9 TO 10 JUNE 2022 | Reykjavík Iceland

4th Fish Waste FOR PROFIT 2022

Icelandic Fisheries Conference

Conference Handbook

Transforming the Blue Economy to 100% Green

Entitled, Transforming the Blue Economy to 100% Green; the 2022 conference will be looking at how the industry is working towards full utilisation of fish by-products and taking steps forward in the use of green technology.

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FOR PROFIT
Icelandic Fisheries Conference

Dear delegate,

Welcome to Iceland to the fourth Icelandic Fisheries Conference, 'Fish Waste for Profit', exploring the prospects for 100% utilisation.

This conference handles a very important subject matter, which has seen Iceland pioneering and yielded significant growth in recent years. A study in cod catch indicates a value increase of 218 million XDR (approx. 36 billion ISK) between 1981 and 2017. This figure becomes even more impressive when you consider that gross catch tonnage decreased by 45% during this same period. (Source: Matis).

This year we are fortunate to return to Reykjavik alongside the Icelandic Fisheries Exhibition to run the fourth conference in the series.

Offerings this year include more speakers and topical presentations from Iceland and abroad, plus the opportunity to visit the Icelandic Fisheries Exhibition at the end of the conference.

Knowledge share with fellow attendees during the coffee breaks and lunches and socialise during the welcome drink's reception at the close of conference day 1. Evident in this year's line-up of speakers is the growing consciousness of the international fish and seafood community of the prospects of maximum utilisation. Innovative case studies focusing on the production of oils, enzymes, cosmetics, and many more niche products feature throughout the one and a half days of presentations.

Thank you to all those who have contributed to the development of this year's programme, in particular our chairman Thor Sigfusson from the Ocean Cluster, our speakers and sponsors including our Gold sponsor Rockwell Automation, and you, our delegates.

On behalf of the Icefish Conference team, I hope you all will have a constructive, informative and enjoyable few days at the conference here in Reykjavik and I look forward to talking to you over the next two days.

Yours sincerely,

MARIANNE RASMUSSEN-COULLING
Events Director

Fish Waste for Profit, 9-10 June 2022
Chairman Welcome Letter
Dr Thor Sigfusson, Founder & Chairman, Iceland Ocean Cluster

Dear delegates,

I welcome you to the 4th edition of the Icelandic Fisheries Conference, Fish Waste for Profit, this year featuring a range of experts tackling 100% utilisation. Icelanders have in many ways been in the forefront of more utilization of seafood products. Innovative health-, pharmaceutical- and even fashion products from wild fish stocks are being developed in the Icelandic economy. There lies our opportunity; Icelanders are putting their minds to create more value from each fish. The results are already out and reveal that we are using more of each whitefish than all the developed countries we compare ourselves with. Fish is not only the fillet, it is also roe becoming health products, the liver becoming omega and pharmaceuticals, the head and bones are used – basically nothing is left for landfill.

In recent years, we have seen a number of new start-ups in Iceland with new ideas on more utilization of seafood products. This has been a result of a growing clustering between seafood businesses, start-ups, investors, universities and R&D. The Iceland Ocean Cluster has taken an active part in connecting these dots. Our role has been to inspire more entrepreneurs to establish start-ups in ocean-related industries. As soon as these start-ups have gone through the initial start-up process and competitions, we are ready to nurture them further - offering a close community, assistance with business planning and strategy, workspace, networking opportunities in our field, forming connections with investors in ocean businesses, and beyond. We have been quite successful in inspiring and supporting start-ups in our field: the business value of start-ups in the Ocean Cluster House in Iceland, which have been in our facilities for the last three years, is approximately USD 100 million. We have sister clusters in the US; The New England Ocean Cluster, New Bedford Ocean Cluster and Pacific Northwest Ocean Cluster.

Icelanders have long taken pride in their efficient fisheries. There is no one explanation for why Icelandic fisheries have for the most part been more efficient than others. I believe there is, as is often the case, a very pragmatic explanation: Icelanders have never had the luxury of treating their fisheries lightly. As the core industry in Iceland it cannot be government subsidised. The entire cluster of seafood businesses in Iceland has, for a long time, been at the heart of the income tax base for government and not the other way around. The same applies to a great extent when examining Icelandic fish by-products; if there is value to be found in by-products, effective fisheries used to focusing on value will find opportunities to use them.

I am confident that it is only a matter of time when fisheries will stop discarding out value and more people join the more utilisation movement. As more companies join the by-product market and the market develops further, the prices will continue to increase and the incentives for fisheries to get value from their by-products are also set to increases.

Scientists believe overfishing, unsustainable seafood farming practices, ocean pollution and acidification will threaten the future of seafood availability worldwide. I strongly believe we can take our experience and cluster model in seafood to other countries and inspire collaboration and start-ups in the field. Now it's up to the rest of the world to imagine, and then build, a value-added world with 100 percent utilization.

The global seafood industry dumps nearly 10 million tons of perfectly good fish back into the ocean or uses it as landfill. At the same time nearly 90 percent of the world's fish stocks are threatened by overfishing. The IceFish Conference is a way for all of us to address the problem by bringing together people with hands on experience in fish by-product utilization.

Yours sincerely,
Thor Sigfusson

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DR THOR SIGFUSSON

Founder & Chairman, Iceland Ocean Cluster

BIOGRAPHY

Thor Sigfusson is an Icelandic entrepreneur, author and speaker.

Thor received his PhD degree in Business from the University of Iceland in 2012. He launched the Iceland Ocean Cluster in 2011. The cluster focuses on developing innovative ideas in the blue economy. In May 2012, Thor founded the Ocean Cluster House in Reykjavik Iceland.
He is also the founder or co-founder of various enterprises in fish utilisation and food. Using the research and information generated from Iceland Ocean Cluster, Sigfusson founded Codland in September 2012. In 2013, he founded the company Collagen with the aim to use fish skin to create marine collagen. In 2017-2018 he founded Grandi Food Hall and co-founded Hlemmur Food Hall and Reykjavik Foods.

Thor has actively been promoting globally his 1000% fish utilisation mission and seafood clusters and he is the co-founder of three ocean clusters in the US; The New England Ocean Cluster, New Bedford Ocean Cluster and the Pacific Northwest Ocean Cluster. Spring 2020, the first Ocean Cluster House outside Iceland will open in Portland Maine.

He has written seven books on topics of international business, knowledge networks and salmon. His most recent book is “The New Fish Wave - Igniting the Seafood Industry” will be published by Leete’s Island Books in the US in April 2020.

Since establishing the Iceland Ocean Cluster, Sigfusson has spent his time speaking to audience in North America, Europe and Asia about the opportunities in building networks in the marine industry.

MADS LAIER

Team Lead Software & Control - Solution Consultant
Network & Security, Rockwell Automation

BIOGRAPHY

Experienced in the development and implementation of automation solutions. Mads has held several positions throughout his 14 years career with Rockwell Automation.

Having previously been commercial engineer and solutions architect in Denmark. Currently he is Team Lead Software & Control and Solution Consultant Network & Security. where his insights and experience are helping our customers overcome the challenges they face.

Smart Solutions: Unlocking Seafood Potential

It may be thousands of years old, but the seafood industry needs to look at very contemporary smart connected solutions if it is to keep pace with growing global demand.

If there was ever an industry that was ripe for modernization – and with perfect timing – it is the seafood industry.

The global seafood market was valued at 253 billion U.S. dollars in 2021 and is projected to reach nearly 336 billion dollars by 2025.[1] This represents a 5.8% compounded annual growth rate (CAGR) – double that of the overall global F&B industry CAGR of 2.9%.[2]

With this growth potential, the time is ripe for fish processors to extract even more value from their people and far greater yield from their raw materials and processes.

Smart automation for greater yield
In order to achieve efficiencies as demand grows, more and more OEMs and end users are looking at modern smart automation infrastructures – for both new and existing plants – that will help deliver even greater yield from processing steps and methodologies that are founded on centuries of tradition and knowledge.

In addition to increasing production output, there is also a growing focus on the supply chain, to help prevent fish products from deterioration, not only through the development of distribution channels, but also through improvements in technology, packaging, processing and storage.

Processing techniques such as heat treatment, temperature reduction and water-content control all help with the preservation of fish; and with the rise of deployment of these techniques, the demand for various types of fish processing equipment is expected to be strong in the coming years.

Processors have so much to gain
And, like many other industries that are already well into their digitalization journeys, it is smart solutions that will offer the biggest improvements, especially when the assets are tightly integrated with production and enterprise solutions. The resulting fully digital sea-to-plate data trail can then be established and leveraged to confirm maximum freshness and quality.

Although many trawlers are exploiting new and emerging technology, to drive greater onboard efficiencies, it is the processing procedures once the catch has been landed that have the most to gain from modern integrated and Connected Enterprise® solutions.

When post-landing processes are undertaken manually, suppliers typically face workforce productivity and skills issues underpinned by monotony and the lower accuracy of what is often semi-skilled and unskilled seasonal labor – all issues that can be addressed by modern automation solutions.

Automation addresses skills gaps
One must also consider the geography of some of these processing locations, which are often remote and experience harsh environmental conditions. From a personnel perspective this also makes it difficult to both employ and retain skilled labor, a significant advantage of fully automated solutions.

There is obviously a yield- and efficiency-improvement requirement, and growing demand from modern systems from the industry, but what do automation solutions providers need to do to target the precise needs of this industry?

Flexible solutions: built tough!
Like any industry, end users are looking for service, support and price, with rugged machines suited to the application and environment that deliver familiarity, hygienic design, and proven hardware based on open protocols and platforms that offer maximum flexibility and agility – without any black-box lock in or segregation.

As a key player in this industry, Rockwell Automation enables seafood OEMs and end users to modernize, connect and streamline their capabilities. Rockwell Automation smart connected solutions not only offer much greater real-time insights into process operations, but also help to deliver higher throughput, higher yield, and greater quality at higher speeds. All of which add up to satisfy growing demand.

With rising global demand and a shortage of skilled labor, the time is right to leverage advanced/smart automation technologies to capitalize on these market trends and drive your organization forward. Contact to your local representative today.

1. https://www.statista.com/statistics/821023/global-seafood-market-value/

2. https://www.businesswire.com/news/home/20200514005421/en/Global-Food-and-Beverages-Market-2020-to-2030---COVID-19-Impact-and-Recovery---ResearchAndMarkets.com

JÓNAS R. VIÐARSSON
Director of Division of Value Creation, Matís

BIOGRAPHY

Jonas R. Vidarsson is the Director of division of value creation at Matís ltd. in Iceland, which is a governmentally owned non-profit limited company working on research and innovation in food & biotech value chains. Jonas holds degrees in Fisheries scenes, Environmental science and Natural resource management. He has in addition long hands-on experience in the fishing sector, both in processing and as a fisherman.

Jonas has been involved in a large number of national and international research & innovation projects, many of which have aimed at creating value from unwanted catches and side streams from processing. Jonas's expertise includes studies related to the entire value chain of different food products and circular economy, environmental impacts of fisheries and seafood production, environmental labelling, Life Cycle Assessment, traceability, logistics and research on various yield- & quality factors in the value chain of seafood. He has also worked on fisheries management, aquaculture, climate change impacts and adaptation, fishing gear, decision support systems, stakeholder interaction, dissemination and knowledge transfer.

Matís ltd. has around 100 employees with multidisciplinary competences in food research and innovation. The company has on average around 200 active research & innovation projects and operates in addition laboratories, pilot production facilities, aquaculture research station and more.

Iceland's Use of Captured Seafood By-Products

The Icelandic seafood industry is considered a world leader in utilisation of unwanted catches and side streams for processing. The by-products created range from low value animal feed and fertiliser, to high value human food, textiles, nutraceuticals and pharmaceuticals. The presentation will seek to explain why Iceland has advanced more than most other countries in utilisation of by-products, give examples of by-product "success stories" and provide an overview of some ongoing initiatives to increase utilisation and value of captured seafood rest raw materials.

PETTER MARTIN JOHANNESSEN

Director General of IFFO – The Marine Ingredients Organisation

BIOGRAPHY

Petter Martin Johannessen joined IFFO – The Marine Ingredients Organisation in 2018 as Director General. He was previously Global Business Director for Risk Management and Sourcing at Cargill Aqua Nutrition and before that Supply Chain Director and Global Sourcing and Purchasing lead at EWOS Group. Before joining the aquafeed and marine ingredients industry, he worked at PwC (Consulting and large international process industry businesses branch). He holds a Diploma in International Marketing and a degree in Business Administration from the Norwegian School of Management.

What role may byproducts play in the future of marine ingredients?

Marine ingredients are essential components of aquafeeds. Almost half (48%) of the raw materials used to produce fish oil comes from by-products resulting from fish processing. This is the case for 29% of fishmeal production. Combined, that is close to one third of all marine ingredients currently produced. While the use of trimmings and by-products is not a new initiative in the marine ingredients sector, the momentum behind the use of these "circular" protein and lipids is clearly growing. This presentation examines this trend over time and provides a review of the IFFO 2020 marine ingredients statistics, highlighting that aquaculture is now a major player in the provision of fish oils, with both salmon and pangasius sectors being significant contributors.

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- Keynote Address: Iceland's Use of Captured Seafood By-Products
- Jonas R. Vidarsson, Director of division of value creation, Matís
- Keynote Address: What role may byproducts play in the future of marine ingredients?
- Petter Johannessen, Director General, IFFO
- Co-Product Valorization – Towards an industrial Implementation of innovative Food Processing
- Concepts to achieve 100% Utilization
- Dennis Lohmann, Head of Product Management, Baader
- Innovative Technology unleashing fish waste value potential Wenche Uksnay, Cluster Manager, NCE Blue Legasea.
- N-Atlantic pelagic fish oils originated from Herring and Mackerel - The new exiting Natural fish oil source in times shortage Snorri Hreggvi Osson, CEO, Margildi

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SESSION 1

Striving towards 100% Utilisation for different Species

OLE MEJLHOLM

Team leader - Corporate Quality, Royal Greenland

BIOGRAPHY

Ole Mejlholm holds a master degree in food science from the University of Copenhagen and a PhD from the Technical University of Denmark (DTU) entitled "Quality and Safety of Lightly Preserved Seafood Products". With more than 15 years of employment at the DTU, Ole has extensive experience in research, primarily from projects in collaboration with the food industry. A common theme has been product development focusing on optimization of food safety and quality, primarily for different types of ready-to-eat seafood products. Ole has been instrumental in developing and validating comprehensive predictive models for the growth of the pathogenic bacteria Listeria monocytogenes. These models have gained wide acceptance and are used around the world as an important tool for assessment and documentation of food safety and quality for a range of ready-to-eat products. Since 2016, Ole has been employed at Royal Greenland in the Corporate Quality Department. Here he primarily works with tasks and projects related to food safety and process optimization.

Utilization of by-products in Greenland: Challenges, opportunities and innovation

Royal Greenland (RG) is the world's largest supplier of coldwater prawns and Greenland halibut, respectively. In addition, significant quantities of e.g. Atlantic cod, snow crabs and lumpfish roe are caught and processed by RG. In total, more than 120.000 tons of raw materials are processed on an annual basis. This extensive production inevitably results in significant amounts of high-quality by-products with a huge potential for value creation.

However, several aspects including i) lack of infrastructure, ii) high energy costs, and iii) labor shortage challenge the utilization of by-products in Greenland. As an example, with close to 40 land-based production facilities located along the west-coast of Greenland (distance of approx. 2.700 km), some of them being very small, RG needs to centralize the processing of by-products in order to make it profitable. This is challenged by the lack of infrastructure in Greenland with no two cities being connected by roads. Thus, all by-products must be transported by sea, which increases the overall production costs considerably.

RG is already producing prawn meal from the shells of cooked and peeled coldwater prawns, as well as fish oil from cod liver. One of the best examples is utilization of cut-offs from the production of Greenland halibut (i.e. heads, tails and frills). Previously, these by-products were used to feed the sledge dogs, now they are sold as high-value products to Asia.

Ice hole fishing of Greenland halibut.

Most recently, RG has invested in two brand-new trawlers (Sisimiut and Avataq) equipped with process equipment for production of fish oil and meal, securing close to 100% utilization of the raw materials.

Trawler Sisimiut and Avataq

As an innovative approach, RG is participating in two EU-funded research projects both focusing on utilization of by-products.

The four-year project WASEABI, which was initiated in 2019, aims at the development and validation of new concepts for exploitation of by-products into e.g. bioactive peptide and protein-based ingredients. As one of the activities, RG will supply by-products from the production of Nutaaq cod in Maniitsoq, Greenland. Nutaaq meaning "New" in Greenlandic is a relative new concept providing products that are frozen within a maximum timespan of two hours from the live cod leaves the sea. This provides products and by-products of a unique quality.

By-product from the production of Nutaaq cod in Maniitsoq, Greenland.

The second EU-project, called PROFIUS, will start at the end of 2021 and run for a period of three years. The main objective of the project is to address challenges in the supply chain of underutilized fish species by developing preservation solutions for maintaining quality and improving utilization of the entire biomass. From an RG perspective, the focus will be on a better utilization of the whole lumpfish. As it is today, only the roe from the lumpfish is utilized, whereas the emptied carcasses are thrown back into the sea. This means that close to 70% of the biomass is discarded. The PROFIUS project will examine potential ways to utilize the carcasses of the lumpfish. In addition, new methods to preserve the roe, constituting an extremely fragile and perishable product, will be examined.

Catch of lumpfish and removal of roe in Greenland.

ALEXANDRA LEEPER

Head of Research and Innovation, Iceland Ocean Cluster

BIOGRAPHY

Alexandra is a passionate advocate for sustainable food production and resource use. After pursuing a BSc honours in Marine Biology and Oceanography at Plymouth University, UK, she we went to work offshore as a seismic navigator in marine prospecting. Her work took her to remote locations all over the world where she saw first-hand the impact that society can have on the marine environment in our search for resources. This has created a desire to drive positive change. Alexandra continued her academic career with an Erasmus Mundus MSc in Marine Environment and Resources across Europe and is currently writing up her PhD focusing on improving the sustainability of Atlantic salmon aquaculture through alternative feed ingredients, based at Matís ohf., Iceland and NMBU, Norway. Her most recent projects explore the possibilities of revalorising the currently wasted side streams from Atlantic salmon aquaculture, and she believes that the key to a healthy planet and future-proof food production, lies in innovative, non-linear supply chains.

Extending 100% fish: Applying the cod model to salmon in Iceland

Iceland has a long tradition of a strong fisheries sector that has played a key part in the socio-economic development of the country. In Iceland, the fisheries sector has historically been dominated by demersal whitefish, like Atlantic Cod and Pollock. Fifty years ago, the landings of Atlantic Cod were around 450,000 tonnes but concerns for the sustainability of the stock has led to tighter quotas and reduced the catch to a more modest size, closer to 200,000 tonnes annually. Despite this reduction in the catch, the value that Atlantic Cod brings to the Icelandic economy has remained stable and has even grown. One major factor in maintaining the worth of Icelandic fisheries has been an innovative re-imaging of ocean value chains.

To re-imagine a value-chain, it is important for the existing and potential players in that value chain to be connected and collaborating, a state that is often lacking when there is a perceived scarcity of the raw material, as is the case for fisheries. It was for this reason that the Iceland Ocean Cluster was originally founded by Dr. Thor Sigfusson in 2012, with the goal of opening the dialogue and connecting the fisheries sectors with each other, with entrepreneurs, with scientists and the wider community. When it was first founder, the Iceland Ocean Cluster had 10 members, in 2022, there are now around 70, as well as a growing number of sister Ocean Clusters that have mirrored the Icelandic model. The cluster functions as a meeting place and innovation hub where startups in the blue bioeconomy are fostered.

One of the main missions of the Iceland Ocean Cluster, is the 100% fish mission, a program that has been a key driver behind maintaining the value of the Icelandic fisheries catch. 100% fish is the target to utilise every part of the fish and seafood caught or produced. Historically only 45-55% of whitefish was used in Iceland in a linear value chain, where only the fillet reached the consumer, and the skin, heads, frames, scales and all other parts were discarded to landfill or had little value. Now, 90% of the whitefish is utilised, providing new processed materials, food supplements and biomedical added value products to the Icelandic and international markets, as well as reducing waste and environmental impact. One reason that this mission has been so successful is because of the collaborative atmosphere created by the Ocean Cluster. This mission however is far from complete, in Iceland we have other ocean catch and a growing aquaculture industry that are not fully utilised and in many other countries fish and seafood utilisation remains around 45-55%, all presenting a huge potential untapped source of value-added products. The whitefish model in Iceland now provides a framework for reaching 100% fish everywhere.

Atlantic salmon aquaculture has been rapidly growing in Iceland, both in sea cage production but also increasingly in land-based facilities. In 2021, there were 45,000 tonnes produced but with large new farms under-construction, production will continue to grow. It is now key that the lessons learned in Iceland for 100% fish are now applied to the salmonid sector to ensure sustainable and value-added production, and to have strong connections between key players in the aquaculture innovation landscape. This talk will highlight some of these key lessons in context of the challenges and opportunities for farmed salmon to support dynamic circular innovation and bring added value to the global blue bioeconomy.

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SESSION 2

Technology Innovation

DENNIS LOHMANN
Head of Technology Management, BAADER

Dennis Lohmann holds a diploma degree in Electrical Engineering and an additional Bachelor of Engineering degree in Business Administration and Engineering. He joined BAADER in 2007 as a programmer with a special focus on fish processing projects. After three years, he became Head of Project Management and five years later he took over the responsibility for the strategic development and further orientation of the BAADER fish portfolio as Head of Product Management. He now acts as Head of Technology Management to focus together with his team on the development of new sales opportunities and drives new product development and applications with a special focus on full utilization of marine raw material in order to achieve 100% utilization and vice versa zero waste management.

DR PIA MEINLSCHMIDT
Product Manager Fish, Food Science & Technology
BAADER

Dr Pia Meinlschmidt holds a diploma degree in food biotechnology and food process engineering and a PhD in innovative food processing engineering. She left her academic career where she worked among others at the Fraunhofer Institute to join BAADER in 2017 as Product Manager within the area of food science and technology. She focuses on projects in relation to the fishing industry and processing concepts for full-utilization of marine raw material to achieve 100% utilization and zero waste management.

DIRK SINDERMANN
Head Process Technology Renewable Resources
GEA Westfalia Separator

Dirk Sindermann is Head Process Technology Renewable Resources at GEA since 2015 focusing on applications for renewable resources such as åvegetable oils, biodiesel, animal and fish co-products and industrial biotechnology.

He joint GEA as Product Manager in 1997 gaining more than 18 years of experience in animal co-product processing, fat and protein recovery. An MBA from Buckinghamshire New University rounded his engineering studies from Coventry University and Osnabrück University of Applied Sciences.

Co-product Valorization: Towards Industrial Implementation of Innovative Food Processing Concepts for 100% Utilization

About BAADER

BAADER is the global partner for food-processing solutions with over 100 years' experience. We design and engineer innovative solutions that ensure safe, efficient, and sustainable food processing in all phases, from the handling of live protein materials to the finished food products. Through our data capabilities, we use data to interpret and forecast along the entire food value chain. In close collaboration and partnership with our customers and partners, we are taking further major steps towards greater transparency, profitability, and sustainability. By sharing knowledge and data, together we can succeed in optimizing the food value chain in the long term. To find out more about BAADER, please visit our website at www.baader.news.

About GEA

GEA is one of the world's largest systems suppliers for the food, beverage, and pharmaceutical sectors. The international industrial technology group specializes in machinery and plants as well as advanced process technology, components, and comprehensive services. With more than 18,000 employees, the group generated revenue of more than EUR 4.6 billion in fiscal year 2020. The major focus is on continuously enhancing the sustainability and efficiency of customers' production processes. GEA plants, processes and components help achieve significant reductions in carbon emissions, plastic use, and food waste in production worldwide. In this way, GEA makes a decisive contribution toward a sustainable future, fully in line with its corporate philosophy of "engineering for a better world."

Abstract

For more than 100 years, BAADER has been developing processing solutions for the seafood industry, thereby ensuring optimized processing of valuable raw protein resource. However, the potential and efficiency of automated solutions are not infinite despite the advancement of automated, integrated and digitalized processing lines. Therefore, the need for alternative seafood products will grow. A joint project of BAADER and GEA promotes efficient utilization and valorization of co-products by increasing nutrients and functional compounds while reducing waste. It improves the value of rest meat that can be recovered from fish backbones along the filleting line.

Status quo – Focus on optimal main product handling

Fish processing activities generate a substantial number of side-streams that are often discarded or used as low-value ingredients in animal feed. Most processing solutions focus solely on separating the main product and a co-product. Co-products are usually directly packed after extracting and will serve as added value in a later stage or further processed in another facility.

The cycle of fish product processing and co-product extraction from heading to packaging

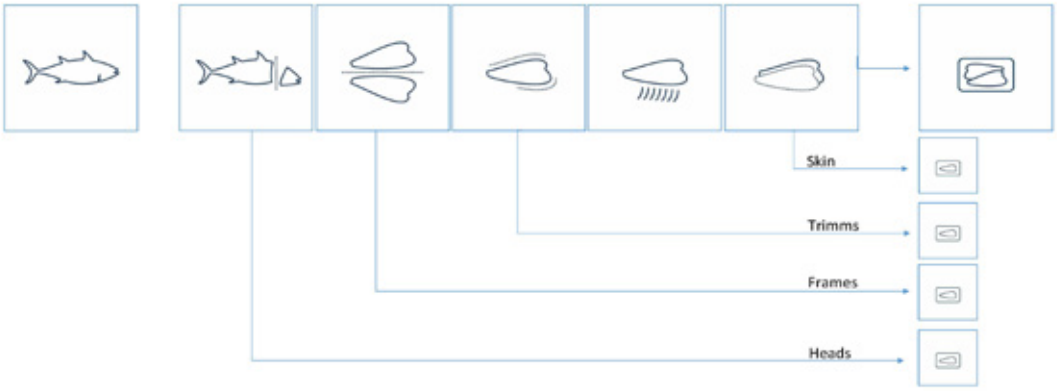


Figure 1: Current fish processing process

This process creates tons of co-products that contain minerals, high-quality proteins, and oils. These derivatives are valuable even though they are mostly untapped. Moreover, the rising demand for marine resources necessitates the optimum utilization of sea resources. In addition, more value is achievable from fewer resources by increasing the utilization rate of every processed fish. This also ensures zero waste in the entire process. Co-product handling generates significant growth in seafood processing and bears the potential to creates new seafood products.

Efficient utilization and valorization of coproducts

This has led to a project dedicated to creating a higher value at industrial scale. The joint project by BAADER and GEA promotes efficient utilization and valorization of co-products. This is done by increasing nutrients and functional compounds while reducing waste. It improves the value of rest meat that can be recovered from fish backbones along the filleting line. The BAADERING technology converts rest meat into fish mince.

Since the BAADERING process is gentle, there is only minimal mechanical stress on the fish mince and preserved muscle fibre structure when sorting the product from fishbone, skin, cartilage, and other impurities. Fine and coarsely structured materials can be added for an attractive product with dominant coarse.

For more utilization, fish mince can be (1) mechanically de-fatted by decantation, and afterwards (2) the liquid phase can be rendered via a centrifuge to high-quality fish oil, rich in omega-3 fatty acids such as EPA and DHA. Consequently, the creation of two end-products from a co-product is a threshold in sustainable food production.

Increased value of co-products in one to three process steps

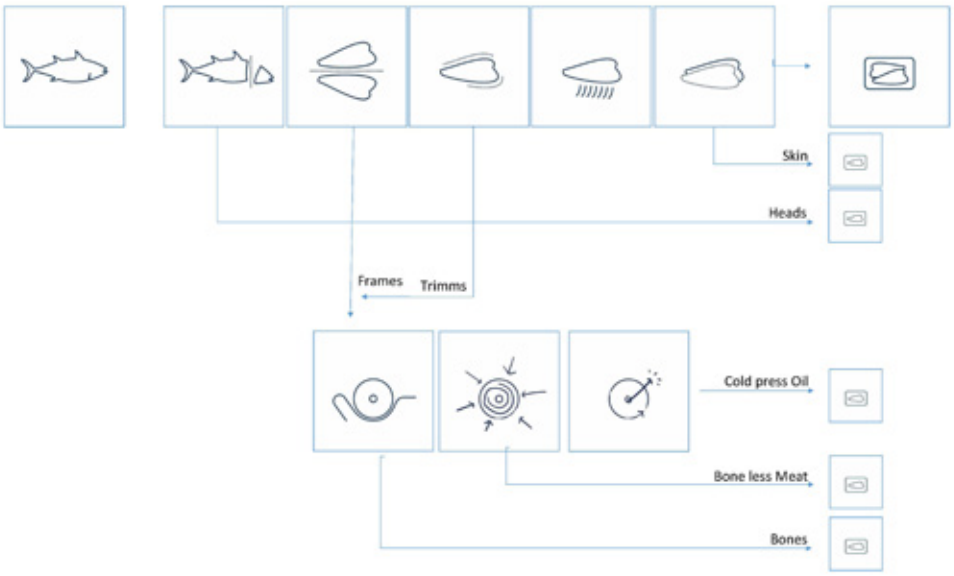


Figure 2: Expanding current processing lines to increase co-product value

In Figure 3, the separation process obtains mincemeat and bones. Afterwards, the mincemeat can be de-pressed and the bones processed for collagen, calcium, and gelatins.

Pressed mincemeat can be decomposed into dewatered dryer meat and a mix of water and oil. Dry meat has a higher utilization potential compared to mincemeat. The water-oil mix contains water and high-value fish oil. With a GEA centrifuge, we separate the water and extract cold-pressed fish oil. This produces a high-value product through three processing steps.

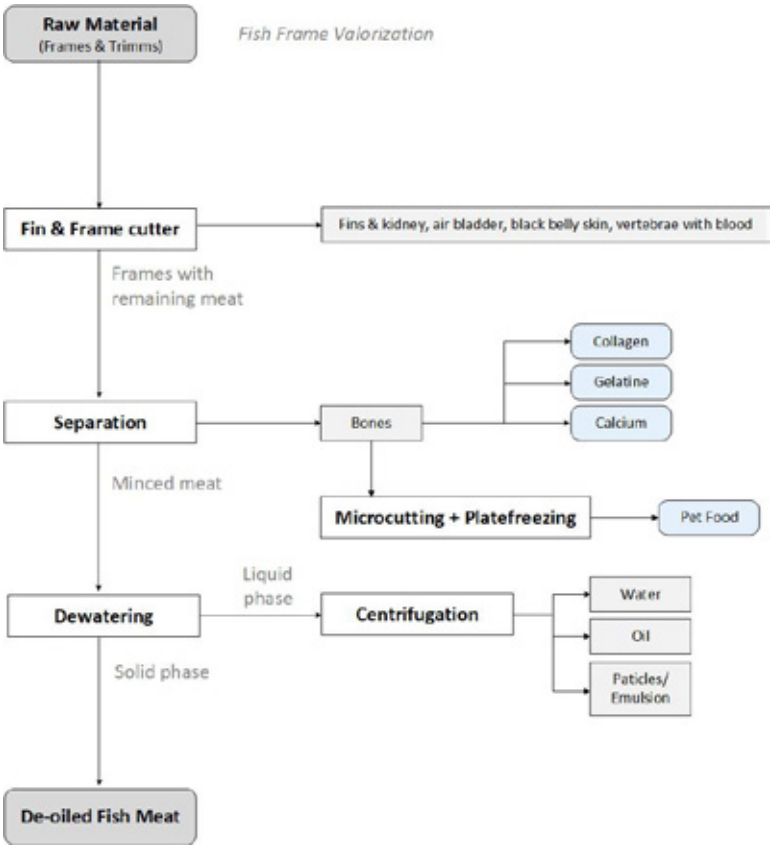


Figure 3: Three process steps of rest meat recovery, dewatering to de-oiled fish meat and high-value cold-pressed fish oil

Conclusion

An industrial implementation of innovative food processing concepts can contribute to a 100% fish protein utilization by integrating advanced co-product treatment. The joint project of BAADER and GEA promotes efficient utilization and valorization of co-products by increasing nutrients and functional compounds while reducing waste. It improves the value of rest meat that can be recovered from fish backbones along the filleting line.

Keywords: Co-products; food processing technologies; value addition; innovation; strategic utilization; industrial implementation

OMAR RIEGO PEÑARUBIA

Fishery Officer, Food and Agriculture Organization (FAO) of the United Nations

BIOGRAPHY

Omar Riego Peñarubia is a Fishery Officer of the Food and Agriculture Organization (FAO) of the United Nations. He joined the Value Chain Development Team (NFIMV) of Fisheries and Aquaculture Division of FAO in 2017, where he works on projects and programmes on fish post-harvest processing, technology and fish loss and waste. Omar holds an Erasmus Mundus MSc in Food Science, Technology and Nutrition. Prior to joining FAO, he worked as a Science Research Specialist in the Food and Nutrition Research Institute and in several food companies in various capacities in the Philippines. Omar is passionate of process optimization and valorization. He has strong interest on technologies or products that has positive impact on people and the environment through efficient use of resources and optimized processes.

Adoption of technological innovations: lessons learned from the field

Abstract

The expansion of processing of fisheries and aquaculture production has resulted in increasing quantities of by-products, which may represent up to 70 percent of fish processed, depending on the size, species and method of fish processing. Fish by-products are rich in nutrients, in particular micronutrients, and can be converted into food and other products with medical, pharmaceutical and packaging applications. These by-products can be converted into fish powder for human consumption, fish silage and fish meal for livestock feeds and fertilizer for agricultural purposes through the use of simple technology and with low upfront investment. However, the adoption of technological innovations may solve only a part of the bigger food loss and waste scenario. Processors, particularly small-scale, faces several challenges and difficulties in adopting new technologies like lack of sources of raw materials, lack of skills and technical-know-how, lack of access for quality systems and certifications and lack of market. To address by-product utilization, the application of multi-dimensional and multi-stakeholder approach is needed. This approach, which is promote by the FAO Voluntary Code of Conduct for Food Loss and Waste Reduction, considers the factors affecting national capacities in loss prevention and that included supportive policies and legislation as well as skills, knowledge, services, infrastructure and technology. Reducing food loss and waste through the valorisation of by-products can lead to economic benefits, positive impact on food and nutrition security and reduced environmental impacts.

Introduction

Food loss and waste occur in all parts of the fisheries and aquaculture value chain, including capture fisheries, aquaculture, processing and storage, wholesale, retail, transport and consumption. To minimize the loss and waste in the fish and improve fish waste management strategies, researches have been done to develop technological innovations to convert these wastes into useful products. Similar to waste, value-added products are being created from processing by-products. The remains of the fish, including viscera, heads, and frames depending on the species, are commonly called by-products and if treated correctly, classified as category 3 by-products according to EU regulation, meaning parts of animals that are fit for, but not intended for human consumption (EC No 1774/2002).1

Fish may be processed by bleeding, gutting, beheading, filleting, skinning and trimming before being bought by consumers. As a result of fish processing, a significant amount of the original raw material is not used for direct human consumption. Fish processing leads to a high volume of by-products, up to 70 percent of fish processed. By-products of fish were traditionally considered to be of low value and as a waste product contribute to or as a major environmental problem. The ever-increasing production of these processing by-products without utilization has resulted in environmental pollution. Inappropriate waste management causes environmental pollution leading to breeding grounds for insects and vermin, thus, posing significant public health risks. Consequently, waste management is coming under strict regulations due to environmental issues and has become an increased cost burden for the seafood industry.

However, the by-products of fish processing provide a good source of macro- and micronutrients. Certain by-products like heads, frames and off-cuts from filleting of fish may be used directly as food while by-products in general can be transformed into feed ingredients. Although sometimes suggested, it is unlikely that by-products can be used to any large extent to produce high-priced products. In addition to the use of by-products directly as human food or for producing preserved feed ingredients like fishmeal and fish oil, much focus has been to transform this biomass into isolated functional or bioactive components to be used

as nutraceuticals, as processing aids and even as pharmaceutical products.1 The utilization of by-products has several environmental and economic benefits as well as the possibilities to produce more food from limited resources.

Adoption of technological innovations

In adopting new technologies in value addition, it will require additional operational costs for acquiring new equipment and skills, a proven market demand for the products and an enabling policy environment.

Challenges

Lack of existing markets

Prior to adoption of new technologies and value addition, studies of market must be conducted to ensure the demand for the product. It is important to know if there are potential buyers or consumers and their buying behavior. In the end it is the consumer who decides what to buy.

The markets for bioactive peptides as nutraceuticals and as ingredients in functional food are limited and unless approvals for health claims are obtained from the authorities, it has been suggested that no dramatic increase in the demands can be expected. Since there are already many bioactive peptide products from ordinary food items, including fish, on the nutraceutical market, it is unlikely that new bioactive peptides made from byproducts
would have commercial success.*

In a study in Barbados, local key informants have highlighted that if fish silage is introduced as a much more affordable (approximately 20 percent lower in price) protein source it may have the potential to outcompete existing dry feed options. For aquaculture production, there are no low- cost feed alternatives currently on the market. As a result, fish silage presents an attractive alternative that may increase profit margins for aquaculture producers. However, in Saint Kitts and Nevis, the longstanding cultural practices of local farmers will be a significant consideration for the development of a productive silage industry. Any changes to the longstanding habits of feed use will require strong education campaigns to convince users of the benefits of fish silage.

In Bangladesh, fish silage will have to compete with known and well-established products like fishmeal, soya meal, gluten soya meal (GSM) and other products. It is not a (well-) known product for the seafood processors and fish feed millers. Customers do not tend to be willing to try silage concentrate unless they have guarantees of good feed performances and constant deliveries. While in the Philippines, much has to be done to increase local awareness of fish silage, and specifically its production technology and potential uses. A comprehensive initial marketing efforts must be carefully planned. This is necessary to increase the awareness of potential buyers on the usefulness of fish silage.

Supply of high quality by-products available on a regular basis

In big industrial fish processing units, by-products are usually processed into fishmeal and oil. However, investing in a fishmeal plant is not economically viable at small-scale processing units, unless at least eight tonnes of raw material is available on a daily basis.

In Saint Kitts and Nevis, fish are gutted at sea and the subsequent waste are discarded. This habit means that at present fish waste that includes viscera cannot be easily collected from the fisheries complex unless efforts to change this cultural practice are given priority. Key informants stated that almost all of the fish waste generated is discarded at sea, but if there was an alternative use to be exploited they are willing to change their practices. While in Barbados, primary feed producers have highlighted the need for stable quantities of silage to be supplied on a monthly basis in order to meet market demand. However, fish landings

* http://dx.doi.org/10.1016/j.tifs.2014.01.007

fluctuate significantly by type and quantity on a monthly basis. This will therefore require large quantities of silage to be stockpiled to supply local demand. The largest feed producer in Barbados highlighted that unless silage producers can supply at least 53 tonnes per month to substitute their 44 percent crude protein input, it would not be a feasible option.

Investment and operational costs

Upfront investment for new innovations can be high particularly for buying new equipment or sophisticated machineries as well as use of reagents for laboratory extraction of isolates. Also, investment must be made for human capital such as for developing new skills and capacity building. Most of the technologies for the utilization of fish processing waste are not economically attractive due to the high initial investment and intensive use of technology. Thus, it is not always a sustainable practice for the aquatic food processing industry.

In the study in Thailand, representatives from the various communities have shown an interest in fish silage technology to develop production of an animal feed that is of higher value than fertilizer. So far, fish silage production is not being practised in small-scale processing communities in Thailand, unlike the industrial food processing sector. However, the provision of substantial and skilled hands-on training is needed.

Enabling environment

An essential step in up-grading by-products to co-products for human consumption is that systems such as Good Manufacturing Practice (GMP) and the Hazard Analysis and Critical Control Point (HACCP) used in food production, are applied. This is currently not always possible due to unsuitable processing facilities, lack of relevant equipment or labour costs. Furthermore, products aimed at the nutraceutical market, the cost of providing the necessary documentation for health claims is high since the evidence must be obtained from studies on humans.

In Ghana, the use of fish by-products and small fish species was identified as a good practice, as these are generally of a lower economic value, making them more affordable for public procurement programs, and were found to be acceptable to school children. A pilot study to test the possibility of including fish in school meals using tuna frames, in addition to three underutilized fish species (one-man thousand, anchovies, and flying gurnard) which were dried and milled into fish powder and then added to meals for school children, was conducted. The fish powder was first analyzed for physico-chemical and nutritional analyses to ensure food safety.

In Barbados, the existing regulatory framework has the potential to facilitate the production and utilization of fish silage. However, existing policy instruments do not directly define the roles and responsibilities of key actors, nor do they address aspects of market and institutional arrangements regarding the handling of rest raw materials, fish offal and the production of fish silage. The absence of such regulations can pose constraints and challenges for the successful implementation of fish silage production. Clearance and permission may have to be institutionalized in order for fish silage to be produced and utilized in, and or as, animal feed.

Lessons learned

Effective stakeholder and community participation and engagement in all phases of the project increase the actors' sense of ownership and chances of success

Effective participation of key stakeholders (especially the local communities and authorities) in all phases of the project from site selection to installation, operation, monitoring and evaluation is crucial. This enhances their sense of ownership and appropriate use of the technology unit put at their disposal, as well as the chances of success, particularly when the installation, the management and stakeholders' responsibilities and contribution modalities have been clarified from the outset.

Empowering the target groups and developing or upgrading their capacities enhances their ability to run the technology or infrastructure made available to them
The success or failure of the technology depends on the capabilities of the processors and those of the personnel responsible for following up their activities and providing guidance such as correcting minor malfunctioning of the facilities and equipment in place. Sufficient hands-on training should be provided to small-scale communities, covering the main principles of production, storage and utilization, as well as financial support. Moreover, information on relevant regulations on animal feed and feed ingredients must be considered when turning fish waste into animal feed or feed ingredients for sale. The establishment of a fisheries/ farmers' cooperative society that is financially driven could be an innovative option for a funding mechanism.

The technical specifications (especially the capacities) and dissemination of future technology must be consistent with the prevailing fisheries status and potential as well as existing practices and market needs.
In any context where the technology is to be introduced, the design of the prototypes should be commensurate with the prevailing fisheries status and potential as well as the needs of the target groups and consumers. It is equally imperative to adapt the facilities and equipment to the prevailing local environment (including fishing and post-harvest practices, the main fish species targeted, and catch levels and potential) and market needs.

Technology management arrangements need to be clearly defined and partners' respective roles and responsibilities in that regard clarified early in the project.
Management arrangements (preferably co-management) of any technology or infrastructure should be decided upon, followed by a timely and transparent process to hire personnel, ensuring that the people appointed can take up their duties on time to avoid unnecessary delays. These management arrangements should specify whether the said infrastructure will be operated solely by the administration or competent authority, clusters of innovation or outstanding community leaders, a private or cooperative enterprise, or jointly. Policy instruments and management plans should explicitly define the roles and responsibilities for the various actors involved in the prospective handling of fish offal and the production of fish silage, and also set rules and regulations for market arrangements and product standards.

Linking all actors to markets by supporting marketing and product differentiation activities enhances livelihoods.
Articulating the market and production interaction is fundamental to ensure that the value chain remains competitive and dynamic and that new products (from the introduced technology) sell at higher prices than those derived from traditional processes. Feasibility studies should be conducted before starting the adoption of the new technology. An economic analysis and marketing plan should also be done as part of this study.

Sensitizing and educating the public at large on the comparative advantages of the new technology and its products enhance the likelihood of product buy-in and consumption.
Consumers in particular should be helped to understand that these products produced using the new technology are good value for money and should attract premium prices to reward compliant producers. A robust educational campaign and training activities will need to be undertaken to change the longstanding habits of fish waste disposal at sea by fishers, and the feed use practices of farmers.

Conclusion
The introduction of appropriate technology is only one of the several entry points for an effective fish loss and waste reduction. A multi-dimensional and multi-stakeholder approach that requires a combination of the right policy, appropriate technology, skills and knowledge, services and infrastructure, regulatory environment, social and gender equity, as well as good linkages to and knowledge of markets in needed.

References

Olsen RL, Toppe J, Karunasagar I. Challenges and realistic opportunities in the use of by-products from processing of fish and shellfish. Trends Food Sci Technol. 2014;36(2):144-151. doi:10.1016/j.tifs.2014.01.007

Drakes C, Mackey T, Wood J. Fish Silage Production and Use in the Caribbean. Feasibility Study for Barbados and Saint Kitts and Nevis. Vol FAO Fisher.; 2020. doi:10.4060/cb0820en

Islam J, Yap EES, Krongpong L, Toppe J, Peñarubia OR. Fish Waste Management – An Assessment of the Potential Production and Utilization of Fish Silage in Bangladesh, Philippines and Thailand. Vol 1216.; 2021. doi:10.4060/cb3694en

Ahern MB, Thilsted SH, Kjellevold M, et al. Locally-procured fish is essential in school feeding programmes in sub-saharan Africa. Foods. 2021;10(9):1-23. doi:10.3390/foods10092080

WENCHE UKSNØY

Cluster Manager, NCE Blue Legasea.

BIOGRAPHY

Wenche Uksnøy is the managing director for the marine cluster NCE Blue Legasea. She has her background from sales and marketing in various types of process industry - the last 14 years in the marine ingredients industry and cluster operations. Wenche has worked within sales, conceptualization, commercialization and marketing of products and solutions for international markets and especially for customer groups in the B2B segment.

Innovative technology unleashing fish waste potential

The presentation "**Innovative technology unleashing fish waste potential**" will investigate value potential in marine waste and biproducts from the perspective of collaboration in clusters and value chains. You will hear about the ambitions from leading Norwegian companies within the white fish, protein and omega-3 producing sector. Examples will be given on NCE Blue Legasea members technologies available to move forward in utilizing 100 % and processing more efficiently what is already harvested from the ocean.

SESSION 3

Kick-Starting Investment Opportunities

DR THOR SIGFUSSON

Founder & Chairman, Iceland Ocean Cluster

BIOGRAPHY

Thor Sigfusson is an Icelandic entrepreneur, author and speaker.

Thor received his PhD degree in Business from the University of Iceland in 2012. He launched the Iceland Ocean Cluster in 2011. The cluster focuses on developing innovative ideas in the blue economy. In May 2012, Thor founded the Ocean Cluster House in Reykjavik Iceland.
He is also the founder or co-founder of various enterprises in fish utilisation and food. Using the research and information generated from Iceland Ocean Cluster, Sigfusson founded Codland in September 2012. In 2013, he founded the company Collagen with the aim to use fish skin to create marine collagen. In 2017-2018 he founded Grandi Food Hall and co-founded Hlemmur Food Hall and Reykjavik Foods.

Thor has actively been promoting globally his 1000% fish utilisation mission and seafood clusters and he is the co-founder of three ocean clusters in the US; The New England Ocean Cluster, New Bedford Ocean Cluster and the Pacific Northwest Ocean Cluster. Spring 2020, the first Ocean Cluster House outside Iceland will open in Portland Maine.

He has written seven books on topics of international business, knowledge networks and salmon. His most recent book is “The New Fish Wave - Igniting the Seafood Industry” will be published by Leete’s Island Books in the US in April 2020.

Since establishing the Iceland Ocean Cluster, Sigfusson has spent his time speaking to audience in North America, Europe and Asia about the opportunities in building networks in the marine industry.

ERLINGUR GUÐLEIFSSON

Engineer, MBA Programme

BIOGRAPHY

Erlingur Guðleifsson is freelance consultant in the field of waste utilization with focus on fish meal. He has been part of the Icelandic Ocean Cluster technical advisory board since 2019. He graduated with a BSc degree in mechanical engineering from Reykjavik University in 2006 and MBA from the same school in 2021. He worked on an innovative fish meal project at Hedinn hf. between 2006 and 2020. He is experienced in working with fisheries and organizations with new investments where waste streams are in foreground. Those investment projects include ground-, pelagic- and shellfish solutions. He has proven experience working with fisheries and shipyards on remote installation projects in Latin America, North America and Europe.

How biases can affect innovation

Abstract

Drawing on journal and magazine articles on how biases can affect decision making in an innovative environment. Efficient usage of R&D funds is the goal of every nation or organization. Cognitive biases and mental state of the decision maker does affect how decisions are taken. As R&D funds are often coming directly from organizations equity, stakeholders watch R&D funds, their usage and outcome closely. By recognizing
those biases do affect decision making in innovative work is positive step towards better usage of R&D funds and higher growth rate for any company or nation.

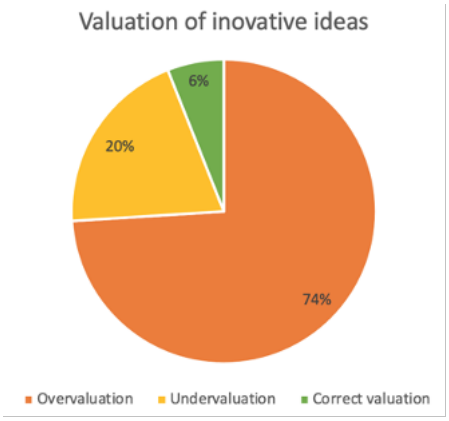
Funding innovative ideas

When looking at established companies and enterprises it's common that most of the initial funding for innovative ideas and R&D work is being funded directly from the company's equity. Later, if the idea is good or promising other funding sources might also come into play. One common bias that does affect decision makers is the so-called short-term R&D bias. One implication can be stakeholders' pressure to boost up short term growth, dividends or share prices by reducing R&D funds for innovative work and investments (Dunk & Kilgore, 2001). In the UK such short term vision has shown to have negative effects on patent rates, one of the key KPIs for innovation despite the fact that stakeholders are generally better informed nowadays regarding the importance of innovation for future growth (Demirag, 1995). How can this be? It's tempting to draw the conclusion that the short-term R&D bias is here affecting the decision makers.

It has though been stated that any research within this field is rather complicated due to lack of data. Decisions are generally made by selection boards or committees behind locked doors leaving less evidence for researchers (Criscuolo et al., 2017).

Group dynamics and the ideator bias

Biases can both affect groups and individuals. Companies and innovative teams often rely on one or few persons to lead and develop an idea; this can lead to effects of ideator bias where the ideator in some cases over- or undervalues his or his team's ideas. According to research done at a German auto manufacturer overvaluation was much more of a problem than undervaluation or about 74% of innovative ideas where overvalued, 20% undervalued and correctly valued ideas only 6% (Sting et al., 2019).



If those findings are in some way presenting a general problem of overvaluation of innovative ideas, we are faced with 3 bad decisions for every 4 taken. This can also be turned around and considered as a discard of one good idea of every 5 ideas considered. This problem must have something to do with a lack of good decisions or procedures.

The effect of overvaluation is shown to have stronger effects by those who are ranked higher on the organization chart than lower where the symbol of the ideator seems to lead to overconfidence. Remarkably, front line workers scored lowest by the effects of ideator bias of overvaluation of an idea by only 11% (Sting et al., 2019).

Who has not heard a front-line worker say "I'm never being heard" when they are trying to work bottom up for improvements?

Lastly, evidence shows that a group can be more likely to overvalue an idea rather than an individual working alone. One possible reason for this can be that the group have been trained to stick and work together which can result in negative effects when comes to innovative decision making (Sting et al., 2019).

What is then a "good decision"

Before heading on towards how we can make better innovative decisions we must agree on what can be considered a "good decision". Psychologists have studied the decision mechanism of our brain and it is quite accepted that there are mostly two masters at work in our brain when we make decisions. System one and system two. System one is often considered dominant and takes care of all our spontaneous decisions, decisions we take with or without conscience during the day. System one has always a cooked solution ready for us at any given occasion. Unfortunately, many of our system one conclusions in complex matters are not any more accurate than as they were concluded with a set of dies.

Gratefully we have our system two or the analytical workstation of the brain. There is just one flaw with system two: it has been considered rather lazy and reluctant to take on assignments. It takes us much more effort and energy to use system two rather than system one. System two is though our best friend when it comes to strategic decision making and the only reliable source (Kahneman, 2011). My strategic decision professor described this perfectly by calling this reluctance of system two "mental laziness" (Weber, 2020).

What is then a "good decision" a good decision is a decision that is made by system two with great work and effort, a decision we can be proud of by telling "I did crunch this case". We might not be right with our analysis on all occasions, some decisions just can't be crunched down to the truth. Just remember, a decision can be considered good despite the result (Kahneman, 2011; Weber, 2020).

How can things get better?

Bin method

Evaluation methods of innovative ideas can have many forms, they usually differ by each corporate or committee. Statistical correlation has though been found regarding how many ideas, cases or issues are being evaluated during each session or meeting where the number of cases does affect the outcome. Decisions tend to be of lower quality when pressure is strong or during long sessions. The bin method ensures that only a reasonable number of cases are evaluated during each session and therefore they can be "better" or less biased (Criscuolo et al., 2017).

Selection board diversity

It's more likely that a good decision can be taken when the selection board has a diverse background, experience, and education. F.x. it's more unlikely to generate creative viewpoints having a selection board of mechanical engineers to evaluate if an R&D project for a new type of pump shall be selected for innovation procedures. Diversity in board selection is a parameter that can be easily controlled.

Effects of diversity can also be enforced with seeking views from external professionals (Criscuolo et al., 2017).

Separation of the ideator from the team

An overvaluation of an idea is more likely to occur within a development team where the ideator states with the team during the innovative work. By procedures the ideator can be removed from the development team shortly after their work starts. By that it's more likely that the team values or works on the idea without effects of ideator biases. Alternative would be creation of two groups, groups of ideators and another group of innovative people that executes the development. Less over engagement by the innovation team is gained by such an approach (Sting et al., 2019)

Apply risk management procedures

Lastly, it's worth mentioning a method that reduces risk and generates quicker returns from innovative work. With creation of a portfolio of R&D projects financial risk of any R&D work can be reduced. Selection of R&D projects for such a portfolio must have different novelty as with increased novelty for any given project both financial risk increases (Criscuolo et al., 2017) and the simple law of risk and return apply.

Conclusions

As managers of today's businesses are aware of the importance of R&D and innovation for future growth, pressure increases on innovators to use their funds wisely. By being aware of possible biases towards innovative ideas, working around them can support future growth of any organization or nation.

DAVID LUDVIKSSON

Senior specialist in tax incentives and innovation projects, RANNÍS

BIOGRAPHY

David has the resent years worked as Senior specialist in tax incentives and innovation projects at Rannis, The Icelandic Centre for Research. David has over thirty years of experience working for the Federation of Icelandic Industries (FII/SI) as Director of strategy management, Innovation and Technical services. David has in his carrier been involved in creation and strategy processing of many membership organizations in various industries, especially involving technology-based industries and seed companies, often with emphases on financing of R&D&I. David has served on the boards and in chairmanship of various organizations such as The Icelandic Standard Association, The Icelandic Association for Quality, The European Organisation for Quality (EOQ), Vottun hf. and High-tech and Seed Companies Forum of Iceland just to mention few of them. David has been active in the Quality Management movement in Iceland since early days and is Honorary member of Stjórnvísi the professional society of Management excellence in Iceland.

David has been involved in numerus initiatives and projects covering cooperation between fishing and fish-processing industries and the technology-based Industries of Iceland. David was a founder of Fisheries Technology Forum in 1994 and a member of its project committee for 23 years also involving the Evaluation Committee of AVS (Adding Value of the Fisheries) from the year 2004.

David holds a MS-degree in in industrial and business engineering from The Technological University of Denmark and BSc degree in mechanical engineering from The University of Iceland. As a young engineer he was developing machineries for the fishing industry. Before entering the Icelandic industry, after graduation, David was working five years at KPMG in Copenhagen as IT and management consultant.

JÓN GARÐAR GUÐMUNDSSON
Partner, MAR Advisors

BIOGRAPHY

Jón Garðar Guðmundsson is a partner at Mar Advisors, a corporate finance boutique with focus on providing advisory services to the seafood industry. He has over 25 years' experience in the finance, consulting and management in the seafood industries in Europe, the Americas and Asia. Previous roles include managing director of Nordic Mar, deputy CEO of Icelandic Group and Senior Advisor with Glacier Securities, a New York-based financial advisory firm. From 2003-2008, Jón Garðar was a member of Glitnir Banks' seafood team and the managing directos for the bank's International region. Jón Garðar started his career in financial management, working for 8 years as CFO, first at VSO Consulting and then at Icelandic Iberica S.A. in Barcelona.

Selected transactions include; acquisition of Ahumados Dominquez SA in Spain, for Iceland Seafood International, sale of shares and equity increase in the trout farming operations of ÍS47 in Iceland, sale of a 33% stake in Valka processing equipment manufacturer, sale of salmon farming company Congelados Pacificos (Chile) to Veintesqueros (Germany/Chile). USD 130 million private placement and listing of the world's largest asparagus producer, Camposol (Peru), on the Oslo Axess and the sale of salmon farmer Salmones Cupquelan (Chile) to Cooke Aquaculture (Canada). Advised the fishmeal and fish oil producer Copeinca (Peru), raising USD 230 million in new equity through an IPO in Oslo, Norway and securing credit financing for the company.

Jón Garðar has served on the board of several companies, such as Bakkavör China on behalf of Glitnir Bank, and on the boards of Icelandic Iberica (Spain) and Icelandic Gadus (Belgium) on behalf of Icelandic Group.

Jón Garðar holds an MBA from IESE Business School and a Cand. oecon. degree in Business Administration from the University of Iceland. He is fluent in Icelandic, English and Spanish.

RUNÓLFUR GEIR BENEDIKTSSON

Executive Director, Corporate & Investment Banking,
Íslandsbanki hf.

BIOGRAPHY

Runólfur Geir Benediktsson has been in the banking sector for more than 18 year and currently serves as an Executive Director at Íslandsbanki´s Corporate Banking division. In that position he head´s up the seafood team of the bank and has therefore been closely involved in the fishing industry, an industry that has always played an important role in Íslandsbanki´s operation since foundation more than 100 years ago.

Runólfur has a bachelor degree in Business Administration and an MBA from Copenhagen Business School.

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SESSION 4

Pioneering By-Product Utilisation

ISABEL CUENCA FLORES
Marine Institute, Memorial University of Newfoundland

BIOGRAPHY

Isabel Cuenca Flores, Graduate student, The institution is Memorial University of Newfoundland, is confirmed to speak at the 4th Fish Waste for Profit conference, this year's conference will take place from 9-10 June 2022, in Smárinn / Fifan halls in Kópavogur, alongside the Icelandic Fisheries Exhibition.

Isabel is an experienced food technologist holding a solid background in new product development and innovation. As a graduate from food industry engineering and developed her career in R&D, Isabel started with a minor in New Product Development followed by eight years in the innovation department of food companies from diverse sectors.

Isabel also worked in the canned tuna, deli meats, dairy products, and functional ingredient industries, translating project ideas to ready-to-market- scaled-up products. Isabel is passionate about innovation and sustainability, and the health benefits of marine fatty acids-Omega 3. She is currently completing a Master of sciences in sustainable aquaculture at the Memorial University of Newfoundland, proposing alternatives to extend the shelf life of salmon by-products for their value maximization.

Isabel will identify the processing opportunities of side streams from fisheries and aquaculture to support the loss of valuable nutrients present in fish resources generating healthy and sustainable foods.

Fostering the storage practices of salmon by-products for their full utilization

Background

After the filleting operations are performed on salmon, numerous side products are generated regarded as by-products commonly incorporated into low-value products such as fertilizers, silage, pet food and fish feed. However, bioactive compounds present in salmon by-products can be extracted for the food, nutraceutical and pharmaceutical industries, increasing the profits of fish farmers and processors.

Highly unsaturated fish oil such as omega-3, EPA and DHA, functional peptides and amino acids, enzymes, calcium and phosphorus are biological compounds present in salmon by-products that can be extracted and commercialized for a higher revenue compared to their actual uses.

The investigation of these compounds' extraction, greener and sustainable methods, higher yields and purity, functionality, and applications is ongoing and has increasingly gained attention in the last decades. However, one of the greatest challenges faced in handling salmon by- products is the fast deterioration occurring after the fish death.

The primary degradation pathways occurring in fish materials are microbial, chemical and enzymatic reactions (Ghaly et al., 2010). Cold storage is commonly used to reduce the rate of fish by-products' deterioration. However, lipid oxidation is the prevailing reaction observed even under frozen conditions. Therefore, restraining lipid oxidation is a milestone for properly handling by-products during storage.

Commonly, lipid oxidation is avoided by adding antioxidants and avoiding oxygen, light, and elevated temperatures, conditions that enhance lipid oxidation. However, it has been found that metals and hemoglobin can especially enhance lipid oxidation in fish materials (Wu et al., 2021). Hemoglobin is present significantly in several organs present in by-products such as gills, kidneys, heart, liver, and spleen, while oxygen is present in the air bladder. The salts and acids present in the bile sac are other compounds that potentially enhance lipid oxidation. Further, the degree of damage occurring to the natural arrangement of cells and tissues of by-products as a result of handling processes such as grinding, performed on by-products to obtain homogeneity for the addition of additives or other ingredients, results in the faster deterioration of fish materials, as observed in the fish mince and fish fillets compared to whole fish (Medina & Pazos, 2010).

The present research aimed to increase the stability of salmon by-products during storage by restraining lipid oxidation; sorting individual organs constituting by-products, identifying those which could potentially enhance lipid oxidation (denominated as reactive organs) and studying the effect of separating those highly susceptible organs from the whole by-products on the oxidative stability of by-products during storage. Parallelly, comparing high-intensity and low- intensity processes applied to by-products before storage, studying the effect of processing intensity on the oxidative stability of by-products during storage. After observing the best handling practices to store by-products regarding organs and processes, the effect of an added antioxidant on the oxidative stability of by-products was studied under frozen conditions applying the suggested handling practices.

Results

Figure 1 shows salmon by-products before and after reactive organs removal from the first part of the experiment. Gills were identified as reactive organs in the head. No reactive organs were identified in the frame, while viscera comprised a variety of diverse organs, from which; the heart, liver, bile sac, kidney, spleen, air bladder, and gonads were identified as the reactive organs.

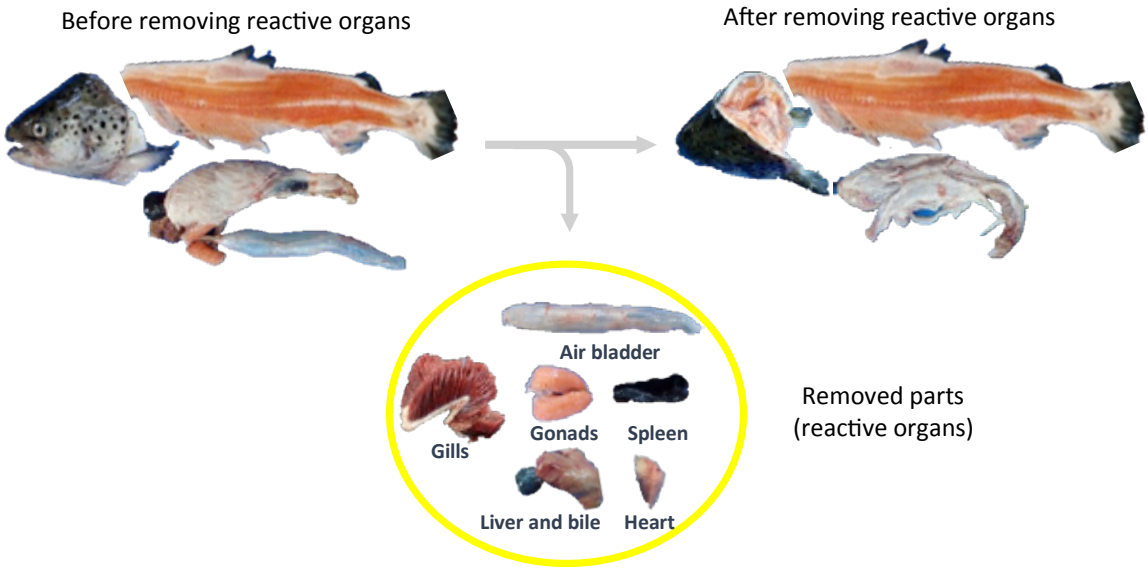

Figure 1. Salmon head, frame, and viscera before and after reactive organs removal.

Therefore, salmon frames were excluded from this first experiment, and the study was performed on salmon heads and viscera alone. The reactive organs were separated from heads and viscera to obtain by-products without reactive organs. The oxidation level was compared to a batch of whole by-products containing reactive organs during storage at 10˚C for seven days. The total oxidation values and the free fatty acid content on days 1 and 7 are shown in

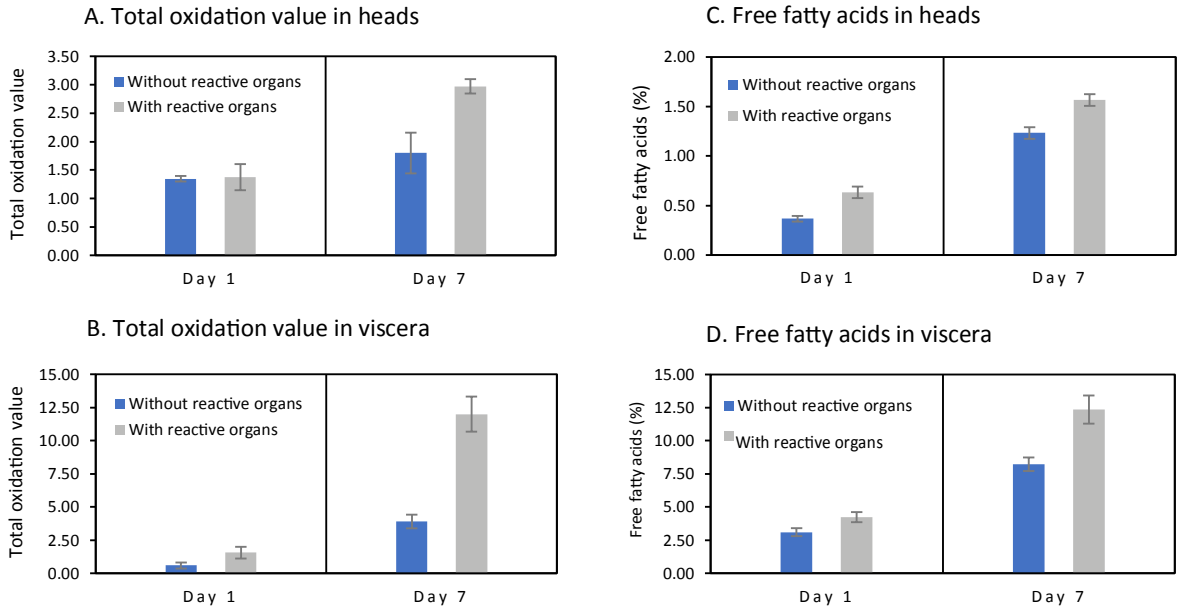

Figure 2. Total oxidation value and free fatty acid content in the oil extracted from salmon heads (A and C) and viscera (B and D) stored at 10˚C for 7 days.

In the second part of the experiment, a batch of by-products, whether heads, frames, or viscera, was ground in a meat grinder (Model 4146 The Hobart MFG. Co. Ltd.) or tumbled in a meat tumbler (Vacuum Tumbler VTS-42, BIRO, USA) to compare the level of oxidation of by-products treated with high-intensity processing to that of by-products treated with low-intensity processing during storage at 10˚C for seven days. The total oxidation values and the free fatty acid content on days 1 and 7 are shown in Figure 3.

During the third part of the experiment, heads without reactive organs, frames, and viscera without reactive organs were divided into three groups. The first group was tumbled without adding antioxidants and regarded as the control (tumbled by-product without antioxidants). The second group was tumbled with the addition of antioxidants and regarded as treatment 1 (tumbled by-product with added antioxidants). The third group was ground with the addition of antioxidants and regarded as treatment 3 (ground by-product with antioxidants). Then the samples were stored at -18˚C for 90 days. The total oxidation values, free fatty acid content, and fatty acid profile were analyzed on days 1, 30, 60, and 90. The results are shown in Figure 4.

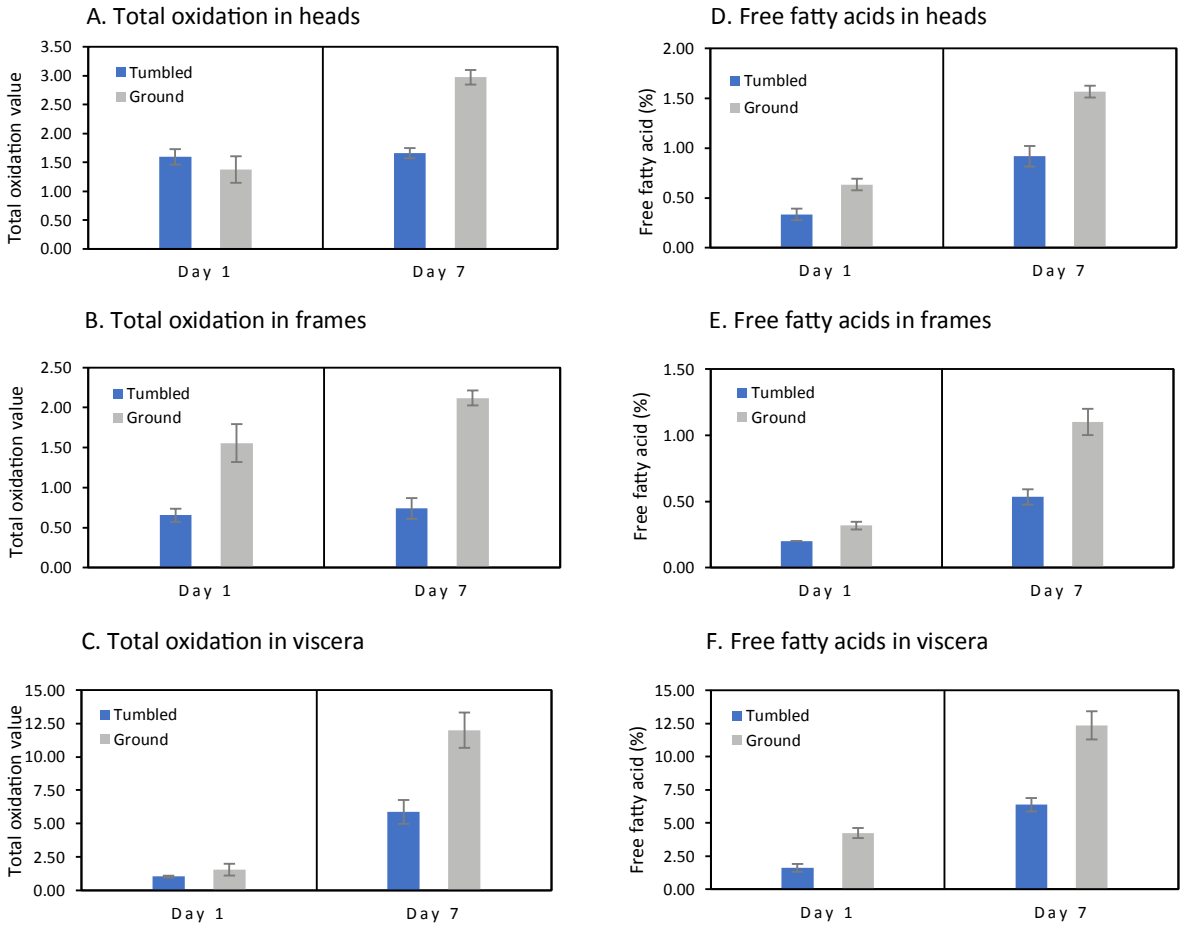

Figure 3. Total oxidation value and free fatty acid content in the oil extracted from salmon heads (A and D), frames (B and E), and viscera (C and F) stored at 10˚C for 7 days.

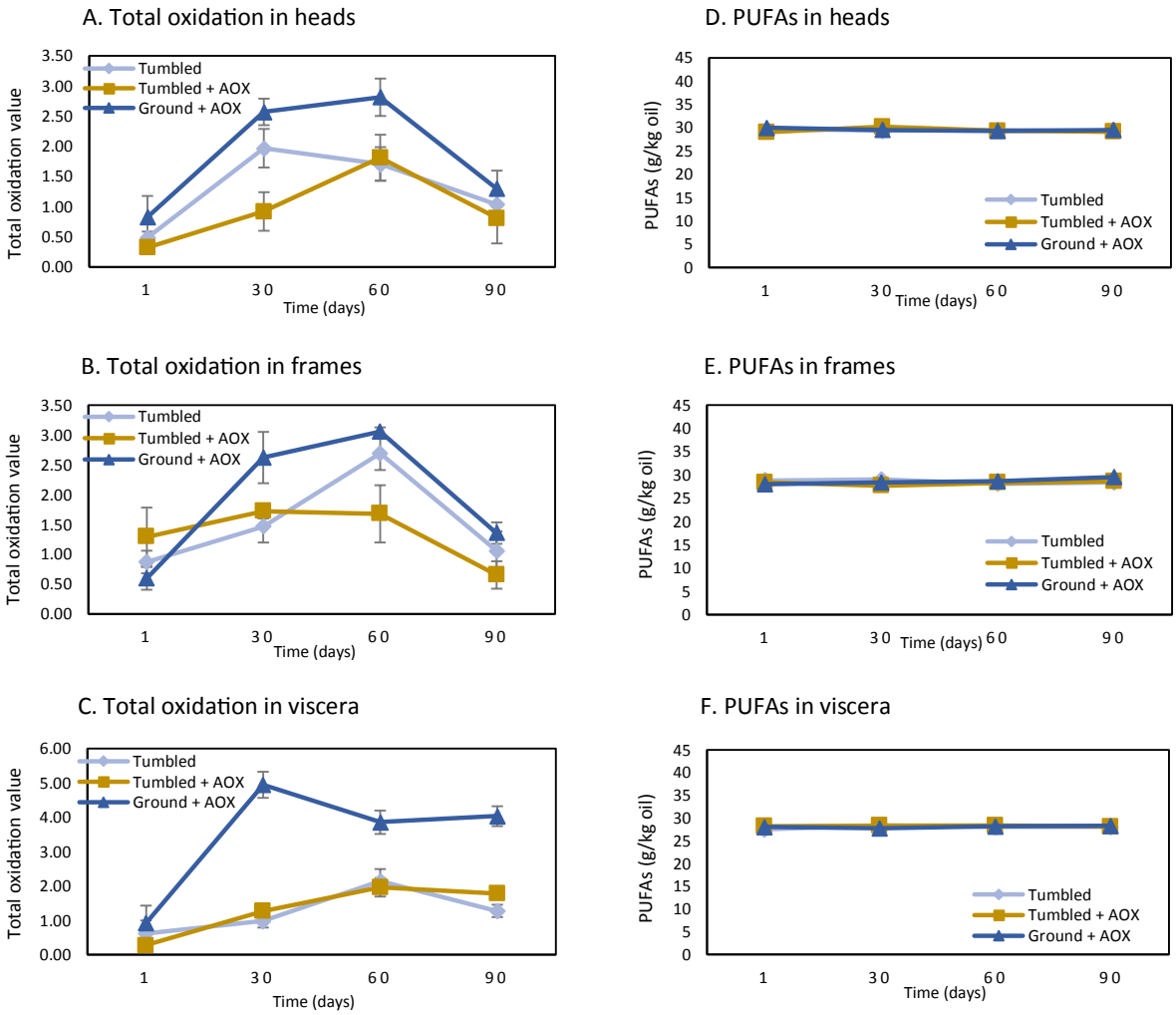

Figure 4. Total oxidation value and polyunsaturated fatty acids content (PUFAs) in the oil extracted from salmon heads (A and D), frames (B and E), and viscera (C and F) stored at -18˚C for 90 days.

Effect of reactive organs

Figure 4 shows lower lipid oxidation developed in the oil extracted from salmon heads and viscera separated from reactive organs after 7 days of storage at 10˚C, corroborating the hypothesis that the organs identified as reactive organs enhanced lipid oxidation in by-products during storage.

Further, the separation of reactive organs was determined as a better handling practice than handling whole by-products during storage to protect them from lipid degradation and quality loss of functional compounds.

Effect of processing intensity

Parallelly, Figure 4 shows lower lipid oxidation developed in the oil extracted from salmon heads, frames, and viscera processed under a low-intensity process (tumbling) compared to that from heads, frames, and viscera processed under a high-intensity process (grinding) performed before storage, corroborating the hypothesis that high-intensity processes promote lipid oxidation in by-products during storage. In the same way, low-intensity processes were determined as better handling practices than high-intensity processes to protect salmon by-products from lipid degradation and quality loss of functional compounds during storage.
Evaluation of handling practices and the effect of added antioxidants during frozen storage

Further, the storage of salmon by-products separated from reactive organs (without reactive organs) at -18°C showed interesting results. Firstly, salmon by-products stored without reactive organs don't require the addition of antioxidants. Even though lower oxidation was observed in by-products added with antioxidants than in control, the oxidation level developed during the 90 days was low, and no degradation of polyunsaturated fatty acids was observed. Secondly, adding antioxidants through the grinding method potentially incorporates antioxidants more properly; however, the damage caused to tissues resulted in higher oxidation than by-products added with antioxidants through the low-intensity tumbling method. These results corroborated the results from the second experiment showing the oxidation-promoting effect resulting from high-intensity processing performed in by-products before storage.

Conclusions

Organs accumulating large amounts of prooxidant compounds (e.g., blood and air) promote the initiation of degradative processes conducing to quality loss of bioactive compounds, negatively affecting the potential profitability of fish by-products. In the same way, high-intensity processing promotes the initiation of the degradative process in fish by-products. Contrarily, the sorting and separation of reactive organs and the selection of low-intensity processes provide a protective effect against oxidation in salmon heads, frames, and viscera. In this research, salmon by- products stored under frozen conditions, including pre-treatment (tumbled and separated from reactive organs), were stable for three months without the need for antioxidants addition.

This research is the first of its kind to analyze the individual organs contained in by-products, identifying reactive organs and studying the effect of those organs on the oxidative stability of by-products during storage. The analysis of the individual organs of by-products could improve the extraction of targeted compounds from organs with specific storage needs, and strategies should be applied according to the primary degradation process affecting these organs containing the compounds of interest. This analysis could potentially provide a wider range of applications and resources in the pursuit of economical benefits from fish by-products.

References

Ghaly, A. E., Dave, D., Budge, S., & Brooks, M. S. (2010). Fish spoilage mechanisms and preservation techniques: Review. American Journal of Applied Sciences, 7(7), 859–877.

Medina, I., & Pazos, M. (2010). Oxidation and protection of fish. Oxidation in Foods and Beverages and Antioxidant Applications, 91–120. https://doi.org/10.1533/9780857090331.1.91

Wu, H., Sajib, M., & Undeland, I. (2021). Controlling hemoglobin-mediated lipid oxidation in herring (Clupea harengus) co-products via incubation or dipping in a recyclable antioxidant solution. Food Control, 125. https://doi.org/10.1016/j.foodcont.2021.107963.

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BIOGRAPHY

Runar Gjerp Solstad is a scientist in marine biotechnology at Nofima the Norwegian institute of food fisheries and aquaculture research where he started working in 2016. He holds a PhD from UiT The Arctic University of Norway focused on isolation and characterisation of novel marine antimicrobial peptides. Current research focuses primarily on utilisation of marine side streams. Common methods include enzymatic hydrolysis and filtration techniques in addition to working on the scalability of these processes from laboratory to pilot scale.

The BlueCC project: Commercial exploitation of marine collagen and chitin

Introduction

Over the coming decades, the world will witness increased competition for limited and finite natural resources. Bio-waste is estimated at up to 138 million tons per year in the EU, of which up to 40% goes to landfill. This includes large amounts of by-catches from the fisheries. Other sources of poorly utilized marine biomass are cleaner fish used in aquaculture, and several invasive marine species which are currently causing devastation to local ecosystems. This represents not only problems, but also opportunities for innovative actions in the EU to better develop targeted uses of what is currently wasted or disturbing our ecosystems.

The BlueCC project aims to take underutilised species such as invasive marine species, by-catch and cleaner fish from the aquaculture industry to develop new eco-friendly marine ingredients and products in a market acceptance approach. The focus will be on sustainably exploiting chitin and collagen produced by invasive crabs, jellyfish, starfish and cleaner fish, respectively, and demonstrate prototype products containing these polymers and/or their hydrolysates.

To succeed with product development of research-intense products such as chitin/chitosan and collagen, we will apply a strong emphasis on market needs and insights throughout the project. BlueCC will be carried out by an interdisciplinary team and is divided into six main work packages addressing market driven concept development, sustainable chitin/chitosan and collagen demonstrators, characterization of the novel marine ingredients, including in vitro documentation of e.g. anti-inflammatory and antimicrobial effects, and finally, commercialization feasibility in an RRI framework.

Altogether, BlueCC will in a sustainable and efficient manner exploit underutilized marine raw materials, from laboratory to prototype demonstration, to reach collagen- and chitin/chitosan-based bioactive demonstrators with potential commercial uses reaching the Technology Readiness Level 7.

Project aims

The overall aim of the BlueCC project is to take underutilised marine species such as invasive crustaceans (i.e. crab and shrimp), echinoderms (i.e. starfish) and ctenophores (i.e. jellyfish), by-catch and cleaner fish from the aquaculture industry to develop new eco-friendly marine ingredients and products using a market acceptance approach. We will develop targeted uses of what is currently wasted or disturbing our ecosystems. The focus will be on sustainably exploiting chitin and collagen produced by the sources above and commercialise products derived from these polymers.

The specific objectives in order to reach our aims are to:

- Investigate the **potential demand** for high quality chitin and collagen across consumer, industry and health sectors. We will here utilize research knowledge and improved know-how from the ERA-NET BlueShell project to develop **product concept elements** that could predict success of potential products in BlueCC.

- Work towards greener methods for **extraction of chitin** from invasive crustaceans in which we will apply environmentally friendly solvents and enzymatic fermentation approaches. Microbial conversion of chitin to chitosan will also be investigated.

- Develop green processes to facilitate **collagen extraction** and **collagen hydrolysate** production from jellyfish, starfish and cleaner fish. Examples of approaches to evaluate are high shear mechanical homogenization, high pressure processing, pulsed electric field, deep eutectic solvents and new commercial enzymes.

- Apply a diverse set of **tests for bioactivity** to the new chitin/chitosan and collagen/collagen hydrolysate demonstrators, as well as to side streams (i.e. process surplas material) from their production. Bioactivities that will be targeted to the discovery of antibacterial, antioxidant, anti-biofilm and anti-inflammatory compounds.

- Deeply **characterize the new chitin/chitosan and collagen/collagen hydrolysate demonstrators** in terms of e.g. purity, physiochemical properties and digestibility, as well as evaluating the efficacy of the new extraction techniques used to isolate the chitin/collagen in large scale.

- Evaluate the **commercial feasibility** of the demonstrators and prepare **commercialisation strategies** for the most relevant cases, including legal and regulatory aspects. The RRI framework will serve as a guideline.

BlueCC will be carried out by an interdisciplinary team which will put emphasis on market needs and extensive value chain insights throughout the whole project. Results of our work will be efficiently disseminated to inform and educate all stakeholders about the benefits of the BlueCC concept from environmental, economic and social points of view. Stakeholders for BlueCC include fishermen and fish farmers, coastal communities, lobbying groups, nutrient developers, funding agencies, regulators and the general audience. **Our working hypotheses are that:**

- Invasive crabs, jellyfish, starfish and cleaner fish represent untapped resources of chitin and collagen, which if exploited further, could become an elegant example of combining innovation with environmental services and put a further emphasis on the use of biobased materials.

- Market driven valorisation of invasive species based on chitin and collagen demand can increase success rate for commercial utilization of these untapped resources.

- Greener extraction methods not only have strong environmental advantages but are also attractive from a consumer point of view, raising the value further of new chitin/chitosan and collagen products.

- Chitin/chitosan and collagen extracted from invasive aquatic resources can introduce a new category of marine origin biomaterials to the market and industry.

- Collagen and collagen-derived peptides are of high commercial value and are used as dietary supplements for joint, skin and muscle health. To develop procedures for collagen extraction from by-catch or underutilized materials is economically smart.

- Identification of other bioactive compounds than collagen and chitin/chitosan in the used raw materials may further increase the value of by-catches and underutilized species.

- Toxins and venoms from jellyfish are an example of the above, and represent an underexploited reservoir of compounds, including peptides, to be exploited for the discovery of novel antimicrobials and anti-inflammatory compounds.

- Ingredients from a production that uses the whole raw material, i.e., that avoids side streams, can be used in new product concepts that fulfil consumer demand for desirable and sustainable products.

- The consortium has strong scientific and industrial knowledge, combining a market push with technology pull thus ensuring a potential for commercialization of the new products developed

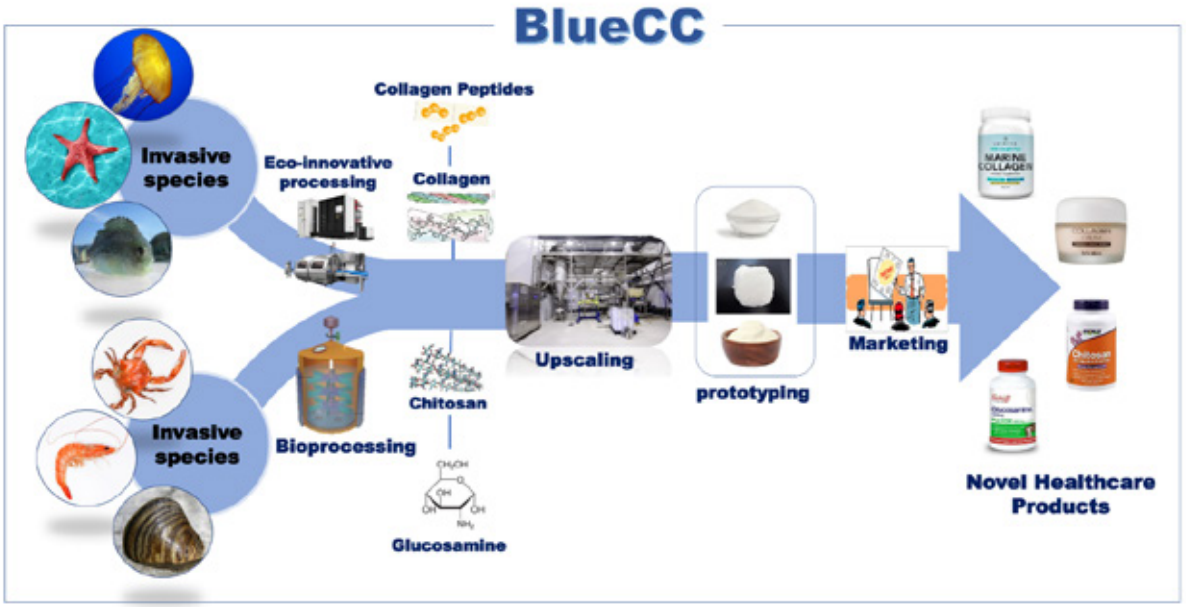

Figure 1. Workflow of the project BlueCC.

State of the art

Market demands and consumer behaviour are key components in the development of marine bioactive ingredients. Most of the marine bioactives discovered in laboratories fail to reach the market due to serious misalignment between researchers, distributers and consumers of the final marine derived product (Calado et al., 2018). Developing marine bioactives thus require, at the start of a development program, a carefully thought-out strategy with the end consumer in mind. Furthermore, the final market value also varies dramatically with the type of application which must be considered when exploring a new marine bioactive substance. **To achieve an RRI framework and increase the chances of successfully commercialize marine bioactives, it is thus crucial to involve the major stakeholders: researchers, industry/distributers and end consumers/patients.**

Collagen derived products: Within the health and beauty segment, marine collagen has gained significant interest as a healthy, environmentally sound, and non-meat alternative to bovine and pork derived products. Some concerns have been raised around the risk of disease transmission from ruminant-derived collagen. In addition, some consumers prefer marine over meat derived products. Marine collagen is linked to digestive, joint, and skin health, and for improved glucose metabolism. **The steadily increasing global demand for collagen and collagen hydrolysates has caused continuous search for new natural collagen sources and upgrading of production methodology (Silva et al., 2014).**

Increased landings of jellyfish *(e.g. Pelagia nuctula, Rhizostoma pulmo) and starfish (e.g. Aurelia aurita and Asterias rubens)* has been observed in Europe due to their cyclic and invasive occurrence along with the new landing obligation. In salmon farming areas, the farming of cleaner fish (lump fish and wrasse) is strongly growing (50 million farmed fish in 2018). Technology to remove the cleaner fish alive from the nets is now in place, but it currently has little use in the market. **All the above species are high in collagen and could be promising new collagen sources provided their effects and uses are demonstrated.**

Chitin/chitosan derived products: Chitin is an insoluble polymer in e.g. crustacean shells, which together with its derivative chitosan have multiple applications as it is biocompatible,

biodegradable, non-toxic, thermally and chemically stable (Zhu et al., 2017). **An increased chitin/chitosan demand has initiated the search for new sources as well as for more sustainable and scalable extraction methods avoiding large amounts of solvents.** Fermentation appears both environmentally friendly and scalable (Zhang et al., 2017) and has along with enzymatic chitin extractions **been developed in the ERA-NET BlueShell project and in the BlueCC consortia; up-scaling and commercialization however remain.**

Recently, invasive crustaceans have been reported in Europe causing devastation of the local ecosystem. Example are Chinese mitten crab (Eriocheir sinensis) (Dittel and Epifanio, 2009), blue crab (Callinectes sapidus), king crab (Paralithodes camtschaticus) and the green crab (Carcinus maenas) (Mancinelli et al., 2017). **A win-win situation would be created by using these species as chitin/chitosan sources and at the same time mitigate species disturbing our ecosystems.**

In both collagen and chitin extractions, several side streams arise that are likely to contain other bioactive substances. E.g. chronic inflammation and oxidative stress are associated with lifestyle diseases, and it is therefore of great public benefit to identify new anti-inflammatory and antioxidant ingredients. Microbial infections are also a huge concern for human health, and therefore the metabolic potential of the side streams will be also exploited to find new molecules active towards them. **Identifying and exploring additional bioactives in invasive marine species would make collagen and chitin extraction more economical and would use marine resources more efficiently.**

Innovation potential

From an overall perspective, **three key scientific innovations** have been identified. **First key innovation of BlueCC is utilization of invasive marine species as untapped resources** and creation of a new value addition chain for these underutilized marine resources for production of biobased materials with potential for healthcare application.

The second key innovation is the merging of market research methodology with natural sciences in order to guide the collagen and chitin production into products that are desired as implied by consumer data. The novelty in the use of this methodological approach lays in fine tuning an emerging consumer research method towards becoming more efficient. The results from WP1 will provide elements that can be combined and further developed by companies when they finalise prototypes into real products in the market.

The third innovation concerns our aim to produce both chitin and collagen in an eco-friendly manner by reducing the amount of chemicals used in the process. Novel eco-friendly processes for production of collagen and chitin will be developed. Moreover, the processes will be finetuned in a way that facilitate and accelerate the solubilization and extraction of collagen and chitin without aggregating or denaturing them as this could limit and negatively affect their bioactivity and final health care application. Also, scalability of the processes will be of constant consideration. The novel processes include high shear mechanical homogenization, high pressure processing, pulsed electric field, ultrasonication, deep eutectic solvents and new commercial enzymes and chitin/chitosan production either by fermentation or enzyme.

Main results of the project that can be expected

BlueCC is constructed as an integrated project with WPs continually communicating and collaborating to achieve the results described below:

BlueCC will deliver guidelines for future product development, built on existing knowledge, previous project inputs (ERA-NET funded BlueShell project) and tested sustainable marine product concepts in BlueCC. These guidelines will be based on statistically strong indications of consumer liking for product concepts that carry elements for future product development by companies in the market. The project will in parallel deliver high quality scientific contributions on the issue of consumer trade-offs during decision making.

BlueCC will establish a new fermentation process for chitin substrates derived from marine invasive species based on the characterised chi5 strain and uncharacterised strains. It will supply diverse fermentation products and side stream products (sugars, chitosan, oligosaccharides, GlcNac, single cell protein, enzymes, or further unknown ingredients) and optimize the fermentation process for selected strains and substrates. The process will be scaled up to pilot scale and finally the process will be evaluated towards economic viability.
BlueCC will demonstrate scalable reproducible isolation and processing methods for collagen derived products from low value biomasses to be developed into high value and marketable products. Hereby, it will introduce a new value chain for valorisation of underutilized aquatic resources based on the market demand for novel bioactive collagen-based products.

BlueCC will deliver added value by reporting important bioactivities such as anti-inflammatory, antimicrobial and antioxidant effects. Proved bioactivity prepares the demonstrators for the use in functional foods and thereby increases the market value.

BlueCC will deliver a full environmental analysis of the innovative processes developed which will demonstrate their positive contribution to the sustainability of fish stocks and reduction of impact on the environment.

BlueCC will develop a commercialisation plan, including identifying sources of financing, for the exploitation of the innovation post-project and identification of potential exploitation partners outside of the consortium. An intellectual property agreement among the partnership will facilitate licensing of the developed technologies to third parties.

BlueCC will deliver research results in a responsible manner to the society as a whole, especially within industry, consumers, regulatory and educational. This will ensure that the research conducted in this project will be shared and can be employed in several settings, thus ensuring larger outreach.

Exploitation of the results

Within BlueCC, various product concepts will be developed based on consumer insights supported by scientific and technological possibilities. The consumer insights will be reported in a way that they can be further used by industrial partners, but also by scientific projects that can build on and study consumer behaviour further. The product concepts developed in BlueCC will allow the participating industry to have a competitive advantage due to the early access to the information. The product concepts will be described in a way that they can be the base for further product prototyping during and after the end of BlueCC, maximising the exploitation of the results. The information related to the product concept development will also be published to contribute to the academic field of consumer behaviour, so that exploitation of the knowledge can also be maximised.

BlueCC aims at novel exploitation pathways of chitin and collagen in a market that appears ever-expanding. The consortium industry partner (Pharmatech) has interests and extensive experience in chitin and collagen-based markets and will ensure valuable insights into the further use and commercialization of the developed demonstrators.

Collagen-products have gained traction in the beauty segment where it is provided both as cocktails, pills, capsules, powders etc and is believed to improve hair strength and nail growth (Dini and Laneri, 2019). Collagen products can be manufactured both as peptides in hydrolysates and as collagen proteins in extraction processes. Chitin is a promising natural polymer in the production of functional materials because of its attractive combination of abundance, price, biological properties and biodegradability (Shamshina et al., 2019).

Project partners

The BlueCC project is an international consortium consisting of academic and industrial partners: Nofima, the Norwegian institute of food fisheries and aquaculture research; Flanders Research

Institute for Agriculture, Fisheries and Food (ILVO); Chalmers University of Technology; Stazione Zoologica Anton Dohrn; Ghent University; Fraunhofer Institute for Molecular Biology and Applied Ecology IME; Centre for Environmental and Marine Studies (CESAM) and Pharmatech. The BlueCC project is funded by the bluebio cofund ERA-NET programme.

Please visit our webpage for updates: www.bluecc.eu

References

CALADO, R., LEAL, M. C., GASPAR, H., SANTOS, S., MARQUES, A., NUNES, M. L. & VIEIRA, H. 2018. How to Succeed in Marketing Marine Natural Products for Nutraceutical, Pharmaceutical and Cosmeceutical Markets. Grand Challenges in Marine Biotechnology. Springer.

DINI, I. & LANERI, S. 2019. Nutricosmetics: A brief overview. Phytotherapy research, 0.
DITTEL, A. I. & EPIFANIO, C. E. 2009. Invasion biology of the Chinese mitten crab Eriochier sinensis: A brief review. Journal of experimental marine biology and ecology, 374, 79-92.

MANCINELLI, G., CHAINHO, P., CILENTI, L., FALCO, S., KAPIRIS, K., KATSELIS, G. & RIBEIRO, F. 2017. On the Atlantic blue crab (Callinectes sapidus Rathbun 1896) in southern European coastal waters: Time to turn a threat into a resource? Fisheries Research, 194, 1-8.

SHAMSHINA, J. L., BERTON, P. & ROGERS, R. D. 2019. Advances in Functional Chitin Materials: A Review. ACS Sustainable Chemistry & Engineering, 7, 6444-6457.

SILVA, T., MOREIRA-SILVA, J., MARQUES, A., DOMINGUES, A., BAYON, Y. & REIS, R. 2014. Marine origin collagens and its potential applications. Marine drugs, 12, 5881-5901.

ZHANG, H., YUN, S., SONG, L., ZHANG, Y. & ZHAO, Y. J. I. J. O. B. M. 2017. The preparation and characterization of chitin and chitosan under large-scale submerged fermentation level using shrimp by-products as substrate. International Journal of biological macromolecules, 96, 334-339.

ZHU, P., GU, Z., HONG, S. & LIAN, H. J. C. P. 2017. One-pot production of chitin with high purity from lobster shells using choline chloride–malonic acid deep eutectic solvent. Carbohydrate polymers, 177, 217-223.

DR ARNE HJ. KNAP

Process Specialist, Sterner AS

BIOGRAPHY

Dr. Arne Hj. Knap has a PhD in microbiology and is the mastermind behind Sterners ABR and MAT technology. Knap has worked actively with biogas technology since 2002 and has a background from the Oil- and Gas Industry.

Knap was the Managing Director of BioTek, which was acquired by Sterner in 2014. He now specialises in what he is most passioned about - developing Sterners technology for biogas and sludge treatment.

Fish waste technology for resource recovery

INTRODUCTION

The collection of sludge from the aquaculture process is on the increase due to significant increases in aquaculture activities on land. Viewing fish waste as a resource is a necessity to ensure sustainability in the industry. How can we ensure that the sludge is used as a resource, instead of viewing it as a problematic polluting waste?

Sterner has developed two unique sludge treatment systems, one which dries the sludge at a low temperature to be used directly as a fertilizer for Norwegian agriculture. Additionally, Sterner is the only company to have developed a biogas technology producing gas directly from fish-based waste and where the remainder called "digestate" is dried in the same drying system as mentioned above, also then to be used directly as a fertilizer. Results from field testing of the two fertilizer products are included as well as presentation of the two technologies.

Fig. 1 Suspended fish sludge settles easily

WHAT IS FISH SLUDGE?

So far, the two technologies have been applied for treatment of fish sludge from land-based aquaculture plants producing salmon smolt up to 200 gm size, either from a Through-Flow system or a Recycle (RAS) system. The sludge consists of a mixture of feces and surplus feed material, separated from the water in the fish basin usually by a drum filter. Other type of filters is also used.

The composition of the feces will depend on the composition of the feed used and digestibility properties. In addition, there will always be a portion of undigested feed mixed with the feces, together referred to as "fish sludge" or just sludge.

The sludge is suspended in the water and easily settles, see fig. 1.

A typical composition of fish sludge is presented in table 1 below giving the content of organic carbon, nutrients and other components.

	Value	Units
Total Organic Carbon (TOC)	340	gm/kgTS
NUTRIENTS		
Total Nitrogen (N)	76	gm/kgTS
Ammonium Nitrogen (NH_4-N)	7	gm/kgTS
Phosphorous (P)	14	gm/kgTS
Potassium (K)	1.4	gm/kgTS
HEAVY METALS (RESTRICTED)		
Lead (Pb)	0.22	mg/kgTS
Mercury (Hg)	92	µg/kgTS
Cadmium (Cd)	0.29	mg/kgTS
Nickel (Ni)	0.39	mg/kgTS

	Value	Units
HEAVY METALS (RESTRICTED)		
Zinc (Zn)	220	mg/kgTS
Copper (Cu)	8.2	mg/kgTS
Chromium (Cr)	0.57	mg/kgTS
OTHER		
Calcium (Ca)	23	gm/kgTS
Magnesium (Mg)	1.4	gm/kgTS
Iron (Fe)	0.26	gm/kgTS
Sodium (Na)	4.8	gm/kgTS
Chloride (Cl-)	16	gm/kgTS
Sulphur (S)	4.1	gm/kgTS

Table 1 Typical composition of fish sludge

The sludge still contains a substantial amount of organic carbon which is why biogas production from the sludge is interesting, and the content of nutrients such as N, P, K makes it ideal as fertilizer or organic fertilizer component. Nitrogen mainly is present as "organic nitrogen" which again is protein and amino acids. Here it is interesting to note that an anaerobic biogas process converts protein to inorganic nitrogen in the form of ammonium, an important ingredient in commercial inorganic fertilizers! Although the phosphorous content is low, it is still of interest because of the scarcity of phosphorous in many countries. Potassium is low but can easily be increased by adding wood ash.

It should be noted that the sludge contains heavy metals which influences the use of sludge as fertilizer. Especially the content of Cadmium and Zinc should be followed.

So, we understand that "the waste material" fish sludge has a potential for being converted to useful products! This is something Sterner has taken advantage of in development of their sludge treatment technologies.

ENERGY EFFICIENT DRYING PROCESS

In both Sterner technologies mechanical separation by gravity, mechanical dewatering and the thermal drying process called "MAT Drying"is a central part of both technologies. In alternative A raw sludge is dried, while in alternative B the residual (digestate) from the biogas process called "ABR Biogas" is dried, see fig. 2.

To save energy in the drying process it is essential to remove all "free water" mechanically before thermal energy is used to remove "pore water" and thus dry the sludge.

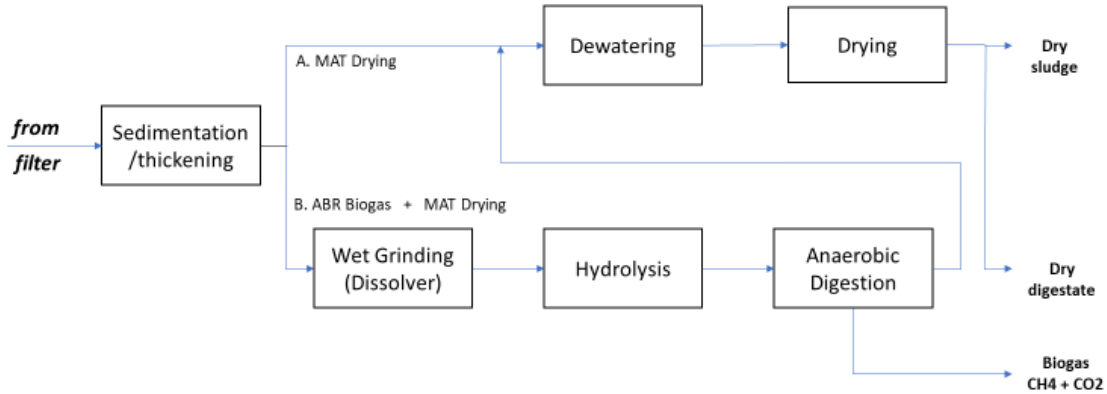

Fig.2 Sterner fish sludge management strategy

Sedimentation/thickening is carried out by means of conical plate separator developed by Sterner as shown in fig. 3. To allow satisfactory flocculation and further mechanical dewatering, the dry matter content of the thickened sludge should not be too high.

The drying unit is delivered by company Watropur in Switzerland, and is a hot air belt dryer utilizing a heat pump principle for heating the incoming air and cooling to remove condensate from the humid exit air, see fig. 4.

Fig.3 Top of conical plate separator for settling and thickening

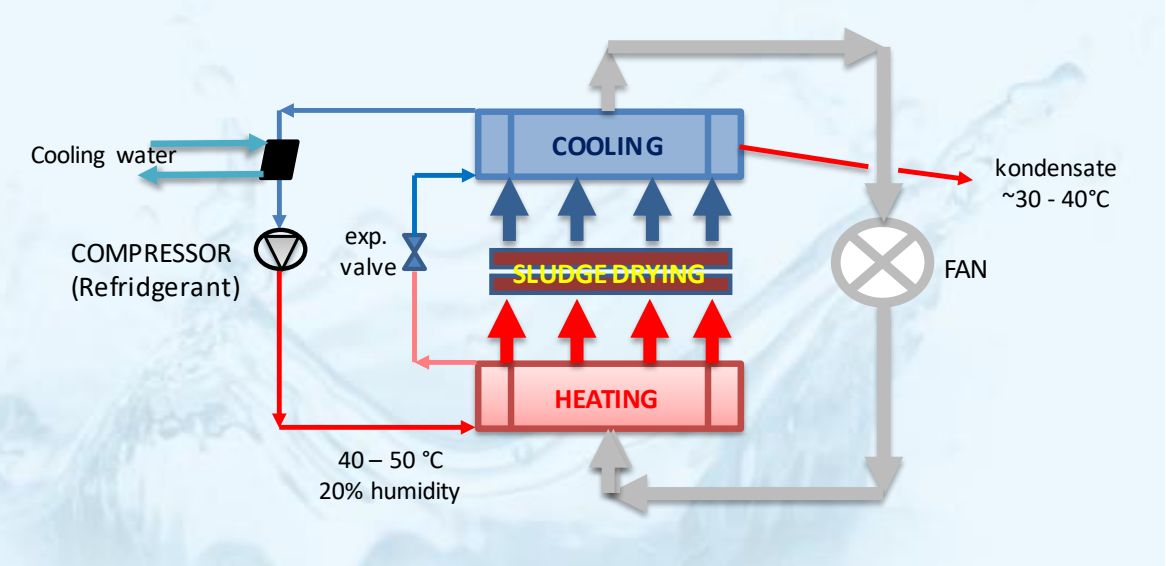

Fig. 4 Principle of heat pump assisted drying process

The air is recycled within the unit giving it the following advantages:

- Reuse of energy, i.e. total low energy consumption

- No air emissions as the drying air is recycled

The sludge is dried to abt. 90% TS making it biologically stable for storage in big sacks. The dry sludge from Sterner plants is mainly used as component for the production of organic fertilizers by the company Grønn Gjødsel AS in Norway. However, the dried product can also be used directly as fertilizer/soil improver. Results from field testing is presented in last chapter of this paper.

Sterner has now delivered 14 such drying plants to the Norwegian smolt market, see picture of the Osland plant (600 tonne/year biomass capacity), fig. 5.

Fig. 5 Osland MAT sludge treatment plant

UTILIZING BOTH ENERGY AND NUTRIENT POTENTIAL OF SLUDGE

Developing a new biogas process
Sterner started developing its sludge technologies in 2014 by first developing a thickening, dewatering and drying process, the MAT process as mentioned, together with company Watropur, and the first plant was delivered during 2015. Parallel to this Sterner saw a potential for developing a biogas system which could work on 100% fish sludge. Fish sludge has a relatively high nitrogen content, giving rise to ammonia formation within the anaerobic reactor which inhibits the formation of methane (CH_4). In other words the C:N ratio is too low for most biogas systems, and there is a need to mix the fish waste with carbon rich waste to adjust this ratio.

Fig. 6 Pilot plant Sterner ABR biogas reactor

During 2015 – 2017 a development project was run together with a local smolt company at Smøla outside Kristiansund, with a pilot reactor, see fig. 6

The anaerobic digester was designed according to the ABR (Anaerobic Baffle Reactor) principle. The pilot unit consisted of hydrolysis reactor, ABR anaerobic reactor and a container with all pumps, heating system and process control unit, as shown on fig. 6.

The ABR reactor itself consists of four chambers in series where the biogas is formed by the use of immobilized microorganisms in the form of granules, see fig.7. In this way it is possible to make a very compact reactor system.

Fig. 7 Microbial aglomorates

Full-scale plant, Cermaq Norway AS.
Based on the findings of this development project, Sterner was asked by Cermaq Norway AS to build a full-scale biogas plant for their new smolt plant at Forsan, Steigen, northern Norway. Sterner was in this connection introduced to IMET (Institute of Marine and Environmental Technology), The University of Maryland, Baltimore, USA. The institute is headed by Prof. Yonathan Zohar and Kevin Sowers is their head professor and specialist of microbial anaerobic technology.

The biogas plant at Forsan, fig. 8, treats all solid waste (sludge) generated at the smolt farm with a capacity of1600 tonnes of biomass per year. The energy in the biogas is utilized to heat incoming water to the fish plant. The fish waste is the only substrate for the anaerobic process producing biogas, a mixture of 55 - 65% methane and 35 - 45 % carbon dioxide. No need to mix with other carbon rich substrates.

Fig. 8 Forsan plant showing treatment building, ABR reactor, gas storage and flare and part of fish plant

Design parameters of Forsan plant:

- Max. input ABR reactor 760 kg TS/day
- Hydraulic design is based on concentration 5% TS
- Hydraulic retention time min. 6 days
- Maximum NH4-N tolerance before inhibition 5000 mg/l (NH3 in equilibrium)
- Due to large variations in fish biomass, large variations in sludge input to ABR reactor:
  - Min. feed 1-2 m3/day at ~2,5% TS
  - Max. feed 15 m3/day at 5% TS
- Estimated total biogas production 900 000 kWh/year.

Fig. 9 Inside plant showing dissolver to he right

The suspended solids being composed of feces and surplus feed is separated from water in the fish tanks by fine filters. The resulting “sludge” is pumped to a receiving tank and from here to the lamella gravity separator/thickener. The thickened sludge is stored and batch wise pumped into a dissolver (fig. 9), which is a liquid grinder. This increases the total surface area of the sludge to make possible very efficient anaerobic degradation.

The biological part of the process consists of a hydrolysis reactor where large molecules are broken down to smaller molecules (mainly organic acids.) The treated sludge is pumped into the heart in the system, the ABR reactor (fig. 10). (ABR = Anaerobic Baffle Reactor). The reactor consists of four chambers in series where the biogas is formed.

Fig. 10 ABR anaerobic reactor (100 m3) at Forsan

The microbial population used in the reactor is the result of a co-operation between Sterner and IMET. The clever microbiologists at IMET under leadership of Prof. Kevin Sowers have done a selection the best microbes from a mixture of sludge from the pilot plant at Smøla in Norway. This to make the microbes sustain high concentrations of ammonia without loosing capacity.

The inoculum was sent from Maryland to Forsan, and two inoculations of 20 litre each (to the 100 000 litre ABR reactor) was needed to get the process going, see fig. 11. About 100 days after first inoculation we had a good process going.

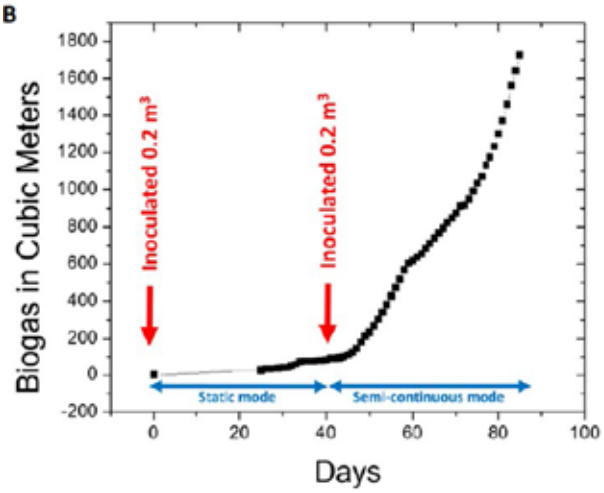

Fig. 11 Biogas production after inoculation

UTILIZATION OF FISH SLUDGE AS A RESOURCE

Sludge treatment from the aquaculture process is a necessity for the smolt plant from an environmental pollution point of view, so it is not a question whether this has to be done or not. But the question is how you do it in the most economical way and at the same time take care of valuable resources?

MAT Drying plant

In Norway the most frequent used method for sludge treatment is dewatering and drying of the sludge. By doing this you are reducing both the weight and the volume which has to be handled. The dried sludge is mainly handed over to producers of organic fertilizers, but their willingness to pay anything for it is so far is not present. The best solution you can achieve is that they pick it up at your site free of charge as long as the nitrogen content of your dried sludge is above a minimum value. So, you are left with expenses both for your OPEX and CAPEX costs connected to your sludge treatment plant. For a MAT drying plant, energy costs for drying can be a large item, see table 2.

Table 2 Sludge TS catch, condensate produced and energy required for drying

Biomass	TS sludge*	condensate **	energy requirement***
tonne/yr	tonne/yr	m3/yr	kWh/yr
500	75	217	97 538
1 000	150	434	195 075
5 000	750	2 168	975 375
10 000	1 500	4 335	1 950 750
30 000	4 500	13 005	5 852 250

* 0,150 tonne TS/tonne biomass
** 2,89 kWh/kg TS (from 25% TS to 90% TS)
*** 450 kWh/m3 condensate

For small and medium sized plants the energy cost can be accepted, but from 5 000 tonne biomass and larger other solutions should also be considered.

ABR Biogas + MAT digestate drying

In general a MAT drying plant has a lower CAPEX than an ABR+MAT plant, even though the amount of digestate generated is only 35-45% of the amount of raw sludge, thus a smaller MAT plant is required. But at 5 000 tonne biomass and larger the answer to this could be changed. For an ABR + MAT plant where electricity and heat energy is produced from the biogas, the plant will be self-supplied in energy and even having excess energy for other internal use.

The energy potential for different size ABR + MAT plants is shown in table 3.

Table 3 Sludge TS catch, VS (volatile solids) content, biogas and energy production

Biomass	TS sludge*	VS sludge **	CH4 produced ***	Energy in biogas
tonne/yr	tonne/yr	tonne/yr	m3/yr	kWh/yr
500	75	60	27 000	280 800
1 000	150	120	54 000	561 600
5 000	750	600	270 000	2 808 000
10 000	1 500	1 200	540 000	5 616 000
30 000	4 500	3 600	1 620 000	16 848 000

*0,150 tonne TS/tonne biomass **80% of TS ***450 m3 CH4/tonne VS

For a 10 000 TPY biomass plant including gas turbine for electricity and heat production which we are planning to build, the excess energy was 57% as electricity and 63% as heat energy.

CULTIVATION TESTS WITH DRIED FISH SLUDGE AND DIGESTATE (Biorest)

Fish sludge together with liquid and dried digestate (biorest) has been tested as nitrogen fertilizer for the production of different grains in a two-year field test. The work was managed by Dr. Eva Brod, Norwegian Institute of Bioeconomy (NIBIO), see reference below

Brod E, Henriksen TM (2021) Fiskeslam som nitrogengjødsel til korn.
NIBIO bok 7 (1), 140-147

(Norwegian Institute of Bioeconomy Research (NIBIO) is to contribute to food security and safety, sustainable resource management, innovation and value creation through research and knowledge production within food, forestry and other biobased industries.)

The study concludes that fish sludge has a big potential as nitrogen fertilizer for growing grain.

The digestate (biorest) of fish sludge showed very good results as nitrogen fertilizer. In this product NH4-N was a large proportion of the total nitrogen, while in raw fish sludge organic nitrogen (protein) is the main nitrogen constituent. When the digestate is dried, much of this effect is lost. However, the dried digestate, showed better properties than dried raw sludge, see fig.12.

Sterner is working to improve this by retaining more of the inorganic nitrogen during the drying process.

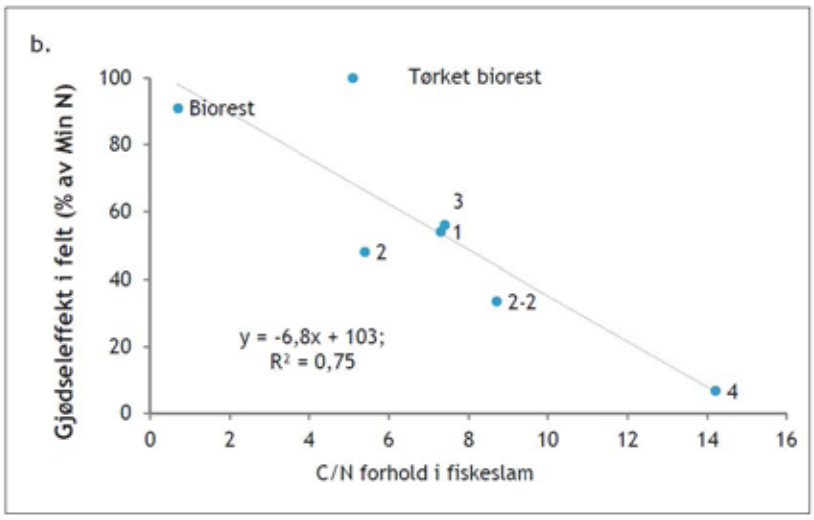

Fig. 12 Field testing of sludge and digestate

Biorest	digestate
Tørket biorest	dried digestate
Gjødseleffekt I felt	fertilizer effect in field
Fiskeslam	fish sludge
Forhold	ratio

JAAKKO HIIDENHOVI
Senior Scientist, Natural Resources Institute Finland (Luke)

BIOGRAPHY

Jaakko Hiidenhovi has over 20 years of experience on bioprocessing and separation techniques from laboratory to pilot scale. To his other research activities include e.g. bioactive properties of proteins and peptides, utilization of agro-food by-products, edible coatings and bioencapsulation, and R & D of food and non-food products.

Currently, he is also a researcher in the EMFF Blue Product project. which focuses on producing value-added fish products from Baltic herring, and other underutilized fish species and their side streams.

High value special products towards commercialization

by Jaakko Hiidenhovi, Senior Scientist, Natural Resources Institute Finland (Luke)
Vesa Joutsjoki, Senior Scientist, Natural Resources Institute Finland (Luke)
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ABSTRACT
This presentation describes, how fish by-products can be refined into high value special products for food, nutraceutical, and cosmetic use. The focus will be in applicability of high value fish fractions in product concepts, and profitability perspectives of the process concepts. The Blue Products innovation program has been underway from 2017 and will end in 2022. The program is funded by the European Maritime and Fishery Fund (EMFF) and aims to increase the value of Finnish fish catch, especially by developing new high value products. A great economic revenue can be reached if underutilized fish species and fish processing by-products are processed into special products for food, cosmetic and nutraceutical use. During Blue Products program, the composition, bioactivity, and techno-functional properties of various underutilized fish materials have been characterized and processes developed for producing and enriching high value fractions from these materials. For example, gelatin/collagen hydrolysates, protein hydrolysates (bioactive peptides), minerals and fish oils have been produced. The developed processes are simple, environmentally friendly, easily scalable and based mostly on hot water extraction and enzymatic hydrolysis. In addition, some underutilized roes, such as pike, perch, and bream roe, has been characterized for high value compounds and as result, they have been found to be high in nutrients, especially vitamin D3. The produced high value fractions have been preliminarily tested in different product concepts.

INTRODUCTION
Finland has a long coastline and thousands of lakes that produce fish for the market through fishing and farming. In addition, a lot of fish is imported to Finland. The amount of commercial fish is about 200 million kgs. Herring and sprat caught in the Baltic Sea cover half of all commercial fish. At present, the value of Finland's largest fish reserve remains low, as the majority of them are used as raw material for fur animals or fish feed. For example, only about four percent of Baltic herring and sprat end up in food. There are also underutilized fish reserves on the coast and in the lakes.

The Finnish fish industry uses almost 80 million kgs of raw material annually. Fish processing produces significant amounts of by-products. The processing of salmonids alone generates more than 10 million kilos of filleting residues. The value of fish catches and fish side streams can be multiplied if they could be used as high value products.

Proteins and peptides, fish oil and minerals, among others, can be isolated from low-value fish and fish side streams. Finland needs new processing companies and value chains to make better use of these raw materials in food, food supplements and, for example, as cosmetic ingredients.

This study is part of the ongoing Innovation program: Blue products (BP) project that is funded by EMFF (2017-2022). The main objective of the program is to provide economic growth for the Finnish fish industry by developing new high value products from Baltic herring, low-value fish species and fish side streams. The BP program is coordinated by Österbottens Fiskarförbund and managed by Aktion Österbotten. The research partners are Natural Resources Institute

Finland (Luke), Technology Research Center VTT Oy and University of Turku. Luke applies and develops technologies suitable for Finnish conditions to produce high value special fractions. The developed processes are simple, environmentally friendly, and easy to upscale.

UTILIZATION OF VALUABLE FISH PROTEINS AND PEPTIDES

Fish protein is regarded nutritionally valuable; highly absorbable and rich in essential amino acids. Protein isolated from fish or its side streams can be used not only in food but also in pet food and farm animal feed. Fish protein hydrolysate (FPH) is prepared primarily by utilizing commercial enzymes that cleave the protein into peptides and amino acids. FPHs are highly soluble in water and have good techno-functional properties and excellent nutritional value. Fish peptides have also been found to have many bioactive properties, such as antimicrobial, antioxidant, antihypertensive, anticoagulant and appetite suppressant effects. Peptides are estimated to have high commercial potential as a variety of dietary supplement, pharmaceutical and cosmetic applications. The biggest challenges in commercialization are the verification of health claims and ensuring organoleptic quality.

Luke has found that FPHs produced e.g. from whole Baltic herring and roach or from their side streams, have properties that affect blood glucose regulation. They could be used as dietary supplements to promote blood glucose tolerance and support diabetes medication. Further research will investigate the exploitation potential of these peptides in more detail.

Gelatin and collagen hydrolysates can also be isolated from fish side streams. Interest in fish-derived gelatin has grown because there are no religious restrictions on its use, and health risks associated with mammalian gelatin; spongiform encephalopathy (BSE) as well as the foot-and-mouth disease (FMD) has raised concern on the risks when collagen/gelatin of mammalian origin is used. Collagen hydrolysate is already used in many different applications, such as cosmetics, food supplements, snack bars and beverages. At present, both collagen and gelatin hydrolysate are imported to Finland, although they could also be made from domestic fish. According to Luke's research, gelatin obtained from Finnish fish has a low melting point. It can be used in frozen or cold-stored products that are ingested quickly after thawing or refrigeration. Fish gelatin has been tested in the manufacture of protein rich ice cream. The smell and taste of the ice cream was mild and the mouthfeel pleasant. Luke is also investigating the potential use of fish gelatin in biodegradable films.

FISH OIL

Fish oil is the most familiar high value product made from fish. The stores offer a variety of fish oil products for people and pets. Fish oil is an important source of n-3 unsaturated fatty acids such as eicosapentaenoic acid (EPA, C20:5) and docosahexaenoic acid (DHA, C22:6). The European Food Safety Authority (EFSA) has approved several health claims for EPA and DHA, including the maintenance of normal blood pressure and brain function.

High temperatures are often used in the production of fish oil, which lowers the quality of the oil. Luke's research has shown that high quality fish oil can be produced from the belly fat separated during rainbow trout perching by using enzyme assisted processing with mild temperatures. Consumers are increasingly interested in minimally processed natural products and the mildly produced fish oil could answer to this growing demand.

SOLUBLE CALCIUM AND OTHER FRACTIONS

About 60-70% of fish bones contain inorganic compounds: calcium, phosphorus, and other minerals. Fish scales are also good sources of minerals. Calcium is a nutritionally important mineral needed to maintain strong and healthy bones. Calcium supplements made from fish bones for humans and animals (dogs and horses) are already on the market. The bones can also be refined into hydroxyapatite, which can be used as a bone graft material in medical and dental applications instead of synthetic hydroxyapatite. In addition, calcium and phosphorus can be utilized in the feed, fertilizer, and chemical industries.

Roe is esteemed and nutritionally good delicacy. Roes are high in protein and are good sources of omega-3 fatty acids as well as vitamins D and B12. In Luke's studies it has been found that many underutilized roes (perch, pike, and pike) are high especially in vitamin D. The vitamin D content can be up to 100 µg / 100 g fresh weight. The recommended intake of vitamin D varies from 10 to 20 µg per day, depending on age and physiological condition. For example, drying of underutilized roes could provide natural vitamin D supplements.

Fish viscera account for about one-fifth of the weight of fish and provide a significant source of digestive enzymes. The survival of fish in cold water requires the activity of enzymes at low temperatures. Such enzymes are of particular interest to the food and detergent industries. Baltic herring side streams have been shown in studies to be potential sources of enzymes with lipase and protease activity.

ROAD MAP FOR COMMERCIALIZATION

The Blue Products program has carried out a preliminary profitability assessment for producing the different of high value products from Finnish fish resources and side streams. Based on the volumes, quality and production technologies, as well as regional business environment, we developed a roadmap for increasing the fish value through the high value fractions and products.

Funding acknowledgements: Funding from European Maritime and Fisheries Fund (EMFF) is gratefully acknowledged.

SNORRI HREGGVIÐSSON

CEO, Margildi

BIOGRAPHY

CEO and founder of Margildi which is an Icelandic fish oil producer established in 2013.

Expertise: Over 15 years experience as CEO (managing director) and COO of Icelandic entrepreneur companies. Inventor of Margildi´s patented winterization process. Specilized in processing of natural pelagic fish oil from N-Atlantic species Herring, Mackerel and Capelin. Vast experience in business development, sales, marketing, R&D, patent applications and process, project and procurement management in electrical power distribution equipment and aluminium industry.

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