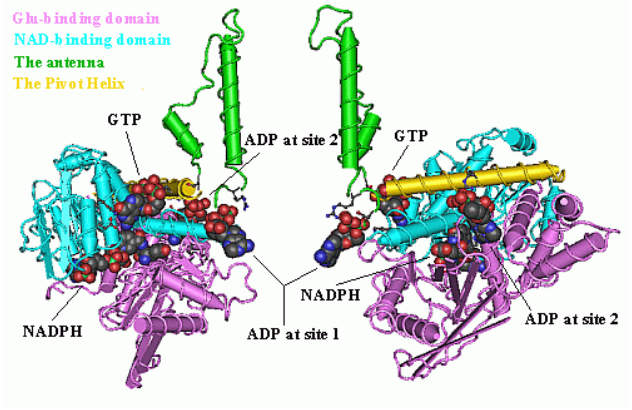
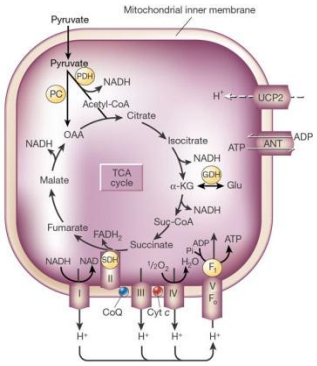
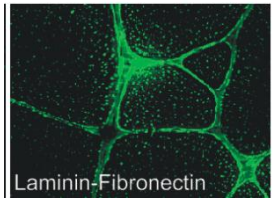
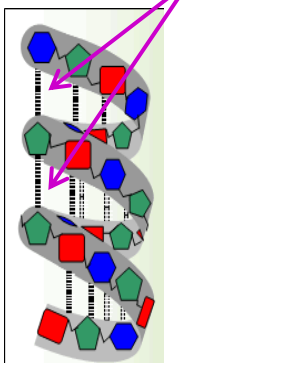
Tekstur i laks









Verdikjede Havbruk

Gruppe Tekstur

Turid Mørkøre

Magnus Åsli

Thomas Larsson

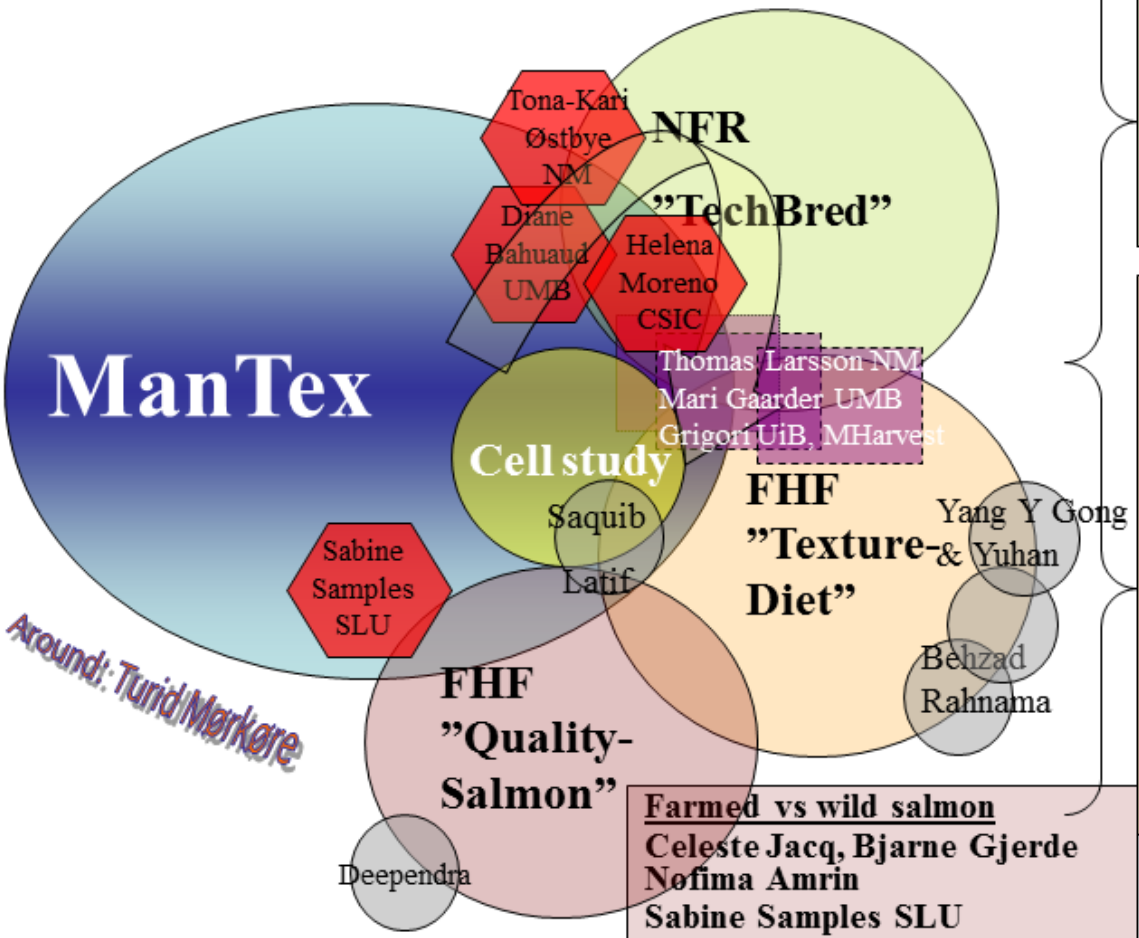
Participants, contributors

-- AND WHERE ARE THE PEOPLE IN THIS TEXTURE UNIVERSE?

STUDENTS
5 Master of science
3 PhD
4 Post doc

Cell study

Bente Ruyter, Tone Kari Østbye, Thomas Larsson, Inger Kristiansen NMarin, Kristin Hollung NMat, Diane Bahuaud, Saquib Latif UMB, Ulf Erikson, Inger B Standal Sintef, Grigori, UiB



Family study

Diane Bahuaud, Magny Thomassen UMB

Thomas Larsson, Aleksei Krasnov, Jakob Torgersen NMarin

Javier Borderias, Helena Moreno, CSIC

Erling Olaf Koppang NVH

Lars Helge Stien IMR

A.A. study, In vivo and in vitro

Diane Bahuaud, Mari Gaarder, Magny Thomassen, 4 master students UMB & Thomas Larsson, Aleksei Krasnov, Kjell-Arne Rørvik, Bendik Terjesen, Tone-Kari Østby, Inger Ø Kristiansen, Målfrid Bjerke NMarin & Erling Olaf Koppang NVH & Ulf Erikson, Inger B Standal Sintef & Eva Veiseth-Kent, Grethe Enersen, Kristin Hollung NMat, Marit Espe Nifes & Jana Pickova SLU & Lars H Stien IMR

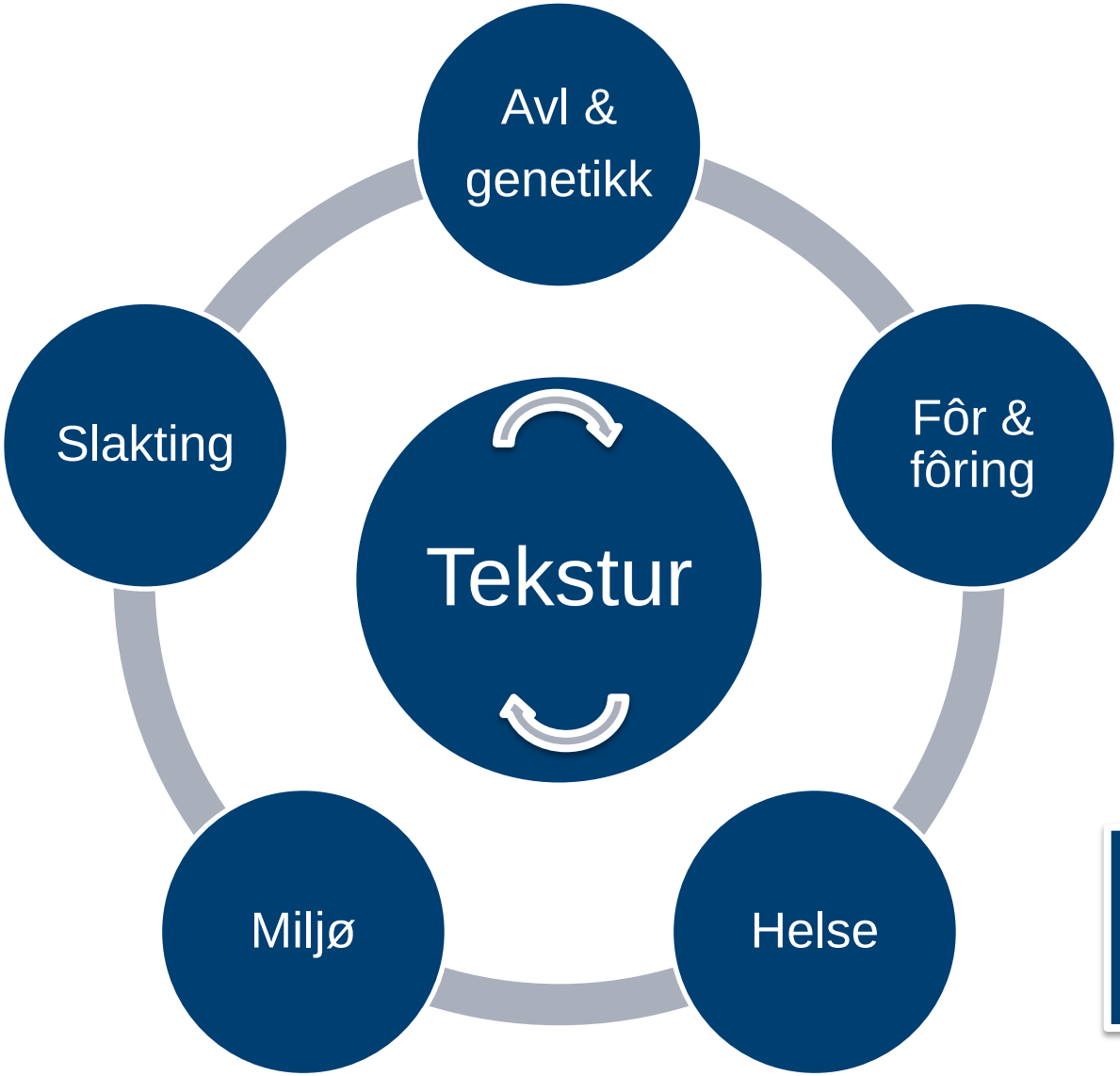
Farmed vs wild salmon

Celeste Jacq, Bjarne Gjerde Nofima Amrin

Sabine Samples SLU

Helena Moreno/Javier Borderias CSIC

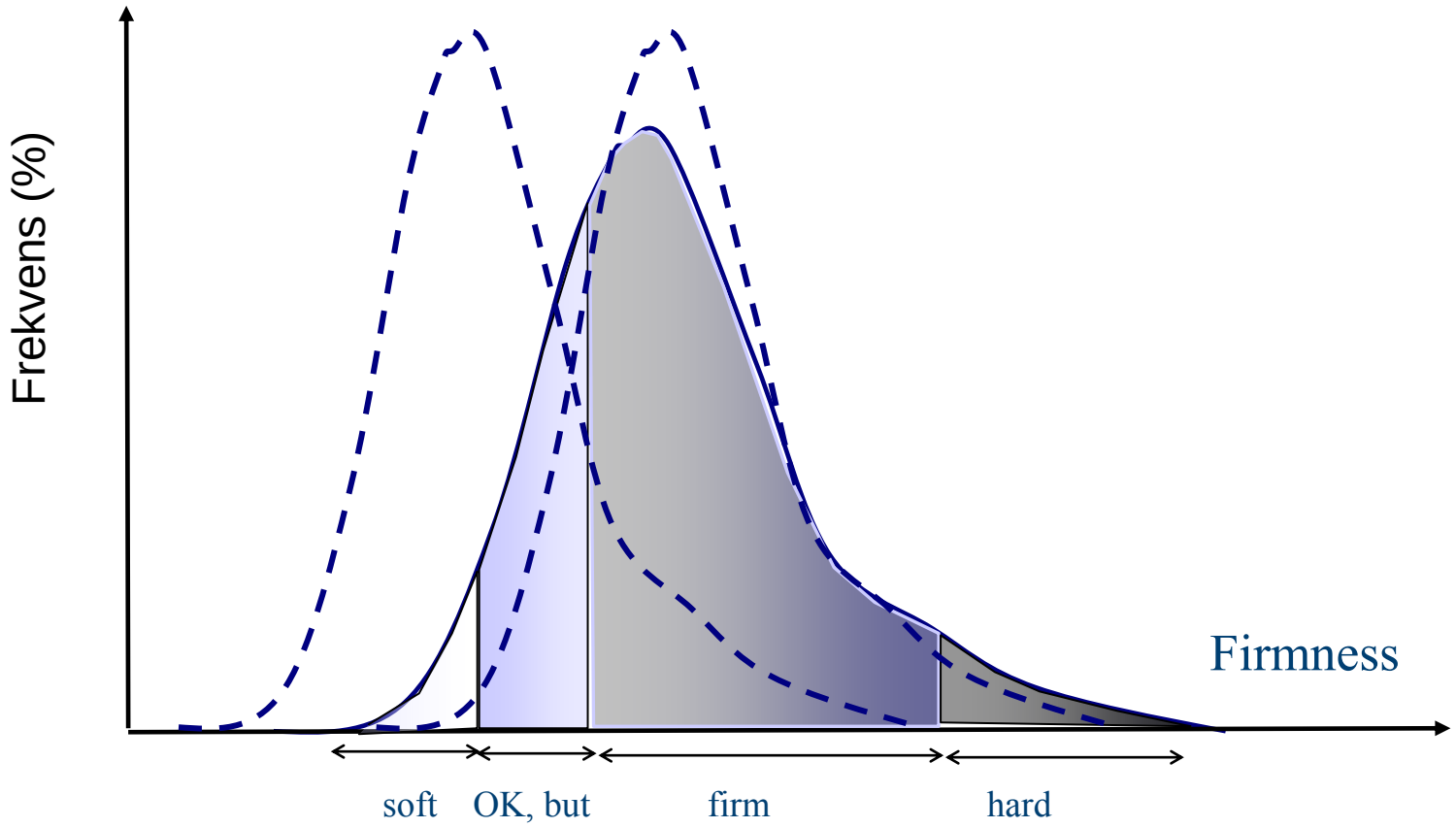
ManTex meeting, Madrid 3.-4. November 2010



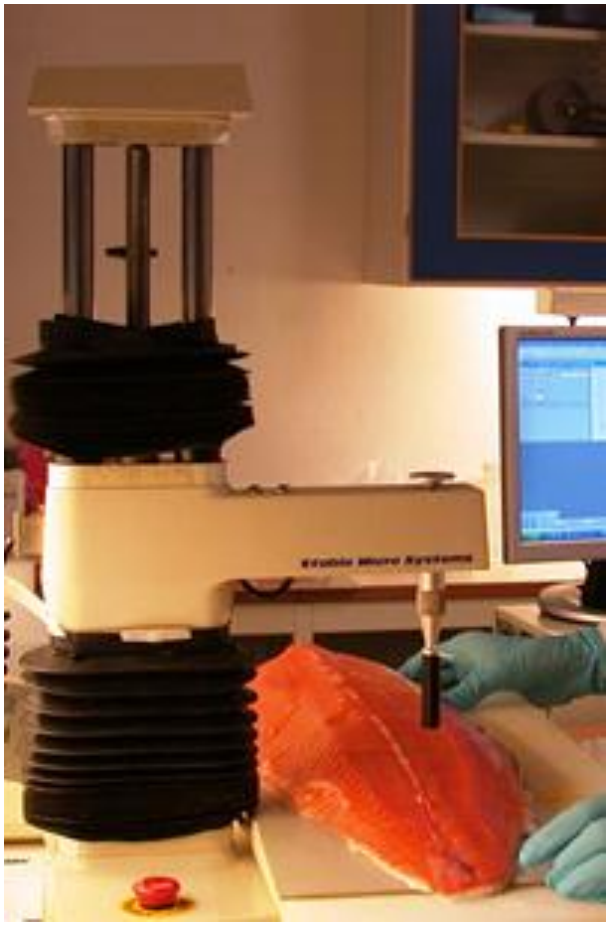
Lagring
Prosesserin
ng
Tilberednin
g

Nofima

Firmness analysed in 7000 salmon from 1995 – 2007 - mangel på statitstikk mht problematisk fasthet

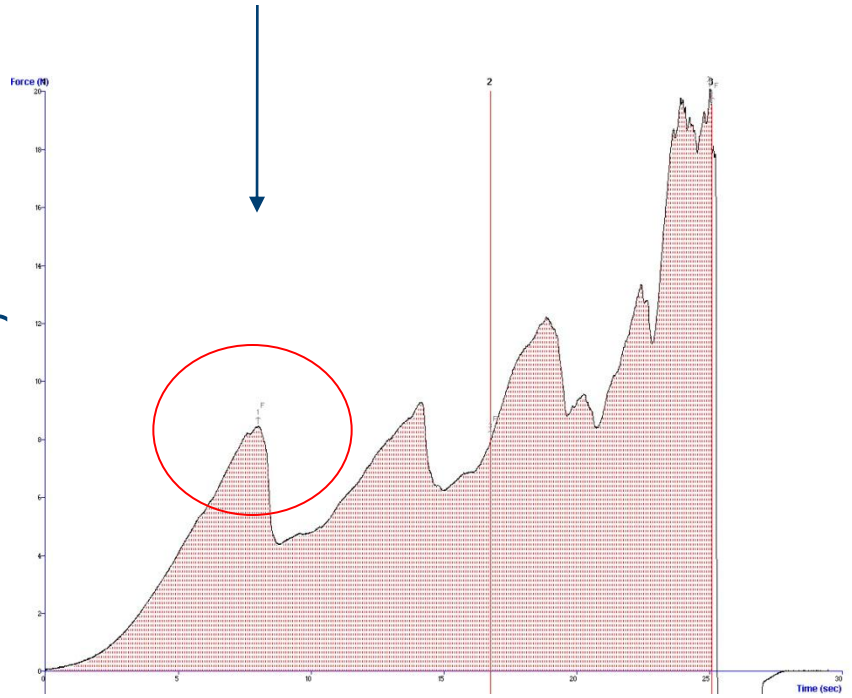


Teksturmåling



Brudd på filetoverflaten

kraft, N



tid

Gode teksturgener

- Beskrivelse av gen-profil for å forstå teksturvariasjon

OPEN ACCESS Freely available online

PLoS one

Gene Expression Profiling of Soft and Firm Atlantic Salmon Fillet

Thomas Larsson[1,2]*, Turid Mørkøre[1,2], Kari Kolstad[1,2], Tone-Kari Østbye[1], Sergey Afanasyev[1,3], Aleksei Krasnov[1]

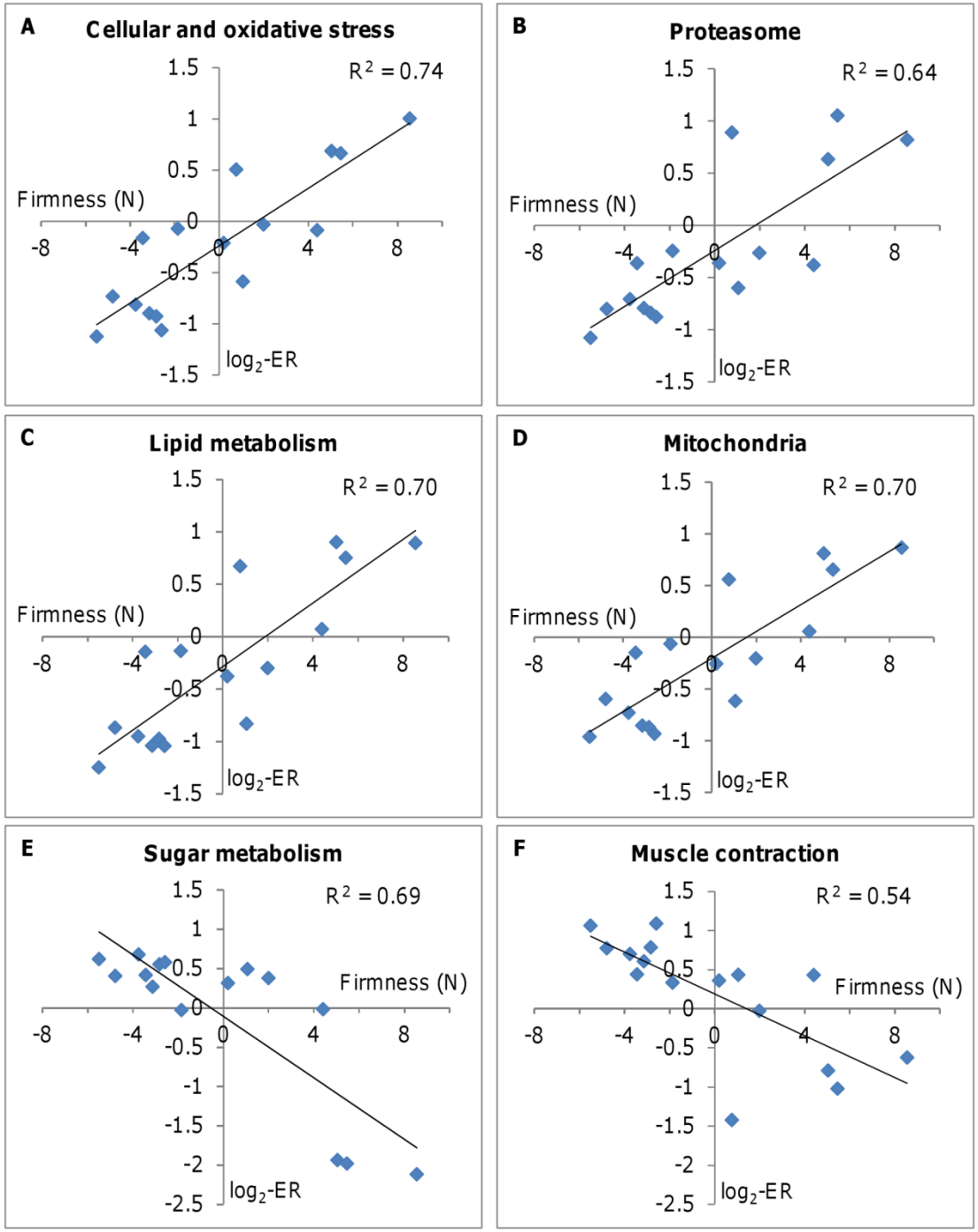
1 Nofima, Ås, Norway, **2** Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences, Ås, Norway, **3** Sechenov Institute of Evolutionary Physiology and Biochemistry, St Petersburg, Russia

Abstract

Texture of salmon fillets is an important quality trait for consumer acceptance as well as for the suitability for processing. In the present work we measured fillet firmness in a population of farmed Atlantic salmon with known pedigree and investigated the relationship between this trait and gene expression. Transcriptomic analyses performed with a 21 K oligonucleotide microarray revealed strong correlations between firmness and a large number of genes. Highly similar expression profiles were observed in several functional groups. Positive regression was found between firmness and genes encoding proteasome components (41 genes) and mitochondrial proteins (129 genes), proteins involved in stress responses (12 genes), and lipid metabolism (30 genes). Coefficients of determination (R^2) were in the range of 0.64–0.74. A weaker though highly significant negative regression was seen in sugar metabolism (26 genes, $R^2 = 0.66$) and myofiber proteins (42 genes, $R^2 = 0.54$). Among individual genes that showed a strong association with firmness, there were extracellular matrix proteins (negative correlation), immune genes, and intracellular proteases (positive correlation). Several genes can be regarded as candidate markers of flesh quality (*coiled-coil transcriptional coactivator b*, *AMP deaminase 3*, and *oligopeptide transporter 15*) though their functional roles are unclear. To conclude, fillet firmness of Atlantic salmon depends largely on metabolic properties of the skeletal muscle; where aerobic metabolism using lipids as fuel, and the rapid removal of damaged proteins, appear to play a major role.

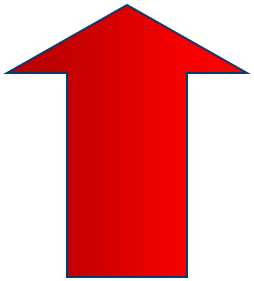
Nofima

Krasnov, A., Timmerhaus, G., Afanasyev, S., Jørgensen, S.M., 2011. Development and assessment of oligonucleotide microarrays for Atlantic salmon (*Salmo salar* L.). Comparative Biochemistry and Physiology D-Genomics & Proteomics 6, 31-38.

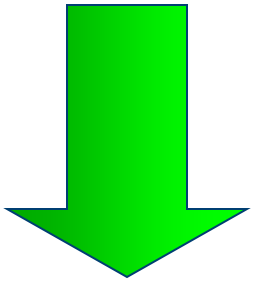

A
Cellular and oxidative stress
R² = 0.74
Firmness (N)
log₂-ER
B
Proteasome
R² = 0.64
Firmness (N)
log₂-ER
C
Lipid metabolism
R² = 0.70
Firmness (N)
log₂-ER
D
Mitochondria
R² = 0.70
Firmness (N)
log₂-ER
E
Sugar metabolism
R² = 0.69
Firmness (N)
log₂-ER
F
Muscle contraction
R² = 0.54
Firmness (N)
log₂-ER

Nofima

Firm meat



Aerobic metabolism
Fatty acids as main fuel
Rapid degradation of damaged protein via proteasomes



Anaerobic metabolism
Amino acids as main fuel

Soft meat

What is inherited: structure of muscle?
Interactions with environment?
Resistance to hypoxia?

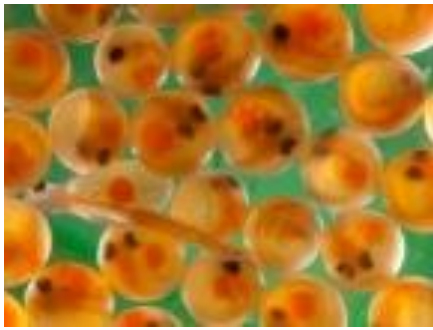
Larsson, T., Mørkøre, T., Kolstad, K., Østbye, T-K., Krasnov, K.
Gene expression profiling of soft and firm Atlantic salmon fillet.
Accepted for publication in PLoS ONE

Avl for kvalitet

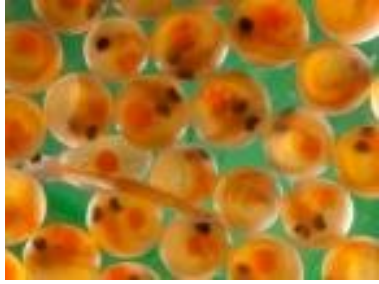
Flere studier, de fleste i samarbeid med FHF har vist:

TEKSTUR ER ARVBART

Photo: www.seafood.no



Avl for kvalitet



Tradisjonelle avlsmål

- Økt vekst (10-12 % økt vekst/generasjon)
- Forbedret fôrutnyttelse
- Forsinket kjønnsmodning
- Sykdomsresistens
- Farge 20-50%
- Fettinnhold

Avl for kvalitet

- Tekstur 20-30%
- Melanin 20-50%

Fremtidige utfordringer

- Gaping
- Lukt og smak

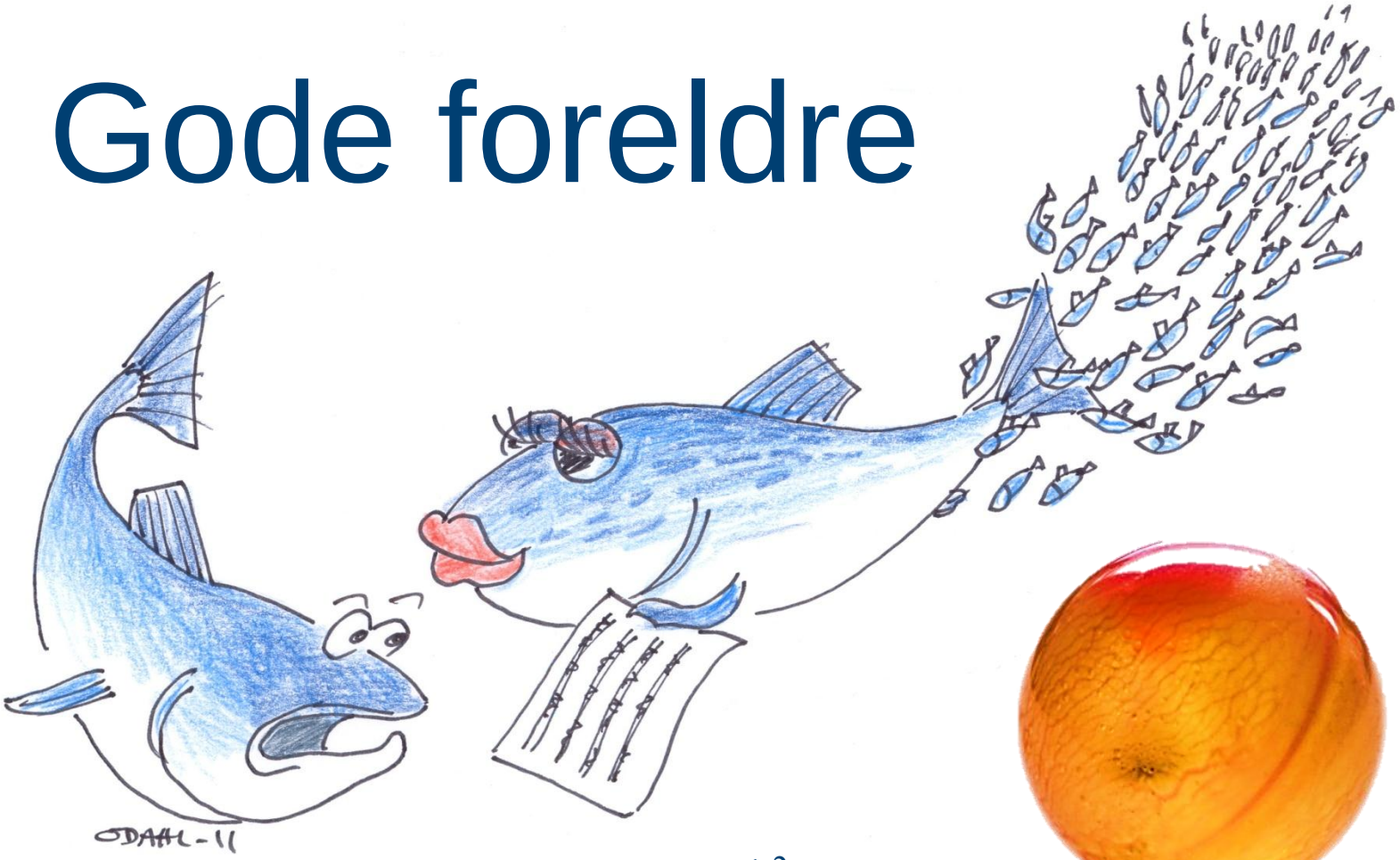
“Kvalitetsforeldre”

n=1181,

- Kriterier
  - Slakteutbytte,% ≥ 90
  - Fett i filet, % ≤ 16
  - SalmoFan, ≥ 26
  - Fasthet, N ≥ 10

Kilde: MSc oppgave av Deependra Acharya

Gode foreldre



$h^2 = 0.16 - 0.31$

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Betydningen av klekketemperatur ?

- Muskelfiberstørrelse
- Blodforsyning
- Fasthet

- Bruk av genteknologi en aktuell metode for å forbedre fasthet og hindre gaping (QTL kartlegging = finne område på et kromosom/markør for god fasthet – selve genet er vanskeligere å finne)

Fôr & fôring

1. Fliser. Fugemasse
2. Flislim.
3. Membran.
4. Påstøp.
Støpemørtel
Varmekabler primer.
5. Betong, mur, puss, gips, våtromsplater
6. Ventilering

Nofima

Verktøy på boks

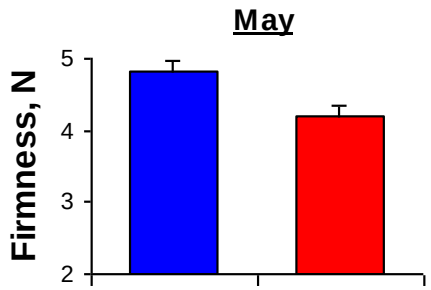
WD40 - For tusen formål på jobben og hjemme

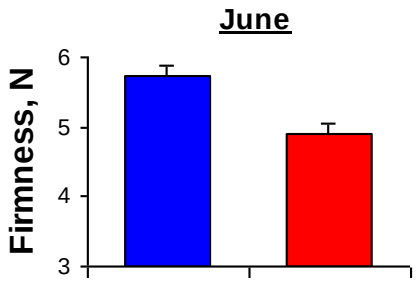
- smører
- driver ut fuktighet
- renser og beskytter
- løsner fastrustede deler
- løsner fastlåste mekanismer

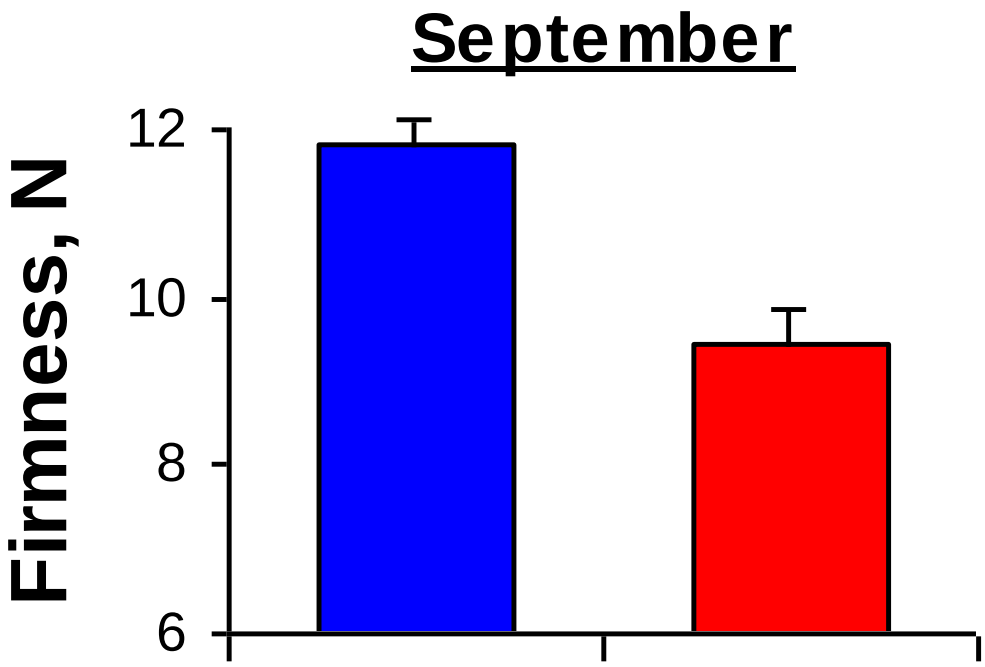
Innehold 400ml

Nofima

Fôr tilsatt glutamat+arginin ⇒ fastere filet enn standardfôr







Mulig å oppnå fastere filet via fôret

Nofima

Firmer salmon fillets

Turid Mørkøre, scientist, Nofima
turid.morkore@nofima.no

Atlantic salmon is the major component of Norwegian aquaculture with a total value of four billion Euro in 2010. Salmon products are sold in 100 countries, with the EU as the largest market. Although Norwegian farmed salmon are generally of good quality, defects such as soft texture may occur.

Soft fillet texture, a challenge

Soft fillets are downgraded because they are not suited for manufacturing of high quality products.

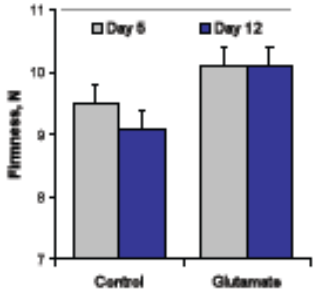
Therefore, the problem with soft texture →

- Large economical losses to the farming and processing industry
- Harmful to the reputation of the industry as a supplier of high quality products

Our new research efforts show that supplementing salmon feeds with specific amino acids (arginine and glutamate) can stabilise the texture and reduce the problem with soft flesh of salmon fillets.

Fortunately, supplemented feeds results not only in firmer texture, but also improved health, improved robustness to stress during slaughter handling and also increased body weight increase during certain life stages in seawater.

The muscle cell density and structure is responding positively to added levels of arginine and glutamate



Results from instrumental texture analyses of salmon fillets after 5 and 12 days of ice storage, respectively

Fruitful interdisciplinary research

These encouraging results are the outcome of interdisciplinary research of salmon throughout two production cycles, from sea transfer to slaughter, and also from in-vitro studies (cell culture). The novel insight helps to improve fillet quality of salmon, and has provided breakthrough knowledge regarding the complex interrelationship between fish health and fillet quality.

Summary of results:

Addition of specific amino acids (glutamate and/or arginin)
Growth: Higher growth rate during Autumn in arginin fish
Texture: Higher firmness (breaking force) and lower degree of gaping
Organs: Smaller and leaner livers. Less organ adhesions (lower Spellberg score)
Histology: Lower degree of deviations in organs (liver, gut, heart) and muscle
Plasma analyses: Lower levels of CK and ALAT
Muscle: Improved buffer capacity in the glutamate fish (higher level of histidin and anserin)
Gene expression for glutamat vs. control feed (Microarray): Changed energy metabolism, healthier tissue, improved antioxidative status, higher protein turnover
In-vitro study: Higher expression of myosin LC, myogenin and higher proliferation (% of positively stained nuclei, PCNA)

Conclusion

Addition of amino acids (glutamate and arginine) improves the

- Firmness of salmon fillets
- Health of the fish
- Robustness to stress

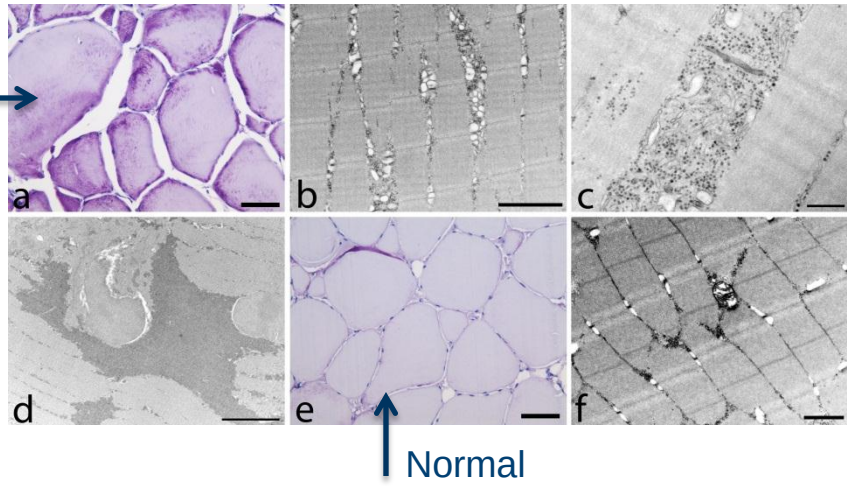
- thus helps to ensure a strong and predictable economy and good reputation of the salmon farming industry throughout the whole value chain

The research was funded by The Fishery and Aquaculture Industry Research Fund (FHF) and The Research Council of Norway (RCN)

Partners:

Nofima

Sukkerlaks/ bløt laks



Viktig årsak hos andre dyr:

- Udekket ernæringsmessig behov i spesifikke perioder?

- Genetikk ?

Opphopning av glykogen medfører

- Nedbrytning av muskelprotein
- Bløt (bleik?) muskel
- Takler ikke stress
- Hjerteproblemer (kan gi plutselig død hos voksne dyr)
- Diagnostiseres ved blodanalyser og histologi

Bløt laks hadde også forstørra mitokondrier

Vi vet ikke når problemet oppstår

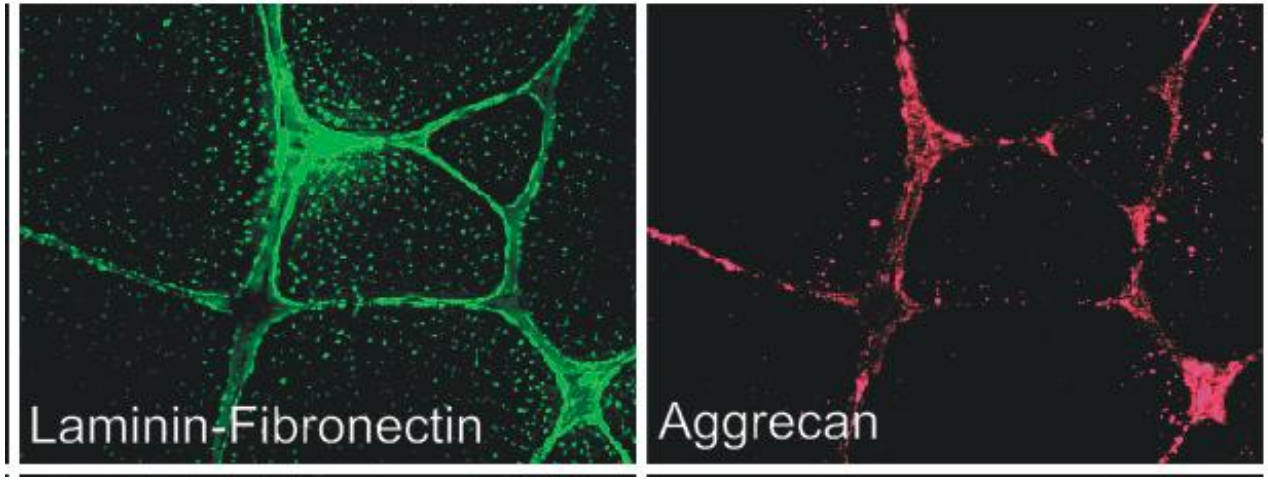
Mulige årsaker

- Lavt nivå vitamin E i fôret (evt tidlig i livet)
- Proteinfattig fôr/ lite karnitin & taurin
- Metabolsk syndrom (problemer med omsetning av næringsstoffer)

Torgersen, J. S., Koppang, E.O., Pedersen, M. E., Stien, L.H. and Mørkøre, T
Morphological characterisitation revealed abnormal glycogen deposition in soft muscle of Atlantic salmon (*Salmo salar* L).

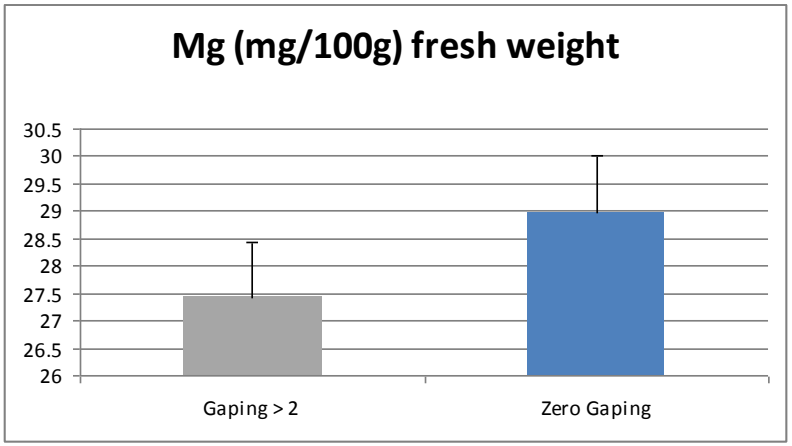
Mikroskopi-bilder av laksemuskel

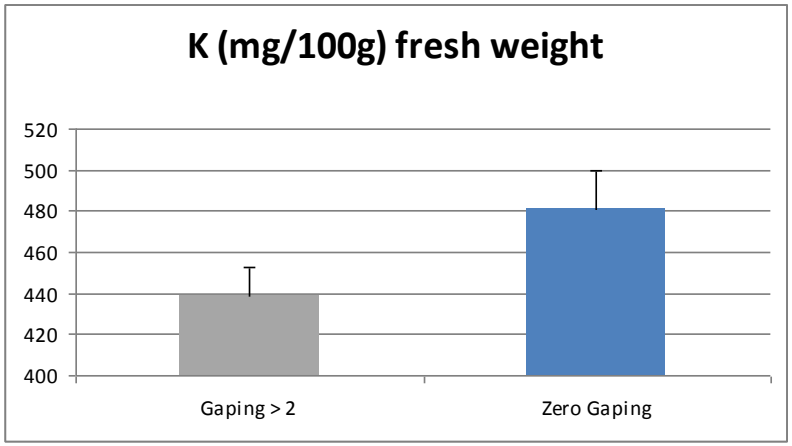
Fast



Torgersen, J. S., Koppang, E.O., Pedersen, M. E., Stien, L.H. and Mørkøre, T
Morphological characterisitation revealed abnormal glycogen deposition in soft muscle of Atlantic salmon (*Salmo salar* L).

Lavere mineralstatus i laks med gaping
Lavt innhold av vitamin E





Celeste Jacq, Bjarne Gjerde, Ingun Thorland, Håvard Bakke, Turid Mørkøre
The impact of selection on fillet quality traits and sexual maturation of Atlantic salmon (Salmo salar L.)
Manuscript

Innovation Award 2011: Processing
NOMINEE

” FIRMER SALMON FILLETS”

Nofima

Soft salmon fillets are an expensive problem for the aquaculture and processing industry, as they are not suitable for the production of high quality products. Our new research has shown that diets supplemented with specific amino acids (arginine and glutamate) promote health, stabilise texture and reduce the problems associated with soft flesh

Nofima

NORTH ATLANTIC SEAFOOD

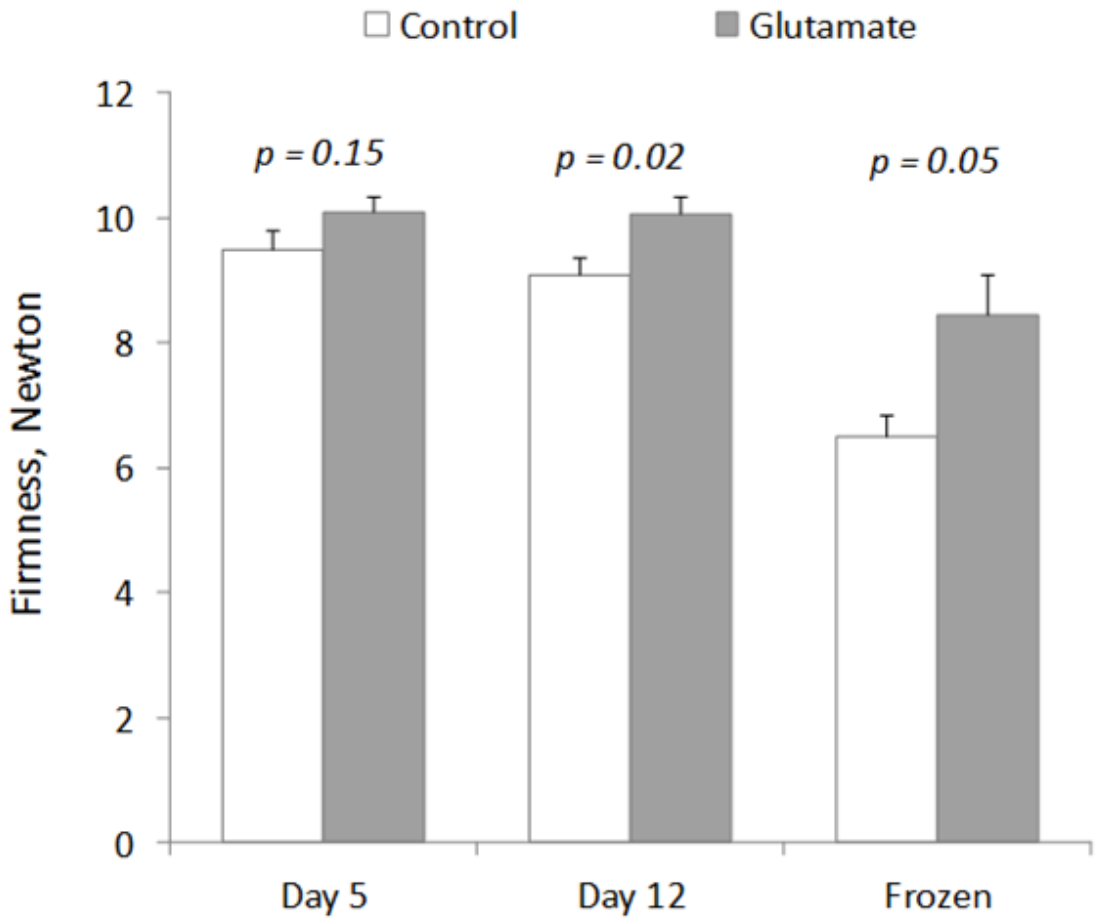
Innovation Award 2011

CATEGORY

Processing

Nofima

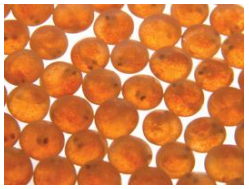
Ekstra glutamat i fôret for fastere filet



- Fungerer ekstra tilsetning av proteiner fra fiskemel / fjørfemel / slo, skinn, hoder fra fiskeindustrien!?

Quality downgrading due to cartilage

– associated with production conditions and nutrition during eraly life stages



- Vertebrae damages develop over time

Source: Bæverfjord, Lein & Helland

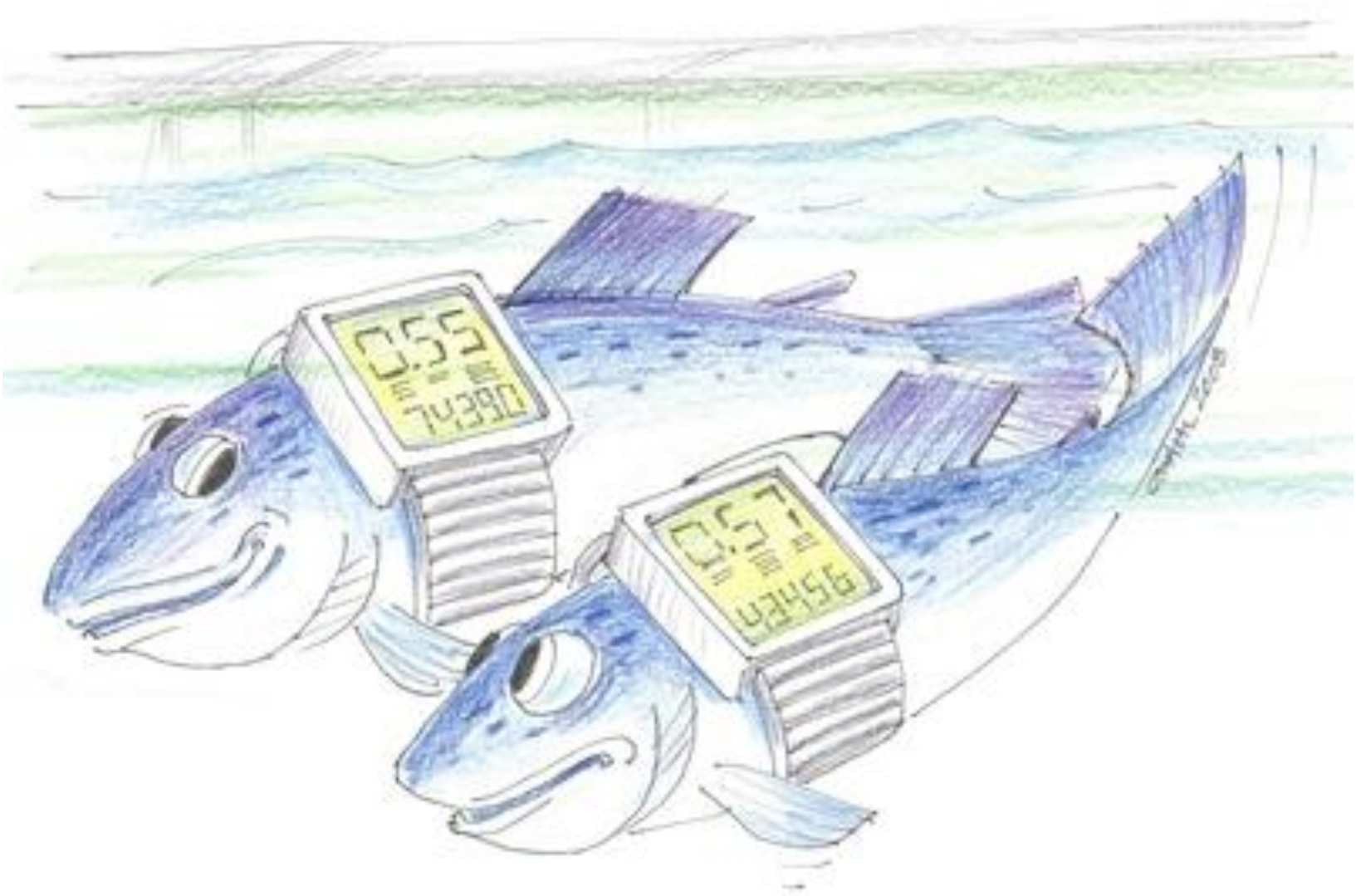
Nofima

- Zink maks grense 200 mg/kg
- For lavt ?

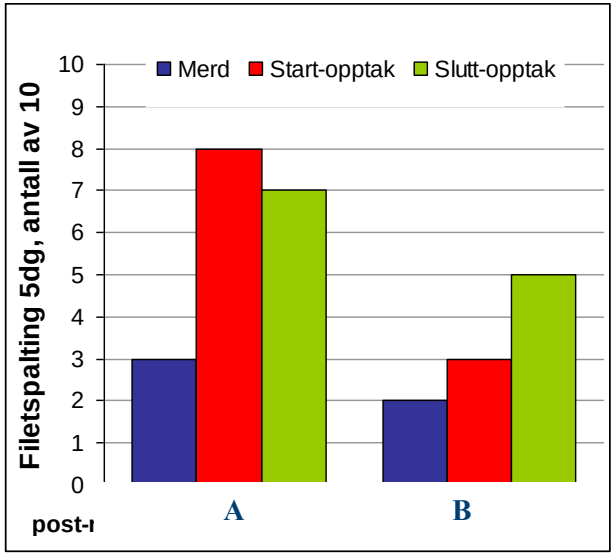
- Sissel Albrektsen
  - Sink
  - Fosfor
  - Kobber ?
  - Jern?

  - Slaktefôr / gjøre fisken klar til høsten / spurt
  - Utsettidspunkt for 0+ / OBS ikke for sent

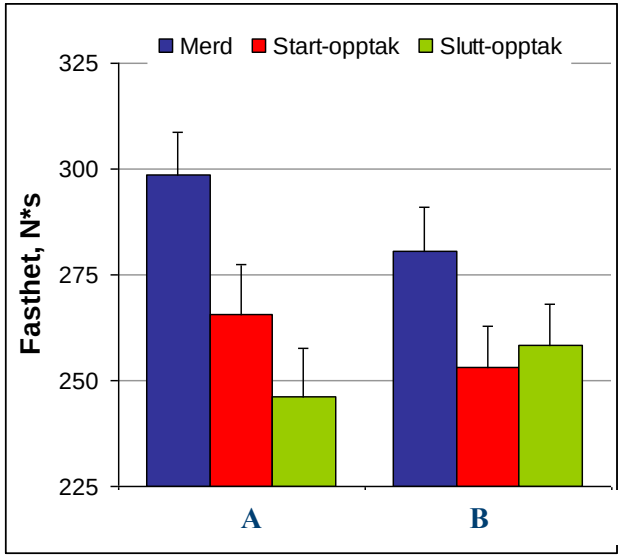
Trening er sunt – også for laks



Laks med god vekst
Analysert etter 5 dagers lagring



A B

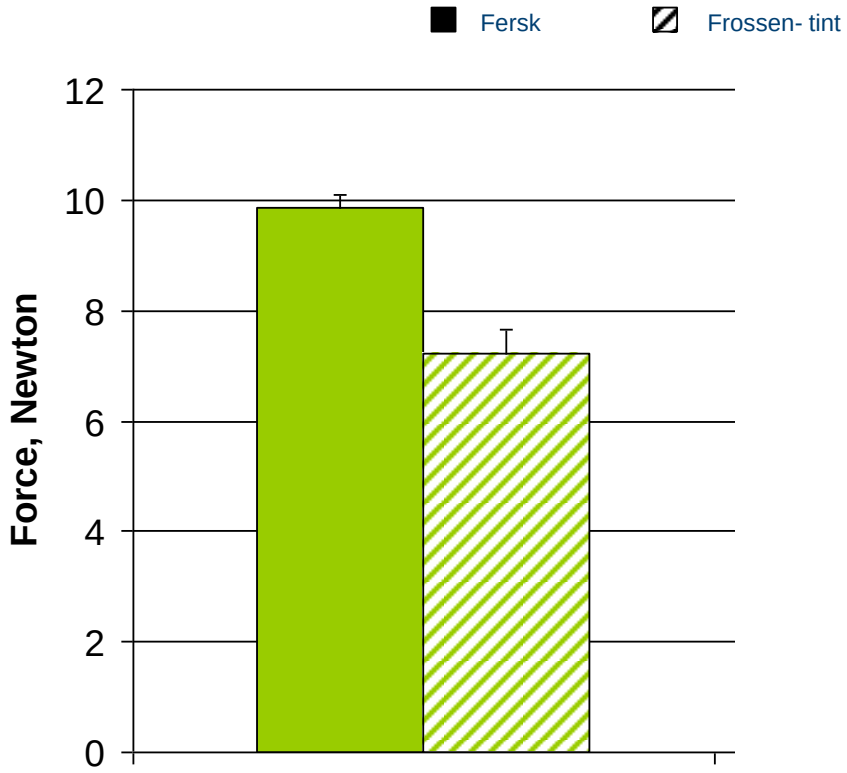


- Bør jobbe videre med å forbedre teksturen og minske gaping
  - – - inkl også bærekraft

- Stor skala
- Gjennomgang av arbeidet sålangt
- Sjekkliste, praktisk

Tekstur etter frysing

- frysemetode … mange faktorer

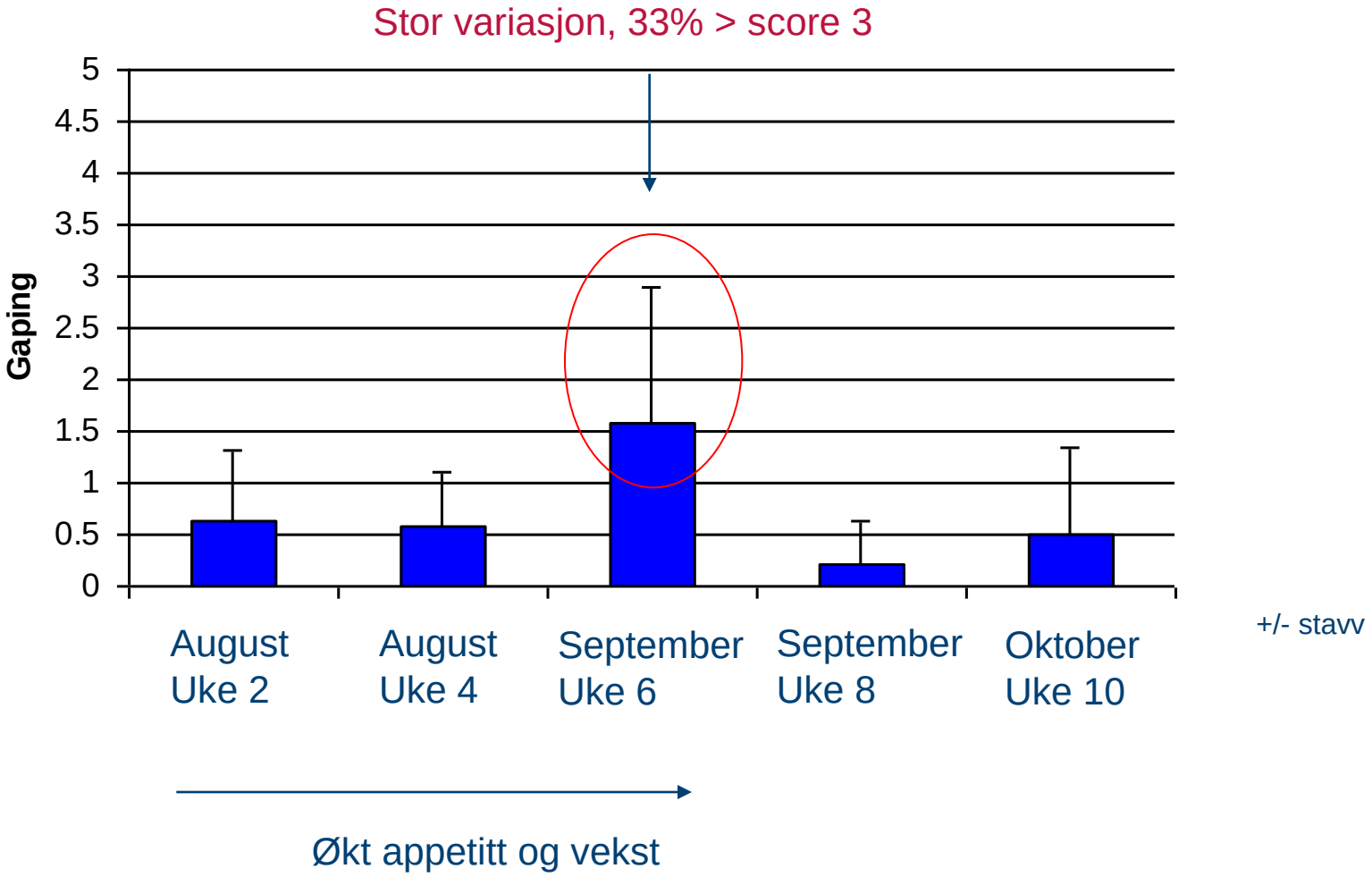


Gaping

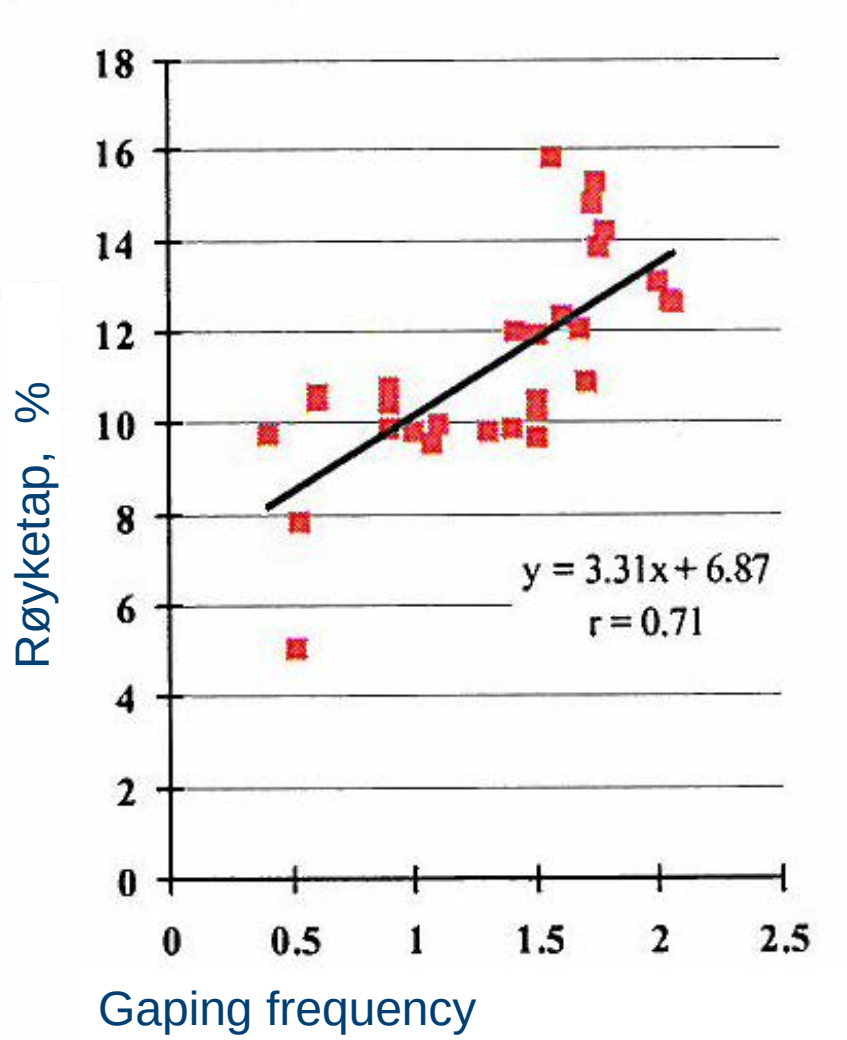
- For lite variasjon for å beregne arvbarhet

- Gaping
  - Filet ødelegges under prosessering
  - Effekt av deformiteter?
  - Væskeslipp?

Sesongvariasjoner



Gaping & prosessering



Source: Mørkøre, M. & Rørå, M.

Tekstur ved røyking
Prosess

Råstoff

Fersk vs frossen

Pre-rigor vs. *post rigor*

Saltfordeling, krymping, tekstur, mindre gaping

Prosess

Mer gaping + bløtere, mer klebring tekstur

Høyere utbytte, bedre saltfordeling

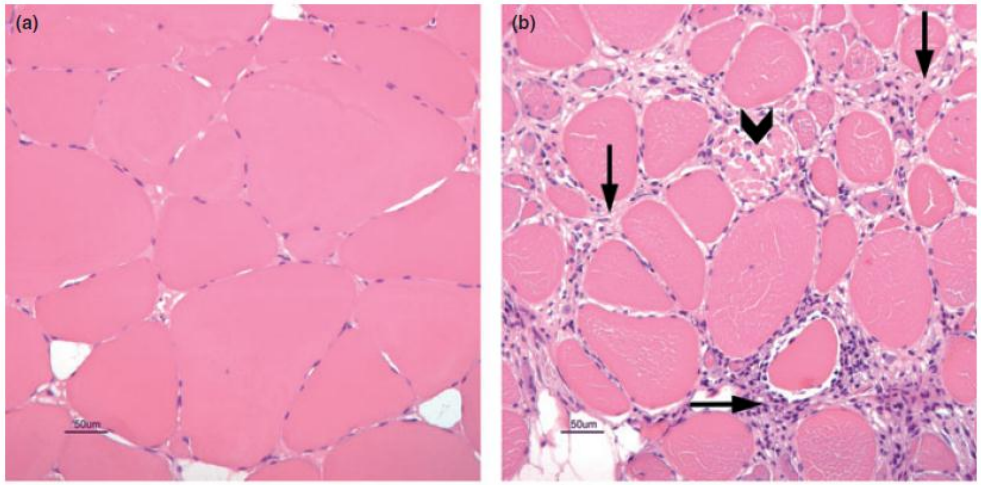
Røyketemperatur 20 vs 27 C; lite betydning sensorikk

Høy lufthastighet; noe «sprøere overflate»

Problemer med muskelstruktur = problemer med kvalitet: tekstur +++?

- Lavere vannbinding (rå)
- Blekere/mer skjoldet
- Hardere tekstur etter røyk
- Stå`an av…?
  - Har man mulighet, vent til fisken er frisk

Etter røyk = gulaktig farge, hardere tekstur

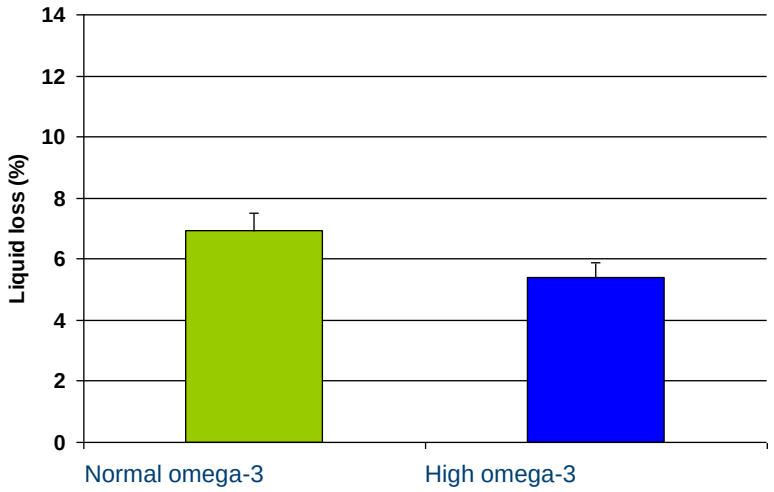


a) Normal muskelfiber ,b) Muskelfibermed nekrose, fibrose og inflamasjon

T Taksdal[1], J Wiik-Nielsen[1], S Birkeland[2], P Dalgaard[3] and T Mørkøre[4]

Væsketap etter røyking.
Effekt av ulike fettsyrer
Bløt fisk mer fettslipp (?)

Frossen - tint røkt



- Måleutstyr/ måling av levende fisk, NIR?
- Stor smolt, hvilke utfordringer vil vi få, andre produksjons/fôringsregimer for å sikre god kvalitet
- Tidlig markør på tekstur/ glykogen?
- Sjekke ved f.eks. biopsi. Følge samme fisken frem til slakt. Evt følge fisk som går til standard kvalitetsanalyse (MH), lusetelling