Overview presentation on quality products from aquaculture

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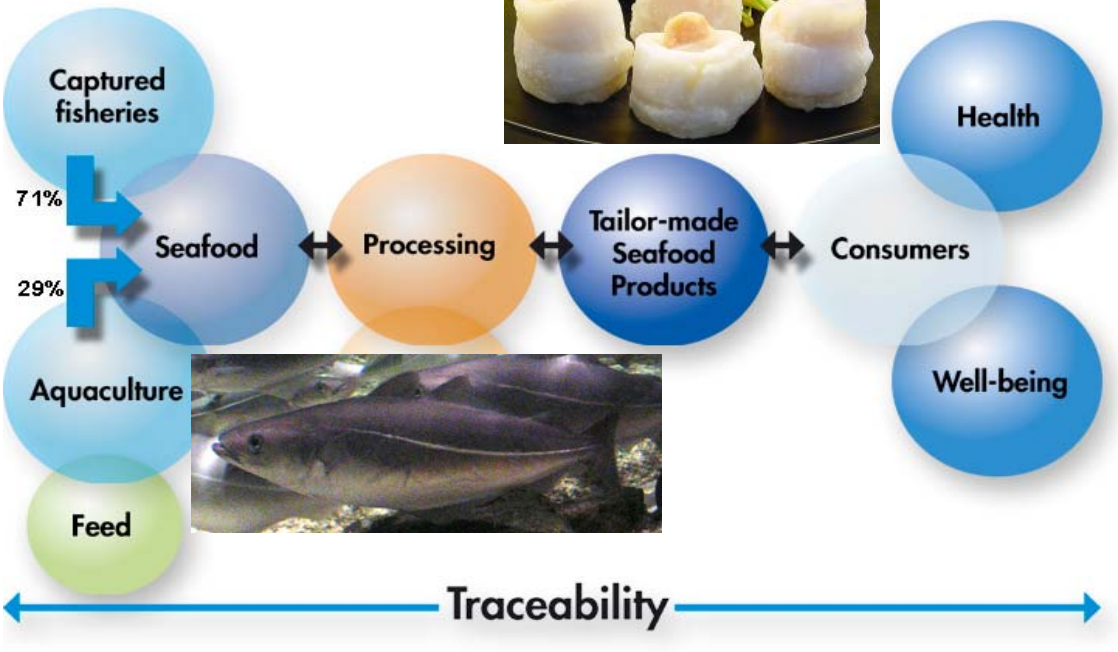
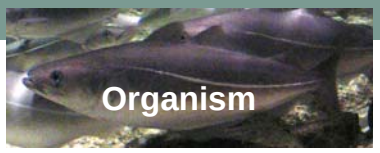
Overview

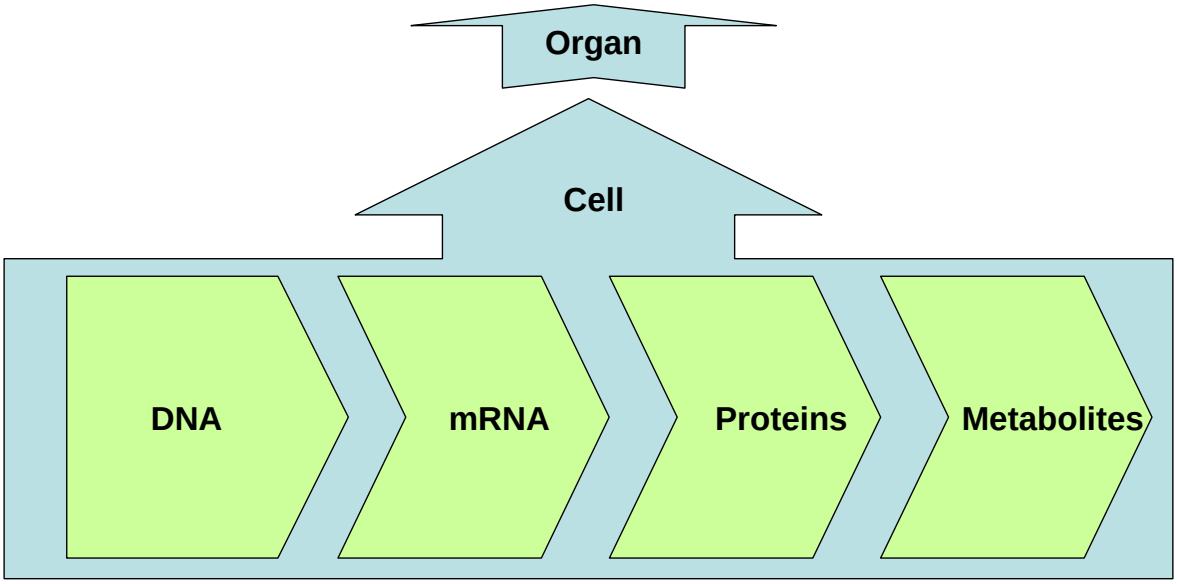
- **Genetic factors**
- **Physiology – endocrinology**
- **Environmental conditions**
- **Nutrition – fish carrier for nutrients**
- **Slaughtering – post mortem handling**
- **Post mortem biochemistry**
- **Quality parameters**
  - Texture, taste, colour
- **By-products**
- **Consumers and market**

The total value chain

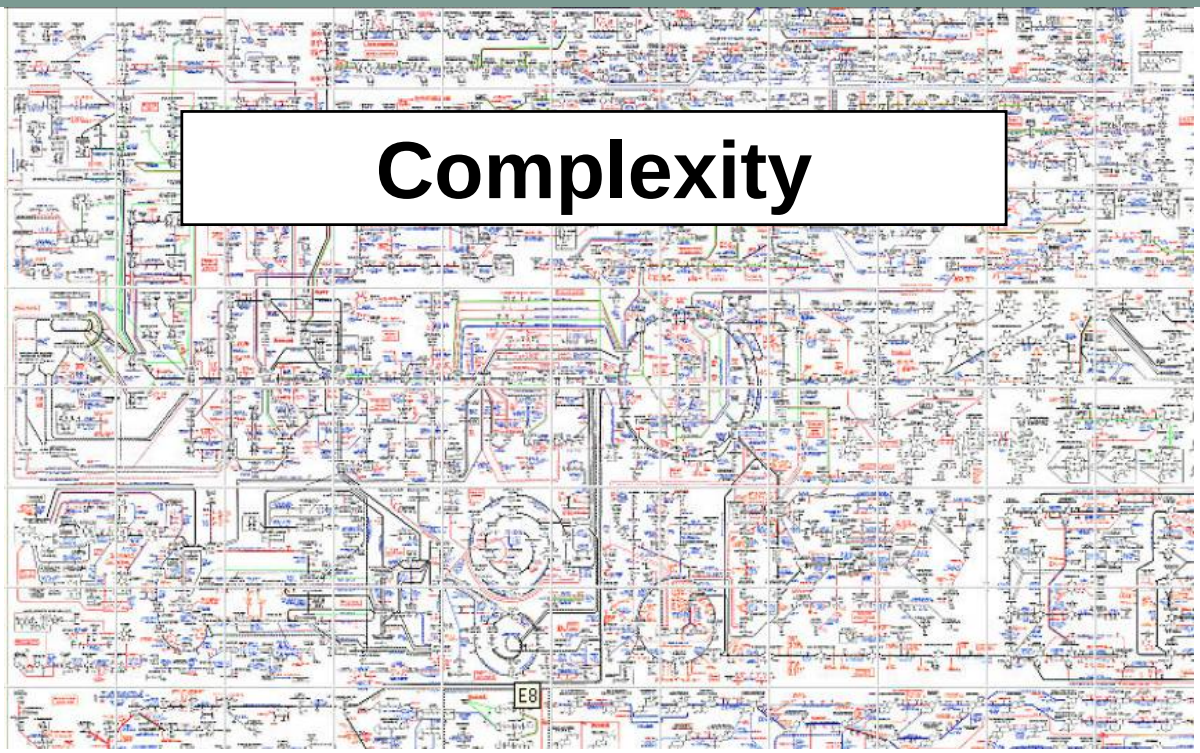


Genetic variation?





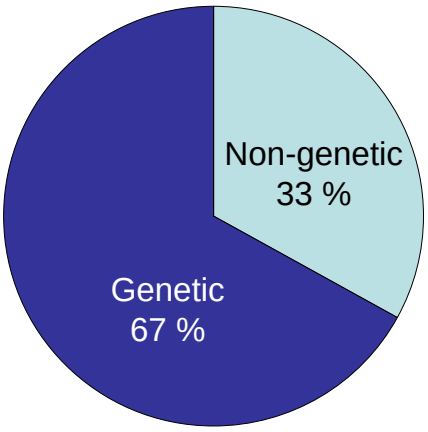
Genetic variation?



Genetic variation - humans

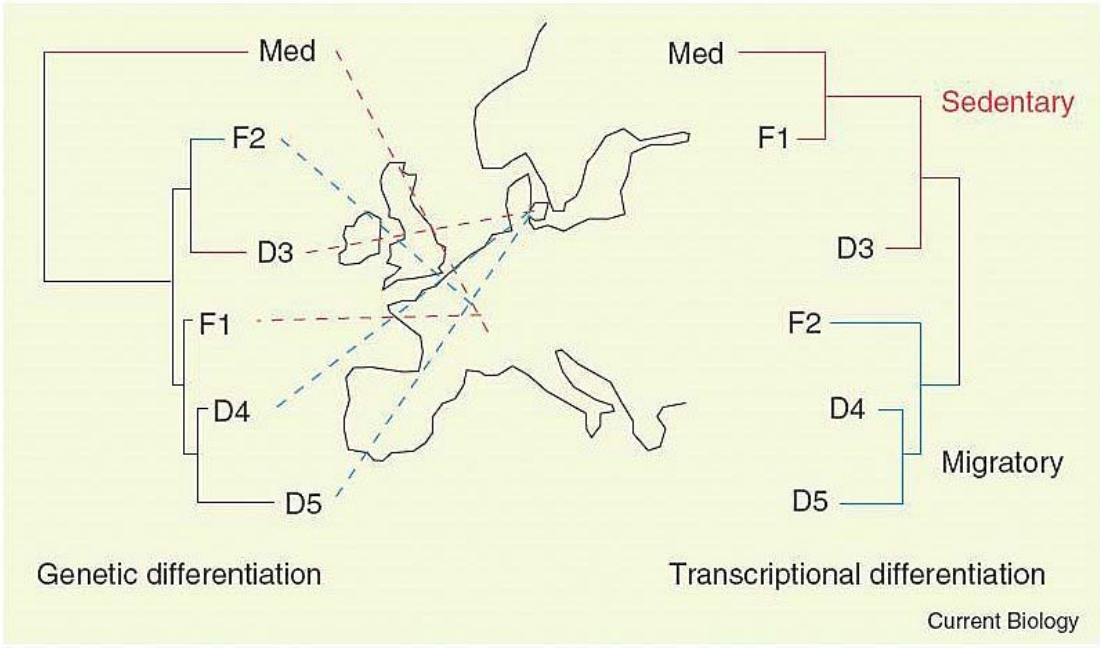
- **How much can be explained by genetic variation?**

- **BMI studied in monozygotic twins reared apart**



*Ravussin and Bogardus, BMJ **83** (2000) S 17 – S 20*

The plastic transcriptome - trout

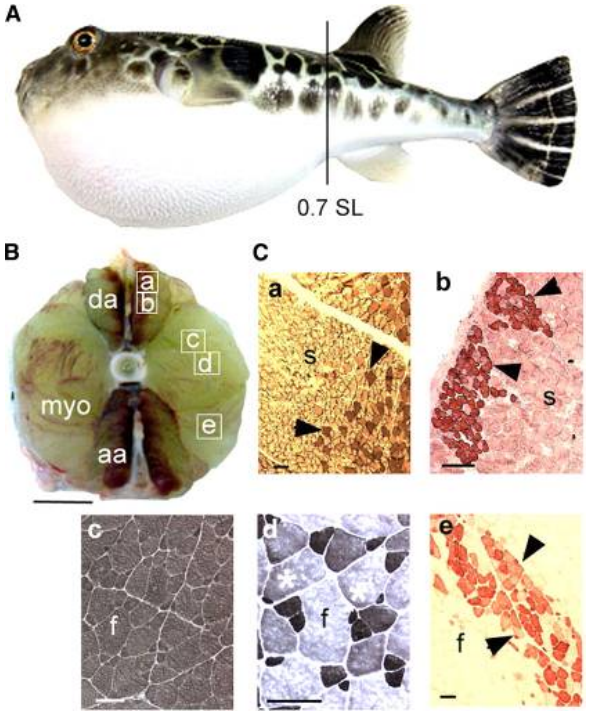


*Gibson, Current Biology **16** (2006) 285-287*

Genes and fish muscle texture

- **Predictors of soft flesh and gaping:**
  - Muscle fibre recruitment
  - Modification of collagen fibres in connective tissue

Muscle fibre recruitment



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- **Firm texture correlated with the density of muscle fibres**
- Novel set of genes identified
- Strongly up-regulated following end of muscle fibre production
- Strong candidates for controlling fibre number

Fernandes, et al. Physiol. Genomics 22 (2005) 327-338

Modification of collagen fibres

- **Concentration of hydroxylysyl pyridinoline collagen cross-links positively correlated with fillet firmness**
- **Lysyl oxidase (LOX) initiates formation of lysyl residues required for crosslinking**
- **High polymorphism levels for the LOX locus in 3 populations**
- **Significant correlation between LOX genotype and crosslink content, suggesting a genetic basis for fillet firmness**

Ian Johnston, Personal Communication (2006)

Metabolic programming

- Metabolism at early embryonic stage determines later metabolic patterns
- Major impact on endocrinology
- Fishes 'learn to grow'
- Number of muscle cells in later life affected
- Metabolism programmed for future life
- EU project: www.metabolic-programming.org

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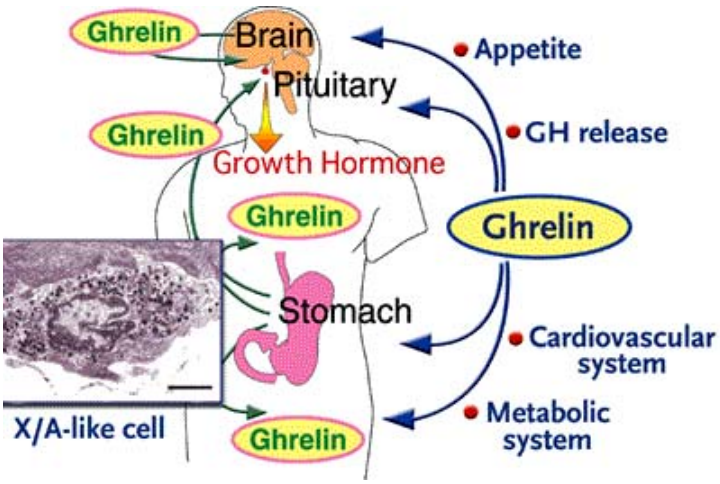
Endocrinology

- Appetite regulation and energy balance
- How does ghrelin work in fish metabolism?
- On-going research in SEAFOODplus
- BIOQUAL Project leader Björn Thrandur Björnsson
- New study: Leptin



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Fish as carrier of nutrients

SEAFOOD plus

a better life with seafood

:: News :: Seafood product development with functional seleno components from plants

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News

Step forward in innovative tailor-made seafood with functional selenium components from plants

One of the objectives in project 4.4 CONSUMERPRODUCTS of SEAFOODplus is to develop innovative functional seafood products from farmed fish, containing health-promoting compounds.

It is the aim to study the possibilities to incorporate Se-(alkyl)selenocysteine from vegetable origin via dietary modulation of fish. The first innovative step in this project was the production of Se-enriched plants from garlic. Levels up to 700 µg Se/kg dry weight of the garlic have been reached. Specific organo selenium components (Se-methylselenocysteine, selenomethionine and γ-glutamyl-Se-methylselenocysteine) were determined in the water-soluble fraction.

Edward Schram
Projectleader RIVO

Now recently the dose response feeding trials has started at The Netherlands Institute for Fisheries Research with African catfish. During a period of 2-3 months catfish is fed with feed containing increasing amounts of seleno components from garlic. At the end of this period samples of the fish fillets will be analysed by various partners for the various functional compounds including selenium. Observations so far showed that the catfish is growing very well on the feed and that the garlic flavor present in the feed and system is accepted by the fishes.

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Physiological conditions

- **Feeding regimes**
- **Temperature**
- **Rearing conditions**
- **Physical activity**
- **Light conditions**
- **Density**
- **Stress factors**

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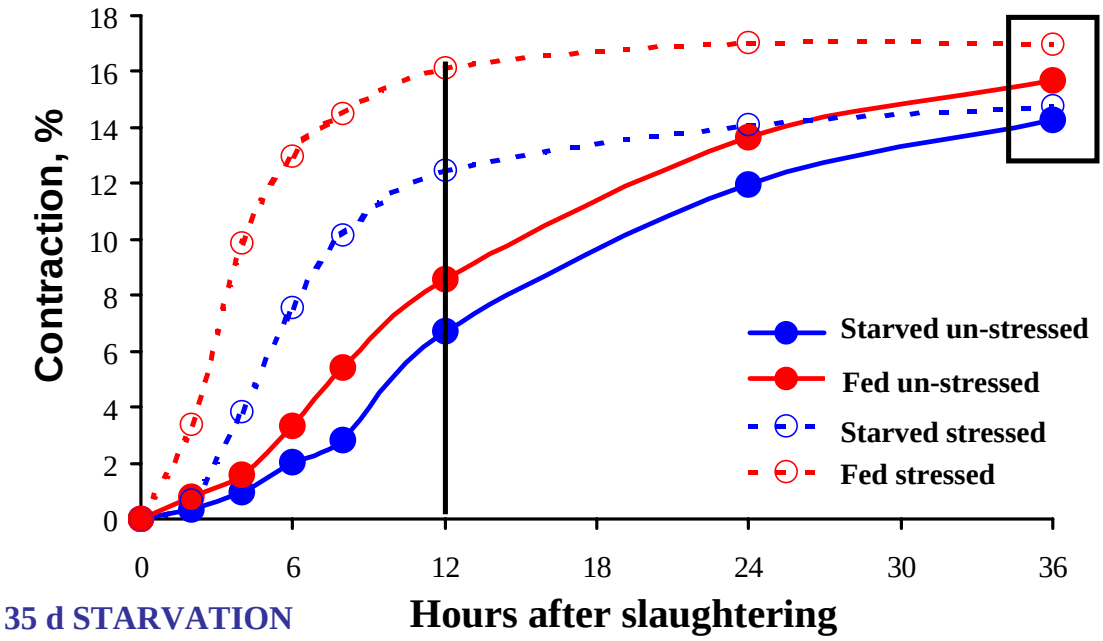
Physiological conditions prior to slaughtering



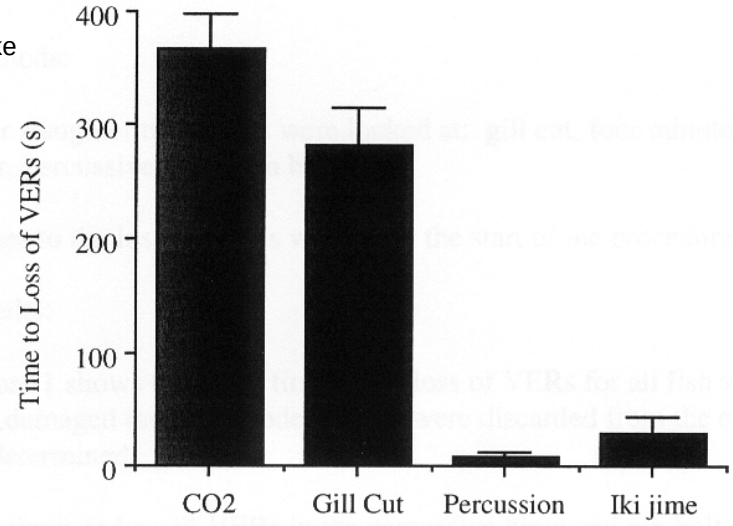
Mørkøre (2001)

Effects of slaughtering

- **Stress caused by handling**
- **Method of immobilising / anaesthesia**
  - Percussion
  - CO_2 treatment
  - Low temperature
  - Electrical stunning
- **Bleeding / slaughtering operations**
  - Ripping of gills
  - Bleeding in water
- **Rested harvest prolongs time until onset of rigor mortis**
  - Iso-eugenol

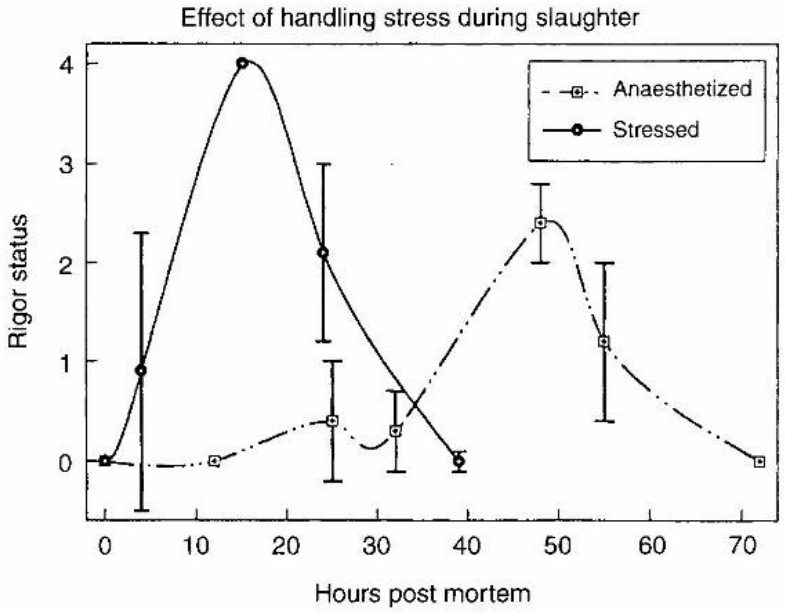
Anaesthesia - killing

VER – visual evoke response



*Robb et al. Veterinary Record, **147** (2000) 298-303*

Rested harvest

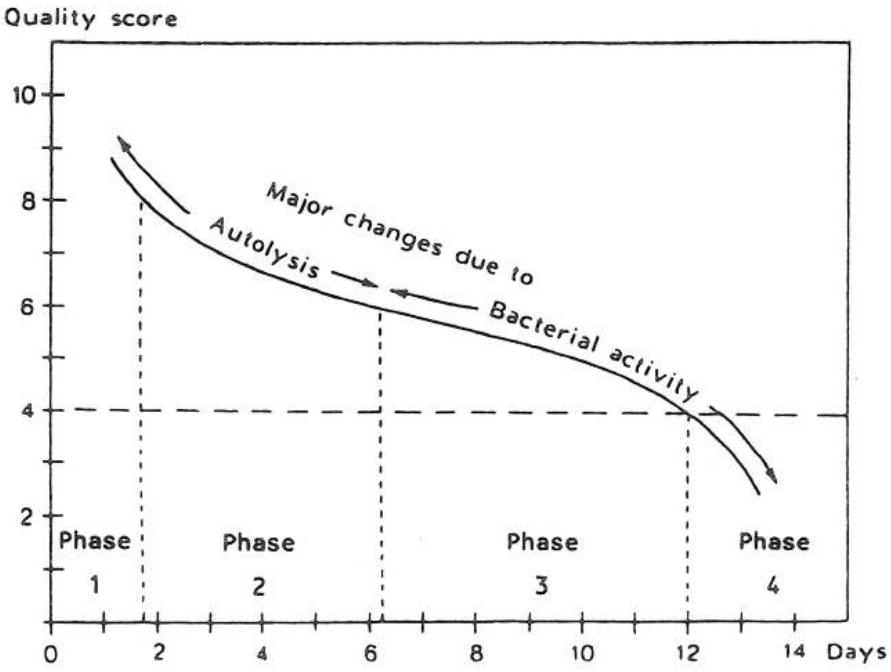


Eriksson In Farmed Fish Quality (2001) 283-297

Post mortem handling

- **Post mortem biochemistry**
- **Quality parameters**
  - Sensory testing
  - Texture/appearance
  - Deformities
  - Taste
  - Colour
- **Safety aspects**

Post mortem biochemistry



Huss, Dansk Vet. Tidsskr. ***59*** *(1976) 165-175*

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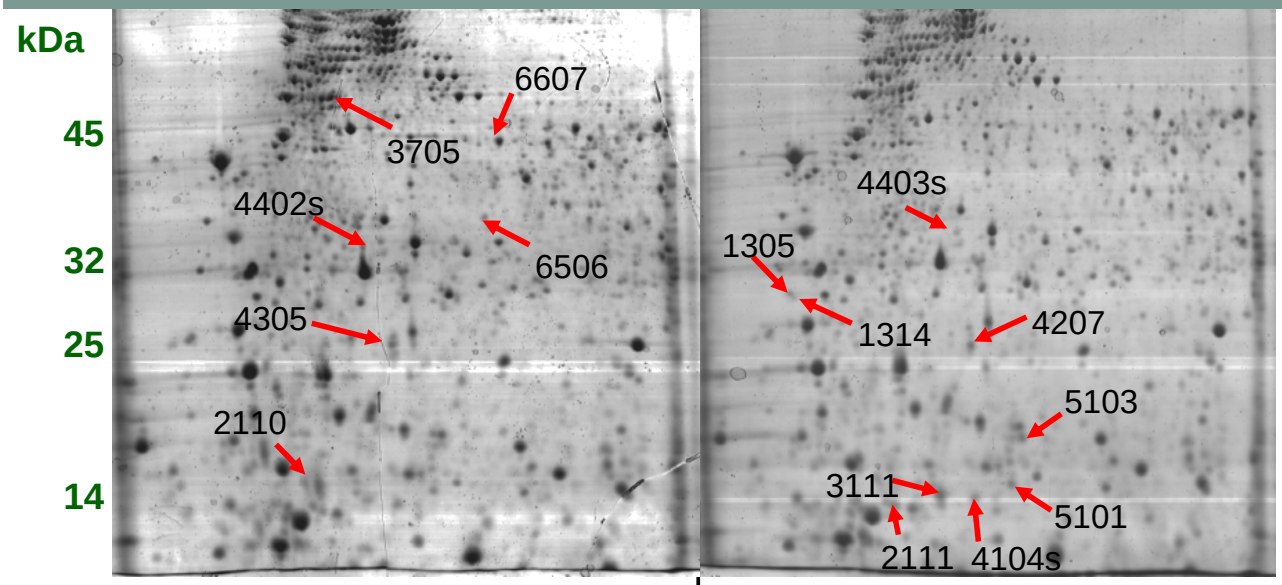
Protein expression in muscle of Atlantic salmon



Control
High quality (firm texture)

Pre slaughter crowding
Poor quality (soft texture)

Flemming Jessen, DIFRES, Unpublished results, 2006

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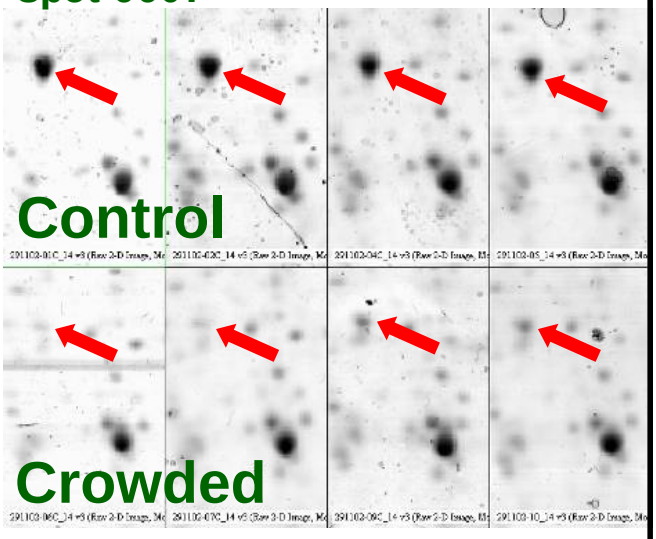
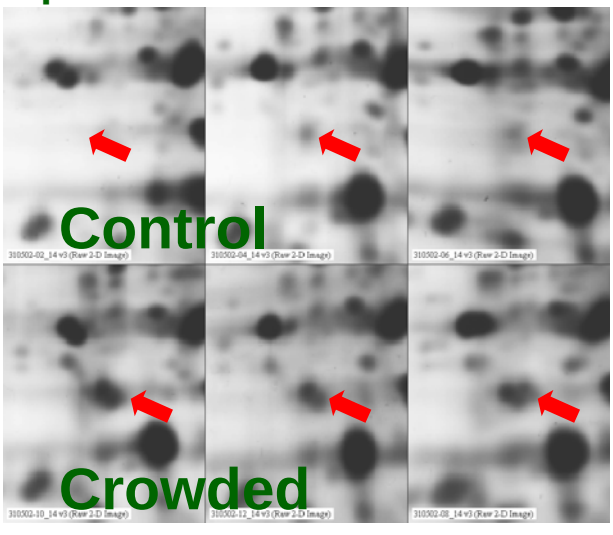
Protein expression in muscle of Atlantic salmon

Myosin heavy chain fragment
Spot 6607



Mw: 45 kDa; pI: 6.0

Arachidonate lipoxygenase
Spot 1305



Mw: 27.5 kDa; pI: 4.4

Flemming Jessen, DIFRES, Unpublished results, 2006

Sensory testing

Quality index method

Gills 1 day on ice

Gills 15 days on ice

www.qim-eurofish.com

Quality Index Method (QIM) Scheme for Farmed Salmon

Quality parameter		Description	Score
Skin	Colour/ appearance	Pearl-shiny all over the skin	0
		The skin is less pearl-shiny	1
		The fish is yellowish, mainly near the abdomen	2
	Mucus	Clear, not clotted	0
		Milky, clotted	1
		Yellow and clotted	2
	Odour	Fresh seaweedy, nutral	0
		Cucumber, metal, hay	1
		Sour, dish cloth	2
		Rotten	3
	Texture	In rigor	0
		Finger mark disappears rapidly	1
		Finger leaves mark over 3 seconds	2
Eyes	Pupils	Clear and black, metal shiny	0
		Dark grey	1
		Matt, grey	2
	Form	Convex	0
		Flat	1
		Sunken	2
Gills	Colour	Red/dark brown	0
		Pale red, pink/light brown	1
		Grey-brown, brown, grey, green	2
	Mucus	Transparent	0
		Milky, clotted	1
		Brown, clotted	2
	Odour	Fresh, seaweed	0
		Metal, cucumber	1
		Sour, mouldy	2
		Rotten	3
Abdomen	Blood in abdomen	Blood red/not present	0
		Blood more brown, yellowish	1
	Odour	Neutral	0
		Cucumber, melon	1
		Sour, fermenting	2
		Rotten/rotten cabbage	3
Quality Index			0-24

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Texture determinants

- **Collagen crosslinks**
- **Muscle cell density**
- **Endogenous enzymes**
  - Cathepsins
  - Calpain
  - Metalloproteinases
- **Muscle fat content**
- **Fat distribution**

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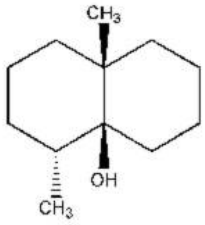
Taste

- **Species specific**
- **Affected by feed composition and components in water**



Geosmin

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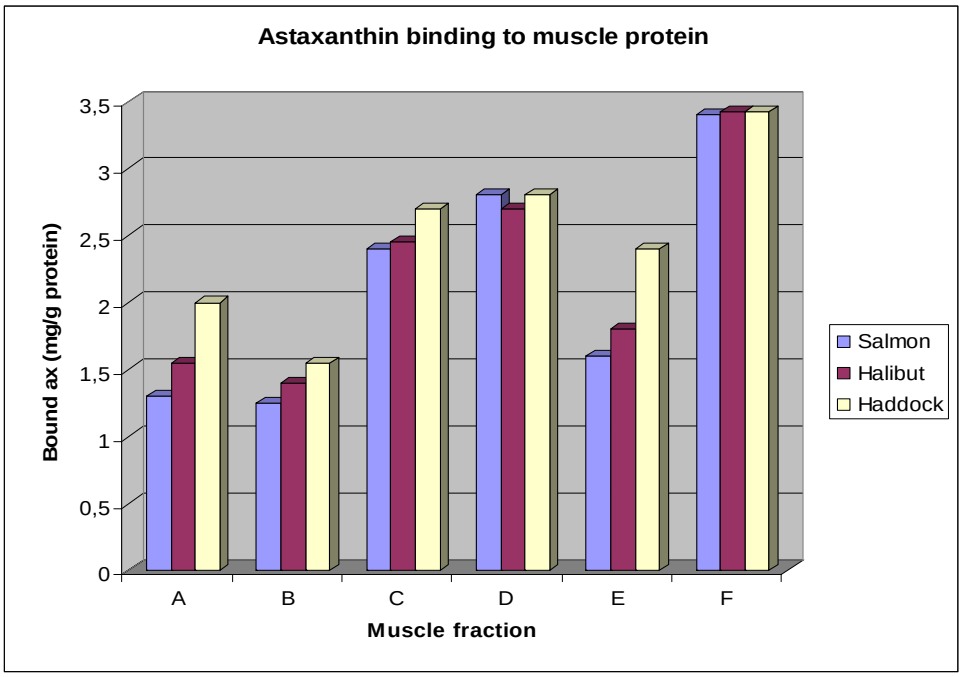
Colour

- **Astaxanthin binding protein characterised in salmonids**
- **Astaxanthin bound stronger than cantaxanthin to actin**

Ozbay, Spencer and Gill,
J. Food Proc. and Preservation
30 *(2006) 208-230*

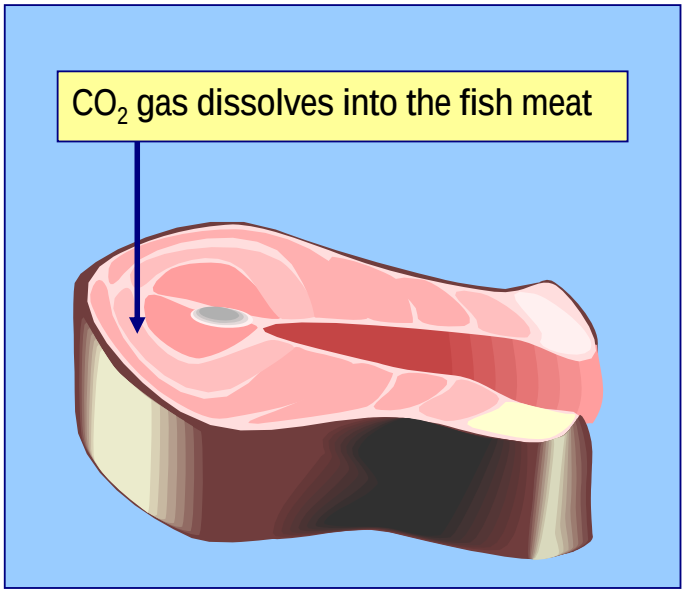
Colour – astaxanthin binding



Torrissen (2006)

Importance of packaging

SGS - Soluble Gas Stabilisation



Sivertsvik, In Novel Food Packaging, (2003), pp. 384-400

By-products

- **As aquaculture expands amount of by-products will increase**
- **Better utilisation?**
  - Oil fraction extracted
  - Protein hydrolysates find new uses
  - SEAFOODplus project PROPEPHEALTH

Antihyper-tensive effect	Anticancer effect	Calciotropic effects	Secretagogue activities	Antioxidant effects	Antimicrobial, antiviral
+	+	+	+	+	*currently studied*

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Consumer considerations - market

- **How do consumers rate farmed fish?**
  - What should we tell consumers? (CONSENSUS)
  - Who do consumers trust?
  - Animal welfare to be considered
- **Toxins – antibiotics**
  - POPs
- **What is the market situation?**
  - Effects of globalisation
  - Traceability
  - Country of Origin Labelling (COOL)

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Toxins

POPs - Persistent organic pollutants

Two sub-groups:

- **Polycyclic aromatic hydrocarbons (PAH)**
- **Halogenated hydrocarbons**
  - Dioxins (PCDD)
  - Furans (PCDF)
  - Polychlorated biphenyls (PCB)
  - Bromated flame retardants (PBDE)
  - Fluorated compounds (PFAS)
  - DDT
  - Dieldrin

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Summing up

- **Quality products from aquaculture better controlled than from traditional fisheries**
- **Consistent quality delivered**
- **Tailor made products possible**
- **Large variation – production to order**
- **Understanding genetics and physiology necessary**
- **Full utilisation possible?**
- **Satisfy consumer needs – health and well-being**

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Thank you for listening

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