THE INFLUENCE OF ALTERNATE SUPPLEMENTAL DIETARY LIPIDS ON THE GROWTH AND HEALTH OF ATLANTIC SLAMON IN SEAWATER

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Introduction

Marine fish oils (MFOs) from such sources as anchovy and herring have traditionally been used in diets for cultured fish to provide fish with energy, essential fatty acids, and other nutritional factors. However, these oils are in great demand world-wide and as a result of their limited supply, they are becoming increasingly more costly. To maintain and enhance the economic viability of aquaculture it has become necessary to find suitable, less expensive sources of lipid. The goal of this research project was to identify economical, alternate plant and/or animal lipid sources that would satisfy the nutritional requirements of Atlantic salmon in sea water for growth and health, while simultaneously providing a quality marketable product.

When MFOs are replaced with other lipids it is essential to provide the fish with the correct amounts and balance of fatty acids to ensure high growth rate without compromising fish health. Fish cannot synthesize n-6 and n-3 polyunsaturated fatty acids (PUFAs), and therefore to maintain optimal growth and health, these fatty acids must be included in the diet in the correct amounts, forms, and ratios. In general, the fatty acid composition of the fish tissues mirrors that of the diet. The fatty acid composition of cell membranes is particularly important because these fatty acids serve as progenitors for a group of immunomodulatory compounds call eicosanoids. It has been reported that diets high in n-6 PUFAs result in relatively higher levels of the pro-inflammatory eicosanoids (2-series prostaglandins and 4-series leukotrienes and lipoxins) derived from the highly unsaturated fatty acid (HUFA), arachidonic acid (Balfry and Higgs 2001). Alternatively, diets high in n-3 PUFAs produce relatively higher levels of the anti-inflammatory eicosanoids (3-series prostaglandins and 5-series leukotrienes and lipoxins) derived mainly from the HUFA, eicosapentaenoic acid.

This research project was designed to examine the effects of partially replacing a MFO (i.e., anchovy oil) with vegetable oils (sunflower oil, flaxseed oil) and/or animal lipids (poultry fat). Various parameters of growth performance and diet utilization, as well as hematology and immune response were measured in replicated groups of Atlantic salmon reared on one of eight different experimental diets. The fatty acid composition of the diets and fish muscle were examined, along with the eicosanoids produced from stimulated leucocytes.

Methodologies

The feeding trial was performed at the West Vancouver Laboratory, using Atlantic salmon (*Salmo salar*, mean starting weight 102.3 g). Fish were reared in outdoor 4000-L tanks supplied with a continuous flow of aerated ambient seawater. Eight diets were prepared whereby supplemental anchovy oil in the basal diet was partially replaced with flaxseed oil, sunflower oil, or poultry fat, and diets that contained blends of each vegetable oil with poultry fat (see Table 1). The eight dietary treatment groups were assigned to triplicate groups of 40 fish using a randomized complete block design. All fish groups were fed their prescribed diet by hand twice daily to satiation for 20 weeks. At the end of this period various indices of growth performance, diet absorption and utilization were determined viz., specific growth rate, feed efficiency, protein efficiency ratio, gross energy utilization, whole body and muscle proximate composition, and diet digestibility. Health assessments were performed by measuring several hematological variables including: erythrocyte numbers, hematocrit, hemoglobin, mean erythrocyte volume (MEV), mean erythrocyte hemoglobin content (MEHC), differential leucocyte numbers, mean erythrocyte hemoglobin, and erythrocyte fragility. The immune responses of the different dietary treatment groups were compared using various tests that examined the relative activity of the non-specific cellular and humoral defense systems (serum lysozyme activity, serum bactericidal activity, respiratory burst activity of peripheral blood leucocytes and head kidney leucocytes). The fatty acid compositions of the diets and muscle samples from the fish were analyzed using gas chromatography. Eicosanoid production of calcium ionophore-stimulated head kidney leucocytes was examined by liquid chromatography and electrospray mass spectrophotometry. The results were analyzed by randomized block ANOVA to test for significant diet-related differences.

Table 1. Percent composition of the supplemental lipid sources used in the preparation of the experimental diets. A total of 150g of supplemental lipid was added to each kg of diet on an air-dry basis. All diets contained equivalent concentrations of protein (501.5 g/kg) and lipid (241.4 g/kg) on a dry weight basis. [1/]

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8
Anchovy Oil	100	25	25	25	25	25	25	25
Poultry Fat	0	75	0	0	50	50	25	25
Flax Oil	0	0	75	0	25	0	50	0
Sunflower Oil	0	0	0	75	0	25	0	50

[1/] The composition of the basal diet was as follows (g/kg air-dry basis): Peruvian fish meal 693.3, wheat flour 124.5, spray-dried blood meal 25.5, vitamin premix 4.7, mineral premix 1.7, supplemental lipid 150.4.

Results and Conclusions

Following the 20-week feeding trial, there appeared to be no significant adverse effects of the different lipid sources on any aspect of growth performance. Comparisons made between the groups fed the different diets revealed that the specific growth rate and final weight of fish fed the high flaxseed diet (Diet 3), were significantly higher than those noted for the groups fed the control diet (Diet 1).

The use of alternate lipid sources did not compromise any of the aforementioned immune response variables, as no significant diet-related differences were detected. Mortality during the 20 week feeding trial was low (<1%) with no diet differences. The various hematological measurements were all within normal ranges for cultured Atlantic salmon (Sandnes et al., 1988), indicating that the nutritional requirements were met in all diet groups. Hence, the health of all groups of fish was not compromised by any of the diet treatments. Some variations in hematocrit, MEV, MEHC, and erythrocyte fragility were detected in fish fed Diets 4 and 8 (high and mid sunflower oil diets), relative to those fed the other diets

In summary, our results to date, reveal that significant cost saving can be potentially realized by using the aforementioned alternate lipids as sources of supplemental lipids for Atlantic salmon. This is especially true in the case of poultry fat (presently about half the cost of fish oil) and the blends of poultry fat with the vegetable oils.

References

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