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Research article

GROWTH RESPONSE OF TWO INDIAN MAJOR CARPS *CATLA CATLA* (HAMILTON) AND *CIRRHINUS MRIGALA* (HAMILTON) FINGERLINGS FED DIET CONTAINING DIFFERENT NUTRITIONAL SUPPLEMENTS

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ABSTRACT : An experiment was conducted to determine the growth performance of two Indian Major Carps *Catla catla*, and *Cirrhinus mrigala* fingerlings for period of 40 days. Nine experimental groups fed commercial pellet diet incorporated with three types of nutritional supplements (Gram positive lactobacil probiotic, Parry's Spirulina and Vitamin C – Ascorbic acid) at different concentrations (2 %, 4 %, & 8 %) and one control group maintained separately for both fingerlings. The results revealed that the Catla fingerlings showed maximum increase in length (28.66±0.70mm), weight gain (353.25mg), FCR (1.01) and SGR (0.88) were observed in 4% probiotic and similar growth parameters were observed with 4% spirulina and 2% vitamin C. In mrigal fingerlings fed with 4% probiotic significant increase in length, weight gain, FCR, SGR were observed (32.55±1.94mm), 447.78 mg, 0.80 and 1.11 respectively. Similarly trends were observed in Mrigal fingerlings fed with 4% spirulina and 2% Vitamin C. In both fish fingerlings lipid concentration correlates strong significant ($P<0.01$) with survival rate and FCR strong significant with SGR. Protein levels moderately significant ($P<0.05$) with FCR.

Keywords: Indian major carps; FCR; SGR; Probiotics; Spirulina.

INTRODUCTION

The Indian major carps *Catla catla, Labeo rohita and Cirrhinus mrigala* are the most important commercial fishes in India with a maximum market demand and acceptability as food by the consumers due to their taste and flesh. They contribute about 67% of total freshwater fish production (ICLARM, 2001). Feeding management plays a critical role in the success of fish culture. The current trend in fish culture is towards increased intensification whereby, provision of feeds becomes necessary and success depends significantly on the availability of well balanced nutritionally complete and cost effective compounded feeds. In India, the aquaculture practices mainly revolve around a few species of finfish and shellfish, among which the Indian Major Carps viz. *Catla catla*, and *Cirrhinus mrigala* contribute substantially to the inland production. Although carp culture is widely practiced, the non- availability of appropriate compounded feed to meet the demands of the species still remains as a major constraint.

Fish require adequate nutrition in order to grow and survive. Nature offers a great diversity of food to fish including plants and animals. 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). The role of artificial feed in intensive fish farming cannot be ignored as nutritional requirements of fish depend upon the feed supplied. The quantity and quality of feed consumed have a pronounced effect on growth rate, efficiency of feed conversion and chemical composition of fish (Hassan et al., 1996; Jena et al., 1998; Erfanullah and Jafri, 1998).

In this present systematic study aims to assess the growth and biochemical parameters of two Indian major carps *Catla catla, and Cirrhinus mrigala* fingerlings with different type of feeds.Both fingerlings were fed commercial pellet incorporated with different nutritional supplements like probiotics, spirulina and vitamin–C at different concentrations and this study will be very useful to determine the suitable ratio of supplementary nutrition for weight gain and survival rate of the *Catla catla, and Cirrhinus mrigala* fingerlings respectively.

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MATERIALS AND METHODS

Collection and acclimation of experimental fishes

Catla catla & *Cirrhinus mrigala* fingerlings were collected from the Barath Fish Farm, Poondi, Tamilnadu, India, using cast net and maintained in the laboratory in a glass aquarium tank and acclimated in aerated tap water (temperature 30±1 ºC; pH 8.0; DO 7.0 ± 0.3 mg/L) with continuous aeration for two weeks prior to experimentation. During this period, fishes were fed with a known amount of fish food.

Experimental procedure and Feeding trials

Catla and Mrigal fingerlings having same size and weight were carefully selected and rearing and feeding experiments were conducted with different feeds (Commercial probiotics 2%,4% and 8%, Spirulina 2%,4% and 8%, Vitamin C 2%,4% and 8% and Control (micropelletized commercial feed). Feeding trials was started at a rate of 4% of the body weight in a feeding regime of 3 times a day and experiment was conducted for 40 days following the protocol of Ramakrishnan et al, (2008). The water in the aquarium tank was siphoned off every day to remove remains of the feed and faecal matter and made up with fresh aerated water in Unit of Aquaculture & Aquatic Toxicology, Post Graduate and Research Department of Zoology, The New College, Chennai. The growth parameters weight gain (%), Feed Conversion Ratio (FCR) and Specific Growth Rate (SGR) were calculated following the method of Aliyu- Paiko et al., (2010). At the end of the experiments, analysis of body homogenate of the Catla and Mrigal fingerlings was carried out for Protein (Lowry et al., 1951), Carbohydrate (Roe, 1955) and Lipid (Folch et al., 1957).

Growth Parameters

The growth parameters of the *Catla catla* & *Cirrhinus mrigala* fingerlings were assessed by taking their body weight at 15 days of interval. The growth performance was assessed using the following formulas:

Percentage weight gain

$$\text{Percentage weight gain} = \frac{\text{Final weight} - \text{initial weight}}{\text{Initial weight}} \times 100 \quad (1)$$

Specific growth rate (SGR)

$$\text{Specific growth rate} = \frac{Ln\,(\text{Final weight}) - Ln\,(\text{Initial weight})}{\text{Experimental periods in days}} \times 100 \quad (2)$$

Food conversion ratio (FCR)

$$\text{Food conversion ratio} = \frac{\text{Feed given (dry weight)}}{\text{Body weight gain (wet weight)}} \quad (3)$$

Survival percentage

Survival percentage was calculated at the end of the experiment by counting the number of fishes in each tub and is calculated as follows:

$$\text{Survival (\%)} = \frac{\text{Total number of animal harvested}}{\text{Total number stocked}} \times 100 \quad (4)$$

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RESULTS AND DISCUSSION

The results of the growth and biochemical parameters of both Catla and mrigal fingerlings with different feeding regimes is presented in Table 1-3. Growth parameters of both Catla and mrigal fingerlings with different feed clearly showed significant enhancement with
4% probiotic, 4% spirulina and 2% vitamin C when compared with other concentrations of these three feed and control. Catla fingerlings showed maximum increase in length (28.66±0.70mm), weight gain (353.25mg), FCR (1.01) and SGR (0.88) were observed in 4% probiotic and similar trends were observed with 4% spirulina and 2% vitamin C. In mrigal fingerlings fed with 4% probiotic significant increase in length, weight gain, FCR, SGR were observed (32.55±1.94mm), 447.78 mg, 0.80 and 1.11 respectively. Similar growth rates were observed in Mrigal fingerlings fed with 4% spirulina and 2% Vitamin C. In both fish fingerlings lipid concentration correlates strong significant ($P<0.01$) with survival rate and FCR strong significant with SGR. Protein levels moderately significant ($P<0.05$) with FCR.
The biochemical parameters of *Catla catla* and *C.mrigal* fingerlings fed with different types of food showed most favourable enhancement in the levels of proteins, lipids, FCR and SGR in 4% probiotic, 4% spirulina and 2% vitamin C. In case of *C.catla* fingerlings fed with 4% probiotic, protein, lipid, FCR and SGR were 3.91±0.02mg/g, 0.43±0.01mg/g, 1.05 and 0.85 respectively. Similar trends were observed for mrigal fingerlings in 4% probiotic, 4% spirulina and 2% Vitamin C.
Results of this study substantiate the fact that probiotics have direct growth promoting effects on Catla and Mrigal which is an accordance with the reports of Who et al., (1994), Chaudhari and Razi (2007). There are various other benefits of using probiotics for fish aquaculture including that of carp such as reduction in culture cost of *Cyprinus carpio* (Ghosh et al, 2003) and Indian major carps (Swain et al, 1996). Studies revealed enhancement of feeding efficiency in Acipenser when fed with probiotics (Jafaryan and Bagherio 2008), enhanced immunity in *Labeo rohita* after oral administration of probiotics *Bacillus subtilis* (Kumar et al,
2008) and enhanced growth performance and feeding efficiency in rohu fingerlings (Chaudhary and Razi 2007). This is an agreement with the present results where significance enhancement in growth performance and nutrient utilization like FCR and SGR where observed in catla and mrigal fingerlings fed with 4% probiotic.
Probiotics are live microbial cells that are administrated to the gastrointestinal tract of the host as a feed supplement, improving its intestinal microbial balance and health (Fuller, 1989). The addition of probiotics reduced culture costs of Indian major carps (Swain et al., 1996) and
Cyprinus carpio (Ghosh et al., 2003). Commercial probiotics, *Streptococcus faecium* and *Saccharomyces cervisiae* (yeast), and antibiotics yielded better growth, when these ingredients were included in carp feed (Noh et al., 1994; Bogut et al., 1998). When probiotics like *Bacillus subtilis* and *B. circulans* were supplemented in the diets of Rohu (*Labeo rohita*) fingerlings, the final body weight and SGR significantly increased than those fed only formulated diets (Bairagi et al., 2004). Gatesoupe (1991) reported increase in growth when fed the probiotic bacilli. Swain et al. (1996) also recorded better growth rate when fed B. toyoi to turbot (*Scophthalmus maximus*). In *Penaeus monodon*, application of appropriate probiotics improved intestinal microbial balance, leading to better growth by improving food absorption and digestive enzyme activities (Surajit Das et al., 2008). Similarly, *Artemia nauplii* enriched with Lactobacillus resulted in better growth and survival in Macrobrachium rosenbergii (Babitha Rani et al.,2008).
Spirulina is being commercially cultivated because of its high nutritional content and as a supplement with many health and economic benefits for humans and in aquaculture (Tongsiri et al., 2010). This study also substantiates many other earlier reports on benefits of using Spirulina as part of aquaculture diet for various commercially important food fishes. In the present study, enhanced growth increment and feed utilization in terms of SGR and FCR was significantly higher in Catla and Mrigal fed with 4% spirulina. This is an agreement with the work of Nandeesha et al., 2001; Ghosh et al., 2003;Ramakrishnan et al., 2008and Tongsiri et al .,2010.
The results of this study indicate that the spirulina could be incorporated in feed for Catla and Mrigal fingerlings as supplement to their feed.Spirulina is a cyanobacterium that has been commercially cultivated for more than
10years due to its high nutritional content consisting of protein, amino acids, vitamin, minerals, essential fatty acid and b- carotene (Vonshak, 1997).

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Spirulina can be considered a nutritional supplement that has various health benefits for humans, and a feed supplement for animals having economic benefits. Microalgae have been found to be a good source of protein for fish (Ehrenberg, 1980). In addition, certain species of Spirulina have no cell wall, which results in improved digestion and absorption (Becker and Venkataraman, 1984; Nandeesha et al., 1998). Improvement in growth of fish by dietary inclusion of Spirulina has been reported earlier in a number of studies (Nakazoe et al, 1986; Mustafa et al, 1994; Nandeesha et al, 2001; Ramakrishnan et al, 2008; Tongsiri et al, 2010).

Results of the present study on Catla and Mrigal fingerlings also revealed that Vitamin C supplement at 2% level resulted in significant increase in length, weight, FCR and SGR. This is in accordance with other studies which showed similar growth trends in Japanese sea bass (Al et al, 2004), Asian catfish (Kumara and Sahoo, 2005) and *Labeo rohita* (Misra et al., 2007) when fed on diet with different combinations of vitamin C. Ashraf et al., (2008) reported that administration of vitamin C enhanced growth, survival and immune resistance in Mrigal fingerlings and hence use of vitamin C supplementation in the diet has manifold benefits like growth promotion, survival and enhancement of immunity. Hence diet supplementation needs to be considered for successful and sustainable aquaculture of economically important Indian major carps.

Table: 1. The biochemical & growth parameters of freshwater fish *Catla catla* (Fingerlings) with different feeding regimes.

TYPE OF FEED	PROTEIN (mg/g)	CARBOHYDRATE (mg/g)	LIPIDS (mg/g)	FCR	SGR	Survival (%)
Control	3.68 ± 0.03	1.27 ± 0.25	0.30 ± 0.02	1.78	0.50	63.86
Probiotic 2%	3.81 ± 0.02	1.16 ± 0.06	0.43 ± 0.02	1.22	0.73	76.47
Probiotic 4%	3.91 ± 0.02	1.10 ± 0.02	0.43 ± 0.01	1.05	0.85	78.0
Probiotic 8%	3.90 ± 0.02	1.05 ± 0.02	0.45 ± 0.01	1.34	0.67	73.2
Spirulina 2%	4.16 ± 0.01	1.02 ± 0.02	0.32 ±0.01	0.94	0.95	72.0
Spirulina 4%	4.21 ± 0.16	0.97 ± 0.01	0.34 ± 0.00	0.89	1.01	73.46
Spirulina 8%	4.21 ± .005	0.97 ± 0.02	0.38 ± 0.02	1.01	0.88	70.53
Vitamin C 2%	3.86 ± 0.02	1.07 ±0.08	0.33 ± 0.05	0.79	1.13	72.0
Vitamin C 4%	3.86 ± 0.05	1.06 ± 0.04	0.33 ± 0.05	0.85	**1.05**	70.8

±standard deviation (number of trials, 7)

Vitamin C is essential for normal physiological functions in animals including fish (Wilson and Poe, 1973, Lim and Lovell, 1978). It is a biological reducing agent and is involved in many intra and extracellular processes, including assembly of collagen by hydroxylation of tryptophan, tyrosine and proline for use in cartilage synthesis. Collagen which is a principal constituent of skink, scales, mucous cartilaginous and conjunctive tissue formation, is heavily dependent on body storage of this vitamin and its supply from outside sources. It is involved in carnitine and adrenal steroids synthesis and detoxifies pesticides and other toxicants using cytochrome P450 system (De Silva and Anderson, 1995). Vitamin C also plays a critical role in its repair and wound healing (Halver, 2002). Like other teleost fishes Cirrhinus mrigala lacks the capability of biosynthesis of vitamin C due to absence of an essential enzyme glucono-lactone oxidase (Fracalossi et al., 2001). Deficiency of Vitamin C results in impaired collagen formation, spinal deformation, hemorrhage and growth retardation (Halver et al., 1969; Al-Amoudi et al., 1992; Coustans et al., 1998).

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Table: 2. The biochemical & growth parameters of freshwater fish C.mrigala (fingerlings) with different feeding regimes.

TYPE OF FEED	PROTEIN (mg/g)	CARBOHYTRADATE (mg/g)	LIPIDS (mg/g)	FCR	SGR	Survival (%)
Control	3.68 ± 0.03	1.27 ± 0.02	0.30 ± 0.02	1.89	0.48	66.8
Probiotic 2%	3.81 ± 0.02	1.16 ± 0.06	0.43 ± 0.02	0.91	0.98	78.8
Probiotic 4%	3.91 ± 0.01	1.10 ± 0.02	0.43 ±0.01	0.80	1.11	80.93
Probiotic 8%	3.90 ± 0.02	1.05 ± 0.02	0.45 ± 0.01	0.99	0.90	78.0
Spirulina 2%	4.16 ± 0.01	1.02 ± 0.02	0.32 ± 0.01	0.79	1.12	78.4
Spirulina 4%	4.21 ± 0.16	0.97 ± 0.01	0.34 ± 0.01	0.73	1.22	78.8
Spirulina 8%	4.21 ± 0.005	0.97 ± 0.02	0.38 ± 0.02	0.92	0.97	72.0
Vitamin C 2%	3.86 ± 0.02	1.07 ± 0.08	0.33 ± 0.05	0.72	1.24	77.0
Vitamin C 4%	3.86 ± 0.005	1.06 ± 0.04	0.33 ± 0.05	0.84	1.06	76.4

±standard deviation (number of trials, 7)

Table.3 Correlation (Sperman's correlation coefficient) between the growth and biochemical parameters of Indian major carps *Catla catla* and *Cirrhinus mrigala*

Parameters	Fish Species	Protein	Carbo hydrate	Lipid	FCR	SGR	Survival
Protein	*Catla catla*	1.000	-.924**	.178	.883*	.274	.315
	Cirrhinus mrigala	1.000	1.000	.159	.889*	.493	.322
Carbohydrate	*Catla catla*	-.924**	1.000	-.073	.338	-.377	-.146
	Cirrhinus mrigala	.176	1.000	-.069	.338	-.398	-.153
Lipid	*Catla catla*	.178	.794	1.000	.318	-.323	.926**
	Cirrhinus mrigala	.174	.290	1.000	.357	-.354	.974**
FCR	*Catla catla*	.883*	.594	.471	1.000	.983**	.079
	Cirrhinus mrigala	.889*	.716	.486	1.000	.989**	.096
SGR	*Catla catla*	.274	-.377	.086	.803*	1.000	-.043
	Cirrhinus mrigala	.493	-.398	.657	.814*	1.000	-.047

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

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CONCLUSION

In this present study, growth and biochemical parameters of two Indian major carps *Catla catla, and Cirrhinus mrigala* fingerlings were assessed.The results revealed that the Catla fingerlings showed maximum increase in length (28.66±0.70mm), weight gain (353.25mg), FCR (1.01) and SGR (0.88) were observed in 4% probiotic and similar trends were observed with 4% spirulina and 2% vitamin C. In mrigal fingerlings fed with 4% probiotic significant increase in length, weight gain, FCR, SGR were observed (32.55±1.94mm), 447.78 mg, 0.80 and 1.11 respectively. Similarly trends were observed in Mrigal fingerlings fed with 4% spirulina and 2% Vitamin C. In both fish fingerlings lipid concentration correlates strong significant ($P<0.01$) with survival rate and FCR strong significant with SGR. In our findings the growth parameters such as weight gain, FCR, SGR and survival rates were significantly higher in 4% probiotic, 4% spirulina and 2% vitamin C experimental groups.

REFERENCES

AL-Amoudi, A.A., EL-Nakkadi, A.M.N. AND EL-Nouman, B.M., (1992). Evaluation of optimum dietary requirement of vitamin C for the growth of Oreochromis sprilurus fingerlings in water from the Red Sea. Aquaculture, 105: 165-173.

Aliyu-PaikoM., Hashim R. &Shu-Chien A.C., (2010). Influence of dietary lipid/protein ratio on survival, growth, body indices and digestive lipase activity in snakehead (Channastriatus, Bloch 1793) fry reared in re-circulating water system. Aquaculture Nuttrition 2010, 16: 466-474.

Ashraf, Muhammad Ayub and Abdul Rauf, (2008) Effect of Vitamin C on Growth, Survival and Resistance to Lernaea infection in Mrigal (Cirrhinus mrigala) Fingerlings. Pakistan J. Zool., 40(3), pp. 165-170.

Babitha Rani A.M., Reddy A.K. and N.P.Sahu, (2008). Growth enhancement and survival of Macrobrachiumrosenbergil larvae fed Artemianaupili enriched with cod liver oil and/or lactobacilius. Israeli J. Aquac. Bamidgeh,58(3):183-190.

Bairagi, A., Ghosh, KS. Sen, SK. and AK. Ray. (2004). Evaluation of the nutritive value of Leucaena leucocephala leaf meal , inoculated with fish intestinal bacteria Bacillus subtilis and Bacillus circulans in formulated diets for rohu, Labeo rohita (Hamilton) fingerlings . Aquaculture Research. 35: 436 - 446.

Bogut, I., Z. Milakovic, Z. Bukvic, S. Brkic and R. Zimmer, (1998). Influence of probiotic Streptococcus faecium M74 on growth and content of intestinal microflora in carp Cyprinus carpio. Czech J. Anim. Sci., 43: 231-235.

Folch J, Less ,Stanley GHS (1957). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol.Chem., 226:497-509.

Fracalossi, D.M., Allen, M. E., Yuyama, L. K. and Oftedal, O. T., (2001). Ascorbic acid biosynthesis in Amazonian fishes. Aquaculture, 192: 321-332.

Fuller R., (1989). Probiotics in man and animals. J. Appl. Bacteriol., 66:365-378.

Gatesoupe, F.J., (1991). The effect of three strains of lactic bacteria on the production rate of rotifers, Brachionus plicatilis, and their dietary value for larval turbot, Scophthalmus maximus. Aquaculture, 96: 335-342.

Ghosh K., Sen S.K., Ray A.K. (2003). Supplementation of an isolated fish gut bacterium, Bacillus circulans, in formulated diets for rohu, Labeo rohita, fingerlings. The Israeli Journal of Aquaculture – Bamidgeh 55 (1): 13–21.

Halver, J.E., (2002). The vitamins. In: Fish nutrition (eds. J.E. Halver and R.W. Hardy), Academic Press, USA.

Halver, J.E., Ashley, L. M. and Smith, R.E., (1969). Ascorbic acid requirements of coho salmon and rainbow trout. Trans. Am. Fish. Soc., 98: 762-772.

Hassan, M. A., A. K. Jafri, A. S. Alvi, S. Rana and U. Nazura. (1996). Dietary energy and protein interaction and approach to optimizing energy, protein ratio in Indian major carps, Cirrhinus mrigala (Ham.) fingerlings. J. Aquacult. Tropics, 10(3): 183-191.

ICLARM (2001). The World Fish Center annual report .

Jafaryan and A. Bagheri, (2008). Effects of probiotic Bacilli on the Enhancement of Feeding Efficiency. The proceedings of Aquaculture Europe.

Jena, J. K., P. K. Aravidakshan, C. Suresh, H. K. Muduli, S. Ayyappan and S. Chandra, (1998). Comparative evaluation of growth and survival of Indian major carps and exotic carps in raising fingerlings. J. Aquacult. Tropics, 13(2): 143-149.

Coden : IJABPT Copyrights@2012 ISSN : 0976-4550

Jhingran, V. G., (1991). Fish and Fisheries of India, 3rd ed. Hindustan Publishing Corporation, Delhi, India, PP: 727.
Kumar, S., Srivastva, A., Chakrabarti, R., (2005). Study of digestive proteinases and proteinase inhibitors of Daphnia carinata. Aquaculture 243, 367– 372.
Lirn, C., Lovell, R. T. (1978). Pathology of the vitamin C deficiency syndrome in channel catfish (Ictalurus punctatus). J. Nutr. 108: 1137-1146.
Lowry OH, Rosenbrough N, Fair AC, Randall RJ (1951). Protein measurements with folin phenol reagent.J.Biol. Chem.,193:265-275.
Misra, C.K., Das, B.K., Mukherjee, S.C. and Pradhan, J., (2007). Effects of dietary vitamin C on immunity, growth and survival of Indian major carp Labeorohita, fingerlings. Aquacult.Nutr., 13: 35-44.
Mustafa, M.G., Umino, T., Miyake, H., Nakagawa,H., (1994). Effect of spirulina sp. Meal as feed additive on lipid accumulation in red sea bream\, pagrus major. J. Appl. Ichthyol. 10, 141- 145.
Ramakrishnan, C. M.A. Haniffa, M. Manohar, M. Dhanaraj, A. Jesu Arockiaraj, S. Seetharaman, and S.V. Arunsingh Chaudhary and JavedIqbalQazi, (2007). Influence of a probiotic Pseudomonas pseudoalcaligenes Fermented Feed on Growth Performance of Rohu(Labeo rohita) Fingerlings. Punjab Univ. J.Zool., v0l. 22(1-2), pp. 41-56, 2007.
Nakazoe, J., Kimura, S., Yokoyama, M., Iida, H., (1986). Effect of supplementation of alga to the diets on the growth and body composition of nibbler, Girella punctate Grey. Bull. Tokai Reg. Fish. Res Lab. 120,43-51.
Nandeesha M.C.,Gangadhara B., Manissery J.K., Venkataram L.V., (2011). Growth performance of two Indian majior carps, catla (Catla catla) and rohu (Labeo rohita) fed diets containing different levels of Spirulina platensis. Bioresource Technology 80 (2001) 117-120.
Noh, S.H.Y., K. Han, T.H, Won and Y.J. Choi. (1994). Effect of antibiotics, enzyme, yeast culture and probiotics on the growth performance of Israeli carp. Korean Journal of Animal Sciences. 36: 480-486.
Surajit Das, Lyla P.S. and S. Ajmal Khan, (2008). Application of streptomyces as a probiotic in the laboratory culture of Penaeusmonodon (Fabricius).Israeli J. Aquac. - Bamidgeh, 58(3):198- 204.
Swain, S.K., Rangacharyulu, P,V.,Sarkar,S.and K.M.Das. (1996). Effect of a probiotic supplementation on growth, nutrient utilization and carcass composition in mrigal fry. Aquaculture.4:29-35.
Roe, J.H. (1955). The determination of sugar in blood and spinal fluid with anthrone reagent. J. Biol. Chem., 212, 335-343.
Tongsiri, KringsakMang-Amphan and Yuwadee Peerapornapisal, (2010) .Effect of Replacing Fishmeal with Siirulina on Growth, Carcass Composition and pigment of the Mekong Giant Catfish. Asian Journal of Agricultural Sciences 2(3): 106-110.
Wilson, R. P. & Poe, W. E. (1973) Impaired collagen formation in the scorbutic channel catfish. J. Nutr. 103, 1359-1364.