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Short Communication

Effect of dietary protein on the growth of spiny lobster *Panulirus homarus* (Linnaeus)

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Abstract

Feeding experiments were conducted on the spiny lobster *Panulirus homarus* (Linnaeus) with pellet diets containing three protein sources *viz*., fish meal (diet A), squid meal (diet B) and clam meal (diet C). The protein (%) and digestible energy levels (kJg^{-1}) were 34.2, 35.8, 35.5 and, 13.75, 13.95, 13.94 respectively for diet A, diet B and diet C. The results indicate that the clam meal diet gave the highest growth of 10.9% (±1.99), followed by squid meal 7.3% (±0.97) and fish meal 6.9% (±0.56). The protein energy ratio was almost equal for all the diets. The one – way ANOVA indicated that weight gain, protein efficiency ratio (PER) and food conversion ratio (FCR) were significantly different ($p < 0.05$) among the groups receiving different diets but the food consumed was not significantly different.

Keywords: Dietary protein, pellet diet, growth, spiny lobster

Introduction

The spiny lobster *Panulirus homarus* is an important omnivorous species occurring predominantly along the east coast of India. Good growth is obtained under captive rearing with conventional diet like meat of the clam *Meretrix casta* (Vijayakumaran and Radhakrishnan, 1984; Radhakrishnan and Devarajan, 1986). Mohamed and George (1968) and Thomas (1972) have reported the growth of *P. homarus* by feeding with brown mussel *Perna indica*. This study was undertaken to test the efficiency of formulated dry pellet diet for rearing the spiny lobster *P. homarus* under captivity.

Material and methods

Using dry packing, healthy spiny lobsters collected from the wild were transported to the laboratory at Kovalam, near Chennai. The initial mean weight of the lobsters was 165.8 ± 5.18g (carapace length: 55.5 ±1.34 mm). They were stocked in one tonne FRP tank with seawater (salinity 37 ppt; pH 8.0; dissolved oxygen 3.5 ml L^{-1}; temperature 20ºC) and provided continuous aeration.

Three isoproteic experimental diets with 35.2 ± 0.39% protein with fish meal (mainly, silverbellies: diet A), squid meal (mainly *Loligo* sp.:diet B) and clam meal (*Meritrix casta:*diet C) were prepared (Table 1) following Johnston *et al*. (2003), Garcia-Ulloa *et al.* (2003) and George *et al.* (1973). The other ingredients were starch (refined wheat flour-18.0g), de-fatted ground nut oil cake powder (30.0g), fish oil (Seven Seas cod liver oil-4.0g) and vitamin and mineral mixture 3.0g in 1:1 ratio (Villarreal *et al*., 2006). The ingredients were mixed thoroughly and the dough was prepared by adding water (Kandasami *et al*., 1987; Easterson *et al*., 1989), introduced into a hand extruder for 3 mm pellets. The pellets were dried at 50º C for 48 h, and stored at -20º C. The proximate composition (Table 1) of the diet was determined following Oser (1979) and Chow (1980). The hydro-stability was tested by weighing 5 g of each experimental diet in pre-weighed net pouches in triplicate and immersed in filtered sea water. The pouches were removed at an interval of 15, 30, 45 and 60 min., rinsed carefully in double distilled water and dried in a hot air oven at 60ºC and weighed. The dry matter loss was

calculated in percentage (Table 2). The energy levels, food conversion ratio (FCR), protein efficiency ratio (PER), apparent digestibility coefficient (ADC) and specific growth rate (SGR) were estimated following Cortes-Jacinto *et al.* (2004), Jover *et al.* (1999) and Bureau *et al.* (1999).

Digestible energy (kJ) = 23.0 kJg^{-1} for protein, 16.7 kJg^{-1} for carbohydrate and 37.6 kJg^{-1} for lipid.

Food assimilation = 100 x (Food consumed (g) – faecal matter (g)) / Food consumed (g).

Apparent digestibility co-efficient (ADC) = 1 – (F / D x Di /Fi) where F = % nutrient (or kJg^{-1} gross energy of faeces); D = % nutrient (or kJg^{-1} gross energy of diet). Di = % digestion indicator (acid insoluble ash of the diet); Fi = % digestion indicator (acid insoluble ash) of the faeces.

Food conversion ratio (FCR) = food intake (g dry weight) / weight gain (g wet weight).

Specific growth rate (SGR) = In Wr – In Wi x 100 / T; where Wr = final individual weight; Wi = initial individual weight and T = feeding period.

Protein efficiency ratio (PER) = Weight gain (g) / protein intake (g) (Bureau *et al*., 1999; Jover *et al*., 1999 and Cortes-Jacinto *et al.*, 2004).

Table 1. Composition of pellet diet offered to the lobster *P. homarus* using three different protein sources for 45 days

Ingredients	Diet A	Diet B	Diet C
Starch (maida)(g)	18.0	18.0	18.0
Ground nut oil cake (g)	30.0	30.0	30.0
Fish Oil (Cod Liver Oil) (g)	4.0	4.0	4.0
Vitamin and mineral mix (g)	3.0	3.0	3.0
Proximate composition			
Crude Protein %	34.2	35.8	35.5
Crude Fat %	7.6	7.2	7.1
Ash %	7.8	8.2	6.3
Carbohydrate %	31.2	31.8	32.2
Digestible Energy (DE) kJg^{-1}	13.75	13.95	13.94
P:E (mg J g^{-1})	1:2.4	1:2.34	1:2.36

Each treatment was experimented with four replicates. The volume of water in each tank was 50 litres and water was exchanged completely every day. Following acclimation, lobsters were individually blotted dry with tissue paper, weighed and tagged with small circular tabs of water proof paper glued to the carapace. The lobsters were fed at the rate of 5% body weight per day. The diet was split into the following two meals: 30% fed at 08.30 h and 70% at 17.30 h. Uneaten pellets were collected at 10.30 h and 19.30 h, siphoned on to a 1 mm mesh screen, rinsed with fresh water to remove residual salt and stored at 40ºC. Uneaten feed was dried at 100ºC for 16 to 20 hours. Growth trial was conducted for 45 days. Animals were weighed every eighth day and daily rations were altered based on the biomass. Molts were recorded and the molted lobsters were retagged again. The pH of seawater during the experiment ranged from 8.0 to 8.3, salinity 39.0 ppt, dissolved oxygen 3.9 to 5.0 ml L^{-1} and temperature from 27.5ºC to 29.2ºC. Difference between treatments was determined using one-way analysis of variance (ANOVA) at 0.05 significant levels (Snedecor and Cochran, 1967).

Results and Discussion

The survival rate at the end of the 45-day experiment was 100%. Crear *et al.* (2000) obtained a survival rate of 98% for *Jasus edwardsii* while Saez-Rouela *et al*. (2002) reported survival rate of only 50.5% for the juvenile white-clawed crayfish fed with pelleted feed. The hydro-stability test indicated that the weight loss of the pellets was maximum (9.8%) after one hour. However the lobsters started collecting the pellets soon after these were dispensed in water. The duration of consumption was only 30 minutes from the time of dispensing. Therefore the loss of nutrients during the consumption time was only ≈ 4.0% (Table 2).

Table 2. Dry matter loss (%) in the test diets at different time intervals (values are mean of the three replicates)

Duration (minutes)	Fish meal	Squid meal	Clam meal
15	2.1	2.3	2.4
30	3.6	3.9	3.8
45	5.2	5.0	5.2
60	9.8	10.0	9.7

The results (Table 3) indicated that food consumption of *P. homarus* was more in the group fed on fish meal diet (31.1 $\pm$ 2.0 g) followed by clam meal (28.6 $\pm$ 1.9 g). Even though the digestible energy of the diet was almost equal (13.75 to 13.95 kJg^{-1}), the efficiency of the diets differed from one another. The ADC was high (≈ 90.0%) for all the

diets. Jones and De Silva (1997) reported ADC of 80.2% to 94% for the Australian crayfish *Cherax destructor* Clark. The clam meal fed group showed higher growth per day (0.38 g), followed by other two groups (0.25 to 0.27 g). Radhakrishnan and Vijayakumaran (1984) and Vijayakumaran and Radhakrishnan (1984) have reported the growth of clam meat fed *P. homarus* (eye stalk ablated) as 0.30 g per day. Mohamed and George (1968) reported the growth of *P. homarus* as 0.21 ± 0.02 g per day by mark-recovery experiment. In the present study, lobsters fed with pelleted feed showed a mean growth rate of 0.3 g per day.

Table 3. Nutritional evaluation of the lobster *P. homarus* using three different protein sources for 45 days; all values are based on four replicates; values in parentheses are standard deviation.

Parameters	Fish meal	Squid meal	Clam meal
Food consumed (g)	31.14 (2.04)	28.53 (1.25)	28.63 (1.9)
Faecal matter (g)	2.88 (0.36)	3.35 (0.53)	2.68 (0.23)
Food assimilation (g)	28.26	25.18	25.95
Apparent Digestibility Co-efficiency (ADC)	90.08 (0.70)	90.55 (2.65)	90.39 (1.37)
Food Conversion Ratio (FCR)	2.49 (0.7)	2.48 (0.19)	1.64 (0.14)
Relative growth rate (%)	6.94 (0.56)	7.30 (0.97)	10.93 (1.99)
Absolute growth (g)	0.27 (0.03)	0.25(0.01)	0.38 (0.02)
Specific Growth Rate (% body weight/day)	0.15 (0.01)	0.15 (0.02)	0.23 (0.4)
Protein consumed (g)	6.67 (0.61)	9.22 (0.62)	10.49 (0.85)
Protein Efficiency Ratio (PER)	1.21 (0.17)	1.14 (0.08)	1.75 (0.13)

Crear *et al*. (2000) have reported SGR of 1.20 -1.32, survival of 98% and FCR of 1.26-1.29 for the southern rock lobster *Jasus edwardsii* at 18ºC. In the present study, the SGR was high in the clam meal fed group 0.23 ± 0.04%. The FCR of the diets A, B and C were 2.49, 2.48 and 1.64 respectively. The PER was 1.21, 1.14 and 1.75 for the diets respectively for A, B and C. Vijayakumaran and Radhakrishnan (1984) reported that the FCR of the lobster *P. homarus* fed with fresh clam meat ranged from 2.2 to 6.6 (mean: 4.92).

The one way ANOVA indicated that weight gain, protein efficiency ratio and food conversion ratio were significantly different among the three groups ($p<0.05$). On the other hand, food and protein consumption were not significantly different ($p> 0.05$). Smith *et al*. (2003) reported that the growth of *P. ornatus* was significantly greater ($p< 0.05$) on shrimp feed than on pellet diet.

Among the three pelleted dry feeds prepared from locally available protein ingredients, the feed prepared with clam meal was found to be better than feeds prepared with other sources of protein *viz*., fish meal and squid meal.

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References

Bureau, O. P., A. M. Harris and C. Y. Cho. 1999. Apparent digestibility of rendered animal protein ingredients for rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 180: 345 – 358.

Chow, K. W. 1980. Quality control in fish feed manufacturing. In: Fish Feed Technology, Aquaculture Development and Co- ordination Programme. Lectures presented at FAO/UNDP Training course in Fish Feed Technology, Seattle, Washington, 9th October - 15th December, 1978. FAO.ADCP/Rep/80/11, p. 369-385.

Cortes-Jacinto, H. Villarreal-Colmenares, R. Civera-Cerecedo and J. Naranjo Pavamo. 2004. Effect of dietary protein levels on the growth and survival of pre adult fresh water crayfish *Cherax quadricarinatus* (von Martens, 1868) in mono sex culture. *Aquaculture Research*, 35: 71-79.

Crear, B. J., C. W. Thomas, P. R. Hart and C. G. Carter. 2000. Growth of juvenile Southern rock lobsters, *Jasus dewardsii* is influenced by diet and tank environment. *Aquaculture*, 190 (1&2); 169-182.

Easterson, D. C. V., D. Kandasami and R. Paul Raj. 1989. Dietary utilization of selected proteins by mullet *Liza macrolepis*. *Indian J. Fish*., 36(1): 65-73.

Garcia-Ulloa, G. M., H. M. Lopez-Chavarin, H. Rodriguez-Gonazalez, and H. Villarreal-Colmenares. 2003. Growth of red claw crayfish *Cherax quadricarinatus* (von Martens, 1868) (Decapoda: Parastacidae) juvenile fed isoproteic diet with partial or total substitution of fish meal by soybean meal: preliminary study. *Aquaculture Nutrition*, 9(1): 25-31.

George, H., B. E. Ross and C. C. Brooks. 1973. Preliminary studies on the preparation and feeding of crustacean diets. *Aquaculture*, 2:369-377.

Johnston, D. J., K. A. Clvert, B. J. Crear and C. G. Carter. 2003. Dietary carbohydrate / lipid ratio and nutritional condition in juvenile Southern rock lobster, *Jasus edwardsii*. *Aquaculture*, 220: 667-682.

Jones P. L. and S. S. De Silva. 1997. Apparent digestibility of formulated diets by the Australian fresh water crayfish *Chernax destructor*, Clark (Decapoda, Parastacidae). *Aquaculture Research*, 28: 881-891.

Jover, M., J. Fernandez-Carmona, M. C. Del Rio and M. Soler. 1999. Effect of feeding cooked – extruded diets, contaning different levels of protein, lipid and carbohydrate on the growth of red swarm crayfish *Procambarus clarkia*. *Aquaculture*, 178: 127-137.

Kandasami, D., R. Paul Raj and D. C. V. Easterson. 1987. Effect of selected levels of dietary protein on the growth and feed efficiency of mullet *Liza macrolepis* fry. *Indian J. Fish*., 34(3): 306-311.

Mohamed, K. H. and M. J. George. 1968. Results of the tagging experiments on the Indian spiny lobster *Panulirus homarus* (Linneaus) movement and growth. *Indian J. Fish*., 15(1&2): 15-26.

Oser, B. L. 1979. Physiological Chemistry. 14th Edn. *Tata McGraw-Hill Publishing company*, New Delhi, 1221 pp.

Radhakrishnan, E. V. and M. Vijayakumaran. 1984. Effect of eyestalk ablation in spiny lobster *Panulirus homarus* (Linnaeus): 1. On moulting and growth. *Indian J. Fish*., 313(1): 130-147.

Radhakrishnan, E. V. and K. Devarajan. 1986. Growth of spiny lobster *Panulirus polyphagus* (Herbst) reared in the laboratory. *Proc. Coastal Aquaculture*, MBAI, 4: 1170 pp.

Saez-Rouela, M., J. M. Carral, J. D. Ceada and J. R. Perez. 2002. Effect of shelter type and food supply frequency on the survival and growth of stage-2 juvenile white clawed crayfish (*Austropotamobius pallipes* Lareboullet) under laboratory condition. *Aquaculture International*, 9(6): 489-497.

Smith, D. M., K. C. Williams, S. Irvin, M. Barclay and S. Tabrett. 2003. Development of a pelleted feed for juvenile tropical spiny lobster (*Panulirus ornatus*): response to dietary protein in lipid. *Aquaculture Nutrition*, 9: 321-327.

Snedecor, G.W. and W.G. Cochran.1967. Statistical Methods, 6th Edn, Oxford and IBH Publishing Co., New Delhi, 593 pp.

Thomas, M. M. 1972. Growth of spiny lobster *Panulirus homarus* (Linneaus) in captivity. *Indian J. Fish*., 19 (1): 125-129.

Vijayakumaran, M. and E. V. Radhakrishnan. 1984. Effect of eyestalk ablation in spiny lobster *Panulirus homarus* (Linnaeus): On feed intake and conversion. *Indian J. Fish*., 31(1): 148-155.

Villarreal, H., R. Civera-Cerecedo and A. Herandez-Ilamas. 2006. Effect of eyestalk ablation in spiny lobster *Panulirus homarus* (Linnaeus): On feed and conversion. *Aquaculture Research*, 37: 293-298.

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