Use of Black soldier fly (*Hermetia illucens)* and Spirulina (*Arthrospira platensi* in diets for rainbow trout (*Oncorhyncus mykiss)*

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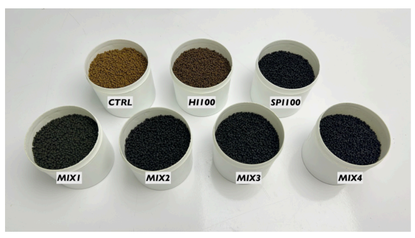
Using wild-captured fish in aquafeeds creates sustainability challenges by increasing pressure on overexploited marine stocks. Developing feeds containing more sustainable ingredients, produced with circular models, is critical to improve the sector's sustainability and resilience. Insects and microalgae offer promising pathways to reduce environmental impact when produced using waste streams.

Aim

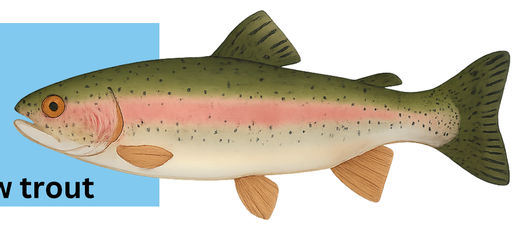
To investigate the use of black soldier fly (*Hermetia illucens*, BSF) fed on agriculture side-streams and Spirulina (*Arthrospira platensis*, SPI) as a replacement of fish meal in rainbow trout (*Oncorynchus mykiss*) diet.

MATERIALS AND METHODS

Insect and microalgae meals were used to replace fishmeal (FM) in the formulation of isoproteic, isoenergetic, and isolipidic experimental diets. In two diets FM was completely replaced with BSF (HI100) or Spirulina (SPI100). Four mixed diets were created with varying proportions (BSF/Spirulina, %) of the two alternative protein sources (MIX1 = 80/20; MIX2 = 60/40; MIX3 = 40/60; MIX4 = 20/80). A control diet (CTRL) was formulated with 15% FM and designed to approximate a typical commercial feed.



RAS
Stocking density: 5.1 kg m³
BW: 19g FBW: 63g



Rainbow trout

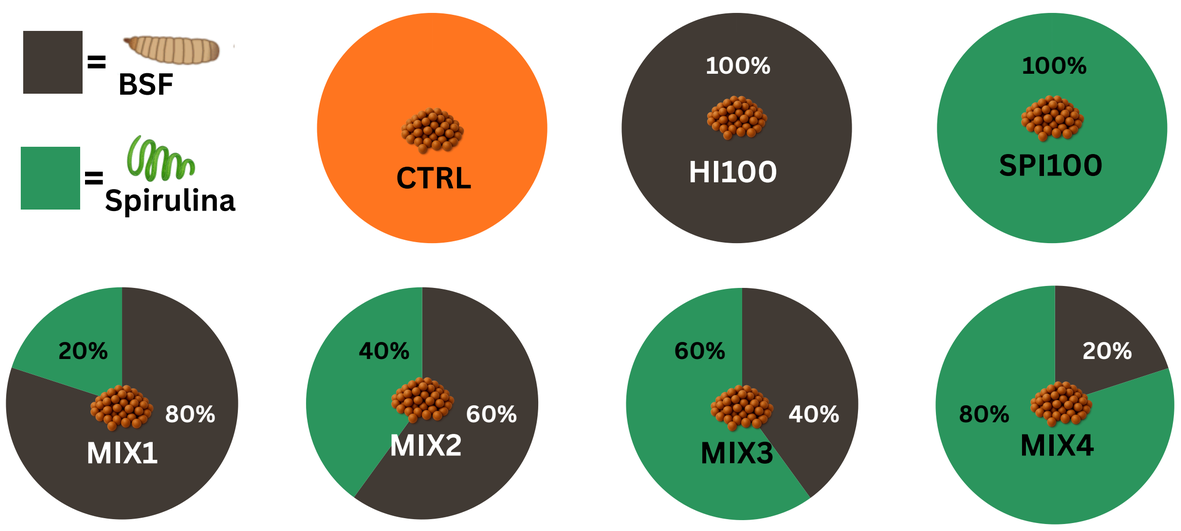
35 days

FM Replacement

= BSF

= Spirulina

Experimental Diets



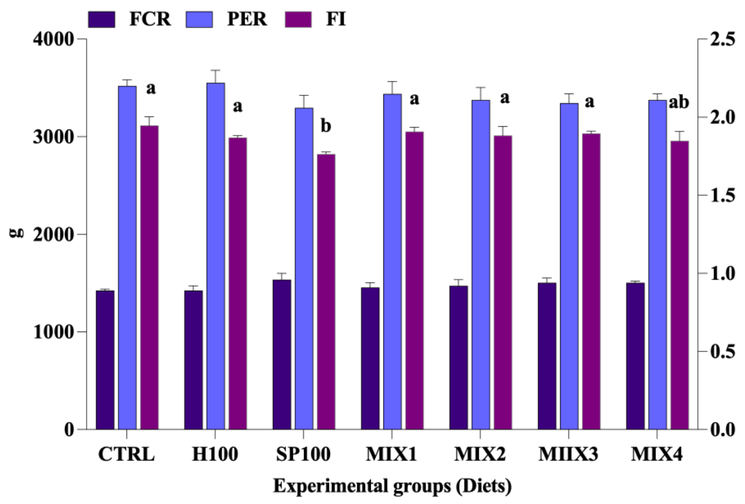
Feed intake of each tank was recorded, along with the initial (IW, g) and final biomass (FW, g) in each tank, to calculate growth metrics: total weight gain (WG, g), feed conversion ratio (FCR), specific growth rate (SGR, %), and protein efficiency ratio (PER). Visceral weight, and liver weight were used to calculate condition factor (K, g cm^{-3}), viscerosomatic index (VSI, %), and hepatosomatic index (HSI, %).

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RESULTS

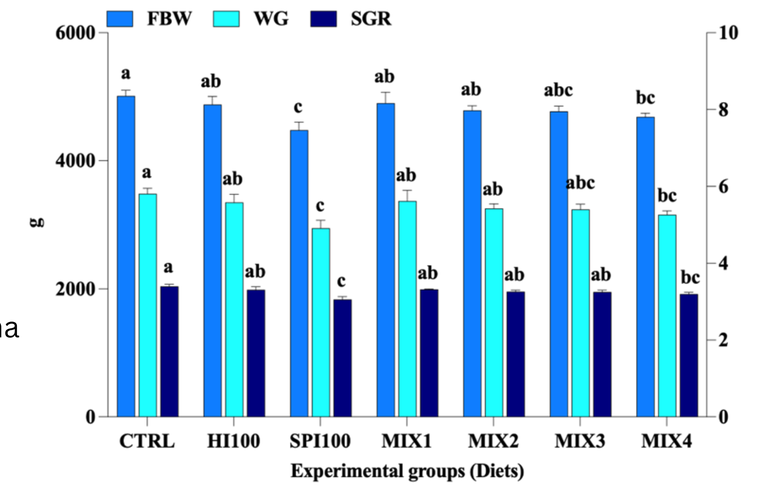
Feed utilisation

- All diets were readily accepted through the all duration of the trial and no differences in FCR and PER were evident.
- Feed intake (FI) decreased with higher Spirulina levels. SPI100 had the lowest intake of all diets, except for MIX4.



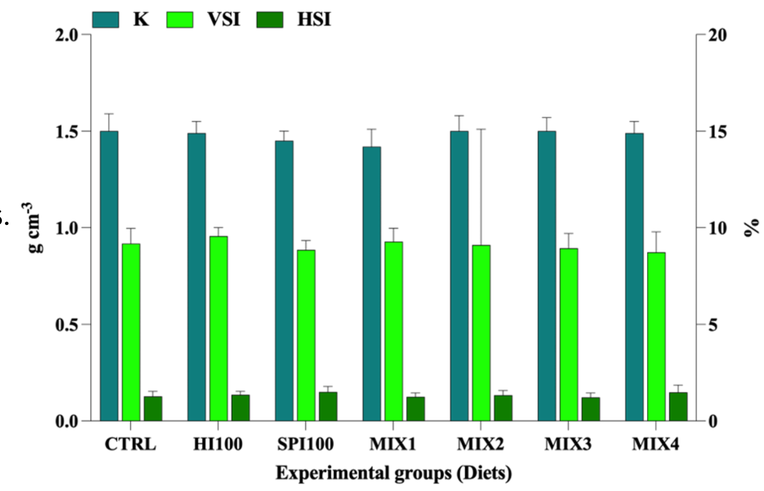
Growth performance

- Diets with BFS or mixed BSF–Spirulina up to 60% Spirulina achieved similar final body weight (FBW), weight gain (WG), and specific growth rate (SGR).
- Higher inclusion of Spirulina (≥80%) resulted in significantly lower fish growth and feed intake.



Health indices

- Condition factor (K), viscerosomatic index (VSI), and hepatosomatic index (HSI) similar across all diets.
- No affected physiological health, such as internal hemorrhages, lesions, or visceral adhesions.



CONCLUSIONS

Fishmeal replacement:
Complete replacement of FM with BSF and Spirulina, either individually or in combination, can sustain normal growth and feed utilization in rainbow trout at most tested ratios.

Performance threshold for Spirulina inclusion:
Diets dominated by Spirulina (≥80%) reduced feed intake and growth, suggesting an
optimal inclusion limit below this threshold.

Pathway toward sustainable aquaculture:
Incorporating insect and microalgal proteins offers the possibility to decrease reliance on wild fish stocks and promote circular and sustainable food systems.

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