Danish Institute for Fisheries Research
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Mechanisms behind texture changes of aquaculture products

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Outline of presentation

- Background
  - Soft texture problems
  - What influence texture ?
  - Observed structural changes
- Mechanisms behind changes
  - Proteolytic activity
  - Cathepsins and texture
  - Protein changes
- Conclusion/Future work
  - Structural changes in fish muscle correlate with development of soft texture
  - Proteolytic effects
  - Protein changes

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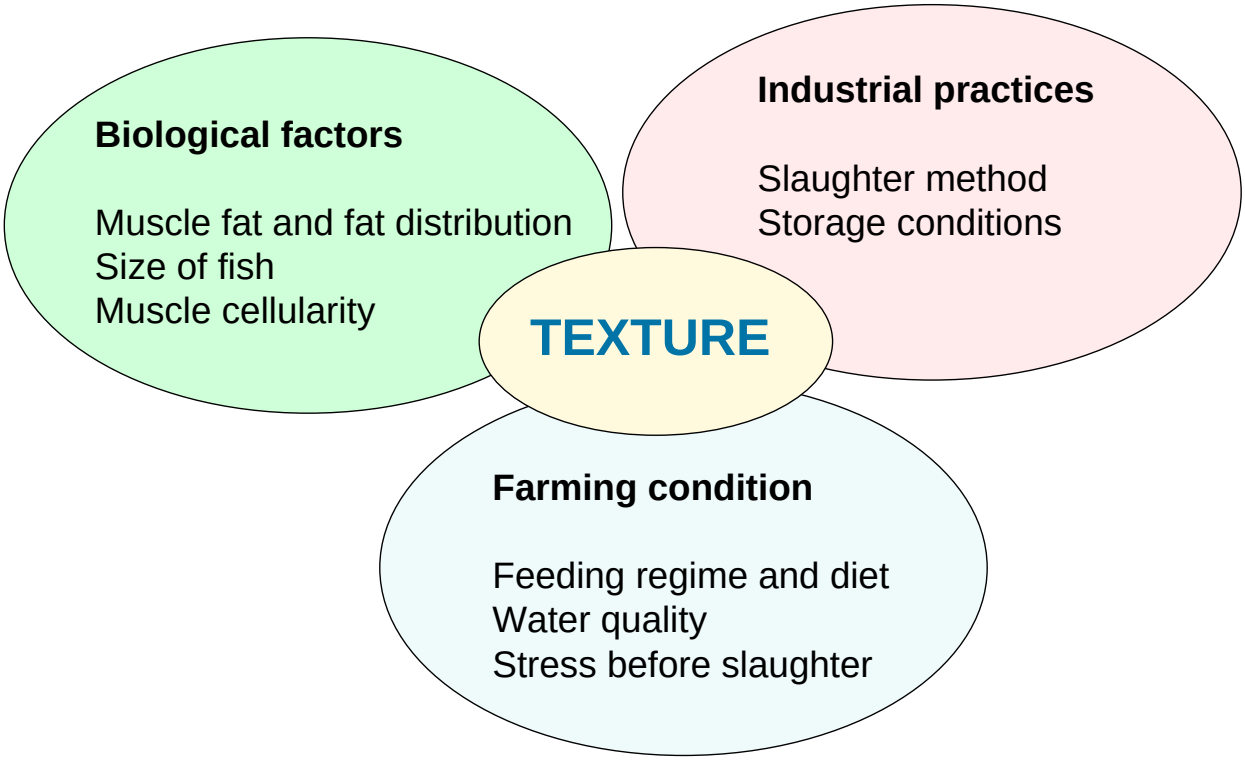
Soft texture problems

- Soft texture and gaping
  - → Reduced yield during mechanical processing of fillets
  - → Undesirable quality
- Farmed fish more soft than wild fish

  (Haard, 1992; Periago et al 2005)
- Texture variation in the raw materials
  - → Complicate processing and utilization
  - → Difficult to deliver a homogenous product

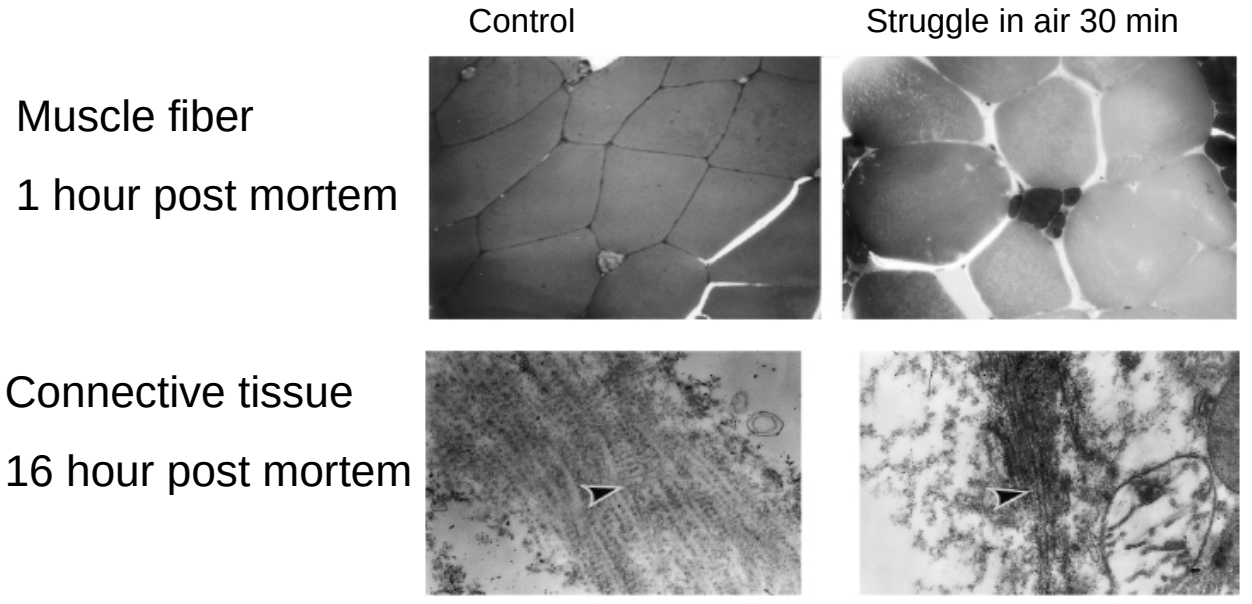
What influences texture ?



Stress and texture

Softer texture (persistent)	CO_2 anesthesia CO_2 anesthesia Crowding, 10 min Salt bath Electricity	Salmon Salmon Salmon Eel Turbot	Rothe et al 2002 Kissling et al 2004 Sigholt et al 1997 Morzel & van de Vis 2003 Morzel et al 2002
Softer texture (initially)	In net in air, 3min Struggle in air	Cod Chub Mackerel	Stien et al 2005 Ando et al 2001
No effect on texture	CO_2 anesthesia CO_2 anesthesia Electricity Struggle in air	Trout Salmon Trout Trout	Azam et al 1989 Erikson et al 2006 Azam et al 1989 Færgemand et al 1995

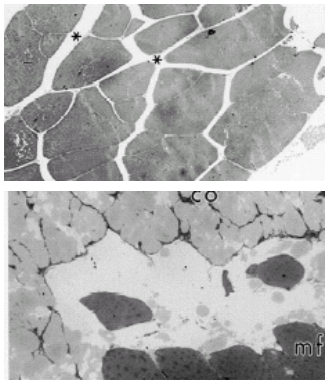
Stress induced structural changes



Ando et al 2001

Observed changes post mortem

- Biochemical observations
  - Breakdown of myofibrillar proteins
  - Disintegration of connective tissue
- Structural changes
  - Gaps between muscle fibers
  - Breaks of the muscle fiber – connective tissue attachment



Taylor et al. 2002

Purpose

- We know
  - Soft texture problem
  - Texture is affected by many factors
  - Observed structural and biochemical changes
- We need to know
  - Mechanisms behind changes

Mechanism of texture development

- Proteolytic activity
  - Before slaughter - physiological state
    - Fat content and distribution
    - Fiber density
  - During slaughter - stress
    - pH
  - Post mortem
    - Lipid oxidation
    - Muscle integrity

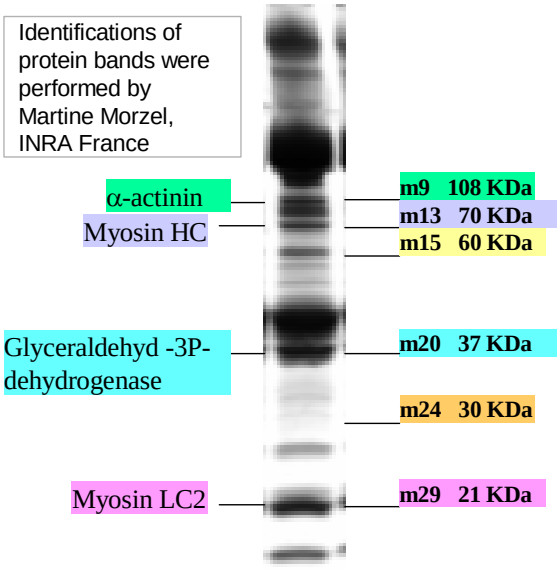
Proteolytic activity

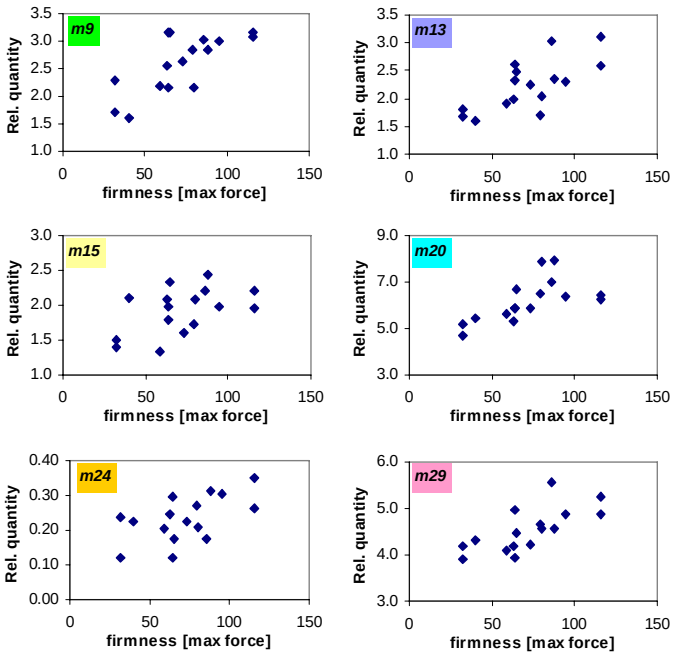
Enzyme		Activator	Localization	pH opt
Calpain	μ-Calpain	Ca^{2+}(μM)	Cytosol	Neutral pH
	m-Calpain	Ca^{2+}(mM)		
Cathepsins	B	DTT	Lysosomal	Low pH < 5-6
	L	DTT Activation of latent form		
	D			
Proteasome		SDS or heat	Cytosol	Neutral pH
Matrix metallo proteinase (MMP)	Collagenases	Zn^{2+} Activation of latent form	Extracellular	Neutral pH
	Gelatinases			

Texture and protein changes

Identification	SDS-PAGE	Protein band intensity versus firmness

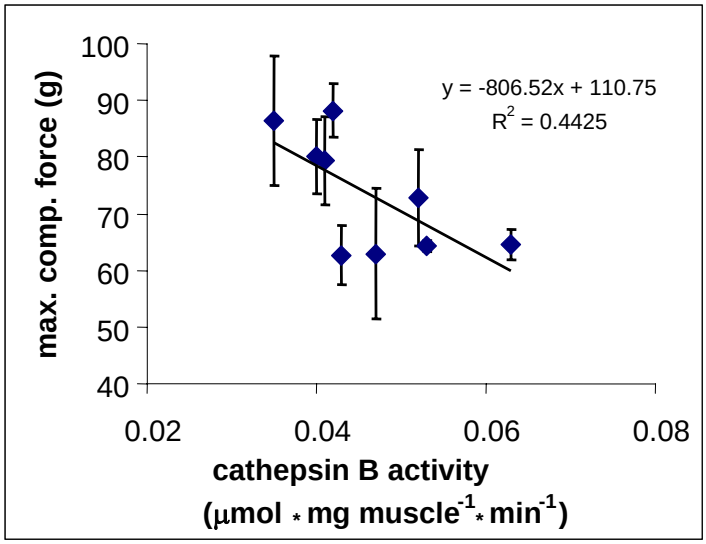
Identifications of protein bands were performed by Martine Morzel, INRA France





Cathepsins and texture

- Cathepsin activity in farmed trout



2D-electrophoresis and texture

Raw material:

16 trout from 4 different fish farms.

Sensory analysis on cooked fillet:

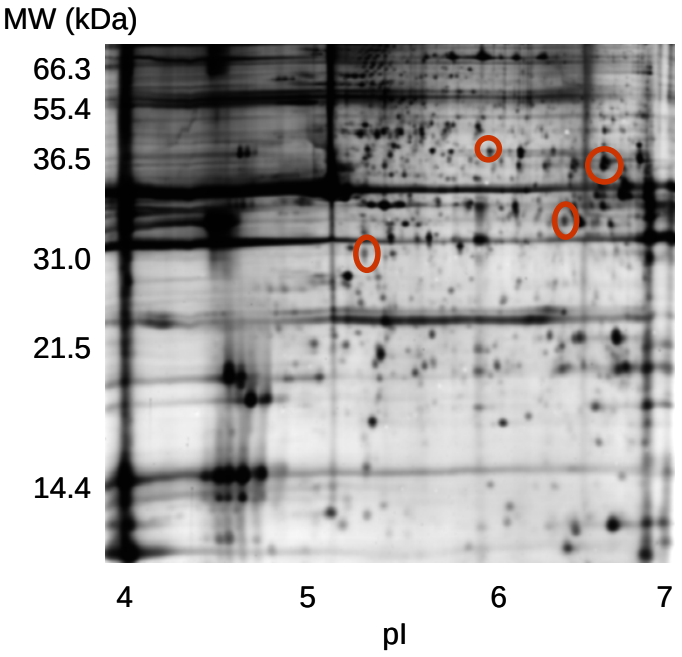
Group 1: flaky, firm

Group 2: juicy

2Dgel electrophoresis:

4 protein spot showed higher intensity in group 2

Potential proteins related to texture



Conclusion

- Structural changes and changes in protein intensity correlate with soft texture
- Cathepsin B may play an important role in development of soft texture
- Identification of proteins related to texture:
  - Explain mechanisms
  - Predict texture development

Acknowledgements

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