Environmental Sustainability of Cyprinid Rheophilic Fish Conservative Aquaculture

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The environmental sustainability of aquaculture is the basis of most current research on aquatic nutrition, and its primary goal is to reduce the use of fish meal and oil. However, in most scientific works, this term remains in the sphere of discussion without its measurable assessment based on empirical results (Rawski et al. 2021; Stejskal et al. 2020). Therefore, in the presented work, an attempt was made to fill this gap by calculating parameters, taking into account the composition of the diet and the degree of its use.

The studies were conducted with juveniles of three species of cyprinid rheophilic fish: chub, vimba and barbel, with an average initial body weight of 9.6 ± 0.1 g, 10.5 ± 0.4 g and 7.9 ± 0.3 g, respectively. Each species was maintained in an experimental recirculating aquaculture system in 21 growth tanks with a net capacity of 400 dm3 each. Fish meal and fish oil substitutes in feed were meals and fats obtained from the biomass of larvae of three insect species: *Hermetia illucens* (HI), *Tenebrio molitor* (TM) and *Zophobas morio* (ZM). The environmental sustainability indicators of fish farming: relative consumption of fish meal (FMU). relative consumption of fish oil (FOU), Fish in - Fish out Ratio (FIFO) were calculated as follows:

$$FOU\left(\frac{g}{1\text{ kg of fish gain}}\right) = (\text{fish oil share in the diet (g/kg)} \times (\frac{\text{feed intake (g)}}{\text{body weight gain (g)}}))$$

$$FMU\left(\frac{g}{1\text{ kg of fish gain}}\right) = \left(\frac{\text{fish meal share in the diet (g/kg)}}{\text{fish intake (g)/ weight gain (g)}}\right) \times 100$$

$$FIFO = \left(\frac{\text{level of fish meal in the diet (g/kg)} + \text{level of fish oil in the diet (g/kg)}}{\text{yield of fish meal from wild fish (g/kg)} + \text{yield of fish oil from wild fish (g/kg)}}\right) \times \left(\frac{\text{feed intake (g)}}{\text{body weight gain (g)}}\right)$$

Sustainability of cyprynid rheophylic fish production with the use of diets containing insect larvae biomass meals results obtained in the experiment:

Chub

Parameter	Group							SEM	p-value
	CON	H75	H150	T75	T150	Z75	Z150		
FMU	528[a]	385[b]	257[c]	342[b]	204[c]	376[b]	347[b]	24.670	<0.001
FOU	61.6[a]	56.4[a]	53.0[a]	38.0[b]	20.4[c]	26.7[c]	0.0[d]	2.6752	<0.001
FIFO	2.14[a]	1.60[b]	1.13[c]	1.38[bc]	0.82[d]	1.46[bc]	1.26[c]	0.0625	<0.001

Vimba

Parameter	Group							SEM	p-value
	CON	H75	H150	T75	T150	Z75	Z150		
FMU	697[a]	426[b]	263[c]	420[b]	282[c]	441[b]	439[b]	35.756	<0.001
FOU	81.3[a]	62.4[b]	54.4[c]	46.6[d]	28.2[e]	31.4[e]	0.00[f]	3.0124	<0.001
FIFO	2.83[a]	1.78[b]	1.15[c]	1.70[b]	1.13[c]	1.18[c]	1.60[b]	0.0820	<0.001

Barbel

Parameter	Group							SEM	p-value
	CON	H75	H150	T75	T150	Z75	Z150		
FMU	528[a]	385[b]	257[c]	342[b]	204[c]	376[b]	347[b]	24.670	<0.001
FOU	61.6[a]	56.4[a]	53.0[a]	38.0[b]	20.4[c]	26.7[c]	0.0[d]	2.6752	<0.001
FIFO	2.14[a]	1.60[b]	1.13[c]	1.38[bc]	0.82[d]	1.46[bc]	1.26[c]	0.0625	<0.001

CON – diet with 300 g of fish meal per kilogram and no insect meal; H75– diet with 225 g of fish meal and 75 g of *Hermetia illucens* meal per kilogram; H150 - diet with 150 g of fish meal and 150 g of *Hermetia illucens* meal per kilogram; T75 – diet with 225 g of fish meal and 75 g of *Tenebrio molitor* meal per kilogram; T150 – diet with 150 g of fish meal and 150 g of *Tenebrio molitor* meal per kilogram; Z75 – diet with 225 g of fish meal and 75 g of *Zophobas morio* meal per kilogram; Z150 – diet with 150 g of fish meal and 150 g of *Zophobas morio* meal per kilogram.

The environmental sustainability of aquaculture production is the foundation of most current research on fish nutrition. The primary objectives are to reduce the use of fishmeal and fish oil in aquafeeds and to explore applicable and scalable alternative feed materials. The obtained results open new perspectives on using insect larvae biomass meals in conservative aquaculture of cyprinid rheophilic fish. It is necessary to conduct case-by-case analyses when introducing feed raw materials and underscore the significant value of such evaluations when they account for parameters assessing diets in terms of the utilisation of fishmeal and fish oil content and the overall consumption of marine-derived feed materials.

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