# International Symposium

## Precision Quality Control of Aquatic and Agro Foods: Innovations in Green Process

**October23-26, 2024 at Iwate University, Morioka, Japan**

Organized by: Agri-innovation center, Iwate University
Co-organized by: NPO Food Society of Modern International Lifestyle Education (FSMILE) and Sushi All Japan Association

Good morning, esteemed scholars and honored guests,

It is my great pleasure to welcome you all to Iwate University for this important international conference on “Precision Quality Control of Aquatic and Agro Foods: Innovations in Green Processes.”

We are honored to host a diverse group of experts, featuring over 43 oral presenters and 34 poster presenters from 10 countries and more than 20 universities and institutes worldwide.

Each participant brings valuable perspectives and insights that contribute to our shared mission.

Under the leadership of Professor Shimono, the Iwate University Agri-Innovation Center was reorganized last year to contribute to the achievement of the UN Sustainable Development Goals (SDGs).

The center is currently engaged in pioneering sustainable agricultural technologies that adapt to climate change, reduce greenhouse gas emissions, and protect biodiversity.

I understand that the faculty members of the Food and Lifestyle Department played a central role in organizing this symposium.

I would like to take this opportunity to thank them for their hard work and dedication.

Due to COVID-19, we started holding online international conferences in 2020.

Last year, we successfully hosted both online and offline international conferences.

This time, we are delighted to welcome many of our previous online participants as well as new friends to Morioka for in-depth research exchanges in person during this beautiful autumn season.

Today, as we come together, we recognize the pressing need to ensure the quality and sustainability of our global food systems.

The innovations in green processes that we will explore for the next two days are not only crucial for improving the quality of aquatic and agro foods but also essential for addressing the environmental challenges facing our planet.

This conference provides a valuable platform for sharing ideas, fostering collaboration, and advancing research that bridges academia and industry.

By coming together here, we strengthen the ties that unite our global community, creating new opportunities for collaborative efforts that will push the boundaries of innovation.

While Morioka may be a compact city, it boasts a rich cultural and traditional atmosphere, as well as an array of delicious local foods.

I hope you will take the time to enrich both your mind and body while you are here.

Thank you once again for being here.

Let us embark on this exciting journey of innovation and collaboration.

I wish you all a productive and inspiring conference!

On October 24th, 2024

OGAWA, Satoshi　President of Iwate University

## Contents

# Agricutlure, Fishery and Foresty in Japan

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Food is esseinal for supporting our live. In Japan, food self-sufficient rate has been very low and now in 38% (calorie supply basis) and 61% (production value basis) in 2023, and this means we rely largely on imports in spite of risk of food supply due to climate changes and geopolitic issues such as Ukraine-Russia war. There are several facts in indutry of Agricutlure, Fishery and Foresty in Japan, which we need to understand them to think future perspective; (1) Reduction of workers in the indutry of Agricutlure, Fishery and Foresty which is only 2% of total population of Japan, (2) Faster aging of the workes in Agricutlure, Fishery and Foresty inductry than other industries, (3) Reduction of agricultural land area for crop, vegetabale and forage production, (4) Decrease of fishing and aquaculture production although the country has a vast ocean area, (5) Decreasing forest production even though 70% of the country is forested, (6) Agriculture, forestry and fisheries account for 1% of domestic production which is 71 billion US dollor (11triilon yen) , and related industries account for 11%. Bease on these facts, we need to reconstract the inducty for sustaibale Agricutlure, Fishery and Foresty in Japan.

**Keywords:** Food self-sufficient rate, Agriculture, Fishery, Forestry

# Everything You Need to Know to Make Sushi and Finding Fascinating Japanese Foods Products

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Today, with the world's population increasing and people becoming more health-conscious, there is a growing demand for seafood in countries around the globe. Raw seafood dishes, such as sashimi and sushi, from Japan's food culture are quickly gaining popularity in Europe, the US, and China, among other places.

Japan's seafood quality is highly praised globally due to the careful handling of the catch and advanced cold-chain technology that ensures the fresh supply of safe and trustworthy raw seafood. As of 2013, more than 55,000 Japanese restaurants were open worldwide, and this number continues to grow year by year. However, in many countries where the food culture of eating raw fish has not taken root, sushi is often adapted to suit the local market. Unfortunately, accidents related to raw fish occur frequently, and restaurants that prioritize food safety still feel uneasy about this situation. The basic principle of sushi preparation is hygiene. To alleviate such concerns and ensure safe consumption of raw seafood, methods for making sushi rice to prevent bacteria growth caused by raw fish, techniques for preparing and processing fish (including marinading, salt-treating, vinegar-treating, blanching, searing, and washing), and fish preservation methods (such as refrigeration, freezing, thawing, and maintaining freshness) will be introduced.

**Keywords:** Sushi, Sashimi, Nigiri, gygiene, food safety

# Maintenance of Fish Freshness at Moderately Cold Temperatures Considering Temperature-dependent Postmortem Changes

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Fish and shellfish are often eaten raw as sashimi or sushi in Japan, and this style of consumption is now spread all over the world. For this purpose, fish and shellfish require a quite high degree of freshness. The commercially valuable bottom fish such as sea bream and plaice require a high degree of freshness and are often delivered live to the market in Japan. However, if these fish can be delivered to the market in a pre-rigor state, there is no need to transport them live, since pre-rigor fish have the same commercial value as do live specimens in the market. Rigor mortis is one of the most prominent changes in muscle occurring soon after death. We spiked live specimens of plaice at the brain, stored at various temperatures ranging from 0° to 20°C and examined for changes in rigor tension and ATP degradation in the muscle. The ATP degradation rate was clearly slower at 5-15°C than at 0°C, resulting in retardation of rigor mortis onset at the former temperatures (1,2). For example, fish stored at 5°C maintained pre-rigor state for 12 h and quite low levels of rigor state for 21 h, indicating that fish transported at 5°C within 21 h can be sold at the same value as live fish. However, the K value, a freshness index, changed most slowly at 0°C. The values at 5 and 10°C were also much lower, indicating that the samples could still be consumed raw after 48 h. The K value decreased rapidly at 15°C and more rapidly at 20°C. The sample stored at 20°C for 24 h emitted an unpleasant odor. Here, we explain the mechanisms involved in such storage temperature-dependent rigor mortis progress of fish.

**Keywords:** Fish freshness, K value, Plaice, Rigor mortis, Storage temperature

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# Present Status of Aquaculture and Quality Improvement of Culture Species

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Based on the report of FAO 2024, fisheries and aquaculture production reached 223 million tonnes, which is an all-time high, and worth USD 472 billion in 2022. This contributes an estimated 20.7 kg of aquatic animal foods per capita, and equivalent to amounts of about 15% of the animal protein supply. Although capture fisheries production has remained constant for decades, that of aquaculture has increased by 6.6% since 2020, contributing over 57% of aquatic animal products used for direct human consumption.

Although the disruption by the COVID-19 pandemic was small, the growth patterns of aquaculture production differed between regions, countries and territories. There are some variations in the scale of conditions such as production, distribution, farming technologies, performance and management.

Live, fresh or chilled products accounted for about 43 percent of the total human consumption in 2022, and those are most high-priced form of aquatic food products, followed by frozen (35 percent), prepared and preserved (12 percent), and others. Freezing is the main method of preserving aquatic foods, accounting for 62 percent of the 93 million tonnes of processed aquatic animal production for human consumption (i.e. excluding live, fresh or chilled). Overall, in high-income countries, aquatic foods are more processed than in other countries, with an increasing share of high-value-added products, such as ready-to-eat meals. Aquaculture products for human consumption are in the forms of frozen, prepared and preserved in Europe and Northern America. In Asia and Africa, most products are preserved by salting, smoking, fermentation or drying, which are higher than the world average.

Commercialization of live aquatic animals has continued to grow in recent years due to improved logistics and technological developments. On the other hand, marketing and transportation are still under the challenge by the strict sanitary regulations, quality standards and animal welfare requirements.

As aquatic species are highly perishable and several chemical and biological changes take place immediately after harvest, this can result in spoilage and food safety risks if good handling and preservation practices are not applied at harvesting. Under the circumstances, aquaculture products may have some advantages on shipping forms, processing methods, and distribution forms.

Finally, recent progress on aquafeeds development is introduced in this presentation. For example, a mixture of some dietary oils is acceptable depending on the ratio of that for edible parts of fish.

**Keywords:** World aquaculture, Quality of cultured fish, Aquafeeds development

# The Current State and Prospect of Recirculating Aquaculture Systems in China

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Recirculating Aquaculture System (RAS) in China has developed rapidly in the past decade, and has also made great contributions to the provision of high-quality animal protein. This report covers the current status of RAS in China, developing opportunities of RAS, main production modes of RAS in China, technical level analyses of Chinese RAS, and perspective. It is hoped that this report will explore ways to upgrade the China's facility aquaculture engineering equipment to promote sustainable development of aquaculture, and provide a responsible development approach to world food security and economic growth.

**Keywords:** Recirculating Aquaculture System, Aquaculture engineering, Current state, Prospect

# A Bond-disruption Approach to Unlocking the Functionality of Structurally Complex Plant Proteins for Novel Food Application

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The structural complexity, strong hydrophobic association, and covalent aggregation of subunits (quaternary) and supramolecules (pentamery), common traits in many plant proteins, are major impediments to their functionality in food processing and innovation. Deliberate disruption of native structure and conformation of proteins by physical, chemical, and biological means proves effective to substantially improve protein solubility and promote ordered interaction, cross-linking, and neo-aggregation under appropriate processing conditions. Resulting nanoscale protein aggregates and particulates produced thereof are capable of forming both isotropic and anisotropic networks in hydrogels and viscoelastic oil/water interfaces in food emulsions. The application of nonthermal treatments, such as pH shifting, ultrasound, disulfide-breaking agents, and plant polyphenols shows promise to modulate native protein structure, facilitate new covalent and noncovalent associations, and significantly enhance the functionality of plant proteins, synergistically aiding in healthy food product development.

**Keywords:** Protein functionality, Structural modification, Pulse and cereal proteins, Disulfide bond.

# Ensuring Food Safety: Regulations and Practical Examples from Türkiye and the European Union

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Ensuring food safety is paramount for public health, and globally, a risk analysis approach is widely adopted. In Türkiye, risk-based inspections are conducted under the "Veterinary Services, Plant Health, Food and Feed Law" No. 5996, which aligns with EU Regulation No. 178/2002 that establishes general principles for food safety and the European Food Safety Authority (EFSA). As of 2023, Türkiye hosts 719,875 registered food businesses, and 1,302,038 official controls were conducted by 7,522 food control officers. These efforts aim to maintain food safety, prevent fraud, protect consumer health, and ensure fair competition. Since 2012, the Ministry has publicly announced 27 cases, identifying 4,164 non-compliant product batches from 1,887 companies. Common fraud issues include unauthorized active ingredients in supplements, C4/C13 and fructose/glucose in honey, dye substances in spices, adulteration of olive oil, and substitution of poultry in beef products.

Türkiye’s approach is consistent with the EU Agri-Food Fraud Network (FFN), which collaborates with the European Commission's Knowledge Centre for Food Fraud and Quality, the European Anti-Fraud Office (OLAF), and Europol to ensure comprehensive food fraud investigations. This presentation discusses the integrated risk-based framework, regulatory compliance, and multi-agency cooperation in Türkiye, highlighting the country’s dedication to aligning with international standards to safeguard food safety and consumer trust.

**KeyWords:** Food Safety, Risk Analysis, Food Fraud, Regulatory Compliance, EU Standards

# Shrimp chitooligosaccharide-polyphenol conjugates: Bioactivities and their uses for shelf-life extension of seafoods

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Seafoods are perish able with short shelf-life, thereby causing the economic loss. The deterioration of seafoods is mediated by microorganisms, enzyme as well as chemical reactions. To alleviate the quality loss, the additives have been widely used. However, some additives are of safety concern. As a consequence, the natural additives, especially from marine- and plant-based origins, have gained increasing interest. Chitooligosaccharide (COS) is the derivative of chitosan, which is produced by hydrolysis of glycosidic bond. COS possesses bioactivities, e.g. antioxidant and antimicrobial activity. To enhance those bioactivities, the conjugation with plant polyphenols has been successfully prepared by ascorbic acid/$H_2O_2$ free radical grafting and the resulting conjugates (COS-PPN) have the increased bioactivities but depends on the types of polyphenols used. COS-catechin (COS-CAT) had higher DPPH and ABTS radical scavenging activities, oxygen radical absorbance capacity (ORAC) and ferric reducing ability antioxidant power (FRAP) than COS and all other COS-PPN conjugates. When whole Pacific white shrimp treated with COS-CAT with the aid of pulsed electric field (PEF) and vacuum impregnation (VI) and stored at 4 °C for 15 days, it was found that a lower melanosis score was found in the samples when pre-treated with PEF, followed by soaking in CHOS-CAT conjugate at 2% (w/v) with VI (CC-PV-2) than other samples after 15 days of storage ($p < 0.05$). Total viable bacteria, psychrotrophic bacteria, presumptive *Pseudomonas*, *Vibrio parahaemolyticus*, other *Vibrio* sp., $H_2S$-producing bacteria, and *Enterobacteriaceae* counts of CC-PV-2 were lower than other samples at the end of storage (day15). Polyunsaturated fatty acids were retained at a substantial amount in the CC-PV-2 at the end of storage. In addition, next generation sequencing revealed a low percentage of spoilage bacteria such as *Shewanella* and *Pseudomonas* and pathogenic bacteria namely *Vibrio* sp. in the CC-PV-2. Overall, CC-PV-2 had a shelf-life of at least 12 days, while the control could be kept only for 3 days. COS-CAT conjugate mainly caused membrane disruptions and damages of microorganisms, e.g. *Vibrio parahaemolyticus* as witnessed by numerous pores and concaves on the cell surface. Membrane damages were further confirmed by the increases in conductivity, extracellular malondialdehyde content, and potassium and magnesium ion leakages. Apart from microbial spoilage, melanosis is the undesirable phenomenon in crustacean, like shrimp. It was triggered by biochemical reaction mediated by tyrosinase or polyphenoloxidase (PPO). When comparing all COS-PPN conjugates, COS-CAT showed the lowest IC50 toward Pacific white shrimp PPO. CHOS-CAT exhibited the mixed-type inhibition. CHOS-CAT was linked with various amino acid residues, including Tyr208 or Tyr209 of proPPO via van der Waals, hydrophobic interaction, and hydrogen bonding as elucidated by the molecular docking of proPPO. Therefore, COS-PPN can serve as the promising additive for prolonging the shelf-life of seafoods.

**Keywords:** shrimp shell, chitooligosaccharide, conjugates, antimicrobial, antioxidant, shelf-life

# Does the freshness of fish affect myosin denaturation upon frozen storage ?

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Frozen storage is an excellent way of ensuring long shelf-life of fish as food. It has been reported that myosin denatures during frozen storage dependent on the storage temperatures. It is also believed that more fresh fish is favourable as food. K-value has been used as a scientific index of freshness. Under the situations, it is very interesting to know whether the freshness of fish affects the myosin denaturation during its frozen storage.

Flounder meat (2 x 2 x 2 cm, roughly diced) wrapped with plastic film was stored on ice for 0 day (immediately after killing, pre-rigor, K-value of 4%), 2 days (rigor state, K-value of 9%), and 5 days (after resolution of rigor, K-value of 20%). These three were frozen stored at -20°C up to 18 weeks. Meat was quantitatively converted into muscle homogenate, and myosin denaturation was monitored by measuring Ca-ATPase activity, salt solubility with and without Mg-ATP, monomeric myosin content, and chymotryptic digestion.

Storage of meat on ice decreased ATPase activity and salt-solubility without Mg-ATP, slightly. Myosin in 0-day sample showed less extent of myosin denaturation in an early phase of frozen storage. However, such advantage of freshness was lost gradually with prolonging the storage period. For the samples stored for 18 weeks, myosin denaturation extent was nearly the same among three samples.

The samples used here showed the K-value less than 20%. Such difference in the freshness does not affect the myosin denaturation extent after long-term frozen storage.

**Keywords:** Flounder, freshness, K-value, rigor-mortis, myosin denaturation, frozen storage, ATPase, salt-solubility, chymotryptic digestion

# Rethinking on food system for sustainable world (part 2)

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My previous presentation for EAFTA 2023 suggested that the current envision in Society 5.0 (Super smart society or anthropocentric society) might be missing a key point for achieving sustainable world because of less emphasized innovation in global food system. The urban population growth is accelerating. Currently more than 60% of world population is predicted in the urban area by 2030. Exploitation of resource for urban development from rural area cannot continue any more.

Consequently, we must reform urban and rural relationship entirely for sustainable future. Here, I propose sustainable relation between urban and rural based on reconstructing food system based on super techno-food production, natural faming, food education “SHOKUIKU” for transforming “Sense of Value” of society.

**Keywords:** super smart society, reconstruction between urban and rural, super techno-food production, natural faming , food education

# Health risks of ultra-processed foods with a focus on protein oxidation

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Ultra-processed foods (UPFs) have gained popularity among consumers from developed societies owing to several reasons including convenience, positive hedonic responses and reasonable prices. Yet, the intake of these foods has been related to the onset of certain health conditions including type 2 diabetes, obesity, and cancer, among others. However, scientific literature is scarce in providing clues of the mechanisms behind this correlation. Hence, efforts have been made recently in order to comprehend the pathophysiological mechanisms of UPFs on health. In this concise work, we unveil some of these potential mechanisms making a special stress on the role that oxidized proteins from UPFs could play on harmful effects of some of these foods. In particular, we found that the intake of oxidized proteins from UPFs leads to a shifted digestion pattern in experimental animals (Wistar rats) leading to a decreased digestion in the upper compartments of the gastrointestinal tract (GIT) and an increase rate of protein fermentation in the subsequent lower GIT compartments, namely colon and cecum. This fermentation may be responsible for not only the shift in the microbiota of the animals but also to the formation of microbial metabolites of carcinogenic potential such as p-cresol. These pernicious effects were found in experimental animals irrespective of the nature of the proteins (whether animal or plant).

**Keywords:** Ultra-processed foods, protein oxidation, health, nutrition.

# Potentials of natural preservatives to enhance the quality and shelf life of fishery products

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The demand of fish and fishery products is increasing rapidly due to their high nutritional value owing to the presence of high-quality protein, n-3 polyunsaturated fatty acids, vitamins, and minerals. However, fish is a highly perishable food item due to its endogenous enzymatic and microbial activity during post-mortem stage. To maintain the quality, several synthetic preservatives are used to prevent the changes in sensory attributes, retard the bacterial growth, and loss of nutrients in seafood during low-temperature storage. Moreover, the use of these preservatives has been associated with potential health hazards. Therefore, natural preservatives with excellent antioxidant and antimicrobial properties have been extensively searched and applied as safe alternatives in seafood processing, with the main purpose of extending shelf life. Plant extracts such as seaweed, guava leaves, water lily, stevia leaves, and roselle calices are applied as natural preservatives, and they demonstrate notable *in-vitro* antioxidant and antibacterial activity. Moreover, a variety of secondary metabolites such as alkaloids, terpenoids, steroids, flavonoids, and phenolic compounds are found in plant extracts, which retard bacterial growth and inhibit the formation of ammonia and other primary and secondary lipid oxidation products. Therefore, these plant extracts can be used as natural additives in the seafood industry for the preservation of fish and fishery products.

**Keywords:** Plant extract, Natural preservatives, Phenolic compounds, Antioxidant and antibacterial activity, Quality, Shelf life

# Application of Deep Sea Water in the Field of Food and Cosmetic

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Known as "the blue gold of the deep sea in the 21st century", deep sea water (DSW) is originated from the ancient deep sea, rich in benficial minerals which bring with many bioactive functions, especially in reducing the cardiovascular diseases, diabetes, inflammation, tumors, and delaying aging. The DSW was believed to have the most similar composition to the amniotic fluid of the fetus, as a result, it is widely accepted as a raw material for cosmetics, superior for gentle cares of the human skin, preventing skin dryness, enhancing skin water holding capacity. Experiment results showed that DSW could promote fibrolast formation and enhance collagen elasticity as well. Due to it uniqe charateristics, it is widely applied in food products. Drinking water, condensed water, DSW salt, bittern for bean curd and supplements for Mg, Zn, Ca and many trace elements are the common food styles for DSW. It also had superior performance in fermented products, such as sake, vineger, bread, notto and kimchi, etc. Because of its special geographical location, only 5 places in the world that could make use of it, Hawaii, Japan, Korea, Taiwan China and the South China Sea. So, it is a great treasure to these places with high obligation to make full use of the DSW.

**Keywords:** Deep Sea Water; South China Sea; Food Science; Cosmetic

# Science of tunas: From ecology to table

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Tunas are most commercially valuable fish. They are evaluated by the quality of meat, especially, freshness and color. The meat color is dependent on the red/ox state of pigment protein (myoglobin). Special care should be taken form fishing/harvesting through transportation and storage before consumption to prevent meat discoloration. It is also necessary to keep freshness after purchase to enjoy their delicacy as much as possible. This lecture is going to introduce culture and ecology of tuna species as well as the updates of proper handling to maintain their commercial values, with special reference to the science of myoglobin.

**Keywords:** Tunas, Commercial values, Meat color, Discoloration, Myoglobin, Red/ox state

# Innovative Real-time Monitoring for Fish Health in Sustainable Aquaculture

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The increasing global demand for sustainable food sources, particularly seafood, has elevated the importance of aquaculture as a vital industry. However, the health management of farmed fish remains a critical challenge due to environmental fluctuations, high-density farming, water quality degradation, etc. Fish health is intricately linked to the quality and safety of the seafood they produce, making effective health monitoring essential for animal welfare and food production systems' sustainability.

Traditional health assessment methods, such as blood sampling and laboratory analysis, are labor-intensive and contribute to additional stress on fish, potentially impacting their growth, immunity, and the quality of their food products. Recognizing these limitations, a novel real-time biosensor system has been developed, offering a breakthrough in the continuous and minimally invasive monitoring of physiological stress responses in fish. With its needle-type biosensor embedded with enzymes that detect fluctuations in key stress biomarkers such as glucose, this system represents a significant advancement in fish health monitoring.

The biosensor system's integration of wireless transmission technology enables real-time data collection and analysis, fostering a proactive approach to fish health management. This early stress detection and prompt intervention not only ensures the production of healthier, higher-quality seafood but also enhances fish welfare. By reducing the stress associated with traditional health assessments, this biosensor system advances aquaculture practices, ensuring the growing demand for seafood is met without compromising fish health or food quality, thereby instilling confidence in the quality and safety of the seafood produced.

**Keywords:** Aquaculture, Fish Health, Biosensor, Real-time Monitoring, Sustainable Farming, Food Quality

# Enhancement of gel-forming ability in Peruvian hake surimi

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The commercial value of Peruvian hake (*Merluccius gayi peruanus*) meat is low because of its soft texture. This study investigated the major factor contributing to the gel-forming ability of Peruvian hake surimi by comparing the effects of endogenous protease activity and parasitic infection. Then, the effects of two egg white powder incorporation on the Peruvian hake gel properties were determined. Heat-induced gels could not be obtained at 50°C–90°C. Surimi with severe parasitic infection showed a stronger gel-forming ability. The endogenous protease activities mainly influenced the Peruvian hake meat proteolysis and contributed to the low gel-forming ability rather than parasitic infection. Specifically, endogenous cysteine proteases played an essential role in protein degradation and low gel-forming ability. Moreover, endogenous transglutaminase was also shown to be involved in the gel-forming ability upon heating at 40°C. These results suggested that Peruvian hake meat could be used as a raw material for frozen surimi for fish gel by inhibiting the activity of endogenous proteases. Moreover, Egg white powder had significantly increased gel-forming ability, especially when it contained 4% Special dried egg white (SDEW) combined with 40/90°C or 90°C heating because of its higher protein concentration, pH value, and protease inhibitory effects.

**Keywords:** Peruvian hake, Parasite, Endogenous cysteine protease, Gel-forming ability, Egg white powder

# The effect of transportation stress on fish muscle quality

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Live fish transportation is an important link in the entire freshwater fish industry chain, which can achieve cross regional resource allocation and supply-demand balance. At present, freshwater fish mainly rely on live transportation with water and high-density transportation. During the transportation of live fish, due to various stressors such as ammonia nitrogen stress, temperature stress, and squeezing stress, the fish body undergoes stress responses, which in turn affect the survival rate, processing characteristics, food quality, and consumer acceptance of the fish. Under stress, changes in muscle mass are the result of fish's spontaneous regulatory strategy, which mobilizes energy to resist environmental changes and maintain basic life activities, involving gene expression, metabolism, and immunity. This report first briefly introduces the stressors and stress responses during fish transportation, and then focuses on the research conducted by the aquatic product processing team of Huazhong Agricultural University in recent years on the impact of transportation stress on the muscle quality of freshwater fish. This report will provide ideas for maintaining and improving the muscle quality of fish after transportation.

**Keywords:** Fish stress, Transportation, Muscle quality, Omics

# Uncovering energy release of salted grass carp (Ctenopharyngodon idella) meat during freezing process: the effects of water state and protein structure on the thermal properties

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The effect of salting on the protein structures, water status and thermal properties of grass carp meat, along with its relationship with energy required for freezing was investigated to improve the quality of frozen meat and to reduce energy consumption for freezing. Adding salt prompted the shifting of the secondary structure of α-helix to β-sheet and exposed hydrophobic groups in protein. The interaction between water molecules and hydrophilic groups in the unfolded protein structure increased nonfreezing water content, which decreased thermal properties of sample during freezing. The lowest energy required (235.69 kJ/kg) for freezing was found in 7% NaCl salted sample, indicating a 38.39% reduction compared to the unsalted sample. The tissue microstructure was improved in the 3% and 5% NaCl salted sample. Therefore, an optimal salt concentration improved quality of frozen meat and reduced the energy required for freezing, thus promoting energy-efficient freezing process of aquatic products.

**Keywords:** Grass carp, Salt concentration, Energy release, Thermal properties, Protein structure

# Protein/Polysaccharide-Based Pickering Emulsion: Structural Characteristics and Its Contribution to Enhancing Surimi Gel Properties

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This research investigated the development of Pickering emulsions stabilized by protein-polysaccharide complexes, specifically ovalbumin (OV) with sodium alginate (SA) and soy protein isolate (SPI) with carboxymethyl chitosan (CMCS). The OV/SA complex was found to stabilize soybean oil effectively through electrostatic and hydrophobic interactions, as well as hydrogen bonding. An increase in OV/SA concentration led to a decrease in particle size and zeta potential (negative value), while rheological properties improved. Incorporating the OV/SA emulsion into hairtail surimi gels enhanced gel strength, whiteness, water-holding capacity, and hydrophobic interactions, resulting in a more stable gel network structure. In the case of SPI/CMCS emulsions, varying the SPI/CMCS ratio affected the emulsification characteristics, rheological properties, and microstructure of the composite emulsions. The optimal ratio of 1:2 (w/w) resulted in decreased particle size and interfacial tension, with a concomitant increase in interfacial protein adsorption. When added to squid surimi gels, these emulsions improved hardness, gel strength, whiteness, and immobilized water content, while reducing drip loss and free water. Overall, protein/polysaccharide-based Pickering emulsions demonstrated strong potential in enhancing the structural and functional properties of surimi gels. These emulsions not only maintained the lipid content but also improved the textural, rheological, and color characteristics of surimi, offering a novel approach to improving the quality of surimi-based products. The findings provide valuable insights into the application of composite emulsions for the development of improved emulsified surimi-based products.

**Keywords:** Protein/Polysaccharide-Based Pickering Emulsion, Surimi, Structural Characteristics, Gel property

# Comparative analysis of organic sodium salts on improving quality and flavor of large yellow croaker (*Larimichthys crocea*)

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Sodium acetate (SA), sodium citrate (SC), and sodium lactate (SL), are colorless, non-toxic, low-calorie organic sodium salts (OSSs) that can serve as substitutes for sodium chloride, thereby reducing sodium intake. These salts are widely used to enhance the sensory qualities of meat, prevent microbial growth, and extend shelf life. However, their application in the curing and preservation of seafood is limited. Therefore, this study investigated the quality changes of large yellow croaker (LYC) during freezing storage at -18 ℃ for 8 weeks, focusing on moisture migration, texture and color, microbial growth, microstructure, protein changes, and flavor compounds.

The results indicated that curing with 5% OSS significantly improved the water-holding capacity, texture, and color of LYC, promoting the formation of a denser microstructure and slowing the migration of bound and immobilized water into free water. Additionally, OSS-curing reduced protein denaturation and oxidative damage. As freezing time increases, the overall water retention and texture properties decreased, while total volatile basic nitrogen and total microbial count increased. Curing with 5% organic sodium salts also reduced ice crystal formation in LYC. Sulfhydryl content increased initially and then decreased over time, while disulfide bond content followed the opposite trend. Furthermore, α-helix and β-sheet structures decrease, while β-turns and random coils increase, indicating that freezing affects the stability of protein spatial conformation. Among the treatments, 5% SC and 5% SL exhibited the best performance in maintaining the quality of LYC. This study provides new insights and technical support for the development of low-sodium food products in industrial applications.

**Keywords:** Large yellow croaker, organic sodium salts, quality, flavor characteristic, GC-IMS.

# The identification of key non-volatile taste components and flavor characteristic of abdomen muscle in *Eriocheir sinensis* under various thermal processing methods

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The identification of key non-volatile taste components and flavor characteristic in abdominal muscle of Chinese mitten crab (*Eriocheir sinensis*) was evaluated based on different thermal processing methods: boiling at rising temperature (BO-R), boiling at constant temperature (BO-C), steaming with boiling water (ST), baking with salt (BK), and raw samples (Raw) as control. The free amino acids, 5'-flavored nucleotides, inorganic ions, organic acids and betaines were determined, identifying the key non-volatile taste components, which were integrated with sensory evaluation and electronic tongue to evaluate the overall taste characteristic of abdominal muscle. The contents of glutamic acid (Glu) and sweet amino acids in BK and ST group were significantly higher than these in BO-C group, and the contents of arginine (Arg), 5'-IMP and the equivalent umami concentration (EUC) were markedly higher in BK group (4.49 MSG/100g) than other groups. The contents of $Na^+$, $Ca^{2+}$, $Cl^-$ and tartaric acid in BK group were significantly higher than these in other groups. The content of malic acid in ST and BK groups was significantly higher than in BO-C and BO-R groups. The BO-R group had a considerably higher lactic acid content than other groups. Compared to other groups, the content of PO43- in BO-C group was markedly higher. Furthermore, Glu, 5’-AMP, glycine (Gly), alanine (Ala), Pro (proline), lysine (Lys), histidine (His), Arg, $K^+$, $Cl^-$, $PO_4^{3-}$, lactic acid, succinic acid and betaine exhibited taste activity values (TAV) higher than 1, indicating that they potentially play a significant role as non-volatile taste contributors in abdominal muscle of *E.sinensis*. Some reference for the most suitable thermal processing method for the *E.sinensis* could be provided.

**Keywords:** *E.sinensis,* abdominal muscle, non-volatile taste, thermal processing, Umami

# Optimaztion of saponins extraction from *Acanthaster planci* (Crown-of-thorns starfish, COTS) and study to its antitumous activity

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In recent years, the outbreak of *Acanthaster planci* (Crown-of-thorns starfish, COTS) not only damage marine ecosystems, but also pose a threat to human life and health. Therefore, the effective ways to reduce or eliminate the harm from COTS are urgent to be sought and investigated, when utilizing COTS as a valuable bioresource has emerged as an alternative solution. In this study, the saponins from COTS were extracted by ultrasound assistant, when the extraction processing was optimized by single factor experiments and response surface analysis. Our results showed that the extraction yield of COTS saponins was optimized to 6.821%, under the condition of 81% ethanol as solvent, sample-solvent ratio of 17:1 (mL: g), and ultrasonic time at 22min (480W). For saponin purification, the macroporous resin AB-8 was used to remove the impurities in COTS saponins. Then, through physical and chemical reactions, the components of COTS saponins were identified, when the main components were steroidal saponins. Furthermore, the effects of COTS saponins on the proliferation activity, nuclear morphology, and apoptosis of human liver cancer cells (HepG2) were detected using MTT assay, DAPI staining and flow cytometry. The results suggested that the COTS saponins could significantly inhibit the proliferation, affect the nuclear morphology, and induce apoptosis to HepG2 cells, with an exhibition of certain concentration dependence. Our study aims to provide theoretical and experimental data support for the development and utilization of saponins from COTS in cancer treatment.

**Keywords:** *Acanthaster planci*; Saponins; Antitumous activity; Hepg2 cell

# Effects of deep sea salt on the quality and characterization of 3D printed surimi

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In this study, one 3D printed surimi was prepared and optimized with deep sea salt, rice starch and lutein as main additive materials. Taking physicochemical property and sensory score as evaluation indices, the results obtained from response surface experiment indicated that the best parameters for the preparation of 3D printed surimi were deep sea salt of 1.5%, rice starch of 2% and lutein of 0.5%. Furthermore, a control group with common salt addition was set and compared with the 3D printed surimi obtained from optimized process. Based on the analysis of microstructure, chemical bonds, digestion and antioxidant activity, the deep sea salt provided better printing characteristics and promoted nutritional function level for the 3D printed surimi. Our results suggested that the deep sea salt could effectively improve the quality and characterization of 3D printed surimi, which highlighted its potential application in surimi processing industry.

**Keywords:** Deep sea salt, Surimi product, 3D printing, Response surface

# Preparation optimization and mass transfer kinetics study of salt-curing *Lutjanus erythropterus* with ultrasound assistant

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*Lutjanus erythropterus*, or commonly called as red fish, is one economic fish widely distributed in the west coast of Hainan, China. Generally, the main processing methods to red fish are salt-curing under dry or wet conditions with relatively low technology contents. For a better utilization to red fish, its processing methods need to be further optimized. In this study, the quality optimizing effects of single factors including sating concentration, curing time, ultrasonic time and ultrasonic power, to salt-curing red fish under wet condition were investigated, when the evaluating indices were salt content, water distribution, texture and sensory score. Based on above single factor test, the Box-Behnken test was used to further optimize the curing process of red fish. Comparing the quality of salt-curing fish under different processing treatments, the best optimized conditions were salting concentration of 20%, curing time of 2 days, ultrasonic time of 20 minutes and ultrasonic power of 300W, with salt content of 3.975% and sensory score of 86.584 in salt-curing fish. Furthermore, in order to clarify the dynamic law of mass transfer in the fish during ultrasonic-assisted salt-curing, the differences about total mass, water content and salt content between traditional salt-curing fish and ultrasonic-assisted salt-curing fish were analyzed and compared, while the microstructures of fish at different curing points were observed by SEM (Scanning Electron Microscopy) and EDS (Energy Dispersive Spectroscopy). Our results showed that compared with the traditional method, ultrasonic-assisted treatment could significantly increase the moisture content, total weight and NaCl diffusion rate of cured red fish ($p<0.05$). Meanwhile, the SEM and EDS analysis indicated that ultrasonic treatment changed the microstructures of fish, which was conducive to the uniform dispersion of NaCl during the curing process.

**Keywords:** *Lutjanus erythropterus*; Ultrasound assistant; Salt-curing; Mass transfer kinetics

# Improving the quality of frozen red fish meat by controlling its biochemical properties

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The quality of fish meat depends on various components and changes in tissue structure. Muscle protein is a major component of fish meat and, together with muscle cell membranes, is responsible for the texture of sashimi and seafood products. Denaturation of muscle proteins, lipid oxidation, deterioration of chromoproteins myoglobin and carotenoids, and the formation of formaldehyde significantly degrade the quality of fish meat.
These components are affected by freezing rate frozen storage temperatures and temperature fluctuations, drying, and thawing conditions. In addition, they are affected by the biochemical state of the fish meat due to stress, fatigue, and freshness.
Fish meat undergoes rapid post-mortem changes such as degradation of adenosine 5'triphosphate (ATP) in the muscle and a decrease in pH due to muscle fatigue caused by the stress of the farming environment and catch. In Japan, such fish have low market value. Fish can be made into value-added sashimi-grade fish by proper fish processing while the amount of ATP and pH in the muscle remain high.
It has been shown that protein denaturation and oxidation of myoglobin (formation of metmyoglobin) in frozen fish meat can be suppressed by maintaining a high ATP level or pH during frozen storage. It has also been reported that fish meat is more stable at pH 7-8 than at pH 5-6, although the pH of fish meat prior to rigor mortis is as high as 7. Based on these studies, it is expected that the consistent production of frozen fish meat with high ATP content and high pH will enable higher quality frozen seafood products and higher value-added products. These are approaches to improving the quality of seafood products by taking advantage of the characteristics of the fish and shellfish themselves.
We thus studied the effects of storage temperatures and thawing conditions using tuna, chub mackerel, spotted mackerel, and horse mackerel to improve the quality of frozen red fish meat. freezing conditions for maintaining high freshness and a method for non-destructive monitoring of the freshness of frozen fish meat were also investigated, and the summary of the results are presented.

**Keywords:** Red fish, Frozen storage, Subzero temperature treatment before thawing, Freshness, pH

# The Freshness of Ingredients and Its Impact on Health and Immunity

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The freshness of ingredients plays a critical role in both nutrition and overall health, with significant implications for the immune system. Fresh ingredients retain a higher level of essential nutrients, such as vitamins, minerals, and antioxidants, which are key to maintaining bodily functions and enhancing immune responses. Over time, stored or processed foods can lose their nutritional value, making fresh ingredients a more effective source for supporting health.

Here I explored the relationship between ingredient freshness and its impact on human health, with a focus on immunity. Fresh foods, particularly fruits and vegetables, contribute to a well-functioning immune system by providing bioactive compounds that protect against illness and support the body's natural defenses. Additionally, practical ways to identify and preserve the freshness of ingredients are examined, promoting healthier dietary choices that can help prevent chronic diseases and boost immunity.

Through a combination of scientific evidence and practical guidelines, I highlight the importance of integrating fresh, high-quality ingredients into daily diets to enhance overall health and strengthen the immune system.

**Keywords:** freshness of ingredients, daily diets, human health, immunity

# Research progress of carotenoid utilization and function in crustacean aquaculture

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**Abstract :** Carotenoids play a significant role in nutrition and physiological of crustaceans. Crustaceans cannot synthesize carotenoids *de novo* but can metabolize and converse external carotenoids to meet the specific physiological and ecological adaptation needs during different stages. To data, research on the carotenoids nutritional requirements of crustaceans has primarily focused on the impact of adding different carotenoids to their diets on parameters such as growth performance, coloration regulation, antioxidant capacity, immune function, and stress resistance. However, there is still limited understanding of the metabolic pathways and regulatory mechanisms of carotenoids within crustaceans. This necessitates further research to uncover these aspects. Building on the comprehensive analysis and summarization of studies regarding the composition and distribution of carotenoids within crustaceans, the types and sources of external carotenoids, the effective utilization of external carotenoids by crustaceans, and the nutritional requirements of crustaceans for external carotenoids, this article proposes a deeper exploration of the metabolic pathways of carotenoids within crustaceans. It suggests identifying the key enzyme genes involved in carotenoid metabolism and elucidating their biological functions. This approach aims to advance our understanding of the metabolism and regulation of carotenoids, which are essential conditional nutrients for crustaceans, and provide a scientific basis for the efficient utilization of external carotenoids in crustacean aquaculture.

**Key words :** Carotenoids; Crustaceans; Nutritional requirement; Metabolic mechanism

# Development and application of tenderizing technology for shrimp products

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**[Objective]** This study aims to optimize the processing technology of Penaeus vannamei to address the issues of meat hardening and tenderness reduction during processing. The research employs ultrasonic waves synergistically with bromelain for pre-tenderization treatment, combined with intermittent drying technology, to explore the impact and mechanism of this technology on the quality of dried shrimp.
**[Methods]** The study was conducted in the following steps: Firstly, different pre-heating temperatures (30 °C, 40 °C, 50 °C, 60 °C) were used in a water bath to tenderize Penaeus vannamei shrimp, in order to investigate the effects of different pre-heating temperatures on the quality of the shrimp. Secondly, different powers of ultrasonic waves (75 W, 100 W, 125 W, 150 W) were applied in a 40°C water bath to tenderize the shrimp, in order to explore the tenderization effects and mechanisms of different ultrasonic powers. Thirdly, through single-factor experiments, the effects of ultrasonic power, temperature, and bromelain concentration on the TPA, shear force, and color of dried Penaeus vannamei shrimp were studied to determine the optimal pre-tenderization conditions. Additionally, reconditioning time was set during the drying process to study the effects of different drying conditions on the texture characteristics, color, and in vitro digestibility of dried shrimp. Lastly, the effects of different reconditioning times on the moisture content, free amino acids, electronic nose analysis, flavor nucleotides, and volatile compounds of dried shrimp were investigated.
**[Results]** The results showed that pre-heating the shrimp meat at 40-50 °C, followed by cooking, can result in shrimp with good tenderness. Among the treatments, ultrasonic treatment at 125 W achieved shrimp with good tenderness. The optimal pre-tenderization conditions, combined with enzyme treatment, were determined to be: ultrasonic power of 100 W, temperature of 50 °C, and bromelain concentration of 20 U/mL. Under these conditions, the myofibril fragmentation index of the shrimp meat increased significantly, surface hydrophobicity and total sulfhydryl content increased, protein degradation and disruption led to increased fiber spacing and large ruptures. After intermittent drying treatment, the tenderness of the dried shrimp was improved, with reduced hardness and shear force values, and it became more digestible, with significantly improved flavor.
[Conclusion] The pre-tenderization treatment using ultrasonic waves synergistically with bromelain, combined with intermittent drying technology, can significantly improve the quality issues during the processing of Penaeus vannamei, enhancing the tenderness, color, and flavor characteristics of dried shrimp.

**Keywords:** Penaeus vannamei; tenderizing technology; myofibrillar protein; microstructure

# New Food from Bast Fiber Crops

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Bast fiber crops, including ramie, flax, jute, kenaf, industrial hemp, and others, have traditionally been utilized primarily to extract fiber for textile. In recent years, new applications in various fields, such as food, feed, and pharmacy, are continuously developed. In terms of edible and feed uses, the crude protein content in the stem and leaves of ramie is generally higher than 20%, making it a potential source of high-quality protein feed. Flax seeds and hemp seeds are rich in essential fatty acids and high-quality proteins, suitable for developing into health foods for both pets and humans. The young leaves of jute, known as the "emperor's vegetable," are rich in crude protein, dietary fiber, malvolic acid, and are considered a delicacy for hot pot dishes. In the pharmaceutical sector, extracts from hemp have been demonstrated to possess pharmacological activities such as anti-anxiety, anti-epileptic, antibacterial, and anti-rheumatoid arthritis effects, making it a global research hotspot. Future research will focus on uncovering the bioactive components of bast fiber crops, improving processing technologies, and assessing their health benefits to promote the application of these crops in the food sector and foster international cooperation.

**Keywords:** bast fiber crops, multifunctional uses, food, feed, pharmaceutical applications.

# Effects of dietary stevia extract supplementation on growth performance, serum biochemical indices and intestinal health of Yellow-Feathered Broilers

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**Objective:** Stevia extract contains chlorogenic acid, terpenoids, steroids, flavonoids, and other active compounds. Research has demonstrated the potent antioxidant properties of stevia extract, making it a viable option for enhancing animal feed, particularly in pig and sheep diets, resulting in improved economic benefits and meat quality. Despite these findings, limited information exists regarding the impact of stevia leaf extract on yellow-feathered broilers. This experiment was conducted to observe the effects of stevia extract on yellow-feathered broilers by adding stevia extract to their diets to provide a reference for the application of stevia extract as a natural feed additive.

**Materials & Methods:** A total of 425 one-day-old female yellow-feathered broilers were randomly divided into 5 treatments (n=5). The feeding trial went on for 63 days. The 5 groups were: control group without stevia rich-chlorogenic acid extract, 100 mg/kg group, 200 mg/kg group, 300 mg/kg group, and 400 mg/kg group. The weights of yellow-feathered broiler individuals were measured both at the beginning and end. We calculated ADFI, ADG, and F/G. The fresh feces were collected before the end of the experiment for three consecutive days. At the end of the experiment, the blood of the broiler chickens was collected for the determination of biochemical, antioxidant and immune indicators of the broiler chickens. Calculation of broiler slaughter performance and immune organ index. The intestinal segment was isolated and fixed, and the intestinal development was measured.

**Results & Discussion:** Results showed that adding 100 mg/kg of stevia extract to the basal diet significantly increased the daily weight gain (ADG) of the broilers, while reducing the average daily feed intake (ADFI) and feed conversion ratio (F/G). However, supplementation with stevia extract at concentrations up to 300 mg/kg led to decreased final weight and ADG. Conversely, dietary supplementation with 100-200 mg/kg of stevia extract improved serum antioxidant capacity and reduced serum total cholesterol levels compared to the control group. Additionally, the cecum n-butyric acid level was significantly higher in the 200 mg/kg stevia extract group than in the control group. In conclusion, supplementation of 100 mg/kg-200 mg/kg of stevia extract in the diet of yellow-feather broilers has been shown to enhance growth performance, antioxidant and immune capabilities, and intestinal health of the birds.

# Research on Ohmic Heating method for Inhibiting the Gel Deterioration of Carp Surimi

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To investigate ohmic heating methods that inhibit the degradation of carp surimi gel quality, this study employed fresh carp as the raw material. It was subjected to thermal treatment using a self-developed ohmic heating apparatus. Initially, we delved into the specific impacts of various ohmic heating conditions, encompassing voltage gradients of 7.5, 10, and 12.5 V/cm, and frequencies of 1 kHz, 5 kHz, and 10 kHz, on the gel quality of unwashed surimi. Subsequently, based on the optimal heating condition identified (10 kHz, 10 V/cm), we further investigated the influence of different temperature rise patterns on the gel quality of unwashed surimi, ultimately determining the best heating mode: under the condition of 10 kHz, 10 V/cm, the surimi was initially heated to 40°C and held for 30 minutes, followed by an increase in temperature to 90°C and maintained for another 30 minutes. Under this mode, the strength of the unwashed carp gel attained its maximum value of 2849.40 g×mm, accompanied by a gel hardness of 18.38±2.46 N, springiness of 0.96±0.03, cohesiveness of 0.72±0.06, chewiness of 13.29±2.51, and resilience of 0.83±0.03. Additionally, the water-holding capacity of the gel peaked at 94.80%, with the whiteness value also exhibiting optimal performance. Compared to traditional heating methods, the heating apparatus and method employed in this study not only exhibit higher heating efficiency but also effectively prevent the surimi from lingering in the temperature range of 50-70°C, where gel degradation is prone to occur, thereby significantly enhancing the water-holding capacity, elasticity, and overall quality of the gel. This research offers a novel technical approach for the industrial production of carp surimi, contributing to the extension of product shelf life and the enhancement of its market competitiveness.

**Keywords:** Ohmic heating, carp surimi, water-holding, gel quality.

# Rheology and texture of myofibrillar protein emulsion gels: Effect of emulsion droplet sizes and oil types

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This study investigated the effects of different emulsion sizes and oil types on emulsion gels' physicochemical and rheological properties.

For emulsion preparation, the ratio of water and oil phase (canola oil, eugenol, and rice bran oil) was prepared at 99:1, and soybean protein as an emulsifier was prepared at 1%. The mixture was mixed using a high-speed homogenizer at 8,000 rpm and a high-pressure homogenizer at 70 MPa. For emulsion gel preparation, emulsions were mixed with 3% agar solution (1:1, w/w) and the mixture was stored at 4ºC for 12 h. The texture and rheological properties of emulsions and emulsion gels were analyzed.

The particle size of nanoemulsions (< 262 nm) was smaller than microemulsions (< 78 μm). High-energy homogenization might have unfolded the protein and the exposed -OH groups were recombined during gel formation. Nanoemulsion gels had tighter gel structures and stronger gel strength than microemulsion regardless of oil type. In the rheological experiments, the microemulsion gels were more stable. Furthermore, no crossover between G">G' was observed in all samples, indicating the formation of a rigid network. Thus, the choice of emulsion size and oil type significantly impacts the physicochemical and rheological properties of emulsion gels, with important implications for food and pharmaceutical applications.

**Keywords:** Emulsion gel, rheological properties, texture, size effect, oil type

# $Ca^{2+}$-nano starch-lutein endowed 3D printed surimi with antioxidation and mutual reinforcing transmembrane transport mechanisms via hepg2 and caco-2 cells model

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To better enhance printing effects meanwhile casting functionality, antioxidation and absorption of bioactive component in printed $Ca^{2+}$-nano starch (NS)-lutein (L)-surimi were investigated. Results shown that $Ca^{2+}$-NS-L promoted surimi printability due to enhanced gel strength and denser structure. Mixing $Ca^{2+}$-NS-L endowed printed surimi with antioxidation (DPPH, ABTS, hydroxyl radical, $Fe^{2+}$ reduction were 42%, 79%, 65%, 0.104 mg· mL-1, respectively) due to the ability of lutein with more -OH groups and conjugate bonds to capture free radicals. It also manifested in cellular antioxidation that $Ca^{2+}$-NS-L-surimi regulated the level of Nrf2 to protect gene expression of antioxidases (SOD, CAT, GSH-Px increased by 30-180%, compared to damaged cells) through keap1-Nrf2-ARE pathway. Additionally, lutein absorption and transportation of $Ca^{2+}$-NS-L-surimi increased by 20%, compared to NS-L. Possibly, combination of samples and membrane was facilitated by surface hydrophobic, promoting endocytosis. Meanwhile, digestive surimi (peptides) with acidic-alkaline amino acids and negative charges made samples be attracted and moved in bypass parts under electrostatic traction and repulsion (electrostatic domain) to promote transport process. Also, $Ca^{2+}$ facilitated CaM expression in membrane and formed $Ca^{2+}$ channel by combining with CaM to accelerate entry of samples into cells. Conclusively, $Ca^{2+}$-NS-L both strengthened printability of surimi and antioxidation, promoting application of printed functional surimi.

**Keywords:** Functional inks, Printability, Antioxidant properties, Transmembrane transport, Absorption promoting mechanism

# Enhancing bighead carp cutting: Chilled storage insights and machine vision-based segmentation algorithm development

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To enhance market demand and fish utilization, cutting processing is essential for fish. Bighead carp were cut into four primary cuts: head, dorsal, belly, and tail, collectively accounting for 77.03% of the fish's total weight. These cuts were refrigerated at 4 ◦C for 10 days, during which the muscle from each cut was analyzed. *Pseudomonas.fragi* proliferated most rapidly and was most abundant in eye muscle (EM), while *Aeromonas.sobria* showed similar growth patterns in tail muscle (TM). Notably, EM exhibited the highest rate of fat oxidation. TM experienced the most rapid protein degradation. Furthermore, to facilitate the cutting applied in mechanical processing, a machine vision-based algorithm was developed. This algorithm utilized color threshold and morphological parameters to segment image background and divide bighead carp region. Consequently, each cut of bighead carp had a different storage quality and the machine vision-based algorithm proved effective for processing bighead carp.

**Keywords:** Bighead carp cutting; Chilled storage; Quality evaluation; Algorithm development; Machine vision

# Seasonal Variation in Myofibrillar Proteins of Silver Carp: Implications for Surimi Production

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This study investigates the seasonal variation in the stability of myofibrillar proteins-specifically myosin, actin, and tropomyosin—in silver carp (*Hypophthalmichthys molitrix*) and its implications for surimi production. Myofibrillar proteins, including myosin and actin, are key components of fish muscle, and their thermal stability is critical for optimizing surimi processing. Our results indicate that both myosin and actin from summer samples exhibit greater stability compared to winter samples. The thermal stability of actin remains consistent across seasons when detached from myosin, but actin denaturation increases without myosin protection. Tropomyosin showed no significant seasonal differences in unfolding and digestion profiles, as observed through circular dichroism and enzyme digestion tests.

The gelation properties of surimi varied with seasonal protein stability, with summer surimi failing to form a firm gel at 30°C, while both summer and winter gels disintegrated around 60°C due to endogenous protease activity. Optimal setting temperatures were determined to be 35°C for summer surimi and 30°C for winter surimi.

These findings suggest that adjusting processing conditions based on the seasonal stability of myofibrillar proteins can improve the efficiency and quality of surimi production from freshwater fish like silver carp, reducing the need for additional additives. This approach could serve as a viable strategy for using low-cost, sustainable raw materials in the surimi industry.

**Keywords:** Silver Carp, Myofibrillar Protein, Gelation, Seasonal Variation, Surimi

# High internal phase double emulsions (HIPDEs) as a novel approach to sodium reduction and flavor retention in food products

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Sodium chloride (NaCl) is a fundamental component in food processing, playing a crucial role in enhancing flavor and texture. However, excessive sodium consumption is strongly associated with adverse health outcomes, including hypertension, cardiovascular diseases, and stroke, creating an urgent need for sodium reduction strategies that do not compromise sensory quality. Conventional sodium reduction strategies, such as the use of salt substitutes (e.g., potassium chloride, magnesium chloride, and calcium sulfate), often lead to undesirable off-flavors, which can reduce consumer acceptance. To overcome these limitations, water-in-oil-in-water ($W_1/O/W_2$) can be a novel technique that can control the encapsulation and release of NaCl. The primary emulsion ($W_1/O$) may encapsulate the salt substitutes with mask undesirable sensory attributes, while the outer water phase ($W_2$) initially releases a favorable taste compound of NaCl and absorbed by the tongue. Additionally, the presence of the inner water phase reduces not only the salt intake but also the fat intake. In this study, high internal double phase emulsions (HIPDEs), characterized by internal phase volume fractions exceeding 74%, were investigated which can effectively deliver saltiness and allow for significant sodium reduction. The findings of this study provide insight into the fabrication of tailored emulsion-based food products, including sodium intake reduction without compromising sensory quality.

**Keywords:** Salt reduction; saltiness enhancement; water-in-oil-in-water double emulsion; high internal phase double emulsion

# Stepwise green extraction of functional components from seaweed Undaria pinnatifida grown in New Zealand

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New Zealand seaweed Undaria pinnatifida is an invasive species from Northeast Asia seas. Harvesting it regularly helps prevent its spread, which is an environmental benefit. Extracts of this seaweed such as protein, alginate and fucoidan have health benefits. However, traditional extraction process using large amount of water to do extraction and ethanol to precipitate fucoidan has adverse environmental impact. We have developed a stepwise green extraction procedure and technology to extract those compounds mentioned above and minimised water usage and waste production. We achieved almost total utilisation of the seaweed.

**Keywords:** Seaweed Undaria pinnatifida, Stepwise green extraction, Alginate, Fucoidan

# Application of synchrotron radiation analysis in marine products

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The next-generation synchrotron radiation facility NanoTerasu started operation on the Tohoku University campus this year. This 3GeV high-brightness synchrotron radiation facility is an advanced facility for observing materials on a nanoscale. The synchrotron radiation generated at the facility has the world's highest brightness of about 1 billion times that of sunlight and is excellent in the soft X-ray range, making it suitable for the analysis of agricultural and marine products. In this lecture, the analysis using synchrotron radiation and visualization of marine product quality in the fishery field is introduced.

# Nondestructive visualization of water within plant using neutron imaging

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Neutron imaging is garnering attention as a nondestructive method for observing water, a vital element for living organisms. Unlike X-rays, neutron beams easily penetrate metals but are less permeable to light elements. Because of these characteristics, neutron imaging is particularly sensitive to hydrogen and boron, whereas even a 5-mm-thick aluminum plate appears nearly transparent.

This unique property is particularly effective for visualizing plant roots in soil. Using neutron tomography, root distribution in soil can be observed in three dimensions without causing damage. This method provides valuable information for studying plant water absorption and offers insights into the relationship between plant roots and soil.

Using heavy water ($D_2O$) as a tracer, we developed a technique to visualize water movement within plants. This method improves our understanding of water transport mechanisms in plant physiology. In this presentation, I introduce examples of water movement within the stems of tomatoes and cut roses visualized using this approach.

Neutron imaging plays a crucial role in food science. For example, it enables the observation of uneven internal moisture changes during fish drying and tissue changes in meat during cooking. These insights are expected to lead to more efficient and safe food processing methods.

Advancements in neutron imaging technology, particularly in spatiotemporal resolution, are currently underway. These improvements are expected to allow the observation of even finer and more dynamic phenomena.

Through this presentation, I aim to highlight the potential of neutron imaging to researchers from other fields and foster new research ideas and collaborative opportunities. I look forward to introducing you to the exciting new scientific possibilities offered by neutron imaging.

**Keywords:** Plant water status, Three-dimensional testing, Heavy water

# Development of new technology for enjoying raw fish (SASHIMI) without risk of anisakiasis

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Sliced raw fish (raw sashimi), considered the epitome of Japanese food, has recently come under scrutiny due to the parasite anisakis. When people have live anisakis with sashimi, it causes food poisoning known as anisakiasis. For this reason, the European countries and the USA already require that fish be frozen when serving sashimi. On the other hand, in Japan, it is still possible to serve raw sashimi by removing the anisakis. However, it is estimated that up to 20,000 cases of anisakiasis occur in Japan each year, and if this trend continues, freezing regulations may also be introduced in Japan. Recently, the killing technology of anisakis in raw fish by using pulsed power which has huge electrical power in very short time have been developed and it could keep the quality of raw sashimi. Therefore, it allows us to enjoy raw sashimi with no anisakis risk. In this presentation, its details would be introduced.

**Keywords:** Anisakis, Sashimi, Raw fish, Pulsed power

# Marine Green Algal Oligosaccharides and Their Nutritional Applications

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Oligosaccharides offer beneficial effects on immune system and gut health, such as immunomodulatory activity, anticancer activity, and complement activation. Functional oligosaccharides are widely found in plants, algae, bacteria, and higher fungi. The consumption of functional oligosaccharides can reduce the risk of lifestyle-related diseases, such as cardiovascular disease, cancer, obesity and type 2 diabetes. Marine macroalgae possess tremendous nutritional value and have been well-known to cure and prevent the chronic metabolic diseases. An increased interest in various bioactive natural products from marine macroalgae, as a potential source of effective agents, has been observed in recent years. Especially, green algae have attracted attentions for their important functional properties and potential biological applications. The effects of marine green algal oligosaccharides may delay the development of chronic metabolic diseases such as diabetes, and alter the metabolic abnormalities through various mechanisms of actions. Marine green algal oligosaccharides used to prevent and manage diabetes. The excellent performance was based on their chemical structures and glycosidic linkages. Our research is focus on structures, accessible sources, physiological and chemical characteristics, and potential health benefits of green algal functional oligosaccharides. Moreover, the project aims to to carry out research on new key gene mining and regulation mechanism of marine green algal functional oligosaccharides to dietary interventions for glucose metabolism. Our group engages in the nutritional evaluation research of functional components from marine algae and has achieved a series of original results: to firstly report the largest gram scale production of fucosylated oligosaccharide lacto-N-fucopentaose I, to reveal the new mode of regulation of algal oligosaccharides on glycometabolism network based on microRNAs, and to elucidate systematically molecular mechanisms of marine algal oligosaccharides to regulate glucose metabolism via mediating intestinal flora. These results make the important breakthrough in the theoretical basis of algal food nutrition and successfully realize them transformation and application.

**Keywords:** Green algae; Oligosaccharides; Pharmaceutical applications

# Effects of glycosylation modifications on egg white protein allergenicity and molecular mechanism

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*Coix lachryma-jobi* L. seed is an important food item in Asia with culinary and medicinal values. The effects of non-fermented coix seed (NFC), fermented coix seed with *Lactobacillus plantarum* NCU137 (FC) and polysaccharides from NFC, FC (FCP) on mice circulating nitrogen and immune disorder induced by high relative humidity (RH, 90 ± 2%) exposure were compared. All the treatments reduced circulating nitrogen (BUN and ammonia) might via increasing excretion of fecal nitrogen induced by altering gut microbiota. In comparison, FC and FCP restored erythrocyte morphology by promoting erythrocyte $Na^+/K^+$ ATPase activity more effectively, and immune function was modulated by reducing plasma IgM and IFN-γ levels, up-regulating IL-4 and IL-6 levels. Herein, these results indicated that FCP, as the main active ingredient in FC, modulated circulating nitrogen through altering gut microbiota, and restored immune homeostasis by regulating Th1/Th2 cytokines in mice receiving high RH exposure.

**Keywords:** Coix seed; Polysaccharides; Circulating nitrogen; Gut microbiota; Immune homeostasis

# Study on flavor deterioration of grass carp meat and its inhibition mechanism during cold storage

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Grass carp accounts for about 11.8% of the freshwater aquaculture worldwide and is considered as one of the most valuable freshwater fish species. However, nearly one-third of freshwater fish are spoiled each year due to the restrictions of storage and sales conditions. Therefore, it is an urgent scientific problem in aquatic product processing to control the deteriorations of fish quality and flavor. Professor Jinlin Li applied molecular organoleptic omics to explore the quality and volatile flavor deterioration rules of dry-pickled grass carp with different low salt concentrations during cold storage. The inhibition mechanism of flavor deterioration in the refrigerated grass carp by low salt dry-curing was studied systematically using flavor omic, metabolomic, lipidomic and microbiome, and the relationships among low salt dry-curing, key flavor substances, key microorganisms, key metabolites and metabolite pathways were further established.

# Comparison of frozen and paraffin sectioning methods to evaluate frozen-thawed fish quality

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Ice crystals form during the freezing process. Depending on the freezing treatment, ice crystals can grow significantly and cause serious irreversible damage to the cellular structure of the food. Damage is often evaluated after thawing by drip loss or changes in color and texture. While these are important evaluation metrics, repeatability and reliability are often compromised, in addition to the fact that cellular damage is not directly observed. Paraffin sectioning, in which the muscle sample is embedded in wax and sectioned on a microtome, is a common histological method that can be applied to thawed fish. However, the processing time is approximately one week and a high level of preparation skill is important, otherwise the results may be of low quality. As a possible replacement, this study investigated the use of frozen sectioning to evaluate cell damage in frozen-thawed horse mackerel. The total time from preparation to observation is only one hour. The thawed sample is rapidly frozen in liquid nitrogen prior to embedding and sectioning in the cryostat. Both qualitative and quantitative results of the two histological methods showed no significant difference. As an additional objective, two freezing treatments (slow and rapid) and two thawing methods (slow and rapid) were investigated. It was found that rapid freezing and rapid thawing caused the least cellular damage to frozen-thawed horse mackerel.

**Keywords:** Freezing, Thawing, Frozen Sectioning, Cell damage, Histological method