Case studies of Flesh Quality issues at Harvest in Atlantic Salmon in Scotland

Dr Marian F. McLoughlin
Fish Vet Group
Outline

— 3 Case studies of downgrading and rejects
— Pale muscle
— Difficulty in skinning fillets
— Linear melanisation of the peritoneum
PALE AND MELANISED MUSCLE AT HARVEST

— Customer complaints about flesh discoloration
Site History

— 525,495 Fish transferred to Site A April 2012
— All vaccinated with Alphaject 2:2 followed by Norvax Compact PD (Feb 2012)
— All feed same high energy diet. (Av 33-36% Oil)
— 230,000 fish moved by well boat from Site A to Site B late Sept 2012 (860g)
— **Site A** current **7.3cm/s** & **Site B 16.7 cm/s**
— Not graded post transfer
— Health -AGD / Plankton issues (A 17.3%) B (11.26%)
— No PD recognised
Other Relevant history

— **Site B fish**  positive for SAV 2 at harvest (Oct 2013)
— Fish from harvest pens 7 & 4 examined @ harvest
— Pen 7 -7/8 SAV antibody, Pen 4: Negative for SAV Ab, but 9/9 PCR SAV positive.
— Pens 1,2,3,6,& 8 sampled on site all SAV Antibody positive 21/10/13
— Pen 9 No SAV antibody 21/10/13
— Suggests recent SAV/PD challenge but no clinical disease
— **Site A fish** – All negative for SAV antibody 21/10/13, no PD clinical disease observed
— All feed high energy diet, Asta ↓ 36→18 then ↑36 Mid Sept & 45 in Oct 2013
— **Significant growth on both sites over summer >2kg in 2 months**
Site A Growth Comparison

08S1
10S1
12S1
Site B Growth comparisons

![Site B Growth comparisons graph](image-url)
Gross appearance of fish

— Grossly all fish looked normal, good condition and plenty of pyloric caecal fat.
— 50% of random sample had muscle lesions 22/10/13
— Butterfly bilateral pattern
— Extending from head to tail in some fish.
— Primarily white muscle
Site B Gross & Histology

Bilateral symmetrical lesions
Acute & Chronic lesions in same fish??
Site A, Gross & Histology
Advanced Site A lesions

Significant melanisation
X-Ray examination

- Platyspondyly of the caudal spine was found in 5/10 fish with flesh discoloration
- Chris Matthews FVG

Normal vertebrae

Flattened vertebral bodies
Platyspondyly
### Site B Slaughter SAV

<table>
<thead>
<tr>
<th>Fish No</th>
<th>Pen</th>
<th>SAV Antibody</th>
<th>SAV PCR HT</th>
<th>Ct value</th>
<th>CK</th>
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<tr>
<td>1</td>
<td>7</td>
<td>Neg</td>
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<td>31.55</td>
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</table>

8/9 PRV Positive PCR ct >30
CK levels Interpretation

— CK levels rise if there is heart or muscle damage in a fish, but does not discriminate between heart and skeletal muscle lesions.
— For PD, ( based on MHS experience)
 — Levels below 10,000 are considered normal,
 — 20 to 30K is indicative of mild muscle damage,
 — 30-80K is concerning
 — > 80,000 revealing significant muscle damage.
 — In cases of HSMI the CK level tends to be between 30 and 80K.
Site B CK Levels

Site B CK levels

CK levels

0 5 10 15 20 25 30 35

0 20000 40000 60000 80000 100000 120000 140000 160000 180000
Summary of Findings

<table>
<thead>
<tr>
<th>Site A</th>
<th>Site B</th>
</tr>
</thead>
<tbody>
<tr>
<td>— Similar gross appearance</td>
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</tr>
<tr>
<td>— Similar prevalence 11.8%</td>
<td>— Similar prevalence 12.8%</td>
</tr>
<tr>
<td>— SAV negative,</td>
<td>— SAV 2 Positive</td>
</tr>
<tr>
<td>— CK levels normal</td>
<td>— Some elevated CK levels (PD)</td>
</tr>
<tr>
<td>— Mild myopathy &amp; progressive melanisation</td>
<td>— Significant acute and chronic white muscle myopathy</td>
</tr>
<tr>
<td>— Excess fatty tissue?</td>
<td>— Focal melanin deposits</td>
</tr>
<tr>
<td>— Inadequate dietary pigment.</td>
<td>— PRV positive High ct levels</td>
</tr>
<tr>
<td>— Low Asta in pale tissue 4.7 vs 11.06 mg/kg in normal</td>
<td>— No gut pathology.</td>
</tr>
<tr>
<td>— Negligible Vit C &lt;0.05mg/100g</td>
<td>— Pancreatic deficiency?</td>
</tr>
</tbody>
</table>
Possible causes

— Two possible pathogenesis (lesion development)

— **Site A**, rapid growth, inadequate pigment and failure to absorb enough pigment during rapid growth especially in largest muscle fibres.

— Excess fat, increased oxidation, increased associated pigmentation/melanisation.

— **Site B**, rapid growth with late onset concurrent SAV infection triggers PD on top of Site A picture.

— Cataracts in Ireland last year, histidine levels normal—speculate rapid summer growth in S1’s (much higher sea temperatures & steeper Spring/Summer rise than normal)
Problems with automatic skinning of Atlantic salmon fillets

— Processing plant were finding it very difficult to remove skins from fillets
— Norwegian salmon from a SAV 3 endemic zone
— Site had history of PD in 2014
— Gross appearance
Histology of affected tissue

- Atrophy of white muscle
- Deposits in red muscle
- Post PD/HSMI skeletal muscle damage and fibrosis
- MSB stain for connective tissue

FishVet Group
Linear Melaninisation

Dr Marian F. McLoughlin
Background

— Quality rejects due to melaninisation of peritoneum
— 5-6% in some stocks
— Initially thought to occur only on mainland sea sites
— Third party fish and off shore fish also now affected
— Gross examination of affected stock
— Revealed very consistent pattern of linear often bilateral melanised tracks with and without associated vaccine
— Preliminary diagnosis – physical damage at vaccination and or grading
Typical Gross lesions
Linear lesion with vaccine nodule
Vaccine removed
Poor vaccination technique
X-Ray through previous fish
X-Rays of cohort smolts
Bone Damage
Melanisation

Vaccine granuloma + melanin

Dendritic melanisation
Histological lesions

Severe fibrosis + vaccine

Vaccine, melanin & inflammation
Conclusions to date

— Lesions probably caused by crush or physical damage close to vaccination
— Brocken or damaged rib bones perforate peritoneum
— Vaccine embeds in damaged tissue, resulting in classic vaccine granulomata and melanisation
— Melanin could also be mobilised by the physical damage.
— Need to observe and adapt grading and or handling to avoid future issues
— Underwater pumps and seawater pen furniture should be investigated.
Summary

— Carcase / fillet downgrading or rejection has many causes
— Detailed description and examination of lesions is required
— Primary insult/cause may have occurred many months prior to harvest
— Need to do retrospective investigation of handling, vaccination, diet, infectious disease etc.
— Test harvests very important
— Use of biological markers of muscle damage may be useful
Acknowledgements

— Farms,
— MSD Animal Health,
— Chris Matthews, FVG

— Thank you!