

**Publikasjoner og presentasjoner i prosjektet:**

**MANAGING TEXTURE QUALITY OF ATLANTIC SALMON THROUGH THE APPLICATION OF MOLECULAR AND MORPHOLOGICAL APPROACHES**

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**Populærvitenskapelige artikler (2)**

1. 2011. Mørkøre, T., Prytz, K. Fôrtilskudd gir friskere og fastere laks. Norsk Fiskeoppdrett, 2, 46-48.
2. 2009. Mørkøre, T., Prytz, K. Lav temperatur og fôrstyrke gir bløt filet. Norsk Fiskeoppdrett, 74-76. (utvalgte resultater fra prosjektet presentert)

**Vitenskapelige artikler**

Publiserte artikler (4)

1. 2010. Bahaud, D., Gaarder, M., Veiseth-Kent, E., Thomassen, M.S., 2010. Fillet texture and protease activities in different families of farmed Atlantic salmon (*Salmo salar* L.). Aquaculture 310, 213-220.
2. 2011. Gaarder, M., Thomassen, M.S., Veiseth-Kent, E., 2011. Identification of calpastatin, mu-calpain and m-calpain in Atlantic salmon (*Salmo salar* L.) muscle. Food Chemistry 125, 1091-1096.
3. 2012 Hansen, A. Å., Rødbotten, M., Eie, T., Lea, P., Rudi, K., Mørkøre, T. The effect of crowding stress on bacterial growth and sensory properties of chilled Atlantic salmon fillets. Journal of Food Science 77, 84-90.
4. 2012 Gaarder, M.Ø., Bahuaud, D., Veiseth-Kent, E., Mørkøre, T., Thomassen, M.S. Relevance of calpain and calpastatin activity for texture in super-chilled and ice stored Atlantic salmon (*Salmo salar* L.) fillets. Food Chemistry 132, 9-17.

Artikler, "in Press" (1)

5. 2012. Moreno, H.M, Montero, P., Gómez-Guillén, M.C, Fernández-Martín, F, Mørkøre, T., Borderías, J. Collagen characteristics of farmed Atlantic salmon from families with different texture characteristics. Food Chemistry (doi:10.1016/j.foodchem.2012.02.160).

Innsendte artikler (2)

6. 2012. Larsson, T., Mørkøre, T., Østbye, T-K., Afanasyev, S., Krasnov, A. Gene expression profiling of soft and firm farmed Atlantic salmon. PlosOne
7. 2012. Larsson, T., Koppang, E.O., Espe, M., Krasnov, A., Moreno, H.M., Rørvik, K-A., Terjesen, B.F., Thomassen, M.S., Mørkøre, T. Dietary glutamate level affects fillet texture and health parameters of Atlantic salmon (*Salmo salar* L).

Manuskripter under arbeid (10 - fleste vil bli innsendt før sommeren 2012)

8. Jacq, C., Gjerde, B., Moreno, H., Larsson, T., Thorland, I., Bakke, H., Mørkøre, T. Slaughter parameters and fillet quality of Atlantic salmon offspring from wild and farmed parents.
9. Moreno, H.M, Montero, M.P., Gómez-Guillén, M.C, Jacq, C., Mørkøre, T., Borderías, A.J. Relationship between collagen properties of farmed Atlantic salmon with different sex, genetic background and muscle texture.
10. Mørkøre, T., Moreno, H., Borderias, J., Sampels, S., Pickova, J., Jacq, C. Minerals, vitamin E and collagen characteristics of farmed Atlantic salmon with and without gaping.

11. Torgersen, J., Koppang, E.O., Stien, L.H., Pedersen, M., Mørkøre, T. Morphological characteristics and the relevance for texture properties of Atlantic salmon with glycogen myopathy.
12. Østbye, T-K., Ruyter, B., Stien, L.H., Standal, I.B., Terjesen, B.F., Latif, M.S.; Rørvik, K-A., Mørkøre, T. Influence of amino acid supplementation on muscle development and texture of farmed Atlantic salmon (*Salmo salar* L.). In vivo and in vitro studies.
13. Østbye, T-K., Hollung, K., Veiseth-Kent, E., Standal, I.B., Erikson, U., Mørkøre, T., Ruyter, B. Gene expression combined with proteomics and metabolomics profile of Atlantic salmon precursor muscle cells cultured in media with different nutrients.
14. Mørkøre, T., Koppang, E-O., Sørensen, M., Larsson, T., Ruyter, B. Oxidation status and Vitamin E level of Atlantic salmon feeds. I: Effects on performance, hematological parameters, tissue indices and robustness to stress.
15. Mørkøre, T., Moreno, H., Borderias, A.J., Pickova, J., Åsli, M., Rødbotten, M. Oxidation status and Vitamin E level of Atlantic salmon feeds. II Effects on meat quality parameters.
16. Sørensen, M., Nygen, G., Ruyter, B., Torgersen, J., Mørkøre, T., Hansen, O.H., Takle, H. Growth, disease resistance and fillet quality in exercised Atlantic salmon fed high and low energy diets.
17. Mørkøre, T., Bahuaud, D., Gómez-Guillén, C., Erikson, U., Jacq, C., Hollung, K., Koppang, E.O., Montero, P., Moreno, H., Larsson, T., Krasnov, A., Pickova, J., Ruyter, B., Standal, I.B., Stien, L.H., Torgersen, J., Veiseth-Kent, E., Østbye, T-K., Borderias, J.A. Underlying factors affecting texture in Atlantic salmon, a review.

### **Bokkapitler**

1. 2010. Bahuaud, D., Mørkøre, T., Østbye, T.K., Torstensen, B., Veiseth-Kent, E., Ruyter, B., Ofstad, R., Thomassen, M.S. Atlantic salmon (*Salmo salar*) flesh quality. Role of lysosomal cathepsins B and L in muscle degradation. In *Salmon: Biology, Nutrition and Consumption*. Editors P. Lacopo and M. Riemma, Nova Publishers. Pages  
  - a. **Brosjyrer/ temahefte**
2. 2012. Proteiner gir fastere filet- Ekstra tilskudd av aminosyrer i fôret gir bedre fasthet og friskere oppdrettslaks, viser ny forskning. Nofima brosjyre
3. 2011. Jakten på gladlaksen. Tema marint. BIOTEK og Mat. Norges Forskningsråd. S. 10-13

PhD Thesis

Gaarder, M, 2011.

Larsson, T., 2012.

### **Mastergrader**

– Universitetet for Miljø og Biovitenskap, Institutt for husdyrfag og akvakulturvitenskaper  
Publiserte (6)

1. 2012. Arachia, D. Phenotypic characteristics of farmed Atlantic salmon and correlation between important quality parameters
2. 2011. Nguyen, H., A.T. Effects of dietary oxidation status and vitamin E level on performance, fillet quality and robustness to acute stress in Atlantic salmon (*Salmo salar* L.)
3. 2011. Hu, Y. The impact of amino acid supplementation on production efficiency, energy status and product quality of farmed Atlantic salmon (*Salmo salar* L.).
4. 2011. Gong, Y. Fillet quality of Atlantic salmon. Relevance of dietary amino acid supplementation and acclimation temperature at slaughter.
5. 2010 Latif, M.S. Influence of nutritional factors on muscle development and texture of Atlantic salmon (*Salmo salar* L.). I vivo and In vitro studies.

6. 2010 Rahnama, B., 2010. Dietary impact of growth and quality of farmed Atlantic salmon (*Salmo salar* L.).

#### Innleveres 2012 (3)

7. 2012. Filina, O. Sustainable production of high quality Atlantic salmon fillets.
8. 2012. Bringslid, K.M. Dietary impact on fillet quality of Atlantic salmon (*Salmo salar* L.) with varying initial nutritional status.
9. 2012. Liu, L. Growth and lipid accumulation measured in live Atlantic salmon (*Salmo salar* L.). Relevance of dietary oil source and the impact on fillet quality.

#### Innleveres 2013 (2)

10. 2013 Marinkovic, A. Performance, texture and muscle structural characteristics of Atlantic salmon as affected by feeding frequency
11. 2013 Dadras, S. Relationship between health status and fillet quality of Atlantic salmon fed diets with different lipid and protein sources.

#### **Abstrakt/ presentasjoner, Internasjonale (11)**

1. 2012. Mørkøre, T. Improving fillet texture and flesh quality of Atlantic salmon through dietary optimization. Alltech 28th Annual Symposium, Lexington, KY, USA.
2. 2012. Mørkøre, T. Fastleiki à alilaksi. Havbùnadarràstevna, Hotel Føroyar 29.02.2012, Tòrshavn, Føroyar
3. 2012. Østbye, T.K., Ruyter, B., Stien, L.H., Muhammed, S.L., Standal, I.B., Eriksen, U., Mørkøre, T. Influence of amino acids on muscle development and texture of farmed Atlantic salmon (*Salmo salar* L.); *in vivo* and *in vitro* studies. XV International Symposium on Fish Nutrition and Feeding, Molde 4.-7. June 2012
4. 2012. Mørkøre, T., Koppang, E-O., Nguyen, H.A.T., Rødbotten, M., Larsson, T., Pickova, J., Moreno, H., Åsli, M., Sørensen, M. Oxidation status and vitamin E level of Atlantic salmon feeds: Effects on performance, health parameters, meat quality and robustness to stress. XV International Symposium on Fish Nutrition and Feeding, Molde 4.-7. June 2012
5. 2012. Larsson, T., Koppang, E-O., Espe, M., Krasnov, A., Eriksson, U., Thomassen, M., Veiseth-Kent, E., Pan, J., Rørvik, K-A., Terjesen, B.F., Mørkøre, T. Health and quality of Atlantic salmon (*Salmo salar* L.) fed a diet supplemented with glutamate. XV International Symposium on Fish Nutrition and Feeding, Molde 4.-7. June 2012
6. 2011. Veiseth-Kent, E., Østbye, T-K., Ruyter, B., Mørkøre, T., Hollung, K. Proteome analysis of primary muscle cell cultures from salmon supplemented with varying concentrations of arginine and glutamine. COST Action FA1002 – Advances in farm animal proteomics, Glasgow, 31 march - 1 April 2011
7. 2011. Moreno, H., M., Gómez-Guillén, C., Montero, P., Mørkøre, T., Borderías, A. J. Effect of genetic background and sex on Atlantic salmon muscle collagen properties and the relationship with muscle texture. 41<sup>st</sup> WEFTA Meeting, Seafood for the Modern Consumer, 27-30 September 2011, Gøthenburg, Sweden.
8. 2011. Mørkøre, T. Firmer salmon fillet. North Atlantic Seafood Forum, Oslo, Norway (NASF).
9. Krasnov, A., Castro, V., Afanasyev, S., Larsson, T., Mørkøre, T., Takle, H., 2011. Development of oligonucleotide microarrays and bioinformatic systems for aquaculture research. Assessment in studies on exercise physiology of Atlantic salmon. FitFish Workshop on the swimming physiology of fish. Barcelona 3-4 July.
10. Bahuaud, D., Mørkøre, T., Østbye, T-K., Ruyter, B., Veiseth-Kent, E., Ofstad, R., Thomassen, M.S. Role of lysosomes and cathepsins in fish flesh degradation. BIT 3rd World Congress of Industrial Biotechnology 2010. Dalian Municipal Party Committee Hotel, Dalian, China, 25-27 July 2010. D China
11. Thomassen, M.S., Gaarder, M., Mørkøre, T., Rørvik, K-A., Veiseth-Kent, E., Ofstad, R., Bahuaud, D., 2010. Studies on the protease systems cathepsins and calpains/calpastatins and their impact on muscle quality in farmed Atlantic salmon (*Salmo salar* L.). Influence of dietary lipid composition, addition of free amino acids and pre-slaughter stress. Dalian Municipal Party Committee Hotel, Dalian, China, 25-27 July 2010. D China

## Abstrakt/presentasjoner, nasjonale (27)

1. 2012 Torgersen, J., Koppang, E.O., Stien, L.H., Mørkøre, T. Sukkerlaks. Glykogenopphopning i bløt muskel. Programkonferansen HAVBRUK 2012, Stavanger.
2. 2012. Østbye, T.K., Ruyter, B., Stien, L.H., Muhammed, S.L., Standal, I.B., Eriksen, U., Mørkøre, T. Aminosyrer påvirker muskelutvikling og tekstur i laks. Programkonferansen Havbruk 2012, Stavanger.
3. 2012 Ruyter, B., Kjær, M.A., Aursnes, I.A., Gjøn, T., Sørensen, M., Mørkøre, T., Berge, G.M. Fettnivå og glutamat i fôr til torsk påvirker vekst, fettmetabolisme og muskelkvalitet. Programkonferansen HAVBRUK 2012, Stavanger.
4. 2012 Mørkøre, T., Bahuaud, D., Borderias, J.A., Gaarder, M.Ø., Gómez-Guillén, C., Erikson, U., Jacq, C., Hollung, K., Koppang, E.O., Krasnov, A., Montero, P., Moreno, H., Larsson, T., Pickova, J., Standal, I.B., Stien, L.H., Thomassen, M.S., Torgersen, J., Veiseth-Kent, E., Østbye, T-K., Ruyter, B. Tekstur av laksemuskel – nye forskningsverktøy har gitt kunnskapsinnovasjoner. Programkonferansen HAVBRUK 2012, Stavanger.
5. 2012 Mørkøre, T. Fillet texture of Atlantic salmon, an overview. Ewos Innovation. Dirdal Januar 2012
6. 2012 Mørkøre, T. Teksturutfordringer på laks – hvordan løses de? Sjømatdagene på hell, 17.-18. januar. Trondheim
7. 2011 Mørkøre, T. Tekstur i oppdrettslaks. Nye funn tyder på at vi har funnet en viktig årsak til bløt filet. FHF Verdikjede Havbruk, Gardermoen 21.-22. november 2011.
8. 2011 Mørkøre, T. Ny kunnskap om faktorer som påvirker slaktekvalitet. NCE Ernæringsforum, Universitetet i Nordland, Bodø
9. 2011. Arnesen, P., Mørkøre, T. Jakten på gladlaksen. Biotek og Mat.
10. 2011 Mørkøre, T. Flesh quality and deformities of salmon. Future research alternatives. Alltech, Norway.
11. Torgersen, J., Larsson, T., Krasnov, A., Østbye, T-K., Mørkøre, T., 2011. Molekylære markører og muskelstruktur - Hva er normalt? Frisk Fisk-konferansen 2011, 19.-20. januar, Tromsø
12. Østbye, T-K., Veiseth-Kent, E., Ofstad, R., Landsverk, T., Rørå, A.M.B., Bæverfjord, G. Bruk av molekulære verktøy for å avdekke underliggende årsaker til teksturvariasjoner i oppdrettslaks. Programkonferansen HAVBRUK 2010. Trondheim, 19.-21. april 2010.
13. 2010 Mørkøre, T. Kvalitet i oppdrettslaks. Salmar Frøya september 2010.
14. 2010 Mørkøre, T. Sammenheng mellom fôr og kvalitet. FHF møte 17.18. November, Trondheim, Norway.
15. 2010 Mørkøre, T. Kvalitet i oppdrettslaks. Kvalitetsmøte innen strategiområdet "Produksjon, fiskevelferd, teknologi og miljø" i NCE Aquaculture. Dønna, onsdag 8. og torsdag 9. september
16. 2010 Bahuaud, D., Gaarder, M., Mørkøre, T., Torstenson, B., Ruyter, B., Veiseth-Kent, E., Ofstad, R., Thomassen, M.S. Role of lysosomes and their cathepsins B and L in Atlantic salmon (*Salmo salar* L.) muscle structure integrity, texture and final quality. Programkonferansen HAVBRUK 2010. Trondheim, 19.-21. april 2010.
17. 2010 Mørkøre, T., Espe, M., Veiseth-Kent, E., Terjesen, B.F., Erikson, U., Koppang, E. O., Rørvik, K-A. Bred kartlegging av faktorer som påvirker teksturegenskaper i oppdrettslaks ved multivariat tilnærming. Programkonferansen HAVBRUK 2010. Trondheim, 19.-21. april 2010.
18. 2010. Larsson, T., Kolstad, K., Krasnov, A., Bahuaud, D., Mørkøre, T. Bruk av molekulære verktøy for å avdekke underliggende årsaker til teksturvariasjoner i oppdrettslaks. Programkonferansen HAVBRUK 2010. Trondheim, 19.-21. april 2010
19. 2009. Mørkøre, T. Faktorer som påvirker tekstur i oppdrettslaks. Fagmøte, FHF, Trondheim

20. 2009. Mørkøre, T. Tekstur i laks. En oversikt over forskningsaktiviteter. Samling i Filetforum Laks. Rica Hell Hotell 17. juni
21. 2009. Mørkøre, T. Kvalitet i laks. Industrimøte, Thon Hotell Opera 14/5-2009
22. 2009. Mørkøre, T., Rørå, A.M.B. Tekstur i laks. Pågående aktiviteter og vinkling. WorkShop Nofima Mat.
23. 2009. Mørkøre, T. Fish processing. Universitetet for Miljø og Biovitenskap
24. 2009. Mørkøre, T. Quality problems in salmon farming, Universitetet for Miljø og Biovitenskap
25. 2009. Mørkøre, T. Kvalitet fra avl til gaffel. Kartlegging av kvalitetsavvik i laksefilet og tiltak for å hindre avvik som melaninflekker, fargeavvik og bløt tekstur. Filetforum laks, Gardermoen 20. oktober.
26. 2009. Larsson, T. Molecular tools for determining factors affecting texture. Work Shop Nofima Mat
27. 2009. Mørkøre, T. Tekstur I oppdrettslaks. Betydning av fôr og fôring. Biomarint Industriseminar. Thon Bergen Airport Hotel 1.-2. desember.

### **Nominations (1)**

2011. Innovation Awards, NASF. Firmer salmon fillets.

<http://marelife.no/north-atlantic-seafood-forum/innovative-cases/aquaculture/firmer-salmon-fillets.html>

### **Methods (10)**

1. Method using muscle stem cells to determine impact of nutrition on muscle cell development/ predict texture development in salmon fillets (Nofima)
2. Molecular tool (Microarray) for defining critical underlying factors affecting texture development in salmon muscle (QualityChip, Nofima).
3. Key muscle regulatory factors/ molecular markers (Nofima & Norwegian School of Veterinary Science)
4. Methodological techniques for connective tissue analyses (CSIC, Madrid)
5. Proteomics as a research tool for determining variation in texture of salmon muscle (Nofima)
6. Metabolomics as a research tool for determining variation in texture of salmon muscle (Sintef)
7. Enzyme analyses in samples from muscle and cell culture studies and inhibitors (Post doc – D Bahuaud, UMB)
8. Cathepsin analyses of salmon muscle (PhD M.Ø. Gaarder)
9. Image analyses (new approach, program/software) to determine muscle morphological characteristics in histology samples (Havforskningsinstituttet).
10. Immunohistochemical characterisation for defining molecular markers for texture deviations (Nofima)

### **Patent**

Improved fillet quality of farmed fish using bioactive amino acids. Provisional patent application.

### **Nettbaserte presentasjoner/ presse**

Fiskerifond.no

Nofima.no

[http://www.fiskerifond.no/index.php?current\\_page=index&lang=no&id=644](http://www.fiskerifond.no/index.php?current_page=index&lang=no&id=644)  
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[http://www.fishupdate.com/news/fullstory.php/aid/15041/Protein\\_supplements\\_91provide\\_firmer\\_salmon\\_fillets\\_92.html?utm\\_source=twitterfeed&utm\\_medium=twitter](http://www.fishupdate.com/news/fullstory.php/aid/15041/Protein_supplements_91provide_firmer_salmon_fillets_92.html?utm_source=twitterfeed&utm_medium=twitter)  
<http://www.nofima.no/marin/nyhet/2011/03/proteintilskudd-gir-fastere-filet>  
<http://fis.com/fis/worldnews/worldnews.asp?monthyear=3-2011&day=11&id=41118&l=e&country=0&special=&ndb=1&df=0>  
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<http://www.aquafeed.com/read-article.php?id=3804&sectionid=1>  
<http://theaquaculturists.blogspot.com/2011/03/firmer-fillets-from-healthier-salmon.html>  
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<http://www.forskning.no/artikler/2011/mars/281890>  
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[http://www.kyst.no/index.php?page\\_id=59&article\\_id=91026](http://www.kyst.no/index.php?page_id=59&article_id=91026)  
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**2012**

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[mat.fvn.no/mat/Helt-vilt-14499.html](http://mat.fvn.no/mat/Helt-vilt-14499.html)

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