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Effects of Salinity and Dietary Protein Contents on Growth Performance and Body Composition of Indian White Shrimp (*Fenneropenaeus indicus*)

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Abstract

The effects of salinity and nutritional status on the growth performance as well as body composition of the Indian white shrimp (*Fenneropenaeus indicus*) were investigated. Juveniles of shrimp (35 days old; 0.25 g mean weight) were exposed to salinities of 10, 20, 30, 40 and 50 g L^{-1} (experiment I). Results showed that salinity affected the growth and survival of juvenile *F. indicus* significantly *($P<0.05$)*. The highest weight gain, final weight and carapace length gain and lower FCR were observed at 20 g L^{-1} of salinity and the highest food intake, SGR and survival were determined at 30 g L^{-1} of salinity. A 3×3 factorial experiment containing three levels of dietary protein (35, 40 and 45%) and three levels of salinity (25, 35 and 45 g L^{-1}) was performed for 60 days to determine the response of shrimp (mean weight of 3.21±0.12 g) to different dietary proteins under different salinity conditions (experiment Π). Results revealed that growth performance was improved due to increase in protein and decrease in salinity. At 45% of dietary protein and salinity of 25 g L^{-1}, the highest weight gain, SGR and better FCR were determined. The proximate analysis of shrimp carcass showed no appreciable difference between the treatments.

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Introduction

The high market value of and great demand for penaeid shrimp in the world market provide a strong stimulus for its intensive culture. In Iran, *Fenneropenaeus indicus* is the major cultured shrimp species due to market demand, local shrimp, growth rate, and efficient food conversion. The development of an economic, artificial ration is an essential prerequisite for the successful culture of shrimps.

The life cycle of penaeid shrimps is well known with most species spending their nursery stages in shallow inshore, brackish waters and moving offshore for maturation and spawning at oceanic salinities. Salinity is one of the most important environmental factors affecting the growth and survival of penaeids, particularly in nursery areas where the animals maybe exposed to rapid salinity fluctuations and extreme environmental condition (Raj and Raj 1982). Food consumption, conversion efficiency and, hence, growth and survival of cultured penaeid shrimps are influenced by salinity and/or temperature (Venkataramaiah et al. 1972; Staples and Heales 1991). The effects of salinity on nutrient utilization have been studied in some shrimp species such as: *Penaeus monodon* (Shiau et al. 1991; Shiau et al. 1992), *Litopenaeus vannamei* (Rosas et al. 2001).

Proteins are the essential components that perform a central role in the structure and functioning of all living organisms.It is also responsible for a large part of the cost of most prepared feeds. If the fish (shrimp) is fed with insufficient nonprotein in relation to the amount of energy, the excess protein is used as an energy source (Philips 1972; Prather and Lovell 1973). Excess dietary protein is wasteful and stresses the animal while excess energy means more fatty fish and reduced feed consumption (Maynard and Loosli 1969; Prather and Lovell 1973; Bautista 1986; Thoman et al. 1999). Cowey (1978) observed that unless sufficient dietary energy is provided, the quality and quantity of dietary protein can not reflect protein synthesis. Protein and energy relationships are basic data in defining other nutritional requirements (Bautista 1986).

This study intends to investigate the effects of salinity on the survival and growth of Indian white shrimp and their protein requirement in different salinity conditions.

Materials and Methods

Culture system

All post larvae (PLs) and juveniles were supplied by the Khozestan Research Center and cultured in 300-liter fiberglass tanks (bottom 70 cm diameter and surface 80 cm diameter × 60 cm high). The tank was filled with 200 liters of water. The water in each tank was cleaned and changed at the rate of 50% every day by siphoning with a minimum disturbance and arranged with an air stone for supplemental aeration connected by air blower.

Experiment I

In this experiment five levels of salinities (10, 20, 30, 40, and 50 ppt) with four replicates were used. The 35-days old juvenile (PL_{35}) with mean weight of 0.26 ± 0.024 g were cultured for 60 days in the experimental tanks. Shrimp juveniles were acclimatized in two concrete tanks (7 m^3) for two weeks. During this period, shrimps were fed with a commercial diet (Chineh Co., Tehran, Iran). At the end of the acclimation period, shrimps were randomly released into the experimental tanks at 20 shrimps/tank. Photoperiod was 12 hours light and 12 hours dark by arranging with florescent lamp. During the experimental period, shrimps were fed to satiation three times at 08:00, 14:00 and 20:00 h daily (Santiago 1996). Feces and other debris were siphoned from tanks and water was changed before feeding every morning. For the growth performance, shrimps were weighed in bulk at 15 day intervals. Whenever the shrimp were removed for weighing, the tanks and the air stones were cleaned thoroughly. Water quality parameters such as temperature and salinity were measured every morning (10:00 to 11:00 h) and pH was measured weekly. Throughout the study period temperature range was 27-32°C, and the pH range was 7.8-8.2. At the end of the experiment, growth indexes and survival rates of shrimps were calculated using the formulas described in the section below.

Experiment II

Three semi-purified diets were used in this feeding trial. They were formulated by using local and imported feed ingredients. The diets contained 3 levels of protein (35, 40, 45 %) at constant digestible energy of 4100 kcal/kg (Table 1). The diets were formulated by using Lindo software (copyright 1995, release 6.1). The diets were compounded with the ingredients casein, gelatin, dextrin, fish meal, shrimp meal, squid meal, and

additives. Each diet was also used in three levels of salinity including 25, 35, and 45 g L^{-1}.

Table 1. Composition and proximate analysis of test diets fed to juvenile shrimps[1]

Ingredients (%)	Diets		
	1	2	3
Casein	14.074	18.631	22.265
Gelatin	1.57	2.917	5.036
Dextrin	30.762	24.906	19.162
Fish meal	10	10	10
Shrimp meal	10	10	10
Squid meal	15	15	15
Soybean oil	5.75	5.75	5.75
Fish oil	5.75	5.75	5.75
Vitamin. Premix [a]	1	1	1
Mineral. Premix [b]	1.5	1.5	1.5
Antioxidant	0.02	0.02	0.02
Binder	2.5	2.5	2.5
Anti fungus	0.25	0.25	0.25
MCP*	0.35	0.35	0.35
Lecithin	1	1	1
VC**	0.1	0.1	0.1
Choline chloride	0.3	0.3	0.3
CAC***	0.074	0.026	0.017
Proximate Analysis			
Protein (%)	34.1±0.63	39.1±0.07	43.5±0.22
Lipid (%)	13.7±0.04	14.09±0.10	14.33±0.10
Ash (%)	8.29±0.10	8.52±0.45	6.66±2.29
Moisture (%)	7.150.38	6.96±0.28	6.89±0.01
Fiber (%)	0.57±0.43	0.82±0.42	0.82±0.23
NFE**** (%)	36.19±0.50	30.51±0.10	27.8±2.83
DE (kcal/kg)	4068±17.00	4085±34.00	4174±86.00

[1]Values are expressed as mean ± S.D. of two replicates.
∗Mono calcium phosphate, ∗∗Vitamin C, ∗∗∗Car boxy alpha cellulose,
∗∗∗∗ Nitrogen Free Extraction.
DE= Digestible energy (kcal kg^{-1}) was calculated based on protein, 4 kcal g^{-1} fat, 9 kcal g^{-1} carbohydrate, 4 kcal g^{-1} (Halver 1976)
[a] g $100g^{-1}$ premix: cobalt chloride 0.004, cupric sulfate pentahydrate 0.250, ferrous sulfate 4.0, magnesium sulfate heptahydrate 28.398, manganous sulfate monohydrate 0.650, potassium iodide 0.067, sodium selenite 0.010, zinc sulfate heptahydrate 13.193, filler 53.428.
[b] g kg^{-1} premix: thiamin HCl 0.5, riboflavin 3.0, pyrodoxine HCl 1.0, DL Ca-Pantothenate 5.0, nicotinic acid 5.0, biotin 0.05, folic acid 0.18, vitamin B12 0.002, inositol 5.0, menadione 2.0, vitamin A acetate (20,000 IU g^{-1}) 5.0, vitamin D3 (400,000 IU g^{-1}) 0.002, dl-alpha-tocopherol acetate (250 IU g^{-1}) 8.0, Alpha-cellulose 865.266.

The diets were prepared by thoroughly mixing the dry ingredients with oil and then adding hot water until stiff dough was produced. The

dough was then passed through a mincer fitted with a 2 mm die and the resulting "spaghetti-like" strings were dried at 60°C using an electric fan for 12 hours. After drying, the diets were broken up, sieved to an appropriate pellet size and stored in a cold room.

Shrimp juveniles were acclimatized in two concrete tanks (7 m^3) for two weeks. During this period, shrimps were fed with the commercial diet (Chineh Co., Tehran, Iran). At the end of the acclimation period, shrimps (average weight of 3.22±0.04 g) were randomly released into the experimental tanks at 20 shrimps/tank. The experiment was arranged in three rooms that were provided with Block Complete Randomized Design (BCRD) and each treatment was randomly assigned in three replicates. Photoperiod was 12 hours light and 12 hours dark by arranging with florescent lamp. During the experimental period, shrimps were fed daily to satiation three times at 08:00, 14:00 and 20:00 h (Santiago 1996). Feces and other debris were siphoned from tanks and water was changed before feeding, every morning. For the growth performance, shrimps weighed as bulky were done at 15 day intervals. Whenever the shrimps were removed for weighing, the tanks and the air stones were cleaned thoroughly. Water quality parameters such as temperature and salinity were measured every morning (10:00 to 11:00 h) and pH was measured weekly. Throughout the study period temperature range was 26-32.5 °C, and the pH range was 7.84-8.18. Shrimps were fed the test diets for 60 days, after which weight gain (g), feed conversion ratio (FCR), specific growth rate (SGR), protein efficiency ratio (PER), net protein utilization (NPU) and survival were determined as follows:

Weight (Wt) gain (g) =Wt (final) – Wt (initial)

FCR= Feed intake (g)/ {Weight gain (g)}

SGR= [{loge Wt (final) –loge Wt (initial)}/ days] × 100

PER= Weight gain (g)/protein intake (g)

NPU= (Protein gain (g)/protein intake (g)) ×100

Survival (%) = Final number of shrimp/initial number of shrimp× 100

Chemical Analysis

The crude protein, lipid, moisture, ash, and fiber contents of the test diets and whole-body shrimp were determined following standard methods (AOAC 1995). Digestible energy was calculated based on 4 kcal g^{-1} protein, 9 kcal g^{-1} fat, 4 kcal g^{-1} carbohydrates (Halver 1976).

Statistical Analysis

All data were analyzed by one way and two way- ANOVA and the means were tested using Duncan's Multiple Range Tests by using SPSS Package (release 9.0).

Results

Experiment I

Results showed that salinity had significant effect on the growth performance of shrimp. The highest weight and carapace length gains with amounts of 3.41 ± 0.40 g and 9.28 ± 0.51 mm, respectively, were obtained in 20 g L^{-1} salinity that was significantly different from 10 and 50 g L^{-1} salinities ($p<0.05$). Salinity of 20 g L^{-1} also had best FCR that was significantly different from 10 g L^{-1} salinity ($p<0.05$). Highest SGR was obtained in 30 g L^{-1} salinity that was significantly different from 10 g L^{-1} salinity ($p<0.05$) (Table 2).

Table 2. Growth performance of *F. indicus* reared at different salinities (Experiment I) [1]

	Salinities (g L^{-1})				
	10	20	30	40	50
Initial weight (g)	0.27±0.02^{a}	0.28±0.02^{a}	0.27±0.02^{a}	0.26±0.02^{a}	0.23±0.02^{a}
Final weight (g)	2.22±0.17^{a}	3.70±0.40^{c}	3.64±0.44^{c}	3.40±0.41^{c}	2.80±0.32^{b}
Weight gain (g)	1.95±0.17^{a}	3.42±0.41^{c}	3.37±0.44^{c}	3.14±0.42^{bc}	2.58±0.33^{b}
SGR	3.51±0.16^{a}	4.30±0.27^{b}	4.33±0.21^{b}	4.30±0.27^{b}	4.17±0.27^{b}
Carapace length gain (mm)	6.51±0.42^{a}	9.28±0.51^{c}	9.20±0.63^{c}	8.68±0.65^{c}	7.58±0.71^{b}
Food intake (g)	5.13±0.05^{a}	7.33±1.17^{b}	7.41±0.74^{b}	6.87±0.50^{b}	5.58±0.09^{a}
FCR	2.64±0.22^{b}	2.14±0.09^{a}	2.20±0.15^{a}	2.20±0.14^{a}	2.19±0.27^{a}

[1]Mean±S.D. of four replicates. Numbers within the same row with different superscripts are significantly different *($p<0.05$)*.

Figures 1 and 2 show that growth of shrimp improved in all of the salinities throughout the culture period. But it is clearer between the salinity levels after 30th day of culture. Furthermore, results showed that after 60 days, growth was better in 20 and 30 g L^{-1} salinity compared to other treatments.

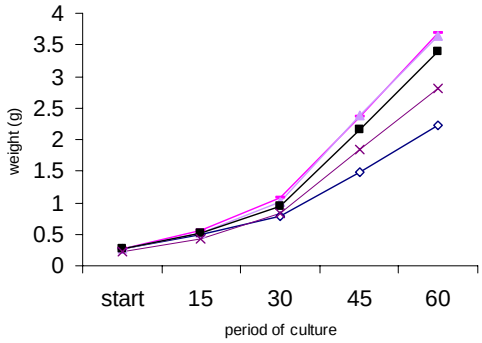

Fig. 1. Average weight growths of *F. indicus* in intervals of biometry (Experiment I) (◊ = 10 g L^{-1}, — = 20 g L^{-1}, ▲= 30 g L^{-1}, ■ = 40 g L^{-1}, × = 50 g L^{-1})

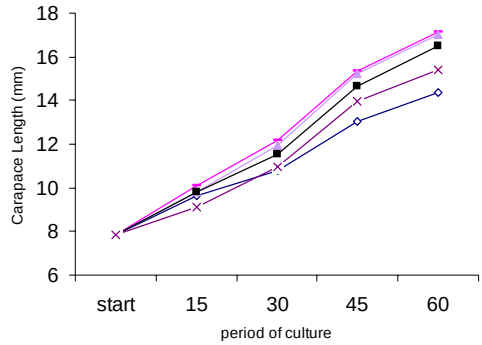

Fig. 2. Average carapace length growths of *F. indicus* in intervals of biometry (Experiment I) (◊ = 10 g L^{-1}, — = 20 g L^{-1}, ▲= 30 g L^{-1}, ■ = 40 g L^{-1}, × = 50 g L^{-1})

The highest survival rate was obtained in 30 g L^{-1} salinity followed by 40, 20, 50, and 10 g L^{-1} salinity, respectively (Fig. 3).

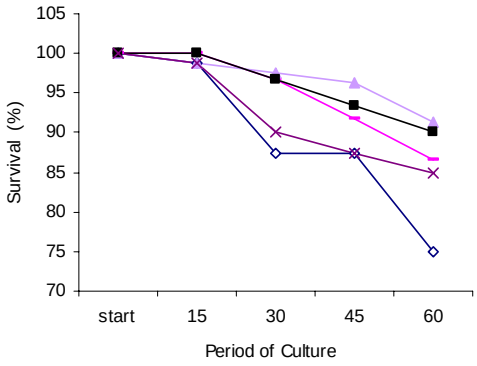

Fig. 3. Average survival rates of *F. indicus* in intervals of biometry (Experiment I) (◊ = 10 g L^{-1}, — = 20 g L^{-1}, ▲= 30 g L^{-1}, ■ = 40 g L^{-1}, × = 50 g L^{-1})

Experiment II

Relation of protein and salinity and their effects on the growth performance of *F. indicus* are presented in table 3. In 25 g L^{-1} salinity the highest average weight gain (2.79g) and SGR (2.65) were obtained in shrimp fed diet containing 45% protein, however these were not significantly different ($p>0.05$) from those of shrimp fed diet with 40% protein. The highest PER and NPU were obtained in shrimp fed diet containing 35% protein that was not significantly different ($p>0.05$) from diets with 40 and 45% protein, respectively. The best FCR was obtained in shrimp fed diet containing 45% protein that was not significantly different ($p>0.05$) from diets with 40 and 35% protein, respectively.

The survival rates were high (90-98%) and not significantly different ($p>0.05$) among the treatments. In 35 g L^{-1} salinity growth performance indexes such as weight gain, SGR, FCR, PER and NPU were better in

Table 3. Growth response of *F. indicus* related to dietary protein and salinity (Experiment Π)[1]

		Growth indexes					
		weight gain (g)	SGR	FCR	PER	NPU (%)	SUV (%)
Salinity ($g\ L^{-1}$)	Diet						
25	1	2.41±0.23 ^{de}	2.51±0.07 ^{d}	7.68±0.52 ^{abc}	0.36±0.02 ^{d}	25.00±1.69 ^{d}	96.67±2.89 ^{a}
25	2	2.61±0.09 ^{ef}	2.58±0.09 ^{de}	6.83±0.09 ^{ab}	0.35±0.00 ^{d}	24.54± 0.42 ^{d}	95.00±0.00 ^{a}
25	3	2.79±0.06 ^{f}	2.65±0.02 ^{e}	6.58±0.15 ^{a}	0.33±0.01 ^{cd}	22.65± 0.53 ^{cd}	93.33±2.89 ^{a}
35	1	2.19±0.22 ^{cd}	2.38±0.08 ^{c}	8.71±0.43 ^{c}	0.31±0.02 ^{cd}	21.93±1.22 ^{cd}	93.33±2.89 ^{a}
35	2	1.56±0.19 ^{a}	2.14± 0.12 ^{a}	10.74±0.64 ^{d}	0.22±0.01 ^{a}	15.59±0.81 ^{a}	95.00±0.00 ^{a}
35	3	1.89±0.04 ^{b}	2.26±0.03 ^{bc}	8.69±0.55 ^{c}	0.25±0.02 ^{ab}	17.33±1.36 ^{ab}	90.00±8.66 ^{a}
45	1	1.80±0.07 ^{ab}	2.21±0.02 ^{ab}	9.09±0.98 ^{c}	0.30±0.03 ^{cd}	21.19±2.39 ^{cd}	93.33±7.64 ^{a}
45	2	2.00±0.01 ^{bc}	2.34±0.06 ^{c}	8.29±0.67 ^{bc}	0.29±0.02 ^{bc}	20.26±1.40 ^{bc}	90.00±0.00 ^{a}
45	3	1.91±0.22 ^{b}	2.29±0.05 ^{bc}	7.71±1.71 ^{abc}	0.28±0.06 ^{bc}	20.31±4.32 ^{bc}	93.33±2.89 ^{a}
Protein		ns[2]	ns	*P<0.05*	*P<0.05*	*P<0.05*	ns
Salinity		*P<0.001*	*P<0.001*	*P<0.001*	*P<0.001*	*P<0.001*	ns
Protein × Salinity		*P<0.05*	*P<0.001*	ns	ns	ns	ns

[1]Mean ± S.D. of three replicates. Numbers within the same column with different superscripts are significantly different *(p<0.05)*.
FCR= Feed conversion ratio; SGR= Specific growth rate; PER= Protein efficiency ratio; NPU= Net protein utilization; SUV=Survival rate
[2] ns= not significant *(p>0.05)*.

D1 (35% protein) than in other diets. Results also showed that in 45 g L^{-1} salinity growth performance of the shrimp fed diet D2 (40% protein) was better than the other diets. Furthermore, in constant protein levels growth performance was significantly ($p<0.05$) better in 25 g L^{-1} salinity than 35 and 45 g L^{-1} salinities.

Whole-body composition indicated higher protein deposition associated with treatment 9 (45% protein and 45 g L^{-1} salinity) that was not significantly different from the other treatments except treatment 5 (35% protein and 35 g L^{-1} salinity) (Table 4). In contrast, highest fiber deposition was associated with treatment 5. Dietary protein and salinity levels had no significant effects ($p<0.05$) on the energy, lipid, ash and NFE deposition.

Discussion

Present study indicated that *F. indicus* (from Oman Sea and Persian Gulf) is also a very successful hypo- and hyper- osmoregulator during postlarval and juvenile stages like what Kumlu and Jones (1995) reported for early postlarval stages from Indian waters. But this race is closer to the Red Sea race (Bukhari et al. 1997) than the Indian race (Kumlu and Jones 1995) because of their growth performance and survival that were better in higher salinity in comparing to lower salinity (first experiment). It could be that *F. indicus* (from Oman Sea and Persian Gulf) is a distinct physiological strain adapted to high saline condition. This has important repercussions for the aquaculture industry as it becomes possible to select broodstock physiologically suited to particular nursery and grow-out salinity regimes. Harpaz and Karplus (1991) suggested that the difference in salinity tolerance between *P. semisulactus* populations in the Philippines (Valencia 1977) and in the Mediterranean (Samocha 1980 cited in Harpaz and Karplus 1991) may be due to inherent differences between the two populations. The optimal salinity for this race was similar to others (Bukhari et al. 1997; Kumlu and Jones 1995) and it was 20-30 g L^{-1} salinity in first experiment and 25 g L^{-1} salinity in the second experiment. Vijayan and Diwan (1995) reported that the optimum level of salinity for better performance of *P. indicus* was 15 g L^{-1}, while they used 5 levels of salinity (5, 15, 25, 35 and 45 g L^{-1}). Kumlu and Jones (1995) showed that *P. indicus* postlarvae grown at 25 g L^{-1} salinity without acclimation exhibited the best growth and survival between PL7 and PL22. Following a 10 day acclimation period, the postlarvae from PL20 and PL 60 reared at various salinities

Table 4. Body composition (100 % dry weghit) of *F. indicus* related to dietary protein and salinity (Experiment Π)[1]

		Body composition					
		Protein (%)	Fat (%)	DE (Cal/100g)	Fiber (%)	Ash (%)	NFE (%)
Salinity (g L^{-1})	Diet						
25	1	70.90±0.25 ^{b}	4.50±0.33 ^{a}	366.2±2.09 ^{a}	5.74±0.12 ^{a}	14.09±0.15 ^{a}	4.78±0.21 ^{a}
25	2	70.33±0.35 ^{ab}	4.85±0.29 ^{a}	367.5±1.63 ^{a}	6.05±0.16 ^{ab}	14.19± 0.14 ^{a}	4.58±0.48 ^{a}
25	3	70.29±0.33 ^{ab}	4.77±0.26 ^{a}	366.6±2.48 ^{a}	5.88±0.13 ^{ab}	14.32± 0.36 ^{a}	4.74±0.32 ^{a}
35	1	70.01±0.28 ^{ab}	4.49±0.27 ^{a}	364.6±2.49 ^{a}	5.74±0.11 ^{a}	14.46±0.35 ^{a}	5.28±0.12 ^{a}
35	2	69.85±0.20 ^{a}	4.22± 0.25 ^{a}	363.4±1.93 ^{a}	6.25±0.18 ^{b}	14.42±0.21 ^{a}	5.27±0.41 ^{a}
35	3	70.21±0.35 ^{ab}	4.87±0.27 ^{a}	366.8±1.64 ^{a}	6.05±0.14 ^{ab}	14.39±0.11 ^{a}	4.47±0.42 ^{a}
45	1	70.63±0.28 ^{ab}	4.51±0.19 ^{a}	366.4±1.09 ^{a}	5.71±0.12 ^{a}	14.04±0.15 ^{a}	5.11±0.35 ^{a}
45	2	70.34±0.21 ^{ab}	4.86±0.25 ^{a}	367.4±1.22 ^{a}	5.94±0.12 ^{ab}	14.23±0.14 ^{a}	4.64±0.32 ^{a}
45	3	70.97±0.14 ^{b}	4.59±0.23 ^{a}	367.6±1.73 ^{a}	5.93±0.13 ^{ab}	13.83±0.21 ^{a}	4.67±0.32 ^{a}
Protein		ns [2]	ns	ns	*P<0.05*	ns	ns
Salinity		*P<0.05*	ns	ns	ns	ns	ns
Protein × Salinity		ns	ns	ns	ns	ns	ns

[1]Mean± S.D of three replicates. Numbers within the same column with different superscripts are significantly different *(p<0.05)*.
[2]ns = not significant (p>0.05). DE= Digestible energy; NFE= Nitrogen free extraction

(10, 20, 30, 35, 40, 50 g L^{-1}) displayed the best performance (growth, survival, total biomass) at salinities between 20 and 30 g L^{-1}, which has close similarity with our result. Optimum salinity for other species of penaeid shrimp is also different such as: less than 15 g L^{-1} for *L. Vannamei* (Olge et al. 1992; Bray and Lawrence 1993; Bray et al. 1994; Samocha et al. 1998), between 15-30 g L^{-1} for *P. monodon* (Parado-Estepa et al. 1993; Parado-Estepa 1998) *Farfantepenaeus californiensis* (Villarreal et al. 2003) and higher salinity for *Metapenaeus monoceros* (Kumlu et al. 2001).

With regard to this fact, there is an interaction between dietary protein level and salinity on growth (Woo and Kelly 1995) and there is abundant literature on the metabolic and growth response of fish acclimated to different salinities (all papers in Woo and Kelly 1995). Thus in our second experiment, dietary protein level and salinity interact to affect the growth of Indian white shrimp.

Regardless of dietary protein level, growth rates of *F. indicus* cultured at 25 g L^{-1} salinity were consistently higher than those at other salinities. This phenomenon was maybe due to reduction of the metabolic cost of osmoregulation (cited in Woo and Kelly 1995). Similar findings have also been observed for sea bream (Woo and Kelly 1995).

But in any salinity condition, shrimps require different protein levels. They need higher protein in lower salinity and, conversely, lower protein in higher salinity. It may be due to a reorganisation of metabolism which would allow protein sparing in favor of shifting towards carbohydrate and lipid utilization. Similar results are reported by Shiau et al. (1991). They suggested that the optimal dietary protein level for *P. monodon* was about 44% in brackish water (16 g L^{-1}) and 40% in sea water (32 g L^{-1}). Rosas et al. (2001) reported that the growth rate of *Litopenaeus vannamei* depended on the combination salinity–dietary Carbohydrate–protein level. The maximum growth rate was obtained in shrimps maintained at 15‰ salinity and with a diet containing low carbohydrate and high protein, but in higher salinity (45 ‰) growth performance of this shrimp was better in low protein.

Colvin (1976) reported that 43% protein based diet with the P/E ratio of 110 mg/kcal and gross energy of 4716 cal/g attained optimum growth and feed efficiency for *Penaeus indicus*, which also has close similarity with this study. Gopal and Paul Raj (1993) reported that protein of 30-40 % in view of growth and survival was better for *P. indicus* and protein amount more than 40% caused to reduce growth. Sadhana and

Neelakantan (1996) showed that growth performance of *P. indicus* increased when dietary protein increased from 34.5 to 42% and after this, growth decreased.

The present study strongly advocates using a combination of 25 g L^{-1} salinity and 40% protein diet for culture of *F. indicus*. Meanwhile for 35 and 45 g L^{-1} salinities, it is better to use 35% dietary protein.

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