Creating value

Project year 2014

32 examples of useful research

Nofima

Norwegian Institute of Food, Fisheries and Aquaculture

Congratulations on winning the Research Council's innovation award

The Tromsø company Polybait A/S has been working closely with Nofima to research and develop an artificial bait for leisure angling, crab pots and long-lining. A smell is extracted from left-over raw materials that attracts the fish. For Polybait this is the smell of success.

This innovation is the first scientifically-documented angling bait on the global market. This innovation from Polybait will have socio-economic and environmental benefits from a sustainability perspective.

The company has received support from the Research Council through the instruments User-controlled Innovation Arena (BIA), SkatteFUNN and the Regional Research Fund and also received the Research Council's Innovation Award for 2014. Founder Svein Kvalvik and Nofima scientist Sten Siikavuopio (pictured) have been collaborating with SINTEF.

Value creation in focus

You are now holding the fourth edition of «Creating value». It covers a cross-section of all the projects our skilled research scientists, engineers, technicians and other employees are involved in every year.

Every year Nofima runs about 500-600 projects of various kinds, from small, short-lived problem-solving assignments for a single company to large,advanced, multi-year research projects. What all our projects have in common is that they are based on the real needs of those in the food industry and that we seek to implement research-based knowledge into real, value-creating activities for companies. We have your value creation in focus, as the examples presented show.

So as to be there for our customers as much as possible, we have focused even more on quality and relevance in the last year. We have increased, and will continue to increase, our commitment to our employees' competence and professional position. Nofima wishes its customers' needs for industry-oriented, research-based knowledge to be accessible and ready for use. We will therefore be available as a host organisation for work practice and study from the industry and have set aside funding to allow our research scientists to also spend time on site with members of the industry. We also see great possibilities in the food industry PhD scheme and wish to continue to present good results that create lasting value in future.

«We wish to offer the most relevant competence for industry through targeted interaction and mutual competence development.»

We live in challenging times, with increasing competition and ever-higher requirements for financial results and returns on research investment. It is therefore worth remembering that research performed at Nofima gives access to relevant competence, grounded on the companies' real short- and long-term needs. We make targeted investments in new competence and in a modern research infrastructure and we help to reduce the individual company's research, development and innovation costs, so that companies are free to focus on their core activities.

We are her for you. We are very familiar with the public funding system, work with relevant and complementary research institutions in Norway and abroad and have one focus: increasing the competitiveness and value creation of the industry members.

I would like to take this opportunity to thank all our clients, partners and the public funding system, and not least all Nofima's skilled employees, for all the good research input in 2014.

Øyvind Fylling-Jensen
Managing Director

32 examples of useful research

Microalgae as salmon food?

Nofima scientists have concluded that microalgae meal could replace fish oil as feed for young salmon.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

«We need more omega-3 sources in salmon feed,» says scientist Katerina Kousoulaki, who researched heterotrophic microalgae as a feed ingredient.

The aquaculture industry needs to access large volumes of new omega-3 sources for use in salmon feed. Fish oil is an ideal source of omega-3, but if salmon is to remain a rich source of omega-3 itself, it will not be possible to produce more farmed salmon with fish oil as the main source of omega-3.

«We need more sources of omega-3, and at the moment we have few other real alternatives to heterotrophic microalgae for high production. The algal flour we have tested has nutrients that salmon need. We have succeeded in liberating and keeping these important nutrients during the process of making feed, which means that it will be possible to use this ingredient in salmon feed,» says Scientist Katerina Kousoulaki.

Heterotrophic algae are single-celled algae that grow in oxygen and a carbon source (such as by-products of plants). Stable, sterile biomass can be produced from heterotrophic algae in great quantities. With today's technology, this can be produced much more efficiently than phototrophic microalgae, which grow needing light, minerals and CO_2.

Kousoulaki of Nofima and colleagues from the Feed Technology Centre in Bergen have tested microalgae meal to see how it affects the salmon's health, performance and nutrition. Microalgae meal from Alltech, one of the world's largest animal health and nutrition companies, is very rich in the healthy marine omega-3 fatty acid DHA, which represents more than a quarter of the fat in the microalgae.

Feed with and without microalgae was used in the trials. The microalgae feed was given to young salmon from about 200 grams for twelve weeks in the sea. The content of long-chain marine omega-3 fatty acids in the fillet was higher for salmon that had received algal meal in their feed than for salmon that had been fed with fish oil as the only source of these fatty acids. The feed containing algae produced salmon fillets of equal quality to fish oil. The fillets were equally firm in their structure, had the same amount of fluid loss and just as small gaps between the muscle fibres.

The conclusion is that the microalgae meal is a very good source of omega-3 for young salmon and it can replace fish oil in feed.

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Alltec

MORE INFO:

Research for healthier juice

Many of the healthy substances in berries are in their skins and seeds. An effective method of using these remains has been developed.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Researchers Kjersti Aaby and Berit Karoline Martinsen have studied the effects of drinking healthier juice. The secret is in the berries' skins and seeds.

A research project has been looking at how berries can be better utilised and has studied the health effects of drinking healthier juice. Only half of the polyphenols - or antioxidants - originally found in blackcurrants and bilberries end up in the juice. The rest stays behind in the press.

«In this project, we have been working with TINE SA, Synnøve Finden (previously Findus, Lier) and Sunniva Drikker to create an «Optijuice» from the commercially available juice «MANA Blue». The juice is enriched with natural antioxidants from the residue from pressing blackcurrants at the rate of 85 per cent MANA to 15 per cent blackcurrant extract from the press residue. This could give the consumer a healthier juice, while the industry gains a more efficient and eco-friendly procedure in which better use is made of the raw materials,» explains Ph.D. student Linda Holtung.

The background for studying the utilization of berry press-residue, mainly consisting of the skins and seeds of berries, is based on knowledge gained from earlier research at Nofima. This research showed that very large amounts of the polyphenols are found in the skins and seeds of the berries. As well as blackcurrants, the scientists investigated bilberries, raspberries and apples, but blackcurrants gave the best effects.

The scientists also tested the health effects of the Optijuice.

«We started with studies in cell models and saw that Optijuice had an inhibiting effect on cancer cells, among others, and also that markers for both blood pressure and inflammatory reactions reacted as we would wish. When we went over to the clinical trial, we found that the effects we had measured in the cell studies were confirmed,» says supervisor and Scientist Kjersti Aaby of Nofima.

Both the group that drank MANA and the group that drank Optijuice found that blood pressure was lowered. The group that drank Optijuice also had a reduction in a marker for oxidative stress, which is associated with cancer and cardiovascular disease, among others.

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Clipfish and shelf life

Clipfish is being studied in various storage condition. The aim is to arrive at the correct recommendation for shelf life.

PHOTO: LARS ÅKE ANDERSEN © NOFIMA

«The result of the project is factual information that will increase knowledge about clipfish and shelf live», says Senior Scientist Grete Lorentzen.

An ongoing research project is studying the shelf life of clipfish at elevated temperatures. All food producers put a use-by date to show how long the quality is retained. All clipfish is currently being declared with a 12-month use-by date, which is not correct in markets with warm climates and a lack of refrigeration facilities. Red halophilic bacteria are found in the sea salt that is used in the production of the fish and high temperatures make these bacteria grow faster. When the number of bacteria reaches 10 million per gram, the clipfish takes on a visible pink discolouration. These bacteria occur naturally and are harmless, but the high temperature gives the fish an undesirable red colour. Scientists have now found out why.

«These bacteria do not grow below eight degrees. Above eight degrees, they start to grow and we have studied the rates of growth at various temperatures and humidity levels. After comprehensive sampling, we can now state that clipfish can be kept at 30 degrees for at least 15 days. Currently, clipfish is being marked with a 12-month shelf life provided a storage temperature of 4 °C. Since there is no reason to suppose that the quality decreases over the course of one year, we will now attempt to produce documentation that clipfish can be kept for two years,» explains Grete Lorentzen, Senior Scientist at food research institute Nofima.

The clipfish being studied now has been under refrigeration since the project started in 2013. Every six months, the fish is photographed with a special camera that provides extremely high resolution. The scientists are thus able to study any physical changes in the fish over the storage period. A sensory analysis is also performed, in which odour and appearance are assessed, and of course the level of red halophilic bacteria is studied carefully throughout the course of storage.

The result of the project is factual information that will increase knowledge about shelf life. This will primarily benefit the klippfisk industry, but it will also provide useful information for markets and consumers.

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No taste of the sun!

New information is making it easier to avoid deterioration of quality in diary products.

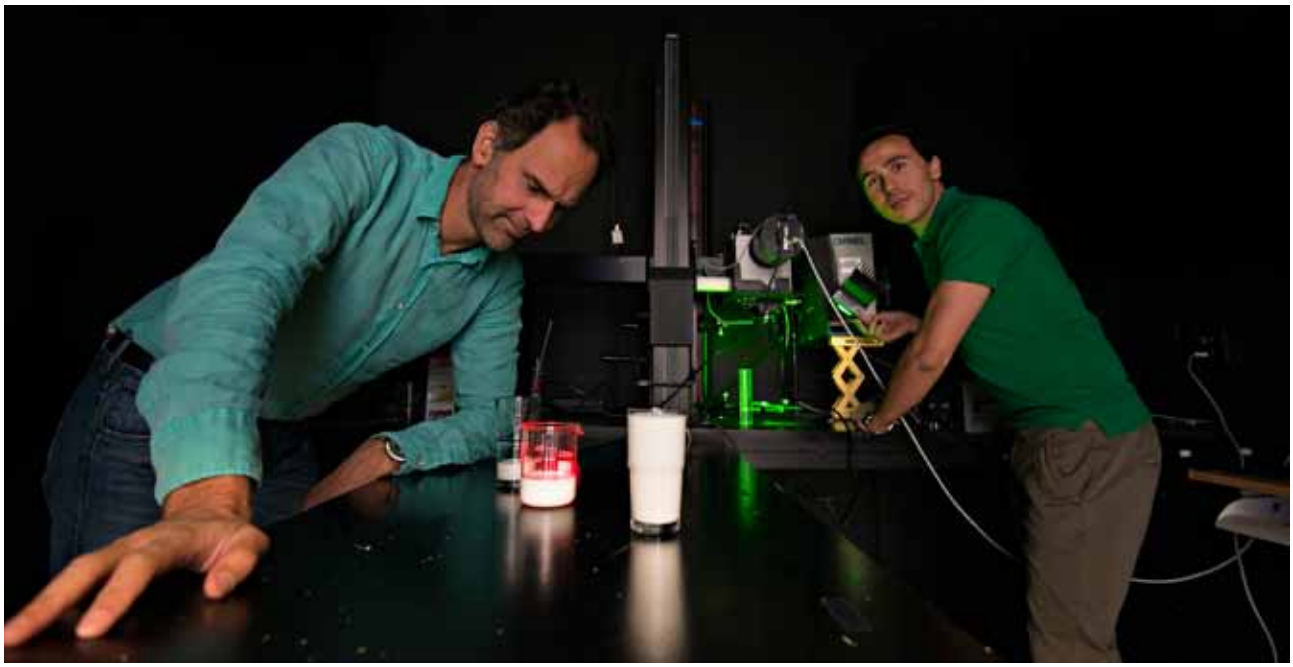

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

«Dairy products contain sensitive molecules that are prone to photooxidation», says Jens Petter Wold and Diego Airado-Rodiguez.

When milk and other dairy products are exposed to light, they can develop an off-taste. This taste and other quality impairments are due to photo-oxidation. It is light-sensitive colourings that cause this oxidation (rancidity), which can be avoided by keeping milk in packs that keep the light out.

«We have used fluorescence spectroscopy technology to find out which colourings give various effects, and then quality-assured the results with the aid of Nofima's sensory assessors,» explains Senior Research Scientist Jens Petter Wold of Nofima. He has discovered that dairy products contain the colourings protoporphyrin IX and in some cases pheophorbide (a product of chlorophyll decomposition) and that these play an important role in photo-oxidation.

By using fluorescence spectroscopy, a very sensitive direct light measurement method, it was found that the pigment and B vitamin riboflavin has less significance for photo-oxidation than was previously thought. This is partly because the anti-oxidant beta-carotene, which is found in milk, protects against light of approximately the same wavelength as that to which riboflavin is sensitive. Working with fellow researcher Diego Airado-Rodriguez, Jens Petter Wold found that the colourings protoporphyrin and pheophorbide are present in milk and that they cause far more damage than riboflavin. Because even though they are present in much lower concentrations, they are extremely photoreactive.

For quality assurance of the results, the researchers chose to use Nofima's accredited sensory assessors.

«As an instrument, the sensory panel is both more sensitive and more precise than alternative reference methods we have tried and the panel is an important reason why we have been able to get so far so fast,» concludes Wold.

This measurement method can for example be used to find out what types of packaging best protect milk and other products against light and light-induced oxidation. We have a specific lab for this type of packaging and lighting study.

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FINANCED BY:
The Foundation for Research Levy on Agricultural Products (FFL) and the Research Council of Norway

Potatoes – no warm potato

Potatoes are healthier than you might think, and make an important contribution to a balanced and varied diet.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

It is a reasonable hypothesis to suggest that when you eat cooked-cold stored potato, its impact in blood sugar is markedly reduced.

Potatoes have an important role as a moderate source of carbohydrate. In addition they are an important dietary source of potassium, vitamin C, dietary fibre and folic acid.

When Glycaemic Index (GI)-studies measure to what extent available carbohydrate in a food increases blood sugar, the available carbohydrate consumed during the study is often way in excess of that in a typical serving.

For potatoes, which contain about 80% water and 20% carbohydrate, GI measurements give a blow-up picture of their potential to raise blood sugar. It would be more relevant to look at the blood sugar changes expressed in relation to a typical portion size (145g).

Recent research shows that one must eat 3-4 times more cooked potato than white bread to get the same blood sugar increase. In addition potatoes are seldom eaten alone, but together with other foods that contain both protein and fat. These other foods reduce the extent of the blood sugar increase because they cause the stomach to empty more slowly.

There is no consistent major difference between different potato varieties in their potential to increase blood sugar, but cooked-cool stored potatoes (eaten cold) contain less rapidly digested starch and more dietary fiber than freshly cooked potatoes.

It is a reasonable hypothesis to suggest that when you eat cooked-cold stored potato, for example in potato salad, its impact on blood sugar is markedly reduced, compared to if you ate an equivalent amount of newly cooked potatoes.

A major part of the glucose from starch in cooked-cold stored potatoes eaten cold is still taken into the blood but this happens more slowly and the rise in blood sugar is less. If cooked-cold potato is warmed up again then the starch goes back to its original easily and rapidly digested form.

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FINANCED BY:
The Foundation for Research Levy on Agricultural Products (FFL) and Funds from the Agricultural Agreement (JA)

Gas cushions – longer food last

Packing fresh foods like fish and meat is advanced science. Scientists are working on methods to increase shelf life of chicken.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Finding the right packaging that takes best care of the food is advanced science.

Using gas and generally available chemical substances such as baking powder and citric acid, scientists are working at finding the optimum pack to improve the shelf life and food safety of fresh chicken.

Nofima has been workingwith an active packaging method and has developed a product-specific CO_2 emitter. A CO_2 emitter is a small pad that starts producing and emitting CO_2 gas inside the package as soon as the food is in place and the package is sealed. Increased shelf life is often desirable and the composition of the gas in the package can affect this. The gas composition and packaging volume can also affect the amount of liquid loss. Chicken is often prone to greater liquid loss that other meat products, which is a challenge for the industry. The use of CO_2 emitters combined with the optimum gas mixture can prevent this, as well as achieving optimum shelf life. The CO_2 emitter that Nofima has been working on together with Vartdal Plastindustri also absorbs moisture.

«The use of CO_2 emitters could affect the product's liquid loss, especially when compared with vacuum packaging. A high CO_2 level is desirable for meat and fish because the gas inhibits bacterial growth. The effect of CO_2 depends on the storage temperature, as well as the relationship between gas volume and product volume. The optimum ratio is twice as much gas as meat or fish, which does not make for the best transport economy,» says Senior Research Scientist Marit Kvalvåg Pettersen. «In other words, the packages are bigger and a lot of expensive 'air' is being transported.»

On this basis, the use of CO_2 emitters could also give transport economy and environmental benefits. The emitter makes it possible to reduce the gas volume in the pack. The degree of filling will be increased, the amount of packaging material may bereduced and fewer trucks are needed to transport the food around.

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FINANCED BY:
The Foundation for Research Levy on Agricultural Products (FFL) and the Research Council of Norway

Reduced losses with post-smolt

All farmed salmon might survive in future facilities for post-smolt production. The key is precise control over the salmon's environment.

PHOTO: TERJE AAMODT © NOFIMA

«We still need to develop innovative solutions in technology and biology if the results are to be seen in the agriculture statistics», says Bendik Fyhn Terjesen.

When salmon are stocked into open cages in the sea, they meet a changing environment, disease and sea lice. Many small salmon smolt are not robust enough to survive.

This is part of the problem that scientists and the aquaculture industry have been collaborating on solving for the last three years in the Optimised Post-smolt Production (OPP) project. They have been looking at how the time salmon spend in open cages in the sea can be reduced by increasing the time onshore or in closed-containment systems at sea. In present-day aquaculture, it is normal to transfer smolt from the freshwater system onshore to open cages at sea when they weigh about 80 grams. In OPP, the fish have been kept in an closed environment past this stage and right up to 1 kilo (post-smolt). The salmon are then transferred to traditional cages until they are of a suitable size for harvest at 4-5 kilos.

After a series of trials, Senior Scientist Bendik Fyhn Terjesen and colleagues obtained very good results with post-smolts with low salt concentration in the water, good exercise and careful handling in closed recirculation systems onshore until the salmon reached 600 grams. The fish were then stocked into normal cages in the sea. When the salmon had reached 2.5 kilos, 99 per cent had survived. Other partners in OPP have found correspondingly high survival rates in semi-closed facilities at sea. According to figures from the Norwegian Food Safety Authority, the average survival rate for Norwegian farmed salmon in the marine phase is 84 per cent.

«These results show that some of the salmon find it too difficult when they are moved into the sea when young. But these become more robust and better able to stand the marine environment as young adults of well above 250 grams,» says Fyhn Terjesen.

The OPP trials have shown that with good environmental control there is excellent potential for a high survival rate. But achieving a high survival rate over time in normal operation is more difficult than in trials.

«We still need to develop innovative solutions in technology and biology if the results are to be seen in the aquaculture statistics,» says Fyhn Terjesen.

The results from OPP were presented at the «Smolt Production in the Future» 2014 conference, which Nofima and Sunndal Næringsselskap organise.

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FINANCED BY:
Research Council of Norway and an industry consortium. The Fishery and Aquaculture Industry Research Fund funds associated activities.

Quick bleeding – better quality

The right equipment and a better balance between catch volume and bleeding capacity is the key to better quality.

PHOTO: BJØRN TORE FORBERG © NOFIMA

The best quality is achieved when the fish are bled alive, immediately after being taken from the sea.

A survey carried out by Nofima in 2014 showed that the commonest reason for loss of quality in Norwegian cod and haddock was incorrect bleeding of the fish. The fish flesh loses its natural whiteness, becomes discoloured and may have unsightly blood specks.

«The best quality is achieved when the fish are bled alive, immediately after being taken from the sea,» says Senior Scientist Leif Akse.

After a wait of more than 30 minutes, the effect of bleeding is significantly reduced and some blood remains in the flesh. Three hours after being caught, bleeding the fish has little or no effect. The survey shows that 44 per cent of seine-caught cod and 37 per cent of trawled cod are so badly bled that they could almost be characterised as unbled. Line-caught cod may also be poorly bled, while jig-caught cod are well bled out.

«In some of the catches we investigated, quality errors meant that the fish could not be used for the best-paid products. There are great variations in quality between the different types of equipment, as well as from boat to boat, and much of this variation continues right through to the products on the market,» says Senior Scientist Sjurdur Joensen.

The method for evaluating quality on the basis of the blood left in the fish flesh has been developed by Nofima. In addition to sensory assessment, technical measurements of the fish are made.

Catch sizes and quotas have been increasing in recent years, while the ratio of crew numbers to caught fish has gone down. Larger catches mean that bleeding is inefficient and is often done after it has any significant effect. Choice of equipment and levelling out seasonal peaks could relieve the problem. Catch volumes must be adapted and bleeding capacity on board the vessels must be improved, either with more crew or with more effective automatic bleeding lines.

«Keeping the fish alive in the equipment or tanks until bleeding could also improve quality,» says Akse.

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The Norwegian Seafood Research Fund

What controls food habits?

Scientists can now tell us a great deal about what controls children's food choices.

PHOTO: AUDUN IVERSEN © NOFIMA

Several hundred children have tasted, eaten, talked about and photographed the food they eat.

Dietary habits that are established in childhood form the basis for dietary habits and health later in life. But why do children like the food they do? What affects children's food choices? There were many questions facing the scientists who study sensory perception and consumer behaviour.

«It is a methodical challenge to obtain reliable responses from children that express their own perceptions of and reactions to food. We therefore decided to make the children into fellow researchers. One of the methods was the photo interview. Children photographed their dinners at home for a week. The photographs were then used during interviews with children and parents to find explanations for children's food preferences,» explains Scientist Siril Alm.

The project has also resulted in new information about what influences children's preferences and food choices. The survey showed that if you involve children in planning and preparing meals, the child's desire and willingness to taste and eat are increased. An experiment led by Scientist Themis Altintzoglou also revealed that children are more willing to eat fish and vegetables if they have the opportunity to choose between two healthy alternatives, such as cod or salmon. The experiment was conducted at Måltidets Hus in Stavanger together with Scientists Aase Vorre Skuland and Izumi Sone.

Intervention trials by Research Scientist Valérie Almli also show that participation in educational programmes and being frequently served samples of unfamiliar foods lead to more positive attitudes to healthy and unfamiliar food, although the researchers are uncertain how long the effect will last. The scientists also investigated the connection between recognition of and preference for basic tastes in modified lemonade. Only sweetness showed a clear connection between recognition and acceptance, while the connection was unclear for sour, salt and bitter, according to Senior Research Scientist Margrethe Hersleth.

«We now know more about children's choice of food and this research can be used to give advice about how to help children and young people to choose a healthier diet,» says Director of Research Pirjo Honkanen.

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The Foundation for Research Levy on Agricultural Products (FFL) and The Research Council of Norway

Same calories, less fattening

Salmon, barley and broccoli is better for both weight and health than a hamburger menu. Even though they both have as many calories.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

«The composition of meals is significant for fat digestion,» says Senior Research Scientist Bente Kirkhus, who was project manager of The Healthy Meal.

Scientists have been researching how different meals affect weight and health. They used a mouse model to compare a meal based on salmon, barley and broccoli with two other meals: a hamburger menu with fried potatoes and beef in brown gravy.

«Even though the calorie content of the different meals was nearly the same, weight gain was lower in mice that ate the salmon, barley and broccoli meal than in those that had eaten the hamburger meal,» explains Bente Kirkhus, Senior Research Scientist at food research institute Nofima. She has been project manager of the research project The Healthy Meal.

The mice were served different meals over the course of 16 weeks. The mice that received the hamburger menus put on weight, developed more fat tissue and scored lower on other health parameters. It is worth noting that mice that were changed from a hamburger menu to the salmon meal after eight weeks quickly improved their state of health.

The scientists compared how the digestion is affected by eating individual raw materials as against whole meals. It was found that the composition of a meal has great significance for the digestion of fat.

The fish fat in salmon is digested differently if the salmon is eaten on its own, together with broccoli, together with barley or as a whole meal. Eating salmon together with barley grains, for example, slows fat digestion, which can affect the feeling of fullness.

«Knowledge about the connections between a feeling of being full-up and the composition of a meal can be used to develop new meal products that could help to prevent overweight,» says nutritional physiologist Ida Synnøve Grini.

As well as looking at digestion, the scientists have also studied the effect of the salmon, barley and broccoli meal on the intestinal flora. With the aid of a large intestine model, they were able to see that bacteria that are considered to play a vital role for good intestinal health were stimulated by barley and broccoli. The same was found for bacteria associated with weight loss.

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Krill makes muscle

Krill makes farmed salmon firm-fleshed and muscular. Firm-fleshed fillets are very attractive to the fastidious palate.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA:

Scientists Thomas Larsson and Turid Mørkøre are seeing krill as a nutritious ingredient of fish feed.

Research into using krill in fish feed has produced results. A number of growth trials have been performed by Aker Bio Marine and feed producer BioMar – Nofima has been looking into the effect of the feed on salmon.

If a salmon is to build strong muscle, the feed must contain good raw materials. Salmon with well-developed muscles produce a high fillet yield, which is important because the fillet is the part of the fish that fetches the best price. Firm-fleshed fillets are highly suited to processing and attractive to the fastidious palate.

Aker BioMarine and BioMar have collaborated in testing krill meal as an ingredient of the feed for farmed salmon and Nofima has studied the fish. The trials were performed at five fish farms and the salmon from 14 slaughter batches were examined. The properties that were investigated included yield after gutting, yield after filleting, muscle development, firmness of flesh and fillet splitting. The average weight of the fish that were investigated was 4.5 kg.

Mixing krill meal into the salmon feed resulted in differences. Salmon that had krill meal in the feed had a higher slaughter and fillet yield, because these fish had less visceral fat and thicker fillets. The krill feed also gave firmer muscle and less fillet splitting. The fed effects were clearer in some slaughter batches than in others, but overall the effects were considerable.

«Krill meal appears to stimulate the salmon to produce larger, firmer fillet. A muscular salmon gives good fillet yield, which is good financially, and salmon with a good, firm texture is highly suitable for filleting and further processing. Last, but not least, a firm-fleshed fillet is important for the sensory experience,» says Senior Scientist Turid Mørkøre.

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FINANCED BY:
Aker BioMarine and
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Reducing salt in food

Herbs and mineral salts are among the salt substitutes of tomorrow. The food industry is now reducing the salt content of many products.

PHOTO: FRANK GREGERSEN© NOFIMA

Reducing salt in food is one of the most important things we can do to improve public health. SALTO has taught food producers how.

A comprehensive collaborative project between the food industry and researchers, SALTO, has shown that it is possible to reduce the quantity of salt in food. Results from SALTO indicate that the salt content of sausages, liver paté, cheese and cooked ham could be reduced by 25 to 30 per cent. And many food producers have already started on this important job, which is believed to be one of the most important things we can do to improve public health. The average Norwegian eats 10 grams of salt a day, which is twice the recommended amount. Calculations show that, if we can reduce the population's salt intake by 10-30 per cent, this could give significant health benefits and cut the cost of future health care.

One of the major challenges for the food industry is that traditionally, salt in food has many different functions. Salt gives flavour and also reinforces other flavours, but at the same time we can soon get used to food with a lower salt content. Salt helps food to last longer and is important for general food safety, in terms of bacteria and disease. Salt is also important for how the food behaves during preparation. The main aim of SALTO was therefore to reduce the salt content of meat products and cheese, while maintaining shelf life, flavour and the various other functions salt plays a part in at present.

Salt substitutes such as potassium chloride, lactates, phosphates and milk minerals have been tested. So have herbs such as thyme, winter savory, oregano, rosemary and sage. Using herbs can be a useful aid to reducing salt in liver patés, for example. Herbs have also been shown to have a growth-inhibiting effect on some bacteria.

SALTO has given the companies more competence in using the salt substitutes available on the market and knowledge about how they affect various products. Many companies have increased their ability to make products with less salt, and several already have the first reduced-salt products on the market.

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The Research Council of Norway

Environmental audit for cod

A new tool can document sustainable cod and haddock fishing in the North Atlantic. A European Good Practice standard has been created.

PHOTO: LARS ÅKE ANDERSEN © NOFIMA

Researchers Petter Olsen, Kathryn Donnelly and Kine Mari Karlsen have developed measurement systems for sustainability in the fishing industry.

The European white fish industry is subject to strict rules for documentation and traceability. Many of the world's fish stocks are highly threatened and powerful forces are warning consumers not to eat white fish. Even though the cod and haddock stocks in the North Atlantic are still healthy and sustainable, the products have problems when they come onto the market in competition with cheap farmed species from Asia and Africa, and it is far from self-evident which products are sustainable and which are not.

In the three-year WhiteFish project, industry organisations and 15 researchers from all over Europe have developed a new method and standard to document the environmental impact and sustainability of cod and haddock. This is about documenting everything from the individual fishing vessel's environmental audit, including fuel consumption and CO2 emissions, to the fisheries' significance to society.

«We have systemised a huge quantity of data about everything that happens relating to harvesting, processing and distribution,» says Scientist Kathryn Donnelly of Nofima.

The fisheries industry is subject to strict rules for documentation and traceability. Using the standard developed in WhiteFish, individual companies can plot information about their operation and calculate their environmental audit and sustainability, which means that individual companies can identify where they could improve in terms of the environment, welfare and economy. The Batch-based Calculation of Sustainability Impact (BCSI) method is based on a huge quantity of collected data and makes it possible for those in the industry to make ongoing sustainability assessments for their own products.

WhiteFish has been a three-year (2012-2014) EU project, with Senior Scientist Petter Olsen of Nofima as project coordinator. The method that was developed is now being implemented and tested in practice and the associated standard is under consultation with industry organisations and other stakeholders.

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FINANCED BY:
EU 7FP

MORE INFO:
See the project's website

Its job is eating lice

It looks like an amusing cartoon fish, but it does an important and forward-looking job in combating salmon lice.

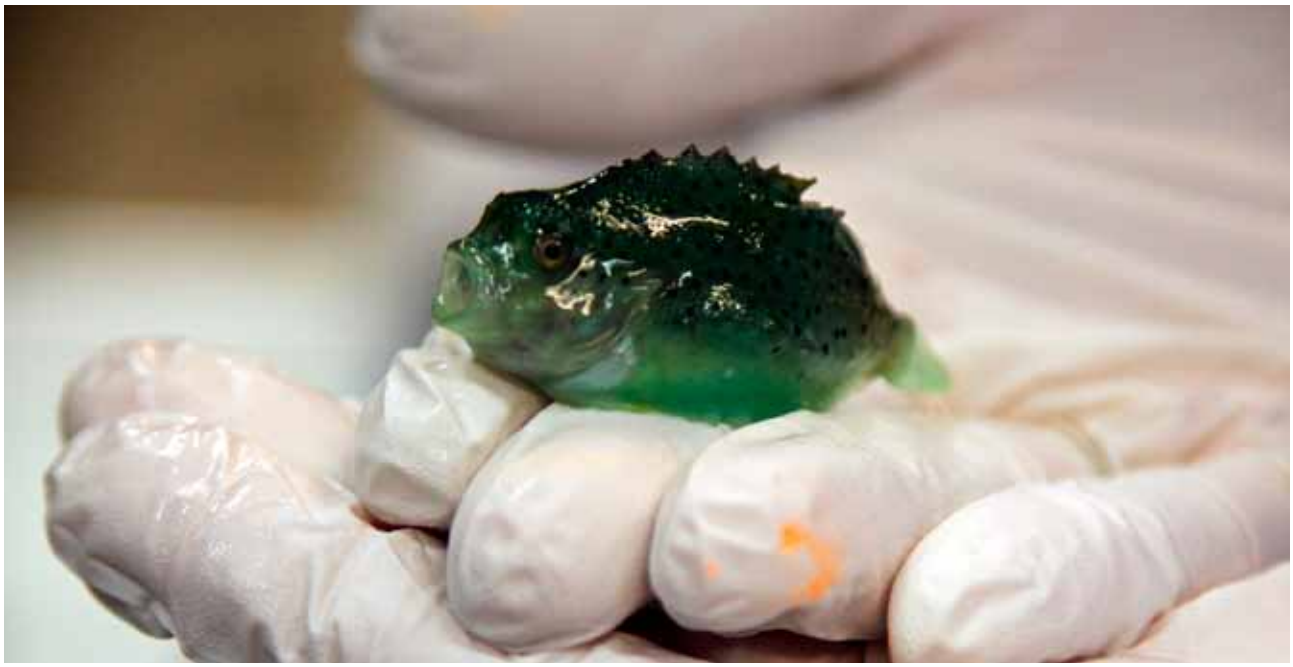

PHOTO: MARIT REIN © NOFIMA

Nofima scientists are looking at methods for combating diseases and developing vaccine for lumpfish.

Significant resources in aquaculture are being put into using cleaner-fish as a supplement and alternative to chemicals. The problematic salmon louse, which weakens or kills salmon, causes great financial losses to the fish farms every year. The idea of using lumpfish as a cleaner was discovered by chance, but in recent years commercial production of lumpfish as a biological control of salmon lice has been started in several places. Unlike the previously-used wrasse, which takes many years before it can start its vital cleaning job, the lumpfish has the advantage of being ready for work only six months after hatching. But since it is a relatively new species in an aquaculture context, much information gathering and review for this fish still needs to be done.

«There is a great need to find out more. Our knowledge, of how to handle the fish, its ability to eat lice and its general behaviour and health, is still limited,» says fish health scientist Mette Wesmajervi Breiland.

«We also need to know more about what proportion of lumpfish actually eat lice,» says Breiland.

Together with research colleagues at Nofima, she is working on systematically building up expertise, especially with regard to reviewing and combating diseases.

«The disease vibriosis has been, and continues to be, one of the main problems for lumpfish. We are using a number of infection trials to search for methods of combating disease and developing vaccine. Establishing infection modules will be an important tool for future work on the health of this species. After the first year's work on this beautiful fish, we now have a great deal of practical and theoretical experience.»

Did you know that the lumpfish has no swim bladder and that it relaxes by fixing itself to some convenient surface by means of the suction cup it has between its pectoral fins? To thrive and function in the fish farm cages, it needs hiding places, and it is a bit of a fussy eater.

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MABIT (an industrial R&D program for Marine Biotechnology in Northern Norway) and SIS Lumpfish.

Plant metabolites interplay

Comprehending the quality of vegetables through the interaction of thousands of plant metabolites – metabolomics is the way forward.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Scientists can now document how food plants are influenced by their genes, growing conditions, post harvest factors, processing and storage.

Scientists can now measure complex biochemical interactions in fruit, berries, vegetables and products thereof. In this way, they can document how food plants are influenced by their genes, growing conditions, post harvest factors, processing and storage. They are working with thousands of plant metabolites. Simultaneously.

«Sensory and health-related qualities are both visible and invisible to the consumer. Plant metabolites play an important role in the quality of vegetables, fruit and berries,» says project manager Grethe Iren Borge. The reason for this is that quantity and composition of different plant metabolites affect taste, smell, colour, shelf life and, not least important, health-related properties. Chemical analysis methods, in which mass spectrometry is central to determine the content of thousands of low-molecular plant metabolites, combined with advanced data analysis, have made it possible to establish a technology for future food research. The primary aim has been to build up and establish this technology, metabolomics, as a generic methodological platform.

The project has used metabolomics in both pre-harvest and post-harvest trials in collaboration with other projects in which the researchers investigated different light and temperature conditions during cultivation and storage, as well as processing vegetables under different conditions. Which complex biochemical reactions do vegetables respond with when external factors change?

Scientists are now harvesting results after years of establishing and using metabolomics. The new and effective feature of this method is that few decisions about which plant metabolites in vegetables are to be studied are made in advance. Instead, scientists first record a large number of metabolites in each vegetable trial and then determine which of the metabolites cause vegetables to have different quality properties, depending on factors such as climate and storage conditions.

«It is no longer enough to analyse only a few predetermined constituents of vegetables to understand how these are affected along the value chain. The plants produce and break down metabolites in a network of biochemical reactions; to be able to control and optimise quality, we must measure and understand these connections within the food at molecular level,» says Borge.

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FINANCED BY:
The Foundation for Research Levy on Agricultural Products (FFL)

Less fish in the feed

In 2013, marine raw materials for the first time represented less than 30 per cent of the feed for Norwegian farmed salmon, a report shows.

PHOTO: TERJE AAMODT © NOFIMA

Norwegian farmed salmon is still a good source of the marine omega-3 fatty acids, says Trine Ytrestøyl.

Scientist Trine Ytrestøyl of Nofima has led the work of documenting the status of utilisation of the raw materials used in feed for Norwegian aquaculture. The 2014 report includes a resource budget for Norwegian salmon production in 2013 that shows the flow of nutrients from feed raw materials to whole salmon and edible product. She has received data from the three largest feed companies in Norway, with information about what ingredients are used in feed for Norwegian farmed salmon.

«This is an exemplary documentation of the actual use of resources in an industry. No other type of food production in Norway has produced such complete documentation before. That an industry is so open about what it has in the feed is unique,» says Ytrestøyl.

The report shows how the feed companies are choosing to solve the challenges of high production growth with relatively little access to fish meal and fish oil. The nutrients that farm salmon need must be obtained from other raw materials and it is here that plant materials dominate.

In 1990, some 90 per cent of the feed for Norwegian farmed salmon came from marine raw material. The corresponding figure in 2013 was 29.2 percent. This involved a 15 per cent reduction in the marine ingredient content between 2010 and 2013. The marine raw materials can be summarised as fish oil, fish meal and krill meal. 72 per cent of these raw materials come directly from fishery, the rest from off-cuts and by-products.

Of the plant raw materials, soya protein concentrate and rapeseed oil are easily the most used ingredients. A greater proportion of the protein in the feed now comes from soya protein concentrate than from fish meal. Of the pure oils in the fish feed, 19.2 per cent come from plant oils and 10.9 per cent from fish oil. Of the 50,000 tonnes of the marine omega-3 fatty acids EPA and DHA in the feed in 2012, around 13,000 tonnes were deposited in the edible product. According to the EFSA (European Food Safety Authority), with these quantities, eating 130 grams of Norwegian salmon fillet a week is enough to cover the recommended intake of EPA and DHA.

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FINANCED BY:
The Norwegian Seafood Research Fund (FHF)

New test for DNA tracing

Scientists at Nofima have developed an effective new DNA test for tracing escaped farmed salmon.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

«The lab equipment is relatively easy to use and minimises the risk of incorrect use by sample takers,» says project manager Matthew Baranski of Nofima.

In order to follow the genetic trail from an escaped fish to its owner, scientists need to obtain the genetic signature of the parents of all farmed salmon. With this system, the fish in the cages can relax. They do not need to be tested for a match against escaped fish, because the parents are tested before the production fish hatch.

Small-scale testing of the system has shown it to be almost 100% accurate, and simulation of data on an industrial scale shows that the method could be implemented in an equally successful manner.

«The advantage of this tracing system is that you only need to test the parents of the production fish, which means 30 to 40 thousand fish at the roe producers,» says scientist Celeste Jacq. By testing the parent fish, scientists obtain an overview of the DNA profile of 350 million farmed salmon, which is the number of salmon found in cages in Norway. By means of a tracing certificate that would follow the roe via the hatchery to the fish farm at sea, the scientists would also have a full overview of which offspring are growing up where. When an escaped farmed fish is found in a river, a simple DNA analysis of the fish is all that is needed to find out where it came from.

With this method, the offspring of each pair of parents have a unique DNA profile, which will be kept in a national database.

Celeste Jacq has developed and validated the new DNA test together with research colleague Matthew Baranski of Nofima. One objective has been to have a DNA test that is as powerful and reliable as those used in forensic medical investigations. In order to find the DNA profile, the scientists selected microsatellite markers from the salmon genome. This is the salmon's DNA fingerprint. Each fish has a unique DNA fingerprint and by using the marker set, scientists can link each offspring to its parents.

DNA markers have been used for several years to trace escaped farm salmon back to cages in the area where the escape occurred, but the advantage of this DNA testing method is that the fish can be traced over large distances and long time periods. The DNA test is also currently used to avoid crossing closely related fish in cultivation work in rivers, in order to minimise inbreeding.

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The Norwegian Seafood Research Fund (FHF)

Low temperature – long time

Slow roasting at low temperature gives especially tender meat. This can give cheaper cuts greater value.

PHOTO: © NOFIMA

Heating meat to 55 to 70 degrees for a period of 10 to 48 hours gives super tenderness and juiciness.

Low temperature long time (LTLT) heat treatment of meat gives it very special qualities. Heating meat to 55 to 70 degrees for a period of 10 to 48 hours gives super tenderness and juiciness. Low temperatures encourage certain enzymes that contribute to the tenderising process, and with the right knowledge they can also be controlled so as to give the desired result. The project has already demonstrated how roasting cuts that are basically tough and hard to chew can become tender and juicy. This could give the industry the opportunity to present consumers with a greater range of cuts, which would otherwise be used for mince and sausages.

The modern version of LTLT products is a version of what is now known as sous vide technology. Sous vide means cooking in a vacuum and is a method in which raw or partially processed foods are placed in a heat-stable plastic bag, vacuum packed and heated. The food is then cooled rapidly to 0-4 degrees for storage and transportation. The airtight bag prevents microbial contamination, which means that this method combines food safety, long shelf life and high quality.

As we know, heat kills bacteria, but a low level of heating can also encourage the growth of dangerous bacteria. So how far can the temperature be lowered - with correspondingly longer cooking time - before there is a risk to food safety?

«The bacteria that cause illness live in two forms, either as a bacteria cell or as bacteria with spores. Bacteria cells are killed at 60 degrees and above. To kill a spore, the temperature should go up to 80 degrees or more,» says Scientist Thomas Rosnes, who has been working with colleagues to study different types of meat and temperature regimes for heat treatment and storage. Food is in the risk zone between 4 and 60 degrees. The heat treatment timing is an important factor, and below 60 degrees there must be precise temperature control and a long time. The research is essential to ensure the safety of future food products.

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FINANCED BY::
Research Council of Norway

Gold from the sea's best silver

We have been studying spring-spawning Norwegian herring and found molecules and bioactivities that can have commercial value.

PHOTO: LARS ÅKE ANDERSEN © NOFIMA

«We have demonstrated potential value in left-over raw material,» says Senior Scientist Bjørna Myrnes. It is now up to industry, business and research to take this knowledge further.

The hunt for molecules and genes from the sea continues undiminished. Marine bioprospecting has already revealed enzymes from cod and prawns from which medicines, health foods and biodegradable packaging are made. But very little has been done to examine the potential bioactivity in the left-over raw materials of aquaculture and commercial fishing.

«We found a lot of enzymes in herring waste, which amazed me. We measured abnormally high biological activity,» says Bjørnar Myrnes, Senior Scientist at food research institute Nofima.

While Nofima has been searching for enzymes and bioactive peptides, their partner Sintef has been bioprospecting for oils and proteins. Biological activity that we previously had no idea about has also been found in left-over raw material. Two years of research are now over, and the scientists have some very interesting findings:

- Substances have been identified that have a bacteria-inhibiting effect on viruses and pathogenic bacteria. Using technically-advanced measuring equipment, several hits have been found relating to serious diseases such as Alzheimers and HIV.
- Herring oil also contains antioxidants, which prevent it from becoming rancid easily. This is an important property for oils that are to be used in dietary supplements or as ingredients in foods. The trials showed that herring oil made from fresh left-over raw material satisfies the requirements for refined fish oils, even when the oil has not undergone a refining process.
- Herring oil made from left-over waste contains all the fatty acids that are necessary for a balanced diet.
- Left-over raw material could also be a source of protein for human consumption. This means that in the future we could use the residual raw materials to make proteins that people could eat.

«We have demonstrated potential value in left-over raw material and pointed to opportunities for increasing value creation from spring-spawning Norwegian herring. It is now up to industry, business and research to take this knowledge further,» says Research Manager Ragnhild Whitaker of Nofima.

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FINANCED BY:
Troms County Council

More survivors with pumping

Vacuum pumping fish from trawl nets is a much gentler method than lifting them on board in nets.

PHOTO: © NOFIMA

Pumping is a gentler way of handling the fish, because it is in contact with water the whole time and is not exposed to the effects of gravity.

The quality is better, and we know more now about what tomorrow's trawlers will look like. Trials on board the trawler «J. Bergvoll» in May showed that vacuum pumping is considerably gentler than releasing from the net and that survival rates of 80 - 100 percent, depending on species, are realistic. Fish that have been trawled should be kept alive in tanks for 5 to 6 hours: long enough to have the blood removed from the white musculature.

«This is the first time anywhere in the world that vacuum pumping has been used to bring the fish on board from the trawl net. Pumping keeps the fish in contact with water the whole time and does not expose it to the effects of gravity. With this method, trawled fish can have at least as good quality as line-caught fish,» says Kjell Midling, Senior Scientist at Nofima and head of the National Competence Centre for Live Storage of Fish.

«Our knowledge about live fish is the key to the trawler industry's future. The new technology is based on 25 years' experience of what fish can tolerate and what conditions they must have for survival. This will decide what the new technology looks like,» says Midling.

The possibilities of implementing new technology in line with the industry are being investigated in a current FHF project and several trawler operators are now considering pumping the catch when new builds and rebuilds are commissioned.

Nofima is now working with Nergård Havfiske AS, ship designers, equipment manufacturers and pump suppliers to make trawled fish as good as possible. Knowledge obtained in the trials will form the basis for what tomorrow's trawlers will look like. The scientists are also looking at how the new technology can be built onto existing vessels.

This research is part of CRISP, which is a centre for research-led innovation in sustainable fishing, catch quality and catch economy. The objective of CRISP is to help increase value creation in the Norwegian seafood industry and reduce environmental impact.

Several of the projects behind the new technology are also financed by T he Norwegian Seafood Research Fund (FHF).

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FINANCED BY:
The Researced Council of Norway

MORE INFO:
Read more about CRISP

Improving carp health

Scientists in Norway and India have found genetic markers associated with resistance of Rohu carp to the bacterial disease Aeromoniasis.

PHOTO: © NOFIMA

Carp represent the world's most important group of aquaculture species, accounting for more than half the total global aquaculture production.

Aeromoniasis is a destructive disease that is a huge problem for carp aquaculture all over the world. The indicated markers for resistance can be used in breeding programmes to select Rohu carp broodstock with genetic variants that make them more resistant to the bacterial disease. As these genetic variants are inherited through generations, the fish species will develop the ability to survive and thrive where the disease is present. Small village communities in India that farm this fish in ponds will benefit, because the production and profitability of each pond can be significantly increased.

Rohu carp are farmed in India, Bangladesh, Burma and Thailand. Carp represent the world's most important group of aquaculture species, accounting for more than half the total global aquaculture production. The aquaculture industry in India produces more than 1.2 million tonnes of Rohu carp a year.

Scientists analysed the genetic code (DNA sequence) of the genes of different individuals in the search for markers. The DNA sequence of more than 3,000 genes were compared in large family groups that were exposed to the disease. The scientists were looking for a connection between the number of hours the Rohu carp survived after being infected with the disease and the DNA sequence of the genes they inherited. In this way, several genetic markers were found that could be linked to resistance to the disease. Some of the markers exist in or are linked to genes that are known to have an immune function in fish.

The project revealed a great deal of information about genes that affect immunity in fish, which scientists in Norway and India are keen to use as the basis for future projects. The many projects that Nofima has conducted in partnership with CIFA and other organisations in India have been very successful and of great benefit to aquaculture in India.

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New products from sheep

Developing new products requires knowledge about taste, consumer preferences and the factors that provide stable meat quality.

PHOTO: WENCHE AALE HÆGERMARK © NOFIMA

Innovations are needed to enable better use of the mutton.

There is a shortage of lamb on the Norwegian market, while it is difficult to sell mutton. At the same time, it is important to encourage sheep farming to protect the cultural landscape and prevent it from overgrowing. Innovations are needed to enable better use of the mutton.

Both Nofima's sensory assessors and untrained respondents have tested meatballs made of meat from lamb and sheep of various ages. The assessors also tested meatballs with various fat contents and it was found that the age of the animals affected the sensory perception of the meatballs more than the fat content. Sensory maps based on the results from the trained assessors, showed some significant differences in odour, flavour and textural attributes and the next step was to study whether this is the reason why consumers prefer lamb.

«Nortura started this project because we saw a need to increase the knowledge about sensory differences in lamb and mutton in relation to age and fat quantity. A taste map showing these differences is important to us when we develop new products. Without the support of the Research Council, this work would have taken much longer time ,» says Per Berg, Director of R&D and innovation at Nortura.

Even though the assessors identified some sensory differences, these were so small that it was uncertain whether consumers would detect them. In a test with untrained persons, meatballs from 9-month lamb, 20-month sheep and 5-year sheep were served. When the repondents in the test did not know what they were tasting, no preferences were found. However, when information were given that some meatballs were made from lamb and others from mutton, the preference for lamb meatballs increased.

«Consumers clearly have a more positive image of lamb than of mutton and the project must continue working with these aspects In addition, we will now study individual variations in lamb and mutton,» states Senior Research Scientist Margrethe Hersleth of Nofima.

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FINANCED BY:
The Research Council of Norway and Nortura

Fish get fit in the gym

Salmon smolts are sorted, and those with the best prospects are exercised so that they perform better and give a better yield as adults.

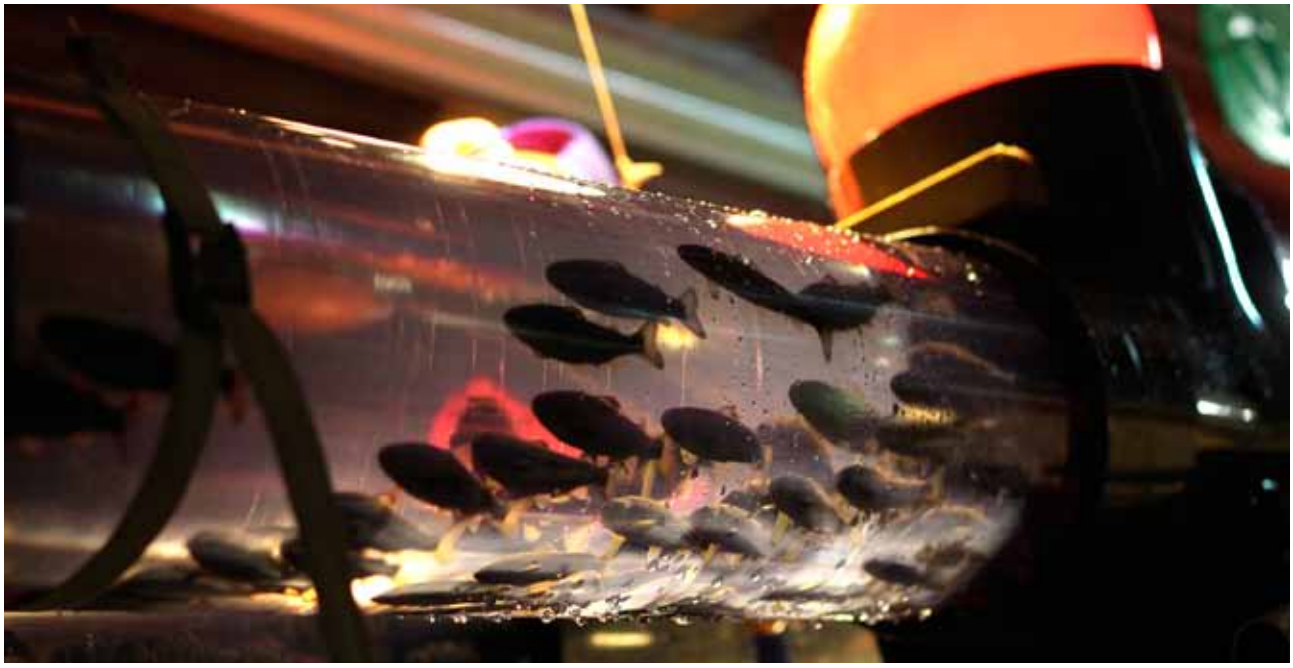

PHOTO: GERRIT TIMMERHAUS © NOFIMA

The treadmill for fish is called the flume and is in Nofima's facility in Sunndalsøra.

The aquaculture industry has long had a problem with survival rates of smolts that are stocked at sea. Losses can be as much as 20 per cent, and a significant number of these are fish in poor physical condition, which makes them more susceptible to disease and to dying soon after stocking.

«The research results show that salmon have a better survival rate after stocking and a greater resistance to disease if they have been through this exercise system. In the FitSmolt project, we will be focusing on how the smolt can develop a greater resistance to disease, how we can get them to cope with different types of stress better and how they can grow quickly, but with natural organ development,» says Nofima Senior Scientist Harald Takle.

The project consists of three parts in which results will be coordinated so as to be used to improve the smolt's robustness. In the first stage, we have shown that sorting of young salmon based on swimming ability gives a post-smolt with 24 per cent stronger heart muscles, 16 per cent greater gill area and 66 per cent lower transport costs from swimming. The increased heart capacity improves the fish's growth and disease resistance. Part two is about training the smolt to make it stronger with the aid of various swimming exercises. In this way, it is possible to find out if the smolt has a higher survival rate if it is physically well-trained before being stocked into the sea. The heart capacity, ability to cope with disease and general performance are tested after the smolt has been stocked into the sea.

«We also wish to compare farmed smolt with wild salmon smolt, to look for differences in heart capacity and to find markers to identify these differences. The wild salmon will come from the Lærdal river, since we know that this produces strong smolt with good swimming capacity. The long-term objective is to ensure that future generations of farmed salmon will be at least as robust as their wild cousins,» explains Takle.

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FINANCED BY
The Research Council of Norway and
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Helping with problem bacteria

Listeria monocytogenes is the greatest challenge to food safety for many food producers. Nofima helps to remove problem bacteria.

PHOTO: KJELL J. MEROK © NOFIMA

In Nofima's high-security production hall, a realistic production environment, scientists will study bacterial development in food production.

Scientists have studied listeria and other food-borne bacteria in many projects. This has provided competence in factors that influence the establishment (biofilm), growth and survival of micro organisms in the food production chain. This knowledge provides the food industry with a better basis for producing safer food of higher quality.

It can be very difficult to get rid of pathogenic bacteria. Some production equipment is of poor hygienic design, and bacteria can become established here in spite of cleanliness and strict routines. Places in the production system that accumulate rubbish and damp and that are difficult to clean are especially vulnerable. Once populations of bacteria have become established, it can be very difficult to get rid of them. We have not found one unique measure to counter this, but we are running a number of projects together with companies in which we find their problem areas and sources of infection and investigate how we can get rid of listeria. Listeria can grow in many products, even with refrigeration. Chilled products with a long shelf life that become infected with bacteria during production are therefore particularly vulnerable.

Nofima's newly built national centre is Europe's first high-security production hall. In a realistic production environment, scientists will study bacterial development in food production - on production equipment, during processing and during food storage. Methods to make food safer will be developed here. We wish to work together with food companies to minimise the risk of food-borne infection and to help with putting an end to dangerous bacteria.

«New varieties of bacteria are occurring all the time. Another vital job is to increase knowledge about the bacteria's ability to adapt to changed formulas and processes in food production. This could also help produce products with a longer shelf life and better eating quality,» says Research Scientist Even Heir.

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Take more responsibility!

The industry itself must get better at making the knock-on effects of aquaculture more evident.

PHOTO: AUDUN IVERSEN © NOFIMA

The industry has an environmental responsibility. «Coordinated operation in zones will help in the fight against disease and lice,» say Scientists Otto Andreassen and Roy Robertsen.

The authorities and the aquaculture industry have set the targets of trebling production by 2030 and increasing it fivefold by 2050. The value of Norwegian seafood exports in 2013 was NOK 63 billion, and as much as 69 per cent of this came from aquaculture. The battle for aquaculture locations will get tougher. Most Norwegian fish farm operators report that more and bigger locations will be the most important challenge to being able to produce more.

«If the industry is to succeed in getting more and better access to space, it must build up and maintain a good reputation so as to be perceived as a responsible and important industry for Norway,» say Scientists Otto Andreassen and Roy Robertsen. They conclude in a major research project that the industry itself must get better at producing and presenting knowledge about sustainability, including in connection with economic and social conditions.

«While Snøhvit off Hammerfest gives the municipal treasurer's department NOK 155 million in property tax, the property tax from aquaculture facilities is amazingly low in comparison. At the same time, the industry is poor at making clear actual employment and local knock-on effects of their activities,» says Andreassen. The researchers use the company Nova Sea as an example to demonstrate the knock-on effects of its 248 employees (full-time equivalents). The employees paid tax to 28 local authorities and the company bought goods and services worth NOK 2.66 billion. The researchers also calculated that purchasing from local companies gave an employment effect of 124 full-time equivalents in derivative business.

The aquaculture industry will only be able to produce more if it becomes coordinated in appropriate zones along the coast. Coastal zone management must also plan for larger areas. The present municipal boundaries and planning responsibilities do not correspond to the local ecosystems current planning work must take into account.

«Coordinated operation in appropriate zones would also help the fight against disease and lice. The industry assumes a great environmental responsibility when it manages common resources.»

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Clipfish is stagnating in Brazil

Brazilian consumers are buying more pre-soaked clipfish, which is quicker to prepare.

PHOTO: FINN-ARNE EGENESS © NOFIMA

Frozen, pre-soaked dried and salted fish products have seen significant growth since they first appeared on the market around 2008.

«Frozen, pre-soaked products represent a third of the market for cod clipfish (dried and salted fish) products in Brazil. Consumers are mainly buying such products in preference to the traditional Norwegian clipfish when there is only a short time from purchase to consumption,» says consumer and market researcher Finn-Arne Egeness.

Brazil is the biggest market by volume for Norwegian klippfisk. Dried and salted Norwegian clipfish features strongly in Brazilian food culture during celebrations such as Christmas and Easter, which are the most important times for consumption of bacalhau in Brazil. Frozen, pre-soaked dried and salted fish products have seen significant growth since they first appeared on the market around 2008. Overall, the market for dried and salted fish products in Brazil has increased, but since Norway exclusively produces whole, dried and salted fish we are losing market shares. Historically, we have had a market share of almost 90 per cent in Brazil; now the figure is less than 50 per cent.

Economic development has given Brazilians the opportunity to eat dried and salted fish products more often, which has made the market more interesting for global food producers. What all the new bacalhau products on the market have in common is that they are more highly processed than Norwegian clipfish, and the proportion of labour costs in the total product costs is therefore higher than for traditional Norwegian product.

«The high cost levels in Norway make it difficult to achieve sufficient profitability with the production of such products in Norway. The changes in the market give Norwegian producers three alternatives: they can adapt to the wishes and needs of processing companies and become the preferred suppliers of raw materials, or they can automate the production of such products in Norway, or they can set up production in a low-cost country, as one company has already done. It is up to Norwegian industry to decide which strategy is most profitable,» says Egeness.

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The Ministry of Trade, Industry and Fisheries

Smolt immune system weakened

Genetic analyses show that the salmon's immunity is lessened during smoltification. This can make the smolt vulnerable to disease.

PHOTO: MARIT REIN © NOFIMA

«The salmon`s weakened immune defence system during smoltification might make it an easy victim for marine virus infections,» says Scientist Lill-Heidi Johansen.

Viruses in particular are the cause of many of the losses of salmon in the sea, which have reached around 17 per cent in recent years. Nofima, in partnership with the National Veterinary Institute, has been looking at the factors that affect the development of diseases during the marine phase, with particular focus on the viral diseases IPN (infectious pancreatic necrosis) and HSMI (heart and skeletal muscle inflammation).

«Our approach to high losses is that it is not a single factor that causes so much smolt death but a combination of a number of factors,» says Lill-Heidi Johansen, Scientist at Nofima and project manager. One of the pieces has now fallen into place.

The scientists first measured the fish's immune-related genes at the time of smoltification. They found that the immune defences, and especially theinnate immunity to viruses, were lower during smoltification and the weeks following. This can make the salmon an easy victim for marine virus infections.

Trials with parr (very young salmon) and smolt infected with HSMI then showed that, while the smolt became ill, the parr mainly stayed healthy. Genetic analysis shows that this occurs because the immune defences reacted more quickly in parr than in smolt. This confirms that the smolt's immune defences against viruses are weakened.

The scientists have also documented something that has been observed by fish farmers andfish health personnel, that salmon that have had IPN during the first weeks in the sea contract HSMI more frequently. Even so, the results indicate that the immune related genes in smolt do not necessarily have to be down regulated in order for their resistance to disease to be weakened. In other words, there are other factors that play a part.

«It may, for example, be different production conditions, handling, water quality or the genetic background of the fish that affect resistance,» says Johansen. «Many of the factors that can have negative effects for the fish after transfer to the sea come from the final phase of smolt production. We wish to do more work on this.»

The aim is to come up with measures that might help to prevent losses in the sea relating to diseases.

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Product success with checklists

New software called ConsumerCheck can help to make product development more likely to succeed, so that fewer launches fail.

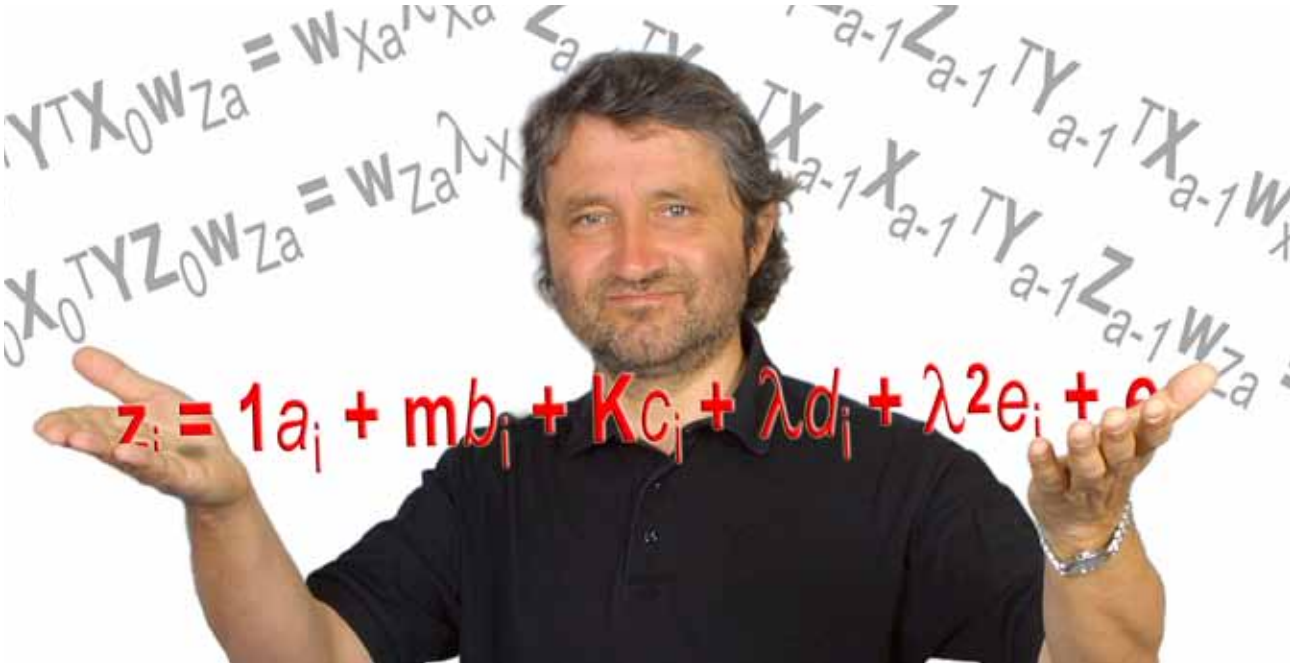

PHOTO: KJELL J. MEROK © NOFIMA

Tormod Næs and his team have developed software that makes it possible to review the connections between consumer preferences and chemical and sensory properties.

While traditional food products are facing strong price pressures, there are higher margins on new products. So it is important for food producers to launch successful new products. ConsumerCheck can give food producers the opportunity to review the connections between consumer preferences and chemical and sensory properties.

«The purpose of ConsumerCheck is to make it easier for the producers to interpret complex and composite results, so that they can be more certain of hitting the target with their product development,» says Tormod Næs. He is a Senior Research Scientist at Nofima and is responsible for the development of ConsumerCheck.

He adds that considerable statistical abilities are normally required to be able to make use of all the information collected. With ConsumerCheck this is far easier, because the choices are limited to the statistical analysis methods that give the most correct basis for decision making.

By linking sensory and chemical properties with what properties consumers are looking for, with consumer attitudes and habits and with demographics, a more complete answer is given.

The results of a survey of low-fat yoghurt by Nofima for example showed that young Norwegian consumers showed a preference (in blind tests) for sweet yoghurt, but that information about lower sugar content can have a positive influence on the taste experience of low-sugar yoghurts.

Many factors affect repeat buying, including taste, packaging and location within the shop. With ConsumerCheck, producers have the opportunity to collect all the knowledge about consumers and products into the same model. Naturally, this software can be used by all kinds of industries.

"The computer modelling is the same whether you are selling a car, electronics or food. Think how much product development and knowledge of consumer preferences is involved in development of an enjoyable smell inside a new car, for example,» concludes Næs.

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FINANCED BY:
The Research Council of Norway

MORE INFO:
Download the software

Breeding for disease resistance

Disease resistance in cod can be improved by selective breeding.

PHOTO: FRANK GREGERSEN © NOFIMA

Scientist Rama Bangera has shown that disease resistance in farmed cod can be increased by breeding and genome selection.

It is important to minimise the risk of disease in cod farming. Scientist Rama Bangera of Nofima has been studying the extent to which the cod's genes affect its ability to withstand three fatal diseases and has found that resistance in farmed cod can be increased by breeding and genetic selection.

Breeding is a very effective tool for improving the production qualities of farmed fish and thereby the economics of aquaculture. For this reason, the national breeding programme for cod was started in 2002. The programme is operated by Nofima on behalf of the Ministry of Fisheries and Coastal Affairs, and its objective is to breed a cod for aquaculture that has better growth properties than wild cod, as well as a greater resistance to important diseases of fish.

In his doctorate studies, Bangera has investigated genetic aspects of disease resistance in cod, in collaboration with scientists at Nofima and the Norwegian University of Life Sciences (NMBU). Two diseases caused by bacteria (vibriosis and francisellosis) and one caused by nodavirus (viral nervous necrosis – VNN) have been studied. Bangera has used advanced statistical and molecular genetic tools in four different studies to analyse resistance to disease.

«Our broad-based test with different statistical methods shows how important it is to choose the right statistical method for the material you have, in order to determine the fish's resistance as precisely as possible and so achieve greater breeding progress for disease resistance properties,» says Bangera.

Bangera found a weak genetic correlation between growth and resistance to vibriosis and VNN. This means that it will be possible to achieve genetic progress for disease resistance and growth at the same time in the breeding programme.

The doctoral studies concluded that future studies should look more closely at the effects of present day selection methods, the practical use of genome selection and the further identification of candidate genes for resistance to disease in Atlantic cod.

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Large smolts make healthier fat

Scientists have found a way of stimulating farmed salmon to convert more plant oil in their feed into marine omega-3.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Salmon has a natural ability to convert omega-3 fatty acids from plants into marine omega-3 fatty acids. This ability is at its greatest before smoltification.

Farmed salmon are rich in fats, but they have less marine omega-3 in their fillets than previously, because a high percentage of the fish oil in their feed has been replaced with plant oil. But salmon has a natural ability to convert omega-3 fatty acids from plants into the marine omega-3 fatty acids EPA and DHA. This ability is at its greatest before smoltification. Smoltification is the process during which the salmon becomes physiologically prepared for the transition from freshwater to seawater. In nature this occurs as the young salmon makes its way downriver to the sea. In present-day aquaculture it is normal for the salmon to smoltify and be transferred to sea water when it weighs about 100 grams.

Results of trials have shown that salmon that remained in freshwater until they weighed 400 grams had a higher percentage of marine omega-3 fatty acids than salmon that stayed in freshwater until 85 grams and then grew to 400 grams in sea water. In these two groups, the proportion of marine omega-3 fatty acids was 9.2 and 7.5 per cent respectively of total fatty acids. It has thus been shown that it is possible to maintain a greater capacity to convert omega-3 fatty acids from plants into marine omega-3 fatty acids by postponing the salmon's smoltification and keeping it in fresh water for longer period.

«This is an important finding, because the proportion of healthy marine omega-3 fatty acids in farmed salmon is important for the salmon's own health, as well as for health-giving properties in the salmon products we eat,» says scientist Tone-Kari Knutsdatter Østbye of Nofima.

The project has been commissioned by the Fishery and Aquaculture Industry Research Fund (FHF). FHF's technical manager for aquaculture, Kjell Maroni, believes that the production of larger smolts in freshwater is relevant for many in the fish-farming industry:

«Many aquaculture companies have a strategy in which part of the smolt production is kept in freshwater until the fish are larger than has been normal in recent years. This gives a shorter period of growth before slaughter and helps to reduce risks from salmon lice, among other things. If this strategy could also help to increase the salmons' own production of omega-3, this would be very positive.»

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FINANCED BY:
The Norwegian Seafood Research Fund

A new source of proteins

We could make better use of by-products from food production, but new measuring instruments are needed.

PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Spectroscopy consists of rapid light measurements, which are used in this case to characterise left-over raw materials, processes and products.

«We use spectroscopy for sorting, screening and monitoring in order to develop new and better processes, so that food by-products can be utilised optimally and contribute to products with a potentially higher market value,» says Nils Kristian Afseth, a Research Scientist at Nofima. He is managing several projects that are looking into better utilisation of raw materials.

Scientists are investigating for example how proteins in chicken by-products can be utilised in new products, and currently enzymatic hydrolysis is used for this purpose. This means that special enzymes are used to convert longer protein chains in to shorter ones, so that the digestibility of the proteins is increased and their functional properties are changed.

The greatest challenge is to find out which conditions of the hydrolysis process that provides the optimal properties of a given product. It is difficult to monitor the process, and in the absence of a good monitoring system, it is time that is currently used as an important indicator.

«We are now developing measurement methods for this monitoring, for which we are using infrared spectroscopy,» says Nils Kristian Afseth.

At present, enzymatic hydrolysis of food by-products of the animal and marine industry is a young and growing industry - and the applications for protein products are many.

Nofima Scientist Volha Shapaval uses moulds (filamentous fungi) to ferment by-products and rest materials from food production into Single Cell Oil (SCO) rich in polyunsaturated fatty acids (PUFAs).

«The same approach can also be used to produce Single Cell Proteins, polysaccharides or bioplastic for example, by using yeast and bacteria,» explains Volha Shapaval.

The fermentation process is based on using moulds to «eat» – ferment the pre-processed by-products and rest materials and to produce new high-value products as PUFAs. Spectroscopy is used here to perform screening and monitoring of the fungal fermentation, in order to see what kinds of fatty acids are produced and to find the most productive moulds. The aim is to find an efficient producer with the highest content of PUFAs in SCO and to optimise fermentation by-products and rest materials from food production.

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FINANCED BY:
The Foundation for Research Levy on Agricultural Products and The Research Council of Norway

High-pressure food

Raspberries will stay in good condition for more than 90 days if they are treated with high pressure.

PHOTO: LIDUNN MOSAKER BOGE © NOFIMA

Berries were among the test winners when Scientist Tone Mari Rode investigated whether pressure treatment could make food healthier, safer and more tasty.

Food that is to be sold in shops is often heat treated to remove bacteria and increase shelf life, but heating causes many foods to deteriorate. By exposing the food to high pressure, micro organisms can be deactivated without using heat. This method treats food products very gently, and gives opportunities for new products.

For three years, scientists at Nofima have been performing trials to find out whether pressure treatment can make food healthier, safer and more tasty. The test winners include berry products.

«High-pressure juice tastes great. It also keeps a high quality for longer than the freshly-pressed juice that can be bought today,» says Tone Mari Rode, who has led the research.

Nofima has had a lot of interest from industry, which wants to try out the technology. In several projects, food producers have been able to test whether their products could be improved with high pressure, and whether new products can be developed. Many different kinds of meat, vegetables, dairy products, fruit and berries have undergone pressure treatment, and the scientists now know much more.

Not all products are equally suitable for high-pressure processing. Untreated fish and meat have proved to be less suitable. But internationally there are both raw oysters and a number of marinated raw meat products that have been high-pressure treated. In Nofima's tests with meat, it was cured and marinated meats that gave the best results. But there were issues with these products too, and they emerged from the tests with everything from rancidity to top quality.

«Small adjustments can make a great deal of difference. Taste, appearance or shelf life can be significantly changed by changing just an oil or a spice. It is therefore essential to test individual products in different conditions,» says Tone Mari Rode.

The scientists believe that high-pressure technology is probably best suited to premium products, where the consumer is likely to be willing to pay more for food that has been carefully treated and therefore is of higher quality.

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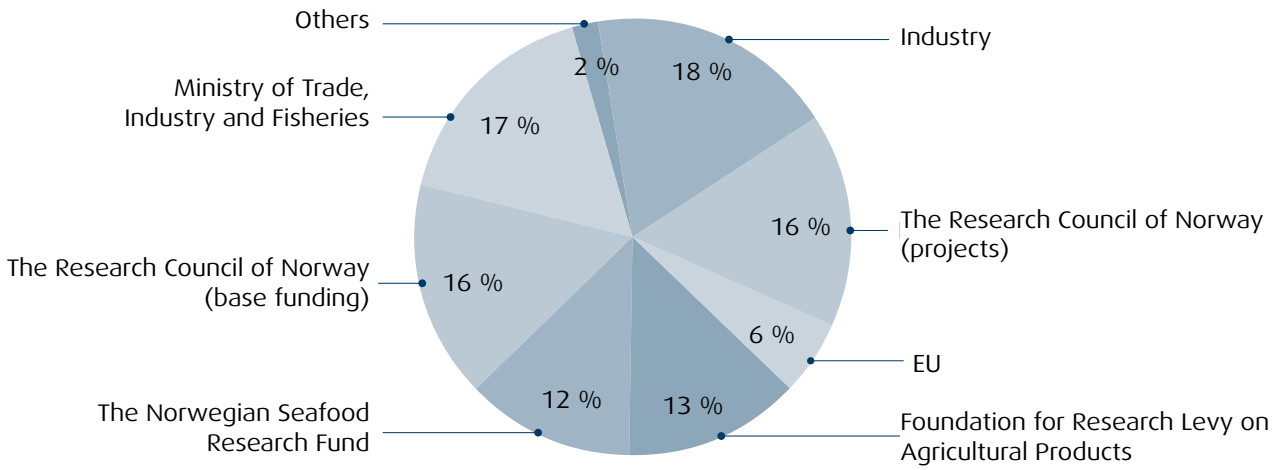
The Research Council of Norway and The Regional Research Fund, West Norway

Facts and figures

In 2014 Nofima's 350 employees delivered research and services worth NOK 530 million to approx. 240 different clients in Norway and abroad.



The following are our largest funding providers:

RESEARCH COUNCIL OF NORWAY is a strategic organ that identifies priority areas and project/programme managers, allocates research funding and evaluates the research that is carried out.

THE MINISTRY OF TRADE, INDUSTRY AND FISHERIES is responsible for the fishery and aquaculture industry, fish health, fish welfare, seafood safety and quality and more.

THE NORWEGIAN SEAFOOD RESEARCH FUND (FHF) shall create added value for the seafood industry through industry-oriented research and development. Financed through a levy on all seafood exports.

THE FOUNDATION FOR RESEARCH LEVY ON AGRICULTURAL PRODUCTS (FFL) shall secure an economic basis for research connected to agricultural products that are utilized to produce food and stimulants, as well as feed grain for animals. Financed through a research levy on agricultural products.

THE INDUSTRY – Nofima's R & D work is oriented primarily towards the aquaculture, fishery and food processing industries.

THE EUROPEAN UNION finances several research projects that Nofima either participates in or has project responsibility for.

Nofima's mission

Our mission is outstanding research, development and innovation for the food of tomorrow.

This means that

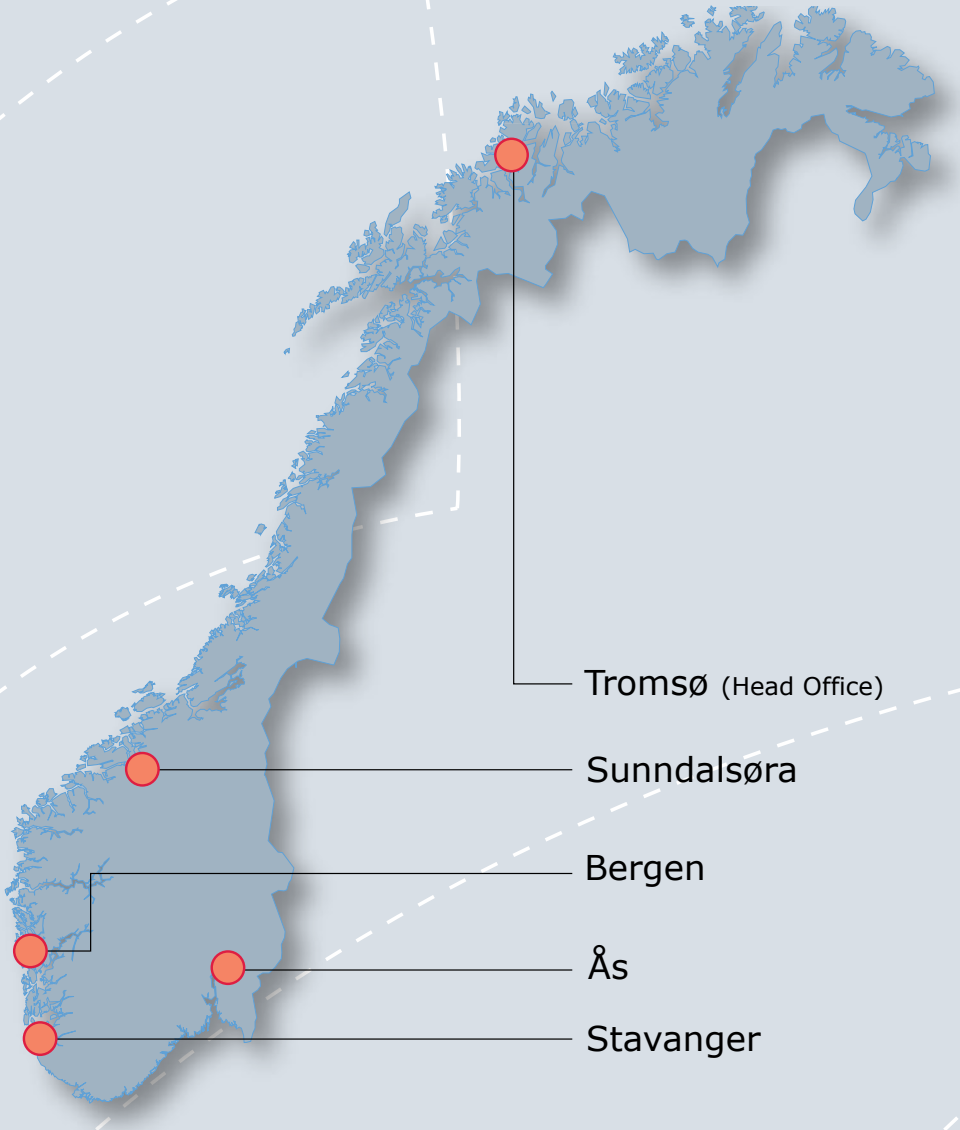
- our research shall be relevant and of high quality and utility value
- we shall be innovative, responsible, committed and inclusive
- we shall think carrying out, competence development and implementation

Our strategy is based on the vision «Creating value together» – and in collaboration with our clients we deliver internationally recognized research and solutions that provide a competitive edge throughout the entire value chain.

PHOTO OPPOSITE PAGE : KJELL J. MEROK © NOFIMA

PATHOGEN PROCESS HALL

The Pathogen Process Hall helps to increase knowledge about dangerous food-borne bacteria. The hall is a national centre and Europe's first high-security production hall. Here, industry and researchers can make changes to formulae and processes and thereby choose the right measures to make food production safer.



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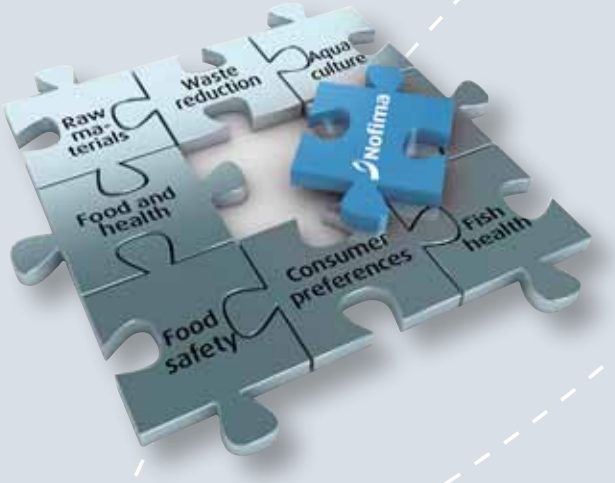

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ISSN 1894-4752