DIETARY EVALUATION OF BY-PRODUCT (FRASS) OF INSECT FARMING INDUSTRY AND INSECT MEAL IN AQUAFEED

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INTRODUCTION

- Aquaculture continue to expand with an annual growth of about 5.8%. This has led to an increase in the demand of protein sources to produce aquafeeds
- Alternative protein ingredients, such as insect meal, may be solution to overcome this problem and replace fish meal in aquafeeds
- Insects are eco-friendly with low carbon footprint and easy to culture (1)
- They have the capability to bio-convert 2kg food waste to 1 kg protein (Fig. 1)
- Among insects, black soldier (*Hermetia illucens*) fly (BSF) has been identified as a suitable candidate for sustainable mass production (2)
- It can assimilate nutrients from a variety of organic wastes, and turn them into a high quality protein (Table 1)

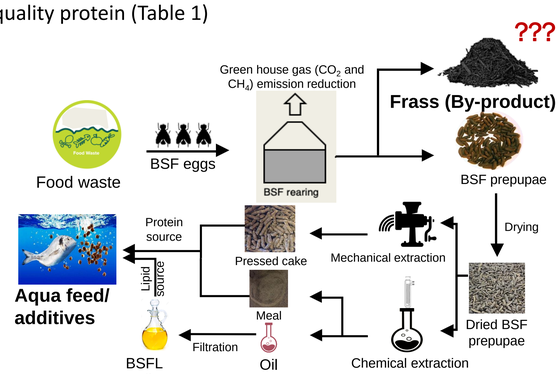

Figure 1: Overview of the bioconversion of organic waste to fish feed

Table 1: Nutrient composition (%) of insects and other major ingredients

	BSF larvae	Yellow mealworm	Fishmeal	Soybean meal
Crude Protein	56.1	52.0	71.0	49
Crude Fat	12.8	33.9	9.2	2.5

GOAL & OBJECTIVES

The overall goal of this project is to use insect meal and Frass (by-product) as a feed ingredient in aquafeed

Specific Objectives :

- To evaluate the nutritional potential of Frass in Nile tilapia
- To use insect meal as a feed additives for Nile tilapia and Rainbow trout

MATERIALS & METHODS

Experiment 1:

Experimental diet for growth study: Six isonitrogenous (32 % crude protein) and isolipidic (9% crude lipid) diets were produced: a **control** diet and five experimental diets that partially replaced protein, lipid and carbohydrate sources by 10%, 20%, 30%, 40% or 50% of frass black soldier fly larvae (FBSFL) (Table 2)

Table 2: Major ingredients of the experimental diets for Nile tilapia

Ingredients	Diets					
	Control	$Frass_{10}$	$Frass_{20}$	$Frass_{30}$	$Frass_{40}$	$Frass_{50}$
Frass	0	10	20	30	40	50
Corn DDGS	30	24.6	19.2	13.7	8.3	2.9
Soybean meal	32.9	31.8	30.7	29.6	28.5	27.4
Wheat flour	23	20.2	17.5	14.7	12	9.3
Canola oil	4.5	3.8	3.0	2.3	1.6	0.8
Fish meal	8	8	8	8	8	8

MATERIALS & METHODS

Experimental setup:

- Feeding trial: re-circulating aquaculture system with 3 replicate per diet
- 20 fish (av. wt.: 2.0 ± 0.12g) per tank
- Fish were fed to satiation level for 9 weeks and water quality maintained

Experiment 2:

A 21-weeks feeding trial was carried out using two diets, a **control** and one other diet with 7% insect protein supplementation (Basal diet +7% insect protein). The set up was as follows:

Rainbow trout

- Feeding trial: Flow-through system
- n = 180, Fish size: 3.0g
- 0-7 weeks: 2 tanks, 145 L
- 8-21 weeks: 2 tanks, 250 L
- Water quality: Temp. 14 ^{0}C spring water

Nile tilapia

- Feeding trial: Recirculating aquaculture system
- n = 180, Fish size: 1.9g
- 0-21 weeks: 2 tanks, 500 L
- Water quality: Temp. 25 - 26 ^{0}C

Table 3: Time, feed size and nutrient contents of the diets

Time (weeks)	Feed size	Protein (%)	Lipid (%)
0 – 2	Crumble	52	18
2 -7	1.5 mm	47	17
7 - 14	2.5 mm	46	17
15 - 21	3.5 mm	45	16

RESULTS

Experiment 1 & 2

- ***Growth performance and feed utilization:*** Up to 50% frass can be incorporated in the diet of Nile tilapia (Fig. 2)
- The tilapia and trout fed black soldier fly larvae meal-based diet had a significantly higher weight gain and lower FCR compared with the control (Fig. 4 & 5)
- ***Liver histology***: The fish fed frass-based diets showed some localized white blood cells, a tendency for vacuolization as well as lipofuscin-like material around the pancreatic islets (Fig. 3)
- It seems possible that the frass may have contained some toxic material, but further research is needed to determine whether these could influence the hepatic health of tilapia

RESULTS

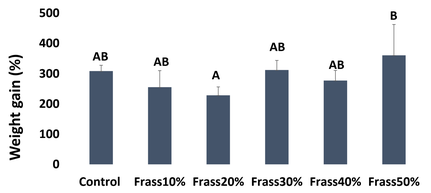

Fig. 2: Weight gain (%) of fish fed Frass-based diet. Values are mean (n = 3) ± standard deviation. Mean values with different letters differ significantly (P<0.05).

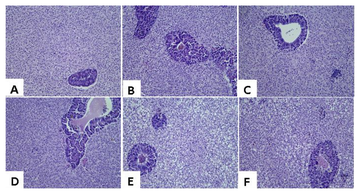

Figure 3: Light micrograph (H&E staining) of the hepatic tissue of Nile tilapia fed Frass. Control (a), FBSFL 10% (b); FBSFL 20% (c); FBSFL 30% (d); FBSFL 40% (e); FBSFL 50% (f).

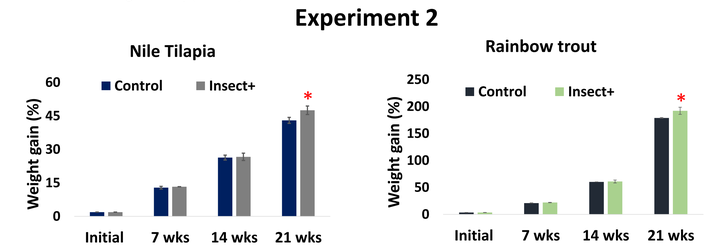

Figure 4: Weight gain (%) of tilapia and trout fed insect meal as an additive. Values are mean ± standard deviation. Mean values with asterisk differ significantly (P<0.05)

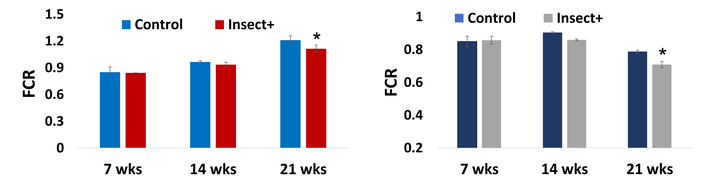

Figure 5: Feed conversion ratio (FCR) of tilapia and trout fed insect meal as an additive. Values are mean ± standard deviation. Mean values with asterisk differ significantly (P<0.05)

CONCLUSION & CURRENT WORK

- Conclusively, highest growth performance was observed at highest (50%) inclusion of frass in the tilapia diet
- Black soldier fly larvae meal as a dietary additive enhances growth performance and feed efficiency in Nile tilapia and Rainbow trout

- Currently we are evaluating the additive effect of insect meal (0%, 4% & 8%) on immune response gene and histology after challenged with pathogen (*Flavobacterium psychrophilum*)
- Evaluation of insect oil as a source of lipid for trout feed

ACKNOWLEDGEMENT & REFERENCES

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