Trial Report

Fishmeal replacement in feed for rainbow trout (*Oncorhynchus mykiss*)

Gefinancierd door

Met projectpartners

Introduction

The use of fishmeal and fish oil for aquaculture purposes is often questioned as it is considered to be non-sustainable. The cultivation of carnivorous species in particular requires an input of fishmeal and fish oil - often expressed as FIFO: Fish In / Fish Out ratio - which, in theory, can be greater than 1. Although enormous progress has been made in this area in recent decades by reducing the fishmeal content (and replacing it by e.g. vegetable protein sources) in feeds on the one hand and improved feed conversion (FCR) on the other, the search for high-performance, alternative protein sources remains very relevant. In this regard, insect meal can be an interesting option, as well as so-called single cell proteins (SCP) that are a by-product of various fermentation processes - whether or not modified.

The main objective of this research was to investigate the potential of a composite core based on SCP as a fishmeal replacer for rainbow trout (*Oncorhynchus mykiss*) - a carnivorous species. Large volumes are grown in Europe and there is an increasing demand for more sustainable feeds. In this respect, the replacement of fishmeal by SCP could offer an answer.

Materials & Methods

Fish

Juvenile rainbow trouts (*Oncorhynchus mykiss*) were obtained from a commercial farm (Vasch Aquaponics, Belgium). The fish were grown and acclimated for 80 days in a common rearing tank, part of a RAS. During this period, the fish were fed a commercial diet.

Before the start of the experiment, a number of size classes was determined depending on the weight distribution. All fish were sorted by size and allocated to the different size classes. Each experimental tank was stocked with 35 fish. In each tank, the same number of fish was used from each size class, resulting in an equal weight distribution. Stocking density at start was 6.31 kg/m³ (average body weight (ABW) = ~25.25 g) , final stocking density was 29.91 kg/m³ (ABW = ~119.64 g).

Experimental setup

18 Fiberglass tanks of 140L each were used for this experiment. Tanks were individually supplied with a continuous and constant flow of fresh water recycled through the shared RAS (the same as for the acclimation period). A photoperiod of 15L/9D was maintained. All fish were individually weighed and measured at the start of the experiment and after 3, 6, 9 and 12 weeks (end of the experiment).

Water quality

Water quality control frequencies and requirements are summarized in table 1.

Table 1: Water quality control frequencies and requirements.

Parameter	Time	Frequency	Location	Setting value
Oxygen (% sat.)	continuous	continuous	fish tank	> 90%
Temperature (°C)	continuous	continuous	fish tank	18 °C
pH	continuous	continuous	sump tank	6.5-8.5
NH4	after feeding	twice a week	drum outlet	<1 mg/L
NO2	after feeding	twice a week	drum outlet	< 1mg/l
NO3	after feeding	twice a week	drum outlet	< 150 mg/l

Experimental treatments

Experimental diets were formulated by Aqua-ERF using BestMix software. The diets were formulated to be isoproteic, isolipidic and isoenergetic and contained 42% of crude protein, 20-22% of crude lipid and an energy content of ±5127 kcal per kg of feed. The positive control contained 15% of fishmeal. In the other 5 diets, fishmeal was replaced by 10% SCP, 10% insect meal and 8% yeast (see table 2).

Table 2: Formulation and analysis of the experimental diets.

Formulation							
Treatment		Fish-meal	SCP	Insect meal	SCP + olive extract	SCP + shrimp solubles	Yeast
Soy bean meal	%	19,98	19,96	20,14	20,01	20,05	17,80
Linseed	%	1,60	1,80	-	1,70	1,40	-
Single cell protein	%	-	10,00	-	10,00	10,00	-
Wheat	%	15,70	12,70	14,70	12,80	12,60	13,10
Soyoil	%	8,58	7,85	7,44	7,83	7,90	8,89
DHA oil	%	2,80	3,70	-	3,70	-	3,70
MCP	%	1,65	2,15	2,20	2,15	2,10	2,70
Linseedoil	%	4,40	4,85	5,41	4,85	4,93	6,44
Poultry Byproduct 65% CP	%	2,22	2,20	2,20	2,20	2,20	2,20
Shrimp solubles	%	-	-	-	-	1,00	-
Hemoglobin powder	%	-	0,47	0,07	0,47	0,26	4,61
Feather meal	%	15,00	18,63	19,76	18,62	18,30	22,08
Guar korma	%	10,00	10,00	10,00	10,00	10,00	4,95
Fishmeal LT	%	15,00	-	-	-	-	-
Black soldier fly	%	-	-	10,00	-	-	-
Lacto Yeast	%	-	-	-	-	-	8,00
Natur Olive MA75	%	-	-	-	0,03	-	-
Fish oil	%	-	-	3,55	-	3,65	-
Vit/min premx	%	3,07	5,70	4,54	5,65	5,61	5,53

Analysis							
Dry matter	%	88,04	87,30	86,14	87,26	87,18	86,02
Crude protein	%	41,99	42,00	42,04	42,00	42,02	42,04
Crude fat	%	20,27	20,02	20,27	19,99	19,96	22,00
Crude ash	%	7,24	6,35	6,38	6,30	6,36	6,57
Crude fibre	%	2,50	2,50	2,50	2,50	2,50	3,80
N-free extract	%	16,04	16,43	14,95	16,47	16,35	11,61
Gross energy	kcal/kg	5119,61	5121,78	5137,86	5119,97	5141,55	5120,51
Lysine	%	2,50	2,50	2,50	2,50	2,50	2,50
Methionine	%	0,80	0,80	0,81	0,80	0,80	0,80
Phosphorus	%	0,93	0,80	0,83	0,80	0,80	0,80

Feeding

The 6 experimental treatments were tested in triplicate (3 replicates per treatment, 18 tanks randomized design). The fish were fed 3 times a day. Feed rates were adapted to fish ABW in accordance with commercial practices. After every intermediate sampling (week 3, 6 and 9) the actual SGR of the previous period was used for feed ration adjustment. Between preparations of daily feed rations, bulk experimental diets were stored in plastic buckets (cool and dry).

Performance and feed efficiency

After tank allocation, fish were acclimated for 1 week. During this period all fish were individually tagged with PIT tags. All fish were individually weighed and measured at week 3, 6, 9 and 12. Before each sampling, the fish fasted for 24 hours. In case of mortality, dead fish were removed from the tanks and ID and BW were recorded.

Following parameters were determined:

- Survival rate (%)
- Total biomass (g)
- Individual body weight (g)
- Individual specific growth rate (%.day^{-1})
- Individual body length (mm)
- Feed intake (g), relative feed intake (g/day)
- Feed conversion (FCR)

End of Trial

All fish were euthanized after the tissue samples were taken, and stored in a freezer until processing by Rendac.

Statistical analysis

For the statistical analysis of body length (BL) and body weight (BW), a logarithmic transformation was carried out in order to solve a problem of heteroscedasticity, i.e. the responce becomes “ln(BL)” instead of “BL”, or “ln(BW)” instead of “BW”. A linear mixed model with random intercept for ID and tank was then estimated. Because the tank effect was estimated to be very small in comparison with the residual effect, we concluded that the tank effect is negligible and this was therefore removed from the model. In the modified model there is a significant interaction between time and treatment (p-value <0.0001). This means that the time evolution differs between treatments.

For SGR, a linear mixed model with random intercept for tank was estimated. Because the tank effect was rather small compared to the residual effect, we can conclude that the tank effect is negligible and was therefore taken out of the model. As a result, an ordinary linear model was estimated with the treatment given as the only explanatory variable, which has a significant effect (p-value <0.0001).

Subsequently pairwise tests with Tukey correction were performed to find out which treatments showed significant differences.

Results

Significant differences were found for body weight, body length and specific growth rate (SGR) at week 12 ($p < 0.0001$) (see figures 1, 2 and 3). Replacing fishmeal with insect meal did not affect growth performance. At the end

of the experiment, we observed no differences in body weight, body length and specific growth rate between rainbow trouts that were fed the diet with insect meal and those that were fed the control diet (see figures 1, 2 and 3). All other experimental diets led to significantly lower body weights, body lengths and specific growth rates starting after week 6.

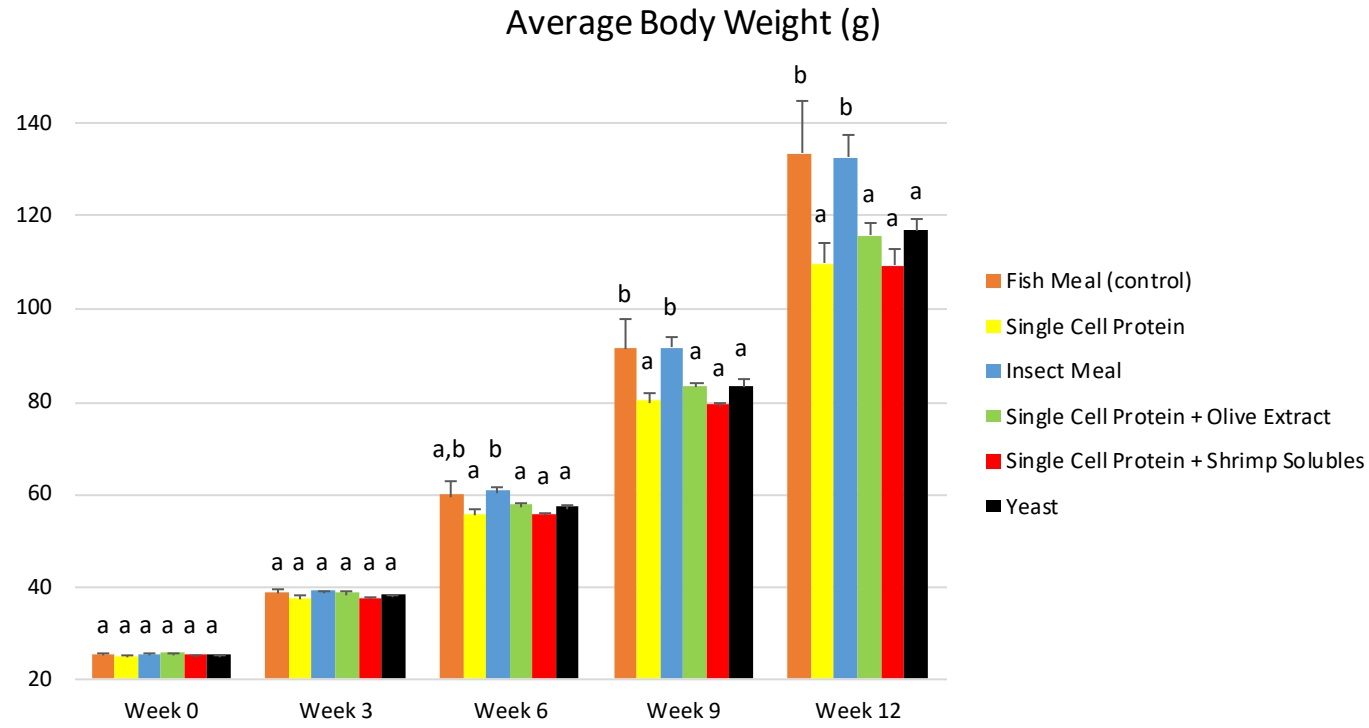

Figure 1: Average body weight. Different superscripts indicate statistical significance.

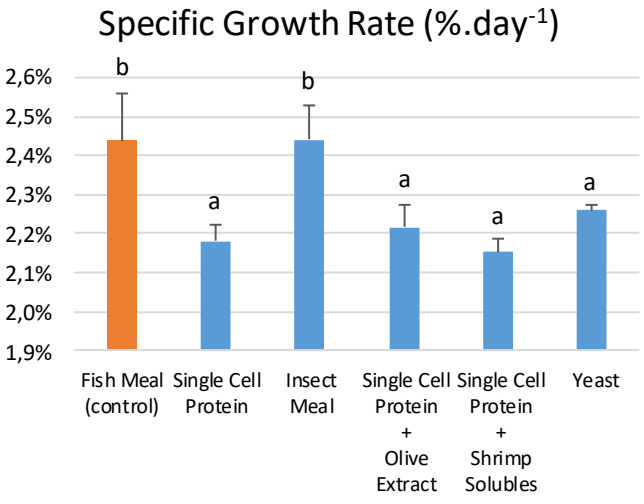

Figure 2: SGR for the 12-week period.

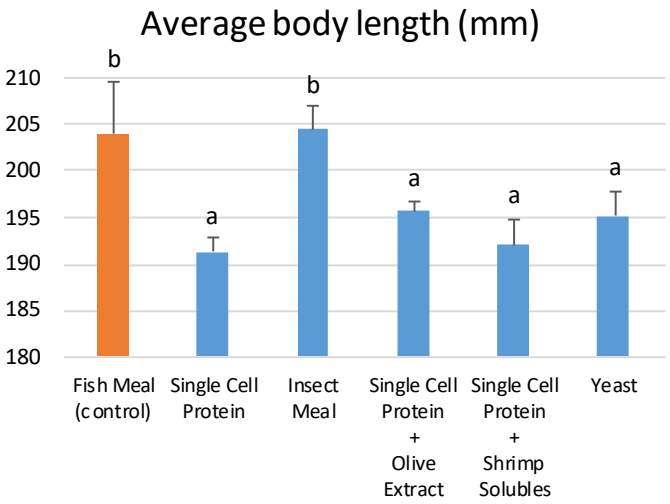

Figure 3: Average body length at the end of the trial.

Conclusion

The results of this experiment indicate that fishmeal can be replaced by insect meal without affecting growth performance in rainbow trout. Diets containing SCP or yeast as an alternative protein source led to a significantly lower final body weight, body length and specific growth rate compared to the diets containing fishmeal and insect meal.