

The role of cell-culture medium components in vaccines on the prevalence of spinal deformities including cross-stitch vertebrae and reduced growth in Atlantic salmon

Trination meeting – April 2026



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Background

1

A new type of spinal deformity named cross-stich vertebrae (**CSV**) (“korsstingsvirvler”) observed in the 2016/2017 winter, in Norway.

2

CSV caused ingrowth of connective tissue into the fillet with associated loss of colour and downgrading.

3

There is a correlation between the use of two commercial PD vaccines and the frequency of **CSV** deformity, with a higher risk in S0's smolts. (Nofima¹)

3

MSD Animal Health has carried out an in-depth investigation into the link between PD vaccines based on inactivated SAV virus and **CSV**.

4

In vitro studies led to the hypothesis that Foetal Bovine Serum (**FBS**), as a component of viral vaccines, could be linked to causing **CSV**.



Background

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Vertebral column deformity with curved cross-stitch vertebrae in Norwegian seawater-farmed Atlantic salmon, *Salmo salar* L.

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A pathomorphological description of cross-stitch vertebrae in farmed Atlantic salmon (*Salmo salar* L.)

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Forebygging av korsstingsvirvler hos laks i oppdrett

Faglig sluttrapport

Grete Bæverfjord, Alf Seljenes Dalum, Vibeke Høst, Aleksei Krasnov, Randi Grøntvedt, Renate Johansen, Anne-Katrine Reed, Anne Aas-Eng, Agnar Kvellestad, Håvard Bjørgen, Cathrine Trangerud, Nina Ottesen, Hege Kippenes Skogmo, Erling Olaf Koppang, Elisabeth Ytteborg

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The effect of vaccine-associated cross-stitch vertebrae pathology on growth of farmed Atlantic salmon

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Introduction

- MSD Animal Health conducted a long-term safety study together with IMR at Matre research station.
- In this study, spinal deformities and bone health of fish vaccinated with different vaccine compositions and raised under distinct smolt production strategies were evaluated.
- The data on smolt production strategy has been published and the data on the different vaccines shared in this presentation will be published later this year.

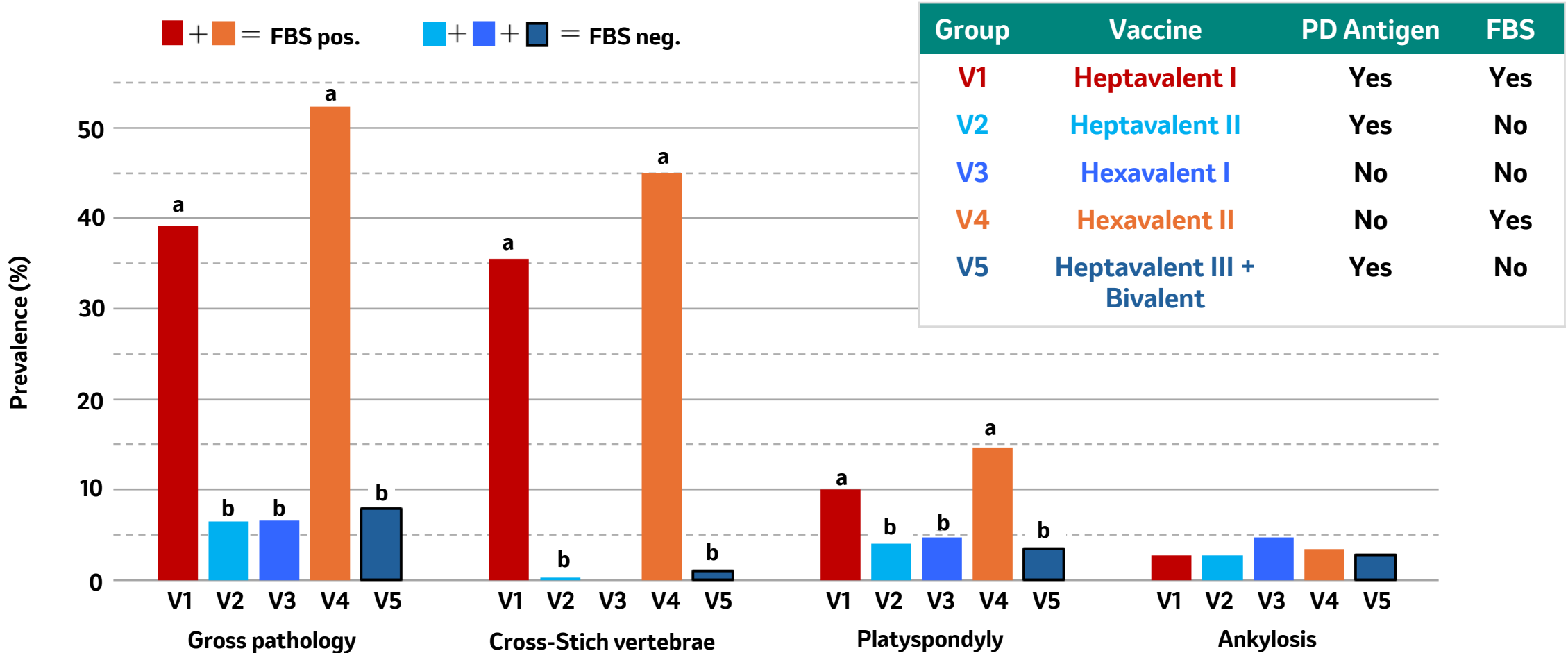
Study design

- 320 fish per group, PIT tagged, immunized with vaccines 1-5 below, under S0 conditions, harvested after 13 months of grow-out (3-4 Kg).
- Hypothesis: It is the presence of FBS (and not necessary PD antigen) in the vaccines that increases the occurrence of CSV.
- Data presented: Every fish was evaluated for **gross pathology** (connective tissue spreading from vertebrae into fillet with risk of downgrade), **spinal deformities** (x-ray) and **growth**.

Group	Vaccine	PD Antigen	FBS
V1	Heptavalent I	Yes	Yes
V2	Heptavalent II	Yes	No
V3	Hexavalent I	No	No
V4	Hexavalent II	No	Yes
V5	Heptavalent III + Bivalent	Yes	No

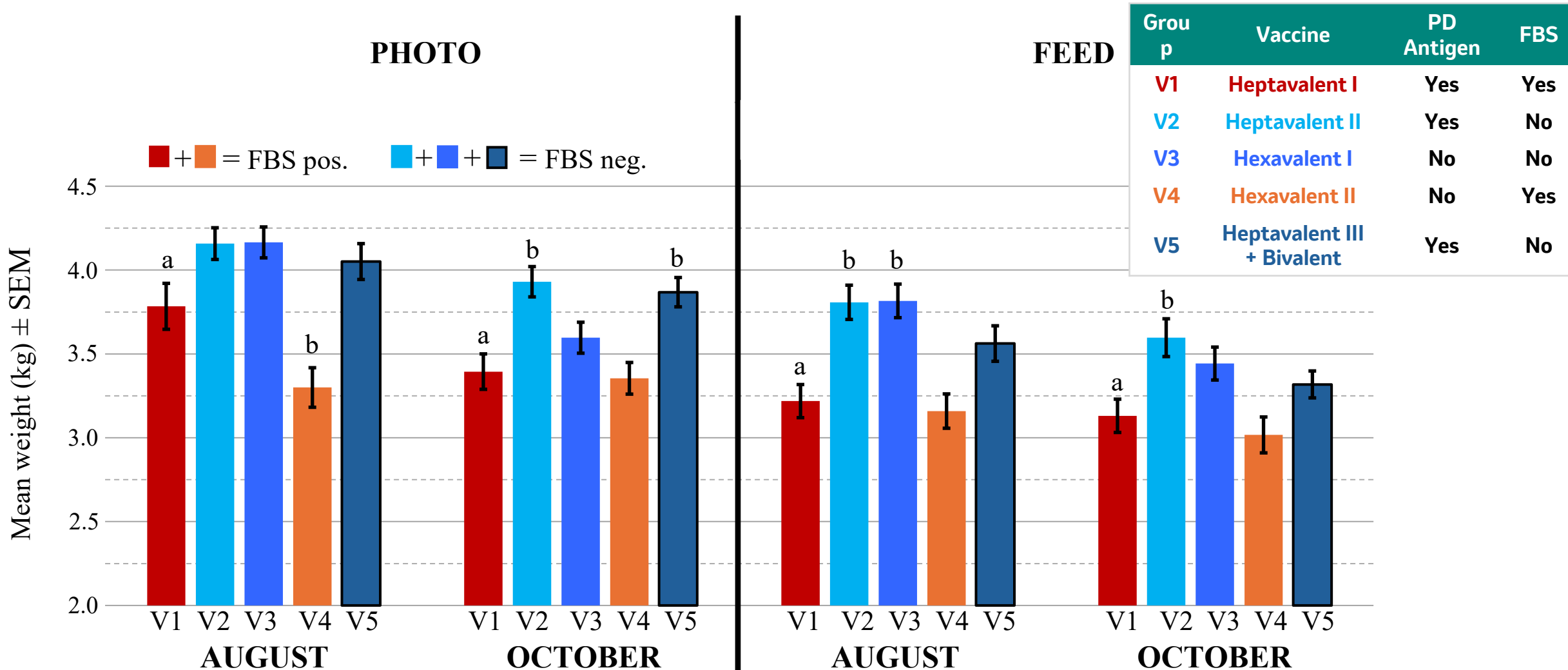


Results: Gross pathology and spinal deformities

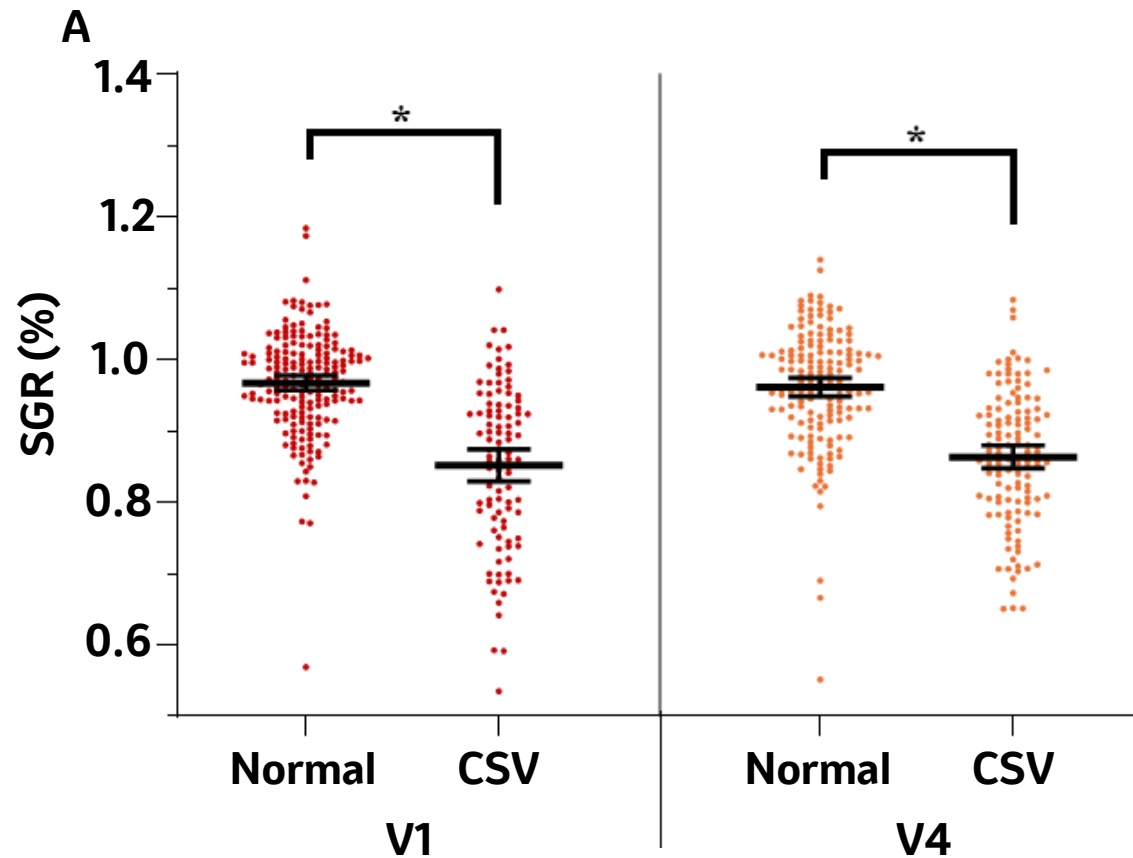


Different letters (a, b, c) denote statistically significant difference (logistic regression analysis; $p < 0.05$)

Results: Growth - slaughter weight by smoltification regime



Results: Growth – SGR comparison between CSV and normal spines

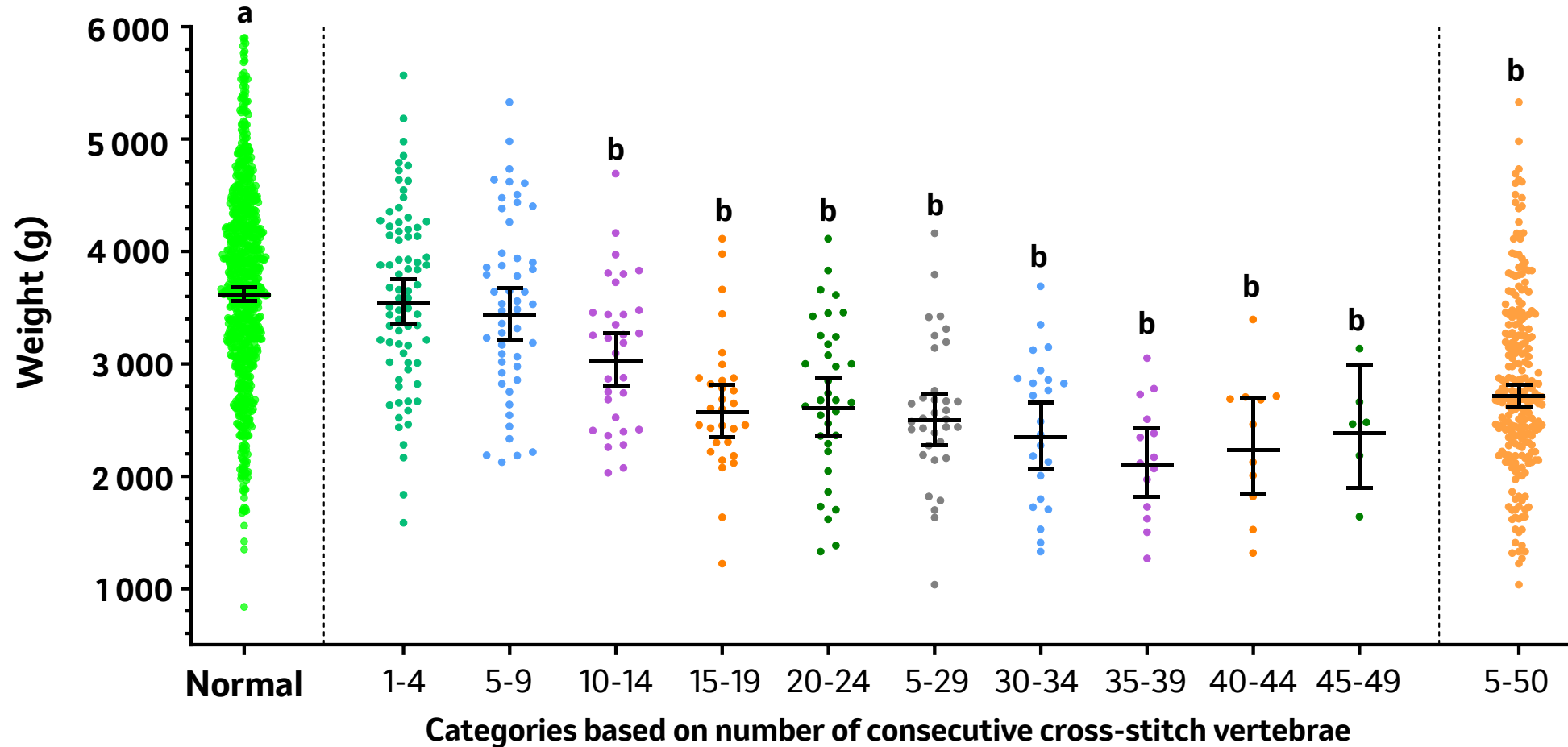


Group	Vaccine	PD Antigen	FBS
V1	Heptavalent I	Yes	Yes
V2	Heptavalent II	Yes	No
V3	Hexavalent I	No	No
V4	Hexavalent II	No	Yes
V5	Heptavalent III + Bivalent	Yes	No

SGR – specific growth rate

* denote statistically significant difference (ANOVA; p < 0.05)

Results: Growth – Correlation between harvest weight and CSV



Different letters (a, b) denote statistically significant differences (Kruskal-Wallis multiple comparisons; $p < 0.001$)

There is also a significant correlation between severity of cross-stitch vertebrae and reduced growth (Spearman rank-order correlation, $p < 0.05$)

Conclusions

Hypothesis: It is the presence of FBS (and not necessarily PD antigen) in the vaccines that increases the occurrence of CSV.



Vaccines with **FBS** caused **40-50% prevalence of connective tissue** irradiating from the spine with risk of fillet downgrading



Vaccines with **FBS** caused **35-45% prevalence of CSV** deformity at the end of the trial



The data strongly indicates that **FBS** is the key factor causing **CSV** pathology and subsequent growth reduction and risk of fillet downgrading due to connective tissue

QUESTIONS?

Are you interested in materials related to today's subject or other fish health themes?



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