SINTEF

SFH80 A105067 - Åpen

Rapport

Nordisk pelagisk workshop

Presentasjon av de siste års Nordiske forskningsresultater innenfor pelagisk fisk – en fremtidsutsikt.

Forfattere
Hanne Digre, Ida Grong Aursand

SINTEF Fiskeri og havbruk AS
ProsessTeknologi
2010-11-15

SINTEF Fiskeri og havbruk AS
Postadresse:
Postboks 4762 Sluppen
7465 Trondheim
Sentralbord: 40005350
Telefaks: 93270701
fish@sintef.no
www.sintef.no/fisk
Foretaksregister:
NO 980 478 270 MVA

Rapport

Nordisk pelagisk workshop

Presentasjon av de siste års Nordiske forskningsresultater innenfor pelagisk fisk – en fremtidsutsikt.

EMNEORD:
Nordisk workshop
Pelagisk

VERSJON
1

DATO
2010-11-15

FORFATTER(E)
Hanne Digre
Ida Grong Aursand

OPPDRAGSGIVER(E)
Fiskeri- og kystdepartementet, Nordisk Arbeidsgruppe for Fiskeri (AG-Fisk)

OPPDRAGSGIVERS REF.
Andreas Stokseth/ Harald Holst

PROSJEKTNR
850284

ANTALL SIDER OG VEDLEGG:
12+ 6 vedlegg (265 s.)

SAMMENDRAG

Målet med prosjektet har vært å etablere et nettverk innenfor nordisk pelagisk fiskerisektor, inkludert både foredlingsindustri, flåtesektoren og FoU-institutter. Det er blitt gjennomført to workshop's høsten 2010, hvor utfordringer og muligheter for næringen ble diskutert. Dette har bl.a. resultert i en artikkel publisert i magasinet Eurofish. I tillegg har nettverket gitt innspill til neste års utlysning i Nordic Innovations Centre (NIC) mht. prioriterte FoU-områder innenfor pelagisk sektor.

PROSJEKTLEDER
Hanne Digre

SIGNATUR
Hanne Digre

KONTROLLERT AV
Stein Ove Østvik

SIGNATUR
Stein Ove Østvik

GODKJENT AV (STILLING, NAVN)
Marit Aursand

SIGNATUR
Marit Aursand

RAPPORTNR
SFH80n A105067

ISBN
978-82-14-05108-7

GRADERING
Åpen

GRADERING DENNE SIDE
Åpen

SINTEF

Innholdsfortegnelse

BILAG/VEDLEGG

SINTEF

Nordisk pelagisk workshop

1 Innledning

Pelagisk fiskeri representerer en viktig del av fiskeriene i Norden. I Norge, Sverige og Island representerer pelagisk fisk mer enn 65 % av den totale fangsten. Sektoren har flere utfordringer både mht. fangst, håndtering, kvalitet og lønnsomhet. Flere FoU-prosjekter i samarbeid med pelagisk industri har blitt gjennomført i de nordiske landene de siste ti-årene, og nasjonale utfordringer er blitt identifisert. Med bakgrunn i oppnådde resultater er det behov for å etablere en kunnskapsplattform for utveksling av informasjon på tvers av landegrenser gjennom tettere samarbeid og nettverksrelasjoner mellom nordisk pelagisk industri, flåtesektoren og FoU-miljøer. Dette vil gi mulighet for å ta ut synergieffekter.

Det har vært søkt EU to ganger om finansiering av prosjekter knyttet til europeisk pelagisk industri, hvor Norge har vært initiativtaker, men uten hell. Disse prosjektene har hatt som målsetting å utvikle (europeiske) standarder, samt teknologi og prosesser som kan bidra til å sikre god og forutsigbar kvalitet på pelagisk råstoff som leveres i det europeiske markedet, og bidra til at pelagisk foredlingsindustri i europeiske land styrker sin markedsposisjon og sin produktportefølje.

FoU-partnere i prosjektet har vært SINTEF Fiskeri og havbruk (Norge), Matis (Island), Chalmers Tekniske Høgskole (Sverige) og DTU Aqua (Danmark). SINTEF Fiskeri og havbruk har vært en viktig aktør i forsknings- og utviklingsarbeidet innen norsk pelagisk sektor de siste ti årene. Å samle den "pelagiske ekspertisen" i Norden vil danne en kunnskapsplattform, og, gjennom identifisering av felles utfordringer, legge grunnlaget for å utforme og gjennomføre kompetente prosjekter som møter behovene til den nordiske pelagiske fiskerisektoren.

Prosjektet startet opp i 2009 og avsluttes i november 2010. Denne sluttrapporten gir en kort oppsummering over aktivitetene som er gjennomført i prosjektet. Referat fra de gjennomførte workshopene, samt innspill til NICe er skrevet på engelsk i rapporten.

1.1 Mål

Målet med prosjektet har vært å etablere et nettverk innenfor nordisk pelagisk fiskerisektor, inkludert både foredlingsindustri, flåtesektoren og FoU-institutter.

Gjennom å arrangere workshop ønsket man følgende:

- Å etablere en kunnskapsplattform for utveksling av informasjon på tvers av nettverket
- Å ta ut synergieffekter av tettere samarbeid og nettverksrelasjoner mellom nordisk industri, flåtesektoren og FoU-miljøer
- Å utforme nye prosjekter på europeisk og/eller nordisk nivå, hvor felles utfordringer innenfor pelagisk sektor blir besvart

2 Gjennomføring

Følgende aktiviteter er gjennomført:

- Det er dannet et Nordisk nettverk innenfor pelagisk FoU bestående av SINTEF Fiskeri og havbruk (Norge), Matis (Island), Chalmers Tekniske Høgskole (Sverige) og DTU Aqua (Danmark).
- Det er avholdt en Nordisk pelagisk workshop på Gardemoen 30. august 2010 med representanter fra flåteleddet, industri, marked, organisasjoner og FoU-institutter.
- Nettverket hadde ansvaret for en av sesjonene på konferansen "The pelagic complex", 7. september 2010, og hadde en representant i programkomiteen til konferansen.
- Det er skrevet en populærvitenskapelig artikkel med tittel "*Challenges for the pelagic fish sector in the future – focusing on pelagic fish as food products*" som trykkes i magasinet Eurofish, des 10/jan 11. Utkast av artikkelen foreligger som vedlegg 6.
- Nettverket har gitt innspill til Nordic Innovation Centre mht. prioriterte FoU-områder innenfor pelagisk sektor.

2.1 Nordisk pelagisk workshop, Gardemoen august 2010

En nordisk pelagisk workshop med tittel "*Challenges and possibilities of the Nordic pelagic sector. Looking towards the future*" ble avholdt 30-31.august 2010. Det var 29 deltakere fra Island, Danmark, Sverige, og Norge som representerte hele verdikjeden fra fangst til marked. Program, deltakerliste, samt presentasjoner foreligger som vedlegg 1-3.

Gruppearbeid ble også gjennomført og følgende spørsmål skulle besvares:

1) What are the main challenges for the fishing fleet to meet the future?
   a) Environmental aspects
   b) Economical aspects
   c) Technological aspects
   d) Quality and on board handling

2) What are the main challenges for the processing industry to meet the future?
   a) Economical aspects
   b) Technological aspects
   c) Rest raw material utilization
   d) Future trends in the processing industry

3) Is there a wish in the pelagic industry to grade pelagic into different qualities (e.g. as for salmon: superior, ordinary, production)? Which quality parameters should be included in such a grading system?

4) Do you think it would be possible to achieve a higher price for special high quality pelagic products if they had a "high quality label"?

5) Is there a wish within the herring industry to communicate health claims on herring products? Why?

6) Do consumers choose to eat pelagic products for their potential health properties? How can the industry communicate the health benefits?

En oppsummering av gruppearbeidet følger nedenfor:

Session 1: Fishing fleet-challenges

a) Environmental aspects:
There are two important aspects. Minimizing the amount of fuel is one, and the other aspect is that the international fishing fleet must recognize that strict regulations are needed. If the whole EU don't agree on which stocks/areas that should be protected, the approach will be "if we don't take up this fish, someone else will do". The question is; who will set the quotas, the politicians or the scientists?

There were some discussions about using more environmentally fuel like gas instead of oil. Sustainability and utilization of the stocks in the most profitable way (MSY) was mentioned as the most important factors. In general the groups considered the pelagic fleet as energy efficient compared to others fisheries due to large catches. However, the fleet would be met with future demands on energy saving, carbon footprint etc.

b) Economical aspects:
The value of industry pelagics vs. "consumer pelagics" was discussed. We agreed that as much as possible of the landed herring should go directly to human consumption. Further, the Nordic countries should become better at adding value to the herring before we export it. For example, it could be filleted and packed in smaller packages "at home". In that way, the value will increase and the by-products would remain in the Nordic countries (and thus can be used for meal or other products).

The fleet would have better economy if it was possible to use the pelagic vessels all year around. Some vessels are at shore several months each year. However, it might be difficult to change fisheries from pelagic fisheries to other species on board.

c+d) Technological aspects, quality and on board handling
In the future, animal welfare will probably become an aspect also in pelagic fisheries. That will constitute a technological challenge (rested harvest etc). Rapid bleeding of pelagic fish came up as a tentatively quality improving step. There were some different views on how important bleeding actually is.

Even though cooling technology could be developed and improved, a future challenge to ensure optimal quality of the raw material is to improve collaboration/communication between the fleet and processing plants on land, and to improve the logistics.

An opinion in one of the groups was that those who are using midwater trawl should think about how to preserve the quality properties, by smaller catches in each haul and shorter towing time. There is a need for an internet based information system on catch, storage and quality parameters that could be used by the processing industry/buyers to optimize utilization and quality of the catch. It should be developed as an international standard. Pelagic information program (PIP) was an example of this. Improving the grading systems on board was also suggested.

Session 2: Challenges for processing industry and its rest-raw material

The question came up whether it actually can become profitable for small pelagic fish processing industries to produce proteins/peptides in small scale. To achieve this, the best would be if the processes were made very simplistic, and that they allow small volumes of fish. The crude proteins/peptides could then be sent to another company for further refining such as drying/purification.

A problem today is that the buyers of frozen herring pay just above the price the herring raw material costs. They have a good insight to the current values of herring. However, if there is some other value addition to the herring (other than just freezing, it could be a process or just knowledge about health effects), there is a chance to get considerably higher price for the exported herring. We also discussed that cleaning of processing factories is a major issue in 24/7-production. The issue whether consumers actually are ready for products from fish guts came up at the end of the discussion.

Economical and technological aspects.
It was mentioned that some processing companies have over-capacity problems. Improved grading and sorting system would increase yield, reduce cost by less down-grading. The companies would need less manpower and the value of the product will increase.

Rest raw material utilization
Development of new products from the rest raw material, would increase the value of the end-product.

Future trends in the processing industry
Improved quality of the fish to further processing could increase the human consumption part. The industry expressed a need for more automation of processes to reduce cost and reduce processing time from landing to product. Quick fast online detections methods were interesting but it was questioned whether the different measuring techniques could match the speed in the production lines. It was expressed that there was a need for automation that could sort herring fillet pieces in very homogenous sizes which was a consumer demand now and in future.

Session 3: Quality and health effects of pelagic fish

3) Grading of herring: This is of interest if you can get a higher price. It was discussed what the basis for grading should be (microbiology, TVN, colour/appearance). The market for lower grade herring was also discussed. If there is a wish from the market to grade the pelagic fish into different sizes then the industry have to act on that. It was questioned whether it was possible to grade pelagic raw material into different qualities in the same way as the salmon industry does. Salmon is a farmed fish where the raw material quality can be influenced /controlled much more than herring. The problem would be to find valid quality parameters that could be correlated to the existing and future sorting systems. As discussed under session 1, sorting of herring according to fat content could be a quality parameter used in a grading system but industry is concerned whether such a grading can pay off compared to the investment in a sorting system.

4) Higher price for high quality label: This depends on the background of the consumer, as well as consumer preferences and marketing. There is a limit for how much herring can cost. One of the groups agreed that some quality labels may result in a higher price. The organic product is an example of this. Branding of a company as producer of high quality products was considered by some in the group as a better strategy, even though branding can take several years.

5) Wish to communicate health claims: Health is an issue for users who depend on "functional reasons". We discussed the great success mackerel in tomato sauce has had in Norway. Obviously, there have been very successful commercials about this product, focusing e.g. on good effects from omega-3 on the skin. Herring/mackerel has an advantage as a good source of omega-3 as one portion gives the whole daily dose.

There were some arguments about that issue, and people were talking about the fact that it is hard to communicate health claims in the market. Who would communicate? Everyone agreed that the industry would not do that, because the industry don't have the money.

6) The consumer's behavior regarding health food is variable. Some people don't eat fish and get their health source from other types of food. Accessibility to pelagic species is different in the countries. Tough people eat white fish, some people don't like herring.

2.2 The Pelagic complex, Færøyene september 2010

Det var totalt 9 foredragsholdere under sesjon 3 på konferansen. Program, samt sammendrag av presentasjonene fra konferansen foreligger som vedlegg 4 og 5. Et kort sammendrag sesjon 3 følger nedenfor:

Session 3: Technological challenges for a more profitable pelagic fleet and industry – how to increase value and reduce costs.

One of the topics in the session was energy efficient motor systems. New technology is developed, and a combination of different systems can be a solution for the pelagic fleet, for instance a combination of liquefied natural gas (LNG) and fuel cells. A holistic approach to the design of engine systems where all important operations, such as the fishing with special gears, are taken into account is crucial to get the best result.

Another topic in the session was carbon foot print of pelagic products to different markets. Compared to other seafood such as whitefish and farmed salmon, the pelagic fish are energy efficient. However, there is still a potential of improvement, especially in the choice of fishing gear and transport method to market. The carbon foot print of products was shown to be a good tool for the industry to trace energy consumption and thereby the energy costs in the value chain.

A new concept for on board handling of fish was shown to have positive effects on fish quality. New grading systems for pelagic fish are under development, and this will give the industry the opportunity to achieve a more uniform and high fish quality. New measurement techniques for characterization of raw material quality such as fat content and risk of belly bursting were presented. This gives the opportunity to get objective information about the raw material at an early stage in the value chain.

Advanced chilling technology was shown to give a high product quality, and it was emphasized that rapid chilling of fish on board is crucial for achieving a high product quality. New concepts are under development, and they should be an important factor in the design of new vessels.

The sustainability of producing feed from fish was discussed. The speaker concluded that as long as the market for food does not exist, it is not unethical to produce feed from some pelagic species.

Different fishing gears effect on quality was presented. The T90 cod end was shown to cause less damages on mackerel compared to traditional trawl, possibly because of the water currents in the gear and thereby because of the movement of fish inside the cod end.

Increased utilization of rest raw material was seen to be an opportunity for the industry, especially for feed production. The restriction of catch sizes for purse seiners especially was mentioned as one of the challenges for the fleet.

3 Videreføring

Prosjektet har gjennomført flere aktiviteter med knappe økonomiske ressurser. Nettverket har laget et innspill til neste års NICE-utlysning, hvor FoU-instituttene sammen med flåte og industri vil utforme prosjekter for pelagisk sektor. Her følger noe av teksten i utlysningen:

The pelagic sector: Main future challenges

Pelagic fish represents an important part of the fisheries in Scandinavia. For instance in Norway, Sweden and Iceland the pelagic fish accounts for more than 65 % of the total catch. This sector is facing several challenges regarding catching, handling, fish quality (e.g. rapid oxidation, "belly bursting") and profitability. In addition, a common trade framework, both within Europe and worldwide, is missing. In the last 10 years, several Nordic RTD projects have been carried out in collaboration with the pelagic industry within different areas. A list of results is shown in a table attached. **The research areas we see as most important for the pelagic sector in the future are the following:**

- *Catching and on board handling of pelagic fish*
- *Effective processing and process control*
- *Processing of pelagic fish and its rest-raw materials*
- *Industrial pelagic fish processing waste water*
- *Quality and health effects of pelagic fish*
- *Reduction of salt in pelagic fish products*
- *Value added pelagic products*
- *At-line and on-line measurement techniques*

SINTEF

4 Vedlegg

1 - Program Nordisk pelagisk workshop, 30.sept. 2010

2 - Deltakerliste Nordisk pelagisk workshop, 30.sept. 2010

3 – Presentasjoner Nordisk pelagisk workshop, 30.sept. 2010

4 – Program "The Pelagic complex" session 3, 7.ssept. 2010

5 – Sammendrag av presentasjonene "The Pelagic complex" session 3, 7.ssept. 2010

6 – Populærvitenskapelig artikkel

Vedlegg nr. 1

The Nordic Workshop

The workshop is aimed at the pelagic sector, including the fishing fleet, industry, equipment vendors and scientists. Challenges facing the pelagic fish sector will be addressed with an industrial focus. Scientific results and their practical use for the pelagic industry will be presented.
Registration (deadline August 15th):
http://www.sintef.no/Marin/Fiskeri-og-havbruk-AS/Nyhetsarkiv/Nordic-Pelagic-Workshop

Organization
The workshop is funded by the Nordic Council of Ministers, Working Group for Fisheries Co-operation (AG-Fisk).

Arrangement by:
SINTEF Fisheries and Aquaculture
7465 Trondheim, Norway
www.sintef.no/Fish
Contact: Hanne Digre
Tel.: +47 95726482

The Nordic workshop - Programme
"Challenges and possibilities of the Nordic pelagic sector. Looking towards the future"
30. August 2010, Gardermoen, Norway

10:00-10:10	Welcome address by SINTEF
10:10-11:50	***Challenges for the pelagic fish sector to meet the future***
10:10	Iceland - Future Aspects - Sigurjón Arason, Mats/Sindri Sigurdsson, Sildarvinnslan
10:30	Norway - Inge Halstensen, Gardar
10:50	Sweden - John Faeraas, Abba Seafood AB
11:10	Denmark - Marco Frederiksen "A new marinated herring product using ecological ingredients and with full product history"
11:30-13:00	***SESSION 1 Onboard handling technology***
11:30	Catching procedures for pelagic fish - quality and processing management, Asbjörn Jónsson, Mats, Iceland
11:50	Added value of pelagic catch - optimised handling and chilling methods, Sigurjón Arason, Mats, Iceland
12:10	Pelagic quality: from sea to dish, including onboard handling systems, Hanne Digre, SINTEF, Norway
12:30	ROUND TABLE DISCUSSION
13:00-14:00	Lunch
14:00-15:45	***SESSION 2 Processing of pelagic fish and its rest-raw materials***
14:00	Grading and sorting of pelagic fish, Stein Ove Østvik, SINTEF, Norway
14:20	Processing technology and quality parameters in the pelagic industry, Sindri Sigurdsson, Sildarvinnslan, Iceland
14:40	Production of protein isolates from pelagic fish and its by-products using the pH-shift technology, Ingrid Undeland, Chalmers, Sweden
15:00	New value added products from rest raw material, proteinhydrolysat og lipider, Ivar Storrø, SINTEF, Norway
15:20	ROUND TABLE DISCUSSION
15:45-16:00	*Coffee*
16:00-17:30	***SESSION 3 Quality and health effects of pelagic fish***
16:00	Health effects from herring-results from human and animal studies, Ingrid Undeland, Chalmers, Sweden
16:20	Influence of catching place and time on quality of fresh and frozen herring, Henrik H. Nielsen, DTU, Denmark
16:40	Characterisation of the bacterial flora of pelagic fish, with special emphasis on Atlantic mackerel, Cecilie Svanevik, NIFES, Norway
17:00	ROUND TABLE DISCUSSION
17:30-18:00	***Summary and further progress***
18:00	Close of workshop
20:00	***Dinner at Best Western Oslo Airport Hotel***

Vedlegg 2 – deltakerliste Nordisk pelagisk workshop 30. august 2010

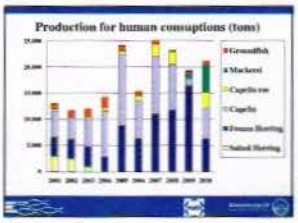
Name	Company
Alex Vejo Rasmussen	Teknologisk Inst, Denmark
Anlaug Å Hansen	NOFIMA Mat, Norway
Ann Mari Haram	Norway
Arne Levsen	NIFES, Norway
Asbjørn Jónsson	MATIS, Iceland
Caroline Baron	DTU Food, Denmark
Cecilie Smith Svanevik	NIFES, Norway
Christer Mattson	Fiskeriberedning P.Mattson AB Sw
Göran Mattson	Fiskeriberedning P. Mattson AB Sw
Hanne Digre	SINTEF Fiskeri og havbruk, Norway
Henrik H Nielsen	DTU, Denmark
Ida Aursand	SINTEF Fiskeri og havbruk, Norway
Inge Halstensen	Gardar, Norway
Ingrid Undeland	Chalmers, Sweden
Ivar Storrø	SINTEF Fiskeri og havbruk, Norway
Jarle A. Hansen	Norges Sildesalgslag, Norway
Jens Petter Wold	Nofima Mat, Norway
Joakim Martinsen	Fiskarlaget, Norway
John Faeraas	ABBA Seafood AB, Sweden
Kristin Lien	Norwegian Seafood Export Council
Lena Brungot	Norges Sildesalgslag, Norway
Marco Frederiksen	Eurofish, Denmark
Marthe Dahl	Eksportutvalget for fisk, Norway
Per Magne Eggesbø	Eros AS, Norway
Per-Aste Persson	Kladesholmen Seafood AB, Sweden
Sara Malmstrøm	ABBA Seafood AB, Sweden
Sigurjón Arason	MATIS, Iceland
Sindri Sigurdsson	Sildarvinnslan, Iceland
Stein Ove Østvik	SINTEF fiskeri og havbruk, Norway

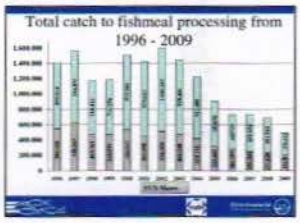
Vedlegg 3

Iceland - Future Aspects

Sindri Sigurdsson and Thorhallur Jonasson, Sildarvinnslan,
Sigurjón Arason, Matis &UoI

The Nordic workshop: "Challenges and possibilities of the Nordic pelagic sector. Looking towards the future"
30. August 2010, Gardemoen, Norway





Challenges in the Swedish market on

pickled herring
Nordic Workshop

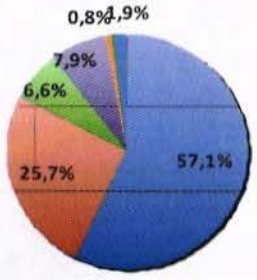
30. August 2010

Abba Seafood

Herring in Grocery st.

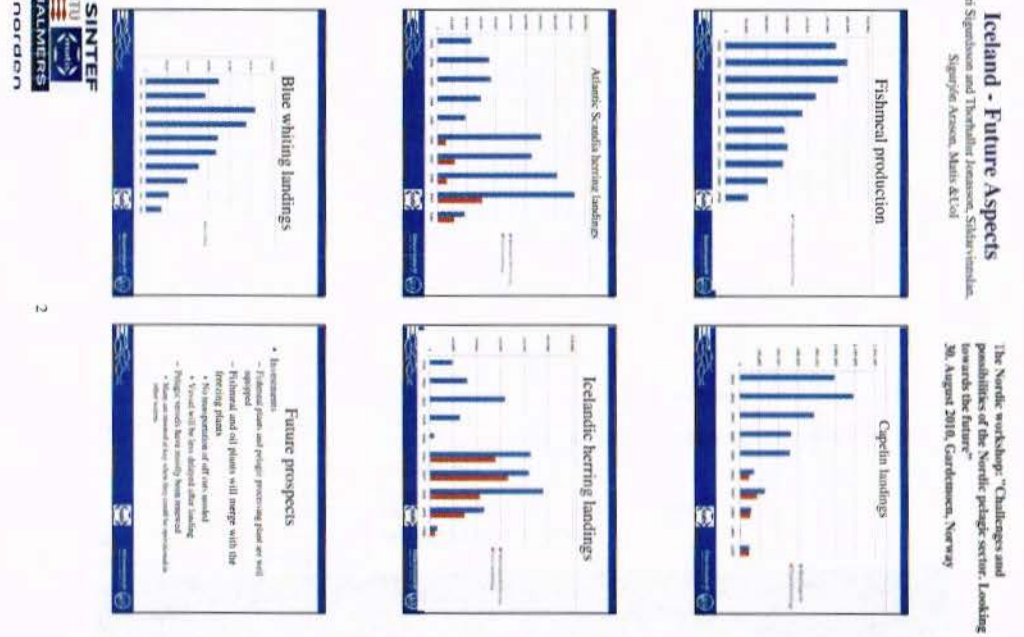
Herring keels total volume 11337 ton +5,3%

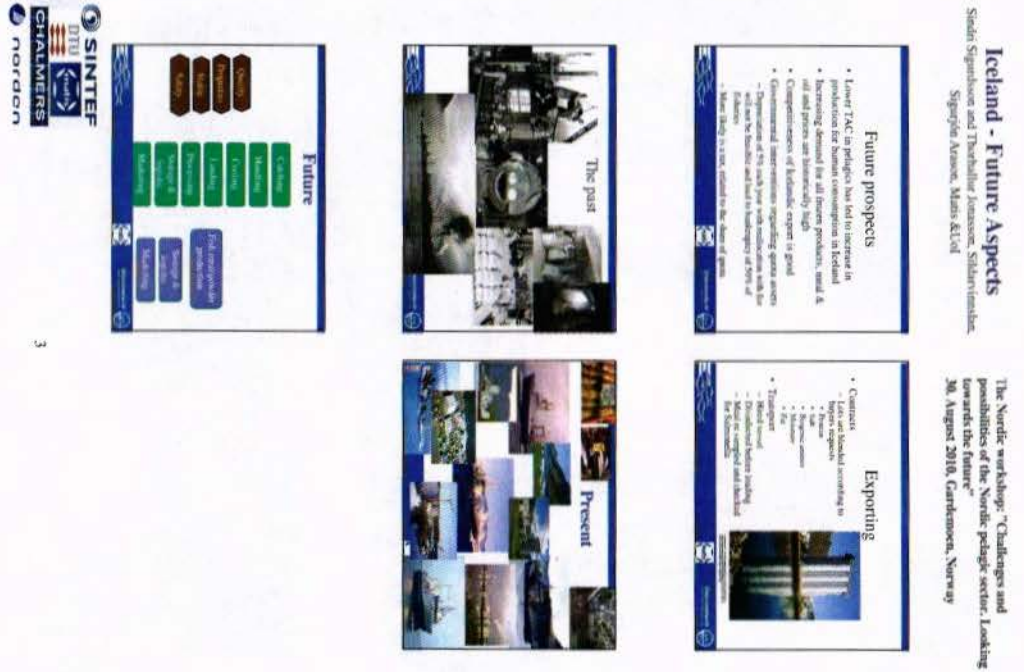
Volums 12 monthes



	Volume (ton)	Trend (%)
Sill i glas	6 470	+9,8
Matjessill	2 919	+1,9
Ansjovis	753	+1,4
Inläggningssill	890	-1,8
Gaffelbitar	94	+0,2
Steksill	211	-19,7

Källa: AC Nielsen rullande helår tom w5309





How do we eat herring?

As a mane component in a meal

On the buffet

As a sandwich

As spice in a dish

As every day food

Abba Seafood

Källa: Fokusgrupper "Sillkylen", 2002

Who is eating herring

Age : 15-24 25-49 50 - >

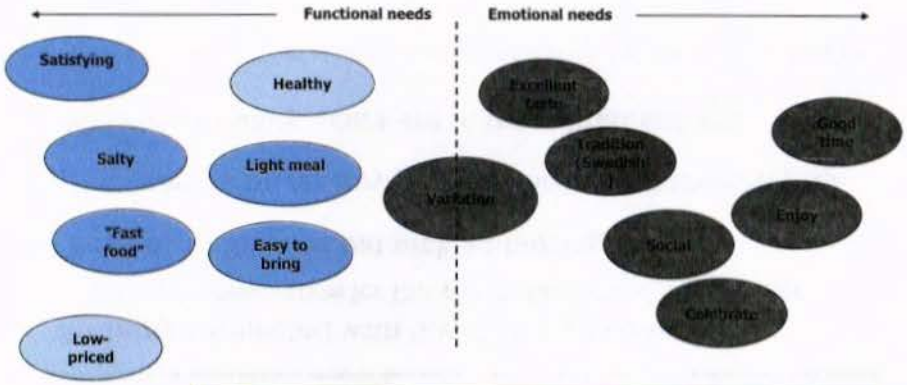
Abba Seafood

"erring universe" a positive place...

Abba Seafood

Why do we eat herring?

Herring are "Food for happy social events and Swedish tradition".



The usual herring consumer eat herring on emotional reasons. The heavy user eats herring form functional reasons.

Abba Seafood

Källa: Fokusgrupper "Sillkylen", 2002

From our consumer contact
Taste

- What is the reason that the herring some times taste bad, I eat a lot of pickled herring and some times the taste is terrible
- I eat a lot of pickled herring, but this time it did not taste good. The taste was bitter.
- The herring tasted rancid!
- The herring smells oily and are very soft

From our consumer contact
Consistency

- Dissolved
  - Had guest and was going to serve a pickled herring lunch. When we opened the tin, the content was dissolved. This ruined the lunch
  - Ruined Easter holyday! Bought two tins of herring fillets, the filets was very soft. Tasty herring is a must during the Easter holydays. Have dried the tears, but there is still the broken heart!
  - Bought four tins of herring fillets in two of the tins the fillets was dissolved.

Herring in the Swedish marked

- **Strongly connected with Swedish traditions**
  - **50 % of consumption for Christmas ,Easter and midsummer**
- **7 out of 10 Swedes eat pickled herring**
- **The average buyer buy pickled herring 4,3 times a year.**
- **50 % of all heavy users are in the retirement age**
- **The share of non users are increasing while heavy users decrease**
- **Large price cuts on pickled herring before Christmas ,Easter and midsummer**

Consumer quality

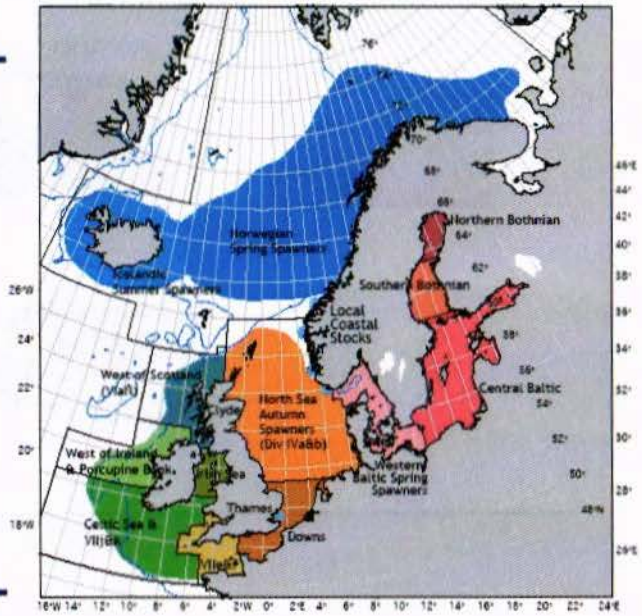
- Taste
- Consistency
- Even sized pieces
- Look
  - Shiny
  - Natural colour
  - No bones
  - No skin
  - Little or no tales pieces


mat & dryck

Dyraste **matjessillen** bäst!

Industrial quality

- Food safety
- Correct function
- Good Storage
- Proper fat
- Correct size
- Correct cut
- Proper packaging
- Correct price



Abba Seafood

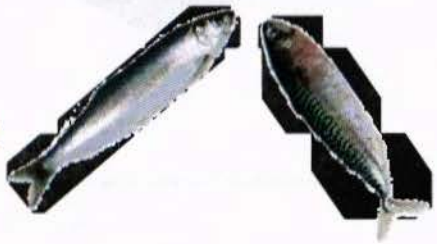
From our consumer contact
Size on the pieces

- There are too many small pieces in the jar, it is not like that in the large jars. Why?
- In the bottom of the jar there was a lot small, soft pieces of herring. No niece pieces as stated on the jar
- The size on the pieces varies too much. Some are so small that the look more like "skin" and others are too large. The pieces should be even and of high quality. The customer has bought several jars the last month (10 Jars) with different dates.

Abba Seafood

Select quality fat

- In the grocery store, we face many choices and temptations.
- Most people know that we should choose fish instead of meat, Why?
- It's not about to buy food without fat, but fat with quality



Abba Seafood

From our consumer contact
Looks

- A head with eye remand on the herring piece
- There was skin and tail left on the herring piece.
- Have "Skjärgårdssill" as a favourite, but this jar did not have any nice pieces of herring. There was an aprox. 13 cm long piece of skin in the jar.
- Yellow herring in the jar

Abba Seafood

Inläggningssill

Sill i glas

Smörgåssill

Traditionell skivad smörgåssill

Modern smörgåssill

Matjes

Når man skal vurdere en silds kvalitet bør man se på 4 dimensioner:

1. Udseende

- Det er vigtigt at en sild ser både frisk og appetitlig ud, når den serveres. For at opnå det velkendte, blanke sølvskær skal silden afskindes nænsomt. Herefter skal silden gennemgås minutiøst, så den er fri for urenheder og fremstår flot.

2. Størrelse

- At "en stor sild er en god sild" er helt korrekt. Det er nemlig fedtet der giver smagen, og store sild er lig fede sild. Specielt efterårets første fangster er gode, da silden på netop dette tidspunkt har spist sig stor og stærk inden den årlige gydevandring.

3. Fasthed

- En god marineret sild er desuden kendetegnet ved at have en god fast konsistens. Fast-heden hænger både sammen med sildens størrelse og råvarens alder. Ofte siger man om en god fast sild, at der er godt bid i den.

4. Smag

- Den foretrukne danske sild er en marineret sild med den karakteristiske let søde smag. Den bedste smag opnås ved at anvende store, fede sild, som enten lægges i en cremet sauce eller i en sukker/eddike-lage tilsat den rette blanding krydderier.

Storkök

A new marinated herring product using organic ingredients and full product history

Eurofish
INTERNATIONAL ORGANISATION

Marco Thorup Frederiksen, Ph.D.

Conference in Gardemoen 30 August 2010

Eurofish

Thank you

Abba®
SINCE 1836

A test herring product - continued

Organic marinade

MSC labelled (Sustainability)

The lid label contains more information

Vessel picture

Catch position on a map

Date of catch, processing dates, names of all companies involved

Access to a Web site with a unique number

Agenda

A test herring product. Organic ingredients and full product story

Freeware: Pelagic Information Program – PIP

Background information on Eurofish

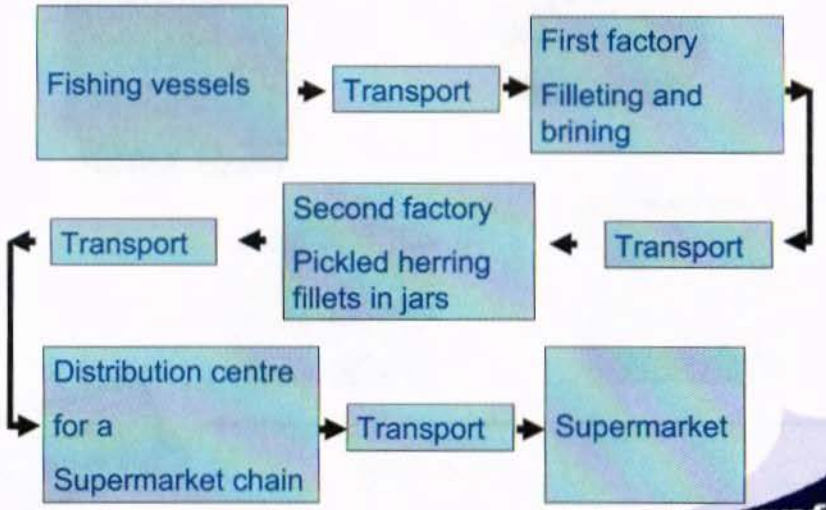
A test herring product - continued

Example: Web-site - Full traceability tree for all product components

More information on:
Producer 1: Kattegat Seafood
Producer 2: Pelagic Skagen
Fishing vessel: HG 263 Stromboli
Organic marinade: All ingredients

A test herring product

The herring chain



A test herring product - continued

The project is ongoing.

Results of the Danish consumer surveys are reserved for the project partners.
Market surveys have been conducted by Eurofish in Germany, Russia and Ukraine.

Future activities- product marketing (packaging/label)

Eurofish would be interested to participate in similar projects

A test herring product - continued

"Organic marinade" and "Onions" are chosen:

More information on:
Organic vinegar
Onions
Spices
Flavouring
Sugar
Salt
Water

For more information about this project please contact:

EUROFISH: Marco Frederiksen
E-mail: Marco.frederiksen@eurofish.dk

Danish Technological Institute: Alex Veje Rasmussen
E-mail: Alex.veje.rasmussen@teknologisk.dk

Pelagic Skagen: Mogens Andersen
E-Mail: ma@pelagic.dk

Kattegat Seafood: Jens Bachmann
E-mail: jb@kattegat-seafood.dk

Foodtag Traceability System: Hardy Jensen
E-mail: haj@agrowise.dk

A test herring product - continued

Is there a market segment willing to pay a premium for the

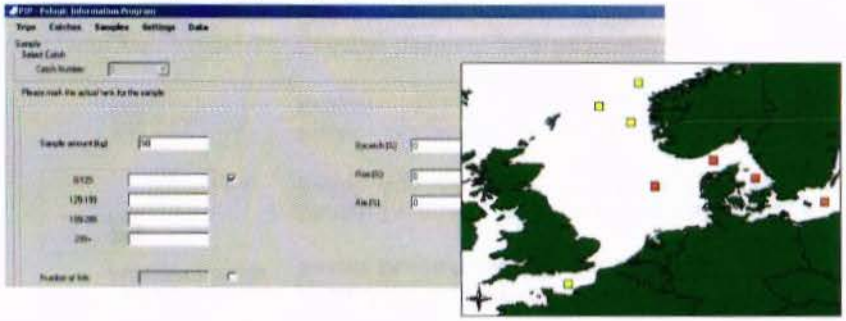
1) Full product story?

2) Organic ingredients?

3) Sustainable catch?

Pelagic Information Program - continued

Catch samples, quality, size grades



Overview of all catches
- A planning tool

Freeware: Pelagic Information Program – PIP

For pelagic vessels only

- **To document the catch and quality**
- **Overview of previous catches on the vessel**
- **Trustworthy information for the buyers**
- **Also a planning tool for the vessels**

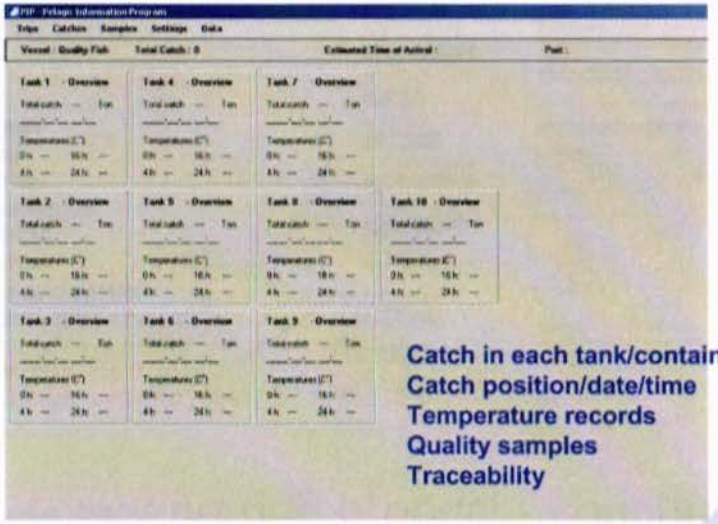
Pelagic Information Program - continued

On the vessel:
Planning fishery from historic catch
Collect all data with one program

On shore:
Improved information
- easy overview of different qualities
- same information format from all vessels
- data can be transferred to production systems

Is being tested in practise at the moment and will be available from www.eurofish.dk in 2010

Pelagic Information Program – overview catch



Project examples

- **Studies for the European Commission: Aquaculture, industry sector, inland fishing, market prices, evaluation of EU support programs for the fisheries sector**
- **EU 6. and 7. framework: SEAFOODplus, Sustain aqua, EcoFishMan**
- **Development of the new herring product**
- **Conference in Latvia**
  - Canning industry
- **Workshop in Georgia**
  - Certification and traceability
- **Workshop in Poland**
  - Recirculation Aquaculture
- **Arrange Business-to-Business meetings, e.g. Spain – Russia**

FAO and EUROFISH Regional Workshop, Ukraine March 2010

WTO and market access issues in fisheries and aquaculture

Eurofish

Who is EUROFISH

- Intergovernmental organization.
  Service provider for its Member States, for the private industry and governments
- 13 Member Countries:
  Albania, Bulgaria, Croatia, Denmark, Estonia, Italy, Latvia, Lithuania, Norway, Poland, Romania, Spain and Turkey

Eurofish

In-House Expertise

- Trade and marketing
- Market, consumer and sector surveys
- Catch handling
- Chain management
- Quality assurance
- Traceability
- Dissemination of information
- IT enabled services and database management

Eurofish

What We Do

- **Projects**:
  All aspects of "post harvest" fisheries and aquaculture
  - Industry, trade and markets
  - Aquaculture
  - Food safety and quality assurance
  - Dissemination of information
- **Publications**
  - EUROFISH Magazine
  - Guides books, special publications
- **Advertising and promotions**

Eurofish

Special publications

Fish industry in Turkey

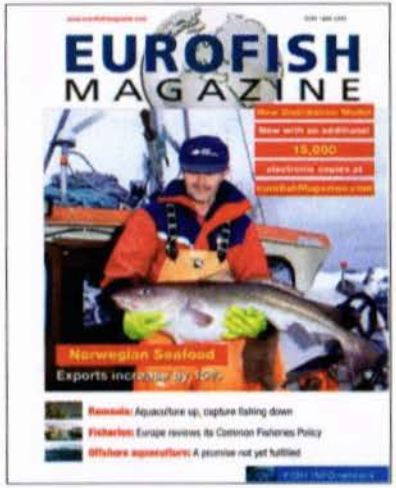
Market opportunities for dorada, seabass and rainbow trout in Poland

Aquaculture in Estonia, Latvia, Lithuania

GLOBEFISH Publications

Eurofish

EUROFISH Magazine



- Leading fishery and seafood magazine
- Promotes industry and events in EUROFISH member states
- Print run 3,000 copies
- Free distribution to member countries
- Features on countries, aquaculture, trade, technology, processing

Online version: www.eurofishmagazine.dk

Eurofish

Thank you for your attention

Eurofish
INTERNATIONAL ORGANISATION

Contact: Marco Thorup Frederiksen
E-mail: Marco.Frederiksen@eurofish.dk
Tel +45 333 777 69

Please visit our sites:
www.eurofish.dk
www.eurofishmagazine.com

Eurofish

Guide books

Guide to Recirculation Aquaculture

Handbook for Sustainable Aquaculture

Guide to Packaging Technology for Seafood Value-addition

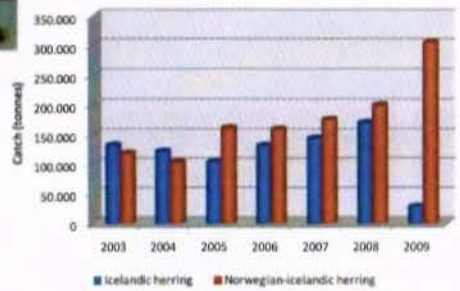
Guide to Seafood Hygiene Management

Guide to Traceability

Sustainability and Quality Assurance in the Seafood Sector
Pipeline

Eurofish

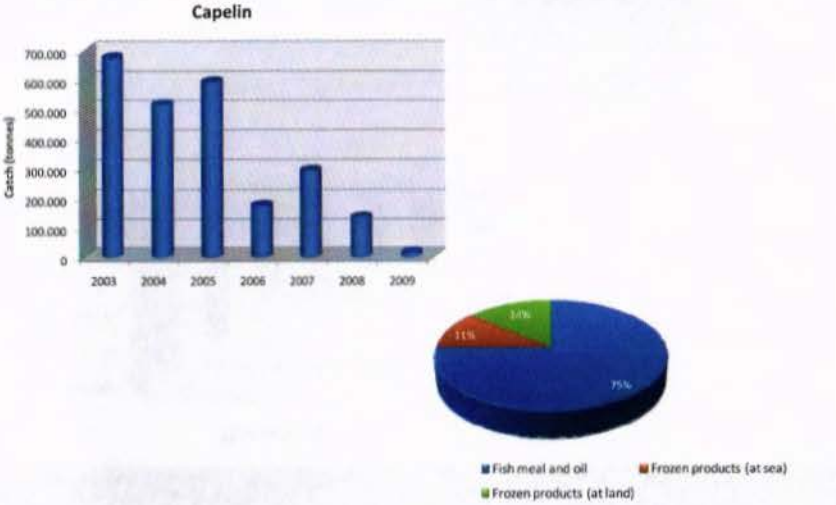
Catch and products of pelagic fish in Iceland



Catching procedures for pelagic fish – quality and processing management

Ásbjörn Jónsson-Matís

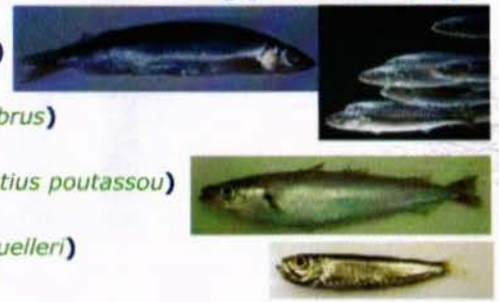
Catch and products of pelagic fish in Iceland



Pelagic fish in Iceland

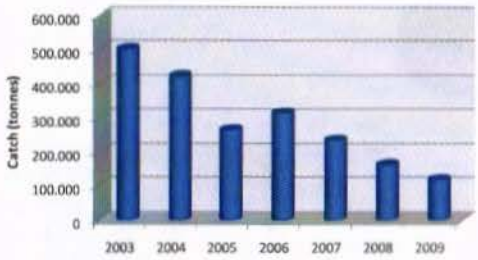
Main pelagic species:

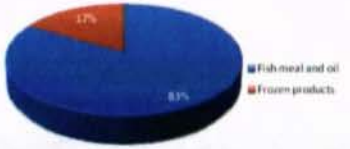
- **Icelandic and Norwegian-Icelandic herring** (*Clupea harengus*)
- **Capelin** (*Mallotus villosus*)
- **Mackerel** (*Scomber scombrus*)
- **Blue whiting** (*Micromesistius poutassou*)
- **Pearlsides** (*Maurolicus muelleri*)



Catch and products of pelagic fish in Iceland

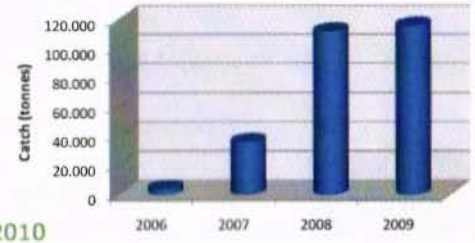
Blue whiting





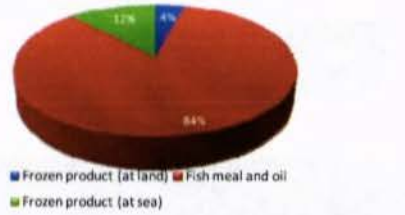
Catch and products of pelagic fish in Iceland

Mackerel



2010

2009



Catch and products of pelagic fish in Iceland

Pearlsides

Catch in 2008 48 tonnes
Catch in 2009 45.967 tonnes

Product-Fishmeal

- **Fat 10%**
- **Water 10%**
- **Protein 65%**
- **Salt 7%**

EU taxes

- **0303 Fish, frozen, excluding fish fillets and other fish meat of heading 0304**
- **0303 74 30 10 Of the species Scomber scombrus**
  - **Third country duty: 20%**
- **0304 Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen**
- **0304 29 53 10 Of mackerel of the species Scomber scombrus**
  - **Third country duty: 15%**
- **0305 Fish, dried, salted or in brine; smoked fish, whether or not cooked before or during the smoking process; flours, meals and pellets of fish, fit for human consumption**
- **0305 41 Smoked fish, including fillets**
  - **0305 49 30 10 Of the species Scomber scombrus**
  - **Third country duty: 14%**

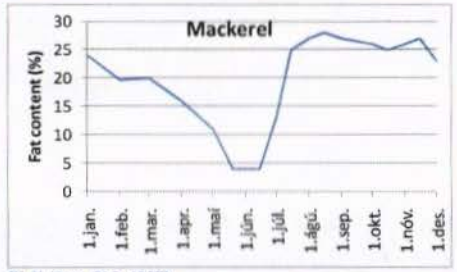
Catching season

Fat content and nutritional stage in herring and mackerel

Herring

- **Max fat 17-19% Sept/Nov**
- **Min fat 5% in May**
- **Suitable for salting**

Fat 12-14%



(H. H. Huss, FAO, 1995)

Process management

Catching method

Midwater trawling

Purse seine

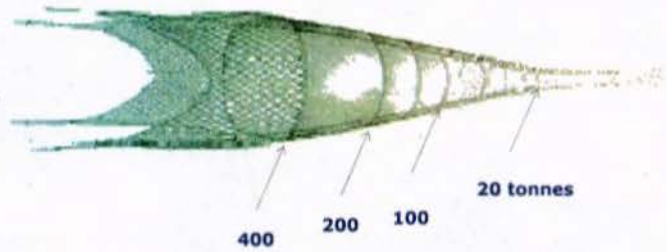
Handline

Process management

Factors that affect the quality and process management of pelagic fish

- **Catching season**
- **Catching method**
- **Size of the haul**
- **Length of the haul**
- **Grading of the fish**

Size and length of the haul



·Optimum size of the haul 100 tonnes
·Optimum length of the haul 2-5 hours

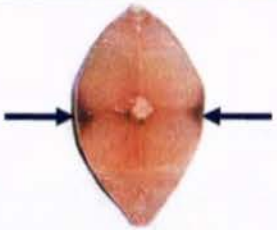
Handline fishing

- Difficult to catch
- Catching time
- Mild treatment
- Cooling
- Environmentally friendly

- **Profitability ?**

Grading of the catch

Style grader for pelagic fish

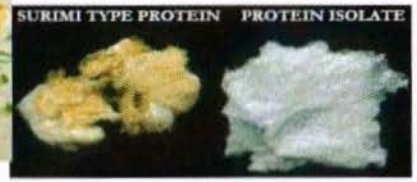


Rod fishing

Products

- **Other products**
  - ✓ **Protein isolate**
    - ➢ **Surimi based products**
  - ✓ **Bioactive compounds**
    - ➢ **Peptides**
    - ➢ **Omega-3**



Products of pelagic fish

- **Fish meal**


- **Frozen**
  - ✓ **Whole**
  - ✓ **Headed/gutted**
  - ✓ **Fillets**


Thank you for your attention

Products

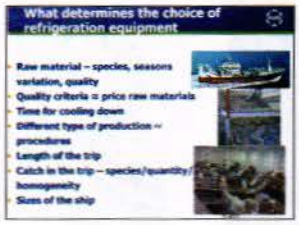
- **Full processing**
  - ✓ **Salted**
  - ✓ **Canned**
  - ✓ **Dried**
  - ✓ **Smoked**
  - ✓ **Breaded**

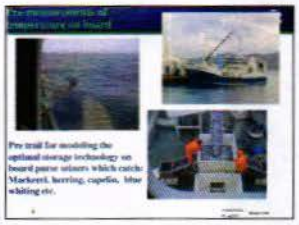


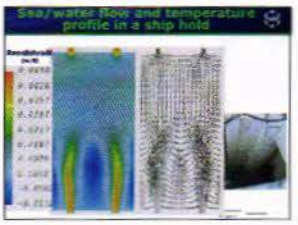

Iceland - Future Aspects

Sindri Sigurdsson and Thorhallur Jonasson,
Sildarvinnslan,
Sigurjón Arason, Matis &UoI

The Nordic workshop: "Challenges and possibilities of the Nordic pelagic sector. Looking towards the future" 30. August 2010, Gardemoen, Norway





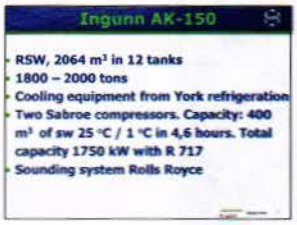


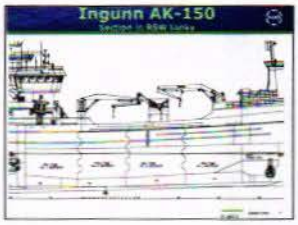
SINTEF DTU matis CHALMERS norden

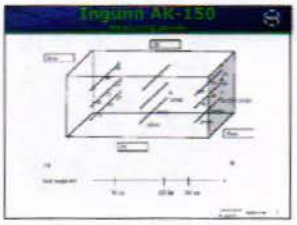
Iceland - Future Aspects

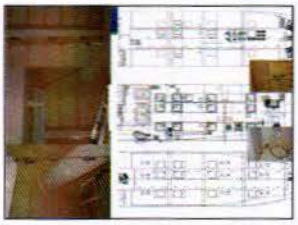
Sindri Sigurdsson and Thorhallur Jonasson,
Sildarvinnslan,
Sigurjón Arason, Matis &UoI

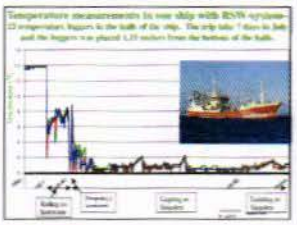
The Nordic workshop: "Challenges and possibilities of the Nordic pelagic sector. Looking towards the future" 30. August 2010, Gardemoen, Norway

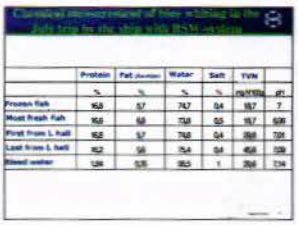












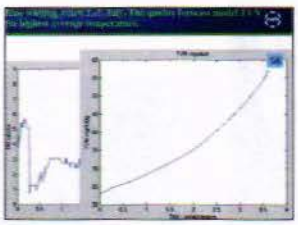
	Protein	Fat	Water	Salt	TVN
	%	%	%	%	mg/100g
Frozen fish	16.8	0.7	74.7	0.4	15.7
Most fresh fish	16.6	0.8	73.8	0.5	15.7
First from L hall	16.5	0.7	74.0	0.4	20.0
Last from L hall	16.2	0.6	75.4	0.4	45.6
Used water	0.04	0.05	99.5	1	20.0

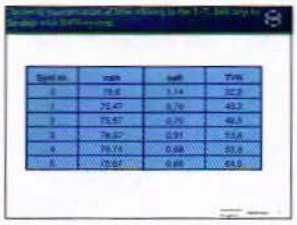
SINTEF DTU matis CHALMERS norden

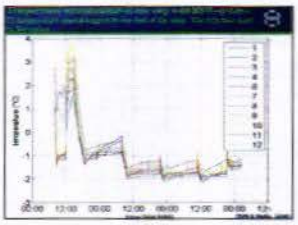
Iceland - Future Aspects

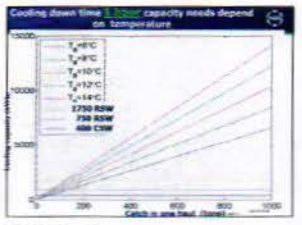
Sindri Sigurdsson and Thorhallur Jonasson,
Sildarvinnslan,
Sigurjón Arason, Matis &UoI

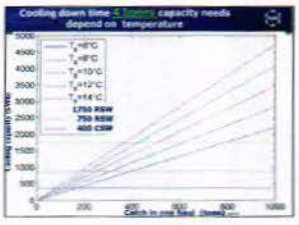
The Nordic workshop: "Challenges and possibilities of the Nordic pelagic sector. Looking towards the future" 30. August 2010, Gardemoen, Norway









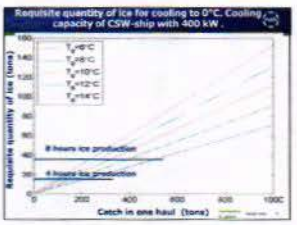


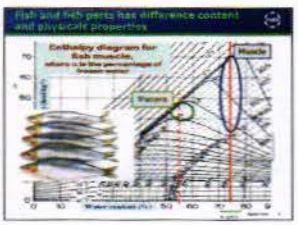
SINTEF DTU matis CHALMERS norden

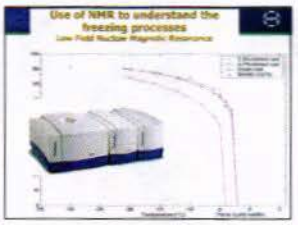
Iceland - Future Aspects

Sindri Sigurdsson and Thorhallur Jonasson,
Sildarvinnslan,
Sigurjón Arason, Matis &UoI

The Nordic workshop: "Challenges and possibilities of the Nordic pelagic sector. Looking towards the future" 30. August 2010, Gardemoen, Norway







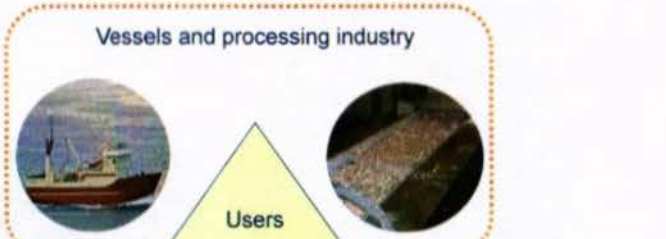
SINTEF DTU matis CHALMERS norden

Iceland - Future Aspects

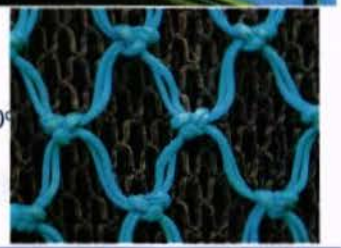
Sindri Sigurdsson and Thorhallur Jonasson, Síldarvinnslan,
Sigurjón Arason, Matís &Unó

The Nordic workshop: "Challenges and possibilities of the Nordic pelagic sector. Looking towards the future" 30. August 2010, Gardemoen, Norway

Working method



Trawl net - T90 cod end



- T90 cod end – the net are turned 90°
  - Improved quality of the fish?

The effect of catching methods on pelagic fish quality

The main aim

Improving fish quality:

(1) Little scientific knowledge about: how do different catching method impact the fish quality?

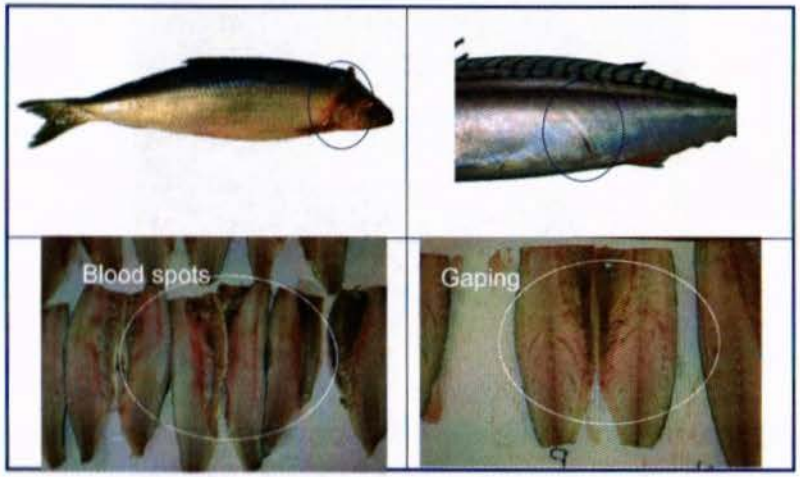
(2) Comparison of two different trawl net and the impact on fish quality, onboard survival rate and size of the catch

Catching data, pelagic fish

	Herring (16.7% fat)				Mackerel (29.3% fat)	
Fishing gear	*Trawl. Trad.*	*Trawl. T90*	*Ring net*	*Coastal net*	*Trawl. Trad.*	*Trawl. T90*
Location	67°	67°	67°	67°	60°	60°
Time	Oct 2004	Oct 2004	Oct 2004	Oct 2004	Oct 2004 ↗ (day)	Oct 2004 ↗ (night)
Catch (ton)	160	200	90, 170	115	170	180
Wind (m/s)	0-5	0-5	0-5	10-14 ↗	3-4	3-4
Catching time (h)	2	1.3	2.3	1.3	1.5	3

Location of the trials

External damage



Quality parameters, herring

Quality parameters	T90 cod-end	Trad. Trawl	Ring net	Coastal net
Weight (g)	389±56^{A}	365±61^{A}	368±52^{A}	365±51^{A}
Mortality (%)	100^{A}	100^{A}	33^{B}	22.4^{B}
Initial pH	6.3±0.1^{A}	6.5±0.1^{B}	6.8±0.2^{C}	6.9±0.2^{D}
Rigor[1] 0 hour (%) 2-4 hour (%)	0^{A} 100^{A}	0^{A} 100^{A}	0^{A} 30^{B}	0^{A} 28^{B}
External damages (%)	1.8^{A}	2.1^{A}	2.0^{A}	6.7^{B}
Fillet gaping score: 0 - 5	0^{A}	0^{A}	0.13±0.3^{A}	0.1±0.3^{A}
Fillet blood spot score: 0 - 2	1.0±0.5^{AB}	1.2±0.7^{AB}	0.9±0.7^{A}	1.4±0.7^{B}

[1] Rigor: 0=pre/post-rigor, 1=rigor

Conclusions, herring and mackerel

- Herring:
  - Trawling was the most stressful catching method
  - In general low degree of external damages,
  - High degree of blood spots in the fillets, with significant higher degree in herring caught by coastal net – weather conditions may have had an impact
- Mackerel:
  - Mackerel caught by traditional trawl net had more external damages than mackerel caught by the T90 cod-end trawl net.
  - The traditional trawl caught mackerel was bigger than T90 caught fish. According to the fishermen, this was due to differences in capture time, i.e. time of the day. Smaller fish are commonly caught at night.

Quality parameters, mackerel

Quality parameters	T90 cod-end	Trad. Trawl
Weight (g)	523±114^{A}	620±133^{B}
Mortality (%)	97.6^{A}	98.9^{A}
Initial pH	6.4±0.1^{A}	6.5±0.1^{A}
Rigor[1] 0 hour (%) 3-4 hour (%)	44^{A} 100^{A}	32^{A} 96^{A}
External damages (%)	8.2^{B}	15.4^{A}
Fillet gaping score: 0 - 5	2.0±1.5^{A}	2.1±1.5^{A}
Fillet blood spot score: 0 - 2	0.4±0.6^{A}	0.6±0.8^{A}

[1] Rigor: 0=pre/post-rigor, 1=rigor

Belly bursting – industrial method

- Fishermen want a roboust, fast and objective method to estimate belly bursting
- A method is developed using the instrument: Bioluminiscence – Uni Lite®

This instrument is available at the market today

Belly bursted herring

Lab scale testing

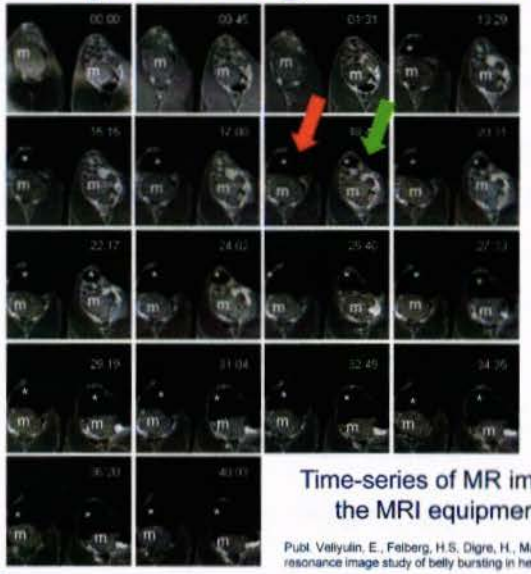
Belly bursting

- One of the quality challenges on board
- Report the amount of "åte" (content of feed in stomach and intestines) at the auction.
- Report a higher amount than what is present to be "on the safe side"
- Amount of "åte" is not a good measurement because the enzyme activity is what decides
- The belly bursting phenomena has been a research area for many years

Qpoint - mobil NIR instrument for rapid fat determination on board fishing vessels (Qvision AS)

On board M/S Traal

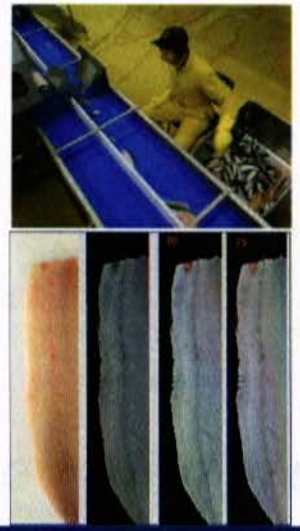
Belly bursting – reasons?

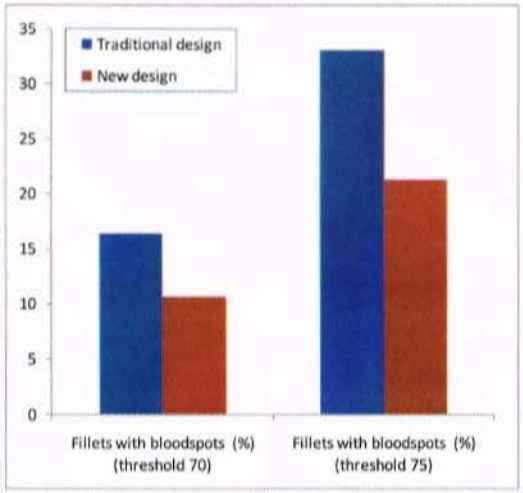


Time-series of MR images and time elapsed in the MRI equipment at room temperature

Publ. Veliyulin, E., Felberg, H.S. Digre, H., Martinez, I. 2006. Non-destructive nuclear magnetic resonance image study of belly bursting in herring (Clupea harengus). Food Chemistry

Product quality vs on board handling system





Data based on n=800 fillets

Web-based quality manual for pelagic fish

- A common framework for the Norwegian pelagic fishing fleet, processing industry and exporters based on quality and safety requirements
- Ensure a uniform quality of the pelagic fish products from catch to consumer
- Species included: herring and mackerel, but may be extended for other pelagic species like e.g. blue whiting, horse mackerel, capelin
- www.fhl.no/book (a temporary version of the quality manual)
- Will be completed by the end of 2011

The "Low salt products" project

Industry: Mills, Nortura, Brødrene Remø, Berggren, Stabburet, Grilstad, Finsbråten
RTD: SINTEF Fisheries and Aquaculture, SINTEF Materials and chemistry, NOFIMA

On board handling systems

Knowledge based development

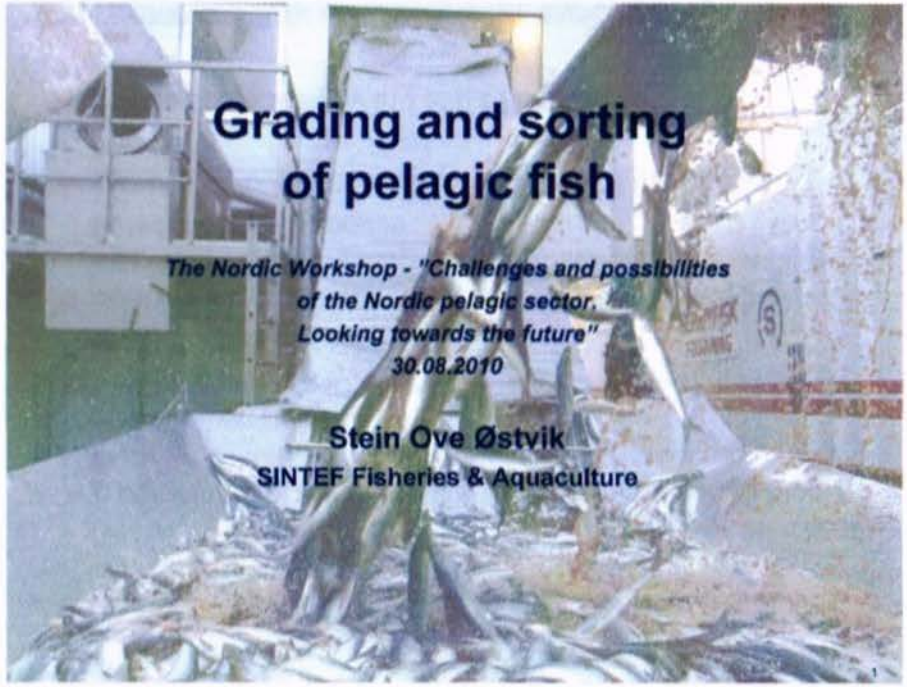
Grading and sorting ...

- All natural raw materials have variations within batches. Food raw materials contain components and units with different physical characteristics and some might be of health hazard.
- "All" buyers of food want predictability to appearance, size and quality. Influence value.
- Grading and sorting of food raw materials are essential operations in processing - ... could include correction/trimming
- Grading = assessment and validation related to criteria's
- Sorting = dividing into groups (a sort=same characteristics or function as other)
- Solution/facit is traditionally the human senses

Grading criteria's

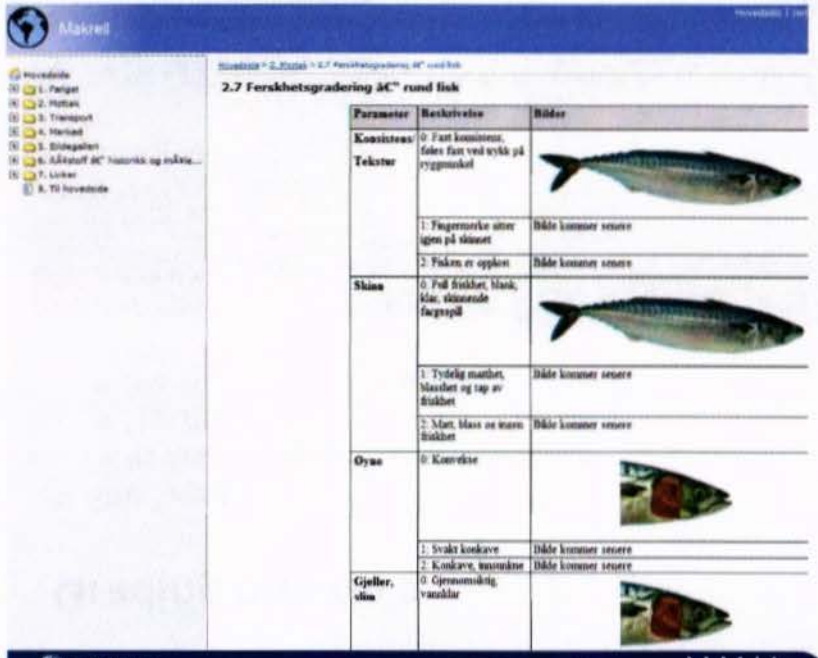
- **Bransjestandard NBS 50-01 (sild) (1989)** omfatter kvalitetsklassifisering av råstoff og ferdig produkt, samt spesifikke krav til fersk og frossen rund sild. Avhengig av egenspakene klassifiseres rund sild i to ulike klasser: Extra eller Normal.
- ***-Extra:*** Fisk i denne klassen viser tydelige tegn på en fagmessig håndtering og er åtefri. Sild i denne klassen har følgende karakteristikker: glansfullt, blanke gjellelokk, hard konsistens, fast buk, frisk lukt, klare og konvekse øye.
- ***-Normal:*** Fisk som tilfredsstiller krav i denne klassen er fisk med små tegn på skader fra fangst og håndtering. Sild i denne klassen har følgende karakteristikker: blankt skinn, blod på gjellelokk, fast konsistens, fast buk, nøytral lukt, røde gjeller.

- Kvalitetshåndbok for pelagisk fisk / Quality manual (2006 (draft))



Grading criteria's ....

- Physiological and microbiological quality
  - Fat content in flesh
  - Other nutritional content
  - Parasites
  - Histamine
  - Freshness:
    - Microbiological status (growth, hygiene)
    - Rancidity
  - Contaminants / environmental matter



Wrong specie – sorted out

Grading criteria's ...

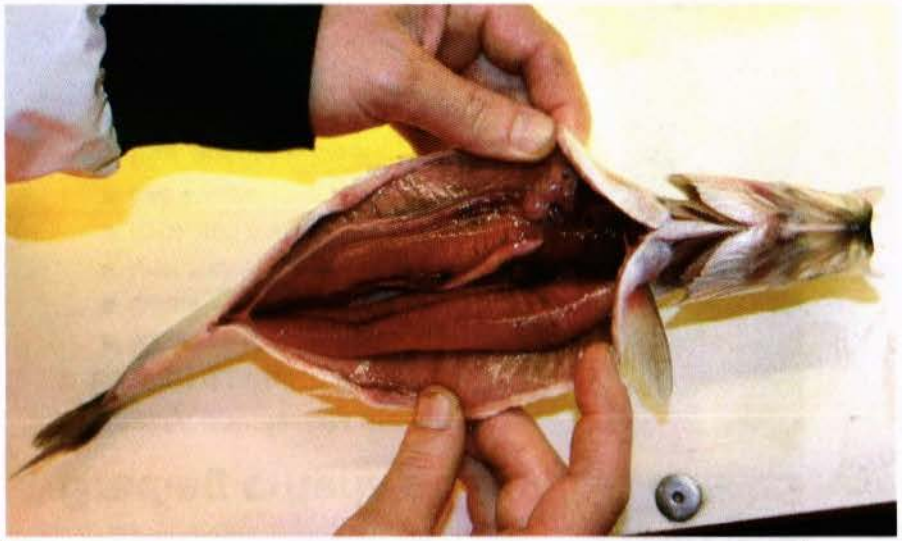
- Identity: specie, sex and origin
- Exterior quality:
  - 3D shape (whole, condition factor)
  - Colour
  - Unbroken skin – fatigue – scales
  - Eyes, gills and belly
  - Fish texture
- Interior quality (visual)
  - Feeding status, Belly membrane
  - Blood spots
  - Flesh texture / gaping
  - Parasites
  - Sex maturity

Present grading and sorting systems - landing

- General assessment of landing lot (catch, tank, …)
- Test sampling during landing for weight and quality assessment
- Weight sorting machines (total volume)
- Manual grading and sorting of flow after size sorting machine (random or manpower consuming)
- Random control in processing/packing

- Filleting of herring: Grading and sorting machinery connected to filleting machine (orientation/feeding to machine, 3D-damage, (quality, size))

Sex sorting – herring roe in Norwegian fisheries; potential 17 000 tons



Size sorting machine – roller bars

Grading criteria's ….

- Size / weight
  - No defined standard - Market driven ranges
  - (e.g. 200-250 g, 250-300 g, 300-350 g, 350 g +)
  - (e.g. 200-400 g, 400-600 g, 600 g +)

Manual sorting of wrong size and quality

Belts with increasing gap

Economic potential in improved size sorting

- Increased yield in herring filleting:
  - E.g. + 2%: 400 000 t x 2% = 8 000 t x 8 NOK/kg = 64 mill NOK/år
- Reduced cost by less down-grading to lower weight class:
  - Mackerel: 200 000 tons x price diff. 4 NOK/kg = NOK 8 mill (pr %)
  - Herring: 500 000 tons whole fish, price diff. 2 NOK/kg = NOK 10 mill (pr %)
- Less manual manpower; 40 persons = NOK 12 mill
- Potential higher price in market – better differensiation in market with better sorting

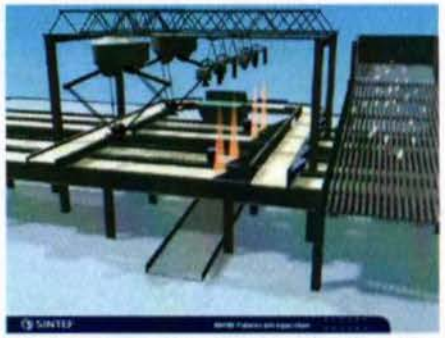
Sorting of herring, integrated in filleting machine

Capacity challange

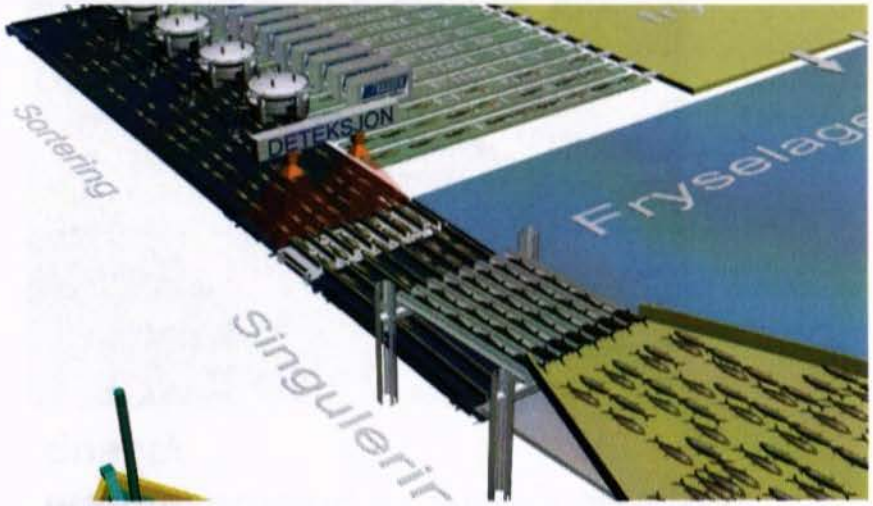
Råstoffkvantum/time	50000	kg/time	50000	kg/time
Fordelt på ant spor	12	spor	15	spor
Gjennomsnittsvekt	300	gr	300	gr
Antall cm/fisk/spor	50	cm	50	cm
=ant kg/min	833	kg	833	kg
=ant fisk/min	2778	stk	2778	stk
=ant kg/sek	14	kg	14	kg
=ant fisk/sek	46	stk	46	stk
=ant kg/min/spor	69,4	kg	55,6	kg
=ant fisk/min/spor	231,5	stk	185,2	stk
=ant kg/sek/spor	1,2	kg	0,9	kg
=ant fisk/sek/spor	3,9	stk	3,1	stk
=cm/sek/spor	193	cm/sek	154	cm/sek
=meter/min/spor	116	m/min	93	m/min

Sortering; FHL Pelagisk forum 2006

Sortering danner grunnlaget for å kunne differensiere i markedet



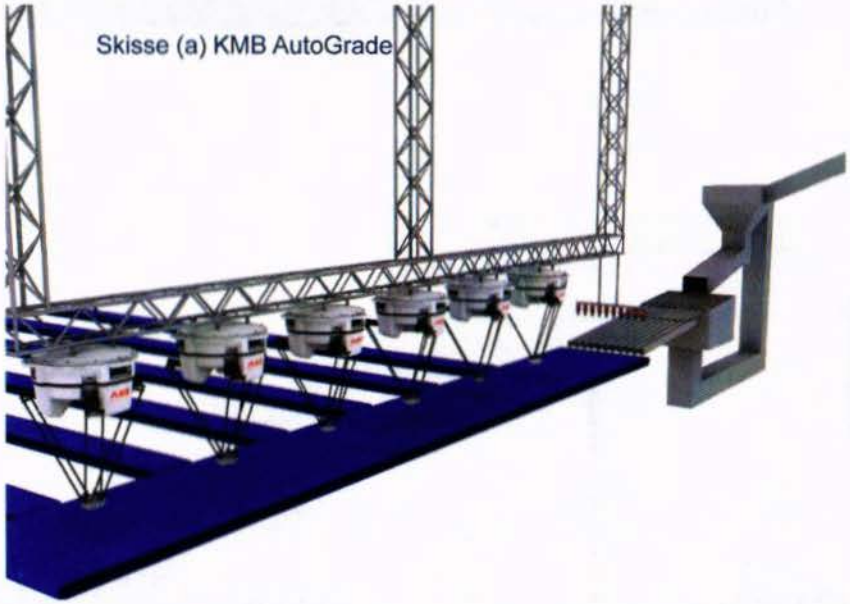
Skisse (b) KMB AutoGrade

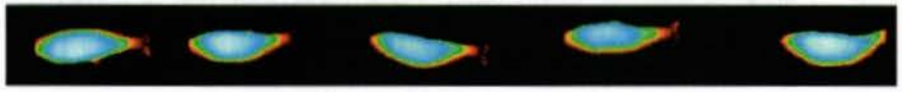


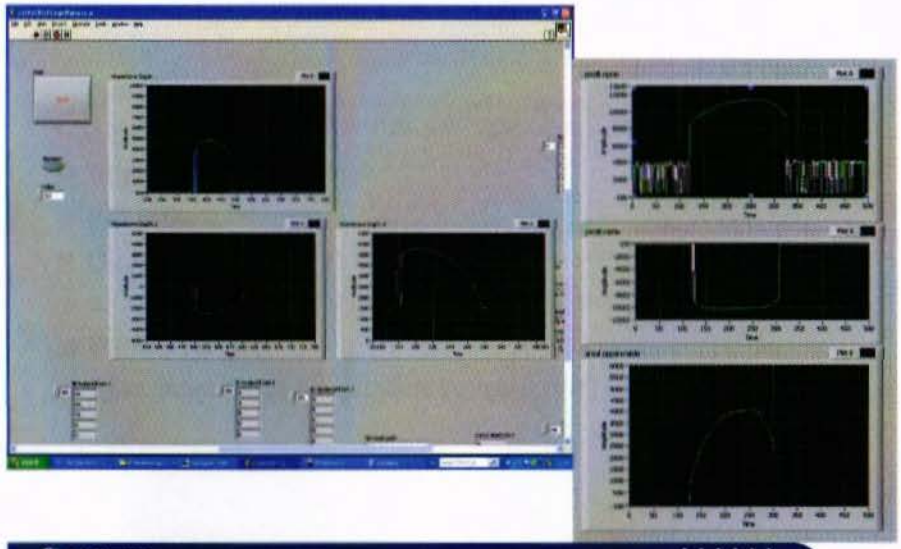
Test model – Industrial prototype

- Mechanical logistics
- Automatic detection and grading
  - Size, weight
  - 3D shape
  - Quality – colour
  - Fatigue
  - Specie
  - Fat
  - Sex
- Computer processing
- Mechanical sorting

Skisse (a) KMB AutoGrade

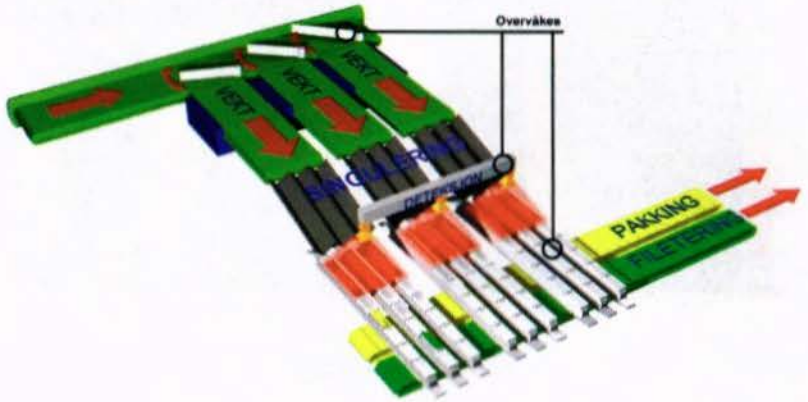






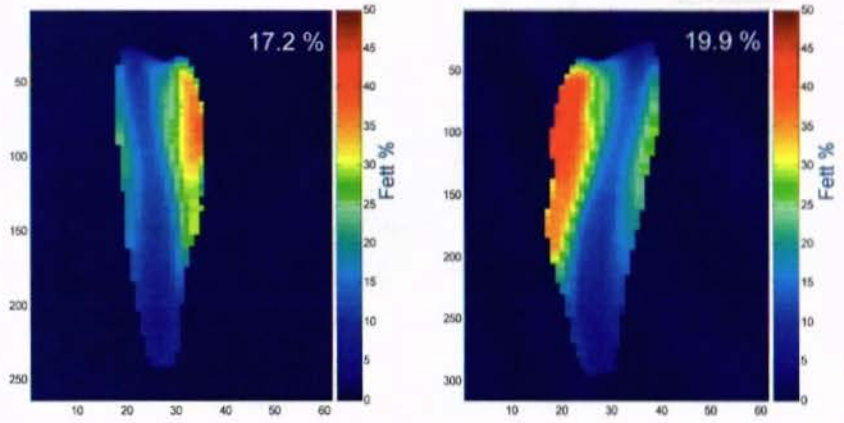
KONSEPT 2 KMB AUTOGRADE

Skisse (d) KMB AutoGrade



- New possibilities – increased demands
- Lead or follow
- Increased transparency - Grading technology
- Diffensiation – Boat <- Land indistry -> Market
- Increased value
- Automated processes
- Flexible technology – market and raw material may change

Fettinnhold i laks

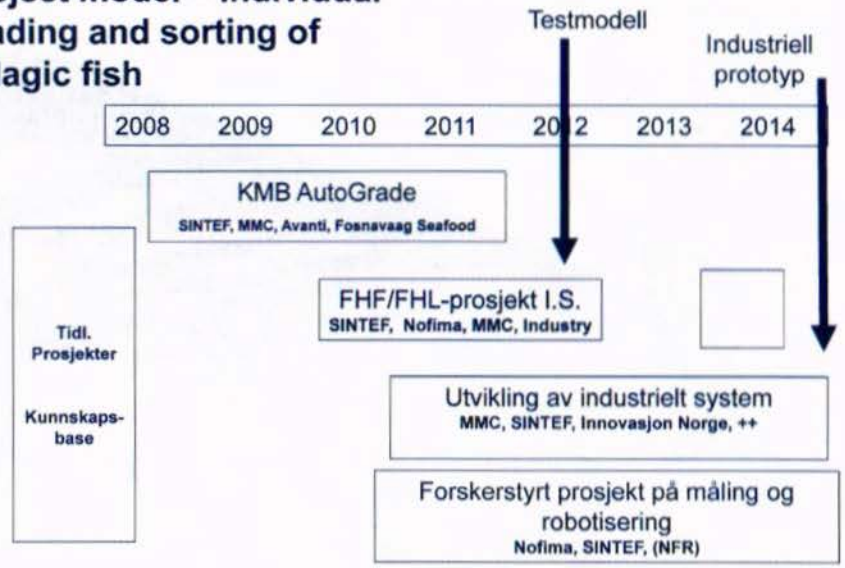


Processing & quality in pelagics

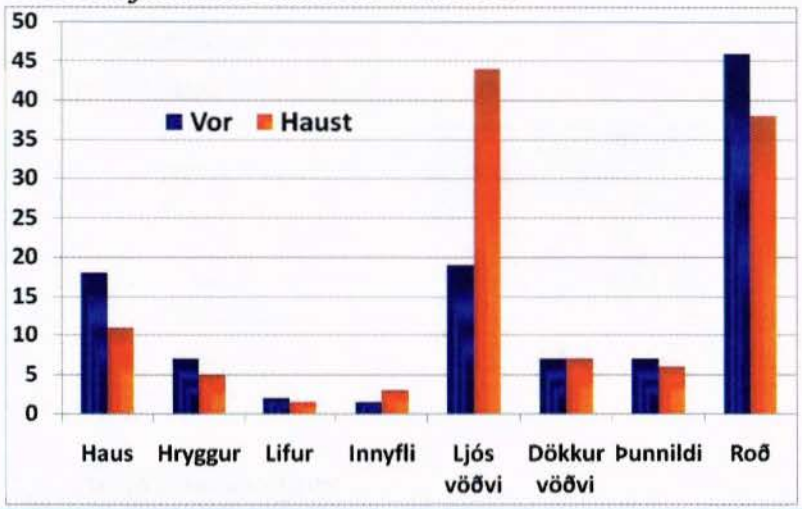
Sindri Sigurðsson Quality/R&D

Síldarvinnslan hf

Project model – Individual grading and sorting of pelagic fish



Annual fat distribution in makcerel



(H. H. Huss, FAO, 1995)

Quality

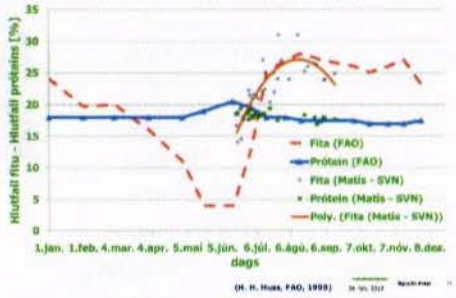
- Influence
  - Natural
    - Feed, maturing, infections, weather, etc.
    - Permanent state, immonent
  - Unnatural
    - Catch methode and treatment after catch
    - Non immonent, we are responsable

Unvelcommed guests

- Parasites
  - *Ichthyophonus* (herring)
    - Degrades the product
    - Blossoms in late November?
  - *Kodua* (mackerel)
    - Also related to handling
    - Usually not detected during processing period
  - *Anasakis* (mackerel/herring)
    - Detected in isolated hauls of mackerel
    - Low in herring
- Not potent to humans
  - If process ensures death of the parasite

Annual changes

- Fat
  - Contents varies heavily in the summertime (4– 30%)
  - Quality parameter?
    - Highly variable between individuals in the same school
    - Is high fat causing gaping and texture failure or is it the growth due to feeding?



(H. H. Huss, FAO, 1995)

Catching

- Catch methods and handling
  - Often little similarity between each fishing trip and even between hauls
  - Fishing is not like going to groceries, but can be more standardized
  - Preparation of chilled seawater
  - Limiting the time of trawling
  - Limiting the amount of fish in each haul
  - Limiting the amount of fish in each hold, refrigerant and fish ratio
  - All of this is not in favor of the fishermen, in the short run

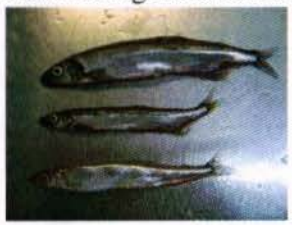
Bacterial

- Human interference
- Process based
  - Build up of fish residues
    - Bacterial nests

- Preventing unwanted bacteria
  - Personal hygiene
  - Access limitations
  - **Chilling**
  - **Process time**
  - Regular removal of residues
  - What's on the floor stays on the floor
  - Cleaning and sanitizing
    - **Cleaning friendly equipment**
  - **Common sense**

Processing preparation

- On board sampling
  - The ships holds do not contain homogeneus catch
    - Size distribution
    - Age of the rawmaterial
    - Feed
    - Hauling time
    - Infections/parasites



- Better info leads to better utilization
  - Pre sampling on board is win/win situation

Monitoring hazards

Matís ohf
Efna-og örverurannsóknir
Mýrargata 10
740 Neskaupstaður
Sími: 477 1250 / GSM: 858 5141
Fax: 477 1923

RANNSÓKNANIÐURSTÖÐUR
Útgefnar af faggildri rannsóknastofu
Report issued by Accredited laboratory

Síða 1 af 1

Síldarvinnslan hf
Neskaupstað
Hafnarbraut 6
Neskaupstaður

5702697479
Neskaupstað

Sýnatökudagsetning
Móttekið 25/03/2010
Rannsakað 25/03/2010

Blaðsíða 1 af 1

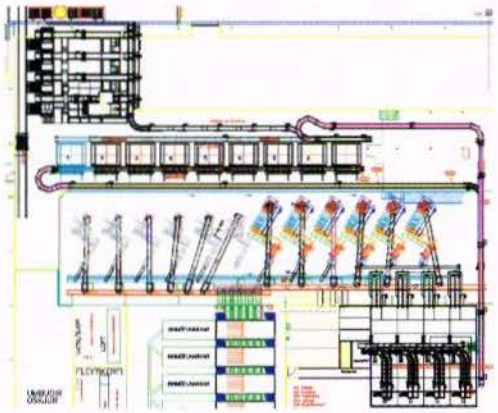
Tegund sýnis : Fiskur og hrogn / Loðna
Skýringar : Listeria rannsakað í 25 g sýnis

Sýni	Merking sýnis	Sýnagerð	Aðferð	Mæligildi	
NI0001890001	Lota 46 sýni A	Hrogn	Listeria (ÓB3)	Positive	
NI0001890001	Lota 46 sýni A	Hrogn	Listeria monocytogenes (ÓB3)	Negative	*
NI0001890001	Lota 46 sýni A	Hrogn	Listeria (talning)	<10 stk/25 g	*
NI0001890002	Lota 46 sýni B	Hrogn	Listeria (ÓB3)	Positive	
NI0001890002	Lota 46 sýni B	Hrogn	Listeria monocytogenes (ÓB3)	Negative	*
NI0001890002	Lota 46 sýni B	Hrogn	Listeria (talning)	<10 stk/25 g	*

ER Mæling var framkvæmd á efnastofu Matís í Reykjavík
EN Mæling var framkvæmd á efnastofu Matís á Neskaupstað
* Mæling er ekki faggild

Processing-layout

- Cons
  - Stops needed for cleaning
- Possibilities
  - Automatic cleaning of conveyors??



Temperature

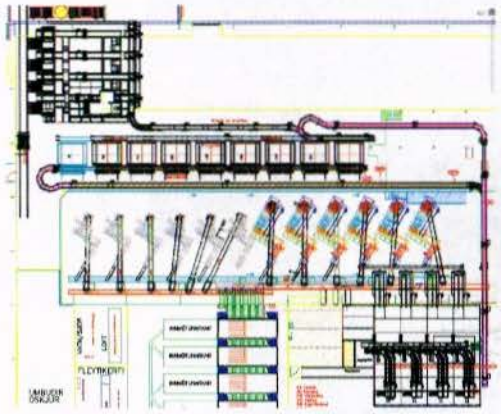
- Chilling
  - Starts at the vessel
    - Mistakes here are unrepareable
    - Is the limiting factor of fishing capacity
  - Retaining the temperature through out the whole processchain is the challenge
    - Absolutly mandatory over the summertime
  - No buffer or storage should be left unchilled

Freezing methods

- The other way
  - Horizontal plates
  - Cartons
  - No top contact
  - More or less automatic
  - Flow process FIFO
  - Shorter freezing time

Processing-layout

- Fast non-buffered
  - Retain chilling
- Minimize handling
  - Minimize risk of containment
- Worker friendly
  - Minimize noise, wet, lifting, etc.
- Fast freezing
  - More throughput
  - Better product
- Informational
  - Decision able
  - Operational friendly

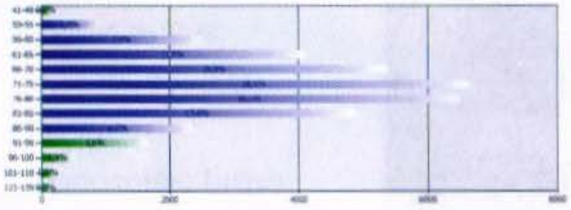


The valuechain between fishing and processing

Uppsjávarskoðanir - Sólarhringur

Skip: Börkur 12/09 09
Lota: 9126
Afurð: UF11-5900 (50-90)

10	13.367	493	3.581	73	13,77	0,00



Skoðunaratriði	Gallar	Gallar (g)	% af þyngd
Skaddað / Damaged	1	62	0,2%
Roðurarg / Peeling	3	216	0,6%
Rifið galla / Skinning	2	122	0,3%
Los / Texture	27	1.807	5,0%
Blóðflís / Bloodfillets	4	354	1,0%

Processing lines

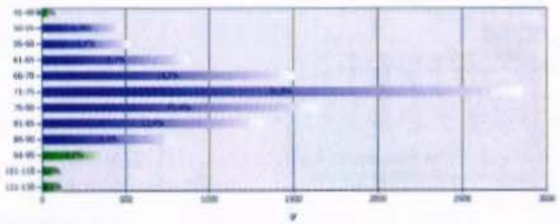
- Risk management
  - Pumping
    - Liquid and fish ratio
    - Force
  - Conveyors
    - Shovels
    - Speed
    - Sensor failures
  - Falling
    - Grading
    - Packing
  - Clipping
    - Gates
    - Scales
  - Hydraulics

The valuechain between fishing and processing

Uppsjávarskoðanir - Sólarhringur

Skip: Börkur 12/09 09
Lota: 9127
Afurð: UF11-5900 (50-90)

3	13.398	146	3.551	73	13,71	0,00



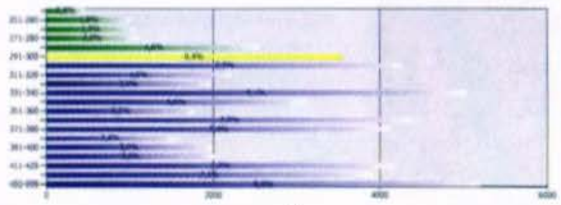
Skoðunaratriði	Gallar	Gallar (g)	% af þyngd
Skaddað / Damaged	0	0	0,0%
Roðurarg / Peeling	3	311	2,0%
Rifið galla / Skinning	2	112	1,1%
Los / Texture	22	1.621	14,3%
Blóðflís / Bloodfillets	0	0	0,0%

The valuechain between fishing and processing

Uppsjávarskoðanir - Sólarhringur

Skip: Börkur 08/09 09
Lota: 9124
Afurð: UH03-3000 (300-999)

5	11.136	158	11.088	351	3,85	0,00

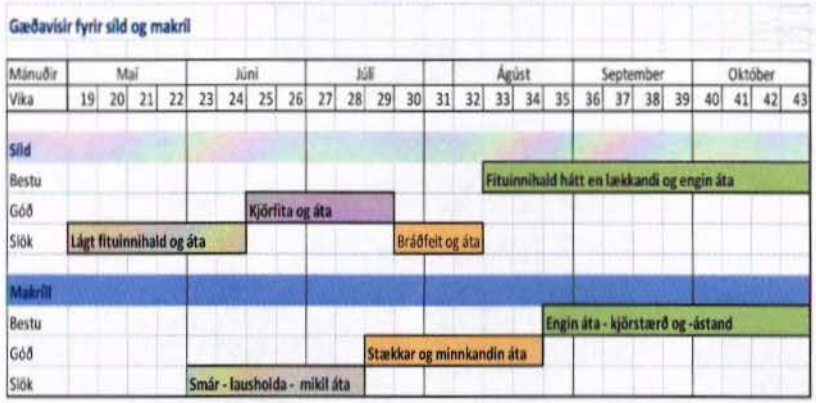


Skoðunaratriði	Gallar	Gallar (g)	% af þyngd
Harðskóðnar	0	0	0,0%
Skaddað / Damaged	1	425	0,8%
Kviðskemmd 1	1	283	0,5%
Roðskemmd/skin damaged	0	0	0,0%
Kviðskemmd 2	1	366	0,7%

Quality guides/standards

- The ecology of the sea
  - Feed and feed types
  - Temperature/currents
- Fat/growth alters between years
  - This year delayed
  - But similar as 2006/7
- To make a quality standard
  - Catching must be more standardized
  - Storing on board and handling must be more standardized
- Purpose
  - Quicker and better decisions !!

Quality guidiense for herring/makcerel



Marine protein isolates in foods

- **Surimi:** Its gelation capacity very attractive in all gelled fish products (fish balls, fish cakes, crab sticks..)
- **Powder:** can replace milk-/soyproteins in soups, energy drinks, bakery products
- **Marinades:** injection into fillets for improved water holding/juiciness (replaces phosphates with a natural product)
- **Coating:** on fried products (nutrilean™)
- **Biodegradable films :** with antimicrobial and antioxidative properties



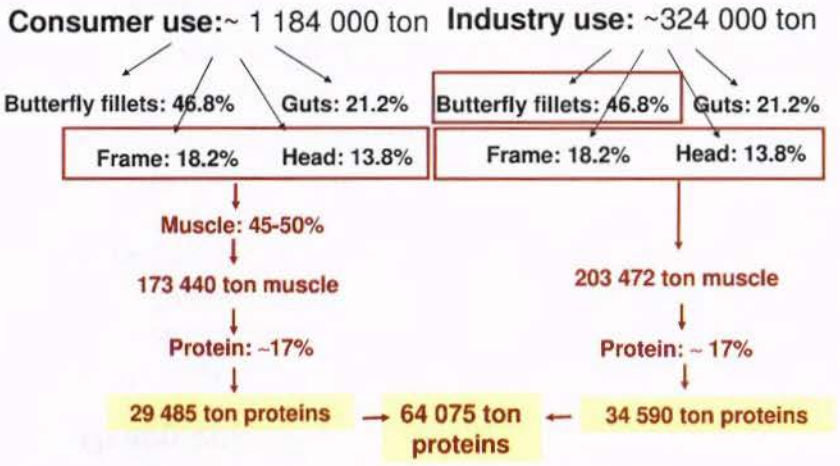
And to the last, new studies have shown positive effects from fish proteins on diabetes and high blood pressure

Production of protein isolates from pelagic fish and its by-products using the pH-shift technology

Ingrid Undeland & Sofia Marmon et al.
Chalmers Tekniska Högskola,
Kemi & Biovetenskap -Livsmedelsvetenskap

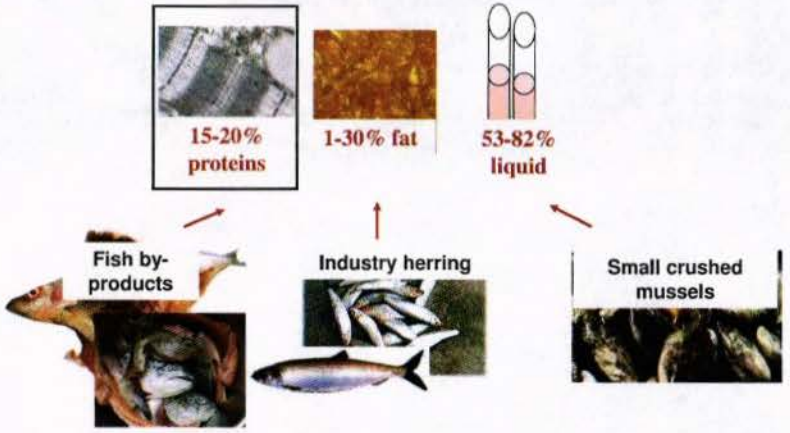
Which volumes of proteins are yielded by Nordic herring fisheries?

Total landing: 1 508 000 ton in SW/DK/IS/NO

Källor: RUBIN, Sintef

Our vision: Use *more* of the catches of marine raw materials for food production



CHALMERS

Patent

•Hultin HO & Kelleher SD (2002). Protein composition and process for isolating a protein composition from a muscle source. Patent US6451975.

•Hultin HO & Kelleher SD (2001). Process for isolating a protein composition from a muscle source and protein composition. Patent US6288216.

•Hultin HO & Kelleher SD (2000b). High efficiency alkaline protein extraction. Patent US6136959.

•Hultin HO & Kelleher SD (1999). Process for isolating a protein composition from a muscle source and protein composition. Patent US6005073.

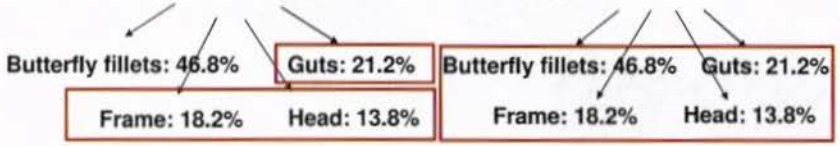
•Hultin HO, Kelleher SD, Feng Y, Mark PR, Kristinsson H, Shuming K, & Undeland I (2004). High efficiency protein extraction. Patent US2004067551.

•Hultin HO, Kelleher SD, Feng Y, Mark PR, Kristinsson H, Shuming K, & Undeland I (2007). High efficiency protein extraction. Patent HK1070790.

Which volumes of proteins are yielded by Nordic herring fisheries?

1 508 000 ton in SW/Dk/IS/NO

Consumer use: ~1 184 000 ton **Industry use:** ~324 000 ton



69 267 ton proteins → 124 347 ton proteins ← 55 080 ton proteiner

Källor: RUBIN, Sintef

CHALMERS

Homogenization
raw material + water (1:6)

↓

Protein solubilization
pH → ~3 eller 11

↓

Separation
(≤10 000g)

↓

Protein precipitation
pH → ~5.5

↓

Protein isolation
(≤10 000g)

↓

E.g surimi production
(+cryoprotectants)

↓

Gelation (pH →7.1, 2% salt, 20 min 90°C)

CHALMERS

But, HOW to isolate the proteins without causing denaturation/proteolysis?

New techniques for protein isolation have been patented during the last 10 years that can be applied on complex muscle raw materials

"The pH-shift processes"

What parameters to determine success?

- **Recovery (total and in the 2 separation steps)**
- **Purity**
  - Ash
  - ***The use of the protein isolates will determine which factor that is the most important***
  - Emulsification
  - Foaming ability
  - (Salt solubility)
- **Stability during processing and subsequent storage**
  - Lipid oxidation
  - Protein oxidation
  - Microbial growth

The whole raw material can be used as starting material. Bones, skin etc do not create problem

Lipids, pigments and contaminants drastically reduced in many cases

The protein functionality increased

Homogenization
raw material + water (1:6)
↓
Protein solubilization
pH → ~3 eller 11
↓
Separation
(≤10 000g)
↓
Protein precipitation
pH → ~5.5
↓
Protein isolation
(≤10 000g)
↓
E.g surimi production
(+cryoprotectants)
↓
Gelation (pH →7.1, 2% salt, 20 min 90°C)

Uses significant amounts of water

Choice of acid/base important

Centrifugation a costly step

Oxidation of pigments, lipids, proteins

Recovery of proteins with acid and alkaline processing of different herring raw materials

	Acid method	Alkaline method
Herring light muscle	74%	68%
Herring fillets	70% /65%*	57%*
Whole gutted herring	59%	57%
Whole herring	71%*	65%*

* Very few replicates

Marmon & Undeland, 2010; Undeland et al; 2002; 2005; Marmon & Undeland-unpublished

We have since 2000 worked with the acid and alkaline processes on herring of different complexity;

- herring light muscle
- herring fillets
- whole gutted herring
- whole herring

Funding from NICe, Formas, Fiskeriverket/EU structural funds

In the last year we have gone from lab to pilot scale

CHALMERS

Changes in color during pH-shift processing of gutted Baltic herring

	Herring mince	Alkali-made isolate	Acid-made isolate
L* (Lightness)	43.2	57.9	61.7
a* (Redness)	4.8	1.9	1.7
b* (yellowness)	6.9	6.3	6.9
Whiteness	42.5	57.4	61.0

Significant increases in lightness and whiteness
Significant reductions in redness and yellowness

Marmon & Undeland, 2009

CHALMERS

Composition of protein isolates produced with acid and alkaline processing of gutted Baltic herring

	Herring mince	Alkali-made isolate	Acid-made isolate
Water (%)	78.0	89.3	89.8
Lipids (%, dry weight)	35.9	17.7	22.2
Protein (%, dry weight)	56.5	81.0	81.3
Ash (%, dry weight)	8.8	1.1	1.5

Significant increases in water and protein content.
Significant reductions in lipids and ash

Marmon & Undeland, 2010

CHALMERS

Photo: Sofia Marmon

CHALMERS

Changes in dioxins/dioxin-like PCB´s during pH-shift processing of Baltic herring

	Herring mince	Protein isolate
Fat % (On 80% water basis)	7.1	2.1
Dioxins TEQ (pg/g, on 80% water basis)	5.7	2.0
Dioxin-like PCB´s TEQ (pg/g, on 80% water basis)	3.3	1.0

*** Average value based on isolates from acid and alkaline processing**

EU limits: 4/8 pg/g

This herring: 5.7/9 → 2/3 pg/g

Marmon et al. 2009

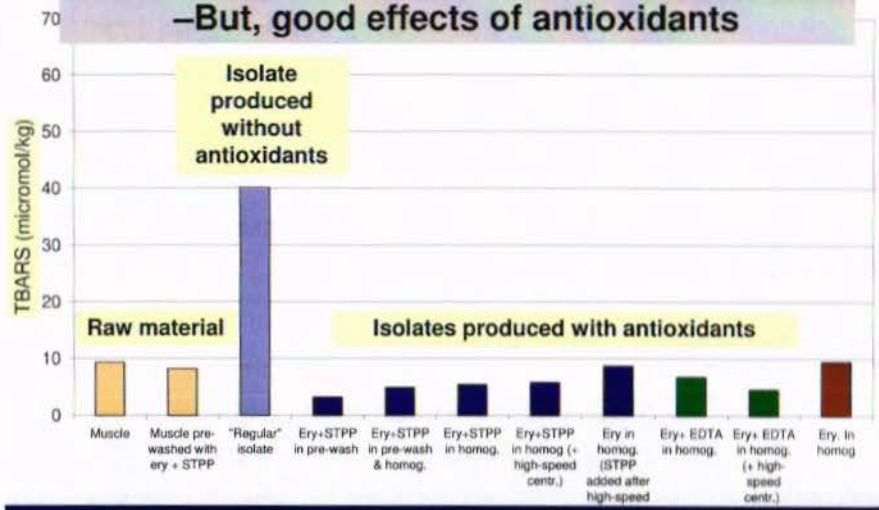
Functionality of proteins produced by pH-shift processing of Baltic herring

	Alkali-made isolate	Acid-made isolate
Gel strength (g)	810	827
Elasticity (mm)	9.8	10.7
Folding	5	5

The herring protein isolatates produced have had decent functionality

Marmon & Undeland, 2009

Lipid oxidation can develop during pH-shift processing of sensitive materials like herring –But, good effects of antioxidants



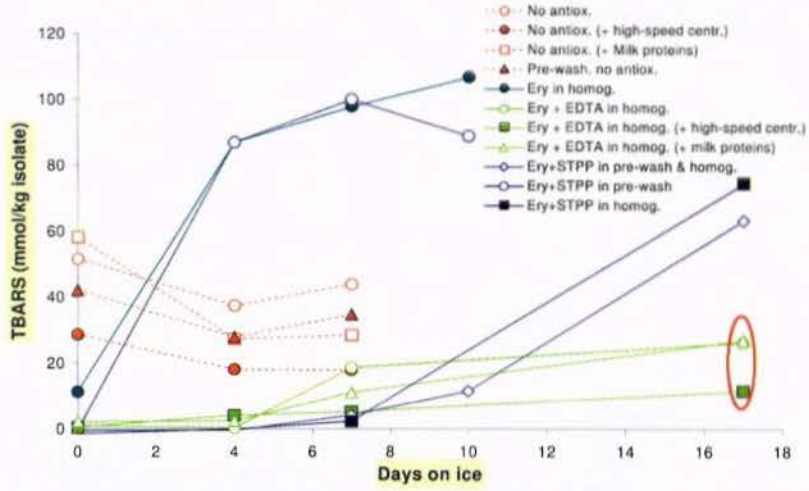
Undeland et al. 2005

Additional possibilities with herring/herring by products

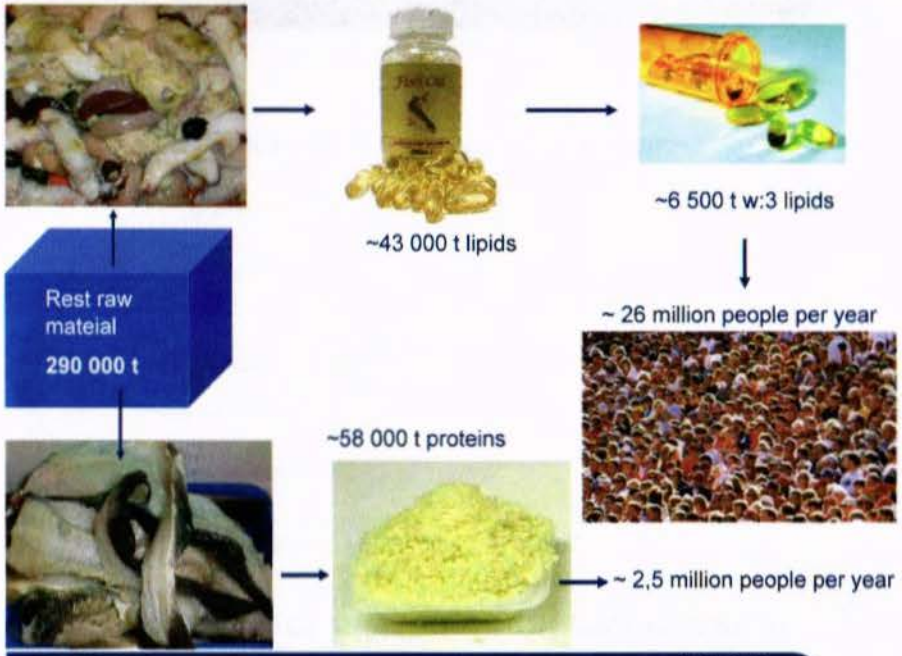


- Isolation of **marine oils** with "pH-shift" methodology (*Okada & Morrisey, 2007*)
- Isolation of **antioxidative liquids** (wash waters, brines, surimi waste water, press juice)
- **Combining** pH-shift protein isolation with oil and press juice isolation would be the ideal way of better utilizing herring for the food ingredients

Some antioxidants were also very effective during further storage of the isolate (erythorbate and EDTA)



Undeland et al. 2005

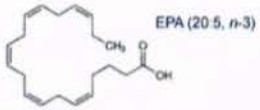


New value added products from rest raw material.

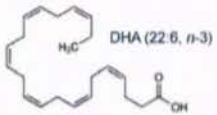
Protein hydrolysates and Lipids

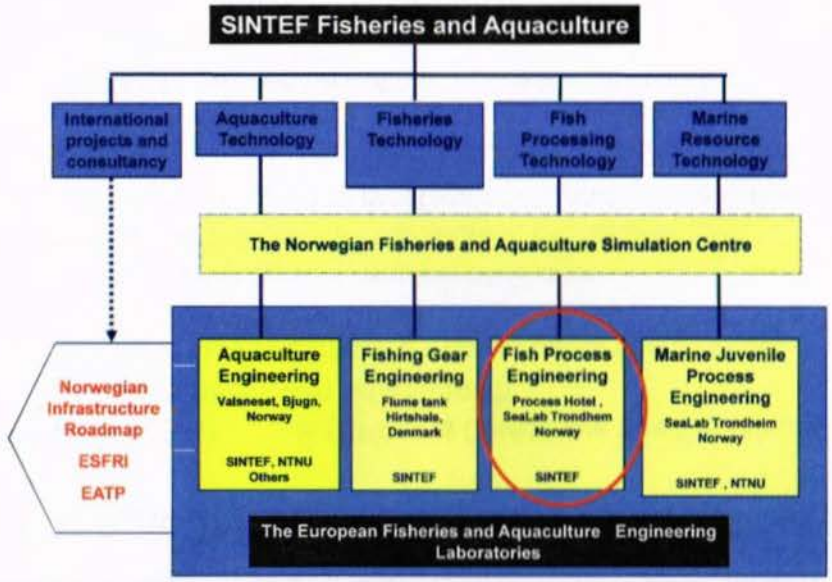
Marine lipids

- Marine lipids are rich in **long chain ω-3 polyunsaturated fatty acids** (LC-PUFA), esp. **eicosapentaenoic acid** (EPA) and **docosahexaenoic acid** (DHA)
  - "essential", RDI (EPA + DHA) ~ 250 mg/day
  - beneficial effect on human health



- In most of Western-Europe there is a low intake of fatty fish and fish products - intake of EPA and DHA is far below nutritional recommendations.
- A way to increase the populations intake of w-3 FA is to add fish oil to different food products – "functional foods"





Fatty acid	Farmed Atlantic Salmon	Tuna	Jack mackerel	Herring	Atlantic cod liver	Atlantic menhaden	South American anchovy	Capelin	Sardine	Seal	Krill
C14:0	4.2	3.9	7.3	7	3.3	7.3	7.5	7	8	5.0	9.5
C16:0	15.7	17.6	15.7	16	13.4	19	17.5	10	18	11.3	20.8
C 16:1n-7	5.1	5.4	5.1	6	9.6	9.1	9	10	10	14.3	9.9
C18:0	4.2	4.1	3.1		2.7	4.2	4			1.1	0.9
C18:1n-9	16.5	12.4	9.9	13	23.4	13.2	11.6	14	11	22.3	10.5
C18:1n-7	3.5	2.4	2.9							4.9	10.3
C20:1n-9	3.3	1.3	8.3	12	7.8	2	1.6	17	4	7.0	<1
C22:1 n11	2.5	0.5	5.8	20	5.3	0.6	1.2	14	3	2.3	<0.5
C18:2 n-6 (Ln)*	6.6	1.9	1.7			1.3	1.2			1.1	2.3
C18:3 n-3 (LnL)*											
C18:4 n-3											
C20:5 n-3 (EPA)*	7.1	12.4	10.9	5	11.5	11	17	8	18	6.6	18.2
C22:6 n-3 (DHA)*	15.7	27.8	11.5	6	12.6	12.6	8.8	6	9	8.7	9.5
Total n-3 LC-PUFA	26.7	41.9	24.4	11	25.7	22	27.4	14	27	19.7	27.3

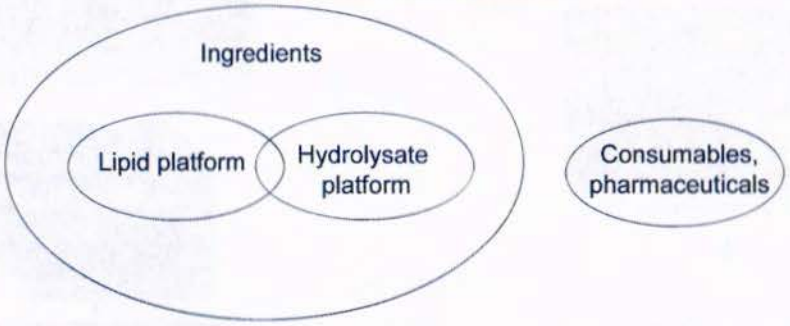
"Long-chain omega-3 specialty oils", Harald Breivik, 2007, The Oily Press, Bridgewater, England

Omega 3: beneficial health effects

- Omega 3 fatty acids (EPA and DHA) have positive effect on human health and development
- Brain and nerves contained high amounts and DHA (40-60% LCPUFA of total lipids)
  - Brain, eyesight development, mental condition
- Prostaglandins control inflammation processes. EPA influences formation of prostaglandins and relieve illness progress
  - Arthritis, arteriosclerosis
- EPA and DHA can be defined as "essential" nutritional components

Structure of SINTEFs rest raw material platform

Marine rest raw materials



Aim: To produce oil and protein hydrolysate of premium quality

Marine oils from *fresh raw materials*

- Fresh Norwegian rest raw materials for high quality omega-3 oil production
  - Rest raw materials from salmon and trout aquaculture
  - Rest raw materials from pelagic filleting industry
  - Liver from cod or other white fish species (both wild and farmed)
  - Oil from other marine sources (calanus, krill etc.)

Mobile SeaLab for Bioingrediens

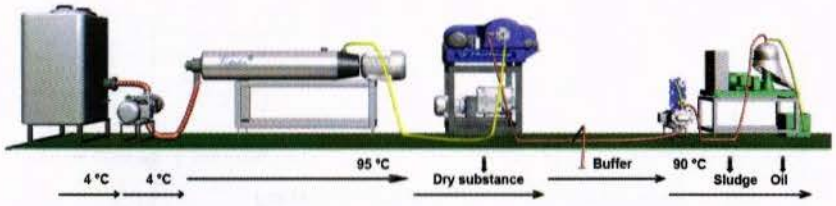
SINTEFs lipid platform

Extraction	Purification	Transformation	Stabilisation
Production of raw oil	Production of highly purified oil	Production of new lipids	Prevent oxidation in oil and food
Extraction equipment in lab and pilot scale. From 50 ml batch to 1000 kg/h continuous (Mobile SeaLab)	Reactors (100L) for: Degumming, bleaching Deodorization (1000L) Short path distillation (lab and pilot 10l/h) Infrastructure (0,5 mill €)	Reactors: 6 reactors of 250 ml 32 reactors of 3 L Several reactors from 8 L to 1500L	Equipment for measuring oxidation kinetics (OSI, and oxygen consumption). Effect of pro oxidants and anti oxidants

Analytical capabilities:
Characterisation: Fatty acid composition, lipid classes, phospholipid classes, positioning of fatty acids
Wet chemical: PV, Ansidin value, TBARS,
Instrumentation: GC, Iatroscan, HPLC-Corna, NMR (Low-high field), GC-MS-MS, LC-TOF-MC

Mobile Sea Lab

Continuous oil production with decanter



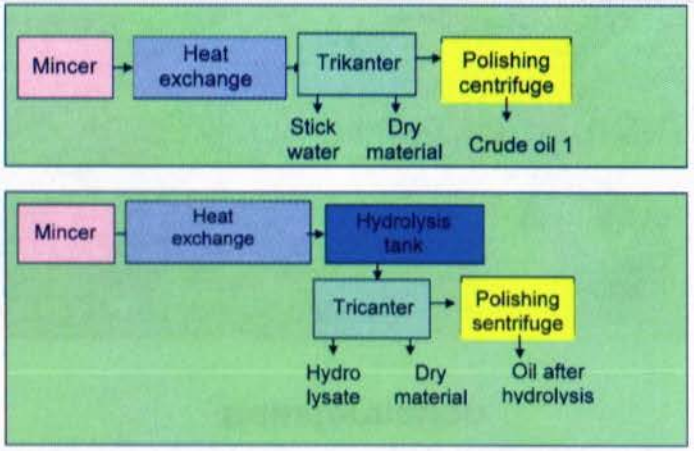
SINTEF

Enzyme reactors for lipid extraction and transformation

Ultra fresh herring oil quality

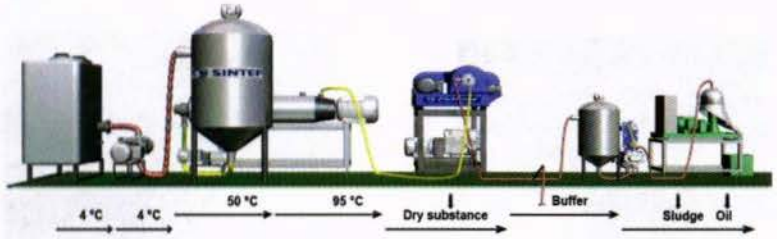
	Fresh raw material				Conventional fish oil	Oil from silage
	Prosess1	Prosess 2	Prosess 3			
	Oil 1	Oil 2	Oil 1'	Oil 3		
FFA (%)	0,12	0,30	0,14	0,13	3-5	8-10
PV	1,9	3,3	2,3	2,4		
AV	0,8	4,9	0,3	6,5		
Totox	4,6	11,5	4,9	11,3	15-25	20-25

Oil and proteins from rest raw material (1 and 2)

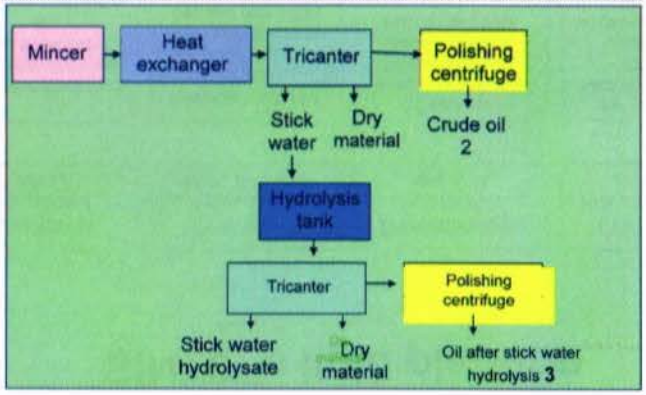


Mobile Sea Lab

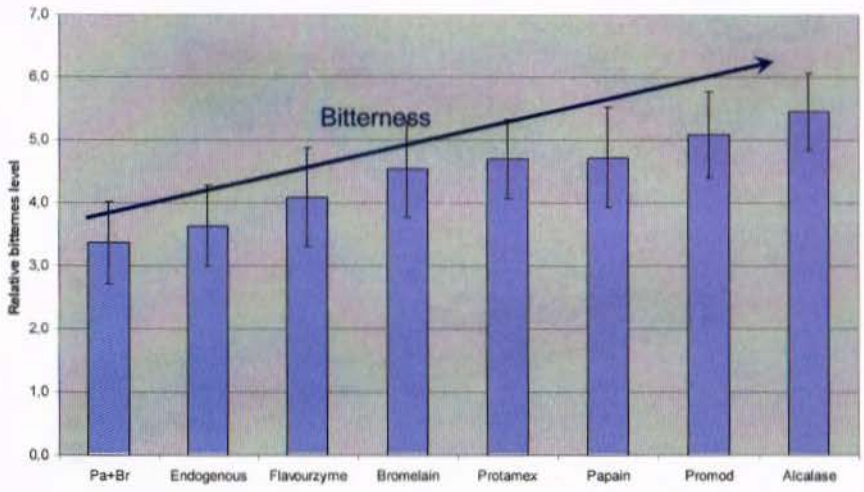
Batch hydrolysis- and oil production with decanter



Oil and proteins from rest raw material (3)



Bitterness of the FPH from herring

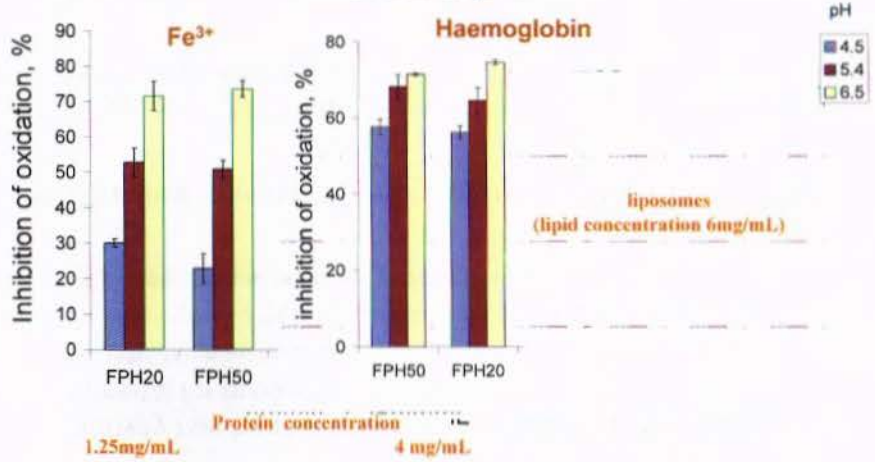


SINTEFs Hydrolysis platform

Biochemistry of hydrolysis	Process optimization	Process verification	Process design
Choice of enzyme(s) Characterisation of raw material and product Reactors, 6 of 250 ml, 32 of 3L	Selection of conditions for best profit Yield, quality Temperature, water content pH, time… 32 reactors of 3L	The best hydrolysis conditions are tested on site with Mobile SeaLab. 1 reactor of 800L. Capasity 500kg/h	Scale up data . Dewatering and drying in cooperation with SINTEF Energy and Enginering companies

Analytical capabilities:
Characterisation: Protein, lipid, ash and water content, Amino acid composition, free and bound, Molecular weight distribution, Water holding capasity, Foaming and emulsifying capability, Fat absorption, Antioxidative properties.
Instrumentation: GC, FPLC, NMR (Low-high field), GC-MS-MS, LC-TOF-MC, electrophoresis

Reduction of oxidation (oxygen uptake rate (OUR) - effect of pH



Fish protein hydrolysates (FPH)

Bioactive properties	Bulk properties	Nutritional properties
Antioxidative properties Antihypertensive Antithrombic Immunomodulatory activities Anticoagulant and antiplatelet properties Accelerate calcium absorbtion Possess hormone-like peptides and growth factors Obesity modulation	Tolerate heat without precipitating Soluble over a wide range of pH Water holding capacity Foaming and emulsifying properties Absorb and retain/hold oil Gel forming ability Cryoprotective properties Protect proteins on drying	High nutritional value Easy digestible proteins/peptides Amino acid composition

Concluding remarks

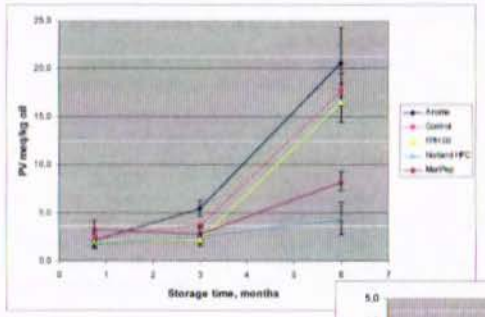
- Norway has huge amounts of available herring rest raw material for production of:
  - Ultra fresh marine oils
  - Herring has a high concentration of cetolic acid, C22:1, n11.
  - Functional and bioactive peptides/proteins
- Ultra fresh marine oils will have higher price in the market
- Peptides/proteins from fish rest raw materials can be used for human consumption
- FPH show antioxidative activity which is beneficial in industrial product formulations

Model food system for evaluation of effect of added fish proteins

Salmon pate

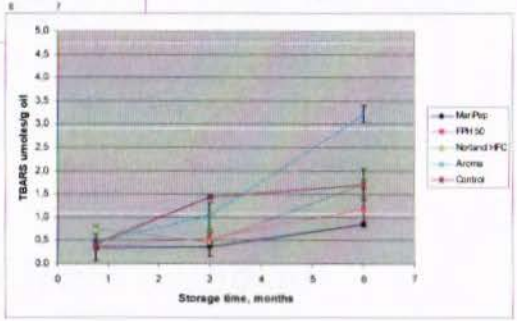
Concentration test | Sensory test | Storage test

Thank you for your attention

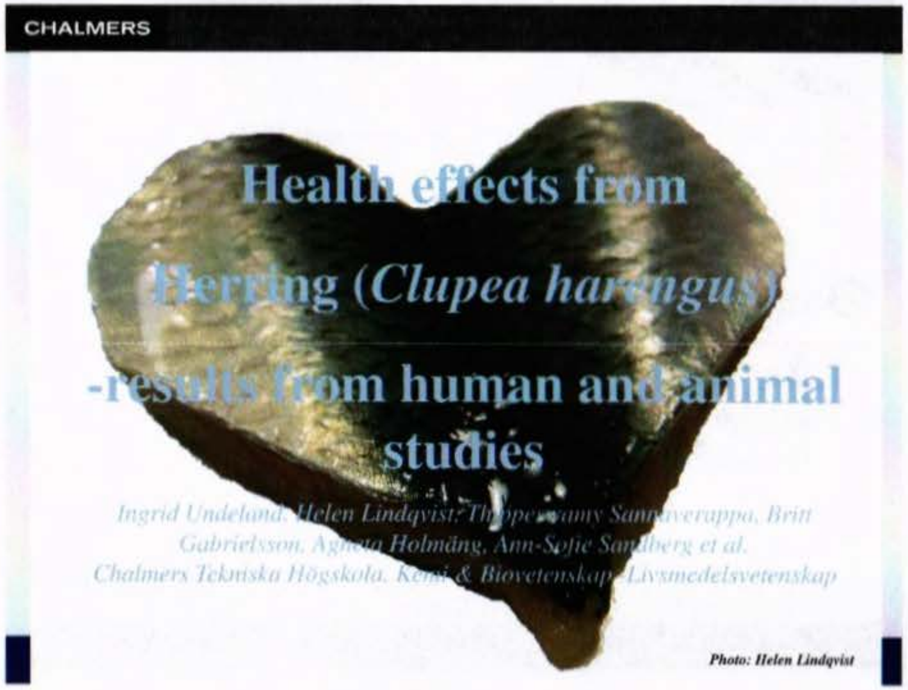


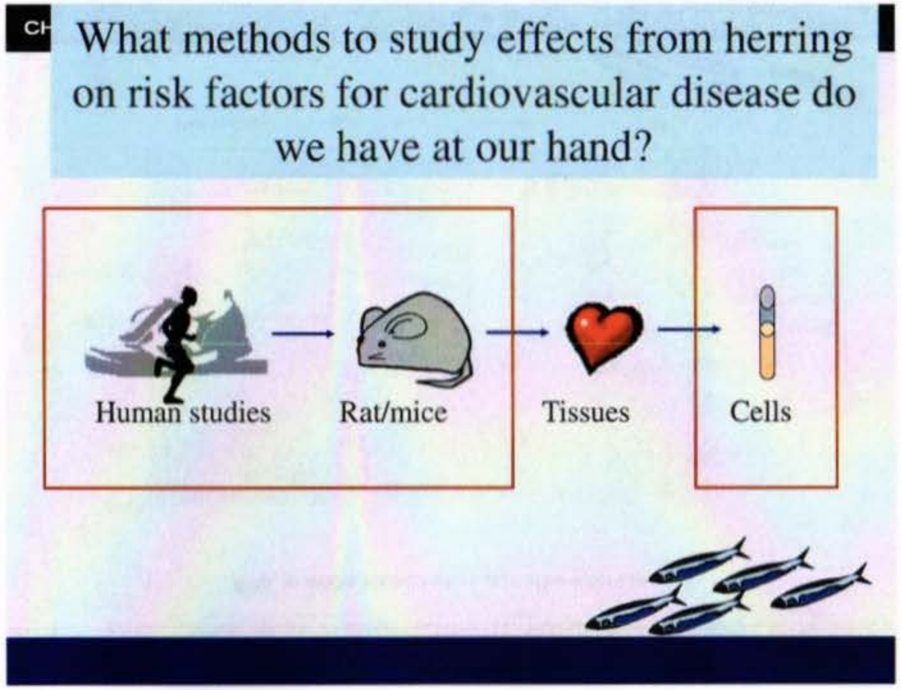
Primary oxidation products – Peroxide value

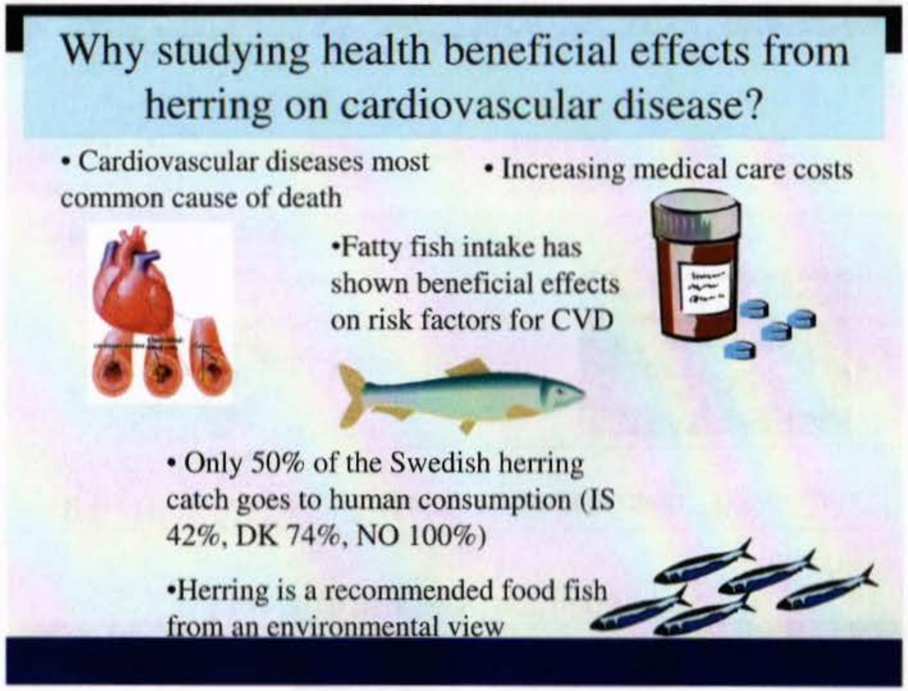
Secondary oxidation products TBARS



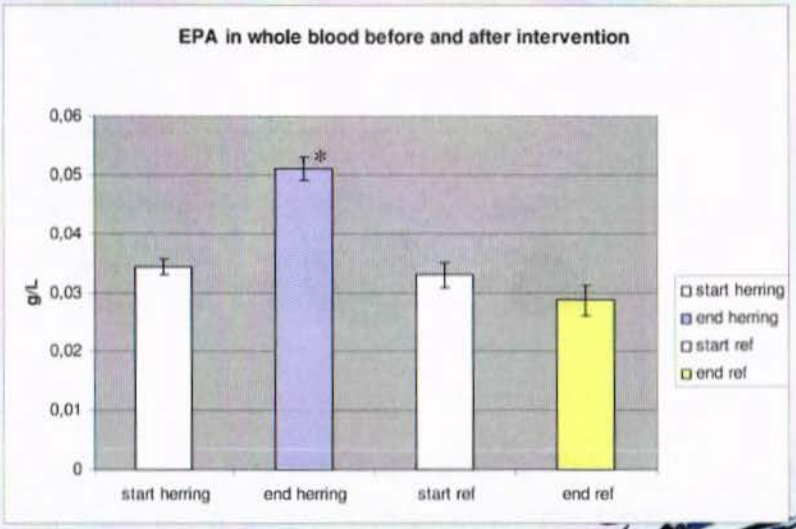

Ät fisk – slipp slaganfall
medicinska nyheter
Until 2002, no clinical studies carried out on herring (*Clupea harengus*)
Fisk flera gånger i veckan sänkte hjärtats hastighet
16 I FORM 14/2003


CHALMERS
Health effects from Herring (*Clupea harengus*) -results from human and animal studies
Ingrid Undeland, Helen Lindqvist, Thippeswamy Sannaveerappa, Britt Gabrielsson, Agneta Holmäng, Ann-Sofie Sandberg et al.
Chalmers Tekniska Högskola, Kemi & Bioveteskap - Livsmedelsvetenskap
Photo: Helen Lindqvist


What methods to study effects from herring on risk factors for cardiovascular disease do we have at our hand?
Human studies
Rat/mice
Tissues
Cells


Why studying health beneficial effects from herring on cardiovascular disease?
• Cardiovascular diseases most common cause of death
• Increasing medical care costs
•Fatty fish intake has shown beneficial effects on risk factors for CVD
• Only 50% of the Swedish herring catch goes to human consumption (IS 42%, DK 74%, NO 100%)
•Herring is a recommended food fish from an environmental view

CHALMERS



Lindqvist et al., 2007; 2009

CHALMERS

The human studies (HS)

HS1: Obese subjects

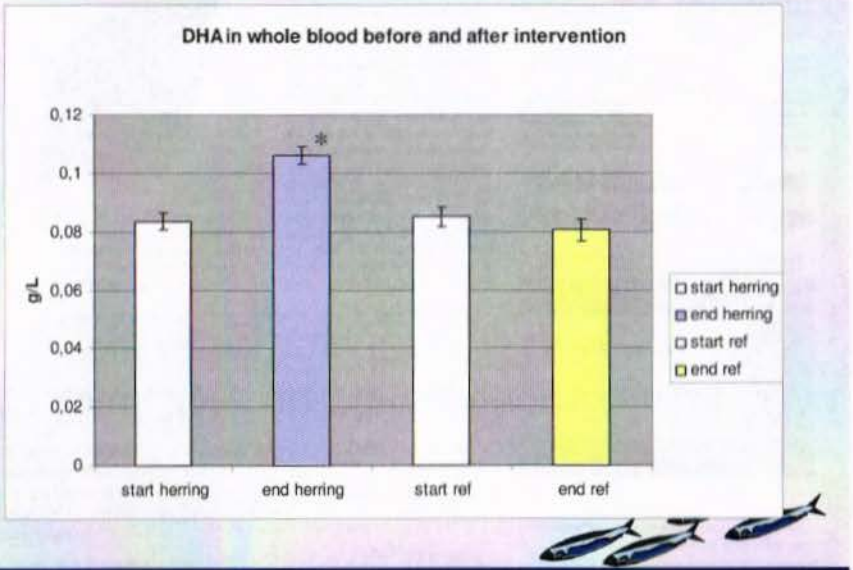
- Both men and women
- age 24-70
- BMI> 27
- 13 of 15 completed the study
- 2x4 weeks and 2 weeks washout

HS2: Overweight men: "Volvo-study"

- Men
- age 35-60
- BMI> 25 not obese
- 35 of 40 completed the study
- 2x6 weeks and 12 weeks washout

Lindqvist et al., 2007; 2009

CHALMERS



Lindqvist et al., 2007; 2009

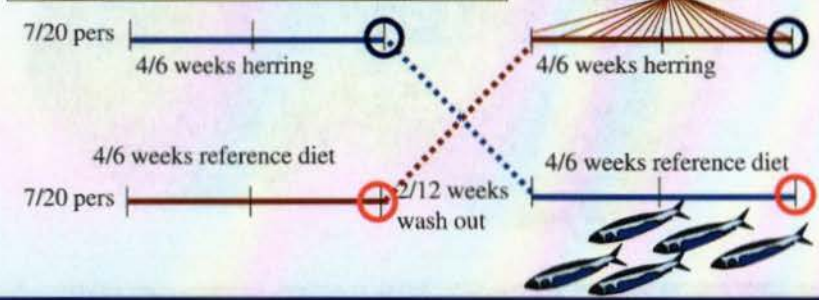
CHALMERS

Design used: Crossover intervention study

One meal a day (150g herring or chicken/pork), 5 days a week

All accompanying food items in the meals were identical

The herring diet provided about 1 g n-3/day



Lindqvist et al., 2007; 2009

CHALMERS

The mouse study

LDL-receptor deficient (Ldlr-/-) mice spontaneously develop atherosclerotic plaques

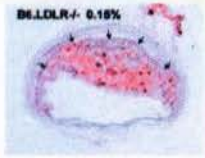
Cookies beef

Cookies herring

16 week diet with:

0.02% cholesterol

0.15% cholesterol



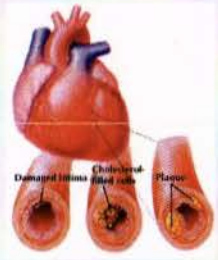
Gabrielsson et al., in manuscript Teupser D et al (2003) ATVB 23: 1907-1913

CHALMERS

Cardiovascular risk factors studied

Blood coagulation:
Bleeding time
Fibrinogen

Blood pressure



Inflammation
High sensitive-C-reactive protein
(hs-CRP)
IL-6 and IL-18
Ox-LDL

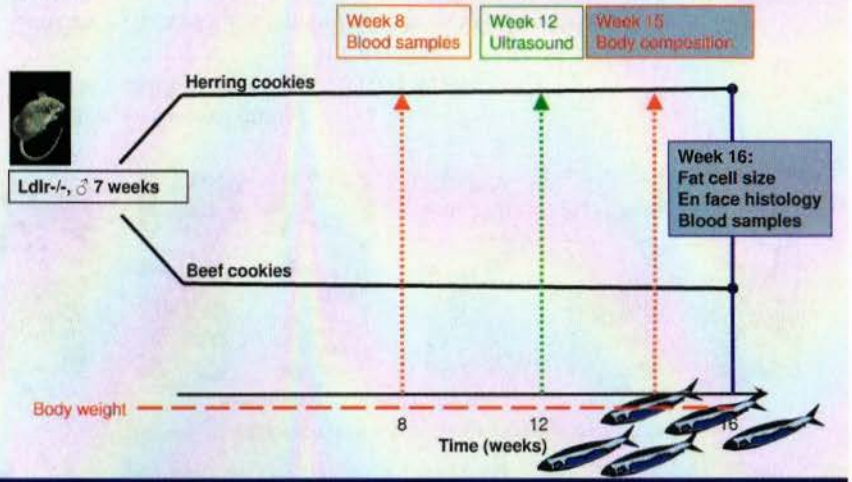
Blood lipids:
Total cholesterol, Triglycerides
HDL, HDL2, HDL3,
LDL,
Apo A, Apo B, Lp A,

Endothelial function
ICAM-1

Lindqvist et al., 2007; 2009

CHALMERS

The study design



Gabrielsson et al., in manuscript

CHALMERS

The animal studies (AS)

AS1: LDL-receptor deficient (Ldlr-/-) mice

AS2: Rats

In both studies, the animals were put on a high fat/high sugar diet. The capacity of herring/herring sub-fractions to counteract negative effects of such an unhealthy diet on atherosclerosis and the metabolic syndrome were then studied.

The rat study

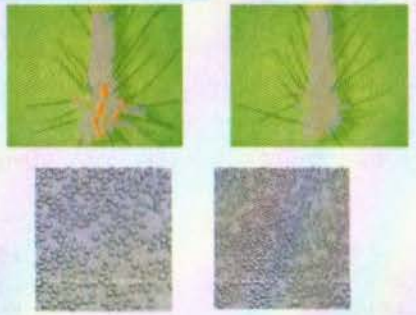
Effect of herring and its subfractions on risk factors connected to the metabolic syndrome

16 rats/group -10 weeks duration

1. Rat chow (= Control group)
2. Cookies + chicken mince (= Cafeteria diet)
3. Cookies + herring mince (= Herring diet)
4. Cookies + chicken mince mixed with herring oil (= Herring oil)
5. Cookies + chicken mince + protein-free herring press juice (= LMW-PJ)
6. Cookies + chicken mince + herring press juice (=PJ)

CHALMERS

Results



Herring compared to beef

-Less atherosclerosis

-Lower blood lipid levels

-Smaller adipocyte cell size in fat depots

Risk factors measured that are connected to the metabolic syndrome in rats

Lower plasma and liver TBARS in all groups getting herring press juice!

No changes

Smaller adipocytes in the group with added herring oil

Lower insulin sensitivity with caf diet. Was reversed by herring oil

More fat tissue with Caf diet

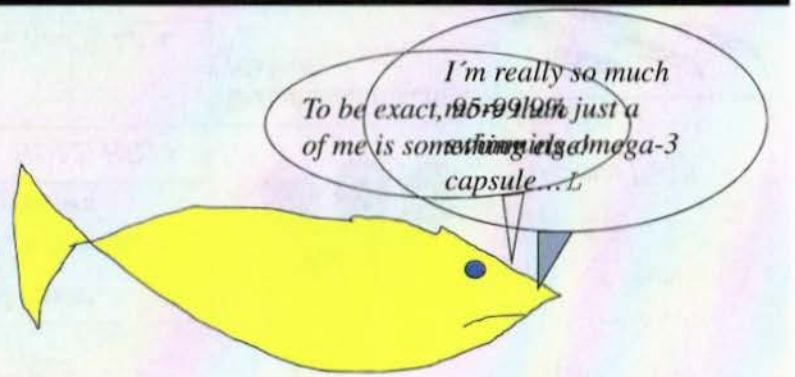
Lipid profile worse with caf diet. Was reversed by herring & herring oil

- *VLD*

Adipose tissue distribution
Fat tissue mass, lean tissue mass, total mass
% fat (fat mass/total mass)

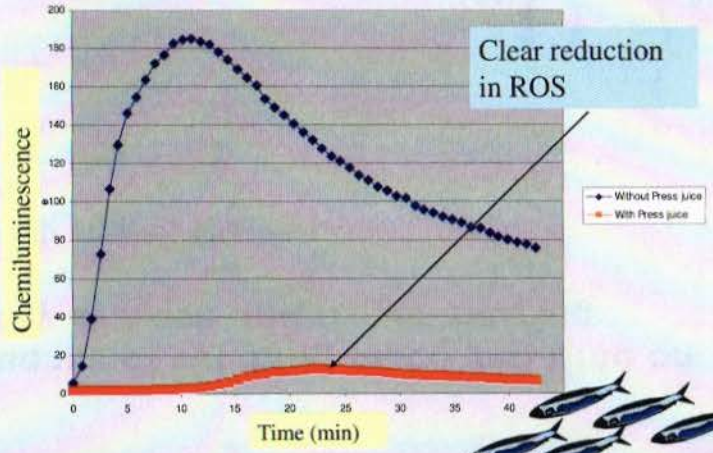
Cardiovascular diseases

CHALMERS



CHALMERS

Effect of herring light muscle press juice on reactive oxygen species produced by human monocytes

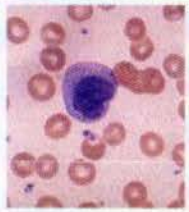


Gunnarsson et al., 2006

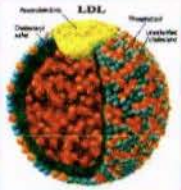
CHALMERS

The cell/lipoprotein studies (CS)

CS1: Human monocytes



CS2: Human LDL



In both studies, Antioxidative effects from a herring press juice have been investigated

Gunnarsson et al., 2006; Sannaveerappa et al., 2008

CH

Effect of herring light muscle press juice (PJ) on Cu-induced oxidation of human LDL

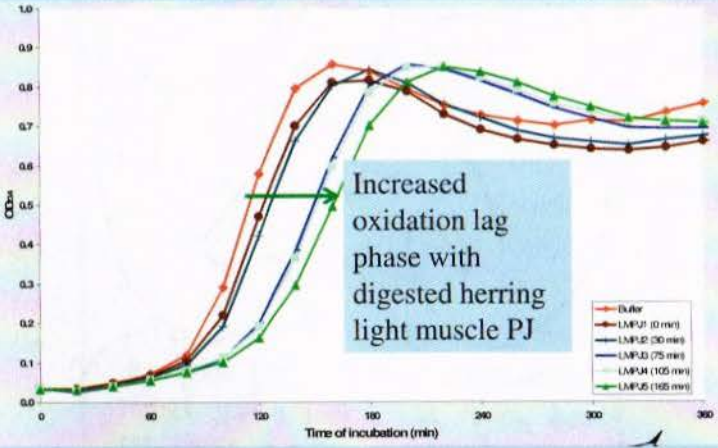
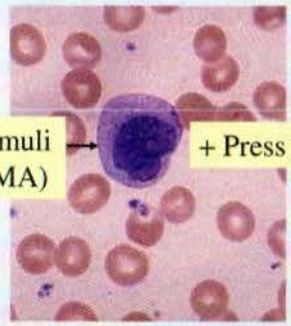


Figure 3: Conjugated diene formation in human LDL (100 µg protein/ml) incubated at 37 °C with 10 µM CuSO4 in presence or absence of <10 kDa-fractions of LMPJ-samples taken at different times during one digestion trial, buffered to pH 7.4. Results are the mean of three determinations.

Sannaveerappa et al., 2008

CHALMERS

Effect of herring light muscle press juice on reactive oxygen species (ROS) produced by human monocytes



Gunnarsson, Undeland, Lindgård, Sandberg, [illegible] Bonassi, 2006

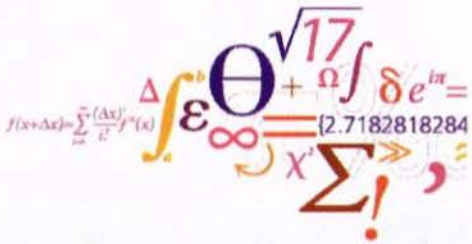
Gunnarsson et al., 2006

CHALMERS

DTU

Influence of catching place and time on quality of fresh and frozen herring

Henrik Hauch Nielsen

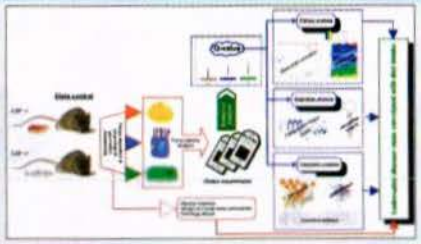


DTU Food
National Food Institute

IU1 CHALMERS

Ongoing/future work herring-health

Linking diet with metabolic activities in different tissues (fenotype-genotype) *Britt Gabrielsson*



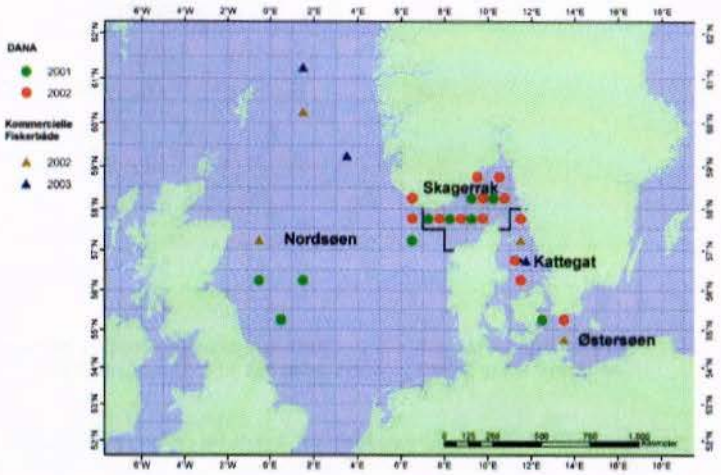
Oxidative changes during the GI passage *Karin Larsson*

Slide 21

IU1 This scenario indicates three important things
THE STOMACH and oxidation biorecatior!

-Antioxidants may be consumed during their GI-passage
-Antioxidants may be seriously altered during the GI passage
-Antioxidants are NEEDED to protect other food constituents during their GI-passage

Herring – A living resource – A good product



Two research projects from 2001 to 2007

Herring – A living resource – A good product, a Danish research project carried out at the Danish Institute for Fisheries Research from 2001 to 2004 funded by Danish Food Industry Agency

- Fresh herring
- Marinated herring

Improved Quality of Herring for Humans , a Nordic Innovation Centre research project from 2004 to 2007 with participation of several Nordic research institutions and companies

- Frozen herring

Results that will be presented

- Sensory quality
- Lipid oxidation
- Nutrional quality

Variation in lipid content within catches

Fishing ground	Time of catch	n	Minimum	Maximum	Average	S.D.
North Sea, east	July - 2001	21	5.5	24.2	17.0 gh	4.6
Skagerrak	July – 2001	175	3.9	25.7	17.6 h	4.3
Kattegat					16.5 gh	3.0
North Sea, west					16.7 gh	4.2
Baltic Sea					12.7 e	2.6
Baltic Sea	March - 2002	60	4.1	17.9	9.3 c	2.9
North Sea, east					11.5 de	5.2
Skagerrak					14.4 fg	4.2
Kattegat	July – 2002	42	3.9	20.8	15.4 fg	3.2
North Sea, west					10.3 d	2.8
Kattegat					17.3 h	2.7
North Sea, north	November – 2002	70	1.4	16.9	7.2 b	2.9
Baltic Sea	November – 2002	50	5.7	18.4	13.5 ef	2.8
North Sea, north	February – 2003	70	1.4	12.5	4.3 a	1.9
Kattegat	February – 2003	90	1.3	16.7	8.6 c	3.5
North Sea, north	May - 2003	63	5.6	15.5	7.0 b	1.8

➢ The lipid content varies between 10 and 20 %-units within catches!!!

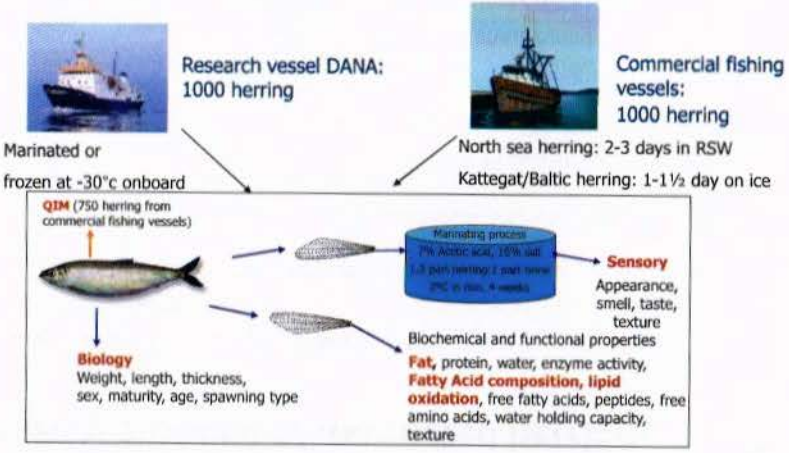
➢ Heterogeneous raw material

Will the variation in lipid content have any influence on the sensory quality?

Nielsen D., Hyldig G., Nielsen J., Nielsen H.H. (2005) *LWT* 38, 537-48.

Herring – A living resource – A good product

- To define raw material quality parameters for herring from different stocks by relating biology with biochemical characteristics and sensory properties



Major influence

Sensory Quality

Storage condition/time on board

The lipid content (season)

The size

The maturity and the fishing ground

Minor influence

Sensory profiling of marinated herring

- Tested and trained by 10-12 assessors
- Served in random order
- 15 cm unstructured scale with anchor point

- **Odour**
  - Sourish
  - Rancid
  - Fish/herring oil
  - Sweet
  - Metallic
- **Texture**
  - Firmness
  - Elasticity
  - Fatty mouthfeel
  - Juicy
  - Gritty
- **Flavour**
  - Sourish
  - Salty
  - Metallic
  - Herring
  - Sweet
  - Rancid

Lipid oxidation in fresh herring

- To investigate the effect of **catching place** and **on board storage methods** of raw fish on **sensory properties** and formation of **volatiles** in herring stored and marinated

- To investigate the effect of **storage time** of raw fish on **sensory properties** and formation of **volatiles** in marinated herring

66 herrings

37 from Mar02 — 29 from Feb03

23 Gilleleje — 14 Esbjerg — 14 Gilleleje — 15 Esbjerg

7: 0 day — 7: 2 days — 8: 0 days — 8: 2 days

7: 2 days — 7: 4 days — 6: 2 days — 7: 4 days

9: 4 days

Gilleleje samples from the Baltic Sea: Ice stored
Esbjerg samples from the North Sea: Tank stored

Main results/conclusions

- Very small variations are found, when storage prior to processing is omitted – will not be encountered by consumers
- Fishing ground is not an important factor
- Differences in quality occur during season – feeding and maturation
- The lipid content and size has a clear influence on the sensory properties
- Onboard handling has profound influence on quality – **one of the most important parameters**
- Differences in raw material quality are retrieved in product quality – even after the harsh marinating in salt and acetic acid
- Sensory quality can be related to biological and hence also compositional parameters
- Product quality can partly be predicted from measurements on the raw material – QIM

Results

- The omega-3 content in herring caught in Nordic waters depends on catching time and place
- Herring caught in the northern part of the North Sea in May 2003 had the highest relative content of EPA and the highest n-3/n-6 ratio. However, these fish had a low lipid content.

Results

- Generally low levels of volatiles
- Potent volatiles (2-alkenals and alkadienals) was not found
- Low intensities of sensory descriptors for ranicd and metallic, especially in 2003
- Samples from Esbjerg were more oxidised – probably due to transportation in tank vs ice for Gilleleje samples
- Oxidative flavour deterioration increased with storage time in samples from Esbjerg
- Good correlations between GC- and sensory data, despite low level of oxidation

Jacobsen, C. DTU National Food Institute

matis CHALMERS INSTITUTE OF MARINE RESEARCH

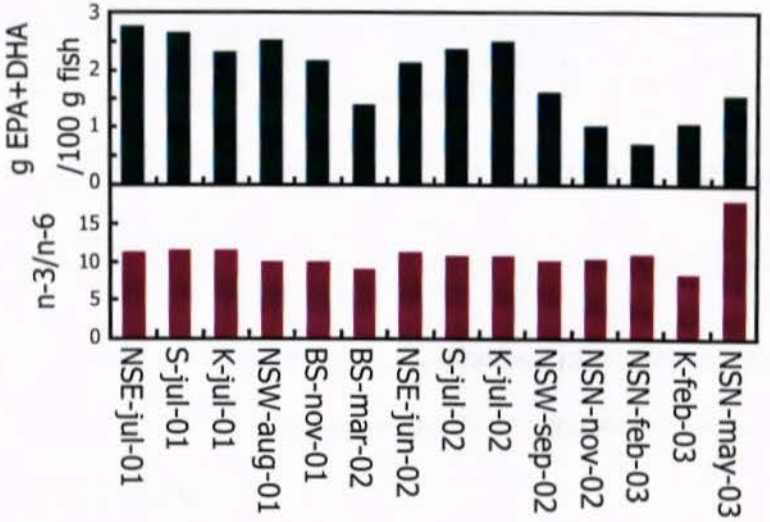
"Improved quality of herring for humans"

Participants

- Matís – Icelandic Food Research Center, Iceland
- Institute of Marine Research, Norway (IMR)
- Technical University of Denmark, National Food Institute
- Chalmers University of Technology, Sweden
- Paul Mattsson AB, Sweden
- Vaster AB, Sweden
- SkeriNova Holding AB, Sweden
- Síldarvinnslan hf, Iceland

To evaluate how variation in catching place and time affects the nutritional and sensory quality of herring fillet during frozen storage.

EPA & DHA contents in grams and n-3/n-6 ratios



Jensen K.N.; Jacobsen C. and Nielsen H.H. (2007). J. Sci.Food Agri. 87, 710-18.

Analyses carried out in the project

Matís
- Microstructure
- Texture
- Expressible moisture
- Colour
- Dark/Light muscle
- pH

Chalmers
- Peroxide value
- TBARS
- Vitamin E
- Haemoglobin conc.
- Dark/Light muscle
- Dry matter
- pH

IMR
- Fatty acid comp.
- Lipid
- Protein
- Protein solubility
- Colour
- Dark/Light muscle
- Dry matter, pH

DIFRES
- Sensory analysis
- Near InfraRed
- Salt
- Dry matter,
- pH

Multivariate data analysis

Changes in sensory attributes | Effects on lipid oxidation | Effects on microstructure

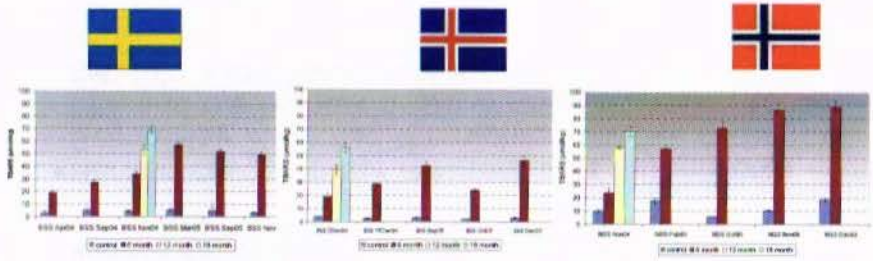
Strategy

Herring was caught at different places during 2004 and 2005

- Around Iceland – Icelandic Summer Spawner, ISS - Responsible: Matís
- Along the Norwegian coast – Norwegian Spring Spawner, NSS – Responsible: IMR
- In Kattegat/Skagerak – Baltic Spring Spawner, BSS - Responsible: Chalmers

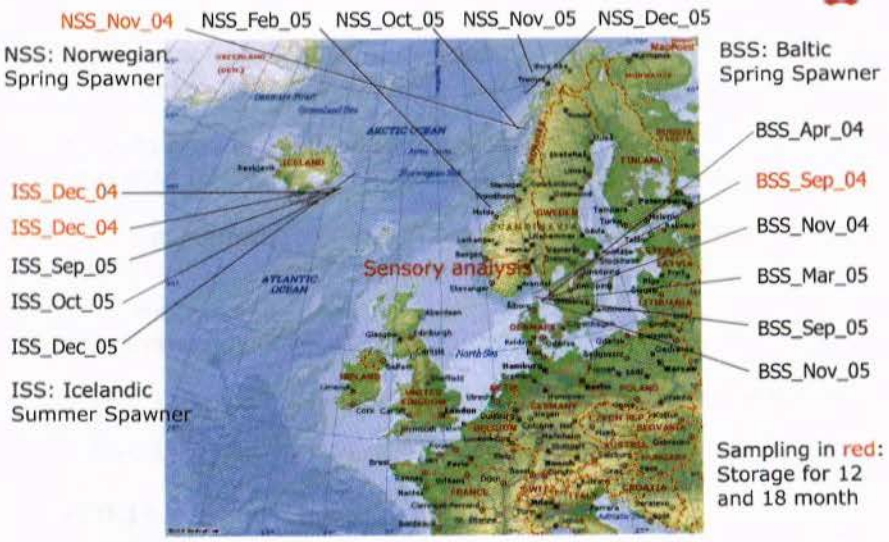
Herring were filleted, frozen and distributed among participating research institutes and stored at -20°C and -80°C (reference sample) for 6 month and subsequently analysed – one sampling also storage for 12 and 18 months.

Development of volatile lipid oxidation compounds during frozen storage in herring caught outside Sweden, Iceland and Norway



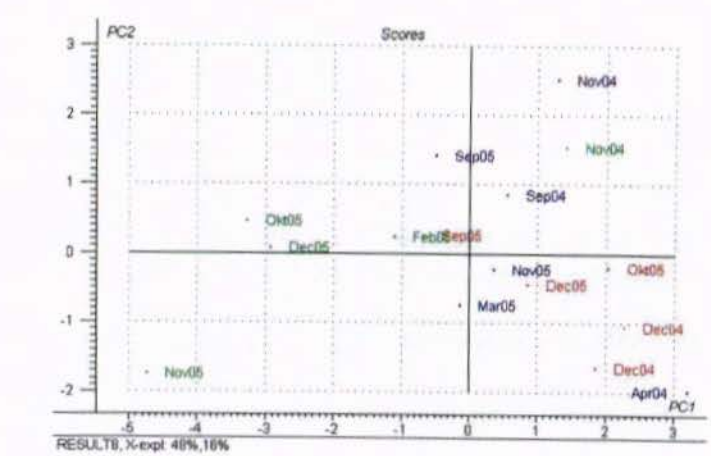
I. Undeland & K. Larsson, Chalmers Technical University

Catching places and time



Conclusions

- No clear differences in lipid oxidation and sensory quality of herring regarding catching place and season based on all storage points
- Frozen storage time at -20°C had the largest influence on the lipid oxidation and sensory quality
- A **trend** in grouping regarding catching place and lipid oxidation was found after 6 months of storage
- Degree of fillet silvering, % dark muscle and salt content had positive impact on lipid oxidation after 6 months of storage
- Long frozen storage at -80°C resulted in very low lipid oxidation and in only very small changes in the sensory quality.



NSS: Norwegian Spring Spawner
ISS: Icelandic Summer Spawner
BSS: Baltic Spring Spawner

Only samples stored 6 months at -20°C

I. Undeland & K. Larsson, Chalmers Technical University

Thank you for your attention

Thank you to the persons who have contributed with results and slides

Senior researcher Grethe Hyldig, DTU National Food Institute

Senior researcher Charlotte Jacobsen, DTU National Food Institute

Kristina Nedenskov Jensen, Foss Electric A/S, Denmark

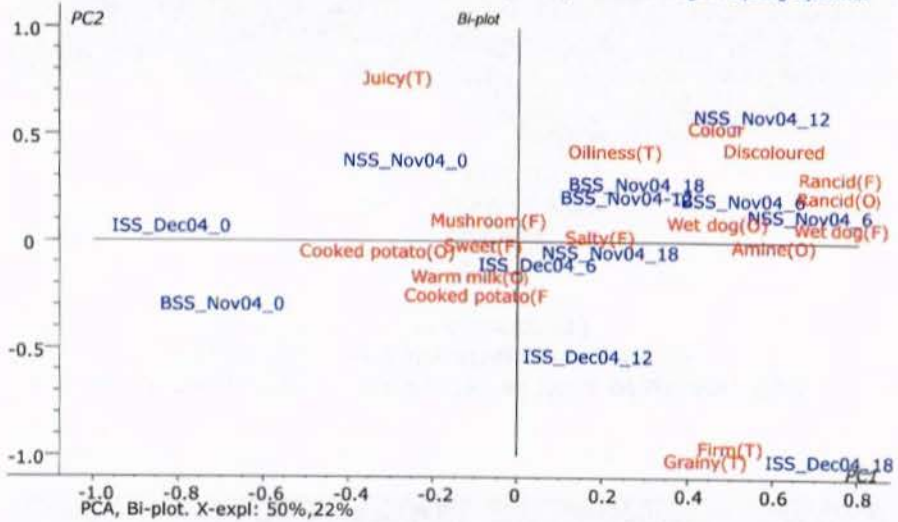
Durita Nielsen, P/F Luna Faroe Island

Associate Professor Ingrid Undeland Chalmers Technical University

PhD student Karin Larsson, Chalmers Technical University

Sensory results: Catching place and storage time

BSS: Baltic Spring Spawner, ISS: Icelandic Summer Spawner, NSS: Norwegian Spring Spawner



G. Hyldig, DTU National Food Institute

Fishing expedition

- Norwegian sea, October 2009
- Total catch of 180 metric tonnes mackerel
- I collected a total of 8 fish
  - 4 fish from the fish net before the fish were pumped onboard
  - 4 fish from the fish tank 12 hours after catching

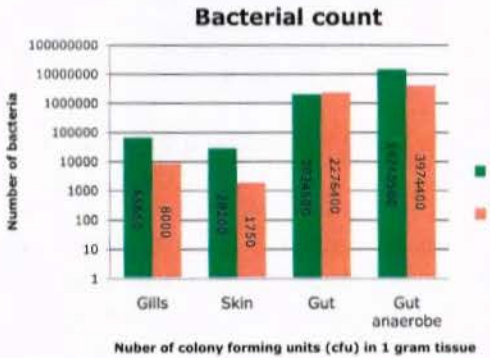
Characterisation of the bacterial flora of pelagic fish, with emphasis on Atlantic mackerel (*Scomber scombrus*)

Cecilie Smith Svanevik
Bjørn Tore Lunestad
Nordic Pelagic Workshop 2010
Gardermoen 30.08.10

Master thesis

- Characterising the bacterial flora of pelagic fish
  - Compare traditional microbiological methods with molecular methods
  - Compare three types of tissue; gills, skin and gut.
  - Compare samples collected from the fish net to those collected from the fish tank

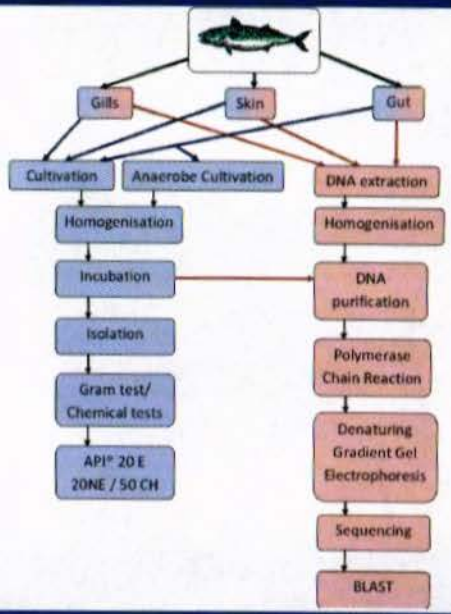
Results microbiological methods - cfu



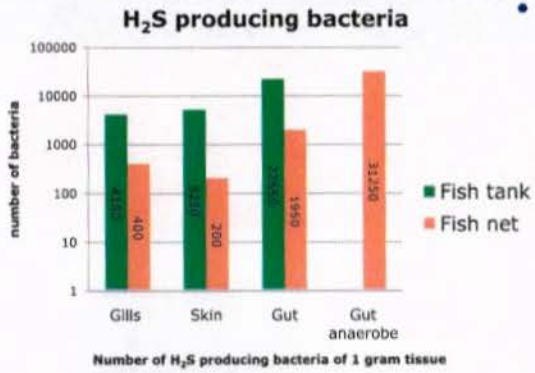
- Fish tank vs. Fish net
  - Generally higher numbers in the fish tank
  - Gills and skin samples differ most

Flowchart

- Blue: traditional microbiological methods
- Red: molecular DNA analysis

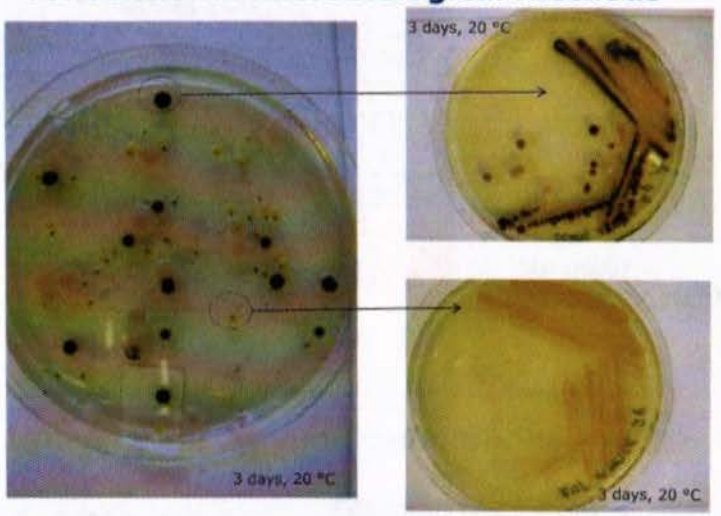


Results microbiological methods – H_2S



- Fish tank vs. Fish net
  - Significant higher number in all samples from the fish tank, except the anaerobe.
  - No anaerobe H_2S producing bacteria of the fish tank

Conventional microbiological methods



Results molecular analysis Species identified by BLAST (sequence library)

DNA from fish matrix and bacterial culture

Species / Groups	Fish net				Fish tank			
	Gills	Skin	Gut Aerobe	Gut Anaerobe	Gills	Skin	Gut Aerobe	Gut Anaerobe
Psychrobacter immobilis	x							
Psychrobacter sp.	x	x	x		x	x		
Oceanisphaera sp. V1-41		x						
Proteus sp.	x	x	x		x			
Proteus vulgaris	x	x	x		x			
Shewanella sp.		x						
Shewanella putrefaciens strain ZH30	x		x		x	x	x	x
Vibrio sp.	x		x	x	x	x	x	x
Photobacterium sp.	x	x	x		x			
Mycobacterium sp.					x			
Vagococcus sp. H2914				x				
Vagococcus carniphilus strain 1843-02	x	x	x			x	x	x
Mycoplasma sualvi	x					x		
Thiotrichales bacterium clone EC7	x		x					
Staphylococcus sciuri/ fleurettii	x	x	x			x	x	
Synechococcus sp.	x		x		x		x	
Uncultured teleost isolate DGGE gel band GL6-5 18S ribosomal RNA gene					x	x	x	

Gram – (red)
- Phylum proteobactreia

Gram + (blue)
- Phylum Firmicutes
- Phylum Cyanobacteria

Teleost DNA

Results microbiological methods - API®

Species/Group	Fish net			Fish tank		
	Gills	Skin	Gut	Gills	Skin	Gut
Proteus vulgaris group	x	x	x	x	x	x
Providencia alcalifaciens/rustigianii					x	x
Stenotrophomonas maltophilia			x			
Empedobacter brevis	x					x
Shewanella putrefaciens group	x		x			
Aeromonas salmonicida ssp.			x		x	x
Vibrio vulnificus			x			
Moraxella spp				x		
Brevundimonas diminuta						x
Vibrio alginolyticus						x
Oligella ureolytica						x

- All species/groups are gram –
- Red: oxidase –
- Blue: oxidase +

Thoughts

- An increased knowledge about the bacterial flora of the fish could result in a better utilisation of harvested resources
- Higher number of bacteria in the fish tank
- Handling activity could cause contamination of the fish from gut content
- Mostly harmless or opportunistic pathogen species
- Methods
  - Microbiological method (API® tests)
    - necessary temperature could not be used
    - designed for clinical isolates
  - Molecular method (PCR – DGGE)
    - reliable results
    - discovers species that are not possible to culture

Molecular methods

- DNA extracted from
  - fish matrix
  - from cultured samples
- Amplified by Plolymerase Chain Reaction (PCR)
- Separated by Denaturing Gradient Gel Electrophoresis (DGGE)
  - Samples loaded in a polyacrylamide gel with a denaturing gradient from 30 % to 55 %
  - Connected to electric current
  - The gel was run for 18 hours at 70 V
- Sequenced by a sequence laboratory
- Identified by a sequence library (BLAST)

NIFES

Thank you for listening!

Acknowledgement:

- Kjersti Borlaug, NIFES and IMR
- Elise Midthun, NIFES
- Betty Irgens, NIFES
- Arne Levsen, NIFES
- Eva Mykkeltvedt, NIFES
- Tone Halvorsen Galluzzi, NIFES
- Hui-Shan Tung, NIFES
- Leikny Fjellstad, NIFES
- Sylvia Frantzen, NIFES
- Maria Befring Hovda, NOFIMA

Contact info:

Cecilie Smith Svanevik
- cecilie.svanevik@nifes.no
- http://no.linkedin.com/in/svanevik

Bjørn Tore Lunestad
- bjorn-tore.lunestad@nifes.no

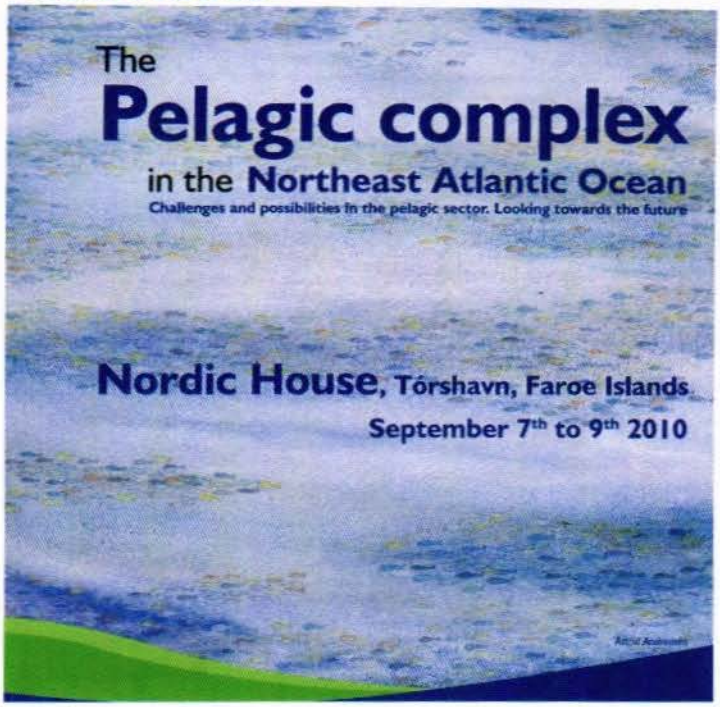
norden Nordic Council of Ministers · NORA · Ministry of Fisheries

Vedlegg 4

DETAILED PROGRAMME

The conference is part of the activities undertaken by the Faroese chairmanship of the Nordic Fisheries Cooperation in 2010

Conference



Get together reception
Monday 6 September – 19[00] hours

Session 1.
Tuesday 7 September 9[00] - 11[40]
Opening

9[00] - 9[10]	Introduction	**Hjalti í Jákupsstovu**
9[10] - 9[30]	Opening of Conference	**Jacob Vestergaard**, Minister of Fisheries, Faroes
9[30] - 11[40]	Challenges in the pelagic sector: private sector perspectives	Chair **Hjalti í Jákupsstovu**

The purpose of this session is to get a better understanding of the challenges that private operators in the pelagic fisheries sector face. Issues to be discussed cover the entire value chain, from harvesting, to processing and markets, and covering a wide geographic view. Key questions are:
What are the future prospects of the pelagic sector?
How should calls for more direct use of pelagic resources (as opposed to fishmeal and oil) be addressed?

9[30] - 9[50]	Faroes	**Bergur Poulsen**, director P/F Havsbrún
9[50] - 10[10]	Denmark	**Christian Olsen**, director Danish Pelagic Producer Organization
10[10] - 10[30]	Iceland	**Hermann Stefánsson**, production manager, Skinney-Þinganes in Höfn
10[30] - 10[50]	Norway	**Audun Maråk**, director, Norwegian Shipowners Association
10[50] - 11[10]	Ireland	**Sean O'Donoghue**, Chief Executive Officer, Killybegs Fishermens Organisation, Ireland
11[10] - 11[40]	**Coffee**	

Session 2.
Tuesday 7 September 11[40] - 17[00]
Changes in the biological and hydrographical conditions for pelagic resources, including climate change. Chair: Eero Aro

The objective of this session is to provide an up-to-date overview of the state of the pelagic resources in the North Atlantic. Often referred to as the pelagic complex, the session will focus on environmental conditions and their impacts on the distribution and productivity of pelagic species, including the effects of climatic change.

11[40] - 12[10]	General distribution of Blue Whiting, Herring, Mackerel and Capelin	**Asta Gudmundsdóttir**, Senior scientist, Marine Research Institute, Iceland
12[10] - 12[40]	Primary production in the Northeast Atlantic and the Nordic Seas	**Trevor Platt**, Executive director of POGO (Partnership for Observation of the Global Oceans)
12[40] - 13[10]	Variation in hydrography, plankton productivity and fish distribution in the Northeast Atlantic	**Hjálmar Hátún**, Senior scientist, Faroe Marine Research Institute
13[10] - 14[00]	**Lunch**	
14[00] - 14[20]	Plankton Production in the Norwegian Sea	**Webjørn Melle**, Scientist, Institute of Marine Research, Norway
14[20] - 14[40]	Can the Norwegian Sea accommodate three large pelagic stocks at the same time?	**Jens Chr. Holst**, Scientist, Institute of Marine Research, Norway
14[40] - 15[00]	**Coffee**	
15[00] - 15[40]	How will climate change effect the Northeast Atlantic and the Nordic Seas?	**Bogi Hansen**, Head of Section on Environment, Faroe Marine Research Institute
15[40] - 16[00]	Climate change and fish distribution	**Gregory Beugrand**, Senior scientist, University of Lille, France
16[00] - 16[20]	Challenges to the Russian pelagic fisheries	**Alexander Krysov**, Head of Pelagic Section at PINRO, Russia
16[20] - 17[00]	Discussion	

Session 3.
Tuesday 7 September 11[40] - 17[00]
Technological challenges for a more profitable pelagic fleet and industry – how to increase value and reduce costs. Chair: Ida Aursand

The objectives of this session is to present and discuss the technological challenges facing the pelagic sector both at sea and on shore, and from this to identify future research priorities.

11[40] - 12[00]	Vessel and gear design	**John Willy Valdemarsen**, Institute of Marine Research, Norway
12[00] - 12[20]	Carbon footprint and energy use of pelagic fish products	**Erik Skontorp Hognes**, SINTEF, Norway
12[20] - 12[40]	Onboard handling system, receiving and grading of pelagic fish	**Leif Roger Gjelseth**, MMC TENDOS AS, Norway
12[40] - 13[00]	Fuel technology and energy efficient design and control on pelagic vessels	**Ingve Sørfonn**, Wärtsilä
13[00] - 14[00]	**Lunch**	
14[00] - 14[20]	Is it sustainable to use fish as feed?	**Ragnar L. Olsen**, Norwegian College of Fishery Science, University of Tromsø, Norway
14[20] - 14[40]	Meeting environmental and quality standards onboard	**Michael Gallagher**, BIM, Irland
14[40] - 15[00]	Effect of catching methods and onboard handling systems on quality of pelagic fish	**Ida Aursand**, SINTEF, Norway
15[00] - 15[20]	**Coffee**	
15[20] - 15[40]	Advanced chilling techniques for pelagic fish – full scale results	**Sigurjón Arason**, Matís, Iceland
15[20] - 16[00]	Potential fast non-destructive methods to measure fat in herring and herring products	**Henrik Hauch Nielsen**, DTU, Denmark
16[20] - 17[00]	Open discussion: The technical needs of the pelagic fish sector – fishing fleet and processing industry	
17[00]	Close of session 3	

Evening reception sponsored by the Faroese pelagic sector

Session 4.
Wednesday 8 September 9[00] - 13[00]
Economics and the management of the pelagic fleet. Chair: Sveinn Agnarsson

Economic considerations in the management of the pelagic fisheries are important to understand the overall outcomes, for fleets, fishers and for the public. Key issues include profitability and how the management framework and tools affect the economic outcomes and prospects for profit generation. Key questions to be covered include:
How can pelagic fisheries be made more profitable?
Does the present management arrangement produce economic profit?
In developing a modern fisheries model, what role does social aspects play?

9[00] - 9[10]	Sum up from session 2 and 3	Session chairs
9[10] - 10[10]	Resource profit in the pelagic fisheries	**Max Nielsen**, Associate Professor, Institute of Food and Resource Economics, Faculty of Life Sciences, University of Copenhagen

Vedlegg 5

10[30] - 11[00]	Economics of the pelagic fleet	**Gunnþor Ingvason**. Director Sildarvinnslan, Iceland
11[00] - 11[20]	**Coffee**	
11[20] - 12[00]	Lost rent, sunken billions	**Ragnar Arnason**. Professor, Department of Economics, University of Iceland
12[00] - 12[20]	The financing of the pelagic fleet at the Faroe Islands	**Bjarni Arnason**. Auditor P/F Notia, Faroe Islands
12[20] - 12[40]	Socio-economics, Political dilemma? Efficiency – social aspects	**Poul Degnbol**. Scientific adviser to EU
12[40] - 13[30]	Panel discussion	
13[30]	**Lunch**	

Afternoon and evening: **Bus trip to Kollafjørð-Fuglafjørð**
Conference dinner in Fuglafjørð

Session 5.

Thursday 9 September 9[00] - 12[30]
Allocation instruments for international shared stocks. Chair: Paul Connolly

Joint resources have to be shared by the legitimate partners in a fair and acceptable way. The objective of this session is to present relevant methods and criteria in use and possible ways forward.

9[00] - 9[20]	The economics of allocating resources on trans-boundary stocks	**R. Quentin Grafton**. Professor, The Australian National University
9[20] - 9[40]	The (lack of) law on allocation of straddling and highly migratory stocks	**A.L. (Andrew) Serdy**. School of Law, University of Southampton, UK
9[40] - 10[00]	Costal state arrangements. Blue Whiting, Herring, Mackerel, Capelin	**Eskild Kirkegaard**. Chief adviser on fisheries, DTU Aqua, Denmark
10[00] - 10[20]	NEAFC management	**Kjartan Hoydal**. General Secretary of NEAFC
10[20] - 10[40]	The Norway – Iceland experience	**Áslaug Ásgeirsdóttir**. Associate Professor of Politics. Bates College, USA
10[40] - 11[00]	Questions – comments	
11[00] - 11[20]	**Coffee**	
11[20] - 11[40]	Is game theory a possible method to solve the allocation problem?	**Rögnvaldur Hannesson**. Professor, NHH, Norwegian School of Economics and Business Administration, Norway
11[40] - 12[10]	Alternative approaches to sharing	**Torbjørn Trondsen**. Professor, University of Tromsø
12[10] - 12[30]	Alternative approaches to sharing	**Hjalti i Jákupsstovu** et al.
12[30] - 14[00]	**Lunch**	

Session 6.

Thursday 9 September 14[00] - 16[30]
Taking stock – the quagmire of allocation. Chair: Kjartan Hoydal

Debate: Based on issues raised in session 5 and brief remarks from key speakers, this session will explore the principles and practices of allocating shared fish stocks, addressing the question – are there more effective approaches?

A major challenges for the purse seine fleet is to catch the correct species and sizes so they can maximize value of their allotted quota without harming non-targets not taken onboard.

The main challenges for the pelagic trawlers relate to high fuel consumption, selecting the right targets and quality of the catch.

Pelagic fisheries - vessel and gear design

by

John Willy Valdemarsen

Institute of Marine Research, Bergen, Norway

Abstract

Fishing vessels fishing for pelagic resources in the Northeast Atlantic Ocean range in size from small 10-15 m vessels catching mackerel with automatic trolling machines till large pelagic trawlers, 145 m in length having engines of 22 000 Hp. The majority of pelagic fishing vessels are equipped for purse seining, trawling or both fishing methods. In Norway purse seining is still the preferred fishing method for pelagic species like herring, sprat, mackerel and capelin (85% of total catch since year 2000), whereas Iceland the Faroe Island recently have converted to more pelagic trawling for the same species (Iceland about 50:50 share of the catch the last 5 years). Other European nations mainly exploit pelagic fish in the NE Atlantic with pelagic trawls. Blue whiting is only fished with pelagic trawls.

Pelagic fish are often shoaling and therefore localization of such fish aggregation is an important part for pelagic fishing operations. Sonar is the best equipment to locate catchable shoals and modern sonar can estimate quantity and shoal movement prior to shooting a purse seine. When the shoal is encircled the fish is pursed and accumulates in the bunt of the net. The fish is pumped onboard the vessel into RSW tanks where they are kept till landing.

Fish that are captured with trawls are similarly pumped from the codend onboard the vessel and in most cases stored in RSW tanks. Some vessels are equipped for block freezing of the catch and a small number also have processing onboard.

The purse seines are mainly produced of PA netting and range in size from 500 till 1000 m length and depth from 150 till 250 m.

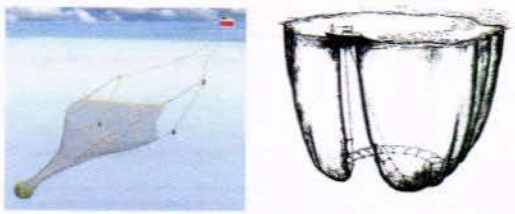
The trawls used in pelagic fisheries all have large mesh front parts, and codend mesh sizes tailormade for the target species (20 – 50 mm). The large mesh trawls developed in the first half of the 70-ties was a breakthrough for pelagic trawling targeting pelagic species. Most pelagic trawls are now designed with front parts of parallel ropes, large diamond meshes (maximum 128 m, commonly 48 m) or large hexagonal meshes. The entrance of a pelagic trawl with a stretched circumference of 2000 m has a vertical opening of 100 m and a horizontal width of 200 m when towed with a speed of 3,5-4 kn. Pelagic trawl doors are hydrodynamic efficient, mostly with a multi-foil design and with a large height/length aspect ratio (between 2 and 3). The door drag is 10-15% of the total gear drag. Therefore, reduction of the resistance of the trawl net can contribute more to the total drag reduction than modification of door design.

The trawl sonar is an important instrument in pelagic trawling to monitor trawl performance and fish entrance. Other helpful instruments for pelagic trawling are a winch control system, catch indicators and distance sensors. For pair trawling an instrument which detects and adjust the symmetry of the trawl when towing has proven to be very useful.

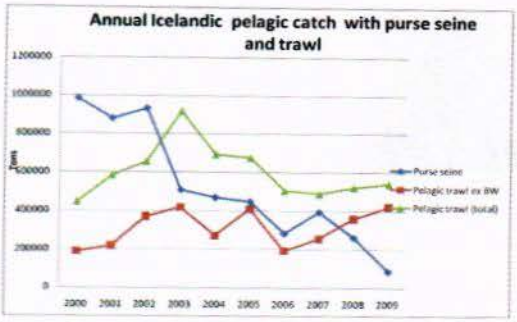
Pair trawling is often a more efficient technique to catch pelagic species than single boat trawling. Two vessels can tow a larger net and often faster than one vessel can alone. Another advantage is that two vessels can share one gear and thus reduce gear costs. When 3 or 4 vessels operate as a group non-fishing vessels are busy with transport and landing when two vessels are trawling.

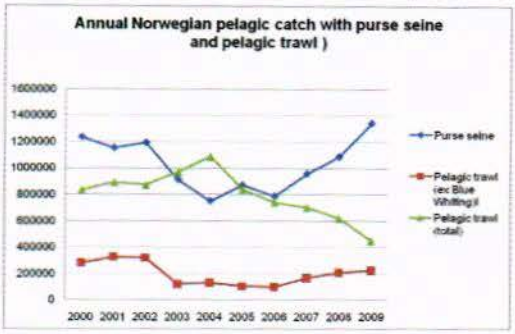
In Norway a fully automatic trolling technique for mackerel has been developed and is used by smaller vessels.

Range of pelagic fishing vessels (automatic trolling for mackerel and a purse seiner/trawler)



The most common pelagic fishing gears (pelagic trawl and purse seine)



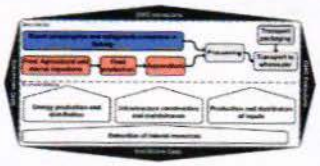


Carbon footprint of Norwegian Pelagic seafood

Erik Skontorp Hognes, SINTEF Fisheries and Aquaculture
(erik.hognes@sintef.no, Phone: +47 40 22 55 77)

The presentation showed results and findings from the report Carbon footprint and energy use of Norwegian seafood products[1] by SINTEF Fisheries and Aquaculture (Norway) and SIK (Sweden).

The report quantified the climate impact from 22 different Norwegian seafood products, both wild caught- and aquaculture products. The carbon footprints were calculated by the Life Cycle Assessment (LCA) method. The following figure shows the system boundaries for the calculations.



The main climate aspects of wild caught seafood are;

- diesel combustion and refrigerants emissions in the fishery
- processing, processing should be done before export to utilize the use of byproducts and transport capacity
- product form, products should be exported as frozen rather than fresh to allow for new transport means

Carbon footprint is high on the agenda for important stakeholders in the seafood value chain. Governmental bodies use carbon footprint to evaluate and choose strategies with less climate impacts. Big retailers wish to show their consumers that they are on top of things and demand that their suppliers can document their carbon footprint.

SINTEF Fisheries and aquaculture is the leading European technological research institute for the fishing and aquaculture sector. SINTEF Fisheries and aquaculture cover the entire marine value chain and work with the goal of contributing to sustainable use of marine resources at a national and international level.

[1] You fin full report here: www.sintef.no/Miljo/Miljovegnskap-for-sjomatprodukter

PELAGIC COMPLEX

Summary of speech Leif Gjelseth, MMC AS

Onboard handling systems, receiving and grading of pelagic fish

MMC specializes in making complete packages consisting of fish handling and refrigeration equipment. The company is a leading supplier within its field of business. The annual turnover is more than 200 mill NOK, and number of employees are 85. With main office in Ålesund area, the company has branch offices along the coast of Norway from Stavanger in the south to Tromsø in the north. Furthermore, offices in Chile and Peru.

MMC is launching a brand new concept for loading, chilling and off loading of purse seiners/trawlers. This project has been developed together with fishing vessel owners and research institutes as Sintef. The project has been supported by Innovation Norge. There is a big hose reel on deck in order to make a safe and smooth handling of the suction hose, which is cutting out the normal hydraulic fish pump. This is also removing the risk of oil pollution in the hydraulic fish pump hoses. The fish hold to be loaded is always full of chilled water, and by pumping water from this hold, an under pressure is created. The under pressure is connected to the new design water separator, which is also connected to the suction hose. The water separator strains off the warm water coming together with the fish, and there is another water pump which is pumping this warm water over board again. This makes a steady and gentle flow of fish into the chilled fish hold at a capacity of some 500 tons per hour. Loading two fish hold simultaneously makes a total capacity of some 1000 tons per hour.

The new chilling design contains two holds only for sea water. From these holds, the RSW pumps sucks at optimal conditions always, and the water is pumped through the chillers and into the bottom of the fish holds. In top of the fish holds, a big area of strainers secure that the water over flows back to the water holds. The system is totally automatic and temperature sensors and flow meters always provide the optimal water flow for each fish hold.

Off loading is done by means of over pressure in the fish holds. Chilled water from the water holds is pumped to the fish hold to be discharged, and creating a flow of water through the off loading line. This water flow is transporting the fish in the most gentle way to the shore plant.

MMC is now making a project with Sintef in order to continue the chilled floating processes from the vessels to the shore plants. This includes a new receiving station consisting of two $30m^3$ stainless steel receiving tanks on the pier, under pressure loading and pressure off loading to the new grading machine. This makes a much simpler receiving system than the traditional today, and at a much lower maintenance and cleaning cost.

The new grading machine is based on vision techniques and will become the only machine which can grade such amount of fish individually and accurate. The machines are intended to make a capacity of some 40 tons per hour, and several machines can be installed in parallel in order to achieve the requested capacity.

The grading machine will replace the recourse weight and in give a lot of possibilities in order to make the traditional fish factories more simple.

MMC has decided to always use scientist institutes in R&D projects.

WÄRTSILÄ

Fuel technology and energy efficient design and control on pelagic vessels

Abstract

The maritime sector is a large part of the total global transportation system.
There will be an increasing need for reducing emissions to air and execute more energy efficient operations for the whole industry. This will have strong influence on the design of vessels and the use of energy on-board. All aspects from ship design, propulsion, power generation, power distribution, operations and services have to be considered.

New energy sources like fuel cells and new gaseous engines will be introduced.
Hybrid propulsion plants will be more attractive due to more flexible and energy efficient operations in emission controlled costal areas.

For the maritime industry the International Maritime Organization (IMO) has issued new regulations for NOx and SOx that will come into force the next years.
The same organization has prepared proposals for reducing CO_2 by introducing energy efficiency plans and indexes and economical market instruments. These matters are in principle agreed and possibly put into force within short time.

Another important area is the expected future fuel cost that will require more efficient machinery systems and operations to support a sustainable business for the owners.

Indicators show strong interest in energy efficient systems and cost effective and reliable solutions. In general a more energy efficient operation will give a more sustainable business, but there are clear obstacles within financing new designs and investments in new technologies on short term.

New research and development programs will be necessary to demonstrate new machinery systems and a total understanding of energy use during different environmental conditions.

Name	: Ingve Sørfonn
Title	: Director
Organization	: Wärtsilä Ship Power Technology
Address	: N-5404 Stord , Norway
Phone	: +47 95732581
Email	: ingve.sorfonn@wartsila.com

Ingve Sørfonn has over 30 years industrial working experience within electrical, automation and energy systems in different markets from onshore power industry, offshore oil & gas and maritime industry.
His current role is to manage new energy efficient technologies and solutions, covering all aspects from production of energy to efficient use of energy.
Prior responsibilities have been management within large scale oil & gas projects and technology development in Aker Kvaerner and later Wartsila. The experience is covering responsibilities within research, development, manufacturing, engineering and project execution.

The Pelagic Complex in the Northeast Atlantic Ocean,
7th – 9th September 2010, Tórshavn, Faroe Islands
Session 3

Short abstract

Title: **Is it sustainable to use fish as feed?**

Dr. Ragnar L. Olsen

Pelagic fish resources have been used for non-food purposes as industrial products and animal feed for more than a century. Today, most of the fish oil and meal available are used in compound feed for intensive aquaculture. It is however often said that it is not ethical correct or sustainable to use highly nutritional fish which could in theory be used for human consumption, as feed for fish and shellfish. The talk will focus on that use fish resources for feed is reasonable as long as the fish is legally caught from well managed stocks.

EFFECT OF CATCHING METHODS AND ON BOARD HANDLING SYSTEMS ON QUALITY OF PELAGIC FISH

I.G. Aursand, H.Digre and I.Martinez

SINTEF Fisheries and Aquaculture, 7465 Trondheim, Norway. Tel: +47 40 00 53 50, Fax: +47 932 70 701,

ABSTRACT

Although not widely studied, it has nevertheless been shown that catching methods and subsequent on board handling (Valdimarsson et al., 1984) may affect fish quality. Botta et al. (1987) compared the effect of season and catching method on the quality of cod (*Gadus morhua*) on muscle-pH, fillet colour, odour, discolouration/bruising and overall grades of cod. The results showed that catching methods had greater impact than season on the quality of fresh cod. Hattula et al. (1995) studied the effect of gillnetting, poundnetting and trawling on mortality and quality of herring. Mortality increased when the trawling time increased from 2 to 5 h. Since rigor mortis started earlier with fish caught by gillnet, this indicated that gillnet was the most stressful catching method. Furthermore, muscle-pH is lower and the condition factor is generally higher of fish caught by gillnet compared with fish caught by longline (Esaiassen et al., 2004). In the present study, the effect of the catching methods when using ring net (coastal vessel and ring net vessel) and trawling with traditional and T90 trawl nets, on quality of two different pelagic fish species; mackerel (*Scomber scombrus)* and Norwegian spring spawning herring *(Clupea harengus),* were evaluated. Fish quality was assessed according to mortality, external damages, initial muscle-pH, development of rigor mortis and visual assessment of fillet colour, texture and various blemishes (gaping, blood spots, bruising etc). The most pronounced effects on fish quality due to different catching methods were mortality rates and external damages. Trawling was the most stressful catching method for herring. Mackerel caught by the new trawl net (T90) had less external defects than those caught by the traditional trawl net. Moreover, mackerel caught by the T90 trawl net were generally of smaller size compared to traditional trawl. According to the fishermen, this was due to differences in capture time, i.e. time of the day. Smaller fish are commonly caught at night. A new design of a water separator on board a purse seiner was shown to give less blodspots on herring fillets compared to a traditional designed water separator, indicating a gentler handling of the fish. Furthermore, a rapid method for measuring risk of belly bursting based on enzyme activity was presented. A web based quality manual (www.fhl.no/book) for the whole pelagic value chain from catch to market was presented. The manual is still under development, and will be completed and translated from Norwegian to English in year 2011.

References

Botta, J.R., Bonnell, G. & Squires, B.E. (1987) Effect of method of catching and time of season on sensory quality of fresh Atlantic cod (Gadus morhua). J. Food Sci. 52, 928-931, 938.

Esaiassen, M., Nilsen, H., Joensen, S., Skjerdal, T., Carlehog, M., Eilertsen, G., Gundersen, B. & Elvevoll, E. (2004). Effects of catching methods on quality changes during storage of cod (Gadus morhua). Lebensmittel-Wissenschaft und-Technologie, Vol 37, Issue 6, 643-649.

Hattula, T., Luoma, T., Kreitsmen, K., Poutanen, J., Kallio, M. & Suurmeyer, P. (1995) Effects of catching method on different quality parameters of Baltic herring (Clupea harengus L.). Fish. Res. 23, 209 – 223.

Valdimarsson, G., Matthiasson, A. & Stefansson, G. (1984) The effect of on board bleeding and gutting on the quality of fresh, quick frozen and salted products. In: Fifty Years of Fisheries Research in Iceland. A. Møller (Ed.). Reykjavik, Iceland, pp 61-72.

Advanced chillin g techniques for pelagic fish – full scale results.

Sigurjón Arason
Chief Engineer, R&D Division at Matis ohf. and
Associate Professor at the University of Iceland [1),2)]

The choice of the right cooling method and techniques for pelagic fish for processing good food products for human consumptions is important. Improved cooling techniques will also give better feed quality. With choice of cooling techniques must also take into account condition of fish, season variation of the difference fish spices, quality criteria of raw materials, etc. Freshness of raw material is an important criterion of food products and fish-meal quality.

[1)]Matis, Vinlandsleid 12, IS-113 Reykjavik, Iceland.
Phone: +354-422 5117. Fax: +354-422 5001. E-mail: sigurjon@matis.is
[2)]University of Iceland, The Faculty of Food Science and Nutrition
Vinlandsleid 12, IS-113 Reykjavik, Iceland. E-mail: sigurjar@hi.is

Potential fast and non-destructive methods to measure the fat in herring and herring products

Henrik Hauch Nielsen
National Food Institute, Division of Food Industrial Research, Technical University of Denmark. Søltofts Plads, Building 221, DK-2800 Kgs. Lyngby, Denmark.

The fat content is an important quality parameter for herring and herring products. The fat content varies throughout the season and follows the cycle of maturation and studies of commercial catches in Denmark show a considerable variation in fat content within the same catch. Furthermore it can be deposited differently in the tissue depending on the maturation status of the herring.
Several methods are applicable for measuring the fat content in individual fish in a non destructive way and can have potential as at-line or on-line measurement of fat. In the Danish research project "Herring – A living resource – A good product" carried out at the former Danish Institute for Fisheries Research, Division of Seafood Research from 2001 to 2005, three methods were studied: Near InfraRed (NIR), Nuclear Magnetic Resonans (NMR) and the Fatmeter. The objectives were to investigate their correlation to a chemical reference analysis and to evaluate their suitability as future quick non-destructive methods for measuring the fat content in herring.
The results confirm the wide variation in fat content within each catch with fat contents ranging from 1 to 25%. The results furthermore show that NIR, NMR and Fatmeter have different suitability and applicability as fast non-destructive methods for determination of fat content. The Fatmeter measurements were highly influenced by gonad maturity and are therefore not suitable for measurements on whole herring. NIR measurements gave good predictions with low prediction errors and thus show high potentiality as a fast and non-destructive method for measuring fat content in a production line. Also NMR gave good predictions but as measurements were done on minced herring, further work on whole muscle is necessary before a final evaluation of the suitability of this method can be done. In the Nordic Innovation centre (NIC)-funded project SILLQUID, the fast and non-destructive method microwave (MW) dielectric spectroscopy, developed in two recent EU-projects, was tested for prediction of fat of a unique herring material collected and analyzed during another NIC-funded project "Improved quality of herring for humans" and also tested during industrial production of herring and mackerel fillets. The MW tool was able to detect fat content of pelagic fish, at least up to fat levels of 18% (herring) or 25% (mackerel).

Vedlegg 6

Challenges for the pelagic fish sector in the future – focusing on pelagic fish as food products

Hanne Digre[1], Henrik Hauch Nielsen[2], Ingrid Undeland[3], Ásbjörn Jónsson[4], Ivar Storro[1] and Ida Grong Aursand[1]
[1]SINTEF Fisheries and Aquaculture, Norway, [2]DTU, Denmark, [3]Chalmers, Sweden, [4]Matis, Iceland

Introduction

The pelagic fisheries are among the largest in the Nordic countries. Approx 1.5 mill tons were landed in 2009. In Norway, Sweden and Iceland the pelagic fish accounts for more than 65 % of the total catch. However, the pelagic fish industry is facing several challenges regarding catching, processing, fish quality and profitability. Approximately 40% of the pelagic catch volume from Europe is discarded or is destined for low value feed applications. The main reason for this is quality losses, but also unprofitability for the fish industry in producing low-value fish species with today's technology is a factor. The pelagic fish value chain is highly internationalised, and both the processors and the consumers demand more information about the raw material and the final product they purchase. In the last 10 years, several RTD projects have been carried out in The Nordic countries in close collaboration with the Nordic pelagic industry. An overview of these RTD-projects is presented in Table 1. With these projects as a basis, and through discussions with the Nordic industry in network meetings and workshops autumn 2010, the future challenges for the sector have been identified. Some of these challenges are discussed in this article.

Catching and on board handling

The catching and handling operations have significant impacts on the quality of the end-product. Many fish are exhausted, injured or killed as a result of inadequate (a) catching methods (b) transfer from sea-to-vessel methods, or (c) on deck handling routines. In addition, the pumping technology used for loading and unloading of catch can also damage the fish. Often the cause of death is anoxia as the fish are left in air or depletion of dissolved oxygen in the water surrounding the fish. A study conducted in 2005 of the effect of different catching methods commonly used in pelagic fisheries (purse seine, coastal purse seine and trawl with traditional and the novel 'T90' trawl nets) on the quality of Norwegian spring spawning herring (*Clupea harengus*) and mackerel (*Scomber scombrus*) showed that catching methods, onboard handling routines and weather conditions had a significant impact on fish quality and survival rate (Digre and Hansen 2005, Norwegian industry project "Pelagic quality from sea to dish", 2003-2007). Two other studies carried out in Denmark in 2003 also showed that onboard handling and storage has a significant influence on sensory properties of both raw material and processed products (Nielsen et al., 2005, Nielsen and Hyldig, 2004).

Once pelagic fish are taken onboard, another major challenge is the lack of efficient cooling and preserving techniques to prevent the onset of spoilage. This is a particular problem for smaller artisinal vessels, prosecuting Southern pelagic fish species. As a consequence of this, vulnerable pelagic species exhibit extraordinarily short shelf life and highly variable quality, which restricts their onshore utilisation to inferior low value products. Equipment vendors and research institutes are continuously working together on better solutions both for handling and chilling of fish on board. The latter years, improvements have been made, but there is still a potential for increasing the pelagic fish quality.

Effective processing and process control

The pelagic fish processing industry in the Nordic countries operates with high volumes and high intensity processing during the production season. Damaged fish or unwanted species are currently sorted by manual labour, a process which is monotonous and prone to errors mainly due to human fatigue. Thus, a cost-effective automation of the process is vital to optimise operational efficiencies and standardise quality control. Weight-grading of herring and mackerel is typically performed using mechanical graders. These mechanical graders are not entirely accurate and, due to the pricing of the different weight-grades of herring and mackerel, this inaccuracy results in a loss of potential income.

Manual processing and grading have several drawbacks as these operations are strongly influenced by human factors. Mistakes, occasional omission in processing, and fatigue can result in imperfections that decrease product quality and thereby lessen profit (Pau and Olafsson, 1991). Previous surveys indicate that the food industry has been rather slow to adapt new automation technologies, but there is currently a growing interest for utilizing such technology in the near future (Ilyukhin et al., 2001). There is a need for more automated and accurate technology for handling and processing. This upgrading of technology will lead to increase in effectiveness, fulfilment of continually differentiation and tightening of product specifications. Especially technology related to grading, sorting according to well defined quality parameters (e.g. fat content), and packing processes for whole fish and fillets are needed.

Additionally, many companies are expanding their filleting capacity as the market is demanding a larger volume of processed herring (fillets and flaps). The processing industry is however struggling with low earnings. In 2005, the Norwegian pelagic processing industries economical result was 0% compared to 85% for the fishing fleet and 15% for the fish meal and oil processing industry (Iversen, 2006). A low degree of processing was pointed out as the main challenge in an earlier study carried out by DMRI Consult for the Norwegian industry in 2007. A higher degree of filleting leads to larger amounts of rest raw material. In Norway, 290 000 tons of rest raw materials was produced in 2009 (Rubin, 2010). Currently, the rest raw materials are processed to fishmeal and fish oil for the feed market. Bringing some of these rest raw materials as roe, milt and herring oil (Hyttan and Østvik, 2009; Stoknes and Breivik, 2009; Østvik, 2009) to the food market will clearly improve the profitability of the land based industry. In addition several new products, as protein isolates produced with the acid and alkaline solubilisation technique (also called pH-shift

technique) (Nolsöe & Undeland, 2009) and protein hydrolysates produced with enzymatic techniques, can be made from pelagic rest raw materials. Both isolates and hydrolysates can be used in health and functional foods, pet foods or as savories. The potential economical contribution from rest raw material utilization is an important element for increasing the profitability in the pelagic industry.

Utilization of blue whiting

Most of the blue-whiting catch landed in Iceland or in the Nordic countries is used to process fish meal for animal feed, a relatively low priced product. Improved quality and shelf life makes it possible to utilize it for human consumption and thereby increase its value. For improved quality it is necessary to change the process, from catch to final product. Some experiments have been done on producing protein isolates from blue whiting. This product can be used in surimi based products, and as a raw material in ready meals. Functional and biochemical properties of fish protein hydrolysate from blue whiting have been studied (Geirsdottir et al., 2010). This study demonstrated that blue whiting proteins can be hydrolysed to make protein powder with functional and bioactive properties, and can be used as a base for development of hydrolysates as a food ingredients, or as a functional food ingredient. Full processing includes the common preservation methods like salting, canning, drying and smoking. Experiments regarding drying and smoking of blue whiting fillets, breaded products from mince, including sausages from minced fillet have been done with promising results (Ingimar, 2001).

Industrial pelagic fish processing waste water

The fish processing industry in general generates large amounts of waste water. Among the worst in this respect is the marinated herring industry where up to 40 m^3 of salt/acid brine can be produced per day for a single marinated herring producer. On top of this comes regular RSW-storage and rinsing waters. Currently, both brines and waters constitute a significant cost for the industry. Beside the cost of water itself, there are cost associated with BOD (Biochemical Oxygen Demand) reductions and the discard of protein sludges. With this background the industry has expressed that any process or potential application that would add value to the waste waters, and/or that would allow recycling of water is of high interest for them.

Quality of pelagic fish

Development of lipid oxidation (rancidity) is one of the main reasons behind quality loss of pelagic fish especially in frozen herring and processed products. Research in the last 10 years has unravelled that one of the primary causes of lipid oxidation in these types of fish is the combination of highly unsaturated fatty acids (e.g. the long chain n-3 fatty acids), abundance of heme-proteins like hemoglobin (Hb) and myoglobin (Mb) as well as low *post mortem* muscle pH, the latter which leads to activation of Hb and Mb into the highly pro-oxidative met-Hb/met-Mb (Undeland et al., 2004; Baron and Andersen, 2004). Met-Hb and met-Mb are greyish-brown, why another very negative side effect of their formation is loss of the reddish-pink colour associated with fresh pelagic fish muscle (Undeland et al., 2010; Chaijan et al., 2005).

It has been found that there is a very high correlation between rancidity development and redness loss, why the latter even can be used as a quick tool to measure rancidity in fish (Wetterskog and Undeland, 2004). A clear future challenge for the pelagic fish sector is thus to find strategies which early on in the processing chain limits the possibilities for met-Hb and met-Mb formation.

Another future challenge is within the production of traditionally barrel salted herring and acid marinated herring fillets. The herring industry primarily uses fresh herring as raw material for these products. However, it is expected that frozen herring and herring fillets will in future account for a larger part of the raw material available on the market. It is therefore important to gain knowledge on how frozen raw material can be used for the production of salted and acid marinated herring and how it will affect the properties and quality of the final products in order to optimize freezing and storage conditions.

Another major quality challenge for the pelagic industry is the phenomenon known as "belly bursting". "Belly bursting" is the *post mortem* rapid tissue degradation that results in the disruption of the abdominal wall in pelagic fish, usually during the spring heavy feeding season. The degradation may be so severe that a few hours after capture fish may become unsuitable for human consumption. Belly bursting has been attributed to the effect of proteases which may originate from the digestive system of the fish, from ingested zooplankton, the intestinal flora and/or the fish muscle (Almy, 1926; Gildberg 1982; Martinez, 1988; Huss ,1995; Veliyulin et al., 2007), and it has been coupled to weakening of the collagen (Gildberg, 1982). The most effective way of avoiding belly bursting is not to fish in vulnerable areas at certain times of the year. However, commercially, this may not be possible due to supply demands from markets. In a Norwegian project ("Pelagic quality from sea to dish", 2003-2008), a simple method that can objectively measure the degree of belly bursting in pelagic fish was developed. However, commercially testing of the method needs to be performed..

Health effects from pelagic fish

Very few controlled human and animal studies exist that focus only on health effects from pelagic fish. The ones available deals with herring (Lindqvist et al., 2007; 2009ab; Gabrielsson et al., 2009; Nookhaew et al., 2010) and show that herring intake can improve blood lipid levels (e.g. elevates the levels of the "good cholesterol" HDL), suggesting a reduced risk for cardiovascular disease. In animal models (rats, mice) also a lower degree of atherosclerosis, and an improved hepatic lipid metabolism was found after herring diet (Lindqvist et al., 2009b; Nookhaew et al., 2010). However, to classify herring or specific herring products as functional foods, more clinical studies are required that focuses on cardioprotective effects of different sub-fractions of herring (e.g. lipids, proteins, water-solubles) and/or other health beneficial effects of herring.

Many traditional herring products like marinated herring are high in salt, a feature which potentially could counteract positive health effects of a herring containing diet. Salt (sodium chloride, NaCl) is the world's most established food additive, because of its excellent preservative effects, the sensorial properties and the increased food processability. This combination of factors has resulted in salt being used at higher levels than necessary in most processed foods. In fact, in the European countries, 75-80% of salt we consume is hidden in processed foods. However, recent studies have shown that there is a strong link between high salt intake, high blood pressure, and consequently increased risk of cardiovascular diseases. Public health and regulatory authorities are therefore recommending lowering the daily salt intake by 50%, and the consumers are becoming more aware of the health risks of high salt products. As a result, food manufacturers in general are facing the dilemma of how to reduce the salt content of foods without losing their palatability, texture, processing yield and long shelf-life. The producers of traditional herring products are here facing a special challenge as they have the possibility to market their products out from their content of long chain n-3 fatty acids, compounds approved for two-step health claims.

References:

Almy, L.H., 1926. The role of the proteolytic enzymes in the decomposition of the herring. J. Am. Chem. Soc., 48: 2136-2146.

Baron, C., Andersen, H.J. 2004. Myoglobin-induced lipid oxidation. A review. Journal of Agricultural and Food Chemistry 50 (14), pp. 3887-3897

Chaijan, M., benjakul, S., Visessanguan, W., Faustman, C. 2005. Changes of pigments and color in sardine (Sardinella gibbosa) and mackerel (Rastrelliger kanagurta) muscle during iced storage. Food Chemistry, 93, 607-617.

Digre, H., Hansen, U.J., 2005. "Pelagic quality – from sea to dish. Relationship between fishing gear and fish quality on pelagic fish". SINTEF Report STF80 A055019.

Gabrielsson, B., Jakubowicz, R., Lönn, M., Marmon, S., Wikström, J., undeland, I., Holming, A., Sundberg, A-S. 2009. Reduced atherosclerosis in obese Ldlr-deficient mice fed herring (Clupea harengus). Paper presented at the 3rd TAFT meeting, Copenhagen, Denmark, September 15-18.

Geirsdottir, M., Sigurgisladottir, S., Hamaguchi, PY., Thorkelson, G., Johannsson, R., Kristinsson, HG. and Kristjansson, MM. (2010). Enzymatic hydrolysis of blue whiting (Micromesistius poutassou); Functional and bioactive properties. Journal of food science, 2010. In press.

Gildberg, A., 1982. "Autolysis of fish tissue - general aspect". Institute of Fisheries, University of Tromsø, Norway.

Huss, H.H., 1995. "Quality and quality changes in fresh fish". FAO Fisheries Technical Paper 348: 195.

Hyttan, S. Ostvik, S. O. (2009)Biråstoff fra filetering av sild. Karlegging og analyse av råstoff og anvendelsesmuligheter. Rubin. (http://www.rubin.no/index.php?current_page=publikasjoner).

Ilyukhin, S.V., Haley, T.A., Singh, R.K. 2001. "A survey of control system validation practices in the food industry". Food Control, 12, 297-304.

Ingimarsson, H. (2001). Blue whiting-catching and processing. MSc. Thesis, University of Iceland and Icelandic Fisheries Laboratory.

Iversen, A. 2006. Pelagisk verdiskaping. Verdi- og kvalitetsbasert høsting av pelagisk fisk. Fiskeriforskning Rapport 24/2006.

Lindquist, H.; Langkilde, A-M.; Undeland, I.; Rådendal, T.; Sandberg, A-S. Herring (Clupea harengus) supplemented diet influence risk factors for CVD in overweight subjects. 2007. Eur J Clin Nutr., 61(9):1106-13

Lindqvist, H., Langkilde, A-M., Undeland, I., Sandberg, A-S. 2009a. Herring (Clupea harengus) intake influence lipoproteins but not inflammatory and oxidation markers in overweight men. British Journal of Nutrition, 101, (3), 383-390.

Lindqvist, H., Sandberg, A-S., Undeland, I., Stener-Victorin, E., Larsson, B-M, Samuelsrappa, T., Lönn, M., Holming, A. 2009b. Influence of herring (Clupea harengus) and herring fractions on metabolic status in rats fed a high energy diet. Acta Physiologica, 196 (3), 303-314.

Martinez, I. 1988. "Degradacion autolitica de la anchoa (Engraulis encrasicholus): Identificacion, purificación y caracterización de algunas proteasas implicadas". Facultad de Ciencias, Universidad del País Vasco-Euskal Herriko Unibertsitatea.

Nielsen. D & Hyldig, H. (2004) Influence of handling procedures and biological factor son the QIM evaluation of whole herring (Clupea harengus L.) Food Research International 37, 975-83.

Nielsen, D., Hyldig, G., Nielsen, J., & Nielsen H.H. (2005) Sensory proerties of marinated herring (Clupea harengus) processed from raw material from comercial landings. J Sci Food Agric 85, 127-134.

Nolsöe, H.; Undeland, I. 2009 The acid and alkaline solubilisation process for the isolation of muscle proteins: State of the art. Food Bioprocess Technology, (1), 1-27.

Nookaew, I., Gabrielsson, B.G., Holming, A., Sundberg, A.-S., Nielsen, J. 2010. Identifying molecular effects of diet through systems biology: Influence of herring diet on sterol metabolism and protein turnover in mice. PLoSONE, 5 (8), art. no. E12361, pp 1-9.

Pau, L.F., Olafsson, R., 1991. "Fish quality control by computer vision". Marcel Dekker, New York, pp. 23-38.

Rubin 2010: Varestrom analyse 2009 (http://www.rubin.no/index.php?current_page=publikasjoner)

Stoknes, I., Breivik, H 2009: Sildeolje til bruk i spesialprodukter for hese og ernæring. Forprosjekt Rubin. (http://www.rubin.no/index.php?current_page=publikasjoner)

Undeland, I., Kristinsson, H.K. and Hultin, H.O. 2004. Hemoglobin catalyzed oxidation of washed cod muscle phospholipids –effect from pH and hemoglobin source. J. Agric. Food Chem., 52, (14), 4444-4452.

Undeland, I. Jonsson, A., Olsen, R-E., Burr, U-K., Janestad, H., Schimmer, O., Hauch-Nielsen, H. Jörgensen, B. 2010. SILLQUID - Can a Microwave Quick Tool Predict Quality and Origin of Herring. Final report of the NICe-funded project SILLQUID. (http://www.nordicinnovation.net/prosjekt.cfm?Id=1-4415-337)

Wetterskog, D.; Undeland, I. 2004. Loss of redness (a*) as a method to measure hemoglobin-mediated lipid oxidation in washed cod mince. J. Agric. Food Chem., 52 (24), 7214-7221.

Veliyulin, E., Felberg, H.S., Digre, H., Martinez, I. 2007. Non-destructive nuclear magnetic resonance image study of belly-bursting in herring (Clupea harengus). Food Chemistry, 101 (4), 1545-1551.

Ostvik, S.O. 2009:Utnyttelse av rogn fra filetering av sild. Forprosjekt. Rubin. (http://www.rubin.no/index.php?current_page=publikasjoner)

Table: An overview of research activities performed for the Nordic pelagic sector the last 10 years

Research Area	Results
Basic research	– Seasonal variations (herring and mackerel) – Improved quality of herring for humans (chemical, sensorial and physical quality linked to catching ground, season and effect of frozen storage) – Catching methods, effect on raw material quality – The role of blood during ripening of herring – Belly bursting, parasites and microbiology – Improved used of herring for humans: antioxidative effects of herring press juice, health effects in humans and animals
Rapid non-destructive measurements	– Fat content measurements of pelagic fish (Microwave based, NIR and low-field NMR, MW-based dielectric spectroscopy) – Quick measurement of rancidity by redness (a^*-value) analyses – Enzyme activity in pelagic fish – objective measurement for risk of belly bursting
Development of industrial tools for defining quality	– Web based quality manual (www.fhl.no/book) – QIM – herring – Product standard for pelagic fish – Rapid objective method for estimation of risk of belly bursting – Prototype for NIR-based objective fat measurements on board
Effective production and automation	– On-line automatic sorting and grading of pelagic fish – Pumping and onboard handling, new concepts and quality effects – Market research, traceability and transport logistic – Chilling methods pelagic fish (onboard and processing)
Process and product development	– Pelagic fish rest raw material utilization – Herring fillets (frozen raw material, marinated and salted, etc.) – Further processing of mackerel (smoking and canning) – Protein isolation from herring and blue whiting by the pH-shift technique – Drying of blue whiting – Packaging of herring (fillets and marinated pieces) – Utilization of protein and oil from pelagic species

Teknologi for et bedre samfunn

www.sintef.no