% (1.5 Million tons) of yearly shellfish production becomes by-products. Besides chitin/chitosan, this marine biomass is either used to make low value products or is sent to landfill, incinerated or dumped at sea. The project ERA net funded BlueShell confronts this situation by exploring three common sources of shellfish by-products: a) shrimp (*Pandulus borealis*) shells, b) crab (*Cancer pagurus*) shells and 3) defect mussels (*Mytilus edulis*), for potentially bioactive compounds targeted at the sustainable supply of new products.

BlueShell focuses on the commercialisation of bioactive compounds sourced from seafood by-products, by testing upscaling feasibility and consumer acceptance. Upscaling tests are taking place at Nofima's Bioteq, a flexible mini factory where a large variety of bioprocesses developed in the lab can be tested in a commercially meaningful scale.

The main focus of this presentation will be on consumer acceptance, describing the first results from a consumer survey in the UK (n=1800). The survey follows a 3x3 experimental design to identify main effects and interactions between: a) communication about by-products (health, environment, control group) and b) product categories (processed food, nutrition supplements, cosmetics). Personality, attitudes, motives and various behavioural variables will be used to explain the results and suggest combinations of communication and product category to increase consumer acceptance.

Expected results will give the first indications on how consumers perceive by-products as a source of ingredients and particularly: a) how socially acceptable is the use of various by-product sources; b) the possibility of disgust vs liking; c) the trade-offs consumers make if the use of these ingredients is related to health; d) considerations about sustainability and waste reduction and e) additional issues consumers may bring forward and are realistic to take into consideration.

OC40 - Halophyte production in marine aquaponics as a source of omega-3 glycolipids

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Halophytes are salt tolerant plants holding great potential for different biotechnological applications. They are promising candidates as biofilters for treating aquaculture wastewater through aquaponics, making them a solution to attain sustainable and profitable crop productions. Halophytes are suitable as leafy vegetables rich in omega-3 polyunsaturated fatty acids (PUFA), which are considered a sustainable source of these health-promoting fatty acids.

The lipid composition of halophytes is susceptible to variations according to environmental and physiological conditions. In this work we evaluated the effects of aquaponics production in halophytes lipidome. We compared the lipidome of two halophyte species (*Salicornia ramosissima* and *Halimione portulacoides*) grown in their natural environment and in aquaponics (performing the bioremediation of superintensive marine fish farm). The lipidome was identified using hydrophilic interaction liquid chromatography-mass spectrometry (HILIC-LC-MS). The dataset obtained from both plant species were explored through multi- and univariate analysis that allowed to distinguish the two groups (wild and aquaponics). In the case of *S. ramosissima*, the separation was due to the presence of a greater amount of omega-3 glycolipids in specimens grown in aquaponics. Concerning *H. portulacoides*, phospholipid species were the most important feature to distinguish between both groups, although omega-3 glycolipids were also enhanced in aquaponics. These omega-3 glycolipids are important lipids not only at a nutritional level, but also because of their bioactive properties, such as anti-inflammatory and antioxidant.

These achievements contribute to the valorization of halophytes as a source of valuable nutrients and bioactive phytochemicals, fostering potential applications in the fields of healthy and functional food products. Moreover, our findings can also promote more sustainable aquaculture practices, as halophytes aquaponics allows the combined production of fish and plants while decreasing the loading of unused nutrients to the environment.

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OC47 - Sodium Reduction by Means of Salt Substitutes in Selected Fish Products

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High dietary sodium intake is an important risk factor for hypertension and a public health challenge worldwide. The aim of this study was to evaluate the feasibility of reducing the sodium contents of fish products by the use of salt substitutes. Two model fish products produced without heat treatment were studied: Matjes *nordische Art* (a typical German product with 5-6% NaCl) and cold-smoked salmon (2-4% NaCl). Sodium chloride was replaced by various salt substitutes including potassium chloride, potassium lactate and commercial salt substitutes. Fish samples containing salt substitutes and the reference products containing pure sodium chloride were stored under typical conditions and analyzed periodically with regard to microbiological, physico-chemical and sensory parameters. Challenge tests were performed with *Listeria monocytogenes* and samples of Matjes *nordische Art* were subjected to a consumer test.

Commercial Matjes *nordische Art* (5% NaCl) and samples containing salt substitutes (2-3.25% NaCl) did not differ significantly ($p < 0.05$) during storage with regard to aerobic and anaerobic mesophilic counts, organoleptic properties as well as texture and color. Moreover, there were no significant differences towards the reference product in the growth potential of *Listeria monocytogenes* and consumer acceptance. Likewise, the sodium-reduced samples of cold-smoked salmon (1.5-2.25% NaCl) did not differ significantly from the reference product (3% NaCl) in most cases. One of the sodium-reduced samples was perceived as less salty by the sensory panel. Before a potential market launch of the sodium-reduced fish products, companies will have to invest in further product development in order to meet product-specific quality and safety requirements

OC48 - Bread enriched with *Chlorella vulgaris* and *Tetraselmis chui* biomass: bioaccessibility evaluation

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Microalgae biomass have been considered a sustainable food ingredient to be used in different food matrices, as a source of several bioactive compounds – proteins, pigments, enzymes, sugars, lipids with valued fatty acids, sterols and vitamins, with a recognised positive impact on health.

Chlorella vulgaris and *Tetraselmis chui* are species allowed by EFSA for human consumption, with high protein content, which is an important requirement to be used in bread with specific nutritional profile.

The impact of *Chlorella vulgaris* addition on the rheology properties of dough and bread was previously studied for wheat flour bread (Graça et al., 2018). In the present work, the use of this microalgae to enrich gluten free bread, based on a maize starch and rice flour formulation, was also studied with technological and nutritional advantages. The same approach was followed with the incorporation of *Tetraselmis*.

To evaluate the impact of microalgae addition on the baking performance - dough rheology and bread texture were evaluated, using a level of 5% w/w of dried biomass (in relation to total flour content). The breads and microalgae nutritional profile were assessed to evaluate the impact of the baking process on the degradation of the bioactive compounds, namely on proteins, fatty acids and antioxidants.

The total amount of compounds present in the bread may diverge from be the absorbable quantity of compounds in the gastrointestinal (GI) tract. In this sense, bioaccessibility, which corresponds to the share of the initial content that is rendered free from the food structure into the GI tract, has to be taken into account (Afonso et al., 2015). For assessing bioaccessibility, an *in vitro* digestion model was chosen for the determination of bioaccessibility in microalgae biomass and in respective bread. This enabled significant findings regarding fatty acid, and bioactive bioaccessibility.

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OC49 - Cardioprotective effect of lean seafood

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It is now well acknowledged that the beneficial effects of seafood consumption is not limited to lipids and fatty acids. Proteins, peptides and amino acids, together with vitamins and even unknown bioactive constituents also contribute to disease prevention. This study was designed to evaluate the putative anti-atherogenic effects of a lean seafood compared to a nonseafood protein source in apolipoprotein E-deficient (apoE^{-/-}) mice. Female apoE^{-/-} mice (5-week-old) were fed Western type diets containing a combination of cod and scallop (n=12) or chicken (n=12) as dietary protein sources for 13 weeks. Atherosclerotic plaque burden, weight, serum levels of leptin, glucose and LDL cholesterol as well as gene expressions from liver and heart were evaluated. The mice fed cod-scallop had a 24 % ($p < 0.05$) reduced total aorta atherosclerotic plaque burden compared to the mice fed chicken. In the less lesion prone thoracic and abdominal parts of the descending aorta the plaque reduction were 46 % ($p < 0.05$) and 56 % ($p < 0.05$), respectively. Further, mice fed cod-scallop gained less weight compared to the mice fed chicken, and had lower serum levels of leptin, glucose and LDL cholesterol. Analysis of expression of the genes from liver and heart showed that hepatic endogenous antioxidant paraoxonase 2 (*Pon2* gene) and vascular cell adhesion molecule VCAM-1 (*Vcam1* gene) were down regulated in mice fed cod-scallop compared to mice fed chicken. In conclusion, atherosclerotic plaque burden, serum glucose, leptin and LDL cholesterol levels were reduced in mice fed cod-scallop, suggesting a metabolic beneficial effect of lean seafood compared to chicken.

OC50 - Cooking procedures affect contaminants of emerging concern levels in seafood

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Abstract

Seafood consumption is a major route for human exposure to environmental contaminants of emerging concern (CECs), including perfluorinated compounds (PFCs), toxic elements species (i.e. inorganic arsenic (iAs), organic mercury (MeHg)), polycyclic aromatic hydrocarbons (PAHs), musk fragrances, UV-filters and toxins from harmful algal blooms [1]. So far, there is still insufficient information concerning the toxicological effect of culinary treatments in seafood CECs levels [2]. The present study evaluated the effect of steaming in a range of CECs, and assessed the potential risks associated with seafood consumption. Thirteen seafood species of commercial size consumed in Europe were collected in different markets. Fish muscle tissues (fillets) were sampled, as well as cephalopods and crustaceans mantle and abdominal muscle (n=25) and bivalves edible part with the intervalvar liquid (n=50). Seafood was wrapped up in aluminum foil and steamed at 105 °C. Steaming affected the levels of most CECs, although varying according to contaminant chemical properties and seafood species. Most toxic elements species, PAHs, musk fragrances and lipophilic toxins levels significantly increased after steaming. On the other hand, steaming resulted in significant decreases in most PFCs, UV-filters and hydrophilic toxins levels. The increase of some toxic elements, carcinogenic PAHs and toxins levels in seafood after steaming, indicates that the risk of adverse health effects can never be excluded, regardless of contaminants concentration. Given the fact that seafood is mainly

consumed after cooking, the observed changes induced by steaming suggest that the effect of culinary treatments should be integrated in monitoring programmes of food risk assessment, as well as accounted in food safety authorities' regulations and recommendations, in order to enhance consumers' confidence in seafood consumption and avoid over/underestimation of human health risks.

Key words: seafood, steaming, contaminants of emerging concern

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OC51 - Effect of species (gilthead sea bream, sea bass, and meagre), seasonal variation, and addition of transglutaminase and glucomannan fiber on the quality of fish hams

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Abstract

The increasing consumer demand for healthier products is driving the development of novel fish-based products, due to the well-known benefits of fish consumption. Within the variety of traditional meat products in market places, cooked ham is particularly appropriated, on account of its broad public acceptance.

This work aimed to study the influence of fish species, capture season, and addition of microbial transglutaminase (MTGase) and glucomannan dietary fiber from konjac (*Amorphophallus konjac*; KGM) in the preparation of fish hams and its effects on the physical and sensory properties.

Sea bass (*Dicentrarchus labrax*), gilthead sea bream (*Sparus aurata*), and meagre (*Argyrosomus regius*), captured in the summer and winter seasons, were used individually to prepare hams. Different formulations varying the amount of MTGase (0-0.5%) and KGM (0-1%) were done. Color, water holding capacity, pH, texture (puncture, compression, and compression relaxation tests), and sensory analysis were determined in the different fish hams.

Results showed that in terms of species used for the preparation of fish hams, hams prepared with meagre had higher water holding capacity and the textural properties were closer to those of traditional hams prepared with pork. The capture season also affected several properties of fish hams, with a minor importance, and it was dependent on the species. The addition of MTGase and KGM in the preparation of fish hams resulted in hams with textural properties closer to those of pork hams. However, the use of KGM compromised the visual appearance of fish hams. In general, fish hams were well accepted by the sensory panelists.

This study showed that the fish hams produced have potential as novel fish-based products. In particular for each species, fish hams prepared with gilthead sea bream captured during winter or with sea bass captured in the summer, both prepared with 0.5% MTGase and 1% KGM, and those with meagre captured in the winter with 0.5% MTGase (without KGM) exhibited the most comparable physical properties to a pork ham.

OC52 - *Anisakis* L3 respiratory analysis as a tool for assessing their human infectivity

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Human infection due to eating fish parasitized by live *Anisakis* larvae in the third stage (L3) is considered an important health problem and the application of treatments to ensure their mortality is crucial to prevent the risk of infection. Mobility is used as the method to assess viability. However, mobile larvae may not always be infective, and there is recognised a need to establish other methods to assess whether these larvae are capable of infecting humans. We suggest that mitochondria may become dysfunctional owing to various physical or chemical treatments applied to inactivate *Anisakis* L3, even if larvae survive these treatments and the oxygen consumption rate (OCR) could give valuable information about the actual mitochondrial function. We aimed to establish whether respiratory analysis of *Anisakis* L3 could identify differences between larvae considered viable, but that had been subjected to stress (thermal and/or chemical). The modulators FCCP and azide were used to obtain the basal, maximum, spare and residual respiration rates. The respiration analysis of larvae subjected to a certain temperature or environmental stress, (i.e. storage at 37 °C or in gastric juice), showed that mitochondria were affected compared to the untreated controls. The maximum respiratory capacity of larvae subjected to freezing could initially decrease immediately after thawing, but after some acclimatization they were able to recover their respiratory capacity fully. However, when treated larvae were stored at refrigeration temperatures their mitochondria became dysfunctional faster than those of untreated larvae. To conclude, *Anisakis* L3 responds to mitochondrial respiration modulators, so respiration analysis can be incorporated for *in vivo* assessment of mitochondrial function in this nematode. These measurements can be used as a tool to characterize L3 subjected to different stresses which, together with other indicators, help to give a broader picture of *Anisakis* L3 characteristics and potential infectivity.

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OC59 Live octopus exportation: establishment of a method for long distances and high densities transportation

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Octopus fishing is an activity of great importance in Portugal, being especially meaningful in the Algarve region where market sales reach top position in some of the fish markets. The growth of the international market, especially the eastern countries, has increased the global demand for octopus. Presently the largest suppliers of octopus to eastern markets are North African countries like Morocco and Mauritania. The demand for octopus embraces several types of presentation - fresh, frozen, canned, prepared meals – and includes live consumption. Recently some Eastern countries have shown interest on national live octopus, a high commercial valued product. This interest has generated a great enthusiasm among fishing community. In this regard IPMA has tested a method for long distances transportation of live octopus at high densities, assuring a good quality product and welfare requirements. The system is composed of 220 l tanks with a cooling and aeration system. The animals were kept isolated in pvc pipes of 14 and 16 cm diameter covered with 20 mm mesh net. The water temperature was maintained at 10° C, after a gently and controlled decreasing rate of 1° C/hour. Live octopus transportation was tested for a 48 h period at two densities: 50 and 100 kg/m³. In order to ensure the water quality and the welfare, temperature, dissolved oxygen, pH and nitrogen compounds as well as the animal's behavior were monitored. For both densities dissolved oxygen and pH remained within the normal limits. Ammonia levels have risen significantly on both densities. Ammonia content (brain tissue), dopamine concentration (hemolymph) and Hsp70 levels (muscle) were analyzed in the beginning and end of the experiment for both densities. No significant differences were found among them suggesting low levels of physiological stress and, consequently, the preservation of freshness and good quality of the meat.

OC60 - Effects of microalgae replacement by *Ulva rigida* on metabolic rates and oxidative stress responses in *Crassostrea gigas* during broodstock conditioning.

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The current study evaluated the effects of the dietary microalgae replacement by dry seaweed (*Ulva rigida*) on the metabolic rate and oxidative stress responses during broodstock conditioning of pacific oyster (*Crassostrea gigas*). Seven hundred and twenty oysters were divided in four dietary groups (3 tanks/diet). Each group were fed with one of the following diets: 100% live microalgae blend (Micro); 75% Micro + 25% seaweed (SW); 50% Micro + 50% SW or 100% SW. The Micro was composed by 33% *Isochrysis galbana* and 67% diatoms (75% *Skeletonema costatum* + 25% *Chaetoceros calcitrans*). After conditioned with the experimental diets for 11 weeks, a 48h respirometry trial were performed using intermittent flow respirometry from Loligo Systems. Catalase, lipid peroxidation (LPO), glutathione S-transferase (GST), total glutathione (GT) and oxidized glutathione were quantified in gills and hepatopancreas to evaluate the dietary effects on the oxidative stress responses. Oxygen consumption (OCR) and standard metabolic rate (SMR) were measured as indicators of the metabolic rate. The GST in gills were significantly higher in oysters fed diets 100%SW and 50% Micro + 50% SW, suggesting that seaweed bioactive compounds, often referred as antioxidant sources, may also induce the production of reactive oxygen species (ROS) in oysters. Oyster fed 100% SW showed a reduction of GSH activity and TG content in hepatopancreas, a direct correlation to a depression of antioxidant capability. OCR and SMR were suppressed in oysters fed 100% SW, suggesting a reduction of the metabolic rate. Co-feeding 75% microalgae with 25% *Ulva rigida* showed to be most effective in reducing oxidative stress responses in *C. gigas* and sustained metabolic rates similar to oyster fed traditional microalgae diets, thus allowing a reduction of operative costs associated to microalgae production in bivalve hatcheries.

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OC65 - Farmed Atlantic salmon

Farmed Atlantic salmon (*Salmo salar* L.) - still a good source of long chain omega-3 fatty acids?

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The limited amount of fish oils available has resulted in an increased use of vegetable oils in the feed for farmed fish, such as Atlantic salmon. The aim of this study was to evaluate how this has affected the fatty acid (FA) composition of farmed Atlantic salmon in 2017 and to follow this over time, by comparing with results reported from 2010. The content of fat in farmed salmon filets is still high and almost twice of what has been reported in wild salmon. The FA composition of the farmed salmon confirmed a substantial inclusion of vegetable oils in the feed, but the total amount of long chain n-3 FA present in the fillets of farmed salmon was still higher than in the wild fish. The n-6:n-3 ratio was increased (0.7) but still below 1. A standard portion of farmed Atlantic salmon fillet (105 g) provides approximately 1.4 g of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which is almost six times higher than the minimum daily intakes recommended (250 mg/day) by WHO. **Keywords:** farmed Atlantic salmon, fat content, fatty acid composition, omega-3

OC66 - MEAGRE PRODUCTION SYSTEMS AND FATTY ACID PROFILE UNDER DIFFERENT REARING CONDITIONS

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Meagre (*Argyrosomus regius*) is an important fish species for marine aquaculture in South Europe and Mediterranean area. Different systems of production can be used: 1) earthen ponds, 2) RAS (recirculating aquaculture systems) and 3) inshore or open sea cages. The temperature conditions above 20°C led to a higher weight increase, in comparison faster than gilthead seabream or seabass. Meagre is a very suitable fish for processing, filet or other products. Nowadays there is implemented a consistent technology developed to reproduce and growth in aquaculture associated with a good knowledge about nutritional requirements for the different rearing periods and systems.

Meagre is a well-known species that exhibits a nutritional composition adequate for consumers concerned with their health. Despite the lower level of fat that characterises this species, is an important source of fundamental fatty acids, like EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), very well recognized for consumer health benefits.

Nonetheless, this adequate fatty acid profile can easily be modified by rearing conditions, like monoculture versus polyculture (with sea bass and seabream), by seasonal variations of water temperature (spring, summer, etc), by the correct feeding procedures and/or the use of alternative ingredient to fish meal and fish oils.

Having this into account this presentation aims to give an overview about different production systems, nutritional aspects, particularly fatty acid profile under different rearing conditions.

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OC67 - Effect of transport conditions (temperature and animal density) on the sea urchin quality

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The sea urchin *Paracentrotus lividus* is an edible echinoid considered a luxury seafood product which makes its commercialization conditions far from harvest areas a major concern. Nowadays, and from our knowledge, in most regions the transport is still done in bulk at ambient temperature conditions inside normal plastic boxes. The main aim of the present study is to understand the effect of transport conditions (temperature and animal density) on the sea urchin vitality and gonads biochemical status. Sea urchins were harvested and randomly distributed into polystyrene boxes. Three transport conditions were tested under wet environment: i) D1T1 – high density (≈ 5 sea urchins/dm²) at room temperature (≈ 20 °C); ii) D1T2 - high density at 7 °C; and D2T2 – low density (8 x 8 cm individual compartments and sea urchins were not able to interact with each other) at 7 °C. Sea urchin vitality was evaluated through visual inspection (including spines position), weight loss, mouth responses and biochemical condition. Five animals from each group were collected every two days and gonads removed. Biochemical responses were evaluated in gonad tissues by assessing oxidative biomarkers (catalase, glutathione S-transferase, superoxide dismutase activities), heat shock response (HSP70 induction), lipid peroxidation (MDA content), protein carbonyl levels and total antioxidant activity (TAC). The transport at lower temperature (D1T2 and D2T2) had a positive effect on the colour of water released, weight loss and spines position in comparison to D1T1. The animal density did not have relevant effect. The results of this work show that for short periods, the transport of live sea urchins out of water is possible at cool temperatures. Transport of sea urchins for longer periods requires other techniques. Additionally, HSP70 and lipid peroxidation seemed to be valuable indicators to follow live sea urchin quality changes over transport.

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OC70 - Isothermal amplification for rapid identification of several fish species in seafood products

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Fish mislabelling involving substitution of valuable species with cheaper ones has been widely described worldwide. In this sense, there is a high demand for fast, reliable, and cost-effective detection methods for species identity verification. PCR-based methods have been extensively used for this purpose. Nevertheless, PCR has some limitations, such as the requirement of both highly-trained staff and relatively complex equipment with precise temperature control and rapid thermocycling steps. Furthermore, PCR-based detection systems might take long analysis times when post-amplification treatment is required. To overcome these problems, we propose the use of Recombinase Polymerase Amplification (RPA), an innovative rapid isothermal amplification based on the use of strand displacing Bsu polymerase, which requires very short incubation times at a single temperature, reducing reaction complexity and timing. Furthermore, Bsu polymerase can perform even in inhibiting environments, enabling its use with complex food matrixes.

We have developed several cost-effective non-destructive rapid RPA systems that allow the identification of Atlantic cod, European hake, Pangasius and some species of tuna, with high sensitivity and specificity. These systems are based on the amplification with specific RPA primers and probes of short regions of Cytochrome oxidase I (COI) or Cytochrome b (CYTB), enabling the identification of the species of interest. The results are obtained within 15 minutes. The RPA systems developed are held on two different formats: either in dipstick format by means of the TwistAmp® nfo kit and Millennia GenLine Hybridtech lateral flow strips or visualization with fluorescent signals with TwistAmp® exo kit and T8-ISO equipment (TwistDx, UK).

We can conclude that RPA is a non-destructive methodology highly suitable for rapid species identification in food matrixes. RPA systems can be employed at-line in non-laboratory settings at several steps of food supply chain (production facilities, retail level, ...) without the need of highly trained personnel or complex equipment.

OC71 - LF ^1H NMR T_2 relaxation rate as affected by water addition, NaCl and pH in fresh, frozen and cooked minced hake

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Abstract

The applications of low field nuclear magnetic resonance relaxometry of proton (LF ^1H NMR) to the study of seafood are increasing. The transverse relaxation times (T_2) provide information about the physical-chemical nature and spatial organization of muscle components and T_2 has been suggested to be particularly useful as a probe to estimate changes in water distribution in a variety of cases. However, the interpretation of T_2 in fish muscle is not straightforward. In order to gain a better understanding of the significance of these changes observed in situations of interest in fish technology, there is a need for a systematic study of the changes of T_2 as affected by protein concentration, NaCl addition, pH or denaturation of muscle proteins, since many of the scenarios in which LF ^1H NMR is applied involve modification of one or more of the above factors. This in turn makes it possible to establish the relation of T_2 with other parameters known to give relevant information about muscle changes. LF ^1H NMR T_2 was monitored in hake (*Merluccius merluccius*) mince with different thermal histories (unfrozen, frozen, cooked) as affected by pH, water and NaCl addition, and it was related to water holding capacity (WHC). T_2 changed in terms of bands shape, relaxation times and relative abundance of the bands. The relaxation rate of the major band ($1/T_{21}$) increased significantly upon frozen storage or pH increase, whereas water or NaCl addition had the opposite effect. WHC decreased with freezing or water addition and increased with NaCl or basic pH. Linearity found for pH and protein concentration with $1/T_{21}$ was consistent with chemical exchange being responsible for these changes. The significance of these results for technological situations where compositional and biochemical changes are occurring is discussed.

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OC76 - Py-GC/MS method development and application for the identification of microplastics from seafood

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Plastics are composing 80% of the marine detritus, among these litter, microplastic (MP) particles with a size below 5 mm, are found in numerous marine species including commonly consumed seafood products. The risk characterization necessitates accurate counting and MP identification to avoid under / over estimation of the contamination level. When performed, studies generally identified plastic polymers with spectroscopic techniques (Raman or FTIR) but these approaches can face technical limitations regarding identification of fibers or pigments added to synthetic polymers. These last years, pyrolysis coupled with gas chromatography and mass spectrometry (Py-GC/MS) has been employed to get insights on the core composition of polymers as this technique burns the whole analyzed particle.

The aim of this work was to optimize, assess performance and apply a Py-GC/MS method to thoroughly identify MP, with the smallest possible size. Optimization of multiple parameters, *i.e.* pyrolysis temperature, injector conditions and oven program, was carried out using polystyrene (PS) and polyethylene (PE) microspheres, which are among the most recovered polymers in the fishery products. Performance assessment was carried out comparing Py-GC/MS and μ -Raman identifications. Repeatability, intra-lab reproducibility and accuracy were also controlled during this step. Finally, the smallest Py-GC/MS detectable mass was calculated for eight polymers, ranging from 0.003 μ g to 0.46 μ g. The smallest easily manipulated size was estimated at 50 μ m. The method allows to accurately identifying unknown particles down to a few dozen of micrometers.

Finally, the method was successfully applied to identify microplastics from seafood samples of diverse origins.

OC77 - Traceability efforts against ciguatera by developing a rapid qPCR method for special snapper species

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In Europe it is not allowed to import fish products containing microalgae toxins like ciguatoxin (Hygiene Regulation (EC) No 853/2004). Therefore, every seafood importer or entrepreneur has to implement necessary precautions in order to ensure that no toxic fish products will be placed on to the market. Nevertheless, there have been numerous ciguatera cases in recent years in Germany. The FAO counts more than 50.000 persons per year who are infected by ciguatoxins which caused by dinoflagellates, common in warm oceans and often located close to dead corals. While in earlier times only people in tropical countries became ill by ciguatera after eating infected fish, nowadays, due to the global trade of fish products also people in the northern part of the world are affected. Thus, governmental authorities and seafood importer have to find common solutions in order to minimize the risk of consumer eating such toxic fish products.

Previous investigations showed that ciguatera cases in Germany can be traced back to imported snapper filets that were mislabeled as Red snapper (*Lutjanus malabaricus*) and mostly identified as *Lutjanus bohar*. Due to the fact that in Europe no reliable and rapid method for detecting different ciguatoxins exists until yet, other possibilities for traceability activities have to be pursued in guaranteeing consumer protection. In our institute we are developing a reliable and cost effective qPCR method that ensure a fast high-throughput of samples in order to detect *L. bohar* and other relevant snapper species. In that case the examination of method specificity represents a challenge in terms of the Nagoya protocol and the organization of relevant different tropical snapper species samples that requires far-reaching cooperation with different national and international institutions. First results on method development and on traceability efforts to prevent the risk of ciguatoxin poisoning in Germany will be presented.

OC78 Application of plasma activated water for surface decontamination of fish

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Generally chemical disinfectants are employed for to ensure microbiological safety and quality of fish. Various concerns over the use of chemical disinfectant new approaches have been investigated. The objective of this study was to investigate the efficacy of plasma activated water to enhance microbiological safety, quality and shelf life of fish. Plasma activated water was generated using two sources of plasma namely cold and microwave plasma. Plasma activated water (PAW) was tested against for various microorganisms pertinent to fish and microbial count was studied with respect to dipping time. Total viable count (mesophilic and psychrophilic), *enterobacteriaceae* sp. and spoilage bacteria were enumerated using standard plate count methods. Key nutritional and physicochemical parameters were investigated for the samples stored at 4 and -20 °C. Dipping of fish (whole and fillets) in PAW generated using Plasma jet system for 30 min showed a significant reduction in surface microorganisms pertinent to fish. Various reactive oxygen and nitrogen species generated within the PAW would have been responsible for achieving microbial inactivation. However, these reactive species did not show a significant effect on lipid and protein oxidation. No significant changes in key quality parameter including colour, fatty acid and amino acid profile of fish was observed. The result of this research demonstrates that PAW can be employed for enhanced seafood quality and safety.

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SHORT PRESENTATIONS

O03 - Learning robots in the seafood industry

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Operations in the seafood processing industry are often subject to highly cluttered and messy environments in combination with slippery and deformable raw material. This makes automation of visual-motor tasks, such as picking fish out of a bin, difficult.

We have proposed the use of deep learning in combination with virtual reality (VR) to automate such tasks. A worker familiar with the task at hand can demonstrate the task for the robot using a VR-headset and controllers in a simulated game environment. Using only these virtual demonstrations to train a deep neural network, we have shown that the robot is able to move real fish from one fish crate to another.

This approach for automation of visual-motor tasks is general and well suited for many operations currently performed by manual labour in the seafood industry such as gutting, sorting by some criteria (e.g. species, quality, wounds/defects etc.) and trimming of fillets.

O04 - Quality changes of Atlantic mackerel during superchilled, chilled and frozen storage

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Increased awareness of the diet's importance for overall health, increase the demand for products with enhanced healthiness having good sensorial properties. Atlantic mackerel is rich in omega-3 lipids (EPA and DHA) with documented beneficial effect against coronary heart diseases, easily digestible proteins; vitamins (E and D), and other compounds that are considered bioactive, such as certain free amino acids and peptides. Mackerel is however a highly perishable food and there is a need for appropriate treatment to prevent nutritional and sensory deterioration along the production chain from catch via processing to consumption. In addition to lipid- and protein oxidation, enzymatic and bacterial processes lead to changes in the content and composition of small molecules such as nucleotides, organic acids and bases, sugars and free amino acid, influencing both sensory and nutritional qualities and safety.

The results presented are part of a project using optimized existing and novel technologies for developing healthy, high quality, safe and sustainable fish products from pelagic fish species. The presentation will evaluate if superchilling can maintain functional properties, quality and safety of mackerel fillets, compared to chilled and frozen storage. Changes in lipids and in low molecular weight (LMW) metabolites relevant for nutritional quality and food safety (including biogenic amines) of mackerel fillets during different processing and storage conditions will be presented.

O08 - Lightly processed seafood – Improving shelf life and food quality

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Easy-to-prepare and ready-to-eat meals are increasingly perceived as an optimal solution in a modern lifestyle. With consumers demanding tasty, high quality yet convenient foods, the pressure has increased to develop processing methods that allow a fulfillment of these demands, while still offering a reasonable shelf life.

As part of a four year PhD, a large effort and workload has been put into understanding the influence of processing methods of seafood, on both shelf life as well as perceived quality. Early on, the experiments showed choice of packaging technology to be a main contributor to reaching the aims set forward by the consumers. Modified atmosphere packaging (MAP) has become a well-established method in the food industry, but with drawbacks such as limitations to packaging ratio, newer methods are being investigated. An example of this is soluble gas stabilization (SGS).

Multiple studies has been carried out to test the influence of packaging technology in combination with heating, on the microbial community of seafood products. Results showed SGS to be significantly better at inhibiting growth of bacteria such as *Listeria spp.*, *Brochothrix spp.*, and lactic acid bacteria, compared to traditional MAP and vacuum samples, with differences as large as one log CFU/g. In most cases, the choice of packaging technology showed larger influence than differences in heat treatment applied (based on either core temperature or D-values).

Equally important is the appearance of the produced products. Results show perceived quality, such as surface color, texture and drip loss, not to be influenced by the application of SGS when comparing to equally treated but MA packaged samples. Thus rendering it possible to lower the processing temperatures and still obtain a safe, durable product, but with superior chemical quality.

The presentation will give an overview of our status in processing technologies for lightly processed seafood products.

O09 - Influence of high-pressure processing on quality characteristics of haddock and mackerel minces and textural properties of fishcakes prepared thereof

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One of the main reason of applying high-pressure processing (HPP) technique is inactivation of microorganisms in fish and meat products. However, for its practical use in fish preservation, textural and functional properties of fish tissue should be maintained. Therefore, the aim of this study was to examine the effect of HPP and subsequent freezing on protein solubility, water-holding capacity, dry matter, ash and color characteristics of haddock and mackerel mince. In addition, changes in textural properties of fishcakes prepared from frozen mackerel and haddock mince (1:1 w/w) were studied as affected by HPP.

The data showed that with increasing the pressure, both haddock and mackerel proteins were more susceptible to pressure-induced denaturation/aggregation. Thus, 300 MPa treatment reduced 1,5 times the solubility of both sarcoplasmic and myofibrillar proteins in haddock and mackerel minces in comparison with untreated samples. The breakdown of fish proteins under high-pressure treatment accelerated changes in water-holding capacity and color characteristics of haddock and mackerel minces, at the same time affecting texture properties of fishcakes prepared thereof. The studied fish minces became lighter compared to control samples (untreated fish) with increasing the pressure of treatment from 200 MPa to 300 MPa. Hardness and cohesiveness of fishcakes varied significantly ($p < 0.05$) between samples prepared from control and differently pressure-treated fish minces (200 MPa and 300 MPa). Thus, the firmness of the fishcakes decreased gradually from 6.9 N to 2.8 N with increasing the pressure from 200 MPa and 300 MPa. This phenomenon can be explained by a significant decrease ($p < 0.05$) in protein solubility of fish minces as affected by HPP.

Lipid oxidation and metabolomics data will also be presented.

O10 - Effects of on-board fresh-fish processing innovation on shelf-life and quality

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The presentation introduces an overview of innovative technological developments in the first stages of the value chain of ground fish in Iceland. It presents a summary of research studies performed on-board trawlers aimed to evaluate the process performance in terms of product quality and shelf-life. Due to an increasing demand for high quality fresh fish in recent years there has been a shift by Icelandic fish producers from less valuable frozen products to high end fresh products, made possible by technological developments along the value chain. Temperature control improvements resulting in extended shelf-life have increased fresh fish processing and export and automation has generally improved yield, product quality and working environment. A part of this initiative included development of new systems on-board fresh-fish trawlers based on automation and superchilling technology, intended to chill the fish below its initial freezing point and then store it fresh at the same temperature using no ice. The goal of the development is to provide uniform and high quality raw material for further processing but also to support more sustainable and economic fishing and processing. Along with extended shelf-life, raw material for high end products like fresh fish loins needs to be well drained of blood and uniform in colour and quality. The aims of the research studies introduced are to evaluate new on-board processes from catch to storage. This includes studies on time and temperature control, variable bleeding conditions, superchilling methods and superchilled storage with focus on the effects on shelf-life and product quality. To conclude a summary will be presented on the next steps toward on-board automation and process development in next-generation fresh-fish trawlers.

O11 - Increasing energy efficiency in fish processing industry

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Global energy consumption is constantly growing and ways to meet both present and future demands are needed. Increasing energy efficiency is often less expensive compared to developing new energy production plants. Industry plays an important role in this, since it represents a significant part of the total energy consumption, and many processes are less efficient than they could be. There are at least 100 000 refrigeration plants in Norway (household refrigerators and freezers excluded) which consume at least 6 TWh per year. In the food industry, refrigeration is used for cooling, freezing and drying.

The opportunities for increasing energy efficiency in the fish processing industry are many. Refrigeration systems are the main electrical consumer, and are used for chilling, ice production, cold storage and freezing of food. Possible improvements include better dimensioning of the system (currently, the design cooling load is often higher than normal operating cooling load), better system regulation of the components, and more uniform use of energy over a 24-hour period. Energy savings can also be had by integrating refrigeration systems with heating systems.

The barriers for making a system more energy efficient relate to economy and uncertainty. Extra capital costs could delay or prevent the installation of new equipment, such as a variable speed drive or a better control system. In addition, the amount of savings from different investments or the length of the payback time may be uncertain. Delaying or stopping production during a hectic season is also not desirable. The industry needs clear guidelines about which changes can be made and how much can be gained. Policymakers also need to be aware of the need for change and the resulting gains, so that appropriate laws can be made or enforced. Research in this field can illuminate the relationship between operational alternatives and associated benefits.

O16 - Screening and processing techniques for macroalgae in food applications

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The trend to consume “to-go”, “ready-to-eat” or “convenience” food has increased over the last years (Statista, 2016). As a consequence, the amount of single-used packaging materials has also increased. Most of these packaging materials are made of non-biodegradable, petroleum-based polymers that have degradative impacts on the environment. This aspect is in conflict with the consumer expectations to have healthy and environmental-friendly food products including the surrounding packaging. Therefore, new, innovative and sustainable packaging concepts need to be established. A way for achieving this ambitious goal could be biodegradable and/or edible packaging concepts made from macroalgae (seaweeds). Macroalgae provide a sustainable, inexpensive and renewable raw material for packaging concepts due to their naturally occurring quantities and characteristic polymers such as alginate or agar. Moreover, marine hydrocolloids are commonly used in the food industry as thickeners or gelling agents and are accepted by consumers. For the proof of concept to develop a macroalgal-based packaging, we conducted a screening of local sources of green, red and brown algae to select a portfolio of functional and environmental-friendly species. We take into account that the intact and sensible maritime ecosystem should still be protected. Key markers for the selection were the concentration of iodine (low), hydrocolloids (high) and possible toxins (low) as well as local availability. The biodegradable macroalgae packaging concept was studied by using different mechanical preparation techniques under various conditions (e.g. energy input, shear rate, temperature etc.). The applied technology as well as the type of macroalgae led to different material properties of the produced macroalgal-based packaging. In contrast with common studies, where edible films are created by extracted hydrocolloids, the aim of the novel production system is to use the macro-algae in an ecological and economic optimized manner.

The project (“Mak-Pak”) is supported by funds of the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support program.

Statista (2016) Umsatzentwicklung im Außer-Haus-Markt in Deutschland nach Segmenten im Jahr 2015 (gegenüber dem Vorjahr); BVE - Jahresbericht 2015_2016, page 24.

O17 - Effect of temperature during pre-heating in fishmeal production from mackerel side streams

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Considerable amount of research has been conducted showing that side streams of fresh fish raw materials are rich in biomaterials, polyunsaturated fatty acids and protein hydrolysates. However, most of the research so far has been on lean fish as fatty fish is harder to handle, resulting in oil-rich fishmeal. From that material, producers have not been able to export their products at maximum value and/or develop products suitable for human consumption. In the current study chemical properties and characteristics of material pre-heated with three different temperatures were analyzed (85°C, 90°C and 95°C), and an overall evaluation of the processing line with regards to quality was performed.

The objective of this research was hence to map the quality changes of the side-streams through-out the fishmeal production line with regards to lipid quality and see if different temperature during pre-treatment impacts the separation of the material and the fishmeal itself.

Preliminary results indicated significant changes in fat content between unheated raw materials and raw materials heated to 90°C and 95°C, but not if only heated to 85°C. However, each time temperature change was applied, raw materials collected did significantly differ in fat content. Preliminary results indicate that overall, variation is high at each sampling point until the materials are heated again, after entering the decanter. Preliminary results indicate that peroxide value and thiobarbituric acid reactive substances from the fishmeal processing line fluctuate in the production where the raw material intended for fishmeal production has already 10 times higher secondary oxidation products at the start of the production than fresh mackerel fillets from the same batch.

The study showed that further research in fishmeal production is needed to optimize pelagic fishmeal production lines, and in the future, to be adjusted for human consumption.

O18 - Chilling of pelagic fish onboard Norwegian fishing vessels

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SINTEF Ocean, Trondheim, Norway

Wild caught fish is divided into pelagic (Herring, Mackerel) and demersal fish (Cod, Saithe and Haddock). Pelagic fish is caught in large quantities and transported fresh to processing on land. Demersal fish are often gutted and frozen onboard the fishing vessel. The temperature of the fish should be low and stable during transport, to avoid product damage.

Ice was earlier used for chilling of fish, but because of large amounts of fish onboard, tanks with refrigerated sea water (RSW) has been used since the 1960s for chilling of pelagic fish. The water is chilled in a refrigeration system and circulated through the fish tanks. The efficiency of the chilling is dependent the ratio of water and fish, species and flow. The most common pelagic species caught are mackerel, herring and blue whiting. Each of them has different behaviour in water and ratio of fish and water.

To investigate this a vessel has been equipped with temperature sensors in two equally tanks where one of them has possibility to change the flow pattern. Results from a research cruise where blue whiting was caught will be presented and discussed. Also the consequence this has on the quality and profitability will be presented.

O19 - Mapping of the volumes and causes of food waste in the seafood processing sector in Norway

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The food sector in Norway has committed to reduce the amount of total food waste by 50 % within 2030 (UN Sustainable Development Goals). Several governmental authorities and branch organizations have signed a binding agreement regarding reaching this goal of reduction in food waste.

The definition of food waste in the agreement is as follows: ' Food waste includes all usable parts of food produced for humans that are either discarded or used for other purposes than food, from the time the animals and plants are slaughtered or harvested'.

The seafood sector has a good overview of the volumes and utilization of rest raw material for human consumption and feed production. However, values on how much of this rest raw materials which is suitable for human consumption and not utilized for this purpose are missing. In addition, the causes of food waste in the seafood processing sector are not known.

By 2020, the project aims to:

- 1) map the volumes and type of food waste in the seafood processing sector in Norway
- 2) define which fractions of rest raw materials are food waste according to the food waste definition stated in the agreement
- 3) map the causes of food waste in the processing stage through industry visits, interviews and workshops with eight seafood companies
- 4) develop and test a tool for reporting of food waste in the seafood sector

O22 - Processing of hot-smoked salmon fillets as affected by salting- and smoking parameters

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The aim of the present study was to determine effects of different salting technologies and smoking protocols on the processing yield, and general quality of hot-smoked salmon fillets.

The experimental setup was designed as a factorial study with salting technology (injection versus dry-salting), salt concentration (high and low), smoking protocol (smoked before, together with, or after the heating process), and storage (24 days) as experimental factors. Investigated parameters were; processing yield, colorimetric and textural properties, contents of NaCl, dry matter and phenols in the product.

The salting process resulted in highest NaCl content of double-injected samples, followed by dry-salted (8 hours), single-injected and dry-salted samples (4 hours) ($p < 0.001$, ranged 2.2-1.4%). Highest yield was found in double-injected samples, followed by single-injected and dry-salted (4 and 8 hours) samples ($p < 0.001$, ranged 96.2-88.9%). It was moreover found that fillets smoked before, or together with heating gave lower yield compare to those smoked after the heating step ($p = 0.001$). Colorimetric properties of the product was found more affected by the smoking procedure than salting technology used ($p < 0.001$, $F = 6.8$ and 33.4 , respectively). A cold-smoking step before heating gave the darkest, less reddish and yellowish products whereas the salting procedure was found to have minor impact on the colour. Textural properties was affected by the smoking protocol ($p < 0.001$), and by storage time ($p = 0.15$) whereas no effect of the salting protocol was observed ($p > 0.79$). Total contents of phenols in the fillet surface was moreover found affected by the smoking protocol ($p < 0.001$), but not by the salting procedure ($p > 0.073$).

Based on the results, we can conclude that injection of salt gave the highest processing yield, similar colorimetric- and textural properties, and contents of phenols as compared to dry salted hot-smoked salmon. We can moreover conclude that the smoking protocol contributed to colorimetric- and textural differences among the products.

O23 - Multi-response optimization of ensilaging process to reintroduce fish processing by-products into the food chain

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Fish currently represents ~17% of animal-derived protein supply globally, which is projected to increase by 30% between 2010 and 2030; aquaculture is expected to meet this increasing demand. However, aquaculture is still heavily dependent on fish-derived feed ingredients, mainly produced via fish meal/oil production from small pelagic species as sardines, or from by-products. For the latter, ensilaging is a milder and more energy smart process option which at the same time stabilizes the raw material against bacterial growth, and produces a nutritious product. The main fundament of ensilaging is that the proteins are hydrolyzed into peptides and amino acids at low pH by endogenous enzymes. To date, limited research has been done on the ensilaging process; and there is room for improvement. The aim of this study was to optimize the ensilaging process for herring (*Clupea harengus*) by-products with desired maximum protein degree of hydrolysis (DH) and minimum formation of unwanted reactions like lipid oxidation and amine formation.

Results suggest that temperature (17-37°C) and time (3-7 days) have significant effects on DH. The endogenous proteolytic enzymes of herring by-products are most active above room temperature, but the maximum activity temperature varies depending on the catching season. The DH increases over time up to 5-7 days where after the rate levels off.

Lipid oxidation takes unexpected routes at elevated temperatures. An increasing trend of lipid oxidation-derived carbonyls, including malondialdehyde (MDA), was noticed up to 22°C followed by a decreasing trend. The latter might indicate hydrolytic cleavage of MDA to acetaldehyde, and/or non-enzymatic interactions of carbonyls with proteins/peptides at elevated temperature. Besides, at elevated temperatures, the endogenous α -tocopherol content decreased at a faster rate, which could indicate that lipid oxidation, is more pronounced.

Further studies are currently ongoing to understand the lipid oxidation mechanism during ensilaging and to optimize the ensilaging process.

O24 - Rehydrated and ready-to-use products of Dried cod (Stockfish) and Dried salt-cured cod

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Convenience of dried and dried salt-cured cod products is in demand by the consumers. Desalted and ready-to-use refrigerated products are therefore of interest, but a relatively short shelf life of these products is a challenge. A number of factors in the production process from salt curing/drying to packaging potentially affect quality changes during refrigerated storage of rehydrated cod. The aim of this study was to investigate how the time of salt-curing prior drying, the rehydration process and packaging method influence the microbiological and sensory quality during refrigerated storage of ready-to-use products of stockfish and dried salt-cured cod.

Dried cod/stockfish: The effect of different rehydrating procedures (with/without skin, 7/9 days soaked in water) and packaging methods (vacuum packaging, modified atmosphere packaging (CO₂/N₂/O₂), and CO₂ emitter) was tested.

Dried salt-cured cod: The effect of different duration of salt-curing (6 weeks and 5 months) prior drying, and rehydration, packaging (air, vacuum, modified atmosphere (CO₂, N₂ + CO₂ emitter)) was tested.

The rehydrated cod products were stored at 4 °C and samples taken for analysis of microbiota, volatile compounds and sensory profiling. Bacterial analyses were done by plating on iron agar and DRBC (mold/yeast), microbiota profiling using high-throughput sequencing of bacterial 16S rDNA (MiSeq, Illumina) and sequencing of bacterial colonies from agar plates. Volatile components (dynamic-headspace GC-MS) and sensory profiling (trained assessors) by different odor attributes were also performed.

Preliminary results show similar microbiota, and a more diverse microbiota of rehydrated salt fish and stockfish, respectively. Further analyses will more deeply show how quality and shelf life develop during refrigerated storage of rehydrated and ready-to-use products.

These studies are part of the interdisciplinary project "CATCH", financed by the Research Council of Norway.

O25 - Innovation and valorization of sea urchin gonads: a road map to the plate

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The purple sea urchin *Paracentrotus lividus* is commercially exploited in many Mediterranean and north-eastern Atlantic regions in rocky intertidal and shallow sub tidal environments. Nowadays there is a significant growing demand towards the consumption of this species due to the distinctive aroma, good taste and commercial value of its roe. Most sea urchins harvested in these regions is conveyed to high reputed restaurants and festivals, and the routes from harvesting areas to close markets and exclusive end-users are relatively simple. Its consumption is limited by freshness, since sea urchin gonads deteriorate rapidly during the storage period and their shelf life is very short. Additionally, the transportation of fresh urchins to distant markets is limited and strategies to preserve and valorize the roe are still poorly documented. Therefore, it is urgent to gather further knowledge about many aspects of this species, including the biochemical composition, potential chemical contamination, preservation and valorization. Such information will enable to reach the highest prices and to enlarge the export markets. Thus, the present study aims to answer to some of these requirements. Protein was the main constituent of sea urchin gonads, whereas lipids and minerals were relatively abundant. The profile of macro and trace elements were respectively Cl>K>P>Ca>S>Zn and Br>Fe>Sr>I>Rb>Cu>Se>Cr>Ni. Saturated fatty acids were the dominant group, followed by polyunsaturated. In what regards toxic elements the general profile was As>Cd> Pb>Hg>iAs, though the levels were very low. Freezing and frozen storage after glazing with water and several coating solutions were tested to preserve the quality of sea urchin gonads under frozen storage. The results were quite encouraging. Regarding valorization, two types of canned sea urchin gonads in light brine with and without macro algae were developed and both products were very well classified and considered an interesting approach to valorize sea urchin gonads.

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O26 - Perspectives of atmospheric freeze-drying of brown seaweeds (*Saccharina Latissima*) with respect to their thermal properties and phase transitions

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Thermal properties of brown seaweeds (*Saccharina latissima*) with different pre-processing (raw, blanched, washed) were determined using DSC technique in the temperature range between -150.0 and 200.0 °C. The following phase transitions were detected: glass transitions, incipient point of ice melting and freezing point. The ice content and amount of unfrozen water was detected by analysis of the melting peaks. The ice content reduction during atmospheric freeze-drying process was predicted for different moisture contents, drying temperatures and types of pre-processing. The data gives essential information about gentle and energy efficient processing of seaweeds.

Keywords: brown seaweeds, ice fraction, freeze-drying, glass transition

O29 - Creating plus products from waste

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Over the last decade, there has been challenges in creating profitability for the Norwegian fillet industry, especially in white fish production, but lately also for the producers of salmon fillets. Falling profitability is partly due to a falling willingness to pay for the fillets, but also increased production costs and lack of value creation from material left after the production (Iversen, A. et al. 2016). Simultaneously, scientific reports claim substantial value creation potential for marine rest raw material (Richardsen, R. et al. 2015). In our study, we look at the possibilities for the firms to create value of these “leftovers”, especially marine protein as an ingredient for the nutritional industry. We have looked in to the profitability of the Norwegian Marine ingredient industry (NMII) in an earlier part of the study. There we found that oil production is most common, and that those including oil in the production have better profitability, than those producing only powder/meal. Oil production of marine raw material is an old and well-established industry, it is therefore necessary with more knowledge about the market demands and opportunities for the protein fraction of the raw material in order for it to contribute to the same or better value creation as oil. Preliminary findings indicate varying possibilities for marine protein, but most producers are holding on to established usages such as ensilage or fishmeal, with low prices for the raw material. Further, there is little knowledge of the market demand for taste, smell and texture of marine protein in new products.

O30 - Valorization of Smooth hound by-products by trypsin hydrolysis: effect of in vitro gastrointestinal digestion and encapsulation on anti-Angiotensin-Converting Enzyme activity

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Collagenous by-products derived from Smooth hound (*Mustelus mustelus*) were valorized by trypsin hydrolysis to obtain peptide hydrolysates with ACE (Angiotensin Converting Enzyme)-inhibitory activity. A surface response experimental design (RSM) was used to optimize the conditions of hydrolysis (pH 7, 8 or 9, and temperature of 35, 45 or 55°C). According to the model applied, neither hydrolysis temperature nor pH in the ranges studied had a relevant effect on DH, whereas pH had a significant effect on ACE-inhibitory activity. The optimum conditions to achieve the maximum activity were 45.9 °C/pH 9, rendering a hydrolysate mainly composed of short peptides, presumably dipeptides. The ACE-inhibitory activity was evaluated after in vitro gastrointestinal digestion, founding a worsening of activity that was related to dipeptide loss and to the appearance of new low molecular weight peptides. Hydrolysate encapsulation by an alginate-whey protein isolate microsphere improved the ACE-inhibitory activity after gastrointestinal digestion.

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O31 - High quality proteins from cod heads

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The Norwegian export of dried cod heads are challenged by instability and unpredictability in the markets. And, in recent years the Norwegian export has been almost not existing. Traditionally cod heads have been dried, a tedious and resource demanding process regarding both time and personnel, and which due to its unpredictability have led to great losses. Cod heads make up 20% of the cod and is found to contain around 15% protein and very little fat, making it a highly desirable raw material for protein production by enzymatic hydrolysis. Different combinations of commercial enzymes as well as active endogenous enzymes in the raw material has been employed to investigate how they influences fish protein hydrolysate (FPH) yield and quality. Using commercial enzymes FPH with a protein content of 79-86%, and fat below 1% were produced, indicating that high quality FPH can be produced from cod heads. Tests were done in both laboratory and pilot scale.

O32 - Microalgae as Important Sources of Coenzyme Q10, Vitamin E and Carotenoids

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Bioprospection of marine resources has consistently confirmed microalgae as a natural source of bioactive molecules, which deliver important benefits to human health. Coenzyme Q10, α -tocopherol (Vitamin E) and carotenoids (β -carotene, astaxanthin and fucoxanthin, among others) are some examples of the compounds often reported in those marine organisms. As potent antioxidants, both coenzyme Q10 and α -tocopherol are able to neutralize free radicals. Coenzyme Q10 takes part in energy metabolism, which is why it is considered to have a high potential for the treatment of cardiovascular diseases and stress oxidative disorders. On the other hand, carotenoids have antioxidant, anti-inflammatory, anticancer, anti-obesity and antidiabetic properties. As a result, there is a great interest in the identification and quantification of such compounds in microalgae, particularly in those recently isolated in Portuguese coast, since it would allow the upgrading, in a sustainable way, of unexploited resources. Coenzyme Q10, α -tocopherol (Vitamin E) and carotenoids were determined in several microalgae species (for instance, *Skeletonema* and *Tetraselmis*). The presence of one or multiple bioactives in these species was confirmed with this research. In view of this, further studies should be carried out in order to assess their potential for technological application in foods, nutraceuticals, cosmetics or pharmacological products.

O35 - The Potential Health Benefits and Applications of Undervalued Macroalgal Biomass from *Petalonia binghamiae*, *Halopteris scoparia*, and *Osmundea pinnatifida*

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The macroalgae species *Petalonia binghamiae*, *Halopteris scoparia*, and *Osmundea pinnatifida* are still undervalued and not thoroughly studied. Therefore, these species were subjected to a thorough process of biochemical bioprospecting. Relevant bioactive compounds (polyphenols, carotenoids, vitamin E, coenzyme Q10, beta-glucans) and key bioactivities (cytotoxicity, anti-inflammatory, anti-hypercholesterolemic, and antidiabetic) were analysed. Concerning bioactives, while beta-glucans were only detected at trace levels, polyphenols were present at non-negligible levels, reaching 140-220 mg/100 g dw. Indeed, whereas the aqueous extract of *H. scoparia* exhibited the highest total polyphenol content, yielding a total of 217 ± 8 mg gallic acid equivalent (GAE)/100 g dw, The lowest polyphenol content was found in an ethanolic extract of *P. binghamiae*, 142 ± 3 mg GAE/100 g dw. The richness in this important class of bioactives with antioxidant and anti-inflammatory properties is consentaneous with literature on macroalgae, particularly brown macroalgae such as *P. binghamiae* and *H. scoparia*. Other studied bioactives were also detected and may warrant further research. Regarding bioactivities relevant to human health, anti-inflammatory activity deserves to be highlighted. In fact, ethanolic extracts of *H. scoparia* and aqueous extracts of *P. binghamiae* showed inhibitory capacity of cyclooxygenase-2 (COX-2), between 40 and 79 %, thus indicating some anti-inflammatory activity. Other bioactivities were detected, being particularly worth of future investigation a possible link between fucoxanthin presence in the biomass and antidiabetic activity. Accordingly, the biomass of these macroalgae has a considerable potential for the preparation of products directed to the promotion of human health (nutraceutical or pharmaceutical applications).

O36 - Alginate edible covers (coating solution and film) enriched with a calcium-rich shrimp extract and green tea. Application for the preservation of shrimp during chilled storage.

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A shrimp extract rich in lipids, proteins, pigments and minerals, mainly calcium (≈ 1.9 g/100 g), was obtained from the mild-acid demineralization treatment applied to shrimp shells to produce chitosan. The freeze-dried shrimp demineralization extract (SME) was incorporated into an alginate matrix to develop an edible coating solution and a pre-formed film. SME increased the gelling power of the solution and improved the physico-chemical properties (water solubility, mechanical and optical properties) of the films. The covers were further enriched with green tea, which provided antimicrobial and antioxidant properties.

Both types of edible covers were used to preserve peeled shrimp during chilled storage. The storage trial showed that the coating solution, and especially the film, increased the microbial stability of shrimp, with reductions in total viable counts and pseudomonads. The shelf life of refrigerated shrimp treated with the composite alginate-SME-green tea film increased up to 10 days compared to the shrimp coated with synthetic plastic film. The edible covers also inhibited the growth of the Enterobacteria group, thus preventing the development of potentially pathogenic microorganisms. With regard to the sensory properties of shrimps, the effect of films were more noticeable than the coating solution, but this effect was reduced when the shrimp was cooked. Although the treated covered shrimps showed different organoleptic characteristics to the uncovered ones, all the samples were considered acceptable by the panel. These covers could be a promising way to improve the quality of shrimp during storage.

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O37 - Enhanced recovery of value-added compounds by high isostatic pressure and supercritical fluid assisted extraction from *Aurantiochytrium* sp.

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Squalene is a compound associated with cardioprotective effect and chemopreventive activity, being produced in high quantities by the microalgae *Aurantiochytrium* sp., as well other bioactive compounds with added value, such as docosahexaenoic acid (DHA), carotenoids and others, being an ecological solution to the conventional animal-based sources. After the extraction of squalene and DHA, the microalgae biomass is still rich in other bioactive compounds that are unable to be extracted by the conventional extraction methods. In order to overcome the limitations of conventional extraction techniques, new extraction methods are being developed, including high pressure assisted extraction (HPE) and supercritical fluids extraction (SFE). The first technique uses isostatic pressures between 100-800 MPa (at room-like temperatures), to reduce the extraction time and the amounts of solvents, with higher extraction yields, improving the quality, selectivity extraction efficiencies. In turn, SFE offers the additional advantage of a prompt and easy separation of the solvent from the biomass and from the produced extract simply by decompression of the system. This technology typically relies on supercritical CO₂ as solvent (inert, innocuous, etc.), moderate temperatures (40-80 °C), and pressures usually up to 30-40 MPa.

This work aimed to evaluate the extraction yields after HPE and SFE of the organic fraction from the remaining biomass of *Aurantiochytrium* sp. For HPE, variables as pressure (300 and 500 MPa, 15 min), extraction solvent (ethanol, isopropyl alcohol, ethyl acetate and n-hexane) and sample-solvent ratio (1/10, 2/10 and 3/10) were studied. Control extractions were carried out at atmospheric pressure (0.1 MPa) for 15-45 min. As per the SFE assays, the studied operating parameters were pressure (20-30 MPa), temperature (40-80 °C), and flow rate (6-12 g min⁻¹), and a total of eight assays were performed.

HPE increased the extraction yields (5-22%) in all solvents, compared to the extraction performed at atmospheric pressure (4-9%), being the yields directly

proportional to the extraction pressure (higher yields at higher pressures). On the other hand, the results showed that for all tested conditions the extraction yield decreased at higher sample-solvent ratios. For the solvents tested, it was found that ethanol and ethyl acetate (along with n-hexane) showed the lowest and highest yields, respectively. The extraction condition: ethyl acetate (and hexane), 500 MPa/ 15 min and the sample-solvent ratio 1/10 resulted in the higher extraction yield (22%). These results are due to the fact that ethyl acetate (along with n-hexane) is the most nonpolar solvent compared to isopropyl alcohol and ethanol and, thus having more affinity to the organic fractions.

With reference to SFE of total extraction yield results, these ranged from 2.1 to 13.4 wt.% (Figure 1), managing to overcome the dichloromethane Soxhlet reference value of 12.8 wt.%. Moreover, a full factorial study of three factors and two levels pointed to temperature as the most influent factor, with a negative effect, followed by pressure and then flow rate, both with positive effects on extraction yield values.

This study indicates the potential of HPE and SFE for bulk algae oil, DHA and carotenoids extraction from the remaining biomass of the microalgae *Aurantiochytrium* sp. with highest extraction yields.

Total extraction yields by supercritical fluid extraction

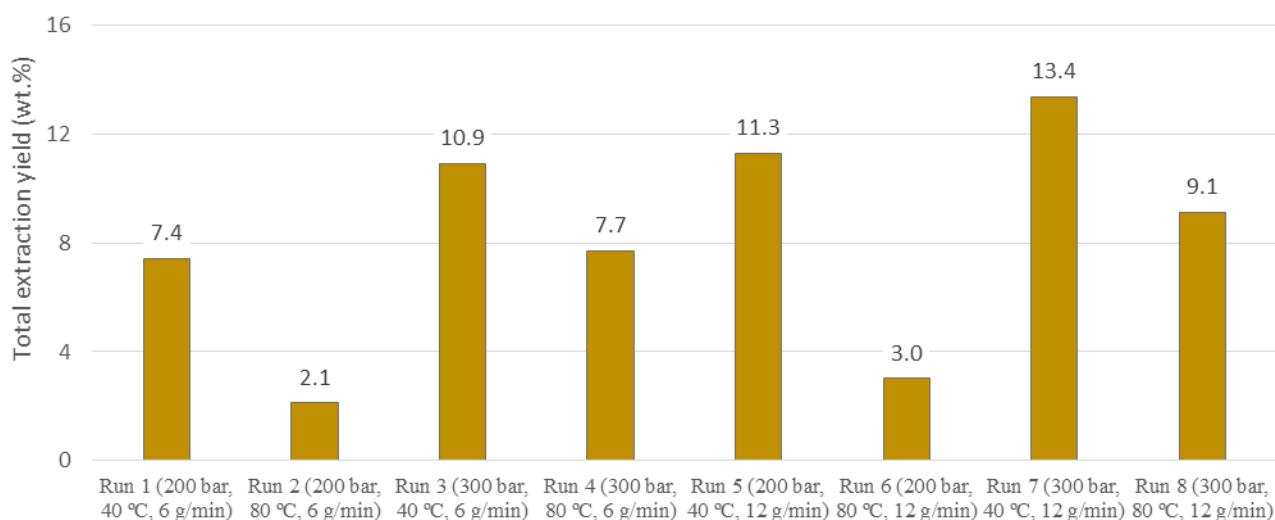


Figure 1: Total extraction yields (wt.%) of the performed SFE assays.

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O38 - Recovery of collagen hydrolysate from fish bones with pressurized hot water extraction

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The side-streams from fish refineries are currently under-utilized. They could be upgraded to value-added protein ingredients. The major components present in these side-streams are collagen and minerals. The global demand for collagen is increasing and therefore new sources of collagen and new eco-efficient methods for its extraction are needed. Potential applications for collagen hydrolysates include functional and health-promoting foods, cosmetics, pharmaceuticals and nutraceuticals.

In the present study, a process to utilize salmon side stream, backbone after filleting from fish refineries was developed. First, the meat remaining on the bones was recovered with enzymatic hydrolysis after which the clean bones were dried and milled. Then, the proteinaceous and mineral fractions of the bones were separated with pressurized hot water extraction. With this method, the minerals remain in the solid fraction and the hydrolyzed collagen is extracted to water. The effect of temperature, extraction time and dry matter content on the extracted protein yield was studied using response surface methodology. The maximum yield of protein from salmon bones (at 190°C and 100 min) was 82 %.

Protein and peptide compositions of the extracts were analyzed to measure the effect of extraction conditions on the collagen fragmentation and hydrophobic properties of the recovered peptides. All extracts were observed to contain large proteins with molecular weight above 100 kDa. However, the higher the temperature and treatment time, the higher the fragmentation of the proteins was. Extracts eluted at 140 - 160 °C contained considerable amount of small peptides with molecular weight of approx, 50 – 200 Da while small peptides were scarce or absent in the extracts produced at 180 – 200 °C. Peptide composition and hydrophobic properties varied remarkably depending on the extraction temperature.

O39 - Influence of pre-treatment and low-temperature on drying kinetics, sorption properties, shrinkage and color of brown seaweeds (*Saccharina Latissima*)

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Drying kinetics of *Saccharina latissima* (raw and blanched) was studied with respect to temperature and air velocity. Two drying methods (batch and fluidized) were investigated. The effective moisture diffusivity coefficient varied with respect to drying parameters. Drying temperature of 38.0 °C resulted in more brown color, when compared with other samples. Sorption characteristics of dried seaweeds depended on salt content and showed high accumulation of moisture at relative humidity of air of 80.0 %. The pre-treated seaweeds showed linear accumulation of moisture within increasing of relative humidity of drying air from 20.0 to 80.0 %, but high level of hysteresis was determined between sorption and desorption isotherms. The shrinkage development within dewatering of blanched and raw samples was also studied. Conclusion concerning effective drying and pre-treatment regimes were made.

Keywords: *brown seaweeds, drying kinetics, sorption isotherms, color*

O41 - Antioxidant-enriched extracts derived from *Alaria esculenta* using membrane filtration

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The use of macroalgae for industrial purposes has so far been focusing on the cultivation and harvesting of edible species and the production of agar, carrageenan and alginate. Lately, the focus has shifted to explore several bioactive components from macroalgae such as phenols, peptides and pigments. This change in focus comes from an environmental pressure, as it is necessary to utilize and exploit available rest raw materials more effectively than what is done today.

The aim of the present study was to establish a method to concentrate phenolic compounds in extracts derived from *Alaria esculenta* using a pilot-scale membrane separation system.

Fresh *A. esculenta* were lyophilized, and the crude extract was produced using food friendly extraction solvents (80% ethanol and deionized water). The filtration was performed using three different cut-off filters (pore-size of 0.2 µm, 100 kDa and 3.5 kDa). Pre-set pressure through the respective filters were 200 kPa, 600 kPa, and 1000 kPa. Each filtration step produced a retentate and a permeate. The total phenolic content (TPC) of the different fractions was quantified using the Folin-Ciocalteu colorimetric method. To identify specific compounds in the 3.5 kDa fractions, UPC2–qTOF analysis was conducted.

Significantly highest TPC was found in the retentate phase, independent of filtration step or extraction solvent (80% ethanol or deionized water). TPC value for the crude water extract was 1.13 ± 0.09 g GAE/100 g DW, while the 100 kDa water fraction value was 2.09 ± 0.04 g GAE/100 g DW ($p < 0.001$). The crude ethanol extract had 1.82 ± 0.05 g GAE/100 g DW, while the fraction with highest TPC was the 3.5 kDa ethanol retentate fraction that contained 4.55 ± 0.1 g GAE/100 g DW ($p < 0.001$). The polyphenols difucol and diploretol were tentatively identified using the UPC2–qTOF analysis.

The experiment demonstrates an industrial method using food friendly solvents to produce antioxidant-enriched extracts from seaweed.

O42 - *Laminaria ochroleuca* brown seaweed and its autohydrolysis extracts features

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Laminaria spp. are marine algae found mainly in the Atlantic Iberian coast. Although widely consumed in Asian countries, these brown algae are mainly valued in Europe through its extracts, which include alginates and pigments (Fernandes et al., 2016). Alginates are commercially used as thickening, gelling and stabilizing agents in food, cosmetic and pharmaceutical industries. This alga contains fucoidans that reduce the pro-inflammatory cytokines expression, and presents antioxidant, antimicrobial and antitumoral properties (Flórez et al., 2017). Several studies were performed with *Laminaria spp.* extracts (Bonneville, 2007). However, little is known about the whole algae functional properties, apart from some studies regarding its chemical composition (Sánchez-Machado et al., 2004).

In this study, dehydrated *Laminaria ochroleuca* (Algas Atlánticas Algamar, S.L., Spain) was used as raw material, it was milled and sieved in order to obtain three particle size ranges: <0.25 mm, 0.25 – 0.50 mm and 0.50 - 1.0 mm. These fractions were used to prepare aqueous solutions from 5% to 20% (w/w, d.b.) at 20°C to 90°C and to evaluate their gelling features. Operation under high temperature and high pressure extraction conditions changes water properties allowing solubilisation and depolymerisation of compounds presents in the matrix of the seaweed. Hydrothermal processing (autohydrolysis) with compressed hot water in a liquid:solid ratio 30:1 (w:w) at 160 °C was proposed to extract bioactive compounds from *L. ochroleuca*. Liquid and solid phases were separated by filtration. Individual fractions obtained from this green technology were used to enrich the gels nutritional features prepared under the same conditions as the whole algae. Gelled systems were evaluated by determining colour, texture, rheology, syneresis and bioactivity.

Overall, the preliminary obtained results indicated that *L. ochroleuca* is a valuable resource that can be used as a whole or taking advantage of its bioactive fractions, in a concept of circular economy and sustainability.

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I Pernet,† A Denis,† JF Nicolas

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O43 - Nofima Peptek

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Peptek is an integrated, comprehensive and multidisciplinary effort within Nofima with the objective to achieve a global better understanding for the processing of different biomasses through enzymatic hydrolysis. This project aims at creating knowledge on how to establish and perform reproducible and efficient methods for procuring high value products from biomass that has low value or is of little use. This type of biomass is often heterogeneous in nature, and varies from batch to batch, thus a deep understanding of how to design, follow and adapt the process in order to obtain the best product is of great value to both academia and industry. The project includes spectroscopic characterization to monitor the degree of hydrolysis by mapping average molecular weight in a continuous flow procedure. NMR spectra mapping is employed to develop techniques for determining the relation between processing, taste, bioactivity and formulation. Response Surface methodology is also used to optimize the hydrolysis by exploring relationships between several variables and one or more response variables.

All these competences will increase knowledge of processing methods on how raw material quality and processing can affect product quality. Increase knowledge of product possibilities and product characteristics such as taste, smell, functional properties, chemical composition, bioactivity and bioavailability. In total, these focus areas will link the entire value chain from raw material to finished product. This becomes the knowledge needed to develop a comprehensive solution for processing all types of raw materials. Biomasses typically include snow crab by-products, poultry off-cuts, fish skins or algae, potato peels and feathers to mention a few.

For each one of those different materials one or any combination of enzymes are chosen to provide tailor made peptide composition of the hydrolysate.

These investigations are done at laboratory scale and can be, when needed, scale-up at our pilot factory.

O44 - Antioxidant, antihypertensive, anti-diabetic, anti-obesity potential of Tilapia (*Oreochromis niloticus*) protein hydrolysates

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Abstract

The need of dietary antioxidants to increase their amount in the human body has been recognised since they play a significant role as health-benefiting factors. On the other hand, many synthetic drugs for the treatment of obesity, diabetes and hypertension have been reported to cause side effects. For these reasons, the development of safe natural products with these properties as an alternative to synthetic ones has gained increasing interest and protein hydrolysates are a good example of these products. Thus, the objective of this work was the preparation and evaluation of biological activities (antioxidant and inhibition of angiotensin-converting enzyme (ACE), α -amylase and lipase) of protein hydrolysates obtained from tilapia muscle using Alcalase (HP-A), Flavourzyme (HP-F) and a mixture of Alcalase and Flavourzyme (HP-AF). The degree of hydrolysis of these hydrolysates was in the range of 22.6-31.2% and protein content varied between 84.1 and 86.1%. HP-F showed the highest DPPH antiradicalar activity ($EC_{50}=1.95\pm0.05$ mg/ml), reducing power ($AC_{0.5}=4.84\pm0.08$ mg/ml) and Fe^{2+} -chelating activity ($EC_{50}=8.64\pm0.24$ mg/ml). However, the ABTS antiradicalar activity ($EC_{50}=2.59\pm0.13$ mg/ml) and Cu^{2+} -chelating activity ($EC_{50}=1.72\pm0.08$ mg/ml) was higher in HP-AF hydrolysate. All hydrolysates with exception of HP-F exhibited ACE inhibitory activity at a concentration of 1mg/ml. The EC_{50} value of α -amylase inhibitory activity was 51.4 ± 0.85 mg/mL for HP-A and 8.9 ± 0.85 mg/mL for HP-F but the inhibitory activity of HP-AF was below 50 % in the concentrations range tested. All hydrolysates exhibited a relatively low lipase inhibitory activity where the EC_{50} was in the range of 150-250 mg/ml.

O45 - Biotechnological process of squalene and DHA production by marine microalgae *Aurantiochytrium* sp.

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The growth of the industry around the source of squalene has been very limited by the scarcity and limitations of raw material for the obtention of this compound, with recognized health benefits and its range of applications. The first aim of this work is to develop a viable biotechnological process for the simultaneous production of squalene and polyunsaturated fatty acids (docosahexaenoic acid - DHA), using as alternative source heterotrophic microalgae strain, *Aurantiochytrium* sp.. The highest biomass production was achieved after 72 or 96 hours (6,6 gL⁻¹). The highest production of squalene (7.3 g/100 g and 250mgL⁻¹) and the highest productivity of DHA (1.3 gL⁻¹), was obtained under the following conditions: salinity at 25-50‰, glucose concentration at 2-4‰, temperature at 26-30 °C and aeration flow 1.2 -3.0 vvm after 72-96 hours of cultivation. Other aim of this work, is to evaluate the extraction yields and identify other bioactive compounds of high added value a, present in algae biomass after squalene and polyunsaturated fatty acids (PUFA), DHA, extraction. Extraction methods, as high pressure assisted extraction (HPE) were used. This technique reduces the extraction time and the amounts of solvents, with higher extraction yields, improving the quality, selectivity and extraction efficiency. The selected conditions were pressures between 300-500 MPa, 15 min., extraction solvent (ethanol, isopropyl alcohol and ethyl acetate and a sample-solvent ratio (1/10, 2/10 and 3/10). After extraction of squalene, PUFA and DHA, the biomass remaining is still rich in other bioactive compounds whose properties make them interesting for the development of functional ingredients for use in animal feed, food and cosmetic formulas. Moreover, AlgaValue project aims to minimize the environmental impact of the exhausted culture medium from microalgae production through its treatment and reuse in the process contributing for the sustainability.

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O46 - Discards protein-based adhesives for the wood-based panel industry

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O53 - Antitumor potential presented by White shrimp (*Litopenaeus vannamei*) protein hydrolysates

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Aquatic organisms are indicated as an important natural source of antitumor compounds because of their amino acid composition and reduced molecular mass, which facilitate the action of the compound on cancer cells. Cancer is one of the leading causes of morbidity and mortality worldwide, which is usually treated with synthetic chemotherapy drugs. However, chemotherapy is reported as a treatment that causes many side effects and irreversible damage to non-cancerous cells. In this sense, the objective of this study was to obtain protein hydrolysates of White shrimp (*Litopenaeus vannamei*) and to verify its antitumor potential. White shrimp culturing by biofloc technology system was supplied by the FURG Marine Aquaculture Station. Protein hydrolysates were obtained by the pH-Stat method, from White shrimp muscle using enzymes Alcalase and Protamex until the reaction reached a degree of hydrolysis of 20%. The hydrolysates were characterized by amino acid composition in a reverse phase high efficiency liquid chromatograph. Antitumor activity was assessed by MTT (3-(4,5-dimethylthiazol-2-yl)2,5-diphenyl tetrazolium bromide) cell availability assay using the Melan-a (non-tumor melanocytes) and B16F10 (melanoma) cell lines. The results indicated that the enzyme Alcalase was more efficient to hydrolyze the proteins of the shrimp, when compared to the enzyme Protamex, since it presented less time of reaction. The hydrolysates obtained had a high hydrophobic content. In relation to the antitumor activity, the protein hydrolysates obtained by the enzyme Alcalase presented antitumor potential at the concentration of 1000 µg.mL⁻¹. In addition, both hydrolysates had no cytotoxic effect against Melan-a cell lines. It was concluded that shrimp protein hydrolysates have a high potential against cancer cells and could be considered as an important source of natural antitumor compounds.

O54 - Loading and bioencapsulation of Iron (Fe^{2+}) mineral in trout egg as a model system for delivering of water-soluble compounds

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Abstract

Iron deficiency is one of the widespread nutritional deficiencies in humans. The World Health Organization calculates that 30% of the world's population suffers from anemia, many due to iron deficiency. Iron supplements are generally manufactured as iron syrup in ferrous fumarate (Fe^{2+}) form. But some phytates, polyphenols and phosphates rich foods could inhibit iron absorption if these are consumed together with iron syrup. Besides oral intake of iron syrup could stain teeth. Loading and bioencapsulation of iron (Fe^{2+}) into rainbow trout egg may protect the iron and help to save teeth health. The aim of this research was to determine iron mineral loading capacity of rainbow trout fish (*Oncorhynchus mykiss*) eggs. Rainbow trout eggs were immersed into 50 ml solutions containing 0, 100, 250, 500, 750 and 1000, 1250 $\mu\text{l/l}$ of iron (Fe^{2+}) for 30 minutes. Then, iron loaded trout eggs were freeze dried up to 0.3 aw in freeze dryer in order to encapsulate loaded iron mineral into the trout egg. Iron contents of trout eggs (TE0, TE100, TE250, TE500, TE750, TE1000 and TE1250) determined by the ICP-MS were 404,79, 410,38, 426,45, 441,75, 459,42, 464,39, 460,82 and 461,47 $\mu\text{g/kg}$, respectively. There was a significant ($P<0.05$) difference between iron contents of dried trout eggs. Among the all concentrations of Iron (Fe^{2+}) tested, samples immersed in solutions containing TE750, TE1000 and TE1250 ppm iron showed the highest loading capacity. The results indicate that the iron (Fe^{2+}) up to 60 $\mu\text{g/kg}$ (dry base) could be successfully loaded into the trout egg. However, further iron (Fe^{2+}) or other micronutrient dose and loading capacity trials should be investigated. The iron encapsulated dried rainbow trout eggs with nutritious properties can be served as a novel functional food to iron- deficiency anemia patients and children.

Keywords: Bioencapsulation, Rainbow trout, fish egg, Iron, Ferrous

O55 - Risk-benefit assessment associated to seafood consumption, case studies

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Abstract

In recent decades, the link between food and health has been shown to be fundamental. However, many and complex factors underlie apparently simple decisions about what to eat. Few foods have baffled consumers as much as seafood because its consumption is subject to a nutritional-toxicological conflict. Indeed, even though new health benefits associated with eating seafood have been found and its consumption is advised in a healthy balanced diet, given its nutritional and health benefits, there are some doubts regarding seafood contaminants that sometimes outshine the good associated to this consumption. Although it is relatively new, risk-benefit assessment (RBA) can help to draw science-based answers to this complicated question/conflict with a large potential impact on public health. The RBA aims to weigh the beneficial and adverse effects that a food (component) may have, in order to facilitate more informed management decisions regarding public health issues. Moreover, bioaccessibility or bioavailability of compounds in different seafood products (raw or cooked) combined with advanced statistical processing of the probabilities of exceeding the advised thresholds is a promising field of research that may shed light into the realistic RBA associated to seafood consumption.

Based on the developed work, we have found strong evidence pointing to the critical importance of coupling bioaccessibility (or bioavailability) studies with state-of-the-art applied mathematics in order to have a realistic assessment of the risk-benefit balance associated to seafood consumption (including fish, seaweeds, and microalgae). Moreover, processing (e.g. canning), culinary treatment, and modeling of dose-response functions are other key aspects that have been studied and proven decisive in the RBA conflict outcome. The RBA obtained results may contribute to better define the nutritional value of seafood and to formulate recommendations of cooking practices and seafood choices in diet in order to promote human health and well-being.

O56 - Assessing changes in quality characteristics of sous-vide cooked Atlantic mackerel during chilled storage by multiple regression analysis

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Sous-vide cooking is a mild heat treatment technique aiming to ensure safe, ready-to-serve meals with enhanced sensory and nutritional properties and extended shelf-life. It widely applies to meat and fish products and consists in cooking the raw material under controlled temperature and time inside vacuum pouches.

The present study investigated changes in quality parameters of sous-vide cooked Atlantic mackerel during chilled storage. Two levels of temperature (70 and 80 °C), cooking time (10 and 20 min) and two types of antioxidants (Fortium TR25 and Fortium RPT40) were tested according to a planned experimental design. Immediately after cooking, fish samples were put in chilled storage at 0±1°C for 1, 3, 9 and 15 days. Cook loss, dry matter and ash, protein solubility, and microbiological and texture parameters were analyzed during storage. Multiple regression analysis was performed to explain and quantify the relationship between process parameters and end-product quality parameters.

Water content in sous-vide cooked mackerel samples showed high variation, ranging from 48.05% to 65.44% along the sampling days. Regression analysis revealed that this parameter was not affected by any of the experimental factors. Contrary to water content, the gradual decrease of cook loss in sous-vide treated mackerel fillets along the storage period was negatively influenced by cooking temperature ($p=0.037$) and positively by duration of chilled storage ($p=0.001$, $R=0.821$).

The significant decrease in solubility of sarcoplasmic (up to 95.9%) and myofibrillar (up to 96.6%) proteins in sous-vide cooked mackerel in comparison with raw fish (control samples) indicated their heat denaturation. Multiple regression analysis showed that temperature and duration of sous-vide cooking were the main factors negatively influencing protein solubility. Moreover, sous-vide treatment decreased hardness of mackerel fillets compared to control sample. However, this parameter further increased during chilled storage for all samples analyzed due to decreased cook loss ($p=0.047$).

O57 - BIVALVE MOLLUSCS CONTAMINATION IN TAGUS ESTUARY (PORTUGAL)

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Tagus River Estuary (ETJ) is one of the largest Portuguese bivalve production areas, which is adversely affected by contaminants and pollutants and presents an unsatisfactory sanitary status (class C). Nevertheless, the number of bivalve harvesters continues to increase and local competent authorities have funded improvements in treatments of urban and industrial discharges. Therefore, the aim of this study was to evaluate the effect of location, species, distance from margin and rainfall in bivalve quality.

Cockles (*Cerastoderma edule*), Japanese-clam (*Ruditapes phillipinarum*) and peppery furrow (*Scrobicularia plana*) were collected from 37 sampling points located upstream and downstream Vasco da Gama bridge and tested for *E. coli* and cadmium (Cd), lead (Pb) and mercury (Hg).

E. coli (MPN/100g) levels ranged between 230 - >180000 in Japanese-clam; 780 - 160000 in cockles; and 490 - 180000 in peppery furrow. Downstream location from Vasco da Gama bridge implied higher counts of *E. coli* ($p < 0.05$) than in the upstream zone. All samples revealed levels of Cd and Hg below the legal limits. Concerning Pb, all peppery furrow samples presented levels above the limit of 1.5 mg/kg, supporting the prohibition of the capture of this species. Some cockles and Japanese-clam samples, collected downstream from Vasco da Gama bridge, also showed high levels of Pb (>1.5 mg/kg). The level of rainfall in the days immediately prior to sampling, margin distance and bivalve species significantly affected ($p < 0.05$) Pb content in bivalves.

Taking into account these results, change of ETJ production zone boundaries is advisable, in order to exclude the subarea which presented prohibited levels of *E. coli* and Pb in cockles. In order to identify possible causes for these contaminations and to define mitigation strategies, it is indispensable to generate more data.

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O58 - Do Norwegian salted fish fulfill Spanish demands?

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Spain is an important market for Norwegian heavily salted fish. The quality of the salted fish depends on several factors, like biological conditions of the fish, catching methods and handling, as well as salting methods and procedures. Thus, the quality of the salted cod vary, and quality rating/grading is necessary.

In order for Norwegian producers/exporters to succeed in the Spanish market, it is important that the quality is according to the quality expected by the Spanish purchasers. The commercial quality grading of the salted fish is carried out by trained quality assessors at the producers before export. However, the quality preferences and guidelines used for quality grading may vary between countries. Thus, the quality rating performed by the Norwegian quality assessors may not be according to the Spanish preferences.

In this work, heavily salted fish, both flawless and with quality defects, were produced and evaluated both by Norwegian and Spanish trained quality assessors. The results showed that the assessors from the different countries evaluated the fish differently. The Spanish assessor downgraded more fish than the Norwegian assessors, and it is also shown that different quality defects were emphasized differently in Spain and Norway. According to the Norwegian assessors, 60 % of the evaluated fish was of superior quality (primeira), while the Spanish assessors evaluated only 39 % of the salt fish as primeira. Defects like erroneous beheading and splitting were more emphasized by the Spanish assessors, and partly explained why the Spanish assessors downgraded more fish compared to the Norwegian assessors.

Individual key: 0005440656

O61 - Omega-3 status of farmed salmon on sale at retail outlets

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Consumers are increasingly aware of the health benefits of oily fish and the current study was a snapshot of the omega-3 status of raw farmed salmon on sale in retail outlets in Dublin. Sampling spanned mid-October 2017 to early-March 2018. Five samples were purchased from retail outlets each week comprising four of farmed salmon (*Salmo salar*) and one a wild species, usually mackerel. In all, 65 samples of farmed salmon and nine of mackerel were tested for eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and linoleic acid (LA) contents by the method of Brunton *et al.*, 2015. Results are presented as g/100g of raw fish flesh. Mean EPA+DHA content (with standard deviation) of the 65 salmon samples was 0.81 ± 0.272 g and of the nine mackerel samples 2.04 ± 0.571 g. Mean LA content was 1.44 ± 0.534 g (salmon) and 0.24 ± 0.079 g (mackerel) indicating the use of vegetable oil in the former. EPA+DHA/LA ratios were 0.64 (salmon) and 8.52 (mackerel). The 65 retail salmon samples tested in the current study came from Scotland (25), Norway (22) and Ireland (18) and mean EPA+DHA contents were 0.86 ± 0.309 , 0.81 ± 0.281 and 0.77 ± 0.198 g respectively. Salmon produced non-organically had a higher EPA+DHA content (0.83 ± 0.293 g) than organic samples (0.77 ± 0.200 g). A cooking trial was conducted where salmon samples were poached (95°C/10min), microwaved (3.3min) or roasted (180°C/20min). Retention levels of EPA/DHA in cooked farmed salmon were excellent and ranged 86 to 88% for the three cooking methods.

Brunton, N. P., Mason, C. and Collins, M. J. 2015. Rapid microwave assisted preparation of fatty acid methyl esters for the analysis of fatty acid profiles in foods. *Journal of Analytical Chemistry*, 70 (10), 1218–1224.

O62 - Quality differentiation of a commodity product - Challenges and opportunities

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QUALIDIFF is a visionary research project with the anticipating impact to enhance the long-term competitiveness and resilience of the Norwegian salmon farming industry through quality-based differentiation strategies. The project will provide novel theoretical insights and practical guidelines regarding whether – or to what extent – relevant intrinsic quality dimension such as type and amount of fat (DHA/EPA), color of the flesh, form and appearance, as well as extrinsic quality dimensions such as ecolabels, branding, and packaging might lead to profitable differentiation of Norwegian salmon.

The project will explore and examine consumers' and industrial buyers' demands and preferences for different aspects of salmon quality as well as price premiums for ecolabels and other quality related product attributes. It will also assess requirements (skills, resources and costs) for various differentiation strategies along the whole value chain. This integrated focus makes for a unique contribution and makes it possible to reveal the true competitive benefits of various differentiation strategies, which increases the chances of successful implementation. Through its focus on matching quality with market demand, QUALIDIFF will contribute new actionable knowledge with the potential to enhance customer satisfaction, product quality, healthiness, profitability and competitiveness. This will benefit consumers, companies and the society at large.

How can one best differentiate on quality? What are the industrial buyers' perception of the salmon quality they buy from Norway, and what kind of cues are they using to help their decision processes? In-depth interviews with key industrial buyers (retailers/foodservice/producers) of salmon in various European countries will be used to explore and draw up a matrix of various types of differentiation strategies for Norwegian salmon.

O63 - Quality aspects of fresh loin, tail and fillet products obtained from feed-deprived Atlantic cod at different times post mortem.

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In Norway, the amount of commercially caught, live-stored Atlantic cod (*Gadus morhua* L.) increased during the last decade. Still, there are several challenges in this production concept. The feeding regime during live-storage and time of processing are essential factors as they may strongly affect the quality, both, of the raw material and of the final products regarding biological, biochemical and physical aspects. Most producers process the cod by using filleting machines, followed by manually trimming of the fillets. Often, products like loins and tails are being made and then offered to different markets at different prices. The goal of this study was to explore how the extent of feed-deprivation and time of processing *post mortem* can affect the quality of fresh fillet, loin and tail products.

Atlantic cod were live-stored in absence of feed for 12 weeks after capture. Feed-deprived cod were slaughtered on day 2, and subsequently every fourth week after catch. The fish were filleted at 4, 6, 10, 14, 24 and 48 h *post mortem*. At each time of filleting (n=10), the whole fillet was made from the right side of the fish, while the left side fillet was cut into loin (the upper dorsal back area of the fillet, length: 28 cm) and a tail (length: 20 cm). All products were then stored in ice until day 7 *post mortem*. The quality attributes studied were product contraction, drip loss, muscle hardness, water content and sensory aspects such as texture, colour and odour.

Pre rigor made fillets had slightly lower water content and higher muscle hardness than fillets made after the onset of *rigor*. The major changes in product quality occurred after 8 weeks of feed deprivation. Prolonged feed deprivation lead to fillets having higher water content, gelatinous texture, atypical white colour and less fresh sea odour. The tails were more prone to contraction and had higher drip loss than loins, independently of the extent of feed deprivation and time of filleting.

O64 - First results on sea urchins (*Paracentrotus lividus*) aquaculture trials in Portugal

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Sea urchins are a marine resource whose value and demand presents a growing trend, especially in international markets. Their gonads (roe) reach very high prices once that are considered a gourmet delicatessen. Because of the growing demand and consequent capture a decrease of the natural stocks has been observed. Production trials of sea urchins (*Paracentrotus lividus*) at IPMA started using breeders captured off the Algarve coast in 2016 and conditioned at Aquaculture Research Station (EPPO) facilities, fed with macroalgae *Ulva spp.* and corn grains (*Zea mays*). Spawning induction is obtained by an injection of magnesium chloride solution in the celomic space. During the planctonic stage sea urchins larvae are fed with brown microalgae (*Isochrysis*), green microalgae (*Tetraselmis*) and diatoms (*Chaetoceros* and *Skeletonoma*). Approximately with one month of age sea urchins larvae suffers metamorphosis and fixation occurs. At the beginning of the benthonic phase juveniles are fed with a mixture of microalgae and macroalgae (*Ulva spp.*) until the age of 4 months. A nutritional trial was made to evaluate two different feeding protocols in juvenile production: diet A - macroalgae (*Ulva spp.*); diet B - macroalgae (*Ulva spp.*) plus corn grains. At 7 months of age sea urchins fed with macroalgae showed a higher somatic growth (test diameter), however individuals fed macroalgae+corn had a better GSI (gonado-somatic index). Gonads fatty acid profile was analyzed for both diets at the end of the experiment and the results clearly reflect the influence of diet. Although the fatty acid (FA) profile was characterized by abundance of polyunsaturated FA (PUFA) in both diets, the PUFA from the omega-3 family were the most abundant in the gonads of urchin fed with macroalgae (36.3±1.4%) whereas in urchin fed with macroalgae+corn grains the omega-6 PUFA were the dominant group (29.8±7.3%). Acknowledgment to DIVERSIAQUA ALGARVE (Mar2020 16-02-01-FMP-0066).

O68 - Taurine: promising growth modulator of meagre juveniles fed with vegetable diets

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As wild fisheries faces overfishing, the demand for aquaculture products has raised. This positive growth trend is expected to continue, reflecting the rising demand for healthy human food products, high in protein and marine oils. Meagre is a very interesting species for aquaculture due to its fast growth rates and flesh quality. This fish species has high dietary protein requirement and a good tolerance to diets containing plant protein sources. Taurine is an abundant amino acid, partly synthesized by fish but not sufficient to meet the requirements of the majority fish species. This characteristic leads to the important usage of taurine as a supplement of fish feeds, especially in a fishmeal replacement scenario. Plant-proteins contain only trace amounts of taurine and their derivate feeds often lead to higher metabolic nitrogen losses, suggesting subtle changes on protein metabolism. Because taurine deficiencies in fish are often associated to depressed growth, we hypothesized that taurine could be a growth modulator of fish fed with vegetable diets. To date, the mechanisms underlying the role of dietary taurine on somatic growth of meagre fed with plant protein diets are still to be discovered. Somatic growth changes in protein turnover with slightly increase in protein synthesis over protein degradation. Protein degradation is a highly controlled process where several proteases assume their role. By feeding meagre juveniles (3.2 ± 0.2 g) with a plant-based diet containing five different taurine concentrations (0%, 0.5%, 1.0%, 1.5% and 2.0%) and analysing the resulting growth parameters and protein degradation levels in several tissues we intended to evaluate the modulator potential of taurine in protein degradation systems and consequently in somatic growth of meagre fed with vegetable diets. Our results showed that meagre grew as Taurine concentration increased and this phenomenon could be in part explained by the concomitant decrease of protein degradation in muscle.

O69 - Pre-rigor changes of rainbow trout (*Oncorhynchus mykiss*) as affected by stunning/slaughtering methods and rearing temperatures

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Stunning and slaughtering processes can cause stress and disturbances to fish and, consequently, they may negatively affect the fish flesh quality. Currently, the electrical stunning/slaughtering (E) is a quite common procedure for stunning that requires a proper application to avoid skin burns, fillets bloodspots as well as a possible recover of the fish, before slaughtering. Recently, carbon monoxide asphyxia (CO) was applied for fish stunning/slaughtering without inducing any visible stress response on salmonids, but a confirmation is still needed. Hence, CO and E were applied to rainbow trout (*Oncorhynchus mykiss*) specimens reared at a water temperature of 8 or 12 °C. The fish (n. 400) were distributed in 4 tanks where water was at 8 (2 tanks) or 12 °C (2 tanks); for slaughtering, the fish were subdued to E (E group, treated for 30 s at 180 V) or CO (CO group, flushed directly into the tanks until the fish apparent death) treatments to have the E8, E12, CO8, CO12 groups. Lactate, glucose and cortisol concentrations in plasma, *rigor mortis* evolution, fillets shape changes, ATP breakdown and Adenylate Energy Charge (AEC) levels were evaluated immediately *post mortem* in the muscle of 18 fish per group. CO groups showed higher glucose level than the E ones (7.46 vs. 5 mM, respectively) and even exhibited higher lactate amount than the other group (5.33 vs. 3.26 mM, respectively) as the fish raised at 12 than those raised at 8 °C (4.65 vs. 3.94 mM, respectively). Any of the treatments affected the cortisol concentrations and the *rigor mortis* evolution. However, the E fillets had the strongest length contraction and height increase. The muscle of CO trout contained more ATP than the E one (around 2.28 vs. 1.12 µmol/g). In addition, ATP concentration was higher ($P<0.05$) in fish raised at 12 than 8 °C (2.35 vs. 1.05 µmol/g). Concerning the AEC, the E8 group showed the lowest value while all the others did not differ among them. In conclusion, the CO method resulted to be a suitable alternative to electroshock, able to limit stress in rainbow trout. In addition, the rearing at 12 °C seemed to better preserve ATP and AEC in muscle.

O72 - Mitochondrial activity as a putative indicator of fish freshness alteration?

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Fish is a rapidly perishable commodity and therefore it has a very short shelf life. Nowadays, consumers are becoming more attentive and demanding about the quality of food like seafood. Fish freshness is a parameter which contributes greatly to the quality of fish and fish products. The development of reliable methods and markers to assess fish freshness has been a big challenge in fish research and industry for several years.

The mitochondrion is an organelle present in cells of all fish species; it plays a crucial role in cell death (apoptosis and necrosis) at early stages. Thereby, mitochondrial activity is correlated with cell and tissue health.

The objective of this study was to correlate mitochondrial activity with the level of freshness of the fish fillets stored at 4°C. Farmed gilthead seabream (*Sparus aurata*), obtained within 6 hours after capture and stored on ice at 4°C was used as a model. An extraction protocol was developed and mitochondrial activity was assessed at times $t = 0, 1, 2, 3$ and 4 days using two approaches: the mitochondrial membrane potential ($\Delta\psi_m$) evaluation using the fluorescent cationic probe Rhodamine 123 and the mitochondrial oxygen consumption with an oxygen electrode.

Both methods showed that mitochondrial activity significantly declined after 4 days of storage *post mortem* demonstrating that the mitochondria is a reliable indicator of fish freshness. This is the first report demonstrating that mitochondria could serve as an early indicator of the state of freshness of fish fillets.

O73 - Capture strategies and quality consequences

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Fishing strategies includes choice of fishing gear, handling of fishing gear and on-board handling of fish. Fish quality in the ocean is typically good, but during catch and handling on-board, this can change. Many factors can influence the quality of a catch. Some of these, such as season, fish-species and condition are beyond the control of the fishermen. Other factors that can affect quality such as fishing depth, catching methods, catch size, haul duration, and processing practices are all variables that can be controlled by the fishermen.

Usually, catch related damages are gear marks, skin abrasions and pressure related injuries causing internal and external ecchymosis. It is also known that fish exposed to increased physical activity during capturing can redistribute blood from the intestines and into small capillary veins in the muscle, when the fish is still alive. Generally on-board fishing vessels, bleeding and gutting fish are difficult tasks with large hauls. Therefore, the fish is kept in storage bins after capture and the last of the fish are often dead before bleeding. This leads to bruises and muscle discoloration due to insufficient exsanguination and pressure on the fish.

To reduce the amount of red or pink discoloration of the fish muscle, two strategies are possible: 1) Gentle handling in the fishing gear followed by immediate bleeding or 2) to keep the fish alive on-board the fishing vessel before slaughter. The later strategy allows the fish to transport blood back into the main veins before slaughtering. In the work to be presented, the two strategies have been compared. During live storage, the blood level in the capillary veins increase the first hours before it starts to decrease. In controlled experiments on-board fishing vessels, the effect of on-board handling on fillet color and blood content was evaluated by hyperspectral imaging.

O74 - Effects of storage atmosphere on growth of *Aeromonas salmonicida* and metabolite composition in Atlantic salmon (*Salmo salar* L.)

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Raw Atlantic salmon, packed in vacuum or modified atmosphere, is a popular ready-to-eat product used in homemade sushi or sashimi. The increased consumption of raw seafood is accompanied with several microbiological challenges. *Aeromonas* spp. can represent a microbiological challenge in RTE seafood, as they are both potential food spoilers and potential pathogens. Environmental *Aeromonas* strains seem to be more adapted to harsh environmental factors used to preserve RTE food, e.g. low temperature, vacuum or modified atmosphere. However, we lack knowledge about the growth and spoilage potential of *Aeromonas* spp. in Atlantic salmon.

The aim of the present study was to assess the growth and spoilage potential of an environmental strain of *Aeromonas salmonicida* in salmon fillets stored under modified atmosphere (CO₂:N₂ 60:40) and vacuum. The experiment was conducted as a challenge test where raw filets of salmon were inoculated with *A. salmonicida* (4.4 log CFU/g). Temperature dependent growth kinetic parameters were compared at 4 °C (optimal storage) and 8 °C (minor temperature abuse). Un-inoculated salmon filets were used as control. High resolution NMR technique was used to monitor metabolites in salmon fillets during the storage.

A lag-phase of three days were observed for the inoculated samples in MAP for both storage temperatures, whereas no lag were observed in vacuum samples. Control samples displayed growth on *Aeromonas* selective agar after approximately 6 (8°C, MAP and vacuum), 10 (4°C, vacuum) and 15 days (8°C, MAP), indicating that *Aeromonas* spp. are present in the natural microbiota of Atlantic Salmon. PLSR-analysis of one dimensional ¹H NMR spectra demonstrated a significant change in metabolite composition due to packaging method, storage temperature and bacterial concentration. The results will be presented in more details at the conference.

O75 - Volatile compounds in *Paracentrotus lividus* gonads related to its sensory properties

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The edible part of the sea urchin is the gonads, which is one of the world's costliest seafood products. Due to its scarcity and seasonality, the quality of the sea urchin gonads is often lacking. There is a shortage of information relatively to this subject and this study emerges with the purpose to characterize the sensory features and odour active volatile compounds (VOC) profile of *P. lividus*, taking into consideration the gender and harvest location (North and the South of Portugal). Sensory evaluation was performed by an experienced panel through the application of Projective Mapping paired with Ultra Flash Profile. VOC were determined by headspace solid-phase microextraction coupled to gas chromatography mass spectrometry (HS-SPME/GC-MS). The Principal Component Analysis (PCA) has shown that gender influenced the sensory properties of sea urchin roe, while the volatile profile of sea urchin roe was affected by gender and harvest location. The perceptual map built from General Procrustes Analysis (GPA) showed that at both locations, males tended to be sweeter, softer and with a pale colour, while females revealed an intense sweet tropical taste and a bright-orange colour. Regarding VOC, PCA unveiled variations in the levels of p-xylene, 1,2,4-trimethylbenzene and m-xylene between locations, whereas levels of β-pinene, 2,4-dimethyl-1-heptene, D-limonene and heptane discriminate the gender. A considerable number of monoterpenes were only identified in the Southern group, while some benzene derivatives compounds were only detected in Northern samples. Male gonads from the North presented volatile compounds that were absent in the female group. This study contributes to a better characterization of the sensory profile of sea urchin gonads aiming the selection of premium gonads. Furthermore, these results together with consumers' preference data can be used to improve the gonads quality through dietary modulation of sea urchin in captivity aiming the regular production of high quality gonads.

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O79 - Information management strategies for improved transparency and resource efficiency in whitefish supply chains

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Globally, 1.3 billion tonnes of food is lost every year. In order to enable a sustainable development of the food system, EU and Member States adopted the Sustainable Development Goals (SDG) in September 2015, which include a target to halve per capita food waste at the retail and consumer level by 2030, and reduce food losses along the food production and supply chains.

Information sharing is one of the main supply chain strategies for reducing uncertainty and is vital for supply chain efficiency. The motivation factors for supply chain information sharing include legislative requirements, efficient product recalls, traceability, optimization of business processes and product differentiation. The objective of this study is to develop information management strategies to support decision making in the whitefish supply chain making them more transparent, profitable and resource efficient. Whitefish supply chains are complex in nature due to seasonal variations, high supply uncertainty and rapid quality deterioration due to handling and temperature variations. In Norway, catch volumes for whitefish including cod, saithe and haddock amounted to 721 525 tonnes in 2014. This included 473 478 tonnes of cod with a value of approximately 520 million Euros. This study presents the results from process mapping conducted in the whitefish industry using the Event-based Process Chains (EPC) modelling technique to analyse the flow of information and material between the fishing vessels and processors and how this information is used by the processors to make supply chain planning decisions. An information architecture for improved data capture and exchange in the supply chain for transparency, loss reduction, and improved decision making is presented.

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POSTERS

PO01 - Traceability of Geographic Origin of Bivalves as a Pathway Towards Safety and Quality

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Seafood trade has been steadily growing over latest years, with the contribution of aquaculture currently rivalling with that secured by fisheries. The increase in seafood consumption per capita has prompt a number of environmental, economic and social challenges. It is therefore critical to implement innovative frameworks that allow a proper management of the complex seafood trade chains and discourage fraudulent practices. Food security issues are increasingly important with end consumers wanting to know what they are buying, as well as how, where and when has seafood been harvested/produced. Consequently, traceability of geographic origin is paramount for controlling its quality and safeguarding the interest of consumers. The concept of traceability is defined by the EU as the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution. However, this information is not always available to end consumers and is prone to fraudulent use (e.g. mislabeling of place of origin). It is therefore critical to develop and validate reliable techniques that allow competent authorities to trace seafood origin, fight fraud and prevent risks to public health. The common cockle (*Cerastoderma edule*) was selected as a model species to determine geographic origin, using biochemical and geochemical tools, namely fatty acid profiles of the adductor muscle and trace element fingerprints of shells (respectively). Results showed, for the first time, that these tools can be used to achieve a reliable and accurate certification of origin for bivalves from different ecosystems, as well as from the same ecosystem with a spatial resolution < 1 Km, and hold the potential to enhance the economic benefits associated with the trade of seafood.

Acknowledgements

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PO02 - EATING FISH IN ANOTHER WAY: DEVELOPING AN INNOVATIVE FOOD FROM SEMOLINA AND FISH FARMER PROTEIN (D. LABRAX)

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In the present research, an innovative food was developed as an alternative way for fish consumption. For that, traditional pastas (Italian style) were developed adding seabass protein to improve both sensory and nutritional properties. First, the farmed fishes were processed to get separately meat and skin protein concentrates (dry and ground) that were used to elaborate pastas, testing different formulations. After an iterative process, two final formulations were established. The first one with addition of 10% of meat concentrate and the second with skin concentrate (20%). Pastas made with those formulations were characterized by physico-chemical, microbiological and sensory analyses. The results showed an adequate food safety with low microbial counts (mesophilic viable count, *enterobacteriaceae* family and molds & yeasts). They also demonstrated that nutritional and organoleptic improvements were achieved in the new foods (dry pasta). The food products made were stable due to their low water activity (<0.85) with higher protein quantity (> 19% in Dry Matter) and moderate fat amounts (3- 7 %) which were an important source of polyunsaturated fatty acids, especially EPA (>1%) and DHA (>2.5 %) according to fatty acids profile. As for its organoleptic properties, the sea bass pastas had different colors that depended on the composition with a homogenous aspect, typical fish smells and flavours, and finally doughy but easily chewing texture.

PO03 - SHELF LIFE PREDICTION TOOLS: PRACTICAL APPLICATION IN A NEW SEAFOOD PRODUCT DEVELOPMENT

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Nowadays, it is important that the seafood industry offers to consumers novel and alternative products from fish to promote their consumption through non-traditional ways. For that reason, research and development should focus on giving a benefit (added value) to innovative products. Before the launch of these to market, we must be sure of their suitability. Considering this, the study for determining the time a product can be expected to keep without appreciable change in quality, safety or character, plays an important role in this process. Shelf life is defined as the period under defined conditions of storage, after manufacture or packing, for which a food product remains safe and fits for using. During this period, the food should retain its desired sensory, chemical, physical, functional and microbiological characteristics. In the present research, a comparative study was developed to establish the shelf life of a pasteurized sausage from farmed sea bass (*D. labrax*). Direct methods, such as NBVT determination, pH measure, microbial growth, sensory assays (Quality Descriptive Analysis) and marketing study (based on Attitudes Toward Consumption) over storage time were carried out. Finally, a combined approach was applied through the application of multivariate statistics (Partial Least Square Regression) to design an integrated shelf life prediction tool for the management of a new product development.

PO04 - Nondestructive monitoring of thermal changes in Atlantic cod (*Gadus morhua*) using fluorescence hyperspectral imaging

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In recent years, there has been an increase in demand for processed and ready-to-eat food. One strategy, which is commonly used in the food industry, is to overheat the processed products in order to ensure safety. However, this practice is wasteful and can potentially also have a negative impact on nutritional quality, as some nutrients are lost under high thermal loads. Therefore, determination of the optimal point of cooking time and temperature would both reduce energy waste and improve product quality.

In this study, the potential of fluorescence, interactance and diffuse reflectance hyperspectral imaging, has been investigated for the analysis of changes induced by application of different thermal treatments on fish. Cod loin samples were vacuum packed and cooked at different temperatures during various times using controlled water baths. The samples were imaged using VNIR-1024 and VNIR-640 imaging spectrographs from Norsk Elektro Optikk, operating within the 410-1000 nm spectral range.

Preliminary results showed a gradual decrease in fluorescence intensity around 460 nm with increasing cooking temperature, which could be attributed to a possible destruction of fluorophores or reabsorption of emission light by various products formed during cooking. Varying cooking temperature seems to have a stronger effect on the measurements than varying the cooking time, for the time and temperature ranges tested.

Results obtained from fluorescence data enabled classifications of fish groups according to the different cooking temperatures. However, measurements of oxidation, volatile compounds, drip loss, color and texture should be performed for future experiments in order to understand exactly why spectral properties change during heating treatments.

PO05 - The UK retail market for fresh and defrosted cod

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Global fish production targeting direct consumption in 2014 was 146 million tons; 87% of total fish production, of which 44 million tons is frozen (FAO, 2016). The average European in-home seafood consumption is 25.5Kg (106€)/capita/year. Portugal and Hungary occupy the two ends; 55.3Kg, 311€ vs 4.6Kg, 11€/capita/year (EUMOFA, 2016). To increase consumption the seafood industry, retailers and relevant stakeholders must develop products, distribution and marketing strategies tailored to consumer demands.

Fresh fish from most commercial fisheries is only seasonally available in sufficient volumes and quality. Several processors and retailers increase seasonal availability by using defrosted fish. This strategy can succeed only with the optimization of the freezing and thawing to develop high quality fish products. With a strong preference for fresh fish in some markets, new marketing strategies for defrosted fish need to be developed. To expand on the issues discussed above and further develop efficient freezing and thawing protocols, the strategic project *Fresk* was established by Nofima.

The purpose of this study within *Fresk* was to create a current overview of the market situation for chilled cod products in UK retail, with focus on defrosted cod products. This was done by visiting 7 different supermarkets (ASDA, Sainsbury's, Waitrose, Marks & Spencer, Morrison, Tesco and Co-op) in London.

The main finding is that defrosted cod products are dominating the UK retail market. Waitrose was the only supermarket that sold fresh prepacked and fish monger cod fillets and loin, at a higher price/kg than defrosted cod in other retailers.

In conclusion, by mainly offering defrosted cod loins and fillets the UK retail market has adapted to the irregular supply of high quality fresh cod, thus making cod available to the consumers whenever they want to buy it.

PO06 - Effect of freezing and thawing of cod heads on the composition and quality of protein hydrolysates

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The Norwegian fisheries produces around 300 000 tons of whitefish rest raw materials each year. In 2015, approximately 166 000 tons were discarded and not utilized, resulting in a significant loss in potential value creation.

The sea-going fleet accounts for 83 % of the unutilized raw material, and to improve their resource utilization and increase the value creation, several issues need to be addressed. One is to improve on-board handling and preservation to increase the quality and shelf life of the raw material.

The aim of the work was to study if freezing can be used as a strategy for increased shelf life of cod heads without lowering the quality of the ingredients products from cod heads.

Enzymatic hydrolysis was used as technological solutions for production of protein hydrolysates (FPH) from Atlantic cod heads. The heads were processed fresh or after freezing and thawing. The parameters that were investigated included storage conditions; frozen storage of minced heads versus whole heads for 3 weeks, thawing methods: air thawing (4 °C for 20 hours) versus water immersion (6 – 10 °C for 3 hours), in addition the effect of hydrolysis time (30 minutes versus 60 minutes) when using the protease ProtamexTM.

Freezing and thawing of the cod heads lead to small changes in the composition of the raw material and the resulting FPH. Slightly higher protein content was found in the FPH produced from fresh heads compared to heads after mincing, freezing and thawing.

The degree of hydrolysis ranged from 14 to 21% and was higher in the protein hydrolysates produced from thawed heads compared to fresh heads. Sensory evaluation of the FPH showed no difference between the different FPH.

PO07 - Skin and bone collagen hydrolysates from European hake (*Merluccius merluccius*): potential cosmetic ingredient

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In order to promote sustainable fishing practices within European fishing fleets and to avoid the large waste of valuable fish biomass through the practice of fish discarding, the new reform of the Common Fisheries Policy includes the obligation of landing all species under TAC's regulation. The new policy also prohibits the use of specimens under Minimum Conservation Reference Size for direct human consumption. In this context it is necessary to find new uses for undersized fish, which might contribute to alleviate the costs that implies the landing obligation but without prompting the creation of a market. European hake (EH)(*Merluccius merluccius*) which is one of the most important commercial fish species for the Spanish fishing industry, with a total TAC for 2018 of 37.423 t, was used for this study. Consistent with the current policy framework and taking into account the importance of this species, the aim of this work was to study the production of collagen hydrolysates with different molecular weight, from the skin and bones (18 % yield) of undersized hake specimens, with the final objective of incorporate them as an active ingredient into different cosmetic preparations. To achieve this objective an experimental design including two different enzymes (Alcalase and Papain), different enzyme/protein ratios and different times of hydrolysis was developed. The analytical characterization of each hydrolysate included: degree of hydrolysis, gel permeation chromatography and SDS-PAGE profiles. The results obtained were compared to commercial hydrolyzed collagen. Preliminary experimental results show a lower molecular weight distribution of EH collagen hydrolysates compared to commercial preparations. Antioxidant capacity of EH and commercial hydrolysates and the effect on the collagen synthesis using human dermal fibroblast will be assessed. The application of the mineral fraction left after collagen extraction will be also evaluated.

PO08 - Freeze-dried *Alaria Esculenta* as a bioactive drip absorbent in a modified atmosphere packaged Atlantic salmon (*Salmo salar* L.) product

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The aim of the present study was to determine the potential of freeze-dried *Alaria esculenta* as a bioactive drip absorbent in a modified atmosphere packaged (MAP) product of Atlantic salmon.

To avoid contamination of unwanted microorganisms or their spores on the salmon product, freeze-dried *A. esculenta* was sterilized (gamma irradiation, 26.4 kGy) before use. As a pre-trial, a water-ethanol based extract (60:40) was evaluated for antibacterial activity against 10 bacterial strains using agar disc-diffusion methodology. Total content of phenols (TPC) and antioxidative properties (DPPH) was moreover measured in extracts of both irradiated and non-irradiated macroalgae. The antimicrobial effect of *A. esculenta* as a bioactive drip absorbent in a salmon product was tested during 21 days at 4 °C (MAP, CO₂:N₂, 50:50) with a non-bioactive commercial absorbent as reference. The experimental design consisted of four groups; two packaged with *A. esculenta* as absorbent (**A**) and two with the commercial absorbent (**C**). Shortly described as **A1**: salmon with natural flora, **A2**: salmon inoculated with *Aeromonas salmonicida*, **C1**: salmon with natural flora, **C2**: salmon inoculated with *A. salmonicida*. Microbial analyses was performed on Iron agar (IA), Starch and Ampicillin agar (SAA) and MRS-media (MRS) at day 0, and every third day throughout storage.

The extract of *A. esculenta* showed antimicrobial effect on four tested strains, whereas irradiated macroalgae showed significantly highest content of phenols and best antioxidant properties. In the storage trial, significant effects of the *A. esculenta* absorbent was found on bacterial growth on IA, MRS and SAA. On SAA agar, microbial growth was only observed in inoculated samples indicating *A. salmonicida* not to be present in the natural flora of the experimental salmon.

Based on the results, we can conclude that the bioactive drip absorbent of *A. esculenta* has an antimicrobial effect on the general flora of a MAP salmon product.

PO09 - The impact of freezing conditions on the quality of fillets of cod

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The impact of freezing conditions on sensory quality and selected physical and chemical properties was tested on fillets of cod *Gadus morhua* from the southern Baltic Sea. The fillets of cod (40 fillets in each test) were placed separately in polyethylene bags and frozen at temperature range: $-18 \div -40^{\circ}\text{C}$ in a "slow" freezer (freezing rate $0.01^{\circ}\text{C} / \text{min}$) and in a "fast" freezer (freezing rate $0.09^{\circ}\text{C} / \text{min}$) for 10 days. Then the cod fillets were slowly thawed at $+2^{\circ}\text{C}$ to obtain $+1^{\circ}\text{C}$ in the middle of the fillets and next were acclimated to $+18^{\circ}\text{C}$ before being analyzed. The temperature and the rate of freezing had a significant impact on the quality of fillets of cod. For example, weight loss of fillets during thawing, free leak and thermal leak were lower in fillets frozen at temperature range: $-25 \div -40^{\circ}\text{C}$ in a "fast" freezer than in fillets frozen at temperature range: $-18 \div -25^{\circ}\text{C}$ in a "slow" freezer. The sensory quality determined by the point method of fillets of cod frozen at temperature range: $-18 \div -25^{\circ}\text{C}$ in a "slow" freezer was lower compared to the quality of fillets of cod frozen at temperature range: $-25 \div -40^{\circ}\text{C}$ in a "fast" freezer. On the other hand, the sensory quality of fillets of cod frozen at temperature range: $-25 \div -35^{\circ}\text{C}$ in a "fast" freezer was higher than sensory quality of fillets of cod frozen at temperature -40°C in the same freezer. This research was supported by The National Centre for Research and Development under the Strategic Program Biostrateg (grant no. BIOSTRATEG2/296211/4/NCBR/2016).

Keywords: cod, fillet, freezing, temperature, quality

PO10 - Melanosis-inhibiting formula based on 4-hexylresorcinol on deepwater pink shrimp (*Parapenaeus longirostris*) quality

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Deepwater pink shrimp (*Parapenaeus longirostris*) is one of the crustaceans most consumed in Europe, with an upward trend both in production and prices worldwide. This specie is very perishable and both melanosis and microbial spoilage strongly reduces the marketability of deepwater pink shrimp. Therefore, it makes necessary the search for additives and/or technologies to avoid or delay the loss in its market value. The 4-hexylresorcinol (0.1%) based formulation was more effective than commercial sulphite (3%) solutions in preventing melanosis, extending the acceptability of shrimp by up to six days in ice storage. During this period, the treatment with the 4-hexylresorcinol-based formula inhibited the growth of microorganisms about 2 log cycles as compared to commercial sulphites. At the end of the experimental period, TVB-N levels were around 30 mg/100 mg muscle shrimp, reflecting a high endogenous enzymatic activity. Regarding the sensory analysis, the panellists rated the lots very similar, although the 4-hexylresorcinol formulation was the one described with a neutral odour at the end of the period. The formulation based on 4-hexylresorcinol could be then an alternative to traditional sulphites to improve the quality of fresh shrimp and prolong their shelf life during storage.

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PO11 - Valorization and chemical characterization of Southwest Atlantic butterflyfish (*Stromateus brasiliensis*)

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It is generally accepted that the increase in global seafood consumption is partially explained on the fact that consumers perceive it as a healthy food. However, fish resources are not inexhaustible and the current exploitation rates are unsustainable. Discards practices contribute to the decrease of worldwide extractive catches during the last years.

The utilization of the low value or underutilized fishes and by-products is a way of increasing the supply of fish for food without increasing its environmental impact.

Galician fishing fleet operates in South Atlantic Ocean (FAO 41) and they catch over there a demersal-pelagic fish, *Stromateus brasiliensis*, which belongs to Perciformes order, with a high discard rate ($\geq 90\%$).

The first step in this work was to study the proximate composition and the yield of *S. brasiliensis*. Stromateidei fish have been associated with food poisoning due to their lipid components, like other Perciform fishes as escolar or oilfish. Thus, for safety reasons, it was necessary to know the lipid composition of *S. brasiliensis*. Heavy metals content was also analyzed.

A mechanical separation process of the edible part and the production of minced could be an alternative valorization strategy for this underutilized resource instead of marketing the whole fish, since this step permits the addition of stabilising agents, such as antioxidants.

Results showed that *S.brasiliensis* had a high edible proportion (55 % of the total fish weight), and a proximate composition of 65.28 % moisture (g of water/100 g muscle), 1.37 % ash (g/100 g), 16.08 % fat (g lipid/100 g), and 16.58 % protein, on the basis of wet weight. The fatty acids profile was similar to other fatty fish species as tuna or salmon being oleic, palmitic acid and DHA, the main fatty acids.

PO12 - Feasibility of using a low molecular-weight fraction from shrimp boiling water as glazing liquid for frozen seafood

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Significant amounts of nutrients leaks into various process waters used during seafood production. A Nordic project, entitled “*Extracting Novel Values from Aqueous Seafood Side Streams-NoVAqua*” introduces innovative solutions to reuse these lost marine nutrients for different applications. Based on our earlier observations that fish muscle press juice contains powerful low molecular weight (LMW) antioxidants (1,2), the aim of this study was to investigate the feasibility of using shrimp and herring process waters as glazing liquids for frozen seafood to protect against lipid oxidation.

Glazing of sole fillets, herring fillets and salmon mince shaped into burgers was done using shrimp peeling water (SPW), shrimp boiling water (SBW), the LMW fraction from SBW and herring pickling brine (spice brine). Glazing with tap water or no-glazing constituted controls. Development of lipid oxidation products (peroxide value (PV) and TBARS values) was monitored during frozen storage of glazed and non-glazed samples for 11 months.

Results showed that both TBARS and PV development rates were affected by storage time, glazing treatments and fish species. Herring fillets oxidized significantly faster compared to sole or salmon burger; making the protective effect from glazing more clear. Among the glazing liquids, the SBW LMW fraction was more protective in all fish types during the first 7 for TBARS development, and during the first 11 months for PV, compared to unfractionated SBW, and SPW. Possibly, the higher amounts of protein and fatty acids in SBW and SPW oxidized when spread out over a large surface, such as during glazing. The spice brine acted as a strong pro-oxidant, most likely due to the high salt content.

In conclusion; a sequential process could be foreseen where proteins and fatty acids are first recovered from SBW for feed or food purposes, where after the LMW residual can replace tap water for glazing of frozen seafoods.

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PO13 - Alternatives to high GWP¹ refrigerants in fishing vessels

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Fish must be chilled during transport, to avoid bacterial growth and product quality reductions. A controlled transport and processing from the start will also reduce food losses later in the cold chain. With today's refrigeration technology, it is possible to do that efficiently. Ice is often used for chilling of fish, but tanks with refrigerated sea water (RSW) is common for chilling of larger quantities of fish, for example pelagic fish. The water is chilled with an on-board refrigeration system.

Refrigerants that are available today are divided into three groups; saturated hydrofluorocarbons, unsaturated hydrofluorocarbons and natural working fluids. The refrigerants from the first two groups all affect the climate and/or the environment, and they are therefore part of phase-out programs. There are less harmful hydrofluorocarbons, but it is still recommended that this industry convert most of the refrigerants to natural working fluids. On a global base, the share of HCFC equipment is very high within this sector. From small fishing vessels to fish processing factory ships they contain all kinds of refrigeration equipment to maintain certain temperatures of the products and working areas.

In Norway, a successful transition from ozone depleting refrigerants (with high global warming potential) to climate friendly natural refrigerants has been made during the last decades. The climate friendly refrigerants ammonia (NH₃) and carbon dioxide (CO₂) have good thermophysical properties and they will be presented, together with examples from Norwegian fishing vessels.

1) GWP: Global Warming Potential

PO14 - Valorization of shrimp waste protein by reaction with glucosamine. Obtaining of antioxidant and antimicrobial molecules with interest as food preservatives.

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Abstract

In this work, we have investigated the antimicrobial and antioxidant properties of Maillard reaction products obtained by heating glucosamine with shrimp shell protein (SSP) or protein from shrimp cooking wastewater (PCE). PCE or SSP were mixed with glucosamine and heated at 100°C during 3 hours. Five aliquots were collected at different times (0, 40, 60, 120 and 180 min). The antioxidant activity of each aliquot was measured and compared to that of the control samples, which were heated in the absence of glucosamine. Interestingly, the antioxidant activity increased significantly after reaction with glucosamine. Thus, the Fe²⁺ chelating activity of the Maillard reaction products improved 5-fold and 17-fold after heating PCE and SSP with glucosamine during 40 minutes, respectively. The ferric ion reducing capacity (FRAP) steadily increased throughout the heating reaction and achieved values 14-fold (for SSP) and 26-fold (for PCE) higher than those of the control samples. The ABTS radical scavenging capacity increased 3-fold after heating during 60 minutes and remained stable from then on. Moreover, the Maillard reaction products obtained after 180 minutes of reaction showed important antimicrobial activity against different Gram-positive and Gram-negative bacteria. To summarize, the reaction between glucosamine and shrimp waste proteins at high temperature leads to the obtaining of Maillard reaction products possessing important antioxidant and antimicrobial properties. These Maillard reaction products could be of interest as potential natural preservatives to increase the shelf life of fishery products.

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PO15 - Isolation of value-added fractions from roach scales

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Collagen is the most abundant protein found in the animal tissues representing approx. 30% of the total proteins. Gelatin is derived from collagen by partial thermal hydrolysis. However, the bovine spongiform encephalopathy (BSE) as well as the foot-and-mouth disease (FMD) has raised concern on the risks related to these diseases when collagen/gelatin of mammalian origin is used. Therefore, there has been a need to find alternative collagen/gelatin sources. One such source is fish and its by-products, especially skins, fish bones and scales. Simultaneously, there is also a growing interest to find more valuable use for fish by-products.

In this study both gelatin and collagen hydrolysates were prepared from roach (*Rutilus rutilus*) scales. Gelatin was extracted with hot water (80 °C, 2 h) from dried roach scales. Obtained extraction yield was approx. 18% (dm gelatin/dm scales) corresponding to approx. 31% of total protein. Moreover, collagen hydrolysates were generated from wet roach scales by enzymatic hydrolysis. In this case the yield was approx. 12% (dm hydrolysate/dm scales) corresponding to circa 50% of total protein. Gelatin and hydrolysate fractions exhibited typical type 1 collagen amino acid content, i.e. glycine representing about one third of total amino acids and relatively high imino acid content. Thus, most likely, both of these fractions could be used in many food, nutraceutical and cosmetic applications. Moreover, in addition to collagen hydrolysate fraction, a calcium-rich fraction (hydroxyapatite) was generated during enzymatic hydrolysis. Hydroxyapatite can be used as a natural calcium supplement both for humans and animals.

In this preliminary study value-added fractions from roach scales were generated. However, further studies are needed for process optimization as well as for characterization of various fractions produced.

PO16 - Influence of chitosan glazing on the quality of farmed sea bass fillets during frozen storage

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European sea bass represents an important economic resource in Portuguese aquaculture that is mainly commercialized as a fresh whole product. Though, there is a growing demand towards more convenient products, such as frozen fillets. Frozen storage (-20 °C) inhibits microbial growth and slows down the chemical and enzymatic reactions that affect intrinsic and sensory quality. Chitosan, a deacetylated form of chitin, has been identified as a versatile biopolymer for a broad range of food applications, and seafood industry has shown interest in its application. For this reason, the aim of this study was to evaluate the effectiveness of a chitosan solution, as an alternative to water glazing, on the quality preservation of frozen sea bass fillets. Fillets (≈150 g) were prepared by hand, washed, drained and frozen in liquid nitrogen, at the Gelpixe, S.A. company. After freezing, two groups were set: fillets immersed in chitosan solution (1 %) (QUIT) and a control group (CTR), where fillets were subjected to water glazing. All fillets were packed and stored in industrial cold chambers (-20 °C). Quality changes were assessed every 45 days during the cold storage (8 months), particularly glazing water, water holding capacity, pH, thiobarbituric acid reactive substances (TBARs), sensory evaluation (steamed fillets, 7 min/ 98 °C), instrumental color and texture. Microbial quality was evaluated at the beginning and in the end of the storage period. Analysis are still in progress.

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PO17 - Evaluation of the effectiveness of weak oscillating magnetic fields during freezing carried out in systems of different complexity

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Abstract

In the last decade, magnetic freezer has been introduced in the market for its potential cryoprotective activity but the published results are confusing and even sometimes contradictory and, therefore, its effects have not been scientifically proven. This work represents a contribution to the current discussion about the potential effect of the application of weak oscillating magnetic fields (OMFs < 7 mT at 50 Hz) during freezing process (about -23 °C) in systems of different complexity. The influence of OMFs was analysed through both the temperature evolution during freezing and properties of the frozen materials after being thawed, in three complementary studies: a) the freezing curves of a ferric chloride solution, b) Lactate dehydrogenase (LDH) enzymatic activity, and c) viability of *Anisakis simplex* larvae and water holding capacity of muscle in experimentally infected hake. No major supercooling or any other variation in the freezing curve of a ferric chloride solution was obtained. LDH enzymatic activity did not show any substantial improvement and the characteristics of frozen/thawed hake muscle in terms of water holding capacity were similar to the controls, whereas all *Anisakis* larvae were found non-viable both with or without OMF freezing. Our study carried out in different complexity systems shows no advantages of OMFs (low intensity and frequency in the order of those mainly employed in commercial OMF freezers) either in the freezing process or in the quality preservation of the samples. Further studies should be

interesting using larger magnetic field strengths and wider frequency ranges of the electromagnetic spectrum, by the employment of adequate technological devices.

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PO18 - Effect of high pressure on the quality of a fish pâté enriched in omega-3 and astaxanthin after prolonged storage

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The implementation of EU regulation 1380/2013 introduces the landing obligation for unintentional catches, but does not allow the direct marketing of them. This is the case of the greater weever (*Trachinus draco*), an abundant fish species on the Atlantic and Mediterranean coast but fairly underutilized. The objective of this study was the design of a healthy and convenience pâté, made of greater weever muscle and enriched in omega-3 fatty acids and astaxanthin. Cod liver, and a protein concentrate with astaxanthin obtained from a crustacean processing industry (cooking waters), were used as ingredients in its preparation. Two pâtés were then obtained: one pressurized (600 MPa, 10 min, 5 °C) and another was conventional pasteurized. Both were stored at room temperature during 4 months.

Immediately after treatment, the pressurized pâté increased the amount of TBARS, although the values reached were lower than 20 mg/kg. A sensory analysis showed a high acceptability of both samples, while the panelists pointed out differences in texture, taste and color among them. In fact, the puncture test showed significant higher gel strength of the pressurized sample. During the storage, the TBARS values of both samples were similar and remained constant. However, the amount of PUFA in the pasteurized sample decreased significantly, suggesting that a high-pressure treatment was more adequate to preserve these fatty acids from oxidation during storage. Moreover, redness (a^*) was higher in the pressurized sample throughout storage, while lightness (L^*) was always greater in the pasteurized sample. It suggests that degradation of astaxanthin was lower when the pâté was subjected to high pressure instead of pasteurization. Thus, high pressure treatment was a useful tool to obtain a high quality pâté from discarded fish as PUFAs were preserved, showing good sensorial characteristics and stable for at least four months of storage.

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PO19 - Effect of prolonged freezing of mince from discard species on the quality of a restructured fish product

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The EU regulation 1380/2013 introduced gradually the landing obligation for discarded species, so fishery industry must seek ways for the exploitation of these species that cannot be marketed for direct human consumption. Comber, greater weever, common pandora and large-scale gurnard are species widely captured at the Mediterranean Sea, but they are usually considered as discards or species of low commercial value.

In this work we have obtained two restructured products from minced muscle, made of a mixture of the species previously mentioned. One of these was elaborated with mince stored one day after captured, while the other was prepared with mince stored one year at -20°C. Starch, albumin, iota-carrageenan, marinated mussels, NaCl and an encapsulated extract of Seaside Arrowgrass (*Triglochin maritima*) were used as ingredients to prepare the cold cuts. The restructured products were obtained by thermal treatment at 90°C for 45 min.

The water holding capacity of the product elaborated with frozen mince was significantly the lower but showed values closed to 60%. The total basic nitrogen-content was very low (<13 mg/100 g) in both products. The highest values of TBARS were observed in the product elaborated with frozen mince, although they were lower than 16 mg/100 g. The gel strength and color of both products was not significantly different.

An untrained panel performed a triangular test (UNE-EN ISO 4120:2008) to detect significant differences between samples. The panelist did not find significant differences between both products.

To conclude, a frozen mixture of minced fish obtained from different discarded species could be suitable to prepare a restructured product with good sensorial quality.

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PO20 - Physico-chemical changes occurring in clean label fish burgers during frozen storage

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Two 'clean label' formulations for fish burgers made with mechanically separated fish meat were chemically and physically characterised during 90 days of frozen storage (T90). The formulations differed in the ratios of European sea bass to rainbow trout (50:50, R1; 30:70, R2). The formulations were added with lemon, salt, water, and potato flakes to obtain products containing 72% of water. The protein and lipid contents were not affected by the presence of the different amount of fish species. Overall, even the fatty acid composition of R1 and R2 was slight affected. The sum of the polyunsaturated (PUFA) ω 6 fatty acids was higher in R2 than in R1 (18.99 vs 18.57g/100g of total fatty acids) while no differences in the sum of PUFA ω 3 emerged. The higher amount of trout in R2 seemed to better preserve the product from lipid oxidation, as revealed from the lower content of secondary oxidative products (thiobarbituric acid reactive substances, TBARS) found in the R2 than in the R1, being 0.81 and 0.98 mg MDA/kg sample, respectively. The high amount of trout in R2 significantly increased the shear stress of the fish burgers (4.09 and 4.99 N, in R1 and R2 respectively). Frozen storage showed to be a good way for food preservation. Indeed, proximate and fatty acid composition of fish burgers were not altered for 90 days. A low oxidative profile of fish burgers emerged by evaluating both conjugated dienes (CD) and TBARS content in the products immediately prepared (T0) and after 90 days of storage. On the other hand, the recipes showed a dramatic decrease in their shear stress during the storage, being 7.62 N at T0 and 3.30 N at T90. In conclusion, the recipe with more trout (R2) showed less changes in physical quality and had more oxidative stability during frozen storage.

PO21 - Using citrus pectin for the preservation of the antioxidant activity of common carp (*Cyprinus carpio*) protein hydrolysates during spray-drying encapsulation

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Complex coacervates of proteins and polysaccharides are often used simultaneously in the food industry in order to enhance structure and stability of processed foods. The interactions between proteins and negatively charged biopolymers favour the formation of complexes which possess advantageous functional properties such as micro- and nano-encapsulation processes, multi-layers structures designing, formation of new food gels and stabilization of food emulsions as well as the recovery of proteins from industrial by-products. The aim of this study was to evaluate the effect of the complexation with low methoxyl (LM) pectin and subsequent microencapsulation by spray-drying, on the antioxidant activity of common carp (*Cyprinus carpio*) protein hydrolysates. Protein hydrolysates showed maximum antioxidant activity at acidic condition (pH 2.4) and the coacervation between protein hydrolysates (1 g/L) and LM pectin (0-7 g/L) at this pH was investigated. An increase in the ratio LM pectin/hydrolysates resulted in increased turbidity in all samples. Particle size measurements indicated that the complexes formed with carp by-product hydrolysates tended to form larger aggregates (ranging from $261.23 \pm 3.71 \mu\text{m}$ to $374.96 \pm 11.29 \mu\text{m}$) when compared with complexes formed with carp muscle hydrolysates (ranging from $165.83 \pm 2.59 \mu\text{m}$ to $\pm 5.71 \mu\text{m}$). Complexes having the highest and the lowest antioxidant capacity and their respective hydrolysates solutions without pectin were chosen for the spray-drying microencapsulation process and the antioxidant activity was measured. The results revealed that spray drying did not have a significant effect ($p > 0.05$) on the protein hydrolysates antioxidant activity when they were complexed with pectin. It can be concluded that the complexation of carp protein hydrolysates with LM pectin and subsequent microencapsulation by spray-drying could be an efficient way to protect their antioxidant activity.

PO22 - ReValue – Improved resource utilization in the Indo-European fish value chains

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ReValue is a three year INNO-INDIGO EraNet project (2018 - 2020) that will contribute to achieving the Sustainable Development Goals target on food losses reduction, by developing innovative technologies for Surimi industry, namely reducing losses by improved cold chain management and efficient conversion of rest raw materials (RRM) and wash water (WW) into value added protein and oil ingredients for food and feed applications. Globally, fish losses account for 160.000.000 tonnes/year, out of which the Surimi industry is responsible for more than 3.5%. Due to the high content of proteins, lipids and other valuable compounds, these RRM are highly valuable from a nutritional, environmental and socio-economic point of view. To use these RRM into value added ingredients for food and feed applications, proper management is required to preserve and retain their quality.

The main objectives of ReValue are:

- To propose concepts for efficient supply chain logistics, cold chain management and climate friendly refrigeration technologies for optimal handling and storage of the fish resources and RRM in order to maintain their quality
- To increase the efficiency, profitability and environmental sustainability of the European and Indian marine processing industry by valorization of Surimi processing RRM and WW into high added value protein and lipid ingredients
- To evaluate the functionality of derived protein and oil ingredients as food and feed components
- To build a basis for joint market exploitation for Europe and India for safe and nutritional ingredients for food and feed applications
- To establish a sustainable partnership between ReValue partners and other relevant stakeholders from Europe and India working in the field of Bioeconomy

PO23 - Protein hydrolysates with antioxidant activity from crab processing waste by enzymatic and fermentation treatment

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Recovery of the protein/peptide fraction from crab (*Cancer pagurus*) processing waste was studied by enzymatic hydrolysis and fermentation. Response surface methodology was used to optimize the hydrolysis parameters (temperature, enzyme concentration and time) by commercial proteolytic enzyme Alcalase® 2.4L in order to obtain the highest degree of hydrolysis (DoH). The results showed the optimum condition to be: temperature at 52 °C, enzyme concentration 1% (v/w) and hydrolysis time 2 h, which resulted in a DoH of 22.46%. Fermentation by lactic acid bacteria (*Lactobacillus sakei* and *Pediococcus pentosaceus*) and without inoculum (blank) was employed to compare the DoH with that of enzymatic hydrolysis. After 72 h fermentation under condition with 15% glucose (w/w), 2% NaCl (w/w) and 1% acetic acid (v/w), the DoH reached to 15.46%, 13.67% and 11.72% ($p < 0.05$), respectively. The radical scavenging activity of obtained hydrolysates were also tested. The IC₅₀ for ABTS+ radical of lyophilized enzymatic hydrolysate was 4.25 mg/ml which was significant lower than that of fermentative hydrolysates (*L. sakei*: 21.06 mg/ml, *P. pentosaceus*: 20.32 mg/ml and blank: 23.96 mg/ml) in comparison with the positive control Trolox of 0.36 mg/ml. Fermentative hydrolysates showed intense bands at molecular weights of approximately 37 kDa and some faint bands corresponding between 2 and 15 kDa, while proteins from enzymatic hydrolysates resulted in a complex of molecules ranging from 2 to 5 kDa. Conclusively, the formation of peptides and amino acids during enzymatic hydrolysis and fermentation is expected to be responsible for the antioxidant activity.

PO24 - Consequences of salting Atlantic cod fillets in pre-rigor conditions.

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Abstract

During catch, bringing the fish aboard and the handling of the catch, may cause quality defects such as bruises, residual bloodspots and red muscle discolorations because of poor exsanguination. Bruises and residual bloodspots are important causes for custom complaints, since residual blood may bring about a reduction in quality. A solution is to keep cod alive after the catch, allowing fish to recover during live-storage. Thus, providing more predictable high-quality products to be produced. Stable and good quality may give a chance of increased product prices, both nationally and internationally. Slaughtering live-stored Atlantic cod enabled pre-rigor processing, meaning that the fish can be processed prior to onset of rigor mortis. Thus, the goal is to produce high-quality salted Atlantic cod for the high-end consumer market. To detect possible quality variation due to rigor-status, the cod was filleted and pickled salted pre-rigor, in rigor and post-rigor. After 6 weeks of salt ripening, the product yield was up to 10 % higher for post-rigor salted fillets, compared to pre-rigor salted fillets. In addition, a yellow colour on the surface of pre-rigor salted fillets was more significant compared to post-rigor salted fillets. The result also showed that salting fish may conceal large quality defects, but these defects become visible again when the salted fish is desalted in water. Generally, the filleting and salting of live-stored Atlantic cod should take place after rigor mortis has passed. The results indicate that this contributes to higher yield and a lighter colour of the product.

PO25 - *Not presented*

PO27 - Characterization of the exhausted culture medium from microalgae *Aurantiochytrium* sp. Production

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The importance and therapeutic value of polyunsaturated fatty acids (PUFA), especially eicosapentaenoic (EPA, 20:5 ω 3) and docosahexaenoic acid (DHA, 22:6 ω 3) is well recognized. Seafood is the major dietary supply of this long chain PUFA. Nevertheless, some microorganisms as microalgae *Aurantiochytrium* sp. are good new alternative and sustainable sources for the production of DHA. The objective of this work was to characterize the exhausted culture medium obtained in different production conditions, in order to evaluate the remaining compounds as exopolysaccharides, fatty acids and carotenoids.

These microorganisms were cultured under heterotrophic conditions, the highest productivity of DHA and polyunsaturated fatty acids (PUFA) was obtained with a salinity of 1.5%, glucose concentration of 4%, temperature at 28 °C and aeration flow 1.2 -3 vvm, after 96 hours of cultivation.

The results obtained allow concluding that the exhausted medium is a promising source of compounds as EPS, with a level of 0.16 g/L of culture medium. The fatty acid profile was similar to the freeze-dried microalgae and the major compounds were DHA, DPA (22:5 ω 6), palmitic acid (16:0) and miristic acid (14:0). DHA represented 26,1% of total fatty acids, DPA account with 11.4%, palmitic acid with 16.4% and miristic with 5,3%.

This is an important strategy in order to minimize the costs and environmental impact. The exhausted culture medium after adequate treatment can be reused in the production process.

PO28 - Fishing discards in the Western Mediterranean as potential new omega-3 PUFA sources

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Since January 1, 2015, and in progressive application until 2020, the European Union legislation demands that fishing discards be transported to the ports. Such discards are mainly composed by fish out of the regulatory size, which until recent times were discarded into the sea, thus constituting an unacceptable waste of resources. In this regard, an exhaustive screening of the PUFA composition of usually discarded fish was accomplished in Almería Bay (Spain), looking for new species sources of n-3 PUFA. The fatty acid (FA) profiles, total FA, and cholesterol contents of the muscle of 13 species belonging to the Sparidae, Carangidae, Centracanthidae, Trachinidae, Haemulidae, and Triglidae families were evaluated in June and January.

The total FA content was subjected to seasonally changes, being maximum in June for most species. In January, *Pomadasys incisus* (Roncador, Bastard Grunt) showed the maximum total FA content (7.3%), while in June was *Pagellus acarne* (Besugo blanco, Axillary Sea Bream), with 10.9%. Concerning n-3 PUFA, the percentages of eicosapentaenoic and docosahexaenoic acids (EPA and DHA) of total FA were higher at the winter, although changes in the concentrations were found to be markedly species-dependent. It highlights EPA amounts in *Pagrus pagrus* (Pargo, Common Sea Bream) with 13.2% of total FA (June), while for DHA the higher percentages were found in *Spicara smaris* (Caramel, Picarel) with 38.9% of total FA (January), and *Boops boops* (Boga, Bogue) with 39.1% of total FA (June).

The species of the Sparidae family showed low amounts of cholesterol content, specially Boga, with 40 mg/100 g, while the maximum amount of this compound was found in *Trachurus trachurus* (Jurel, Mackerel), with 132 mg/100 g. Overall, the species studied were found to be valuable raw material to produce high-quality fish oil.

PO29 - Proximate Composition of Fish Roe of Four Finnish Fish Species

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During fish processing large quantity of various by-products, such as heads, skins, trimmings, visceral and roe, are generated. Although these side streams are good sources for various value-added nutritious compounds, such as proteins, oils, amino and fatty acids, they are usually considered as low-value products and used for example as mink feed. However, there is a growing need to find out more reasonable and profitable use for them. Therefore more detailed information of various side streams, like the roes of under-utilized fish species, is needed.

In this study a proximate composition of roes of four Finnish fish species, Baltic herring (*Clupea harengus membras*), smelt (*Osmerus eperlanus*), bream (*Abramis brama*) and perch (*Perca fluviatilis*), were determined. There was a large variation in crude protein between fish species. Bream and smelt contained the highest amount of protein (24.3 and 20.3% wet weight, respectively), whereas perch roe contains only 11.8% protein. Although the lipid content in roes was quite low, from 1.6% (Baltic herring) to 8.5% wet weight (smelt), they were found to be rich in polyunsaturated fatty acids (PUFAs). PUFA content varied from 27.4 (bream) to 57.4% (perch) of total fatty acids. The major PUFA was docosahexaenoic acid (DHA, 22:6 ω 3), which averaged 37.2 and 24.8% for perch and Baltic herring, respectively, and 16.9 and 13.5% for smelt and bream, respectively. The vitamin D content of perch and bream (69.0 and 63.5 μ g/100 g wet weight, respectively) was considerably higher in comparison to that of smelt and Baltic herring (9.7 and 1.4 μ g/100 g wet weight, respectively).

Summarizing, this preliminary study showed that all of these four roes are promising candidates for value-added use as food for human consumption, due to their nutritious compositions.

PO30 - Enzymatic-inhibiting activities of skin collagen hydrolysates from Mediterranean fisheries discards

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In the Mediterranean Sea, discards can reach values around 230,000 t (26.8%) of total catches. However, and despite the great economic potential of discards, they are sold in the market at a low price, and mainly destined for the production of fish stocks. In this work, we have valorized six discarded species of the Spanish Mediterranean coast, namely tub gurnard (*Chelidonichthys lucerna*), common Pandora (*Pagellus erythrinus*), comber (*Serranus hepatus*), greater (*Trachinus draco*), European conger (*Conger conger*) and pout whiting (*Trisopterus luscus*). Skin collagen from each of the fish species was hydrolyzed with Alcalase to obtain protein hydrolysates with potential bioactive properties. The protein hydrolysates were able to produce inhibition of three enzymes involved in important human diseases: prolyl oligopeptidase (PEP, involved in amnesia and depression), dipeptidyl peptidase IV (DPP-IV, involved in type 2 diabetes) and Angiotensin Converting Enzyme (ACE-I, involved in blood pressure regulation). The molecular weight distribution of all hydrolysates was very similar. Thus, they were composed of high MW molecules (>7000 Da) and short peptides (2-4 residues). The skin collagen hydrolysates of greater, tub gurnard and European conger (1 mg/ml) showed the highest PEP-inhibiting activity, with inhibiting values around 47-49%. The greater skin collagen hydrolysate (1 mg/ml) also showed the highest DPP-IV-inhibitory activity (47.46%), although the ACE-inhibiting activity of this hydrolysate was very scarce. The pout whiting skin collagen hydrolysate (0.6 mg/ml) showed the highest ACE-inhibiting activity (40%). The different results observed can prove the importance of the peptide sequence and length in the inhibitory effect of the hydrolysates. The presence of Proline and/or hydrophobic residues in the raw material seemed to be important for producing potential bioactive peptides. These results suggest that skins from underutilized fish species captured at the Mediterranean Sea could be used to produce bioactive hydrolysates with interest for nutraceutical applications.

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PO31 - ALGARED: a network of scientists and entrepreneurs for the development of novel products from microalgae

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ALGARED + is an excellence network co-financed by the European Regional Development Fund (ERDF) through the Cooperation Program INTERREG VA POCTEP_055_ALGARED_PLUS5_E. Spain - Portugal (2014-2020). This network is formed by nine partners from Spain and Portugal, namely three universities (University of Huelva [UHU], University of Algarve [UALG], and University of Cordoba [UCO]), four research institutes (CTAQUA, IPMA, ICMAN and IFAPA) and two SMEs (NECTON and SEA4US) in the aquaculture sector, as well as in biomedicine and microalgae production. Its main objective is the implementation of a strategy between Spain and Portugal to promote research and a technological development in microalgae biotechnology and its use in health, cosmetics and aquaculture. ALGARED+ will be carried out in the Algarve / Western Andalusia cross-border area. This area is heavily influenced by the Atlantic Ocean. It is a place of great richness and biodiversity to form a framework for important economic activities, such as aquaculture and ficoculture, which have a high potential for innovation, and can be a source of resource still unexplored as a source of substances of pharmacological and cosmetic interest. ALGARED + is developing and promoting: i) Bioprospecting and establishment of a transnational collection of new strains of microalgae of rapid growth and high value, ii) Valorization of microalgae biomass for the development of innovative biomedicine and cosmetics bioproducts, iii) new knowledge in the field of microalgae associated with the key metabolic pathways involved in the assimilation of nutrients, production of bioenergy and the synthesis of compounds of interest for microalgae and iv) development of new applications for aquaculture based on microalgae.

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PO32 - Stability to digestion of bullfrog (*Rana catesbeiana*) skin hydrolysates exhibiting antioxidant and anti-diabetic activities

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The skin of bullfrog represents 11% of the living animal and it is a by-product of processing units which can be used for the production of hydrolysates. The objective of this study was to evaluate the effect of fractionation and *in vitro* digestion on the antioxidant and anti-diabetic activities of bullfrog skin hydrolysates prepared with different enzymes (Pepsin, Alcalase, Protamex, Flavourzyme and Corolase H-pH). The hydrolysate prepared with Corolase H-pH (HCo) was used in a biscuit (20%, 140°C, 20min) and the thermal stability of its antioxidant activity evaluated. The degree of hydrolysis (DH) ranged between 6.0±0.3% and 21.3±0.5% where the pepsin hydrolysate had the lowest value and Corolase H-pH hydrolysate exhibited the highest one. The pepsin hydrolysate (HPe) exhibited the lowest DPPH radical-scavenging activity ($EC_{50}=2.07\pm0.1$ mg/mL), the Flavourzyme hydrolysate (HFI) presented an intermediate activity ($EC_{50} = 0.40\pm0.06$ mg/mL) and the EC_{50} hydrolysates prepared with Alcalase (HAI), Protamex (HPr) and HCo was in the range of 0.18-0.25 mg/ml. Hydrolysate fractions with molecular weight below 1000Da showed higher DPPH radical scavenging activity than those of molecular weight above 1000Da. The *in vitro* gastrointestinal digestion of these hydrolysates caused a decrease in the DPPH inhibition. The EC_{50} value of α -amylase inhibitory activity was 45.0mg/ml for HPe and 64.5g/ml for HFI but the inhibitory activity of the other hydrolysates didn't attain 50% in the concentration range tested. HPe, HCo and HPr fractions with molecular weight below 1000Da presented higher α -amylase inhibitory activity than the original hydrolysates. The α -amylase inhibitory activity also decreased after *in vitro* gastrointestinal digestion of bullfrog skin hydrolysates. The radical scavenging activity of HCo incorporated in biscuit was not affected by the thermal treatment.

PO33 - NICKEL LEVELS IN BIVALVE MOLLUSCS PRODUCED IN PORTUGAL

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Nowadays, there is a concern related with the risk to human health posed by the presence of nickel (Ni) in food, including bivalve molluscs. Nevertheless, the data collected by European Food Safety Authority (EFSA) are still scarce in order to implement any risk management measures. Consequently, European Union published a recommendation on Ni monitoring in food (EU 2016/1111). Thus, the main objective of this work was to evaluate data of Ni levels in bivalve molluscs produced in Portugal and the possible risk associated with their consumption taking into account the tolerable daily intake (TDI) for adults of 2.8 ug Ni/kg body weight per day (EFSA, 2015).

Data were obtained from bivalve molluscs collected in several production areas (coastal and estuarine lagoons) of Portugal, between 2014 and 2017, in the frame of National Bivalve Mollusc System (SNMB) of IPMA. Nickel was analysed by flame atomic absorption spectrometry, based on the methodology described by Jorhem (2000).

Nickel median levels ranged from 0.11 to 1.7 mg/kg and the highest values were obtained in samples of Japanese clams (3.8 mg/kg) and cockles (2.7 mg/kg). Taking into account median Ni values recorded for bivalves analyzed and considering a meal of 100g per day, and a person of 69 kg (mean body weight for the Portuguese citizen) the TDI of Ni is not achieved. Nevertheless, TDI can be attained if some samples of cockle, Japanese clam and blue mussel, with the maximum Ni level registered, are consumed. However, it would be unlikely for a person to consume that amount of bivalves per day, since the consumption of bivalves in Portugal is usually considered as a snack.

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PO34 - Temporal and geographical trends of enteric viruses in Portuguese shellfish production areas

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The harvest and production of bivalve molluscs in Portugal has expanding in both economic and social importance. The increasing number of aquaculture plants and the higher demand of certain species of interest for local consumption and international export illustrates the need to monitor the health and security of this foodstuff.

Among the contaminants present in bivalve molluscs that could prevent or delay their trade or consumption, such as marine biotoxins, coliforms or metals like lead or cadmium, are also others equally emerging, namely the enteric viruses like Norovirus (NoV) and hepatitis A viruses (HAV). These pathogens are the major cause of human waterborne and water-related diseases (i.e. gastroenteritis and hepatitis). Due to their filter-feeding activity, mollusc bivalves are susceptible to accumulate these viruses in their digestive tract if present in contaminated water with animal and human fecal waste. Consumption of bivalves contaminated with these viruses present a potential risk to human health. Understanding the temporal and geographical dynamics of enteric viruses in Portuguese PA could help to diagnose and predict the presence of these contaminants. Detection and quantification of these viruses by qRT-PCR is the most used methodology, since traditional microbiological culturing was just recently developed.

The results showed the presence of genome copies of GI and GII NoV, which seem to be regularly present in certain production areas during the winter months. The fact that Portuguese health services have not registered incidents or virus outbreaks is probably due to the lack of expertise about this type of contaminants as well as their detection and quantification, resulting in poor traceability of the actual causes of gastroenteritis. Bivalves, and especially oysters, being usually eaten raw or barely grilled, contrary to other species that are consumed cooked, makes them the most suitable candidate for monitoring enterovirus in this food matrix.

PO35 - The Best Source of EPA and DHA in the Diet May Be Found in Fish, Microalgae or Oil Supplements? A Benefit Analysis Approach Based on Contents and Bioaccessibility Data

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This study compares the relative advantages of fish, microalgae or oil supplement consumption for an adequate intake of eicosapentaenoic (EPA) and docosahexaenoic fatty acids (DHA). Specifically, concentration of EPA and DHA in different important sources of omega3 polyunsaturated fatty acids —sardine (*S. pilchardus*), *Isochrysis galbana*, and cod liver oil supplement— was determined and their bioaccessibility was assessed through an *in vitro* human digestion model. A mathematical model for calculating the probability of exceeding the recommended daily intake (RDI) of EPA+DHA (500 mg/day) was used, evaluating the health benefit for different scenarios (from a monthly serving to a daily meal). Whereas fat content of fish was 16.6 % w/w, freeze-dried microalgae contained 25.3 % w/w fat. In the latter, EPA+DHA content was 10.4 % of the total fatty acids (FAs). Fish had 8.6 % of EPA+DHA in the total FAs and the oil supplement 13.1 %. Accordingly, 35 g, 19 g, and 4 g of sardine, freeze-dried microalgae, and oil, respectively, would have to be consumed daily to meet the EPA+DHA RDI. However, this appraisal is altered after taking into account bioaccessibility. While EPA and DHA bioaccessibility was less than 12 % in *I. galbana*, it was in the 60-70 % range in fish and exceeded 70 % in the oil. Hence, 53 g, 211 g, and 5 g of sardine, freeze-dried microalgae, and oil, respectively, would be advisable on a daily basis, given the large bioaccessibility differences. Mathematical modelling showed that three weekly meals of 160 g fat fish would be more than enough for ensuring the EPA+DHA RDI. Other alternatives would be troublesome, since 5 g of oil supplement every day may be too unpalatable and huge amounts (even higher after rehydration) of microalgae would be required. Therefore, 2-3 weekly meals of fat fish are still the best choice.

PO36 - Iodine and selenium content in fish and seafood consumed in Portugal

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Iodine and selenium are micronutrients essential for thyroid hormones synthesis. There is also some evidence that low plasma iodine and selenium levels increase the risk of autoimmune thyroid diseases. Enzymes thyroperoxidases (TPO), using as substrates iodine and hydrogen peroxide lead to hormones thyroxine (T4) and triiodothyroxine (T3) syntheses. Selenium is a very important trace element for thyroid function, because this endocrine gland is the tissue with the highest concentration of selenoproteins and is able, in case of deficiency of selenium, to retain this micronutrient and satisfied its requirements of this chemical element. Since foods are their main natural sources the main objective of this work was to determine the contents of I, Se in fish and seafood as consumed collected in Portuguese TDS pilot study as representative of diet in Portugal. Three hundred fish and seafood samples were collected. The iodine and selenium contents were determined using ICP-MS after alkaline (iodine) or acid digestion (selenium). The iodine content in fish group was 163µg/100g and 138µg/100g for selenium. Regarding iodine content, bivalves and molluscs with 157±6µg/100g was the food that present the highest concentration and octopus are the lowest with 13.1±0.5µg/100g. In subgroup lean fish Atlantic cod present the highest concentration, 138±1µg/100g and Atlantic salmon (12.3±0.6µg/100g) with the lowest value. Concerning the fat fish, the highest content was mackerel, 40.6±1.1µg/100g. In case of selenium content, the highest concentration was the European sardine with 132±5µg/100g. The European conger was the lean fish that presented the highest content of this micronutrient, 81.6±1.5µg/100g, and the shrimp with 69.4±3.9µg/100g was the seafood with higher content of selenium. The present study allows to combined information on contents of iodine and selenium in fish and seafood. This information integrate with consumption data is a contribution to understand the relationship between iodine dietary intake and iodine deficiency diseases.

PO37 - Mercury, Cadmium, Lead and Arsenic in sea cucumber from Portugal

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Abstract

There are five sea cucumber species of economic interest in Portuguese Atlantic waters, *Holothuria forskali*, *Holothuria mammata*, *Holothuria tubulosa*, *Holothuria arguinensis* and *Parastishopus regalis*. Of these, three are present in Sado Estuary region, being this watershed important for seafood local economy. Sea cucumbers are not traditionally Portuguese food, but its nutritional benefits aroused interest of all. However, sea products are exposed to pollutants considered to be a potential risk to human health. In this context, Mercury (Hg), cadmium (Cd), lead (Pb) and arsenic (As) levels in 87 animals *H. forskali*, *H. tubulosa*, *H. arguinensis* and *H. sp.* (between hybrid them), from mouth of the Sado Estuary at 37 indoor, in a total area of 157Km/85.5 nautical miles were evaluated.

The most (95%) of As in sea food is organoarsenic, not toxic. At the moment, there is not a legal limit in UE for As levels in this kind of food, however the WHO suggest an ingestion/day limit of <0.05mg / kg. Sea cucumber species analyzed in this study, showed As concentrations lower than the suggested ones, being < 0.32 mg/kg. On the other hand, Cd, Pb and Hg content in sea cucumber species were always lower than the legal limits established by European Union (Regulation (EC) No 1831/2003), 1.0mg/Kg, 1.5mg/Kg and 0.50mg/Kg, respectively.

Regarding the elements studied, these preliminary results indicate that sea cucumber species do not appear to present a hazard for human consumption.

Why this research is important?

Sea cucumber, species with economic potential in Sado Estuary, region of importance and tradition in the fishing, ally to insufficient studies on holothuroids captured in Portugal, show that data obtained in this work can be relevant for the knowledge of those species and if they are fit for human consumption.

These results on contaminant content of three Portuguese are part of a larger study that aims to analyze the quality and safety of holothuroids, as well as applying and evaluating the use of new processing technologies in order to add value to the fish product. There are.

O38 - How effective is freezing at killing anisakid nematodes? An experimental evaluation of time-temperature conditions

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The effectiveness of freezing was tested on two species of fish that are known to be naturally infected with anisakids: cod *Gadus morhua* from the North Atlantic and herring *Clupea harengus* from the southern Baltic Sea. Samples, which comprised skinless fillets of cod (n = 40) with visible parasites and whole herring (n = 240), were placed separately in polyethylene bags and exposed to temperatures of -15°C, -18°C or -20°C in a “slow” freezer and -20°C, -25°C or -35°C in a “fast” freezer. After thawing, parasites were stained with malachite green and observed under the microscope. All *A. simplex* and *Pseudoterranova* sp. larvae in cod fillets died at a temperature of -15°C or lower. However, freezing did not kill all the *A. simplex* larvae in whole herring: spontaneous movement of these parasites was observed in samples stored at all three temperatures tested in the “slow” freezer, i.e. -15°C, -18°C and -20°C over 24 h. This research was supported by The National Centre for Research and Development under the Strategic Program Biostrateg (grant no. BIOSTRATEG2/296211/4/NCBR/2016).

PO39 - Novel Antimicrobials from By-products of Baltic Herring

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It has been estimated that only ca. 40% of fish raw material is used for food production, and by-products including offal account for 60%. In addition to the fish industry, the other source of fish by-products is generated from low-value and/or under-utilized fish. In Finland, one under-utilized fish species is Baltic herring. Currently, three-quarters of Baltic herring catch were used as feed material. However, Baltic herring and its by-products contain value-added components such as bioactive peptides that are involved in various multitude biological functions such as antimicrobial activities. Antimicrobial properties of Baltic herring and its by-products are not known.

Antibiotic resistance has become an increasingly serious problem worldwide. Hence, there is the urgent need for development of novel antimicrobial agents. The most promising candidates are antimicrobial peptides (AMPs) because of their broad antimicrobial spectrum, antimicrobial activity and immunomodulatory properties, and also an apparently low level of induced resistance.

The aim of our study was to investigate the antimicrobial activities of enzymatically hydrolyzed offal of Baltic herring against the selected pathogens belonging to the following genera: *Pseudomonas*, *Listeria*, *Yersinia*, *Escherichia*, *Staphylococcus*, and *Candida*. These microbes might cause harmful and serious diseases in humans or in animals. The antimicrobial activities were evaluated by an *in vitro* bioassay using the modified disk diffusion method. Our preliminary results indicate that the crude extracts of the hydrolyzed offal of Baltic herrings possess antimicrobial activity against pathogenic bacteria belonging to the genus *Listeria*.

PO40 - Is bioaccessibility of toxic elements in seafood influenced by the presence of other food items?

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A seafood-based diet has been widely recommended due to its health benefits. Indeed, seafood is an excellent source of essential nutrients, such as omega-3 fatty acids, amino acids, vitamins and minerals [1]. Nevertheless, seafood consumption can also raise human health-related concerns, as it can be a route of human exposure to some chemical contaminants [2]. The major toxic elements detected in seafood include mercury (Hg), mainly in predatory fish species, cadmium (Cd) in crustaceans hepatopancreas and lead (Pb) in molluscs [3]. Yet, the levels of ingested contaminants do not always reflect the amount released from the food into the gastrointestinal fluid after the digestive process that becomes available for absorption by the intestinal epithelium, defined as bioaccessibility [2].

In this context, the aim of the present study was to evaluate the effect of different food items commonly served as part of a seafood meal in seafood toxic elements bioaccessibility. Bioaccessibility was evaluated in complete cooked meals based on: tuna (*Thunnus spp.*) for mercury, brown crab meat (*Cancer Paguros*) for cadmium, and peppery furrow (*Scrobicularia plana*) for lead. A recently optimized *in vitro* digestion protocol [2] was used to assess Hg, Cd and Pb bioaccessibility in complete meals.

Preliminary results showed that cooking increased seafood toxic elements concentration. However, cooking also enabled a reduction of toxic elements bioaccessibility. For example, Hg bioaccessibility decreased in tuna after cooking (15-24%) compared to raw (43%). Moreover, the other food items used in complete seafood-based meals, also affected the bioaccessibility of toxic elements, varying accordingly with the food item and seafood matrix, ranging from 32% to 36% for mercury in the seafood meal.

This information is extremely relevant to help consumers to wisely select their meals and to enable food safety authorities to integrate this information in risk assessment and communication strategies for consumers.

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PO41 - *Not presented*

PO42 - *Not presented*

PO43 - What to do when everything changes?

- Using resource based view to explain strategy and behavior during unexpected changes.

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Snow crab is a new species in the Barents Sea with first commercial catch in 2013. Predicaments from the marine researchers described a strong foundation for a new industry. Within 2025 catches was estimated to 50 000 tons and within 50 years the value could exceed the cods. A Klondike like atmosphere grew from this quota free and promising fishery in international waters. Investments for more than 100 of million Euros were done within the Norwegian fleet. Most aiming to serve a steady market for frozen clusters in Japan and USA. Then everything changes; first the main catch area is no longer international waters, then the catch volume is decreasing. Furthermore, fishermen finds themselves in the middle of international politics.

A resource based view (RBV) focus on development and deployment of unique internal firm resources as foundation for company strategy. Literature describe that when the external environment is subject to rapid change, the companies dynamic capabilities offer a more secure basis for strategy than a pure market focus. RBV is extended and propose that enterprises should constantly adapt, reconfigure and renew their resources and capabilities to address environmental change. Thus the strategy in itself should be the ability to change. Offered a unique opportunity to witness a "new born" industry in a time of turbulence and change, we will compare theory and practice. Using a RBV what are the dynamic capabilities of the companies, what where their strategy when entering this new fisheries and who, if any will ride and not drown in this wave of change?

**PO44 - How to do research on skeptical objects
– the necessity of a qualitative approach**

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Quantitative research are dominating the field within social sciences. Often qualitative research is described as a step towards “real” research- the quantitative investigation of the model. Researchers has published that this is a cause of concern as a qualitative approach increase the probability of novel insights, is necessary to consider focuses and environmental factors in a national context and to strengthen the portrait of given theories. Furthermore, we will argue that a qualitative approach is necessary to get any reliable information at all.

Fishermen and vessel owners are not particularly known to be researcher friendly. Most of the time they do not read research material, certainly not academic papers and have low trust in the competence of what they believe to be desk-bound academics, especially within social sciences. This makes it hard to do research on this group of people, who still possess information and experiences valuable for empirical research and to make models and theories more suitable for exactly this type of industries. In marketing, strategy and innovation research banking, technology and hotel management are dominating, the lack of research on nature-based industries are eminent.

In our research, we do in-depth interviews with the full seafood value chain from fishermen to point of sales. To get this information we use a sett approach. Often the challenge is to get hold of the right person, then get him or her give the interview. It is then important to take the time necessary, to do the interview on their turf it being their vessel, factory or office, to speak their “language” and to show a through context understanding. In this way you get the interview, earn their trust and more often than not they extent the originally time given and share much more than expected.

PO45 - Seasonal variation of nutritional, microbiological and chemical composition of *Corbicula fluminea* from the Minho River estuary

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The increasing demand for seafood has led to an overexploitation of several commercial species and consequently to the decline of their wild stocks. Changing consumption patterns can reduce the pressure on overfished species and lead to a long-term sustainable management of wild-capture fisheries. The Asiatic clam *Corbicula fluminea* is an exotic invasive species in Europe, United States of America and other parts of the world. In some Asiatic countries, it is used for human consumption. In Portugal, *C. fluminea* has colonized almost every river basin and, in the Minho River estuary (M-est), its population constitutes more than 90% of the benthic biomass. Thus, the objective of this work was to evaluate the potential of *C. fluminea* from the M-est for consumption as food by humans, according to the standards established by European Union regulations (EC 629/2008, EC 420/2011, EC 2073/2005, EC 854/2004). Adult specimens were sampled in summer (July 2017) and winter (February 2018) in the tidal freshwater area of the M-est and immediately transported to the laboratory. The protein content was 8-9% and the total fat content was 1.3 -1.4 mg/kg in both seasons. Concentrations of Cd, Hg and Pb in the whole soft tissues were always below the allowed maximum limits for human consumption. Significant differences ($p \leq 0.05$) in the Pb concentration between summer and winter were found, with bivalves sampled in the winter having ~2 folds higher levels than those collected in the summer. In both sampling seasons, *Escherichia coli* counts were between 320 and 4600 NMP/100 g and none of the samples contained *Salmonella* spp. No parasites were found. Overall, the results suggest that *C. fluminea* from the M-est population has a good potential for human consumption regarding its nutritional value and food safety criteria.

PO46 - The consumers behaviour in purchase processes of fish product. Results of JPI Prohealth project.

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JPI ProHealth project proposes to develop a comprehensive toolbox of optimized existing and novel technologies for developing healthy, high quality, safe and longlife fish products from pelagic fish species. The project is conducted by consortium consisting of 5 partners from 4 countries. The partners are: Teagasc (Ireland), University of Perugia (Italy), Norwegian University of Science and Technology (Norway), SINTEF Fisheries and Aquaculture (Norway) and National Marine Fisheries Research Institute (Poland).

First step made in the project was research of purchase behavior on European market. The survey included consumer groups in four countries i.e. Poland, Norway, Ireland and Italy determining desirable features of pelagic fish products that consumers demand in their purchasing processes. The research (1009 interviews) was conducted by the NMFRI in Dec 2016 using on-line quantitative consumer surveying — CAWI (Computer-Assisted Web Interview).

Basic conclusions are disturbing for future small pelagic fish consumption (herring, sprat). In all categories of evaluation they got the worst consumer rating which indicates the disappearance of the market and decreasing demand for pelagic raw material. Particularly alarming is the situation among young consumers (18-30 y.o.), for whom the pelagic species are not popular and have not healthy image (based on social media).

This facts determining growing indifference and lack of emotions correlated with the volume of consumption in young consumer segment. Detected market position of the pelagic fish products requires restructuring through a suitably selected package of activities focus on increasing the added value and changing the market behavior. In presentation Authors show the most important fish product factors and measures obtained in the survey of young consumers segment in four European countries.

PO47 - Development of healthy product based on fishing discard and marine purslane: “Marine roller”

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The percentage of young populations with inadequate nutrition in recent years is alarming. For this reason, in the formulation of fast food or ready to eat product, a diversity of healthy ingredients should be considered, thus allowing the development of attractive food for new generations that do not usually eat healthy products such as vegetables, legumes and easy to digest protein. This would allow young generations to make use of this type of food

In this work, four “*Marine Rollers*” similar to “*Mexican Burrito*” with high protein content were developed. They were composed of a wrap and a filling.

Two wraps were prepared, consisting in a gel of protein from muscle of discarded species (tub gurnard (*Chelidonichthys lucerna*) or Common Pandora (*Pagellus erythrinus*)), chopped marine purslane (*Halimione portulacoides*) leaves and chickpea flour (*Cicer arietinum*). This last ingredient confer interesting techno-functional properties, due to i) modification the texture in the manner that the viscoelastic and rheological behaviour of gels of different quality are balanced, with the industrial relevance that this implies, and ii) offering a final product healthy and gluten free. The extended masses were heated at 40 °C for 15 min at 50%HR to facilitate the setting process and thus allow its manipulation.

Two fillings were prepared with minced muscles of discarded fish and shrimp (*P. vanamei*) and a) fried onions, garlic and tomato sauce, or b) marine purslane leaves liquated. Each filling was baked 4 minutes at 230°C.

The final products were *in vitro* digested. The digests showed a clear concentration of substances reactive to Folin, as well as a remarkable inhibition of Dipeptidyl Peptidase IV (IC₅₀ between 0.72-0.99 µg/µl).

A sensorial analysis revealed a slightly preference of the panellists by the rolls formulated with the filling a, and there were not found differences regarding the rest of attributes evaluated in the final products.

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PO48 - Methodologies for the Spatial Management on the Northwest Portuguese Coast

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Topic area: Health and nutrition: A global issue;

Subtopic: Valorization of seafood through bioaccessibility/bioavailability studies

Abstract

The pressures induced by human activities on marine ecosystems have been increasing especially in coastal areas. Therefore, there is an urgent need to identify areas of priority protection regarding biological and other resources and plan human activities to avoid potential conflicts. To contribute to the European Marine Spatial Planning (EMP) (Directive 2014/89/EU), the Georeferenced Interactions Database (GRID), was applied on the NW Portuguese coast. The main objective was to develop a spatial planning for a more effective management avoiding or decreasing conflicts among human activities (e.g. fisheries, aquaculture, maritime traffic), and between them and the need of protecting natural resources. The assessment of the spatial interactions among human activities in the NW Portuguese coast allowed weighting the efficiency of management choices for the optimal use of the marine space in the NW Portuguese coast. This research was carried out in the scope of the project ECOAST – “New methodologies for an ecosystem approach to spatial and temporal management of fisheries and aquaculture in coastal areas”, EU ERA-NET COFASP, Portuguese component funded by the Portuguese Foundation for the Science and Technology (COFASP/0001/2015).

Keywords: Spatial planning, Georeferenced Interactions Database (GRID); NW Portuguese Coast; Coastal Activities Conflict Assessment.

PO49 - Determination of folates in Icelandic edible seaweeds

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Icelandic seaweeds are abundant sources of bioactive compounds, but the exploitation of edible seaweeds for foods is less studied. Folate is an essential nutrient functioning in human DNA synthesis, and thus folic acid, the synthetic form, is usually used in food fortification. The current study aimed to determine total folate contents and folate vitamers in Icelandic edible seaweeds. Dried seaweed products were purchased in local market in Iceland. Total folate contents were determined using an official microbiological assay method (with *Lactobacillus rhamnosus* ATCC 7469). Quantification of folate vitamers was carried out using affinity chromatographic purification and ultra high performance liquid chromatography coupled to UV and Florescence detectors (UHPLC-UV-FLR).

Microbiological assay revealed that Wakame had an exceptionally high folate content among sampled edible seaweeds. Two edible seaweeds, Dulse and Atlantic kombu contained about seven times less, but more than Fjorugros and Royal kombu. Extraction method will be optimized before UHPLC-UV-FLR analysis to determine the composition and contents of folate vitamers in seaweed samples.

PO50 - Influence of sample matrix on determination of histamine in fish by Surface Enhanced Raman Spectroscopy

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In our previous studies, SERS method for determination of histamine in fish was developed on mackerel samples. Since histamine is detected in fish muscle extract without separation of components as in HPLC methods, influence of sample matrix on SERS method performance and linear regression model reliability was examined using histamine spiked fresh yellowfin tuna, fresh bonito and salted anchovy samples.

Result showed significant influence of sample matrix on spectral features of fish muscle extracts which led to differences in choice of optimal histamine SERS band for construction of regression models, regression model slope and reliability. In spectra of yellowfin tuna and salted anchovy samples, histamine band at 1570 cm⁻¹ is completely obscured and shifted to 1580 cm⁻¹ thus better results were obtained with models based on histamine band at 1264 cm⁻¹. Due to interfering band at 1269 cm⁻¹ in spectrum of fresh bonito samples, which partially obscures histamine band at 1264 cm⁻¹, better results were obtained with model based on 1570 cm⁻¹ histamine band.

In spectra of all three samples, band at 1457 cm⁻¹ can be observed which partially interferes with band at 1437 cm⁻¹ used as internal standard and influences regression model reliability. This interference is lowest in fresh bonito samples and highest in salted anchovy samples resulting in regression models with correlation coefficients 0.990, 0.987 and 0.964 for bonito, yellowfin tuna and salted anchovy samples, respectively.

This study showed significant influence of sample matrix among different types of samples which has to be examined prior to histamine assay in different species and products. Interferences generated by sample matrix affect choice of optimal histamine SERS band for construction of regression models, model slope and model reliability.

These effects have to be taken into account during construction of calibration models in order to obtain best possible results of histamine assay.

PO51 - Microbial quality and survival of *Listeria monocytogenes* and *Staphylococcus aureus* in the production of marinated anchovies.

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Marinated anchovy is a traditional food that is quite common in the Mediterranean countries. Although it is prepared from ancient times, the microbial quality of it has not been documented. *Listeria monocytogenes* and *Staphylococcus aureus* can cause disease with consumption of ready to eat foods, such as marinated anchovy, being the main vehicle of transmission. The purpose of the study was a) to monitor the microbial quality of marinated anchovies during storage with various antimicrobial substances b) to investigate the survival of *Listeria monocytogenes* and *Staphylococcus aureus* during marinated anchovy's preparation. The anchovies were cleaned, boned and filleted. Filets were divided in four groups, in which different substances were added [1st garlic essential oil (5%), 2nd chitosan (1%, coating), 3rd garlic + chitosan (as previously mentioned), 4th control]. Three samples of every group were examined for total heterotrophic plate count at 30°C (THPC), total Enterobacteriaceae, lactic acid bacteria, histamine producing bacteria, sulfite reducing bacteria, and *Shewanella putrefaciens* count every two days during salting and every twenty days during storage (120 days). Although the initial counts of THPC and total Enterobacteriaceae were 3×10^4 CFU/gr and 4.9×10^2 CFU/gr respectively, a rapid decrease was recorded during salting with counts <100 CFU/gr (detection limit) until the 60th day of storage. From there on a steady increase was recorded. For pathogen survival, the anchovies were inoculated by a cocktail of four *L. monocytogenes* strains (2.2×10^5 CFU/g) or four *S. aureus* strains (1.1×10^4 CFU/g) prior to salting. Anchovies were stored at 4°C for 10 days and examined every two days. Although initially a decrease in the counts of both microorganisms was observed, on the 10th day the counts of *L. monocytogenes* and *S. aureus* were 2.9×10^3 CFU/g and 1.2×10^3 CFU/g respectively. Consequently, these pathogens can survive processing and possibly further preservation.

PO52 - Quality of mussels (*Mytilus galloprovincialis*) produced in south Portugal

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The mussel (*Mytilus galloprovincialis*) is a bivalve with great commercial interest with excellent nutritional characteristics such as high levels of protein and polyunsaturated fatty acids and low carbohydrate content. Offshore mussel production has recently been introduced in the South of Portugal. The APPA (Pilot Aquaculture Production Area) has developed a production system of mussels on longlines that operate between the 6 and 13 meters deep. Seasonally there is a significant variation of the main water quality parameters such as temperature, chlorophyll-a, nitrogen compounds, silicates and phosphates. In this work a study of the variation of quality of mussels produced on APPA was performed considering the depth and seasonality. Condition index, gonad maturation, microbiological content (*E. coli*, vibrionaceae and total number of bacteria) were analyzed. The annual presence of marine biotoxins was also considered. The condition index showed a typical seasonal variation, with high values in autumn and late spring and minimum values in January. In general no significant differences were found on condition index between different depths. Gonads maturation phases presented a seasonal pattern, with a clear dominance of spawned/resting phase, maturation until April and spawning phase in May and June. Mussels in APPA have shown good levels of fatty acids with a content of eicosapentaenoic acid (EPA, ω -3 20:5) greater than many fish species. The value of total fatty acids has decreased during the winter, due to the decline of the reserves, recovering in early summer. No differences were found on SFA, MUFA and PUFA among samples collected in October, January and June for different depths. These mussels revealed excellent microbiological characteristics. This area of production is however affected by the presence of biotoxins (DSP- Diarrhetic shellfish poisoning) usually between the months of May and November, which unfeasible the commercialization during this period.

PO53 - FIRST STEPS ON SARDINE (*Sardina pilchardus*) AQUACULTURE PRODUCTION: ADAPTATION TO CAPTIVITY, NUTRITION AND SPAWNING

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The southern stock of European sardines (*Sardina pilchardus*) is exploited by Portugal and Spain, where it has a high cultural and gastronomic demand in fresh consume and is also absorbed by an economic relevant canning industry. Present historical sardine low biomass levels led to strict catching/landing restrictions to the fishing sector, which raised the question on the viability of the production of the species in captivity. In 2016 EPPO adapted to captivity two wild sardine broodstock with different ages. The broodstock A (n=80) composed by animals with an initial mean weight of 21.2 ± 2.8 g and the broodstock B (n=300) by individuals with 16.4 ± 2.2 g. These breeders have adapted well to captivity, presents very few mortality and good growth rate ($6.7\text{g}\cdot\text{month}^{-1}$ during the first 6 months of captivity) within an optimum wide thermal range ($13\text{-}20^\circ\text{C}$). Adapted well to artificial diet, in the case, sea bream commercial inert feeds 1 and 2mm, with a daily feeding rate of approximately 1.5 % of the total biomass. At present both broodstock lots had natural spawns that began at the end of January 2018 until late June in a total of 252 g (lot A) and 367 g (lot B) with an average viability of 65%. Preliminary growth results with larval rearing (Fig. 1) lead us to consider that rearing sardines in aquaculture might be promising in a near future. Additionally, in a previous published study we sowed that captive sardines fed during one year with seabream commercial inert diet, had a higher deposition of n3-PUFA and achieved almost twice the level of total lipids when compared to the wild fish. These cultured sardines showed very good levels both in EPA and DHA for human consumption achieving the recommended levels. Therefore, the production of sardines in aquaculture may be a promising new food source either for the high demanded fresh market but mainly assuring a constant supply for the canning industry allowing a reduction in the exploitation of the wild declining stocks with clear ecological advantages.

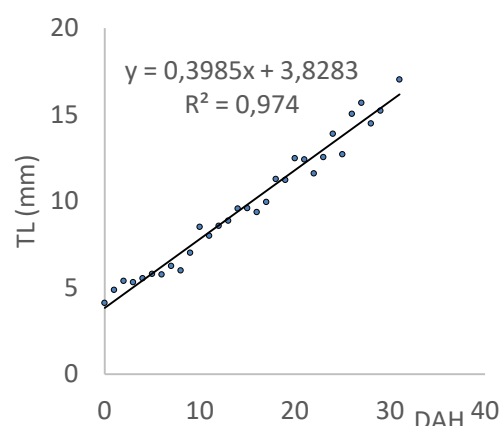


Figure 1 – Growth (TL total length) of several batches of sardines reared at EPPO.

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PO54 - Combined effect of salinity and temperature on mortality and behaviour of European clams *Ruditapes decussatus*.

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European clam (*Ruditapes decussatus*) farming is one of the most relevant economic activities of the aquaculture sector in Portugal. Climate changes represent a potential limiting factor to this activity, directly interfering with survival and behaviour of bivalves. Severe fluctuations in temperature along with periods of heavy rainfall or periods of drought that significantly change the salinity of the surrounding environment, can promote physiological stress of bivalves, resulting in changes in physiological and behavioural responses and, in extreme cases, leading to high mortalities.

The current study aimed to evaluate the combined effect of salinity and temperature on mortality and behaviour of *R. decussatus*. Juveniles and adults of *R. decussatus* were exposed to a combination of temperature (5-35°C) and salinity (0-35). Each trial had a duration of 120 hours, with survival and behavioural activity being evaluated every 24 hours. Survival of both juvenile and adults was optimal combined at salinities between 25 and 40 and temperatures below 29°C for juveniles and salinities between 20 and 40, and temperatures between 20-23°C for adults. Likewise, the behaviour of both clams' size classes showed an optimal combination of salinity and temperature. Juveniles' activity increased with salinity, reaching a maximum at 20°C and salinity of 40. In contrast, adults' activity was almost inexistent at low salinities, reaching its maximum activity at temperatures of 5°C and 29°C, and at salinity of 40.

Climate changes in south of Portugal are expected to be characterized by heavy and sporadic rainfall and high temperatures that will contribute to a decrease in salinity and an increase in seawater temperature. The results clearly indicate that abrupt reductions in salinity will lead to high mortality of *R. decussatus* (either in adults and juveniles). Juveniles may suffer higher mortalities from the combination of low salinity and high temperatures. In this way, the recruitment of European clam may fail, compromising the exploitation of the species.

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PO55 - Determination of nitrofuran metabolites in fish samples using liquid chromatography coupled to high-resolution-orbitrap mass spectrometry

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Nitrofurans (NFs) are synthetic antibiotic drugs exhibiting broad spectrum activities and have been widely used as veterinary medicines or as feed additives in industrial farming of food-producing animals. Aquaculturists also use NFs to treat diseases found in aquatic animals, such as fish, shrimp, and crabs. The four most widely used NFs in veterinary medicine are nitrofurantoin (NFT), furazolidone (FZD), nitrofurazone (NFZ) and furaltadone (FTD) which all contain a characteristic 5-nitrofuranyl ring [1]. After intake, NFs are extensively metabolized into their corresponding metabolites (NFM), identified as 1-amino-hydantoin (AHD), 3-amino-2-oxazolidone (AOZ), semicarbazide (SEM) and 3-amino-5-methyl-morpholino-2-oxazolidinone (AMTZ), for nitrofurantoin, furazolidone, nitrofurazone and furaltadone, respectively. NFs and their metabolites are suspected to possess carcinogenic and mutagenic potency, therefore their application in food and animal production was banned in the EU in 1995 and in the USA in 2002 [2]. A minimum required performance level (MRPL) of 1 µg kg⁻¹, for each nitrofuranyl metabolite in meat product has been established by the EU. Nevertheless, NFs are still being used to treat animal diseases in some countries because of their efficiency, availability and relatively low cost [1-3]. Since parent NFs are extensively metabolized to tissue-bound metabolites, recent analytical methods have been focused on the determination of the NFMs instead of the parent compounds. Therefore, the aim of the present study was the development of an analytical method for the simultaneous determination of four of NFMs residues (AHD, AOZ, SEM, AMTZ) in fish farm samples in North Western Greece. More specifically, a liquid-liquid extraction method followed by UHPLC-LTQ-Orbitrap-MS methodology, in positive ionization mode, was applied. To the best of our knowledge, until recently, there were very limited works concerning confirmation and quantification of NFMs by means of High Resolution Mass Spectrometry (HRMS) in fish samples.

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PO56 - Center for capture-based aquaculture

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In Norway, many fisheries are seasonal and large parts of the quotas are harvested within a short period. Handling of large quantities of fish are often associated with reduced quality and lower prices. However, by keeping fish and shellfish alive post capture and selling when the quality and market are favorable, it is possible to extend the season and multiply the yield. This practice is now named "Capture-based Aquaculture", and in 2010 The Ministry of Fisheries and Coastal Affairs in Norway established a national center of excellence to be run by Nofima. The center focuses on the live-storage of wild cod, haddock and crustaceans and collaborates closely with both fleet- and land-based industries.

Activities at the center include the complete value chain, and aim to do research that ultimately leads to the development of products and methods that increase value. The research includes capture, transport, delivery, processing and storage of fish, crustacean and echinoderms. Technology development regarding pumping, transport tanks, storage tanks, storage cages and slaughter procedures. The scientists follow the fish, crab and the sea urchin from capture to its distribution to the markets, restaurants and supermarkets. Because the center deals with live animals, it places special demands on welfare. Therefore, investigations of the physiology of the animals, and their response to capture, transport and storage is carried out. Nofima investigates the efficiency and consideration of the various fishing gears, techniques and methods, as well as the impact of traditional and novel technology on animal welfare, and quality of both raw material and final product.

The knowledge obtained by *Center for capture-based aquaculture* is used to provide consultancy services for government departments, directorates, and also operational guidelines and advice in the form of courses, handbooks manuals and advice for the fisheries and industries.

PO57 - Nutritional quality of rainbow trout fillets from fish fed with *Hermetia illucens* meal

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In a world where the aquaculture sector is expected to provide more than the 65% of global fish demand by 2030 and the fish stocks are overexploited, the aqua-feed production based on alternative protein sources to the common fishmeal is necessary. Researchers are intensively looking at the use of insects as sustainable ingredient because of their fast growth, easy reproduction, few nutritional requirements and their ability for recycling organic waste. Since no detrimental effects on fish growth and health emerged, *Hermetia illucens* meal has been accepted as protein source up to 25% for different fish species. However, such as substitution significantly modified fatty acid composition of fish fillets. The present research aimed at calculating the nutritional impact of the substitution of fishmeal at 0, 25 and 50% (C, Hi25, Hi50 diets) with *H. illucens* in rainbow trout feed. Since the only recommendation about polyunsaturated fatty acid (PUFAs) intake in relation with their role for human health is the sum of eicosapentaenoic (EPA) + docosahexaenoic (DHA) acids per day, suggested in 500 mg, this amount was calculated in cooked fillets from rainbow trout fed diets including insect meal. Because of growing levels of *H. illucens* in aquafeeds, a significant reduction of EPA and DHA was observed, thus implying that consumers should increase the number of portions consumed every week in order to introduce the suggested 3.5 g of EPA+DHA per week. Specifically, people should eat around 196 g (= 2 scarce portions), 254 g (= 2.5 portions), and 311 g (= 3 portions) of trout fed with C, Hi25, and Hi50 diets, respectively. Such increase would imply an increase of the saturated fatty acids and the total caloric intake which could not properly be considered as healthy factors. Other aspects related to the sustainability of the fish meal replacement with alternative sources of protein should be appropriately considered.

PO58 - Oxidative stress response in *Crassostrea angulata* cryopreserved sperm

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Oxidative stress is produced by an increase of reactive oxygen species (ROS) being one of the main causes of sperm traits impairment during cryopreservation. ROS are highly reactive molecules that can interact with proteins, lipids, DNA and RNA, promoting cell injury at several levels. Spermatozoa characteristics make this type of cells very prone to suffer oxidative stress-related damage, mainly due to the high content of PUFA present in their membranes. In recent years, several oxidative markers have been tested in sperm from different species. Therefore, the main objective of the present work was to analyse the oxidative response of *Crassostrea angulata* sperm exposed to cryoprotectant solutions and after freezing/thawing. With this purpose, ten sperm samples were obtained directly from the gonad by the dry method and maintained at 4°C. Samples were diluted in 10% DMSO, 10% DMSO supplemented with 0.45 M trehalose or sucrose (1:1 (v/v), final concentration). The mixture was transferred into 0.5 ml straws, cryopreserved after 10 min in a programmable biofreezer at -6°C/min from 0 to -70°C and plunged into liquid nitrogen. Straws were thawed at 37°C for 10 s. Oxidative stress was assessed by the detection of intracellular reactive oxygen species using flow cytometry and the fluorescent probes cellROX, H₂DCFDA and DHE (Invitrogen). Lipid peroxidation was determined by MDA (malondialdehyde) detection using spectrophotometry. Sperm antioxidant capacity was evaluated through glutathione peroxidase, glutathione reductase, superoxide dismutase and catalase activity. Results demonstrate that cryopreservation induces some levels of oxidation caused by reactive oxygen species, contributing to post-thaw sperm lower quality. Acknowledgments: supported by: 0139_VENUS_5_E (Interreg POCTEP), ASSEMBLE+ JRA2-H2020-INFRAIA-2016-2017 (No 730984) and EBB-EAPA_501/2016 (Interreg Atlantic Area).

PO59 - Does sugar extender supplementation improve *Crassostrea angulata* sperm cryopreservation?

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Cryopreservation allows the conservation of the genetic material for different purpose such as the preservation of biodiversity for conservation or the management in aquaculture. This tool has been applied in gametes, embryos and larvae in different species, although most of the protocols have been developed for sperm storage. In the present work we tested the effect of sugars in the protection of *Crassostrea angulata* sperm against cryodamage, since sugars can have a stabilizing effect in plasma membrane constituents during freezing/thawing. Sperm was collected from individual males (n= 5-8) directly from the gonad by the dry method. Samples were pre-diluted 1:10 (v/v) in ASW, maintained at 4°C. For cryopreservation, sperm samples were diluted in three extenders prepared in ASW: 10% DMSO, 10% DMSO supplemented with 0.45 M trehalose or sucrose (1:1 (v/v), final concentration). 0.5 ml straws were filled 10 min after and freezing was performed in a programmed biofreezer at -6°C/min. For thawing, straws were removed from liquid nitrogen and placed in a water bath at 37°C for 10 s. Post-thaw sperm quality was analysed by fertilization; sperm motility with CASA software; cell viability was determined using PI and flow cytometry; DNA fragmentation was assessed by comet assay. Results demonstrated that there were no significant differences (p>0.05) in motility and viability analysis between DMSO and DMSO supplemented with trehalose or sucrose. The same finding was observed for comet assay, where sugars did not reduce DNA fragmentation in cryopreserved samples. In fact, sucrose produce worst results than trehalose. According to the obtained results, it is possible to conclude that supplementation with sucrose or trehalose did not improve the viability, motility or reduced DNA damage in *Crassostrea angulata* cryopreserved sperm. More specific tests need to be conducted to be sure that the incorporation of these sugars would not have any beneficial effect.

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PO60 - Effect of different cryopreservation conditions on the freezing storage of *Tetraselmis* genus

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Microalgae have a high biotechnological potential in different areas of research and production. Over the last few decades, aquaculture has been the main market for microalgal biomass, but only a limited number of species has been used for commercially rearing bivalves and to enrich live preys. However, new markets with specific requirements (e.g. high levels of PUFA and bioactive compounds) call for novel microalgal species/strains obtained via bioprospecting campaigns. Techniques to store this genetic resource are important to avoid accidental loss, contamination, mutation, and to decrease the maintenance costs. In this context, cryopreservation of microalgae is an important tool in stocks management. The aim of the present work was to develop a simple and reliable method to cryopreserve four species of the *Tetraselmis* genus, namely *T. chui*, *T. apiculata* CTP4, *T. rubens* and *T. striata*. For this purpose, two cryoprotectants, ethylene glycol (EG) and dimethyl sulphoxide (DMSO) were tested at two freezing rates (low and high) and two concentrations (5 and 15%). Samples were equilibrated in the extender for 30 min (15 min light/15 min dark) and cryopreserved either in 0.5 ml straws or cryovials in a programmed biofreezer (Asymptote Grant EF600, UK) or in vapour liquid nitrogen. Sample thawing was performed at 25°C/20 s. Cells were centrifuged (200 g, 5 min, RT) to remove the cryoprotectant and resuspended in the same seawater volume. Post-thaw cells were cultivated in Modified Algal Medium¹ in small volumes, determining cell recovery and growth during 8 days. Results show that higher freezing rates produced better growth rates, especially with DMSO as cryoprotectant. Cryopreserved cells showed a growth curve with a pattern similar to that of fresh cultures.

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PO61 - Microbiological and molecular approaches to control vibriosis in sea bass (*Dicentrarchus labrax*)

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Vibrio species represent a major concern for food security. Highly abundant in freshwater and marine ecosystems, they can be found in a free-swimming state. Nevertheless, they are mostly fixed to inert and organic substrates. Some *Vibrio* can be pathogenic shellfish and fish, leading to vibriosis.

A few years ago the Aquanord fish farm, located near Gravelines (north of France), had to deal with economic losses. They noticed a huge decline in sea bass biomass production. The main cause was vibriosis, due to *Vibrio* Harveyi clade. Curative strategies have been undertaken, such as the use of antibiotics or vaccines. The disease is now under control. Nevertheless, the bacteria still remain. Indeed, *Vibrio* have acquired the ability to live in hostile environments by forming biofilm on surfaces, such as the walls of aquaculture ponds.

The aim of the project is to study the presence and the behaviour of *Vibrio* in Aquanord. This will help the search for ways to cure vibriosis in a "clean label", animal welfare and sustainable development perspective.

Beforehand, we have to identify the different *Vibrio* species present in Aquanord. Thus a sampling campaign was undertaken during 9 months. Three different ponds, containing sea bass, with the same hot and cold-water inlets have been chosen. Every week, water samples from ponds and inlets were collected and filtrated, in order to collect bacteria. Bacteria in biofilms were also collected by swabbing concrete pucks (5cmx2.5cm) every two weeks. *Vibrio harveyi* will be then quantified by qPCR and isolated bacteria will be identified by MALDI-TOF. Thanks to this first experiment a bio-base will be created. Bacteria able to form biofilm will be identified. Finally a screening will be set up to determine natural antibacterial molecules that will be able to control vibriosis and biofilm formation.

PO62 - Traceability systems in cod processing plants in the aspect of the presence of parasites in fish products

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Infection with parasites of the Baltic fish has increased in recent decade due to an increase of the number of seals (final hosts for anisakid nematodes). Cod (*Gadus morhua*), is one of the fish species that is most heavily infected with these parasites. In addition to the presence of live parasites in fish meat, which poses a hazard to human health, consumers may also be exposed to allergens from parasite (both somatic antigens and ES molecules). Fish infected with parasites are therefore dangerous to human health and should not be placed on the market. Fish processing plants should implement procedures for effective detection and inactivation of parasites, e.g. by effective freezing in accordance with reg. No. 853/2004.

Aim of the survey undertaken in SeaQual project is investigating what procedures were established by the Polish processors in order to detect and inactivate parasites in cod from both Baltic and Atlantic fishing. Whether they can determine the fishing vessel and the catching area where the given batch of cod has been caught, and whether they will effectively determine to which final products batches the particular batch of cod was used. Also interesting is the question of the possibility of specifying the traceability system by registration the catch area number if formal data on catch areas with fish highly parasitized are published.

Fish processing plants in Poland have implemented traceability systems that allow tracking of fish lots "one step back-one step forward", but they are not always able to confirm the area of fishing. Not all processing plants are interested in specifying the traceability system in order to register a code which determines the area of fishing in the raw material batch number.

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PO63 - Authentication of fish oil by NMR and FT-IR spectroscopy

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Due to their high contents of the health-promoting omega-3 fatty acids, fish oils are becoming increasingly popular as a dietary supplement and as animal feed. For economic reasons, fish oil may be adulterated with omega-3 fatty acids containing vegetable oils of lower quality and value. Consequently, there is a need for reliable authentication methods that can be used by authorities trying to detect food fraud as well as food/feed suppliers interested in protecting high quality products. In this work, ¹H NMR, ¹³C NMR, and FT-IR spectroscopy were used in combination with multivariate statistics including Artificial Neural Networks and Support Vector Regression in order to detect adulteration of cod (*Gadidae*) liver oil with vegetable oils (rapeseed and sunflower oils). Moreover, fatty acid profiles were determined by GC-MS in order to compare the accuracy to detect adulteration levels with the spectroscopic techniques. High-field NMR spectroscopy has been used in the authentication of plant oils before [1,2], but no study has reported on its application in the context of fish oil adulteration and using Artificial Neural Networks or Support Vector Regression.

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PO64 - Conventional solutions towards convenient, versatile and healthy seafood: frozen boiled common octopus

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Currently the specific challenge of food research and industry consists in developing healthier convenient food products (e.g. low salt, sugar and fat levels), ensuring sensory quality. Cephalopods are good sources of minerals, indispensable amino acids and polyunsaturated fatty acids (PUFA), particularly n-3 PUFA eicosapentaenoic (EPA) and docosahexaenoic acid (DHA). In particular, common octopus is highly appreciated by the consumers having an important role in the gastronomy. Thus, this species constitutes a good raw material for the development of healthy ready to use products through the application of conventional processes/technologies. The main goal of the present work was to assess the effect of industrial boiling (without salt or condiments addition) followed by freezing on the nutritional profile of common octopus (*Octopus vulgaris*) caught off the Portuguese coast. Boiled octopus and cooking broth were packed and immediately frozen at -35 °C. The products were stored at -20 °C during eight months. Samples of raw, boiled octopus and broth were taken at initial and during the cold storage for quality evaluation, following reference methods. Microbial quality was within the recommended values. The true retention of iodine (I), selenium (Se) and sodium (Na) are 86.8, 53.5 and 44.6 %, respectively. A meal of 150 g of boiled octopus represents 75.6 and 12.4% of the daily adequate intake (DAI) of Se and I, respectively, suggested by EFSA for adults. The Na content (332 mg/100 g) is far below the EFSA limit value of 1500 mg/day (equivalent to 3.75 g of salt). This Na level is sufficient to confer an adequate salty taste for the boiled octopus as perceived by sensory panel. The consumption of 150 g fulfills completely the DAI of EPA+DHA (250 mg/day). Other results are still under treatment.

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