Aquafeeds

Determining optimal dietary protein level for Litopenaeus vannamei postlarvae

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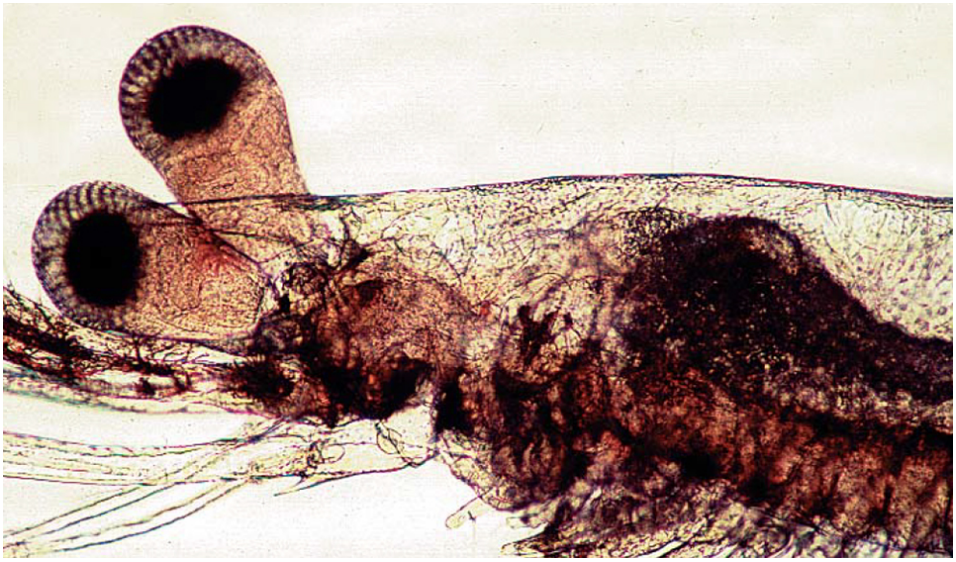
Factors include protein, water quality, stocking density, daily ration size and feeding frequency



The protein requirement of early postlarval stages of shrimp has not been well studied.

Protein is typically the most expensive macronutrient in shrimp feeds, and determination of the optimal protein level is important for formulating cost-effective feeds. Little information is available on protein requirement during the early postlarval stage of Pacific white shrimp (*Litopenaeus vannamei*). Here we report the results of a study to determine the optimal dietary protein level for postlarvae of this species held in a recirculating culture system.

Experimental setup

Hatchery-reared *L. vannamei* PL7- PL10 (mean weight 0.95 to 1 mg) were stocked at 1.5 PL per liter (or 444 PL per square meter) in 20 l of water in fiberglass tanks with six to seven replicate tanks per treatment. These tanks were part of a closedrecirculating culture system equipped with a water pump, a fine sand filter, submerged and trickling biofilters, a heat exchanger, a 50-mm cartridge filter, and UV lights. Water exchange in each tank was approximately 125 percent per hectare. A photoperiod of 12 hours of light and 12 hours of dark was maintained with cool fluorescent tubes. PL were fed every 96 min with automatic feeders during the 20-day experimental period.

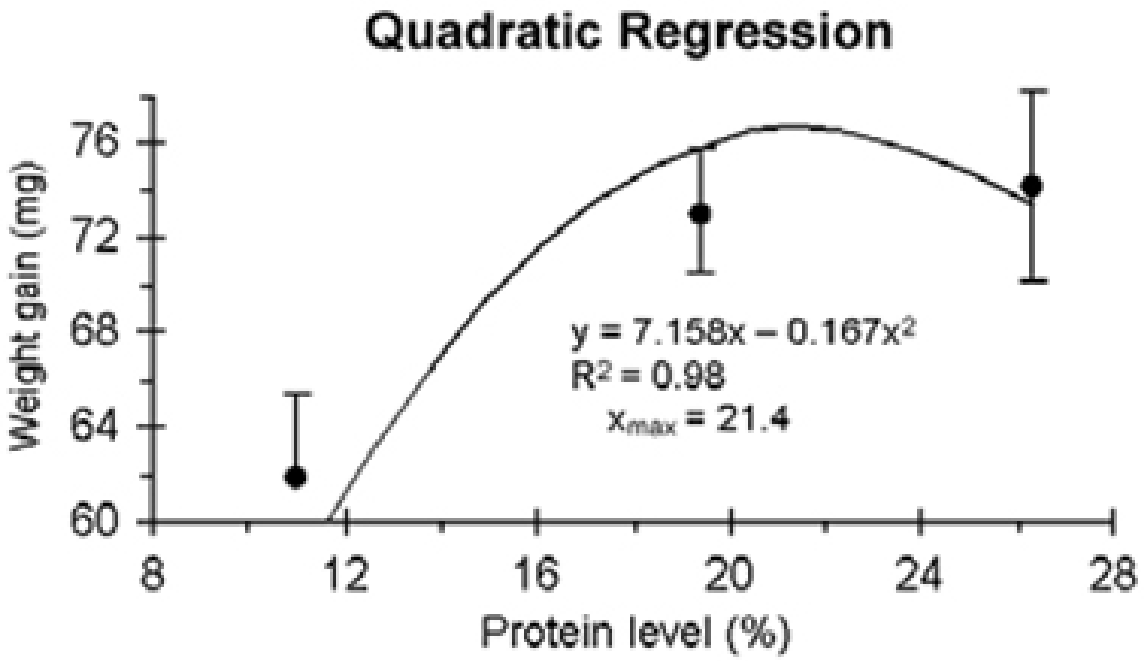


Fig. 1: Weight gain (mean ± SE) of *Litopenaeus vannamei* postlarvae fed graded levels of protein as determined by proximate analysis (Table 1) in Experiment 1.

Experiment 1

Table 1. Ingredient composition and proximate analysis of test diets (% as-fed basis) used in Experiment 1.

	Nominal Protein Level/Nominal Lipid Level					
Ingredient	**10/3**	**10/8**	**18/3**	**18/8**	**25/3**	**25/8**
Wheat starch	63.4	63.4	54.4	54.4	45.5	45.5
Soybean protein isolate	0	0	5.3	5.3	10.6	10.6
Wheat gluten	3.5	3.5	7.4	7.4	11.3	11.3
Menhaden fish meal	8.0	8.0	8.0	8.0	8.0	8.0
Krill meal	4.0	4.0	4.0	4.0	4.0	4.0
Menhaden fish oil	0	8.2	0	8.2	0	8.2
Lecithin	1.5	1.5	1.5	1.5	1.5	1.5
Cholesterol	0.5	0.5	0.5	0.5	0.5	0.5
Carboxymethylcellulose	4.0	4.0	4.0	4.0	4.0	4.0
Diatomaceous earth	8.2	0	8.2	0	8.2	0
Na_2HPO_4 reagent	1.9	1.9	1.7	1.7	1.4	1.4
Mineral mixture AIN 76	42	4.2	4.2	4.2	42	4.2
Vitamin mixture	0.5	0.5	0.5	0.5	0.5	0.5
Stay-C® (25% active)	0.3	0.3	0.3	0.3	0.3	0.3
Proximate Analysis						
Crude protein	10.9	11.1	18.9	20.0	26.1	26.6
Crude lipid	2.7	8.2	2.6	12.3	2.9	11.1
Ash	15.6	7.3	15.5	79	154	7.3
Moisture	7.8	8.8	7.5	85	79	7.3

In the first experiment, six semipurified diets were formulated to contain 10, 18 and 25 percent dietary protein with either 3 or 11 percent lipid level (Table 1). Graded levels of protein were achieved by replacing wheat starch with wheat gluten and soybean protein isolate. Lipid level in the feed was modified mainly by replacing acid-washed diatomaceous earth with fish oil.

Mean PL survival (Table 3) ranged from 66 percent to 92 percent. Survival was not significantly affected by protein level, but was significantly lower for diets containing 11 percent lipid. Quadratic regression analysis of weight gain data indicated the optimal protein level to be 21.4 percent, while broken-line analysis indicated 20.2 percent (Fig. 1).

Table 2. Ingredient composition and proximate analysis of test diets (% as-fed basis) used in Experiment 2.

Ingredient	Nominal Protein Level 5	10	15	20	25
Wheat starch	71.6	66.4	61.2	56.0	50.8
Soybean protein isolate	0	5.3	10.7	16.0	21.4
Menhaden fish meal	4.0	4.0	4.0	4.0	4.0
Krill meal	4.0	4.0	4.0	4.0	4.0
Menhaden fish oil	6.4	5.9	5.3	4.8	4.2
Lecithin	1.5	1.5	1.5	1.5	1.5
Cholesterol	0.5	0.5	0.5	0.5	0.5
Carboxymethylcellulose	4.0	4.0	4.0	4.0	4.0
Diatomaceous earth	3.0	3.3	3.6	3.9	4.2
Mineral mixture AIN 76	4.2	4.2	4.2	4.2	4.2
Vitamin mixture	0.5	0.5	0.5	0.5	0.5
Stay-C® (25% active)	0.3	0.3	0.3	0.3	0.3
Methionine[3]	0	0.08	0.16	0.24	0.32
Arginine[3]	0	0.02	0.05	0.08	0.1
Proximate Analysis					
Crude protein	6.0	10.7	15.4	18.2	25.1
Crude lipid	9.3	8.4	7.7	7.5	7.0
Ash	7.9	8.3	8.9	9.4	9.9
Moisture	6.0	6.0	7.3	7.4	6.0

Experiment 2

In the second experiment, five semi-purified diets were formulated to contain 5, 10, 15, 20 and 25 percent dietary protein, and 8 percent lipid level (Table 2). Mean PL survival (Table 4) of all treatments was high (93.3 to 98.9 percent). PL growth was significantly lower for diets containing 15 percent or lower protein compared to diets with 20 and 25 percent protein (Table 4). This indicates that essential amino acids were limiting at this protein level. Quadratic regression analysis of weight gain data indicated the optimal protein level to be 24.5 percent, while broken-line analysis indicated 21.5 percent (Fig. 2).

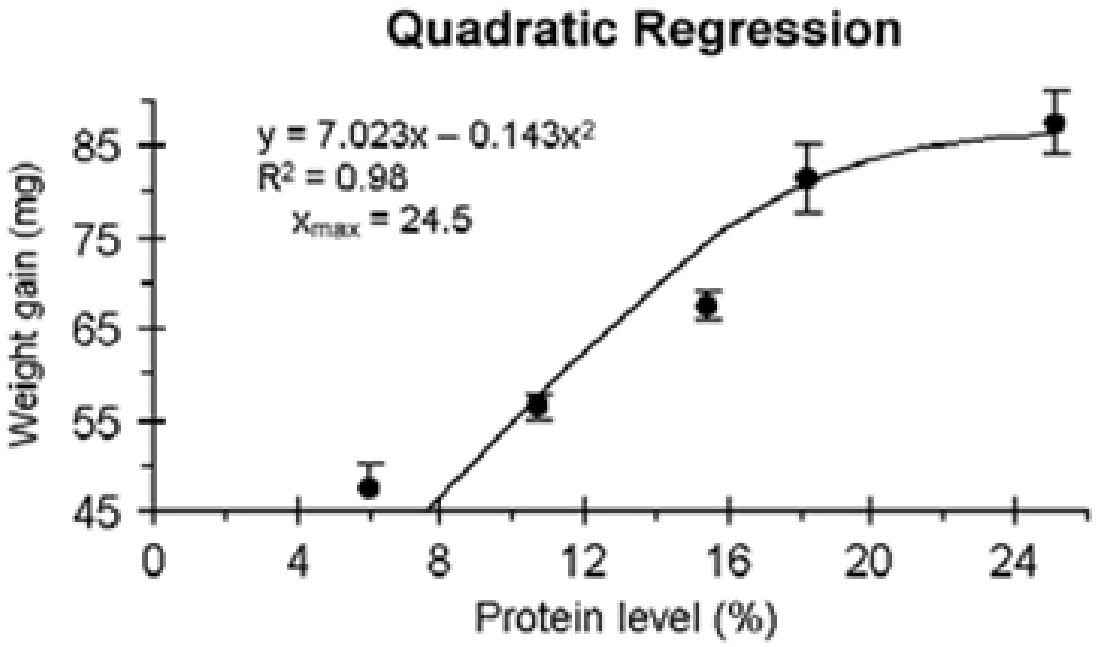


Fig. 2: Weight gain (mean ± SE) of *Litopenaeus vannamei* postlarvae fed graded levels of protein as determined by proximate analysis (Table 2) in Experiment 2.

Conclusion

Two growth trials with postlarval *L. vannamei* using protein levels ranging from 5 to 25 percent yielded estimates of protein optima in the range of 20.2 to 24.5 percent. However, determination of optimum dietary protein level is also affected by the level of other components in the feed, such as protein and water quality, and experimental factors such as stocking density, daily ration size, and feeding frequency. The optimum protein level estimates found in this study are generally lower than those previously reported for larger size *L. vannamei*. Further research to optimize the protein-amino acid to energy ratio for this species should be conducted.

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