MANNAN OLIGOSACCHARIDES FROM COCONUT RESIDUE IMPROVES INTESTINAL HEALTH OF ATLANTIC SALMON (*Salmo salar*) PARR

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1] INTRODUCTION

The mucosal barriers of fish are an important first line of defense against pathogenic invasion. Functional feed additives such as mannan oligosaccharides (MOS) have the potential to promote improved mucosal physiology and barrier function, which can lead to improved fish robustness, health, and welfare. The aim of this study was to investigate the efficacy of a novel source of MOS derived from coconut residues on the mucosal health of Atlantic salmon.

2] MATERIALS AND METHODS

Atlantic salmon parr (ca. 11.68 ± 0.11g) were fed with either a control diet or diets supplemented with one of three levels of MOS (0.25%, 0.35% or 0.5% Pretego™, GreenSage Prebiotics Inc) (Table 1). Diets were manufactured by Skretting using commercially relevant formulations meeting the known nutritional requirements of salmon. Fish were reared in a freshwater RAS system (16.22 ± 0.16°C) for 70 days, with three replicate tanks per treatment group. Fish were fed at 1.0-3.5% of biomass per day. At the conclusion of the trial, growth performance and feed conversion ratio (FCR) were determined and, fish skin and intestinal samples were taken for appraisal of targeted gene expression profiling, histology, electron microscopy and 16S rRNA metabarcoding as described elsewhere (Dimitroglou *et al*. 2010; Al-Hisnawi *et al*. 2019).

Table 1. Dietary formulations and proximate composition (%).

Ingredients	Control	0.25%Pre	0.35%Pre	0.50%Pre
Wheat	10.83	10.30	10.13	9.83
Wheat Gluten Meal	17.93	17.96	17.93	17.93
Fish Oil	6.67	6.67	6.67	6.67
Fish Meal	30.00	30.00	30.00	30.00
Rapeseed Oil	6.39	6.39	6.39	6.39
Faba Bean Dehulled	7.00	7.00	7.00	7.00
Phosphate	0.56	0.56	0.56	0.56
Soy Protein Concentrate	20.00	20.00	20.00	20.00
Astaxanthin	0.01	0.01	0.01	0.01
Vitamin Premix	0.19	0.19	0.19	0.19
Mineral Premix	0.56	0.56	0.56	0.56
Pretego™*	-	0.25	0.35	0.50
Proximate Composition (g/100g)				
Moisture	8.0	8.1	8.0	7.9
Crude Protein	50.2	50.7	51.0	51.1
Crude Fat	18.7	18.5	18.8	19.1
Ash	5.4	5.6	5.5	5.5

* Source of MOS, GreenSage Prebiotics Inc.

3] RESULTS

There were no significant differences between the treatment groups in terms of growth performance and FCR (Table 2). However, histological appraisal (Figure 1) revealed that dietary MOS increased the length of distal intestinal mucosal folds (0.25%Pre) and the number of goblet cells in the distal intestine (0.25%Pre and 0.35%Pre) and the dorsal region of the skin (0.5%Pre). Samples from the trial mid-point (data not shown) revealed that benefits started to emerge from as early as day 35, with the 0.25%Pre treatment group showing significantly elevated mucosal fold length, intestinal goblet cell levels and skin goblet cell levels compared to the control fed fish.

Table 2: Growth performance metrics. Data presented as mean ± standard error of the mean (n = 3)

	Control	0.25% Pre	0.35% Pre	0.50% Pre
IBW (g)	11.64 ± 0.25	11.60 ± 0.23	11.87 ± 0.08	11.60 ± 0.24
FBW (g)	32.44 ± 0.76	32.19 ± 0.25	35.02 ± 2.34	33.35 ± 1.17
WG (g)	20.46 ± 0.67	20.17 ± 0.43	22.48 ± 2.18	21.24 ± 1.10
SGR (%/day)	1.34 ± 0.05	1.33 ± 0.03	1.41 ± 0.09	1.38 ± 0.05
FCR	1.00 ± 0.04	1.03 ± 0.03	0.97 ± 0.06	0.98 ± 0.05
SR (%)	98.10 ± 0.95	100.00 ± 0.00	100.00 ± 0.00	99.05 ± 0.95

IBW, initial body weight; FBW, final body weight; WG, weight gain; SGR, specific growth rate; FCR, feed conversion ratio; SR, survival rate.

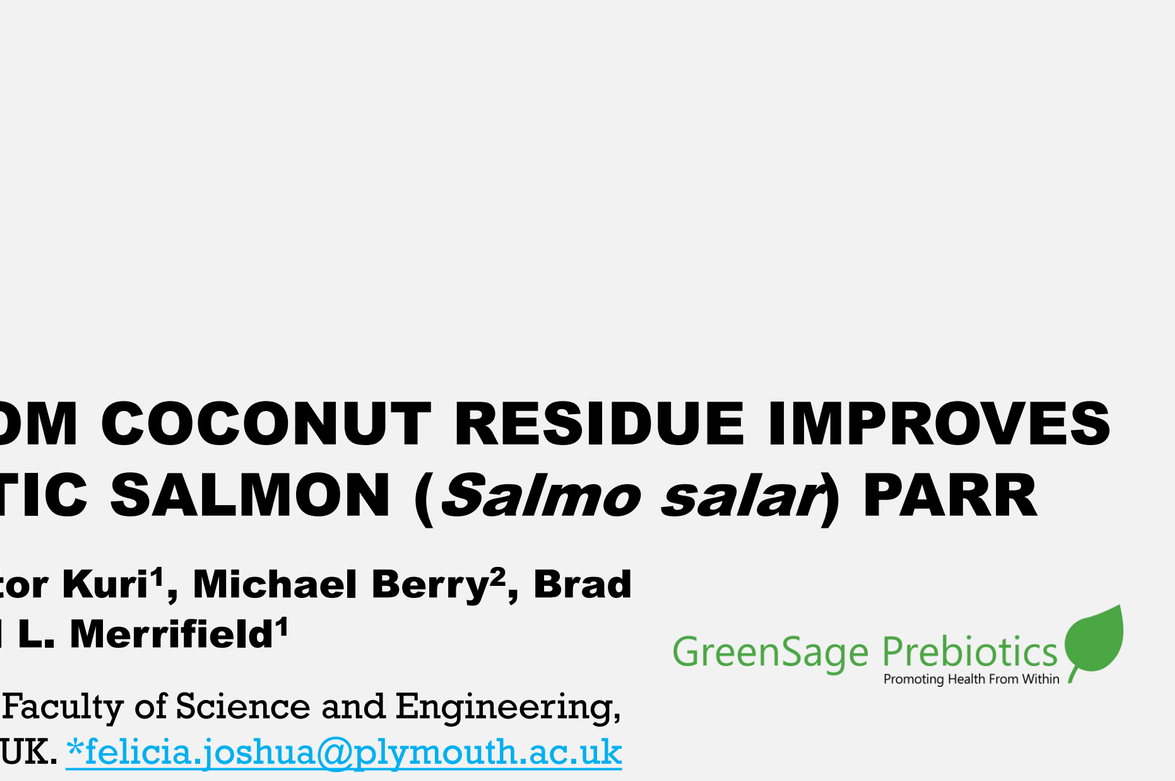

Figure 1 Light microscopy (A, B, D) and transmission electron microscopy (TEM) (C) analysis of Atlantic salmon distal intestine (A-C) and dorsal skin samples (D). Data presented as mean ± standard deviation (n = 9 for light microscopy and n = 6 for TEM). Significant ($p < 0.05$) differences between treatments is denoted by different superscripts.

4] DISCUSSION

Given the high-quality diets and near optimal rearing conditions, there was likely little scope for improvement of performance between the treatment groups. However, feeding Atlantic salmon parr with MOS derived from coconut by-products (Pretego™) can improve the morphology of the Atlantic salmon intestine. In addition, dietary MOS improved the abundance of goblet cells in both the intestine and skin. Goblet cells secrete mucus onto the epithelial surfaces which provides a mechanical, chemical and immunological protective barrier against biotic and abiotic threats. These findings are in line with a number of previous studies which demonstrate that other dietary MOS sources (e.g. yeast) enhances the mucosal barriers of fish (Dimitroglou *et al*. 2010; Torrecillas *et al*. 2017). The benefits of coconut derived MOS will be further explored in on-going analyses including intestinal gene expression profiling and 16S rRNA metabarcoding.

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