

PROJECT REPORT to:

Soy Aquaculture Alliance

Title:

Enhancing the soybean utilization in Atlantic salmon diet *via* using insect meal as complementary ingredient

From:

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_____ Date: February 17, 2023 _____

Principal Investigator(s)

Objectives:

The overall aim of our proposed project was to increase the usage of soybean meal (SBM) in salmonids feeds for the commercial production of Atlantic salmon, *Salmo salar*. The specific objectives of this study are to:

- a. Improve the feed formulation to incorporate maximum amount of SBM in Atlantic salmon
- b. Investigate the effects of supplementation of “***insect meal, black soldier fly larval (BSFL) meal***” in SBM based diets on growth production performance, feed efficiency, distal intestinal structure (enteritis), intestinal barrier function, immune functions, and health of Atlantic salmon

Procedure:

The use of experimental animals was according to the scientific research and animal care and use protocols of the University of Idaho, which comply with all relevant local and/or international animal welfare laws, guidelines and policies.

Feed ingredients and diet formulation: Seven experimental diets were formulated to contain 40% crude protein and 20% crude lipid.

Seven experimental diets were formulated:

Diet 1: Control feed - 0% SBM + 30% fishmeal (FM)

Diet 2: 30% SBM + 10% FM

Diet 3: 40% SBM + 10% FM

Diet 4: 30% SBM + 10% FM + 5% BSFL meal

Diet 5: 30% SBM + 10% FM + 10% BSFL meal

Diet 6: 40% SBM + 10% FM + 5% BSFL meal

Diet 7: 40% SBM + 10% FM + 10% BSFL meal

**Feed Formulation for Atlantic salmon Project (Soy Aquaculture Alliance)
SAA Project August 2022**

	D1	D2	D2	D4	D5	D6	D7
	0%	0.00%	0.00%	5% Insect	10% Insect	5% Insect	10% Insect
Ingredients	Control	SBM30	SBM40	SBM30	SBM30	SBM40	SBM40
FM	30	10	10	10	10	10	10
Soybean meal	0	30	40	30	30	40	40
Whole BSFL	0	0	0	5	10	5	10
Canola meal	12	7	3	6.5	5.2	2.7	1.5
Wheat gluten meal	3.5	4	2.4	3.5	3.1	2.7	2.4
Corn protein concentrate	3.5	4	2.4	3.5	3.1	2.3	2.1
Blood meal	3.7	4.1	3	3.5	3.3	2.4	1.8
Wheat flour	23	14.5	12.5	13.4	12.9	11.5	10.7
Poultry meal	6.4	6.4	6.4	5.8	4.8	4.2	3.5
Fish oil	15	16.3	16.3	15.1	13.9	15.2	14
Dicalcium phosphate	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Choline chloride (60%)	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Vitamin premix	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Trace Mineral mixture, Trouw nutrition	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vitamin C, Stay C-35)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Lysine	0	0.6	0.8	0.6	0.6	0.8	0.8
Methionine	0	0.2	0.3	0.2	0.2	0.3	0.3
TOTAL	100	100	100	100	100	100	100

Fish meal was replaced by SBM and other feed ingredients in the diets of 2-7. Defatted BSFL meal inclusion replaced protein based feed ingredients (except FM and SBM) proportionately in the diets of 2-7. All seven diets formulations were designed to meet the essential amino acid (EAA) requirements of Atlantic salmon. The diet formulations were adjusted such that all diets contain same level of digestible protein, energy and essential amino acids (EAA) while meeting the minimum nutrient requirements of Atlantic salmon (NRC, 2011).

Feed manufacture: All ingredients used in the experimental feeds were analyzed for protein and amino acid content and analyzed values were used to refine feed formulations to achieve target protein lipid and key amino acid levels for salmon. Experimental feeds were produced by cold-pelleting according to standard methods at the Hagerman Fish Culture Experiment Station and feed were shipped to ARI, Moscow ID.

Experimental setup: Total (average weight 8 - 10 g) juvenile Atlantic salmon were stocked into 21, 60-L tanks supplied in a freshwater recirculatory aquaculture system. Water quality were monitored and maintained optimum range for salmon culture. A total of 21 tanks were used,

incorporating three replicates per diet. A completely randomized design was used to assign diets to account for any tank position effects.

Results:

Feed manufacture – **Completed.**

Proximate composition of experimental diets – **Completed.**

Fish feeding trial: 12 weeks of feed trial was **completed.**

Growth data, feed intake and feed efficiency data were **measured – Completed.**

- There was significant difference in growth performance. However there was no significant difference in terms of feed utilization parameters (feed conversion ratio and protein efficiency ratio). Highest growth performance was observed in soybean meal inclusion at 30% with insect meal at 5% compared to fishmeal and other groups.

Histology of distal intestine (fish) – **Completed.**

- Diets have significant effects on gut histology. High inclusion of soy cause gut inflammation whereas supplementation of whole insect meal mitigate the gut inflammation in salmon.

Gene expression data for the growth performance, oxidative stress, gut barrier integrity and acute inflammatory-related cytokines and chemokines, NF- κ B and TNF- α -related genes, and regulators of B and T lymphocytes function. All the data has been analyzed but statistical analysis is pending. Based on preliminary data. Genes data are supporting the growth performance and gut histology data.

Conclusion:

Dietary supplementation of whole black soldier fly larvae meal in soybean meal diets for Atlantic salmon:

- Improves growth performance

- Enhances soybean utilization
- Mitigates gut health/enteritis
- Provides an alternative dietary approach to improve utilization of feed ingredients in sustainable aquafeed.