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COMPARATIVE EVALUATION OF ISO-NUTRITIONAL MASH AND PELLET FEED UNDER MIXED CULTURE CONDITIONS OF INDIAN MAJOR CARP ROHU (*LABEO ROHITA*) AND MRIGAL (*CIRRHINUS MRIGALA*)

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ABSTRACT

Comparative evaluation of iso-nutritional mash and pellet feed (crude protein- 22%) were assessed for 96 days of culture in outdoor experimental tanks (180 L) subjected to mixed culture of column- bottom feeder, Rohu (*Labeo rohita*) and bottom feeder, Mrigal (*Cirrhinus mrigala*) under Indian pond culture protocols of management practices. Though, the feed types (mash and pellet) were not influential in determining the growth rate of the test fishes, the higher overall mean value of feed conversion ratio (FCR) in pellet feed (9.21) indicated that it was less effective compared to the mash type of feed.

FCR maintained almost a steady level during the first half of the investigation period after which, the value increased sharply for both the feed types tested. Net protein utilization (NPU) and protein efficiency ratio (PER) continued to decline sharply during the period of investigation in both feed types tested. The average value of NPU and PER for mash feed (5.98 and 1.36) did not differ much to that of pellet feed (5.93 and 1.345). As the body weight of fish increased overtime with concomitant decline in the values of PER and NPU as well in both the feed types tested, the relationships between them became inversed and were fitted either by polynomial or linear models.

Therefore, it was obvious that the test fish as advanced fry required more protein during the initial phase of their culture. Absence of any significance difference in FCR between the two physically different feed types with iso-nutritional properties indicated that nutritional quality not the feed types acted as determinants for the feeding efficiency in terms of FCR. Therefore, for culture of omnivorous Indian carps *viz*. rohu and mrigal ordinary mash feed is equally effective with costly pelleted feed under manured culture condition as supplementary feed.

KEYWORDS: ISO-Nutritional Feed, *Labeo rohita*, *Cirrhinus mrigala*, FCR, NPU, PER

INTRODUCTION

Aquaculture has established itself as an effective livelihood for a large section of economically under-privileged population in India. Asian aquaculture is dominated by semi-intensive freshwater, earthen pond culture systems. In these systems natural productivity is enhanced with fertilizers and the fishes are provided with supplemental feeds (De-Silva and Hasan, 2007). India is the second largest aquaculture producer in the world. Aquaculture contributed 45 % of the country's total fish production of 6.98 million tonnes in 2006. Most carp production in India is made through extensive, polyculture systems. The three Indian major carps, namely catla (*Catla catla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) contribute the bulk of production of over 3.02 million tonnes (FAO, 2006) followed by silver carp, grass carp and common carp forming a second important group.

Aquaculture ponds are fertilized to increase the available natural food (phytoplankton and zooplankton) for fry or larval fish, or for species that are efficient filter feeders (Brunson *et al.*, 1999). Fish can use protein, lipid and carbohydrate as energy sources (Hardy, 2000), thus, well-balanced ratio of these three dietary components is crucial for fish farming (Umer and Ali, 2009). Continued growth and intensification of aquaculture production depends upon the development of sustainable protein sources like fish meal (animal source) and oilseeds, legumes and cereal grains (plant source), which are used traditionally in aquafeed (Gatlin *et al.*, 2007).

Fish biomass production and water quality is affected by fertilizer, fish feed or both. Fish production can be increased up to 5,000 kg/ha by feeding and fertilization (Ekram, 2002). Fertilizers, fresh feed or both are manipulated in fish ponds to increase production (Lane, 2000). Supplementary feed is found to be a useful tool for providing nutrient components and energy required for better fish growth and production (Abdelghany *et al*., 2002) and is known to increase the carrying capacity of culture system thereby enhancing fish production by several folds (Nazish and Mateen, 2011). The net fish production of treatment with supplementary feed was 7.7 times greater than the treatment without feed in conducting the experiment in polyculture system (Kabir *et al.*, 2009). Artificial feed plays an important role in semi intensive fish culture where it is required to maintain a high density of fish than the natural fertility of the water can support (Jhingran, 1991).

Determination of palatability of a feed ingredient is an important criterion in the evaluation of that ingredient for fish. The growth of fish depends upon the ingredients and its percentage in the formulated feed (Glencross *et al.*, 2007). Floating feed had better results as compared to sinking pelleted feed but not for all fish species, bottom feeder species performed better on sinking feed. Yaqoob *et al.* (2010) observed that floating feed had much lower value of food conversion ratio (FCR) than sinking feed. It was also found that floating feed is better than the sinking feed for increasing productivity. There was a direct relationship between the feeding frequency and growth performance. Feeding frequency @ 3 times per day is found to be optimum for best growth, survival and feed utilization on fingerlings of *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* (Saeed *et al*., 2005; Biswas *et al*., 2006). Final weight gain and specific growth rate of black sea trout were found to be maximum with feeding frequency of supplementary feed@ three times per day (Bascinar *et al*., 2007).

The use of commercial feed has become inevitable for the success of cyprinid culture under intensive culture conditions particularly rohu along with other carps (Abid and Ahmed, 2009). The development of new species-specific diet formulations supports aquaculture industry as it expands to satisfy increasing demand for affordable, safe and high-quality fish products (Craig, 2002). There is a growing interest among the farmers to opt for pellet feed over mash feed generally used as supplementary feed in traditional polyculture of carps under pond culture conditions.

Pellet feeds are likely to be superior to mash feed as loss of nutrients out of leaching is comparatively less and wastage of feed is also minimized. Moreover, as the feed wastage is less, physico-chemical and biological conditions of the culture system under application of pellet feed might be better because of less decomposition and organic loading over application of mash type feed.

MATERIALS AND METHODS

Preparations of Cistern

Nine outdoor experimental cylindrical cement tanks (180 L) were selected for the present investigation. After thorough washing and sun drying the tanks were provided with soil base of 15 cm. and then filled with ground water (pH-7.5). All the tanks were manured with cowdung @10,000 kg/ha. as practiced in traditional pond preparation for fish farming in the locality. They were then randomly grouped into three batches in triplicate for the three systems designed. All the tanks were applied with lime @ 200 kg/ha after seven days of manure application and kept undisturbed for another seven days.

Stocking of Fish

Healthy fingerlings of *Rohu* (8.1 ± 0.2 cm; 12.75± 0.21g) and *Mrigal* (7.08 ± 0.2cm; 13.31 ± 0.21g) were collected from Naihati Fish Seed Market and acclimatized in experimental tanks for 7 days. Stocking of fish was done in two of the three batches of tanks @15 nos./tank (10 nos. of *Rohu* and 5 nos. of *Mrigal*) two weeks after application of cowdung when the colour of the water changes to greenish blue indicating development of planktonic organisms. They were reared for 96 days.

Preparation of Feed

Supplementary mash feed of 22% protein content was prepared by using the Double Pearson's Square method. Total protein input was equally distributed into animal and plant sources. Freshly collected fish meal (45 % protein) and mustard oil cake (30 % protein) were used as animal and plant sources of protein input in the designed feed respectively. Rice polish was used as carbohydrate source as well as filler, whereas, equal mixture of groundnut oil and cod liver oil @ 6 % was used to supplement essential fatty acids. The proximate composition of each of the ingredients was analyzed and different ingredients for protein and carbohydrate supplementations as required upon calculations were weighed, powered by using a mixer-grinder and mixed thoroughly. The mash was then fortified with 5% vegetable oil and vitamin-mineral mixture @ 2g/kg.

For preparation of pelleted feed, the mash was prepared with the same method and formulations and then mixed with boiled tapioca starch as binder @ 2 % to make it dough with addition of required quantity of moisture. The dough was cooked in a pressure cooker for 10 minutes and after cooking it was cooled. The cooled dough was passed through an automated pelletizer machine with dye size of 2 mm. diameter. The pellet was then sprayed with 5% vegetable oil and vitamin-mineral mixtures (@ 2g/kg) by using a hand sprayer; air dried and packaged in polythene bags with proper sealants for future use.

Feeding and Water Replenishment

Fish were fed with mash and pellet feed once daily between 9.00 a.m. to 10 a.m. @ 5% of body weight in first (M) and second (P) batches of tanks respectively. The required amount of feed was broadcasted over the water surface in both the two batches of treatments (M and P), whereas, the third batch of tanks with fish were not applied with any kind of feed which served as control (C). A fixed level of water was maintained in the experimental tanks by periodic addition of ground water to compensate the losses due to evaporation and sampling.

ANALYSES

Fish Growth

Fish growth was recorded at 15 days intervals from each cistern. Half of the stocked fish were caught randomly with a hand net and their weight (g) increments were recorded for estimation of average weight gain, specific growth rate (SGR), feed conversion ratio (FCR) and protein efficiency ratio (PER).

Net body weight gain = (Final wet body weight- Initial wet body weight)

$$\text{Body wet weight gain (\%)} = \frac{\text{(Final wet body weight – Initial wet body weight)}}{\text{Initial wet body weight}} \times 100$$

$$\text{Specific Growth Rate (\%)} = \frac{\text{(In final wet body weight) - (In initial wet body weight)}}{\text{Number of days}} \times 100$$

Feed Efficiency

To assess the efficiency of the feed, feed conversion ratio (FCR), protein efficiency ratio (PER) and net protein utilization (NPU) were calculated as follows:

Feed Conversion Ratio (FCR) = (Total dry feed fed in g / Fish weight gain in g), (De silva and Anderson, 1995).

Protein Efficiency Ratio (PER) = (g wet weight gain/ g crude protein fed), (Pfeffer, 1982).

$$\text{Net Protein Utilization (NPU)} = \frac{\text{(Final body protein – Initial body Protein)}}{\text{Total protein fed}}$$, (Cowey, 1980).

STATISTICAL ANALYSIS

All the results were subjected to statistical analysis. One way analysis of variance (ANOVA) were applied to test the significance among the treatments followed by CD test to find out significance in difference between every possible pair of treatment combinations. Correlation co-efficient (r) test was applied to establish relationship between selective parameters using appropriate software and where significant, selective variables were fitted with appropriate models to find out the nature and intensity of dependency.

RESULTS AND DISCUSSIONS

The rate of growth in terms of body weight was sharp until day 48 after which the growth rate slowed down. The differences in body weight showed significance ($F_{2,\ 20} \geq 8.54$; $P \leq 0.001$) for both the fishes but insignificant differences were observed when compared the two feed types tested (Figure 1). Though net weight gain of both the fishes among different systems did not differ significantly ($P > 0.05$) live weight gain as well as specific growth rate differed significantly ($F_{2,\ 20} \geq 4.19$; $P < 0.05$) (Figure 2). Feed conversion ratio (FCR) maintained almost a steady level during the first half of the investigation period after which, the value increased sharply for both the feed types tested (Figure 3a). The value of net protein utilization (NPU) continued to decline sharply during the period of investigation in both feed types tested. The average value of NPU for mash feed (5.98) did not differ much to that of pellet feed (5.93) (Figure 3b). The value of PER followed an identical trend to that of NPU. The average value also did not differ much between M (1.36) and P (1.345) (Figure 3c).

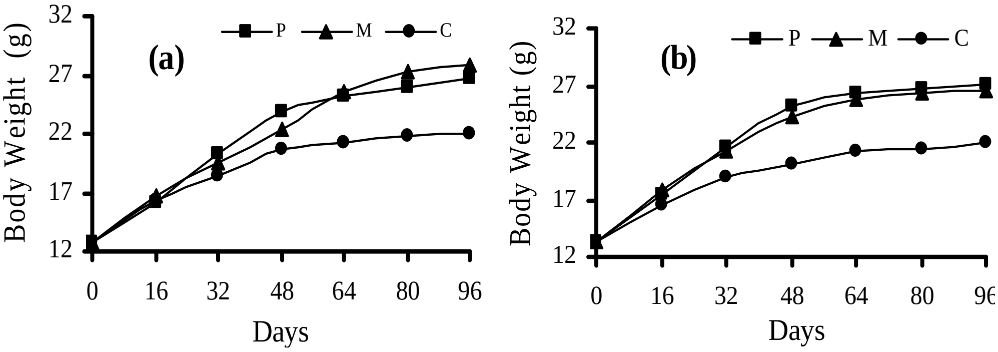

Figure 1: Temporal Changes of Body Weight of Rohu (a) and Mrigal (b) in Different Treatments Employed

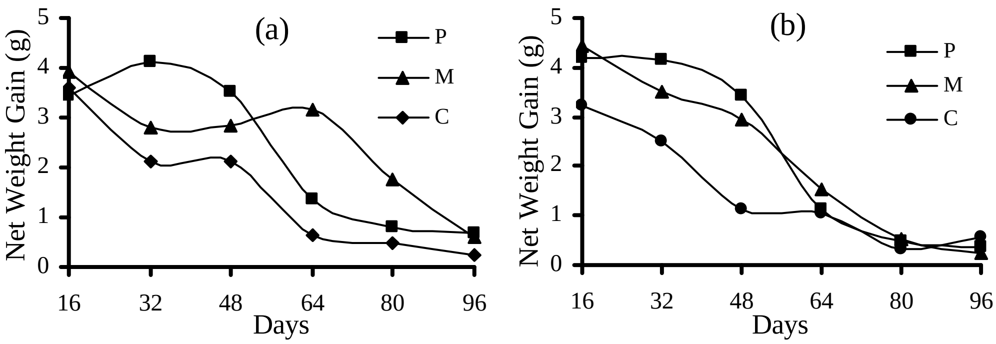

Figure 2: Temporal Changes of Net Body Weight Gain of Rohu (a) and Mrigal (b) in Different Treatments Employed

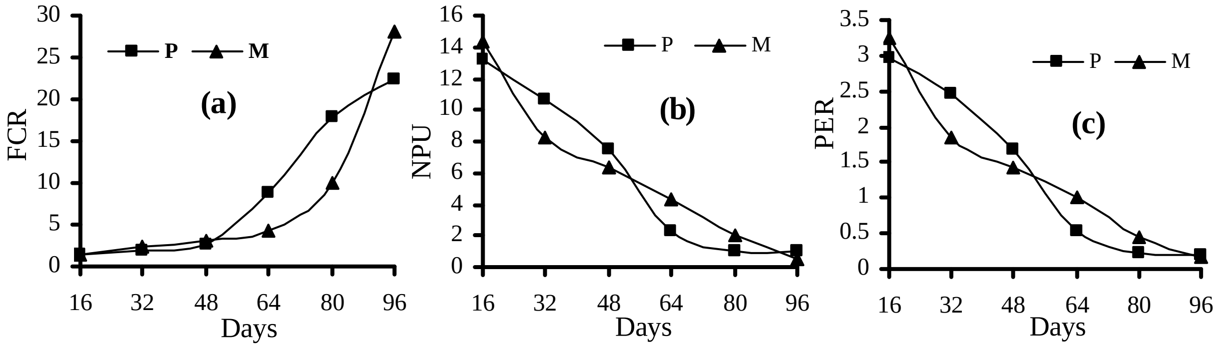

Figure 3: Temporal Changes in FCR (a) NPU (b) and PER (c) in Different Treatments Employed

It is discernable from the results of the present studies that two physical forms of iso-nutritious feed tested under mixed culture of *rohu* and *mrigal* was effective in substantially enhancing the growth of the test fishes. Specific growth rate (SGR) declined with the advancement of the study as the body weight of fish continued to increase (Figure 4, 5, 6). Singh *et al*. (1998) and Ujjania (2012) stated that growth rate of carps is more at the early stage of life and gradually decreases as the age advances. Though, bioavailability of the nutrients and the physical quality of the feed are both of great importance (Sorensen, 2007), it is apparent that nutritional composition of the feed not the physical types *viz.* ordinary pellet and dry mash was operational in contributing growth of the test fishes in the present experimental conditions. Though the feed types (mash and pellet) was not influential in determining the growth rate of the test fishes, the higher overall mean value of feed conversion ratio in P (9.21) indicated that it was slightly less effective so far feeding efficiency was concerned compared to the mash type of feed. Culture of any of the fish subjected to feeding regimes tested in the present study will not be economical beyond 48 days as the FCR value sharply increased thereafter (Figure 3a). This was because, the FCR value crossed above two (> 2) after day 48. Stickney (2005) considered FCR values of 1.5 to 2.0 as good for most aquatic organisms.

Moreover, Bergheim *et al*. (1991) estimated that with an increase of 0.5 unit of FCR, pollution loading increased 86% as chemical oxygen demand, 70% for total N and 86% for total P. Again, when subjected to mathematical model the economic efficiency of both the feed types was further reduced to 36 days beyond which (Figure 7) the combined culture of *rohu* and *mrigal* under the present protocol was not found to be judicious. Absence of any significance difference in FCR between the two physically different feed types with iso-nutritional properties indicated that nutritional quality not the feed types acted as determinants for the feeding efficiency in terms of FCR.

As the value of net protein utilization (NPU) and protein efficiency ratio (PER) did not differed significantly in pellet and mash fed treatments differences in the physical forms of feed did not exert any influence upon the efficiency and utilization of protein in the present study. As for preparation of mash and pellet type of feeds the ingredients used were same, NPU and PER did not vary significantly. Again, fish meal and oil cake were used as protein ingredients which are considered as good sources of high quality proteins (Jambunathan, 1991; Miles and Chapman, 2006). Moreover, NPU and PER declined with increment of the total fish biomass in both P and M (Figure 8a, 8b, 9a, 9b), and with the advancement of the study period as well (Figure 9a, 9b). Therefore, it was obvious that the test fish as advanced fry required more protein during the initial phase of their culture. As the body weight of fish increased overtime with concomitant decline in the values of PER and NPU as well in both the feed types tested, the relationships between them became inversed and were fitted either by polynomial or linear models (Figure 10, 11, 12, 13).

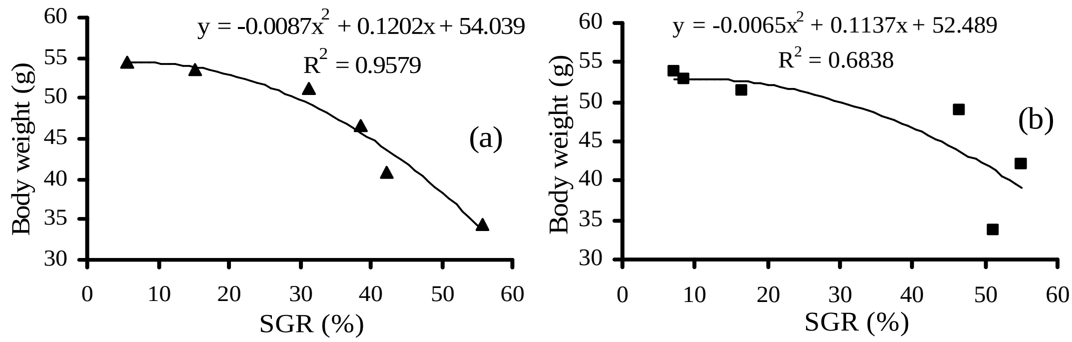

Figure 4: Fit Curve between Specific Growth Rate and Body Weight of Fish in Mash (a) and Pellet (b) Fed Treatments

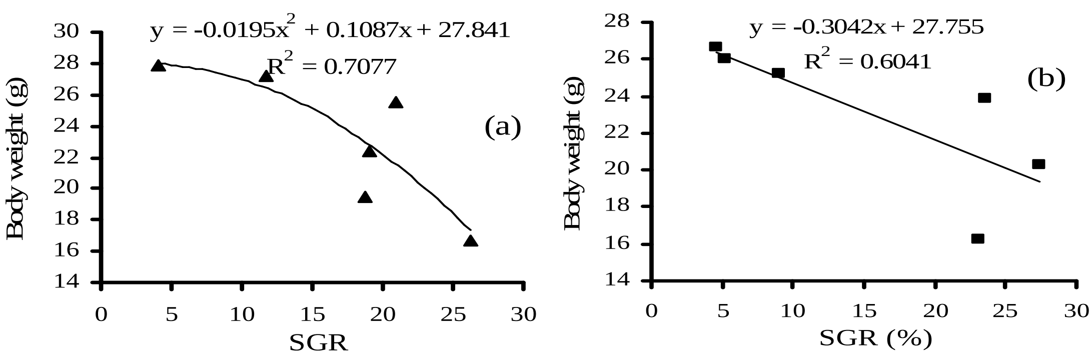

Figure 5: Fit Curve between Specific Growth Rate and Body Weight of Rohu in Mash (a) and Pellet (b) Fed Treatments

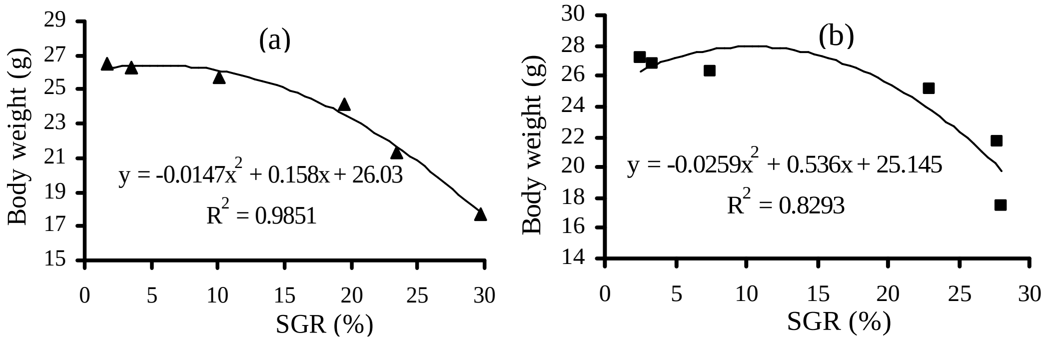

Figure 6: Fit Curve between Specific Growth Rate and Body Weight of Mrigal in Mash (a) and Pellet (b) Fed Treatments

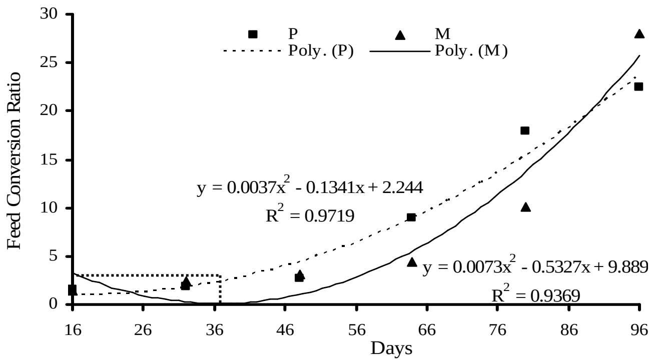

Figure 7: Fit Curve between Feed Conversion Ratio and Period of Investigation in Different Treatments Employed

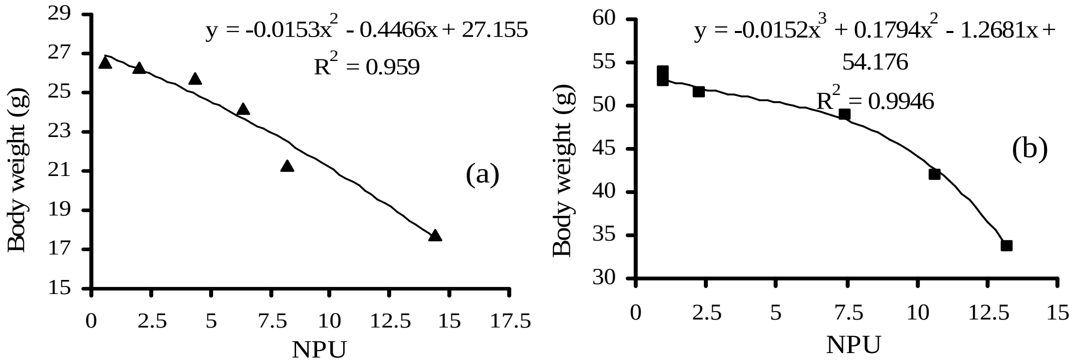

Figure 8: Fit Curve of Net Protein Utilization with Body Weight of Rohu (a) and Mrigal (b) in Different Systems Employed

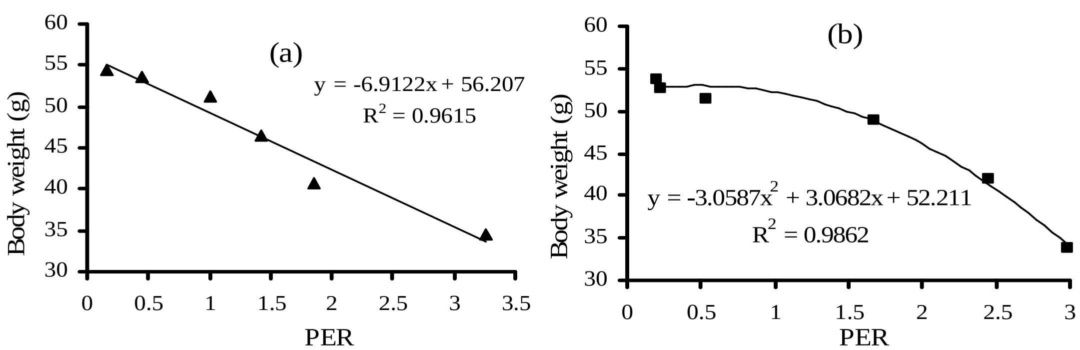

Figure 9: Fit Curve of Protein Efficiency Ratio with Body Weight of Rohu (a) and Mrigal (b) in Different Systems Employed

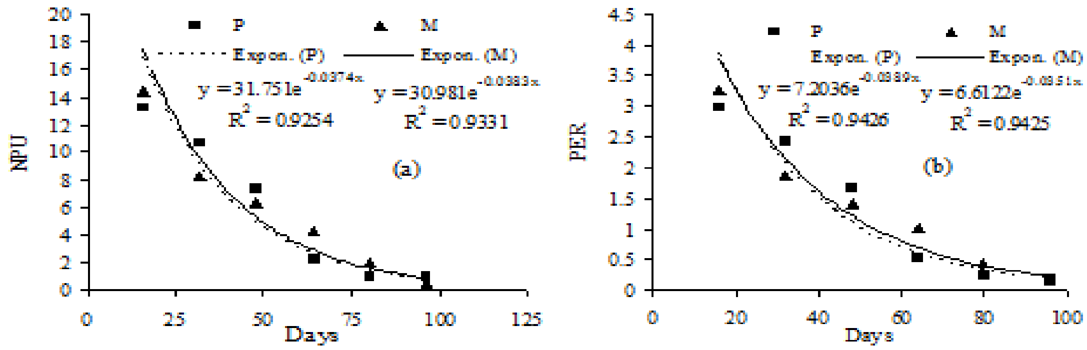

Figure 10: Fit Curve between Net Protein Utilization and Period of Investigation (a) and Protein Efficiency Ratio and Period of Investigation (b) in Different Treatments Employed

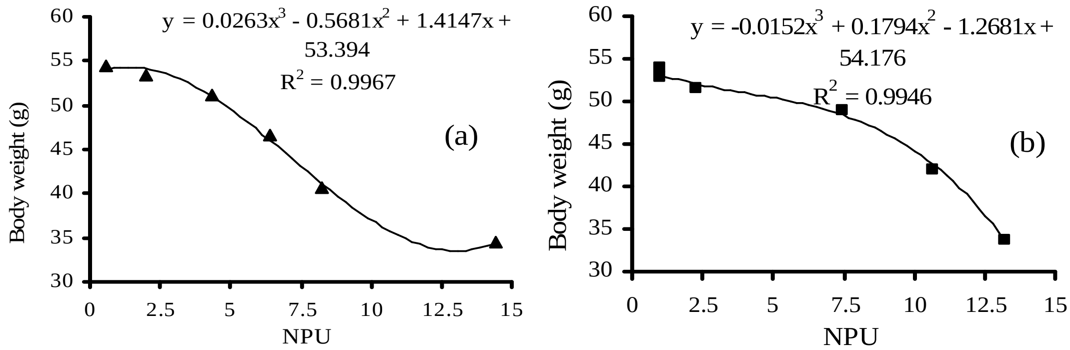

Figure 11: Fit Curve between Net Protein Utilization and Body Weight of Fish in Mash (a) and Pellet (b) Fed Treatments

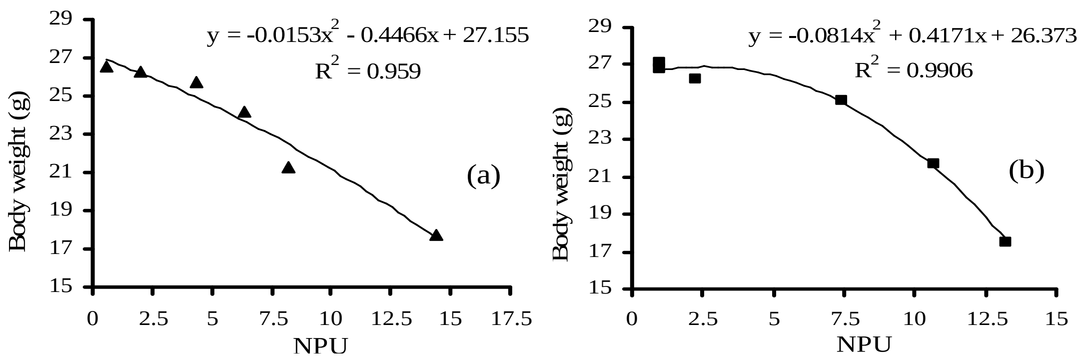

Figure 12: Fit Curve between Net Protein Utilization and Body Weight of Mrigal in Mash (a) and Pellet (b) Fed Treatments

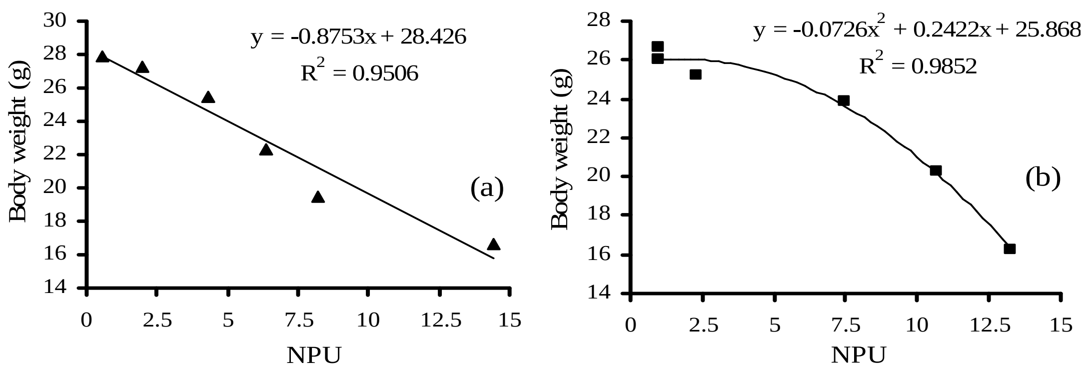

Figure 13: Fit Curve between Net Protein Utilization and Body Weight of Rohu in Mash (a) and Pellet (b) Fed Treatments

CONCLUSIONS

The present study clearly indicated that culture of the test fishes in the present study was not influenced by the physical form of the feed rather nutritional quality being identical governed the performance of the fish growth parameters. Therefore, for culture of omnivorous Indian carps *viz*. rohu and mrigal ordinary mash feed is equally effective with costly pelleted feed under manured culture condition as supplementary feed.

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