Improving fish health with OceanFeed™

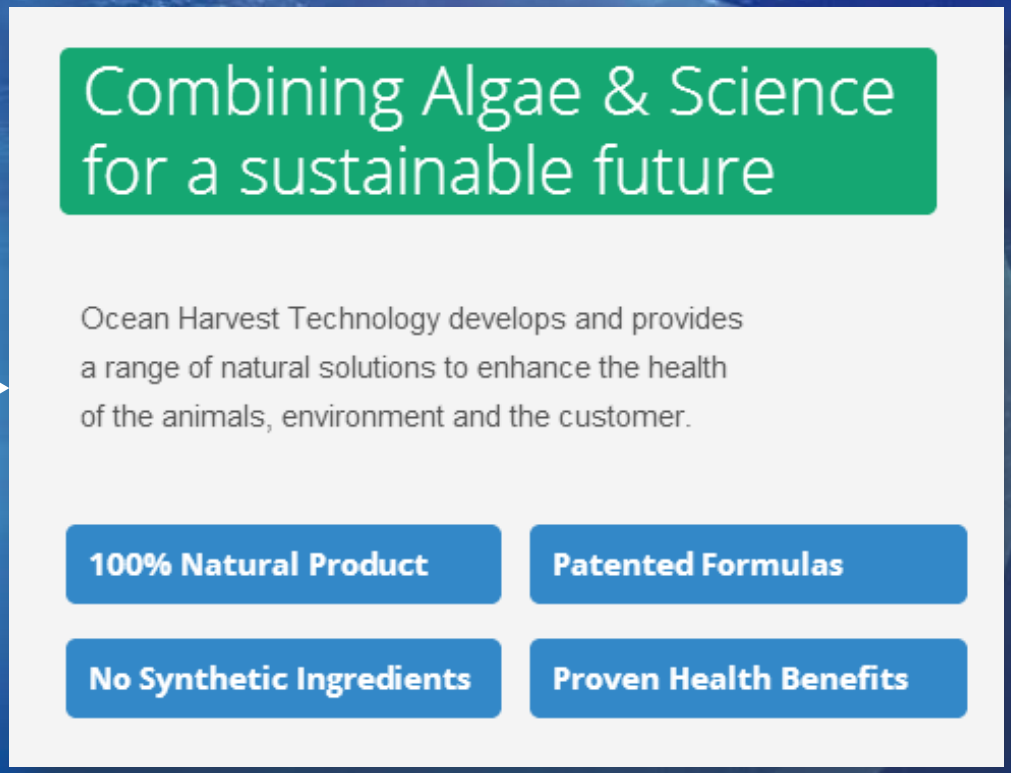
Dr. Simon Faulkner

3rd Gill Health Initiative Meeting

16th April 2015

www.oceanharvest.ie

OCEAN HARVEST TECHNOLOGY



- Seaweed-based feed ingredients
- Liquid seaweed extracts
- Seed coating and fertiliser applications

Micro-ingredients opportunity

- Public perception of fish farming can be negative because of the use of (expensive) chemicals

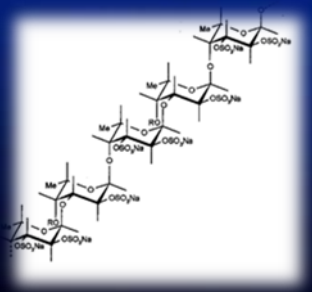
- Can some or all of the 'Micro-ingredients' be obtained from a sustainable and natural resource?

Yes! Look at Seaweeds

Seaweed composition

Component	Contents in % dw
Moisture	8-12
Ash	20-45
Carbohydrates	35-45
Lipids	0.5-5
Protein	4-40
Fibre	4-7
Iodine	0.1-0.5

- Specific composition
- Range of polysaccharides, proteins, vitamins
- Higher value compounds (colorants, mannitol, fucoidan, proteins, fucoxanthin)
- Many exotic compounds (e.g., laminine)
- High mineral content (Calcium, Magnesium, Iodine)



Patents on the therapeutic applications of Phycobiliproteins

Therapeutic application	Patent number	Reference
Anti-inflammatory	US 7,025,965	(Pieloch, 2006)
	JP 256478	(Hirabashi et al., 2004)
Liver protecting	CN 1633889	(Ke and Suo, 2005)
Anti viral	CN 1524574	(Que, 2004)
	US 6,346,408	(Chueh, 2002)
Anti tumour	CN 1478552	(Jue and Jue, 2004)
	CN 1325729	(Wang and Li, 2001)
	CN 1091976	(Shu and Xinhan, 1994)
	US 5,163,898	(Morcos and Henry, 1992)
	JP 065216	(Iijima et al., 1983)
Treatment of atherosclerosis	US 4,886,831	(Morcos and Henry, 1989)
Lipase activity inhibitor	JP 359638	(Koda and Okuda, 2004)
Serum lipid reducing agent	JP 137805	(Nagaoka et al., 2003)
Skin function activation factor	JP 036744	(Fujikawa and Matsushima, 2006)
Anti oxidant	JP 330733	(Oho, 2002)
As an agent that obstructs absorption of environmental pollutant deposition in the body.	JP 157559	(Yoneda, 2001)

(Sekar and Chandramohan, 2008);

Fish farming and algae

- Not new, but always looking at protein/oil replacement
- Trials with Trout (Soler et al., 2009); Sea Bass (Valente et al, 2006); Red Bream (Nakagawa et al, 1997)
- Potential for seaweed-based replacement of artificial ingredients, antibiotics, colorants and preservatives

Sinking Fish Feed

OceanFeed™-Salmon

Floating Fish Feed

A formulation of selected species of macroalgae

(No Ascophyllum, Fucus or Kelp)

OHT Commercial Trials with OceanFeed™ Salmon

Test (OceanFeed™) and reference (high class organic) diets produced at a commercial feed mill

Test diet replaced the mineral and vitamin pre-mix with OceanFeed™

Tested at a research farm in Scotland (at 15% inclusion) over 18 months

6 cages, three replicates for each diet each cage with 600 fish

Commercial Trials

Fish sampled individually from each cage for length and weight every 3 months , at end of trial all fish measured.

- Length, Weight and Gutted Weight
- Lice Count
- Gut sample for Microbiology
- Intestine for Histology
- SalmoFan Colour
- Lipid Profile on Flesh
- Organoleptic Testing

Trial results salmon

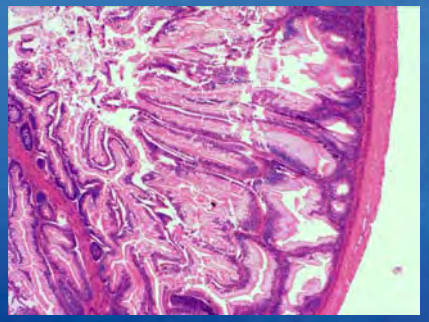
- OceanFeed™ is highly palatable
- Growth rate 14% higher for OceanFeed™ diet
- Final harvest weight 2.6% heavier than control
- Significant sea lice reduction observed
- 60% less mortality
- Improved FCR (0.1 point)
- SalmoFan colour test values identical (23/24)

Histological Examination

-Immediately after killing separate intestine and immerse in buffered formalin

-Sections from intestine stained with H&E

OceanFeed™ diet with seaweed



No pathological abnormalities in OceanFeed™ fish

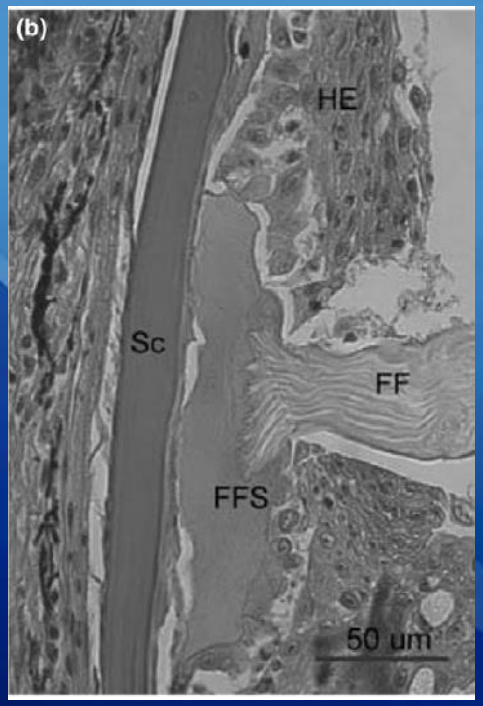
- No pathogens, Salmonella, Listeria were detected in feed or fish (Microsearch Laboratories Ltd, Halifax)

Organoleptic results

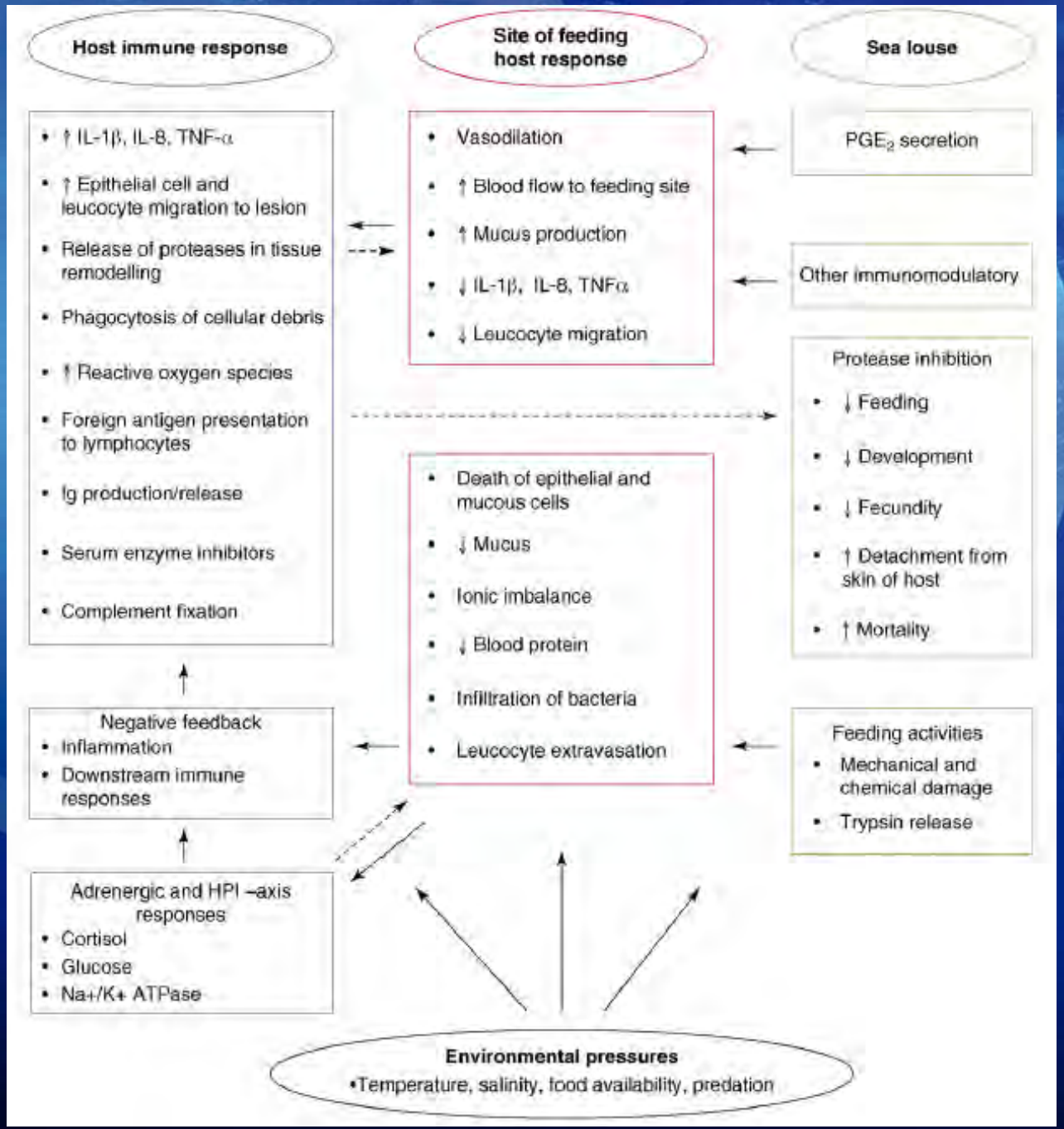
Samples were presented to double blind panels and scored for appearance, texture, colour, smell, taste

- Results showed an obvious preference for the OceanFeed™ fed fish (raw and cooked) with an overall score of 2 (Good) compared with the organic diet fed fish with a score of 3.1 (indifferent)
- Active compounds in the OceanFeed™ have a marked influence on taste

Sea Lice



FF=mouth part sealice
FFS= sea lice secretion
SC= salmon fish scale

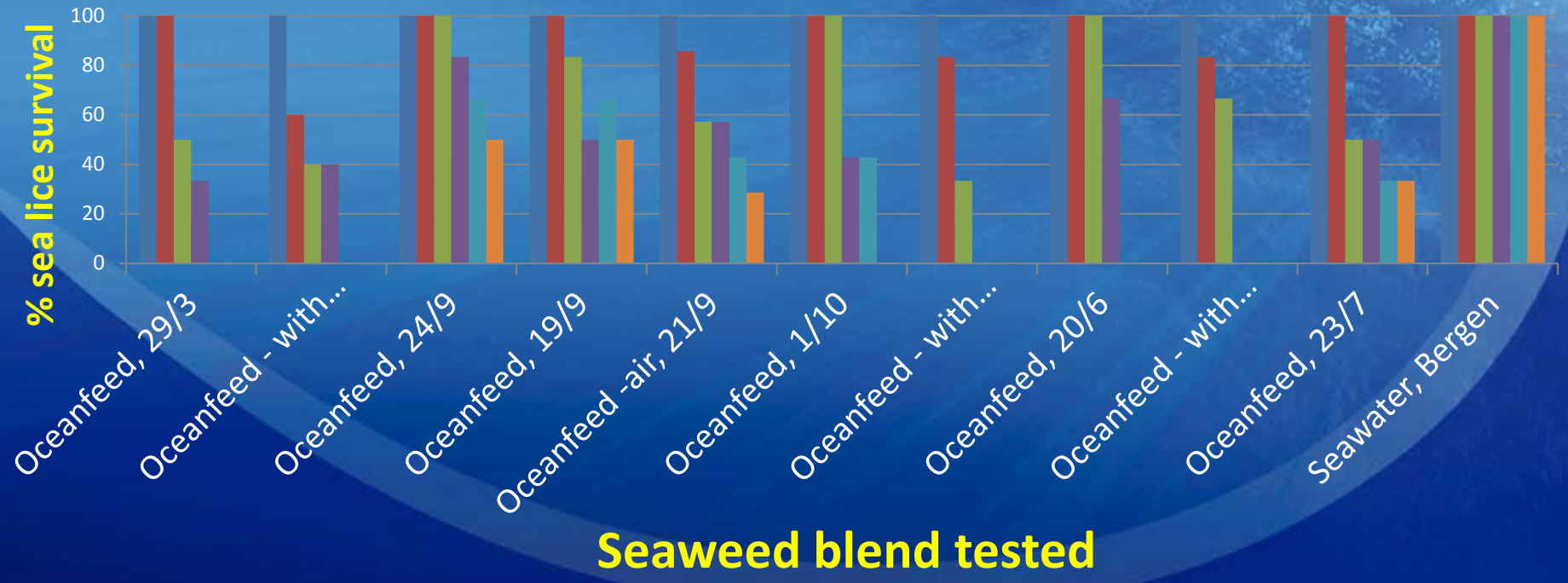


Sea lice in salmon

- **Lice release……**
- Prostaglandin PGE2 (endogenous PGE2 also plays a role)
- Range of proteases
- Phosphatases
- Macrophage inhibitors

- **Which have the following effects…**
- Reduced respiratory burst
- Lower macrophage activity
- Increased apoptosis
- Necrosis
- Decreased numbers of mucosal cells
- Down-regulation of immune genes interleukin IL-1ß and MHC-1

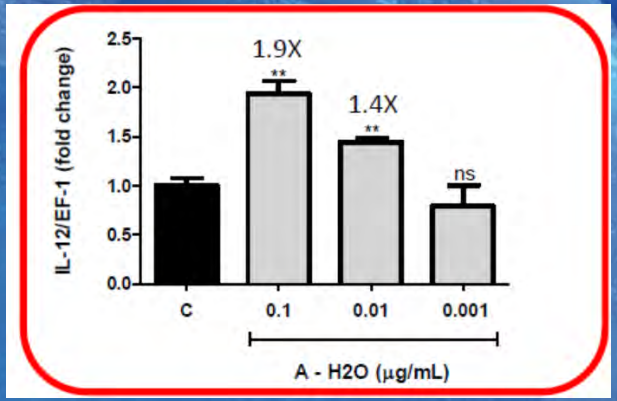
Salmon lice survival after addition of seaweed extract. Bars indicate the hour of counting.



- Lice trials performed by commercial client (ILAB), reported 70-80% reduction

OceanFeed™ and sea lice

- *What we know so far……*
  - Bioactive ingredients stimulate the production of interleukin 12, an immune boosting cytokine

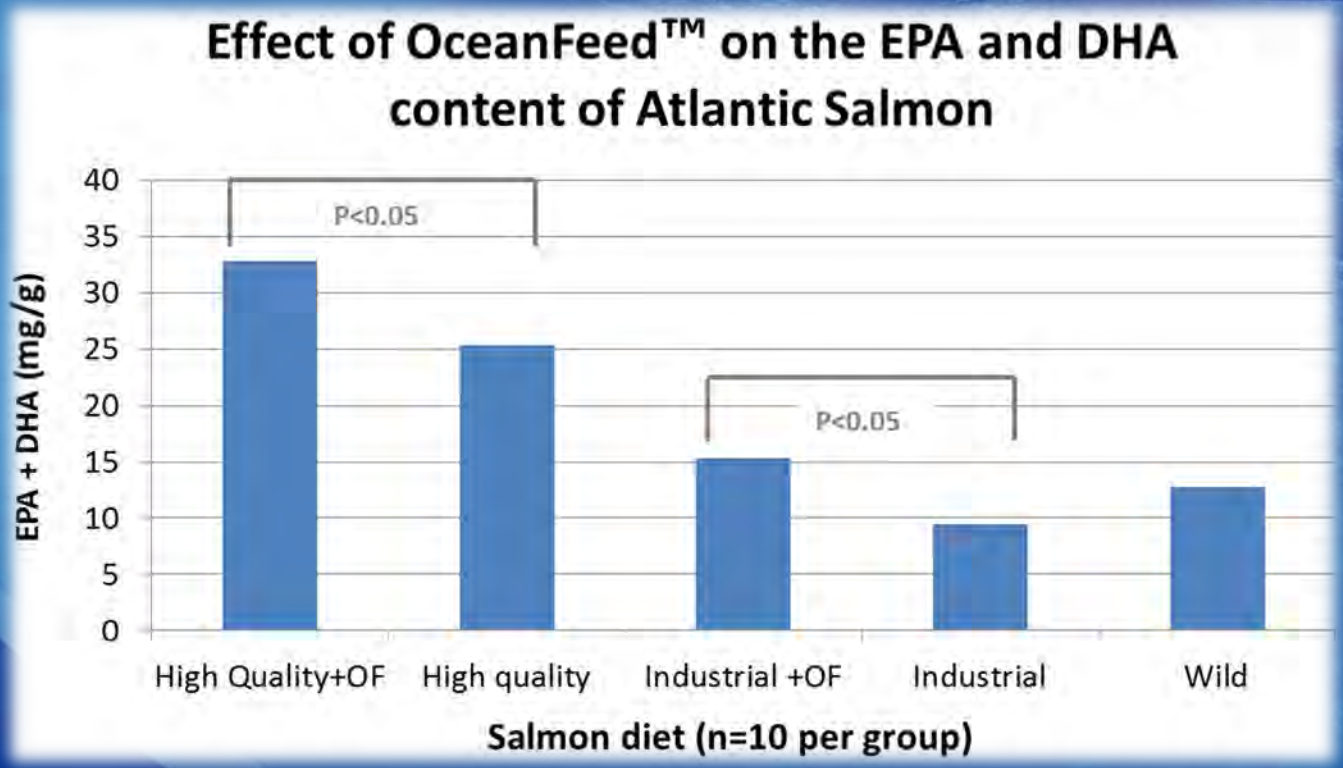


n=3, ** = P<0.005, ns = P>0.05

  - OceanFeed contains molecules (eckol and di-eckol, fucoidan & fucoxanthin) that inhibit the COX enzymes which are responsible for PGE2 production
  - Mucus layer is stimulated and more mucus is produced
  - OceanFeed increases n-3 PUFA (EPA and DHA) levels

OceanFeed™ and salmon lipids

- Effect of OceanFeed on PUFA content of salmon flesh investigated in collaboration with Maastricht University
- Fish from the Scottish trial, commercial samples and wild salmon analysed (n=10 per group)
- Addition of OceanFeed increases the omega 3 (EPA and DHA) in fish fillets by 30%-62%



Eur. J. Lipid Sci. Technol. 2015, *116*, 0000–0000

Short Communication

Seaweed enrichment of feed supplied to farm-raised Atlantic salmon (*Salmo salar*) is associated with higher total fatty acid and LC *n*-3 PUFA concentrations in fish flesh

Toine Wilke[1], Simon Faulkner[2], Laura Murphy[2], Laura Kealy[2], Stefan Kraan[2] and Fred Brouns[1]

OceanFeed™ and salmon fatty acids

- Impact of seaweed on fatty acid metabolism has already been observed in mouse and rat livers, where smaller chain n-3 PUFAs such as alpha-linolenic acid (C18:3 n-3) are converted into EPA and DHA (Airanthi et al. 2011, Maeda et al. 2008 and Tsukui et al. 2009)

- Similar results have been also been observed for rainbow trout (Dantagnan et al. 2009 and Güroy et al. 2013)

- Bioactives in OceanFeed helps consumers to reach the recommended daily intake for EPA + DHA

OceanFeed & Gill disease?

- Limited data so far…
- Plenty of anecdotal data but an applied scientific study is needed – collaborations welcome!!!!
- Potential sustainable, environmentally friendly in-feed alternative solution?

OceanFeed™ & Gill disease

Increased Omega-3

Has direct effect on health of fish

Omega 6 inflammatory

Omega 3 anti-inflammatory

May help attenuate inflammatory responses associated with gill disease

Altered gene expression

↑ IL-1β, TNF-α, TCR-α chain, CD8, CD4, MHC-IIα, MHC-I, IgM and IgT in infected gills

OceanFeed alters expression of immune related genes (e.g. Il-12) in salmon cells *in vitro* @ only 10ppm

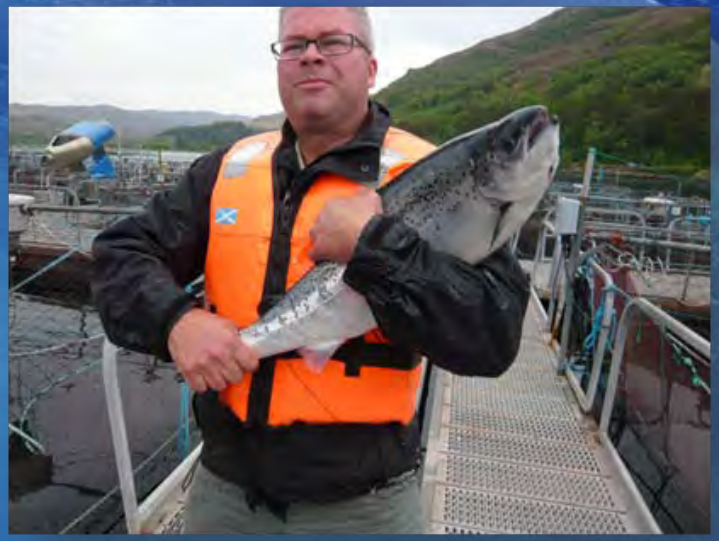
Altered mucus production/ composition

The layer of mucus surrounding a fish is a defensive boundary

OceanFeed alters mucus production and/or composition (Irish trial in 2015)

BIM
Bord Iascaigh Mhara
Irish Sea Fisheries Board

May modulate resistance/susceptibility to GD



Ocean Harvest Technology Ltd.

N17 Business Park, Milltown

County Galway, Ireland

info@oceanharvest.ie

Telephone: +353 93 51807

www.oceanharvest.ie