PARTIAL REPLACEMENT OF FISH MEAL WITH SHRIMP WASTE MEAL IN PRACTICAL DIETS FOR EUROPEAN LOBSTER (Homarus gammarus, L.) JUVENILES

Goncalves, Renata; Lund, Ivar; Sousa, Dionisio; Skov, Peter V.

Published in:
Proceedings of Aquaculture Europe 2020

Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

PARTIAL REPLACEMENT OF FISH MEAL WITH SHRIMP WASTE MEAL IN PRACTICAL DIETS FOR EUROPEAN LOBSTER (*Homarus gammarus*, L.) JUVENILES

Renata Goncalves*, Ivar Lund, Dionísio Sousa, Peter V. Skov

Technical University of Denmark, DTU Aqua, Section for Aquaculture, The North Sea Research Centre, DK-9850 Hirtshals, Denmark
E-mail: rego@aqua.dtu.dk

Introduction

The combined effect of high market price and wild stocks decline makes the European lobster (*Homarus gammarus*) an excellent candidate species for commercial aquaculture. European lobster hatcheries experience high mortalities often related to moulting problems and knowledge on nutritional requirements and diet formulation for larvae and early juvenile stages is essential. While previous studies have focused on the substitution of fresh natural diets by dry pelleted feeds [(1)], the use of more sustainable ingredients in the formulation of lobster feeds has shown limited success [(2)]. The use of sustainable feeds is necessary to support the future commercialization and a more viable production. Cold-water shrimp waste meal has been identified as an animal protein with great potential. Moreover, the growth of the shrimp industry has led to a large production of processing waste and shrimp heads alone represent 35-45% of the total production [(3)]. The aim of this study was to evaluate the impact on growth and nitrogen metabolism of using meal from cold-water shrimp (*Pandalus borealis*) waste (heads and peels) as a protein source included at different levels in diets formulated for European lobster juveniles.

Materials and Methods

Homogeneous groups of 15 *H. gammarus* juveniles (164 ± 55 mg) were individually reared on five semi-moist diets for 8 weeks in a raceway recirculation seawater system (18±0.5˚C temperature, 34±1·PSU salinity, >7mg/L dissolved oxygen, <0.1mg/L NH_4). The experimental diets were formulated to contain 50% crude protein [(1)] combining different proportions of shrimp waste meal (SWM) and fish meal (FM), thus FM was substituted by 0%, 10%, 20%, 30%, or 40% of SWM . Individual lobsters were hand-fed one pellet (approx. 55 mg) of the assigned diet each morning, and allowed to feed for 4h. Moulting frequency and mortality were recorded daily. Wet body weight (BW) and carapace length (CL) of individual lobsters were measured every second week. Nitrogen excretion rate was determined between the second and fourth week of the growth trial. Briefly, each lobster (previously starved for 24h) was transferred to a 130 mL seawater container. Water samples were collected manually from individual containers at time 0h, 2h, 6h, 12h, and 24h for baseline screening of total ammonia nitrogen (TAN) excretion rates. Following this period, lobsters were offered a pre-weighed pellet for 4h. The uneaten fraction was collected, filtered, and dried to estimate feed intake (FI). After the meal, lobsters were transferred to a similar container with clean seawater. Water samples were collected at the same sampling times for the determination of postprandial TAN excretion rates. N intake was calculated as 16% of protein intake.

Results

The experimental diets had a significant effect on survival highest for the SWM40 group (87 %) and the lowest (47%) for the SWM10 group (Fig. 1). Experimental diets with higher inclusion of SWM had a significant positive effect on FI (Table 1). Specific growth rate (SGR), carapace length increment (iCL), and intermoult period were not affected by the dietary treatments. Despite the generally higher N intake and N excretion at the highest replacement levels, no significant effect of dietary treatment was observed on nitrogen budgets (Table 1).

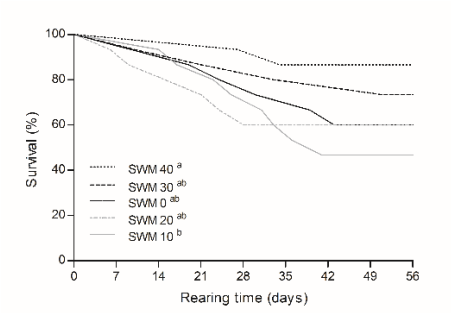

Fig. 1. Survival of *H. gammarus* (% of initial numbers) fed on experimental diets. Different letters denote statistically significant difference ($p<0.05$) determined by Log-rank test.

Table 1. Growth performance and nitrogen balance of *H. gammarus* fed the various experimental diets over an eight-week period.

	Levels of SWM as % of FM replaced				
	0	10	20	30	40
Growth performance					
SGR (%.d^{-1})	1.1 ± 0.2	1.2 ± 0.2	1.3 ± 0.2	1.1 ± 0.1	1.3 ± 0.1
iCL(%.CL$_i$)	34.9 ± 4.7	33.6 ± 5.7	26.9 ± 3.7	24.1 ± 4.3	26.0 ± 2.9
Intermoult (days)	29.3 ± 1.6	26.0 ± 2.4	28.3 ± 2.0	30.7 ± 2.1	30.9 ± 1.8
FI (% BW d^{-1})	1.8 ± 0.3^{b}	1.9 ± 0.3^{b}	1.6 ± 0.5^{b}	2.6 ± 0.3^{ab}	2.9 ± 0.4^{a}
Nitrogen balance					
N$_{int}$ (µg g BW^{-1})	1464 ± 221	1323 ± 177	1241 ± 344	1880 ± 197	2046 ± 264
N$_{exc}$ (µg g BW^{-1})	140 ± 40	187 ± 45	144 ± 34	218 ± 33	226 ± 33
N$_{ret}$ (% intake)	91 ± 2	88 ± 3	86 ± 4	89 ± 2	89 ± 2

SGR – specific growth rate; iCL – carapace length increment, FI – feed intake; N$_{int}$ – nitrogen intake; N$_{exc}$ – nitrogen excretion; N$_{ret}$ – nitrogen retention. Values are means ± standard error. Different superscript letters indicate statistically significant differences between diets at $p < 0.05$ measured by one-way ANOVA followed by LSD test.

Discussion

Results showed that FM can be replaced by SWM in practical diets for juvenile *H. gammarus* up to 40% without negatively influencing growth or nitrogen retention. The replacement of FM by SWM had a positive effect on the feed intake and survival rate of the lobster juveniles. The increased survival rates of lobsters reared on the SWM40 could be the result of a higher chitin content in this diet. Shrimp meal is a natural source of chitin. After enzymatic degradation, chitin splits into N-acetyl glucosamine which can potentially be used to synthesize new chitin during the moulting process [(4)]. The SGR observed here is similar to what was reported for *H. gammarus* juveniles of similar size, reared under the same conditions, and fed a standard diet composed of fresh Antarctic krill (*Euphausia superba*) [(1)]. Nitrogen budget results showed that nitrogen retention is high for all dietary treatments, within the same range observed in a previous trial using extruded feeds and above the levels of the fresh standard dietary treatment [(1)]. Results suggest that European lobster juveniles were able to utilize efficiently the dietary protein in new tissue deposition when reared on all the experimental diets.

This study was financially supported by the NordForsk, Denmark (SureAqua), Ph.D. school at DTU Aqua, the FiskeriLAG NORD, Denmark and ENV Fonden, Nord Energi, Denmark (Hummer).

References

1. Goncalves R, Lund I, Gesto M, et al. (2020) The effect of dietary protein, lipid, and carbohydrate levels on the performance, metabolic rate and nitrogen retention in juvenile European lobster (Homarus gammarus, L.). *Aquaculture* **525**, 735334.
2. Hinchcliffe J, Powell A, Langeland M, et al. (2020) Comparative survival and growth performance of European lobster Homarus gammarus post-larva reared on novel feeds. *Aquac. Res.* **51**, 102–113.
3. Malaweera BO & Wijesundara WMNM (2014) Use of seafood processing by-products in the animal feed industry. In *Seaf. Process. By-Products Trends Appl.*, vol. 9781461495, pp. 315–339 [Kim SK, editor]. New York: Springer Science + Business Media.
4. Fox CJ (1993) The effect of dietary chitin on the growth, survival and chitinase levels in the digestive gland of juvenile Penaeus monodon (Fab.). *Aquaculture* **109**, 39–49.