Functional feed with krill meal reduce heart pathology and viral load in heart of Atlantic salmon.

Gunner Molland, Trygve Sigholt & Ralph Bickerdike
PD TriNation, Dublin, June 3rd 2015
Constituents of krill have been shown to have positive effects on the heart and circulation system in humans and warm blooded animals.

Comparable and significant effects seen in other species can be transferred to farmed fish through the use of Qardio.
Numerous studies have shown the beneficial effects of krill lipid fractions.
## Lipid class comparison

<table>
<thead>
<tr>
<th>Structural form</th>
<th>Triglyceride (fish oils)</th>
<th>Phospholipids (krill oil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glycerol</td>
<td>![Glycerol Image]</td>
<td>![Glycerol Image]</td>
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<tr>
<td>Fatty acids</td>
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<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Triglyceride</th>
<th>Phospholipids</th>
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</thead>
<tbody>
<tr>
<td>Non-polar</td>
<td>![Non-polar Image]</td>
<td>![Non-polar Image]</td>
</tr>
<tr>
<td>Hydrophobic – does NOT mix with water</td>
<td>![Hydrophobic Image]</td>
<td>![Hydrophobic Image]</td>
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</tbody>
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<table>
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<tr>
<th>Function</th>
<th>Triglyceride</th>
<th>Phospholipids</th>
</tr>
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<tbody>
<tr>
<td>Energy storage</td>
<td>![Energy storage Image]</td>
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<table>
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<tr>
<th>Phospholipids</th>
<th>Choline</th>
<th>Phosphate</th>
<th>Glycerol</th>
<th>Fatty acids</th>
</tr>
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<tr>
<td>![Choline Image]</td>
<td>![Phosphate Image]</td>
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<tr>
<th>Phospholipids function</th>
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<td>Main structural component in all cell membranes</td>
<td>Energy storage</td>
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<th>Phospholipids function</th>
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<tr>
<td>Membrane</td>
<td>Fat cell</td>
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</tbody>
</table>
Cardiovascular health in farmed fish

Supply all organs with blood, oxygen and nutrition

- Limited O$_2$ availability
- Impaired gill function
- Variable temp conditions
- Recovery from damage
- Viral diseases
- Stressful operations

Applied comparative knowledge on benefits of krill on heart health in farmed salmon
Product development

Investigation of mode of action
(PhD Uni. Aberdeen, NRC project 2015 – 2018)

Commercial trials in Norway & Scotland to confirm effects under realistic farming conditions

Controlled cardiomyopathy (PRV) challenge study to determine proof of concept & document physiological & immunological effects.
PRV transmission study, VESO 2013/2014

- 4 replicates/diet, basal control or Qardio
- 100 individuals/tank, start weight 20 grams
- 8 weeks of feeding pre-transmission (cohabitant PRV)
- Sampling (heart tissue for histology & genomics):
  - 0-sampling: 6 weeks pre challenge
  - At challenge (after 6 weeks of feeding)
  - 3 - 6 - 8 - 9 - 10, -12 and 14 weeks post challenge
Growth during study

Average weight on sampled fish

- Consistently higher growth for Qardio fed fish.
Development of heart size

- Tendency for increased relative heart size for Qardio fed fish (nsd).

8 fish sampled per diet
Higher expression of genes involved in the immune defense and other cellular processes in Qardio fed fish.
Viral load in relevant organs (qPCR)

• Lower viral load in heart tissue for Qardio fed fish (p<0.05).

(qPCR analysis for PRV by Øystein Evensen (NMBU))
Development of heart histopathology

- Significantly lower number of fish with severe histopathology at peak time point of pathogenesis for fish fed Qardio (p<0.05).

(Histological examination by Øystein Evensen (NMBU))
Commercial field trial 2013 - CMS

- Farm located in Mid-Norway, S1-2012
- Feed trial April - Sept 2013 (harvest)
- Duplicate pens fed control or Qardio

DISEASE HISTORY
- IPN post transfer to SW
- HSMI with prolonged mortality (all cages in 2012)
- CMS diagnosed in two of four trial cages in 2013
• Lower cumulative mortality for Qardio fed fish in both cage parallels
Significant difference in histopathology score profile for Qardio fed fish.

(Histological examination by Øystein Evensen (NMBU))
Development of heart size

- Tendency for increased relative heart size for Qardio fed fish (nsd.)
Commercial field trial 2014

• Farm located in South-Norway, S1-2013.
• Feed trial May - Nov 2014 (4.3kg - harvest).
• Single pen fed control or Qardio.
• Site selected with historical cardiomyopathy but no disease outbreak during trial.
• 50 fish per pen assessed at harvest for heart size.
• Significantly larger heart size for Qardio fed fish
Consistant benefits to cardiovascular health

<table>
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<tr>
<th>HSMI - VESO 2013</th>
<th>Field trial 2013</th>
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<tbody>
<tr>
<td>Reduced viral count</td>
<td>Reduced mortality</td>
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<tr>
<td>Immune response</td>
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<tr>
<td>Reduced histopathology during viral disease</td>
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<tr>
<td>Heart development (increased relative heart size)</td>
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Acknowledgements

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• AkerBioMarine

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