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EFFECTS OF DIETARY BETA-GLUCAN ON GROWTH AND BODY COMPOSITION OF *MACROBRACHIUM ROSENBERGII*

S. J. MESHRAM* H. SHIVANANDA MURTHY, H. S. SWAIN, H. ALI, T. D. JAGADEESH AND H. B. DHAMGAYE
Department of Aquaculture, College of Fisheries, (KVAFSU), Kankanady,
Mangalore - 575 002, Karnataka, INDIA
e-mail: aaryameshram@gmail.com

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***Corresponding author**

ABSTRACT
The experiment was carried out on Freshwater prawn, *Macrobrachium rosenbergii*, reared for a period of 60 days with a dietary supplementation of beta-glucan to evaluate the effect on growth, body composition and water quality changes. Juvenile of *Macrobrachium rosenbergii* (with initial weight of 0.34 ± 0.01 g) were fed with beta-glucan incorporated diets at levels 0, 1, 2 and 3 g/kg of feed. The final weight of the prawn at the end of the experiment were 1.22g, 1.31g, 1.19 g and 1.13g fed with beta-glucan incorporated diets at levels 0, 1, 2 and 3 g/kg of feed respectively. There was no significant difference observed ($p > 0.05$) in growth of experimental groups, however significant ($p < 0.05$) survival rate (84%) was observed in prawn fed with 1 g/kg beta-glucan incorporated diet as compared to other treatments. Proximate composition showed no significant difference ($p > 0.05$) among groups. Water quality parameters observed within the tolerance limits for *M. rosenbergii* during the experimental period. These results reveals that supplementation of dietary β-glucan 1g/kg could improve survival rate without affecting body composition in *M. rosenbergii* juvenile culture.

INTRODUCTION

The giant freshwater prawn, *Macrobrachium rosenbergii* (de Man) commonly known as scampi is an economically important cultured freshwater prawn throughout the world and has commanded significant attention in tropical freshwater aquaculture. The scampi is native to Southeast Asian countries and being cultured in India, China, Bangladesh, Vietnam, Malaysia, Thailand, Taiwan, Brazil, Ecuador and USA. Global level current aquaculture production of *M. rosenbergii* contributes to 215029 t and the China is on the top with (125203 t) production, followed by Bangladesh (30636 t) and Thailand (25606 t). While India ranks at fourth position (13525 t) in the world aquaculture production (FAO, 2010). In India, the production of *M. rosenbergii* in 2005 was higher (42820 t) which was continuously decreased in last few years from 2006-2009 (30115-6600 t). Again it was dramatically found some increased trends to (13525 t) in production (FAO, 2010). Major constraints like diseases, feed cost, seed availability, water quality and inadequate nutrition are responsible for fluctuation of *M. rosenbergii* production. The dietary supplementation of proper nutrients helps in improving growth, survival and FCR of prawn. In recent day's attention has been paid for use of some nutraceutical products derived from yeast like β-glucan, nucleotide, mannan oligosaccharide (MOS) and organic selenium as dietary supplements, which helps in promoting growth and survival in fish and shellfish (Sakai, 1999; Ganguly *et al*., 2010). Also use of these types of nutraceutical products will helpful to minimize the use of antibiotics in aquaculture, which will be serve as one of the solution for eco-friendly aquaculture.

Beta-glucan is naturally a occurring polysaccharide derived from yeast *Saccharomyces cerevisiae* with glucose as structural component, linked by β-glycosidic bonds. Dietary administration of beta-glucan in aquaculture was reviewed (Meena *et al*., 2013). Different workers have tested supplementation of β-glucan in crustacean growth and survival are *Litopenaeus vannamei* (Chotikachinda *et al*., 2008 and Murthy *et al*., 2009), *Penaeus latisulcatus* (Hai and Fotedar, 2009), *Fenneropenaeus indicus* (Sajeevan *et al*., 2009). Lopez *et al*. (2003) reported the physiological, nutritional role of dietary β-1-3-glucan and ascorbic acid in *Litopenaeus vannamei*. Studies have been carried out on different fish species such as *Labeo rohita* (Misra *et al*., 2006), nile tilapia (Whittington *et al*., 2005), have shown the effect of β-glucan on growth and survival. Realizing the importance of nutraceutical in prawn diets, the research theme was conceptualized with objective to evaluate the effect of β-glucan on growth and biochemical composition of giant freshwater prawn *Macrobrachium rosenbergii* and water quality changes cultured in recirculatory aquaculture system (RAS).

MATERIALS AND METHODS

Feed ingredients and diet formulation

The ingredients used in the formulation of experimental diets and proximate composition of diets are presented in Table 1. The basal diet was supplemented with β-glucan. All the

ingredients mixed thoroughly and pelletized with 1.2 mm size (Hardy, 1980). Experimental diets were supplemented with β-glucan at levels of 0, 1.0, 2.0 and 3.0 g/kg (Table 1).

Experimental protocol

The study was carried out in the indoor closed recirculatory system (RAS) consisting of 12 fiberglass reinforced plastic (FRP) tanks having 120 l capacity for a period of 60 days in three replicated groups. The post larvae (PL-20) produced in the Freshwater Prawn Hatchery at the College of Fisheries, Mangalore were reared in cement tanks for two months and juveniles (0.34 ± 0.01 g) were utilized for the experiment. Prawns were stocked in the experimental tanks at a rate of 50 numbers per tank and were fed at the rate of 5% of biomass twice daily. Fecal matter and uneaten food was removed daily. Water samples were determined by following standard methods (APHA, 1995). The prawns were sampled and weighed on an electronic balance (Essae, India) to assess the growth. Growth parameters were assessed after completion of experiment. Body compositions were analyzed for moisture, crude protein, crude fat, and ash employing standard methods (AOAC, 1975). Data were analyzed statistically by using one way analysis of variance (ANOVA) followed by Duncan's multiple range tests by using SPSS software (16.0 versions).

RESULTS

Water quality parameters

The average fluctuation of water quality was recorded and it is presented in Table 2. There were no significant differences found among water quality in experimental groups. Temperature of water of experimental tanks was 28.4ºC. The pH showed alkaline during experimental period and ranged from 8.27 to 8.72. The average value of dissolved oxygen was ranged from 7.50 to 8.64 mg/L. The free carbon dioxide ranged from 0.83 to 1.11 mg/L. The average values of total ammonia-nitrogen were ranged between 0.04 to 0.08 mg/L. The average values of total alkalinity were varied from 77.68 to 78.19 during experimental period.

Table 1: Ingredients used in the preparation of experimental diets and proximate composition of feed

Ingredients(g/kg)	Dietary treatments (β-glucan)			
	0.0	1.0	2.0	3.0
Fish meal	200	200	200	200
Groundnut oil cake	300	300	300	300
Shrimp meal	100	100	100	100
Rice bran	100	99.00	98.00	97.00
Wheat flour	150	150	150	150
Soya flour	100	100	100	100
Vit.- mix.*	50	50	50	50
Beta-glucan	0.00	1.00	2.00	3.00
Proximate analysis (%)				
Moisture	6.50	4.95	5.40	5.86
Crude protein	35.09	35.22	35.35	35.48
Crude fat	7.52	5.68	6.10	7.42
Ash	15.05	15.20	15.35	15.70

*Vitamin-mineral mixture (Agrimin Forte)- Vitamin A-7,00,000 IU, Vitamin D_3- 70,000 IU, Vitamin E-250 mg, Nicotinamide-1000 mg, Cobalt-150 mg, copper-1200 mg, Iodine-325 mg, Iron-1500 mg, Magnesium-6000 mg, Manganese-1500 mg, Potassium-100 mg, Sodium-5.9 mg, Sulphur-0.72%, Zinc-9600 mg, Calcium-25.5%, Phosphorus-12.75%

Growth studies

The increase in weight of prawn in different experimental treatments and growth parameters (survival percentage, specific growth rate, feed conversion ratio, protein efficiency ratio and weight gain) are presented in Table 3. It was observed that there was no significant difference ($p > 0.05$) in terms of weight in different experimental groups. Highest average weight was recorded in treatment 1 g/kg was (1.31 g), followed by control (1.22 g), 2 g/kg (1.19 g) and 3 g/kg (1.13 g) after 60 days of culture (Table 3). However significant survival percentage ($p < 0.05$) was observed in dietary treatment 1 g/kg as compared to other groups (Table 3). There were no significant differences ($p > 0.05$) in experimental groups in terms of specific growth rate, FCR, PER and weight gain.

Biochemical composition

At the end of experiment, prawn body composition was estimated and presented in Table 4. There were no significant differences ($p > 0.05$) found in experimental groups in terms of moisture, crude protein, crude fat and ash percentage. However decrease in protein percentage and increase in fat percentage was observed in prawn body as to beta-glucan level was increased.

DISCUSSION

Successful aquaculture depends on providing animals with a satisfactory environment (Boyd and Tucker, 2009). Earlier studies reported ideal and optimum water quality parameters in *M. rosenbergii* culture (Boyd and Zimmermann, 2004). In the present study water quality parameters were ranged within the tolerance limit for *M. rosenbergii*.

Use of nutraceuticals product provides nutrients and thus helps to improve growth performance (Paliyath *et al.,* 2012). It includes use of products like, phytochemicals in livestock (Niwas *et al.,* 2013), prebiotics and probiotics in aquatic animals (Ganguly *et al.,* 2010), which helps to improve growth by altering intestinal integrity of host animals. These products contain materials like carbohydrate, MOS and beta-glucan, which are derived from yeast (prebiotics), live bacteria *Bacillus* species (probiotics) and also from some plant extracts like *Bambusa balcooa* shoots (Singh *et al.,* 2012). Previous studies reported that dietary yeast β-glucan at lower levels (1-2 g/kg) showed no significant difference in growth however, survival rate observed significantly higher in the marron, *Cherax tenuimanus* (Huynh and Fotedar, 2010), in *Litopenaeus vannamei* (Murthy *et al.,* 2009) and in *L. rohita* (Andrews *et al.,* 2011). Similarly in the current study, there was no significant difference observed in growth parameters of prawns among the groups after 60 days of culture however, significantly higher survival rate were recorded in 1 g/kg beta-glucan supplemented group.

On the contrary earlier studies reported nutraceutical products like beta-glucan had shown its positive effects on growth and survival of *Litopenaeus vannamei*, in combination with probiotics (Rodregeuz *et al.,* 2007) vitamin C and other immunostimulants (Lopez *et al.,* 2003), in *M. rosenbergii* fed on 0.2% plant extract of *Centella asiatica* (Salini *et al.,* 2013) and in *Cyprinus carpio* koi fed with 0.9 g/kg beta-glucan showed significantly enhanced growth in terms of weight (Lin

Table 2: Water quality parameters recorded in different experimental tanks

Water parameters	Dietary treatments (β-glucan g/kg)			
	0.0	1.0	2.0	3.0
Temperature (°C)	28.4 ±0.00	28.4±0.00	28.4±0.00	28.4±0.00
pH	8.56± 0.1	8.72 ± 0.3	8.48 ± 0.1	8.27 ± 0.1
Dissolved oxygen (mg/L)	7.83± 0.5	8.03± 0.2	7.50± 0.1	8.64± 0.3
Free carbon dioxide (mg/L)	0.83± 0.4	1.03± 0.1	0.97± 0.3	1.11± 0.3
Total ammonia- nitrogen (mg/L)	0.04± 0.3	0.04± 0.6	0.06± 0.5	0.08± 0.8
Total alkalinity (mg/L)	78.19± 0.2	77.82± 0.1	77.85± 0.2	77.68± 0.1

Table 3: Growth parameters of *Macrobrachium rosenbergii* fed with different beta-glucan levels over the 60 days feeding trial

Growth parameters	Dietary treatments (β-glucan g/kg)			
	0.0	1.0	2.0	3.0
Initial body weight (g)	0.34 ± 0.00	0.34 ± 0.01	0.35 ± 0.00	0.34 ± 0.00
Final body weight (g)	1.22 ± 0.06[a]	1.31 ± 0.02[a]	1.19 ± 0.02[a]	1.13 ± 0.01[a]
Weight gain (g)	0.88 ± 0.06	0.96 ± 0.01	0.84 ± 0.02	0.77 ± 0.01
Specific growth rate (%)	2.09 ± 0.07	2.21 ± 0.03	2.04 ± 0.05	1.93 ± 0.04
Feed conversion ratio	2.73 ± 0.16	2.52 ± 0.02	2.73 ± 0.06	2.84 ± 0.07
Protein efficiency ratio	1.04 ± 0.05	1.12 ± 0.01	1.03 ± 0.05	0.99 ± 0.06
Survival (%)	69.33 ± 1.76[a]	84.00 ± 1.15[d]	76.00 ± 1.15[c]	72.66 ± 1.76[b]

Means of three replicates ± Standard Error, Different superscript indicate significant difference ($p < 0.05$)

Table 4: Biochemical composition of prawn meat taken from different treatments (% on dry weight basis)

Parameters	Dietary treatments (β-glucan)			
	0.0	1.0	2.0	3.0
Moisture[a]	80.86 ± 0.3	80.13 ± 0.1	80.25 ± 0.4	80.33 ± 0.2
Crude protein	21.80 ± 0.2	21.90 ± 0.3	21.88 ± 0.1	21.83 ± 0.6
Crude fat	1.4 ± 0.4	1.1 ± 0.3	1.2 ± 0.1	1.3 ± 0.4
Ash	5.3 ± 0.3	5.2 ± 0.6	5.6 ± 0.2	5.8 ± 0.1

Means of three replicates ± Moisture on wet weight basis

et al., 2011). The results suggest that use of nutraceutical product should be studied before advocate to any species.

The body composition of fish is strongly affected by the composition of their food (Orban *et al.,* 2007). This aspect is also important in relation with nutritional value of prawn for consumer point of view (Dinakaran and Soundarapandian, 2009). In the current study, there were no significant differences recorded in body composition among groups after 60 days of culture. However, decreased trend was observed in protein percentage of prawn meat with the increased β-glucan inclusion level in diet. There are not many published reports especially on the effect of beta-glucan incorporated diets on body composition of fish muscle and prawn meat. Some previous studies of dietary yeast derivatives were reported no significant differences ($p > 0.05$) in body composition of *Astacus leptodactylus* juvenile among groups fed on MOS (Mazlum *et al.,* 2011), *M. rosenbergii* fed on nucleotide supplemented diets (Shankar, 2008), *Labeo rohita* fed on MOS incorporated diets (Jagadeesh, 2010) and *P. semisulcatus* fed on dietary MOS diets (Genc *et al.,* 2007). The results obtained in the present study suggest that β-glucan inclusion does not affect the body composition in prawn meat.

CONCLUSION

The results of the present study indicated that supplementation of dietary β-glucan 1g/kg has no effect on growth, however, it has improved survival without affecting body composition in *M. rosenbergii* juveniles.

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