Innovative sustainable recirculating aquaculture system aquafeeds for Mirror carp (*Cyprinus carpio carpio)* and Rainbow trout (*Oncorhynchus mykiss)* utilising UK-sourced, non-soy, low-emission ingredients, exclusively

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Introduction

- A wide selection of UK-produced ingredients were identified and sourced (see Tables 1 and 2).
- Three isonitrogenous and isolipidic experimental aquafeeds were formulated to meet the known nutritional requirements of rainbow trout and mirror carp.
- The cost per tonne of each ingredient and its rate of inclusion was considered in order to produce an "expensive", "moderate" and "economically-priced" experimental feed for each species.
- The experimental aquafeeds were trailed *in vivo* against a commercially available control.

Rainbow trout: methods and materials

- Duration: 8 weeks (56 days)
- Species: Rainbow trout (Bw_i= 67.5 ± 0.7g; 20/tank)
- System: Circular recirculation tanks (300L); 15°C ± 0.5
- Experimental diets: Four, assigned to triplicate tanks
- Sampling points: 4 and 8 weeks

Table 1. Ingredient inclusion (%) for the experimental rainbow trout aquafeeds. Novel proteins are shaded purple

Ingredient (% inclusion)	Expensive	Moderate	Economical
SCP	14.4	11.1	7.2
Wheat flour	13.7	13.6	14.2
Wheat gluten	11.0	6.5	7.0
Insect meal	10.0	5.0	0.0
Pea protein concentrate	10.0	0.0	0.0
Rapeseed oil	7.1	8.5	9.8
White Lupin	7.0	8.0	3.4
Fish oil	6.0	4.0	3.3
Hemp meal	5.0	2.0	0.0
Fishmeal	5.0	10.0	17.5
Blue Lupin	3.0	8.0	15.0
Crab Meal	0.0	9.0	8.5
Mussel Meal	0.0	7.5	8.0

Mirror Carp: methods and materials

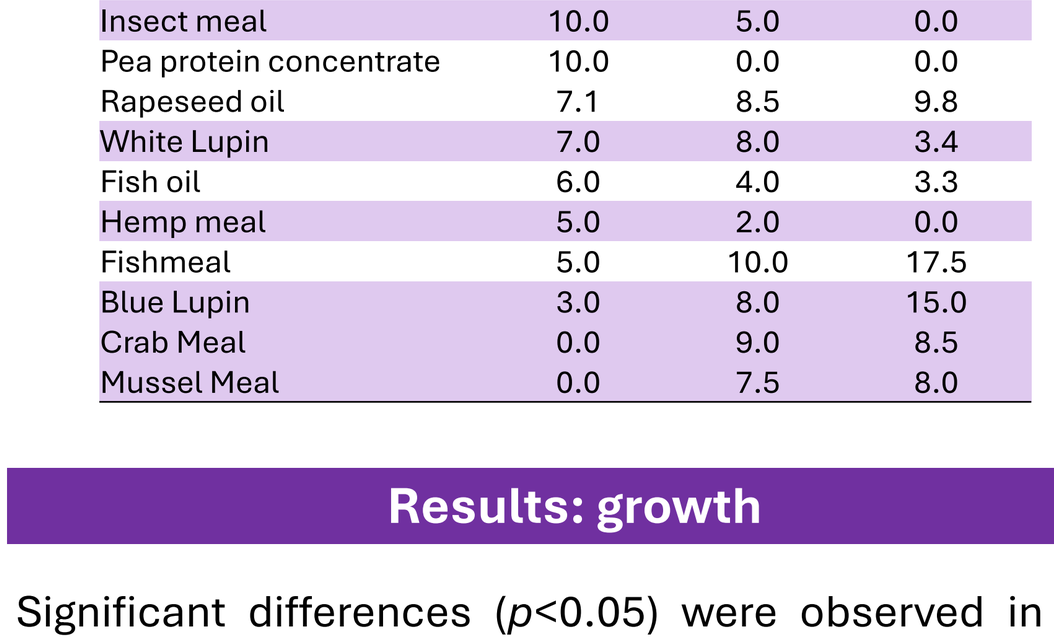
- Duration: 10 weeks (70 days)
- Species: Mirror carp (Bw_i= 36.9 ± 0.05g; 20/tank)
- System: Square recirculation tanks (100L); 24°C ± 0.5
- Experimental diets: Four, assigned to sextuple tanks
- Sampling points: 13 weeks

Table 2. Ingredient inclusion rates for the experimental mirror carp aquafeeds. Novel proteins are shaded purple

Ingredient (% inclusion)	Expensive	Moderate	Economical
Potato protein concentrate	14.50	16.50	22.90
Potato Starch	12.00	11.00	2.00
Rapeseed meal	10.00	8.00	5.00
Maize gluten	10.00	0.00	5.00
Insect meal	10.00	5.00	0.50
Rapeseed oil	7.40	5.10	4.00
Faba beans	7.00	0.00	5.00
Peas	7.00	0.00	5.00
Wheat flour	5.90	10.44	21.31
Algae	3.50	0.00	0.00
Hemp meal	3.00	0.00	0.50
Wheat gluten	2.00	1.60	0.00
Pea protein concentrate	0.00	10.00	0.00
Blue Lupin	0.00	8.00	5.00
White Lupin	0.00	8.00	5.00
SCP	0.00	6.50	0.50
Fish oil	0.00	2.50	5.00
Algae oil	0.86	0.42	0.00
Fishmeal	0.00	0.00	3.50
Brewer's Yeast	0.00	0.00	2.50

Results: growth

Significant differences (p<0.05) were observed in the SGR and FCR performances of both rainbow trout (Fig. 1A) and mirror carp (Fig. 1B) administered the different experimental aquafeeds in comparison to the commercial control.



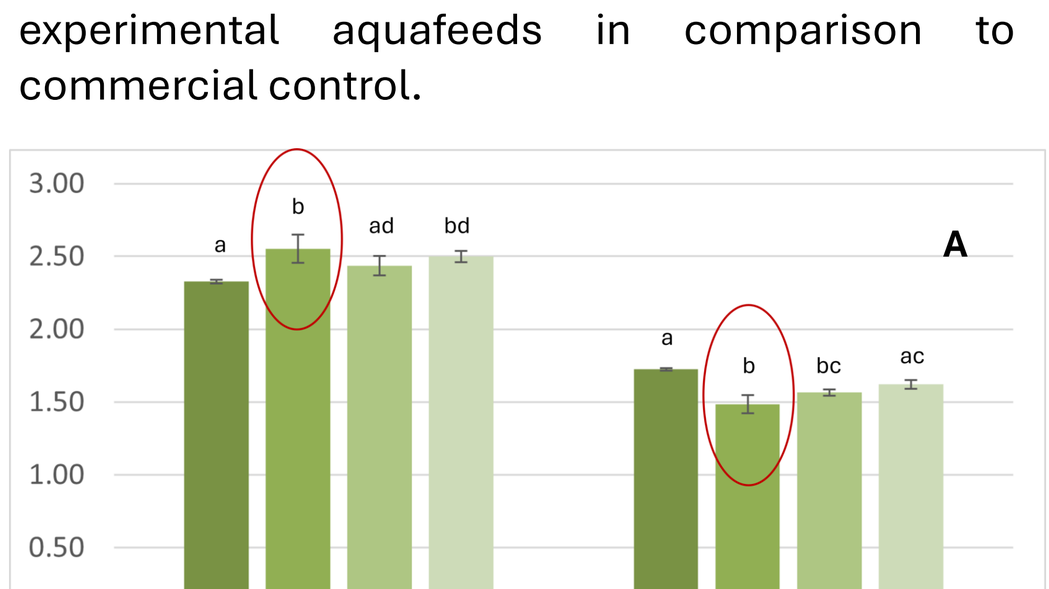
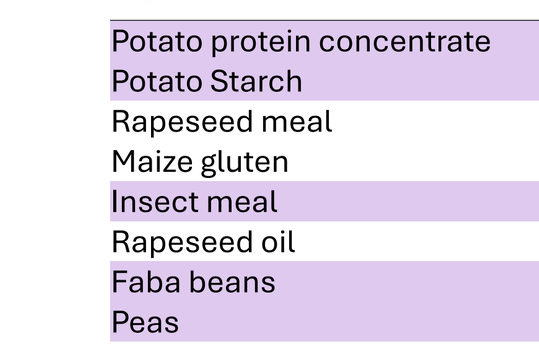
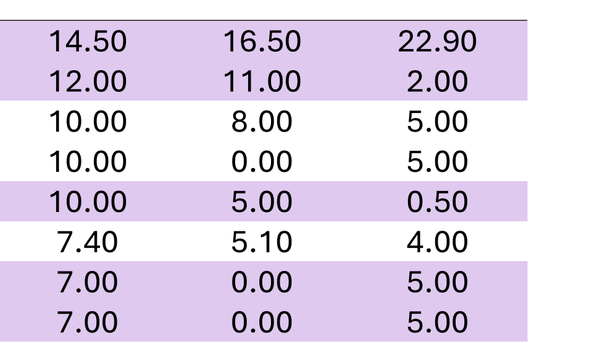
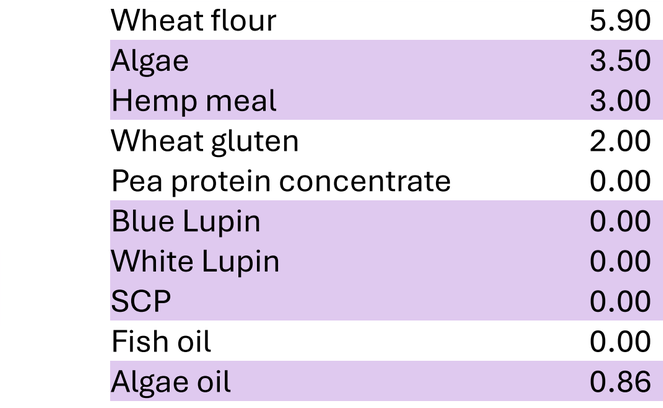
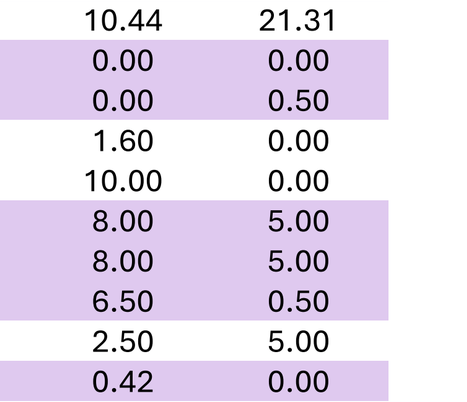


Figure 1. Feed Conversion Ratio (FCR) and Specific Growth Rate (SGR) of (A) rainbow trout and (B) mirror carp fed the experimental aquafeeds for 56 and 91 days, respectively









Conclusions

This research has established that experimental aquafeeds utilising exclusively non-soy, low-emission, UK-sourced ingredients, demonstrate comparable fish growth, and improved SGR and FCR in comparison to commercial controls.

At present, the majority of commercially available aquafeeds have a very large associated carbon foot-print due to the sourcing of ingredients from across the globe. By utilising locally-sourced ingredients, the large emissions associated with aquafeeds can be significantly reduced, promoting the sustainability of the aquaculture industry, while continuing to support optimal productivity, growth and health of the fish.

Further analyses are yet to be completed.