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Growth performance effect of dietary fish meal quality in shrimp *Litopenaeus vannamei*

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Abstract
The objective of this experiment was to evaluate three fish meal sources added to diets for the shrimp, Fishmeal quality is major important consideration for the aquatic animals especially shrimp *Litopenaeus vannamei*, however, it varies widely depending on raw material sources and processing methods. A ten-week feeding trial was conducted using six formulated diets to examine effects of fishmeal quality on growth performance, protein digestibility in *Litopenaeus vannamei*. Each test diet was fed four times daily to four groups of shrimp with an average initial weight of 2 g shrimp -1. The shrimp fed D-1 (FM-1) and d-2 (FM-2) feed attained high body weight, specific growth rate with the best feed conversion ratio (FCR). Growth of shrimp fed D-3,4 (FM-3 & 4) was less than D-1 (FM-1) because containing diets were inferior to those of FM-1 fed group. The d-5 (FM-5) diet-fed group showed the slowest growth and feed utilization efficiency than all the other groups.

Keywords: Fish meal, shrimp growth, *vannamei*, nutrition

1. Introduction
The Pacific white shrimp *Litopenaeus vannamei* is a commercially important cultivable crustacean species that is being widely farming in globally because of its rapid growth, delicious taste and high survival rate in high-density culture [1]. Fishmeal is a brownish powder which contains a rich source of animal protein, lipid, and minerals. World fish meal production, about 90% is produced from oil-rich fish species like a sardine, anchovy, capelin, and menhaden, and less than 10% from white fish offal (frames), such as cod and haddock, global annual catch of marine fish, about one-third is used for fish meal production, it is due to being sustainable catches for which there is no direct outlet for human consumption [2].
Fish meal and fish oil are natural ingredients which are coming from the wild fish catch having high nutritional value and are the main ingredients in aquaculture feeds because fish meal provide essential amino acids and lipids needed for an animal's development. Fish meal is a rich source of high-quality animal protein with well-balanced major amino acids. In this view of its advantages, aquaculture has continued to increase the demand for fish products during the last few decades. Moreover, provender and fish oil offer a balanced quantity of the most essential minerals, phospholipids, and fatty acids, that facilitate to extend the expansion rate and production yields. Fish oil is a great source of omega-3 eicosapentaenoic fatty acid (EPA) and docosahexaenoic fatty acid (DHA), which are not made by the fish but become concentrated further up the food chain from the marine phytoplankton. However, good quality processed fish meal and fish oil are generally expensive due to availability and quality.

2. Materials and Methods
Five diets were formulated using different grades and sources of fish meal, first grade FM-1 (70% protein), FM-2 (68% protein) produced from sardine, second grade FM-3 (65% protein) produced from sardine, third grade FM-4 (65% protein) produced by mixing grade FM-5 (55.22% protein) produced from fish and shrimp processing by-products. The diets contained crude protein and lipid at 40% and 10% of diet, respectively. The composition of experimental fish meal diets is shown in Table 1.
The coarse ingredients were finely ground and sieved through 30 mesh sieve screen. Dry Good quality fishmeal having rich nutritional content and suitable balance of essential amino acids is in high demand and vital for shrimp and carnivorous fish feed production, especially when used in combination with inferior alternative protein sources.

However, incorporating the premium quality fish meal of similar protein level from different sources into a shrimp diet does not guarantee good shrimp growth and production. This may be due to fish species, fishing methods, types of raw materials source (fish variety, whole fish, processing by-products or seasonal availability, by-catch), raw material freshness and processing methods of fishmeal production that resulted in different essential amino acid composition, essential amino acid/non-essential amino acid ratio and modification of protein structure affecting protein digestibility.

All the selected feed ingredients were mixed using Hobart mixer for 10 min then lecithin and oil were gently added and mixing was extended for 5 min. pure water was gradually added at 35% of diet and mixing was continued for another 10 min. The resulting mash was pelleted using a pellet mill with a 2 mm diameter pore size die and cut into 2 mm length. Pelleted diets were dried at 60 °C for 24 h. The dried formulated diets were sieved through a 2 mm diameter mesh screen for remove small pellets and dust particle and feed stored in polyethylene bags at room temperature (25-28 °C) until used. The proximate composition of feed ingredients and formulated experimental diets were determined according to AOAC [3].

Diet leaching test was performed using three replicates according to the method modified from Cruz-Suarez *et al*. (2001) [4]. Five grams of the feed pellets were put in fine mesh baskets and submersed in seawater for 1 h with aeration simulating cultured condition in glass aquarium tanks under the temperature of 27-28 °C. The percent dry matter loss (% DML) shown in Table 1.

Table 1: Proximate composition (% as fed basis) and leaching loss (dry matter basis) of experimental diets.

Proximate composition (% as fed basis) and leaching loss (dry matter basis)					
Experimental diet	**D1 (FM-1)**	**D2 (FM-2)**	**D3 (FM-3)**	**D4 (FM-4)**	**D4 (FM-5)**
Crude Protein	44.5	42.6	40.5	39.8	39.5
Crude Fat	11.4	11	10.5	10	9.8
Ash	11.68	11.81	11.57	13.82	15.44
Leaching loss (%)	11	11	12	10	11

% DML = 100 x (DWd-DWwid)/DWd

Where DWd and DWwid = dry matter weights of the diet before and after submersion, respectively.

2.1 Experimental Growth trial

Shrimp *L. vannamei* post larvae were obtained from a local farm near Muthukuru, Nellore. The shrimp were stocked and acclimatized in an FRP tank for 10 days and fed a commercial feed which contained 40% protein and 5% lipid. Thirty shrimp with an individual initial weight of 2.50±0.01 g were selected and randomly distributed into each of 65-70 liters FRP experimental tanks containing 18-20 ppt salinity brackish water, pH ranged 7.5-8.4 and water temperature ranged from 26-30°C with artificial aeration facility.

Five experimental tanks were randomly assigned to four replicated tanks and fed the respective formulated diets. Feeding was done by hand to satiation, determined by slow approach or no response of shrimp to the diet, four times daily at 7.00 am, 11.00 am, 3.00 pm and 6.00 pm for ten weeks. Amount of given feed was recorded daily and uneaten feed was collected for feed intake correction. During the feeding time, shrimp were monitored for feeding and abnormality, mortality. After ten weeks of feeding, shrimp were individually weighed to obtain the final weight.

2.2 Growth performance and feed utilization evaluation

Initial weight, final weight, mortality, amount of eaten feed and proximate protein composition of shrimp were used for calculation of the following parameters:

- Survival rate (%) = Final number of shrimp x 100/Initial number of shrimp
- Weight gain (g shrimp^{-1}) = = Final weight (g shrimp^{-1}) – Initial weight (g shrimp^{-1})
- Specific growth rate (SGR, % day^{-1}) = (ln W2-ln W1/T2-T1) x 100
- W1 = initial weight, W2 = final weight, T2-T1 = cultured period (days)
- Feed conversion ratio (FCR) = Feed intake (g shrimp^{-1}) /Weight gain (g)

2.3 Statistical analysis

Growth performance, survival rate, feed utilization efficiency, protein digestibility and trypsin gene expression data were analyzed using analysis of variance to determine if significant difference ($p< 0.05$) existed among treatments Table 2 and Table 3.

3. Results and Discussion

The present research work was conducted to assess quality of fish meals related to shrimp growth responses, and feed utilization efficiency. The growth performance of the fish meal in shrimp *L.vannamei* was observed in experimental diets D1, D2, D3, D4, and D5 was 12.9g, 21.6g, 12.4g, 12g and 11.8 respectively with average specific growth rate ranged from 2.83-2.96g and survival rate observed high in D1, D2 whereas observed low survival rate and growth was observed in D3, D4 and D3 shown in Table 2. The reduced growth and high feed conversion ratio found in this study may be related to the lack of supplementation of methionine and threonine in of fish meal incorporated diets [5].

Studies reported that shrimps and red sea bream fed the diets formulated using good quality fishmeal showed significantly better feed conversion ratio, weight gain, and protein digestibility than those fed low-quality fishmeal and Peruvian fishmeal containing diets [6]. Similarly, Atlantic salmon fish fed with the diet containing amino acid imbalance protein due to the processing in high temperature gave lower growth than those of the control because of high disulfide groups formed during meal processing affected the utilization efficiency of the diet [7].

Table 2: Growth performance of *L. vannamei* fed diets containing different fishmeal qualities for 10 weeks.

Experimental diet	Final weight (g shrimp)	Weight gain (g shrimp)	SGR (%)	Survival rate (%)
D1 (FM-1)	12.9±0.82	10.9±0.91	2.96±0.08	89
D2 (FM-2)	12.6±0.76	10.6±078	2.91±0.05	86
D3 (FM-3)	12.4±0.72	10.2±0.68	2.84±0.06	82
D4 (FM-4)	12±0.68	10±0.72	2.83±0.08	76
D4 (FM-5)	11.8±0.67	9±0.53	2.89±0.04	68

The feed intake and feed utilization efficiency of the shrimp in experimental diets D1, D2, D3, D4, and D5 was 9.79, 10.16, 10.24, 10.19 and 12.51 in the experimental diets the fish meal diet D1 shown very less feed consumption among the all experimental diets, and it observed feed conversion

ratio in experimental diets D1, D2, D3, D4, and D5 was 1.2,1.4,1.4,1.5and 1.5 respectively among all the diets the D1 observed that low feed utilization 9.7 gm. with effective feed conversion ratio, 1.2% were observed than all the remaining diets shown in Table 3.

Table 3: Feed utilization efficiency of *L. vannamei* fed with formulated diets containing different fishmeal qualities for 10 weeks.

Experimental diet	Feed intake (g shrimp)	FCR (g shrimp)
D1 (FM-1)	9.79±0.68	1.2±0.16
D2 (FM-2)	10.16±0.76	1.4±0.13
D3 (FM-3)	10.24±0.43	1.4±0.11
D4 (FM-4)	10.19±0.41	1.5±0.09
D4 (FM-5)	12.51±0.55	1.5±0.08

The effects of different quality fish meal on shrimp growth performance were observed in the present study. Overall, growth responses of shrimp fed FM diets significantly outperformed those fed the high grade FM. Although there were no statistical differences in weight gain and SGR within the FM-4 and 5 fed groups, shrimp fed the FM-1, and FM-2 diet showed the highest weight gain and SGR with the best FCR. From the present study it was found that there are many fish meal originated by-products, which contains a lot of nutrients. So these by–products may be used in feed formulation for the contentment of nutrients requirements of specific aqua culture species. In the present study eight feed ingredients

The best growth performance and feed utilization of FM-1 fed group was due to good quality protein with higher levels of essential amino acids, good amino acid balance and high EAA/NEAA ratio of the diet. Shrimp fed this diet also had good feed intake and protein digestibility, which would provide greater amount of amino acids for muscle growth than other groups may be growth depression due to amino acid imbalance of protein sources was also found in *L. vannamei.* Significantly, the lowest growth of imported FM diet fed shrimp was due mainly to low feed intake, low protein digestibility and lower ratio of EAA/NEAA than other diets. In spite of high protein content FM that produced from pelagic fish, a long shipping and storage time necessitated inclusions of antioxidant to prevent lipid oxidation which may affect acceptance and intake of diet in shrimp. Laohabanchon, *et al*. (2009) [8] reported that black tiger shrimp, *Penaeus monodon*, fed the diet with long storage time and ethoxyquin treated fish meal had lower feed intake, slow growth were observed.

4. Conclusion

Growth performance and feed utilization of shrimp could be divided into three groups; the highest growth in D-1 and grade D-2 diet-fed shrimp, and significantly the lowest growth in other D-4,5 fed diets shrimp than D-1,2,3. Domestic premium grade fishmeal produced from a single species gave the best growth performance, the highest protein digestibility and utilization, and the highest trypsin gene expression. The present study clearly demonstrated that the quality of fish meal affected growth performance and feed utilization of shrimp *L. vannamei* mainly by protein digestibility, a rich source of amino acid composition and good feed intake.

5. References

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