Cargill Aqua Nutrition

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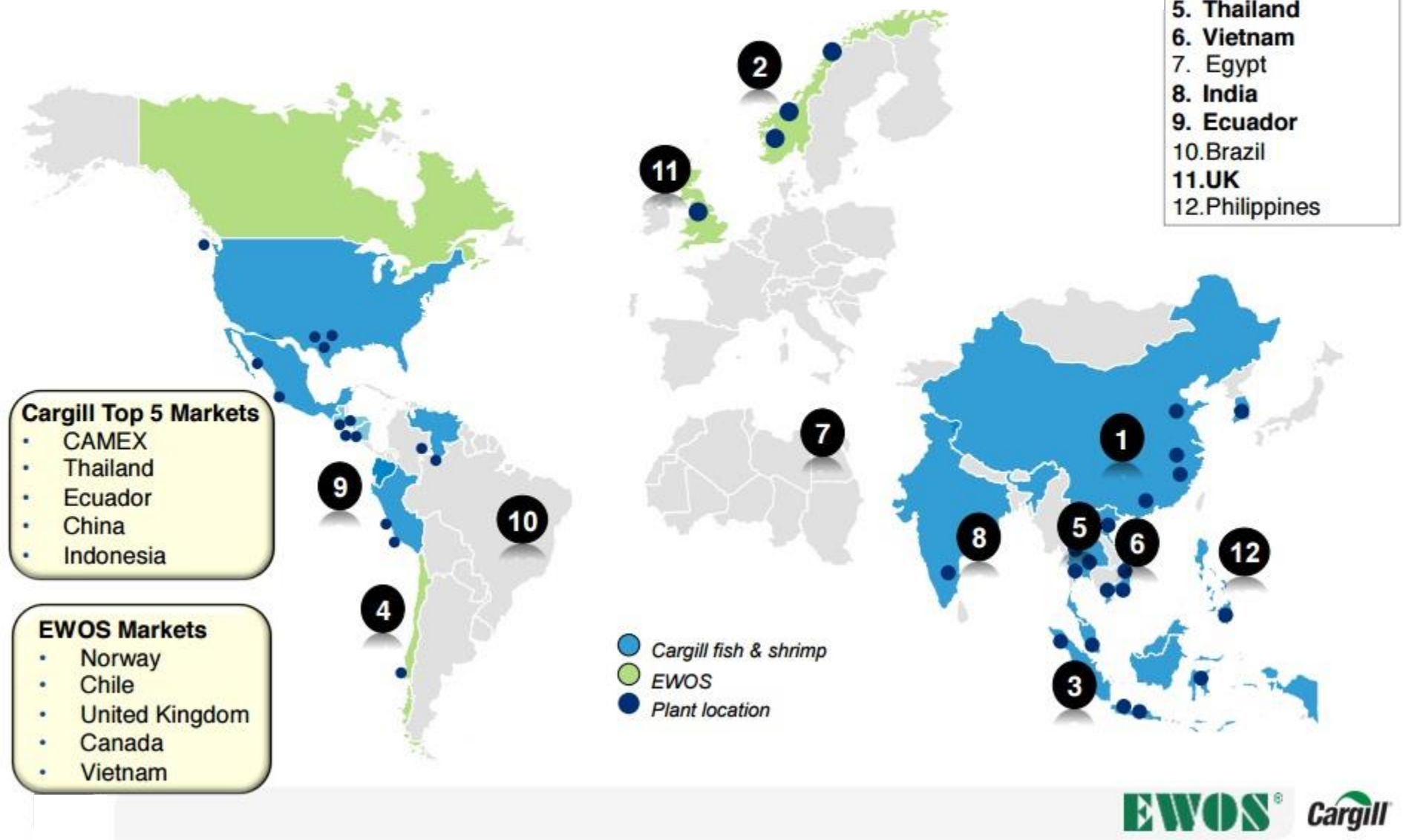
Cargill Aqua Nutrition

- Part of Cargill Group: $107 billion Revenue
- 170,000 employees, 67 countries
- Agriculture, Industry, Animal nutrition

- Aqua Feed: 1.8 million tonnes (2017)
- Focus on salmon, shrimp, tilapia




Cargill Aqua Nutrition present in all main fish and shrimp markets



Cargill Innovation Centre Colaco

Development of effective tools for sustainable health control

- Global R&D Manager Aqua Nutrition
- Background in feed & farming
- Last 2 years Chile establishing R&D centre
- $10.5 million investment, state of the art
- VESO as key partner in the facility
- Clinical diets, oral vaccines and medicines
- Salmon with warm water development

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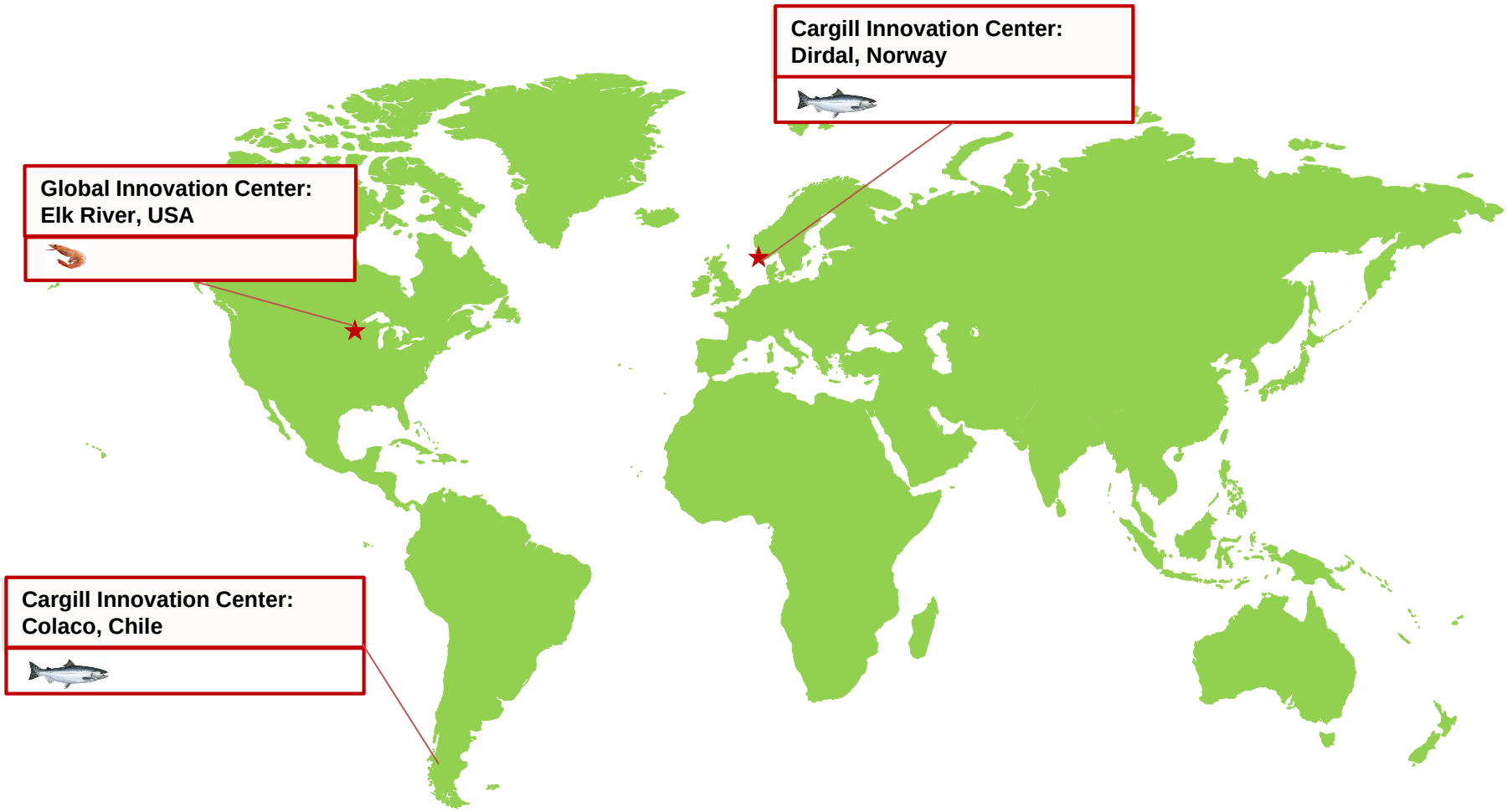
Cargill Innovation Centre



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Technology Application Centres

Norway

TACs along Norwegian coast (**salmon & trout**):

- Gråttnes, Oltesvik,
- Arctic Research Center

China

Zhongshan, Guangdong province
Species: **Tilapia**, **shrimp**, Snakehead, carp, catfish, largemouth bass

Vietnam

Dong Thap province

Species: **Tilapia**, Snakehead

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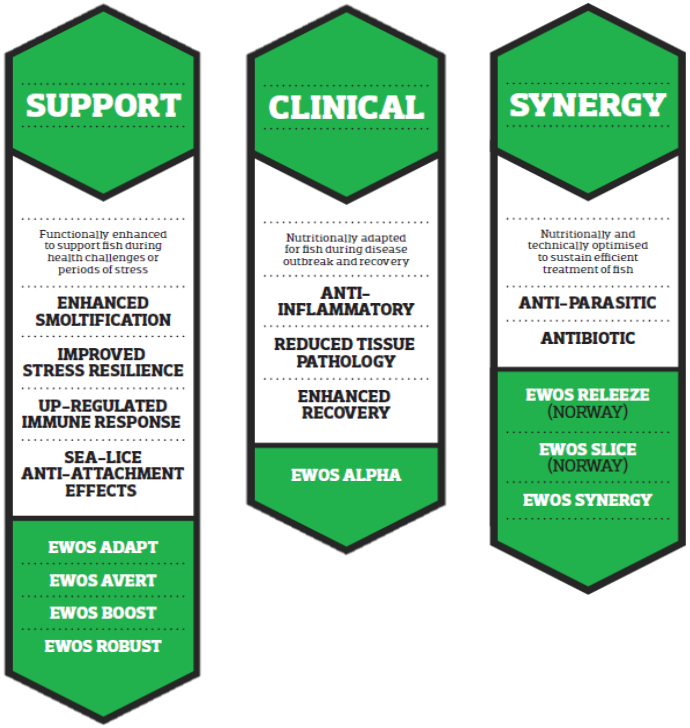
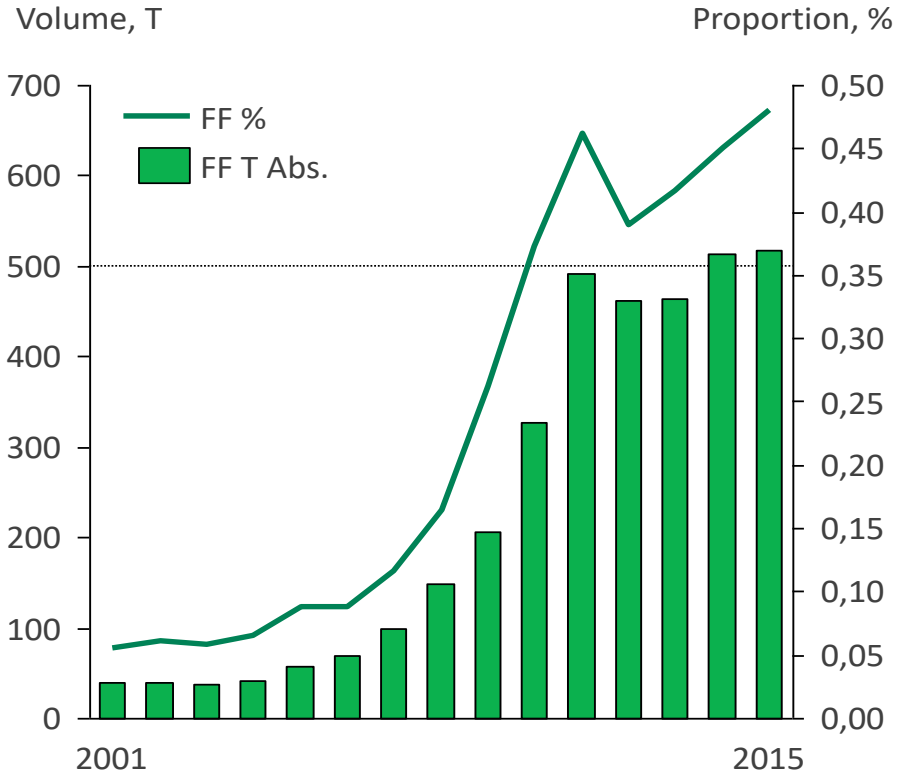
Product development & open innovation

Since 2001 there has been an increasing focus on product development of functional feeds, clinical and performance diets. **All** these products have been developed through Open Innovation and partnerships with supplies, other commercial groups, institutes and academia





R&D approach: some key success factors

Sustained R&D

The R&D programme have been focused on a few priority areas with sustained effort and resources. Core areas have included nucleotides, gut health (prebiotics), anti-parasite, anti-viral, anti-bacterial, oral delivery.

Open Innovation

There has been a core focus on open innovation to access external resources, primarily challenge facilities and molecular techniques. Partners have included suppliers, commercial companies, institutes and academia. **SLRC**: Sea Lice Research Centre www.slrc.no

Access to talent

Molecular tools

The use of advanced molecular tools (PCR, Microarray, RNA-seq) have given us a unique insight into the key immune physiological and immune pathways of Atlantic salmon undergoing health challenges. This has significantly speeded up and facilitated the product development process. It has also assisted in the technical sales environment.

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Anti-Parasite: publication

Sea Lice Research Centre

Universidad de Concepción

University of Victoria

THE UNIVERSITY OF MAINE

CONICYT COMISIÓN NACIONAL DE INVESTIGACIÓN CIENTÍFICA Y TECNOLÓGICA

Núñez-Acuña, G., Pino J., Wadsworth S., Gallardo-Escárate. C. (2014). Insights into the olfactory system in the ectoparasite *Caligus rogercresseyi*: Molecular characterization and gene transcription analysis of novel ionotropic receptors. Parasitology Research. 145. 99-109.

Holm H., Santi N., Kjøglum S., Perisic N., Skugor S., Evensen Ø. (2015). Difference in skin immune responses to infection with salmon louse *(Lepeophtheirus salmonis)* in Atlantic salmon (*Salmo salar L.)* of families selected for resistance and susceptibility. Fish & Shellfish Immunology. 42. 2. 385-394.

Núñez-Acuña G., Vera-Bizama F., Boltaña S., Hawes C., Pino Marambio J., Wadsworth S., Gallardo-Escárate C. (2015). In-feed additives modulate ionotropic receptor genes from the sea louse Caligus rogercresseyi: A comparative analysis in two host salmonid species. Aquaculture. **451.** 99-105.

Bizama F., Valenzuela-Munoz V., Gonclaves A., Pino Marambino J., Hawes C., Wadsworth S., Gallardo-Escarate C. (2015). Transcriptome expression of immune related genes from *Caligus rogercresseyi* evidences form host dependent patterns on Atlantic and coho salmon. Fish Shellfish Immunology. 1-7.

Núñez-Acuña G., Goncalves A.T., Valenzuela-Munoz V., Pino Marambio J., Wadsworth S., Gallardo-Escárate C. (2015). Transcriptome immunomodulation of in-feed additives in Atlantic salmon *Salmo salar* infested with sea lice *Caligus rogercresseyi*. Fish and Shellfish Immunology. **47**. 450-460.

O'shea B., Wadsworth S., Pino J., Birkett M., Pickett J., Mordue J. (2015). Disruption of host -seeking behaviour by the salmon louse, *Lepeophtheirus salmonis*, using botanically-derived repellents. Journal of Fish Diseases. Submitted.

Jodaa Holm, H., Wadsworth, S., Bjelland, A.K., Krasnov, A., Evensen, Ø., Skugor, S., (2016). Dietary phytochemicals modulate skin gene expression profiles and result in reduced lice counts after experimental infection in Atlantic salmon. Parasites & Vectors **9**, 1-14

Jodaa Holm, H., Skugor S., Wadsworth, S., Bjelland, Radunovic S., Koppang E., Evensen, Ø. (2016). Contrasting expression of immune genes in scaled and scaeless skin of Atlantic salmon infected with young stages of Lepeophtheirus salmonis. Development and Comparative Immunology.

Vargas-Chacoff L. J., Muñoz J., Hawes C., Oyarzún R., Pontigo J., Saravia J., González M., Morera J., Labbé S., Bertrán S., Mardones J., Pino J., Wadsworth S. (2016). Atlantic salmon (*Salmo salar*) and Coho salmon (*Oncorhynchus kisutch*) display differential metabolic changes in response to infestation by the ectoparasite *Caligus rogercresseyi*. Aquaculture. **464**. 469-479.

Skugor S., Jodaa Holm, H., Bjelland A. K., Evensen Ø., Krasnov A., Wadsworth, S. (2016). Nutrigenomic effects of glucosinolates on liver, muscle and distal kidney in parasite free and salmon louse infected Atlantic slamon. BMC Parasites & Vectors.

Vargas-Chacoff L., Muñozc J., Hawes C., Oyarzúna R., Pontigoan J. P., Saraviaa J., Gonzáleze M. P., Mardonesc O., Labbéc B. S., Moreraf F., Bertrána C., Pinod J., Wadsworth S., Yáñez A. (2017). Ectoparasite *Caligus rogercresseyi* modifies enzyme responses in Atlantic salmon (*Salmo salar*) and Coho salmon (*Oncorhynchus kisutch*). Veterinary Parasitology. **243**. 6-11.

Sutherland B., Covello J., Friend S., Poley J., Koczka J., Purcell S., MacLeod T., Donovan B., Pino J., González-Vecino J. Gonzalez J., Troncoso J., Koop B., Wadsworth S., Fast M. (2017). Host–parasite transcriptomics during immunostimulant-enhanced rejection of salmon lice (*Lepeophtheirus salmonis*) by Atlantic salmon (*Salmo salar*). FACETS. 20. DOI10.1139/facets-2017-0020.

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Anti-viral: publication

- **Maehr T., Wang T., Vecino J., Wadsworth S., Secombes C. (2011).** Cloning expression analysis of the transforming growth factor-beta receptors type 1 and 2 in the rainbow trout *Oncorhynchus mykiss*. Developmental and Comparative Immunology. 50. 1-10.
- **Wang T., Maehr T., Vecino J., Secombes C., Wadsworth S. (2011).** Fish suppressors of cytokine signalling (SOCS): Gene discovery, modulation of expression and function. Journal of Signal Transduction. 20. 1-20.
- **Martinez-Rubio L., Morais S., Evensen Ø., Wadsworth S., Vecino J. G., Ruohonen K, Bell G., Tocher T. (2012).** Functional feeds reduce heart inflammation and pathology in Atlantic salmon (*Salmo salar* L.) following experimental challenge with heart and skeletal muscle inflammation (HSMI). Public library of science. **7**. 1-17.
- **Casadei E, González Vecino J., Wadsworth S.L., Secombes C.J. (2013).** The effect of peptidoglycan enriched diets on antimicrobial peptide gene expression in rainbow trout (Oncorhynchus mykiss). Fish and Shellfish Immunology. 34. 529-537
- **Martinez-Rubio L., Wadsworth S., Vecino J. G., Bell G., Tocher T. (2013).** Effect of dietary digestible energy content on expression of genes of lipid metabolism and LC-PUFA biosynthesis in liver of Atlantic salmon (*Salmo salar* L.) Aquaculture. 384-387. 94-103.
- **Martinez-Rubio L., Wadsworth S., Vecino J. G., Bell G., Tocher T. (2013).** Effect of functional feeds on expression of genes of LC-PUFA biosynthesis and eicosanoid metabolism in liver and head kidney of Atlantic salmon (*Salmo salar* L.) with experimentally induced Heart and Skeletal Muscle Inflammatory disease (HSMI). Fish and Shellfish Immunology.
- **Maehr T., Vecino J. G., Wadsworth S., Secombes C. (2013).** Transforming growth factor-β1b: A second TGF-β1 paralogue in the rainbow trout (Oncorhynchus mykiss) that has a lower constitutive expression but is more responsive to immune stimulation. Fish and Shellfish Immunology. 34. 420-432.
- **Martinez-Rubio L., Wadsworth S., Vecino J. G., Bell G., Tocher T. (2014).** Functional feeds affect lipid composition, transcriptomic responses and pathology in heart of Atlantic salmon (Salmo salar L.) challenged with cardiac myopathy syndrome (CMS). BMC Genomics.15. 462.
- **Maehr T., Vecino J. G., Wadsworth S., Wang T., Secombes C. (2014)**. Four CISH paralogues are present in rainbow trout Oncorhynchus mykiss: Differential expression and modulation during immune responses and development. *Molecular Immunology*. 62. 186-198.

Gut health: publication

Kristiansen M, Merrifield DL, Gonzalez Vecino JL, Myklebust R, Ringø E (2011). Evaluation of prebiotic and probiotic effects on the intestinal gut microbiota and histology of Atlantic salmon (*Salmo salar*). J Aquac Res Development 2011, S1. http://dx.doi.org/10.4172/2155-9546.S1-009

Sørensen, M.; Penn M., El-Mowafi A., Storebakken T., Chunfang C., Øverland M., Krogdahl Å. (2011). Effect of stachyose, raffinose and soya-saponins supplementation on nutrient digestibility, digestive enzymes, gut morphology and growth performance in Atlantic salmon (*Salmo salar*, L). Aquaculture 314 (2011) 145–152.

Wang T., Maehr T., Vecino J.G., Secombes C., Wadsworth S. (2011). Fish suppressors of cytokine signalling (SOCS): Gene discovery, modulation of expression and function. Journal of Signal Transduction. 20. 1-20.

Hartviksen, M.; Gonzalez Vecino, J.L.; Ringø, E.; Bakke, A.M.; Wadsworth, S.; Krogdahl, Å.; Ruohonen, K.; Kettunen, A. (2013) Alternative dietary protein sources for Atlantic salmon (*Salmo salar* L.) affect intestinal microbiota, intestinal and liver histology and growth. Aquaculture Nutrition.

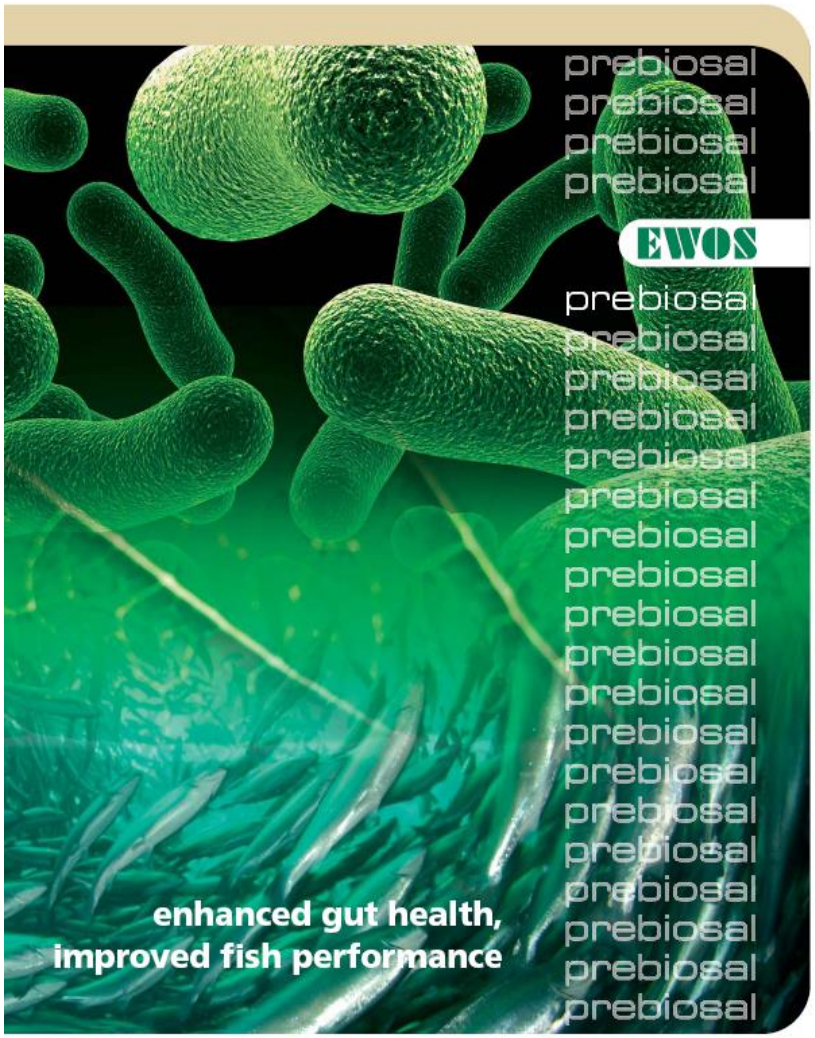
Hartviksen, M., Gonzalez Vecino, J.L., Kettunen, A., Ruohonen, K., Wadsworth, S., Ringø, E. (2013) Atlantic salmon (*Salmo salar* L.) fed four different protein sources: An *ex vivo* approach to evaluate the histological changes and adherence of *Carnobacterium divergens* and *Aeromonas salmonicida ssp. salmonicida* to intestine. Aquaculture Nutrition.

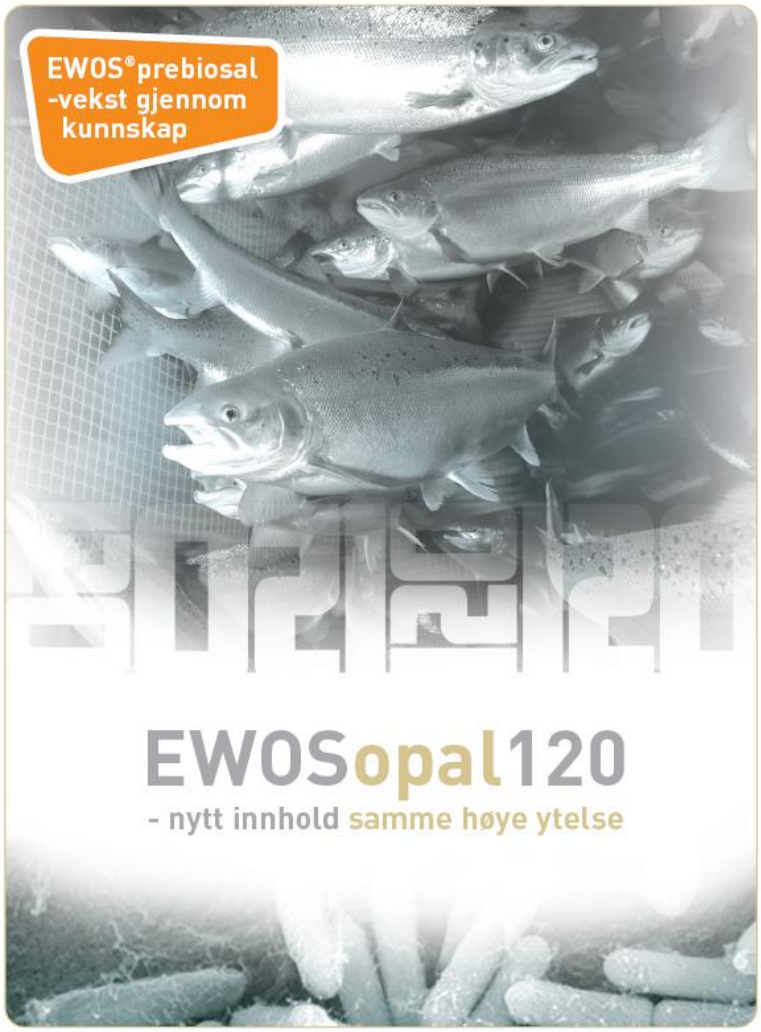
Hartviksen M., Gonzalez J., Ringø E., Bakke., Wadsworth S., Krogdahl Å, Ruohonen R, Kettunen (2014). Alternative dietary protein sources for Atlantic salmon (*Salmo salar* L.) affect intestinal microbiota, intestinal and liver histology and growth. Aquaculture Nutrition. 19. 1-9.

Hartviksen M., Gonzalez Vecino J., Kettunen A., Myklebust R., Ruohonen K., Wadsworth S., Ringø E. (2015). Probiotic and pathogen *ex-vivo* exposure of Atlantic salmon (*Salmo salar* L.) intestine from fish fed four different protein sources. Journal Aquaculture Research Development. 6. 340.

Ringø E., Zhou Z., Vecino J. G., Wadsworth S., Romero J., Krogdhal Å., Olsen R. E., Dimitroglou A., Foey A., Owen M., Lauzon H., Martinsen L., Schryver P., Bossier P., Sperstad S., Merrifield D. (2015). The effect of dietary components on the gut microbiota of aquatic animals, A never ending story? Aquaculture Nutrition. 1-64.

Gut health and growth





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