AQUACULTURE WITH PLYMOUTH UNIVERSITY

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Growth Performance Evaluation of Rainbow Trout (*Oncorhynchus mykiss)* Fed Practical Diets Containing a Solid-State Fermentation Product.

Peter H. Bowyer[1], Simon Davies[1], Daniel Merrifield[1], Ana Rodiles[1] and John Sweetman[2]

[1] Plymouth University, Aquatic Animal Nutrition and Health Research Group, Plymouth, United Kingdom

Technology Strategy Board Driving Innovation *

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Digestive Aids

Digestive aids in the form of exogenous enzymes are long established tools in feed technology for terrestrial monogastric livestock production, particularly poultry. However they remain less explored in aquaculture, despite potential to augment nutrient bioavailability, combat anti-nutritional factors (ANFs) and reduce waste. Temperature is likely to be the main obstacle to successful supplementation of such dietary aids in aquafeeds.

Solid-State Fermentation & Synergen™

Solid-state fermentation (SSF) is an ancient process which consists of a solid culture substrate seeded with microorganisms which breakdown biochemically complex molecules into bioavailable single molecules. Synergen™ (Alltech Biotechnologies, KY) utilises a selected strain of (non-GMO) *Aspergillus niger*, who's residual enzymatic activity is intended to work in synergy with the animal's digestive system in breaking down layers of the feed that were previously inaccessible through digestion.

Fig. 1.Filamentous fungi, *Aspergillus niger.*

Objective

Determine whether supplementation of a solid-state fermentation product, Synergen™, could promote fish performance in rainbow trout (*Oncorhynchus mykiss*).

Materials & Methods

Rainbow trout were subjected to a 10 week feeding trial with a practical diet containing 0% (LC), 0.1% (S0.1) and 0.5% (S0.5) inclusion of Synergen™, as well as a 'gold standard' high fishmeal diet (FMC) (Table 1), in quadruplicate. The trial was run at 12.5°C.

Dietary Formulation & Composition

Ingredient (g kg^{-1})	Diets FMC	LC	S0.1	S0.5
Yellow Lupin	_	300.00	300.00	300.00
Herring Meal (LT94)	638.622	250.00	250.00	250.00
Soybean (Hamlet HP100)	_	180.71	180.71	180.71
Fish Oil	119.97	137.15	137.15	137.15
Corn Starch	230.40	71.14	70.14	66.14
Soya (Biomar SPC60)	_	50.00	50.00	50.00
Carboxyl-methyl-cellulose	5.00	5.00	5.00	5.00
Vitamin/Mineral Premix	5.00	5.00	5.00	5.00
Ascorbyl-Phosphate	1.00	1.00	1.00	1.00
Synergen™	_	_	1.00	5.00

Table 1. (left) Dietary formulations
Table 2. (bellow) Proximate analysis of diets

Proximate Composition (%)	Diets FMC	LC	S0.1	S0.5
Crude Protein	46.02	44.17	44.83	45.67
Crude Lipid	19.63	20.64	20.74	20.69
Ash	8.01	6.01	5.75	5.64
Moisture	8.59	6.98	7.02	7.46
Energy (MJ/kg)	21.56	22.35	22.14	22.41

Treatment Abbreviations: 'FMC' (fishmeal control), 'LC' (lupin control), 'S0.1' (Synergen™ 0.1%), 'S0.5' (Synergen™ 0.5%)

Improved Fish Performance

- **Specific growth rate** (SGR) was significantly different between diets ($p \leq 0.01$). The SGR of FMC was significantly higher than LC, S0.1 and S0.5. The SGR of S0.5 was significantly improved over LC and S0.1. (Fig. 2)
- **Feed conversion ratio** (FCR) was significantly different between diets ($p \leq 0.01$). FMC and S0.5 displayed lower FCRs than LC and S0.1 fed fish. No difference in FCR was observed between FMC and S0.5. (Fig. 3)
- **Average fish weight gain** (WG) was significantly different between diets ($p \leq 0.01$). WG was greater in FMC than all other diets. Greater WG was observed in S0.5 compared to S0.1. (Table 3)
- **Average final fish weight** (FW) was significantly different between diets ($p \leq 0.01$). Greater FW was apparent in FMC compared to LC, S0.1 and S0.5. The FW of S0.5 was significantly higher than LC and S0.1. (Table 3)

Performance parameters	Diets[1] FMC	LC	S0.1	S0.5
Initial fish weight (g)	43.38 ± 0.17	44.04 ± 0.44	43.26 ± 0.18	43.65 ± 0.34
Final fish weight (g)	159.56 ± 4.76 ^{a}	140.42 ± 5.71 ^{b}	135.44 ± 3.56 ^{b}	146.54 ± 2.33 ^{c}
Fish weight gain (g)	116.18 ± 4.66 ^{a}	96.38 ± 6.00 ^{bc}	91.79 ± 3.38 ^{c}	103.28 ± 2.22 ^{b}
K-factor	1.85	1.79	1.75	1.75

Table 3. Fish performance results. SGR (specific growth rate), FCR (feed conversion ratio), K-factor (condition factor)

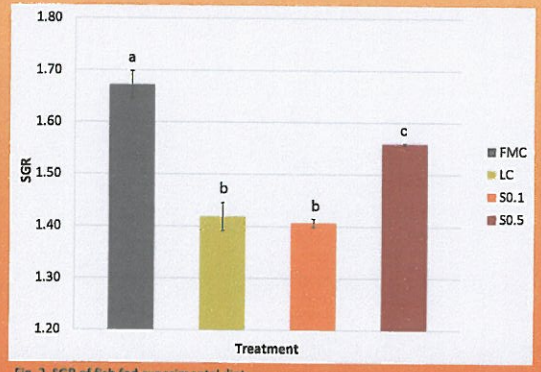

Fig. 2. SGR of fish fed experimental diets.

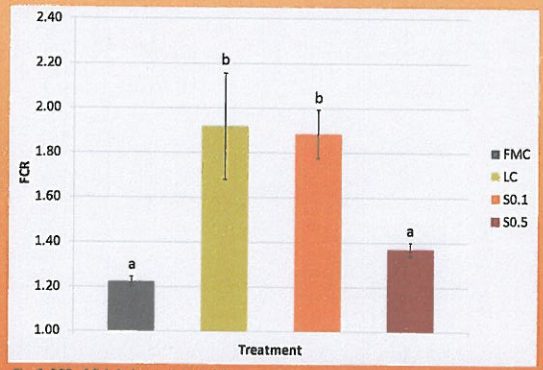

Fig. 3. FCR of fish fed experimental diets.

Discussion

Previous studies have demonstrated that exogenous enzyme activity can be an effective dietary aid in finfish aquaculture however these have generally focused on species cultured in warmer water.

The results of this trial consistently suggest that 0.5% Synergen™ inclusion in a practical trout diet with high plant ingredient content can improve fish performance at a mid-range rainbow trout culture temperature. It can be speculated that the experimental ingredient increased bioavailability of nutrients and/or reduced ANFs.

Ingredients derived from SSF technology look promising for improving performance in temperate carnivorous finfish aquaculture, facilitating effective application of plant ingredients.

Conclusion

Synergen™, at 0.5% inclusion, improved fish performance. Ingredients derived from SSF technology appear to have potential for improving aquafeeds and production.

On-going Work

- Digestibility analysis
- Analysis of gut and liver health
- Haematology
- Microbiology
- Endo & exogenous enzyme activity

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** Lupins as a sustainable protein source for U.K. Agriculture and Aquaculture