INCLUSION OF ENRICHED AND NON-ENRICHED INSECTMEAL IN FEED FOR RAINBOW TROUT (*Oncorhynchus mykiss*)

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1.INTRODUCTION AND AIM

Insects show a great potential as an alternative protein source in feeds for aquaculture, but it is unclear how their inclusion in feeds could compromise the growth efficiency and quality of the fish fillet. Previous studies have shown that low inclusion level of insects (10%) may affect the ω-3 fatty acid (FA; Melenchón *et al*., 2019) and amino acid profile in fish fillet (Iaconisi *et al*., 2019). Moreover, insects are able to modify their body composition according to growth substrate used. In this vein, Barroso *et al*. (2019) highlighted that feeding fish wastes to *Hermetia illucens* can improve its ω-3 FA profile, producing an "enriched *Hermetia*". The aim of this study was to evaluate the effect of the inclusion of different insectmeals (enriched or not) in feed for rainbow trout on growth performance and proximate composition of the fillet.

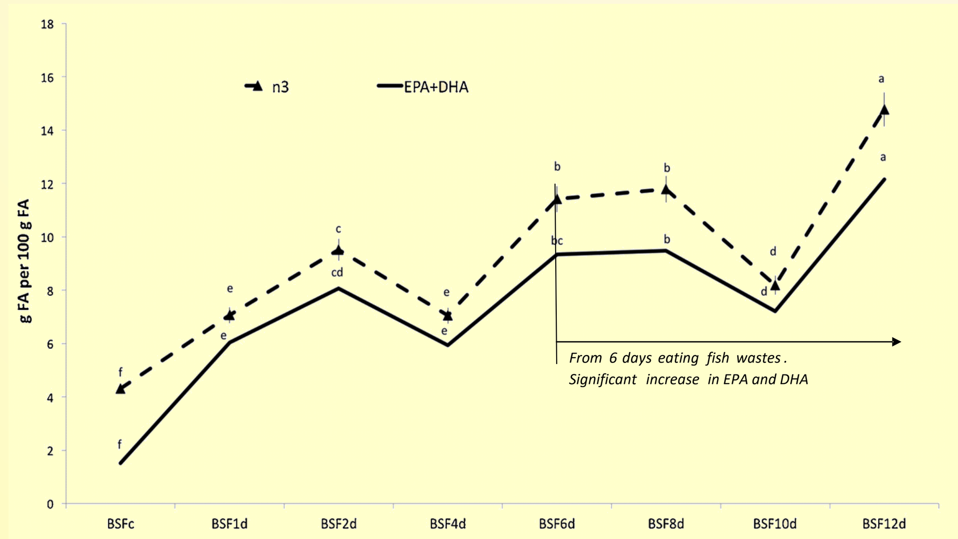

Figure 1. Barroso *et al*., 2019. ω-3 FA levels of *Hermetia illucens* (Black soldier fly, BSF) at 0, 1, 2, 4, 6, 8, 10 and 12 days of eating fish wastes (c, 1d, 2d, 4d, 6d, 8d, 10d, 12d).

2.MATERIAL AND METHODS

5 isoproteic (~43%) and isolipidic (~18.4%) diets. Different fishmeal replacement (repl.) levels	T50	H30	H50	H*50	C
	50% repl. *T. molitor* (18% inclusion)	30% repl. *H. illucens* (11% inclusion)	50% repl. *H. illucens* (18% inclusion)	50% repl. *Enriched Hermetia* (18% inclusion)	Control

Sample	Analysis
General (fish + faeces)	Growth (+ protein digestibility)
Insectmeals	Proximate composition, FAs, Amino acids
Fillet	Proximate composition

In a previous study (Melenchón *et al*., 2019), the lower levels of EPA and DHA in insectmeals showed a decrease in these FAs in fillet, with replacement levels up to 30% (11% inclusion level in feed). In this line, the replacement of 50% fishmeal by enriched *Hermetia* could show an improvement in those parameters. These analysis are running, it is expected to confirm this hypothesis.

3.RESULTS

Figure 2. Proximate composition of insectmeals

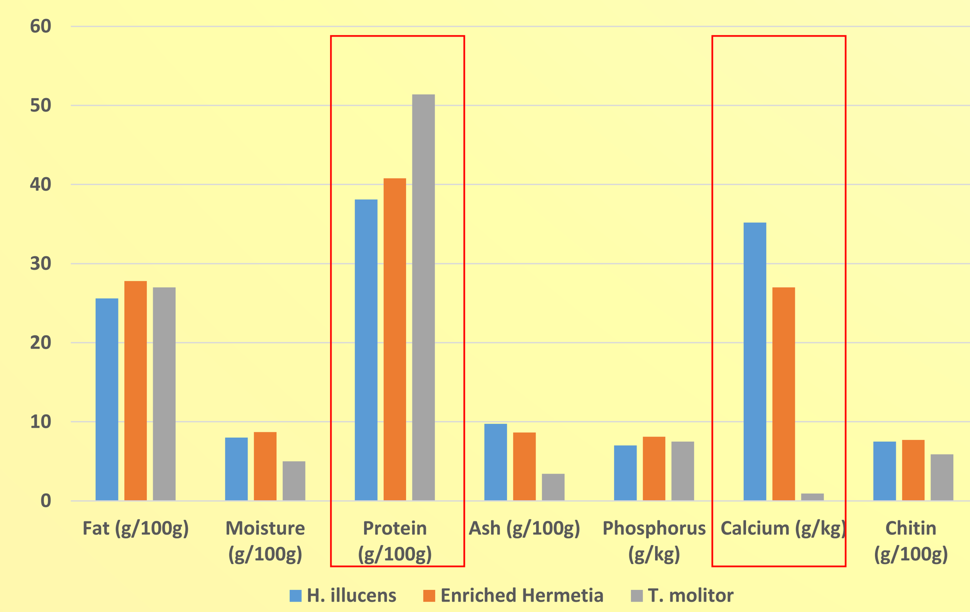

Figure 3. Amino acids composition of insectmeals

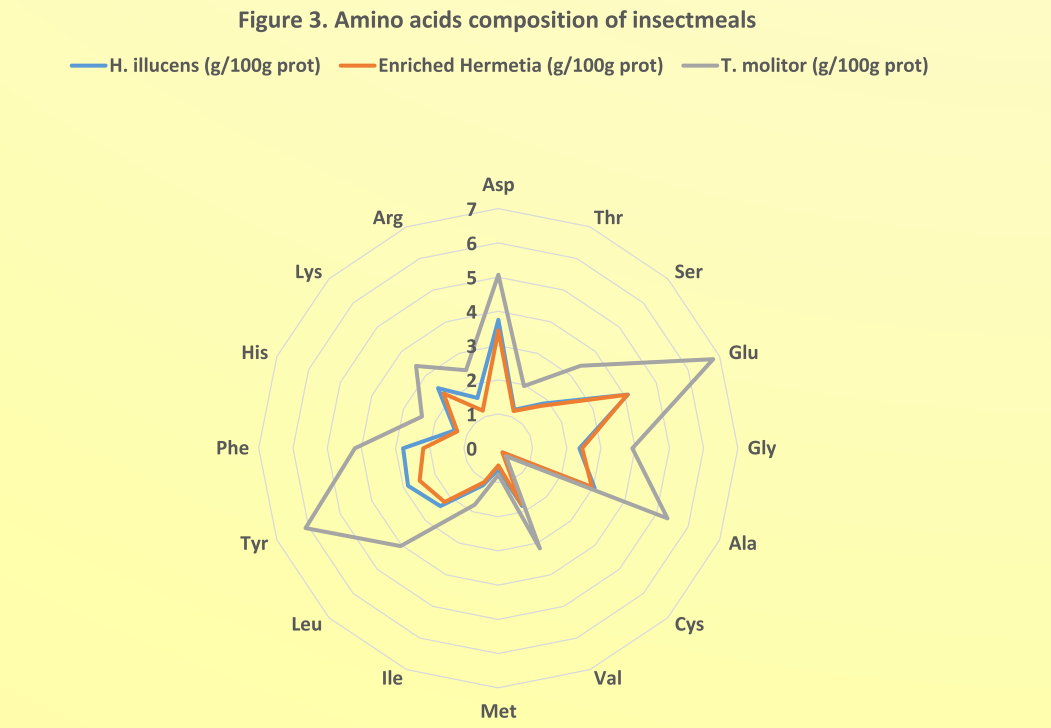

Figure 4. Fatty acids composition of insectmeals

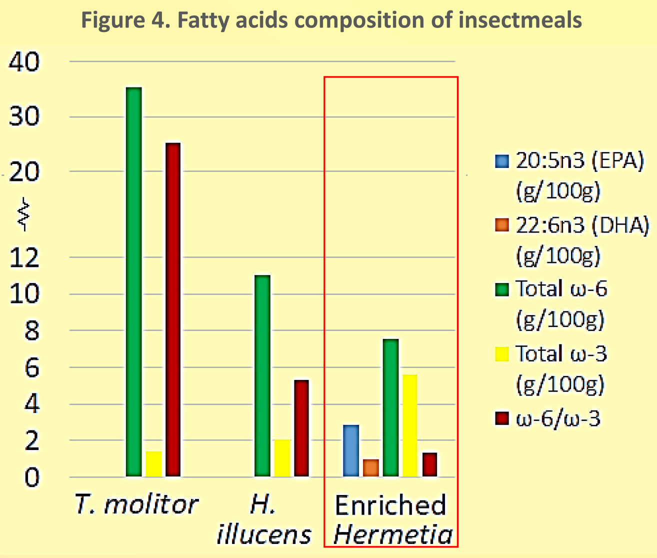

Table 2. Proximate Composition of Fillet (%, dry matter)

Diet	C	H30	H50	H*50	T50	SEM
Moisture	77.63 a	77.46 a	77.15 ab	77 ab	76.41 b	0.22
Fat	4.92 ab	2.87 b	8.19 a	5.42 ab	6.42 a	0.82
Protein	81.41	83.82	85.62	81.33	82.54	1.15
Phosphorus (g/kg)	13.32	12.47	12.80	12.54	12.55	0.24
Ash	1.29 c	1.30 bc	1.43 a	1.38 ab	1.38 ab	0.02

N=8 fish/diet. SEM: Standard Error of the Mean. P<0.05

Lowest growth performance

Table 1. Growth performance, protein utilization

Diet	C	H30	H50	H*50	T50	SEM
IBW	14.33	14.28	14.82	14.73	14.68	0.22
FBW	76.39 a	73.35 ab	69.36 b	75 ab	81.92 a	2.74
WG	415.03 ab	400.03 ab	354.75 b	387.87 ab	438.84 a	15.86
SGR	2.17 ab	2.12 ab	2 b	2.11 ab	2.23 a	0.04
DFI	1.57	1.59	1.62	1.54	1.57	0.02
FCR	0.90 ab	0.92 ab	0.98 b	0.90 ab	0.88 a	0.03
ADCprot	92.58 a	84.49 b	81.01 b	84.8 b	91.17 a	1.13
PER	2.26 ab	2.21 ab	2.10 b	2.25 ab	2.34 a	0.047

IBW: Initial Body Weight (g); FBW: Final Body Weight (g); WG: Weight Gain (%); SGR: Specific Growth Rate (%/day); DFI: Daily Feed Intake (g/(100g fish x day); FCR (feed conversion ratio) = [total feed intake (g)/weight gain (g)]; ADCprot (apparent digestibility coefficient of the protein) = [100-(marker in diet/marker in feces) x (% protein in feces/% protein in diet)] x 100; PER (protein efficiency ratio) = [total weight gain (g)/protein intake (g)]; N=4 tanks/diet. SEM: Standard Error of the Mean. *P<0.05*

4.DISCUSSION AND CONCLUSIONS

Fish fed with H30, H*50 and T50 showed a similar growth (FBW, WG and SGR; Table 1) than control diet. Fish fed with H50 reached the lowest final weight; this stresses the possibility of having surpassed the maximum viable amount of fishmeal replacement with *H. illucens* insectmeal for rainbow trout. This result coincides with Kroeckel *et al*. (2012) on turbot (*Psetta maxima*), where a significant decrease in growth was described as the inclusion of *H. illucens* in feed was increased. Respect to protein utilization, fish fed with T50 showed a better ADCprotein than *H. illucens* diets, and the PER increased significantly in comparison with H50. These differences could be due to the overall low essential aminoacidic profile of *H. illucens* and the high levels of calcium in comparison with *T. molitor*. In fact, an excess of Ca in diet relative to P has been shown to adversely affect growth (Hossain and Yoshimatsu, 2014). When *H. illucens* was enriched, the result was similar between H30 and H*50. Having in account the similarities in composition between H and H* (Fig. 2, 3 and 4), this result could be due to the differences in the FA profile, and more specifically to the differences in the ω-6/ω-3 ratio (Sivaramakrishnan et. al 2017). Respect to the proximate composition of the fillet (Table 2), fish fed with H50 showed the lowest moisture content and a significant increase in fat content respect to H30. These differences could be relevant in the sensorial perception. Finally, the highest value of ash could be related with the greater calcium levels of *H. illucens*.

Based on the results, *T. molitor* is a promising option as source of protein in feeds for rainbow trout, and the use of enriched insectmeals could cover the nutritional deficiencies. However, further studies are required to determine the cost-effective use of enriched insectmeal, and the viable maximum level of fishmeal replacement with *T. molitor* without compromising the growth and fillet quality.

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