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Effect of Mineral Mixture on Growth, Feed Utilization and Economic Performance of Composite Fish Farming

Prem Kumar[1]*, Sanjay Khar[1], Punit Choudhary[1], Rakesh Sharma[1], Poonam Abrol[1] and Sushma Sharma[2]

[1]*Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu, J&K, India*
[2]*Government Gandhi Memorial Science College, Jammu, J&K, India*

*Corresponding author: pk_singh1@yahoo.com

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ABSTRACT

Aquaculture is promoted all over the world due to the limitations of capture fisheries production. According of the State of World Fisheries and Aquaculture, total world fisheries and aquaculture production has reached to 170.9 million metric ton (mt) collectively including 90 mt from capture fisheries and 80 mt from aquaculture during 2016. Aquaculture in India has grown over six and half fold in the last two decades in which freshwater aquaculture contributing over 95% of the total production. Indian fisheries occupy the second position in global fish production and second in aquaculture in the world with an annual growth rate of 4.7%, contributing 1.1% to the total GDP and 4.5% to the agricultural GDP of the country. Aquaculture is a feed based industry where feed source alone constitute 60% of the operational cost due to which feeding of fish with balanced diet is very essential. Fish feed management is one of the most important factors in commercial fish farming because feeding regime mostly decides the cost of production of per kg fish, as fish feed have consequences on both, growth efficiency and feed wastage. Lack of suitable technologies to meet location specific demand of farming community and to enhance their adoption rate, there is a need to undertake technology assessment, dissemination, field demonstration, and farmer's participatory research and training programs. This study aimed to investigate the effects of feed supplement (mineral mixture) on the growth performance of fish in the form of total yield and the economic returns. The feeding trials were conducted in practicing fish farmer's earthen pond under composite fish farming system with six species. The study revealed that fish fed with mineral mixture added feed (T1) exhibited significant improvement in daily weight gain, feed conversion ratio, feed conversion efficiency and survival as compared to the recommended (T2) and farmers practice (T3).

Keywords: Aquaculture, mineral mixture, economics

Due to the modern age disease such as obesity, osteoporosis, cancer, diabetes, allergies, heart and dental problems, today's consumers are paying attention to food safety, quality and health-related issues and moving towards fish protein. Shoot in demand of fish resulted into increasing aquaculture. Aquaculture production is increasing at faster pace in comparison to rise in human population. Aquaculture is also promoted all over the world due to the limitations of capture fisheries production. According of the State of World Fisheries and Aquaculture (FAO 2018), total world fisheries and

aquaculture production has reached to 170.9 million metric ton (mt) collectively including 90.0 mt from capture fisheries and 80.0 mt from aquaculture during 2016. Between 1961 and 2016, the average annual increase in global food fish consumption (3.2 %) outpaced population growth (1.6 %) and exceeded that of meat from all other terrestrial animals in toto (2.8 %). Not only in terms of enhanced production, per capita fish consumption also grew from 9.0 kg in 1961 to 20.2 kg in 2015, at an average growth rate of about 1.5 % per year.

Aquaculture in India has grown over six and half fold in the last two decades in which freshwater aquaculture contributing over 95% of the total production. The three Indian major carps (IMCs), namely catla (*Catlacatla*), rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*) contribute to the tune of 87% of total fresh water aquaculture production (Paul and Giri 2015).Indian Fisheries occupy the second position in global fish production and second in aquaculture in the world with an annual growth rate of 4.7%, contributing 1.1% to the GDP and 4.5% to the agricultural GDP of the country. Fish farming typically involves the culture of fish in a closed system under conditions which they can thrive and grow. To increase production, interventions in fish life cycles range from exclusion of predators and competitors to enhance of food supply to the provision of all nutritional requirements. Aquaculture is a feed based industry with over 60% of operational cost from feed source alone (Paul and Mohanty, 2002) due to which feeding of fish with balanced diet is very essential. Information on mineral requirements of fish has been compiled by the National Research Council (NRC, 1993; NRC, 2011) and in reviews on mineral nutrition of fish (Schwarz, 1995; Davis and Gatlin, 1996; Watanabe *et al.* 1997; Kaushik, 2002; Lall, 2002). Fish feed management is one of the most important factors in commercial fish farming because feeding regime mostly decides the cost of production/kg fish as fish feed have consequences on both growth efficiency and feed wastage (Tsevis and Azzaydi, 2000). Feeding excess will not only make financial loss but also disturb the pond water quality. The use of 1:1 cake-bran traditional feed mixture is still in practice, which is provided in fertilized pond ecosystem to supplement the nutritional deficiencies. Since the traditional feed mixture is not nutritionally balanced, there is a need to use the diet which provides the required essential nutrients and energy. In this context, there is a need to strengthen our knowledge on mineral requirements of fish to effectively utilize the information for optimizing mineral supply and utilization by fish reared with feeds having different ingredient profiles or under different rearing systems.

On-farming testing helps in refining and documenting technologies according to location specific need for sustainable land use systems. There is a need to undertake dissemination, field demonstration, and farmer's participatory research and training programs to overcome the lack of suitable technologies to meet location specific demand of farming community and to enhance their adoption rate. This study aims to investigate the effects of feed supplement (mineral mixture) on the growth performance of fish in the form of feed utilization, total yield and the economic returns. The feeding trials were conducted in practicing fish farmer's earthen pond under composite fish farming system with six species.

MATERIALS AND METHODS

Field trials were carried out in 6 different private fish farms located indifferent villages of Jammu district (32° 43' 58.7928'' N and 74° 51' 51.3828'' E) of Jammu & Kashmir, India.

Experimental design and diets

A total of six earthen ponds (2 replicates for each trial) belonging to different farmers, each of 1000 m^2 total area, with water depth of one and half meter were used in this study. All ponds were cleaned from weeds, predatory insects and weed fishes. Liming and organic manuring (cattle dung) was applied in fish pond @ 500kg/ha and 10000kg/ha respectively, about two weeks prior to anticipated stocking. Fish ponds were filled with ground water from submersible pumps and 15% water was changed fortnightly to keep water quality optimum for fish growth.

Mix seeds of six species namely catla, rohu, mrigal, common carp, grass carp and silver carp(Average body weight 19.79 ± 3.10g, Av. length 13.34 ±1.86 cm) were procured from Jammu and Kashmir Government hatchery, Ghomanasa, Jammu and cultured under composite fish system @10000 nos./

ha. The first two experimental ponds received mineral mixture supplemented farm feed, other two ponds received recommended diet without mineral mixture under observation while rest two ponds were conceived as farmer's practice (Table 1). The diets were fed to the fishes at a daily rate of 2% of the total fish weight present in fish pond, divided into two feedings /day for 5 days a week for 12 months (August-July). The weights and lengths of the fish were recorded in a sample of 20 fishes from each pond at bi-monthly intervals. At experimental termination the fish were harvested by seining and then weighed as total fish weight (total yield) of each replicate within groups and counted for calculation of WG, FCR, FCE, specific growth rate (SGR) and survival rate. The growth and production were taken as main parameter to assess the performance.

Table 1: Detail of treatments

Treatments	Practice/ Intervention	Feed
T1	Intervention	Rice bran and mustard oil cake mixed with mineral mixture @20gm/kg @ 2% of bodyweight.
T2	Recommended	Rice bran and mustard oil cake at the ratio of 1:1 @ 2% of bodyweight.
T3	Farmer's practice	Rice bran, mustard oil cake without any ratio,waste from kitchen as feed. Feeding at will without any schedule.

Statistical analysis

Data (WG, FE, SGR, PER) were analyzed using one-way analysis of variance (ANOVA) and significant differences among treatment means were compared using Duncan's multiple range test (Duncan, 1955). Significance was tested at 5% level and all statistical analyses were carried out using the SPSS Version 16 (SPSS, Michigan Avenue, Chicago, IL, USA).

RESULTS AND DISCUSSION

Water quality

Water samples were taken monthly for determination of pH, dissolved oxygen, hardness, and alkalinity as per methods of American Public Health Association (APHA, 2012). All water quality parameters were in acceptable range and there was no significant difference among the treatments. The pH value ranged in between 7.4 to 7.58 while dissolve oxygen varied from 5.33 mg/l to 5.67 mg/l in different treatment without any significant difference. Water hardness ranged from 213.50 to 216.83 mg/l and alkalinity varied from 127.50 to 132.08 mg/l in different treatments (Table 2). The pH < 6.5 causes poor growth performance of cultured species (Mount 1973) while total alkalinity (> 90 ppm) indicates a better productive ecosystem (Banerjea 1967) where increased plankton density reflects higher nutrient status of the water body. The phytoplankton growth depends on availability of CO_2 which is related to total alkalinity. The total alkalinity of water ranging 20-150 ppm, produce suitable quantity of CO_2 for plankton production (Boyd and Pillai 1985).

Table 2: Physico-chemical parameters of pond water

Parameters	T1	T2	T3
pH values (Unit)	7.58 ± 0.15 [a]	7.5± 0.15 [a]	7.42 ± 0.51 [a]
D. Oxygen (mg/l)	5.67 ± 0.14 [a]	5.33 ± 0.14 [a]	5.42 ± 0.15 [a]
Hardness (mg/l)	216.83 ± 3.21 [a]	214.50 ± 3.93 [a]	213.50 ± 4.61 [a]
Alkalinity (mg/l)	132.08 ± 2.19 [a]	130.75 ± 2.37 [a]	127.50 ± 2.11 [a]

**Values are presented as mean±SE. Means in each row with different superscripts are significantly different (p<0.05).*

Growth performance

At the end of the experiment, WG, FE, SGR, and PER of fishes fed with the different experimental diets were determined (Table 3). Fish fed with mineral mixture added feed (T1) exhibited significant improvement in WG, FE, SGR, and PER as compared to the recommended (T2) and farmers practice (T3). The mortality was recorded in all fish groups during the experimental period which ranged from 30-37.5% which was mainly due to predatory birds and snakes. Based on the on-way ANOVA, T1 showed the optimum growth followed by T2 and T3.

The mean values of FCR were 1.85, 2.06 and 2.43 in T1, T2 and T3, respectively. The FCR was lowest in T1followed by T2 while T3 was significantly higher. In the present study, the better performance observed in FCR in two treatment groups as compared to control group which indicated the positive affect of supplementation of feed with mineral mixture. It has been reported in many studies that mineral mixtures containing essential amino acids play an important role. The earlier studies reported improved production levels ranging from 2000-3400 kg/ha (Mazid *et al*. 1997) to 3600 kg/ha (Shahabuddin *et al*. 1994) in polycultures of the South Asian region. A significant increase in fish growth was reported due to the effect of nutrients on plankton production in the pond (Sumitra *et al*. 1981). Azim *et al*. (2002) and Islam et al. (2008) also reported that mineral mixture @2% influenced the growth and survival of carp fingerlings on the basis of specific growth rate and harvested fish biomass.

Table 3: Growth performance of fingerling

Growth performance	T1	T2	T3
Initial average length (cm)	13.6 ± 1.84.0 [a]	13.3 ± 2.0 [a]	13.13. ± 1.76 [a]
Final average length (cm)	30.45 ± 5.00 [a]	29.90 ± 5.19 [a]	29.98 ± 4.40 [a]
Initial average weight (g)	19.92 ± 0.63[a]	19.83 ± 0.68 [a]	19.63± 0.18 [a]
Final average weight (g)	1049.40 ± 28.85 [a]	945.97 ± 17.83 [b]	803.72 ± 12.23 [c]
Weight Gain (WG)	1029.50 ± 29.48 [a]	926.15 ± 18.50 [b]	784.10 ± 12.40 [c]
Feed Conversion Ratio (FCR)	1.85 ± 0.05 [a]	2.06 ± 0.04 [a]	2.43 ± 0.04 [b]
Feed Conversion Efficiency (FCE)	53.96 ± 1.59 [a]	48.55 ± 1.01 [b]	41.11 ± 0.66 [c]
Daily Weight Gain (DWG)	2.82± 0.80[a]	2.54± 0.05[b]	2.15 ± 0.03[c]
Survival (%)	62.5 [a]	62.5 [a]	62.5 [a]
Specific growth rate (SGR) (%)	1.084	1.057	1.016
Condition factor (CF)	3.72	3.54	2.98

Values are presented as mean±SE. Means in each row with different superscripts are significantly different (p<0.05); WG (%) = [final weight (g) – initial weight (g)]. FCR= Total feed/ weight gain. FCE (%) =1/FCR × 100; SGR (%) = {[ln final weight (g) –ln initial weight (g)]/days}×100. CF = [fish weight (g)/fish length (cm)3]×100.

Economic performance

Fishes were healthy with improved growth and result was reflected as increased production in the ponds supplemented with mineral mixture added feed. The net fish production was found to be 43.00q/ha, 35 q/ha and 28.00 q/ha in T1, T2 and T3 respectively. The results showed that fish production was significantly higher in T1 than T2 and T3 (P<0.05). T1 showed 53.57 percent increase in fish production than that of T3 and 22.86 percent increase in fish production in comparison of T2 (Table 4). Increase in production ultimately resulted into higher income which was indicated in BC ratio. The BC ratio was observed highest in T1 in comparison to T2 and T3.

Table 4: Economic performance of fingerling

Treatments	Production (q/ha)	% increase in production	Total income (Rs./1000m^2)	Total Expanses (₹/1000 m^2)	Net Return ₹	BC Ratio
T1	43.00	53.57	43000	18000	25000	2.38:1
T2	35.00	25.00	35000	17000	18000	2.05:1
T3	28.00	–	28000	14000	14000	2.0:1

CONCLUSION

It can be concluded that mineral enriched feed premix significantly (P<0.5) improved growth and total production with improved feed efficiency. The mineral enriched feed premix treatment (T1) showed highest weight gain, highest feed conversion efficiency and lowest feed conversion ratio in comparison to others which might be attribute to the fact that, mineral mixture contains different vitamins, minerals, amino acids that promote growth. Trace minerals are essential for fish and is involved in the normal metabolism and life processes. The minerals are required in extremely small amounts in the diet as excess causes toxicity. In deficient condition, growth is retarded in general, and affect normal metabolism in particular (Lall, 1995). Ensuring adequate dietary supply of minerals to farmed fish is essential for proper somatic and skeletal growth, health and final flesh quality. Fish can absorb part of the required minerals directly from the water through gills or even through their entire body surface. The

minerals absorbed from water do not meet the total requirement and a certain supplementation through the diet is required whether in the natural food or supplementary feed. This research would be useful for the farmers to generate better production and economic returns through aquaculture.

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