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EVALUATION OF GROWTH PERFORMANCE OF WALKING CATFISH (*Clarias Batrachus*) USING LOW COST FISH FEED

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ABSTRACT

To evaluate the effects of various types of low cost conventional fish feed on biomass conversion rate as well as on gonad (ovarian) weight in walking catfish (Clarias batrachus) an experiment was carried out in Badkulla. Three groups of juvenile fish (5.0 ± 0.15 g; 4.5 ± 0.12 cm) were fed with four different types of feeds as, silk worm meal (SWM), magmeal (MGM), vermimeal (VRM) and molluscan meal (MCM) which were isonitrogenus (30 g 100 g^{-1}) and isocaloric (4 Kcal g^{-1}) in nature. Due to presence of dry earth warm dust, rice bran, mustard oil cake and eggshell powder the SWM was proved to be the best proteinacious and economical feed among the three feed tested. Significant differences (P<0.05) in body weight gain, protein efficiency ratio and gonadosomatic index were observed in fishes when they were fed with different types of diets such as the SWM, MGM, VRM and MCM. There were no significant differences (P<0.05) among feed conversion ratio, energy retention and hepatosomatic index. The study suggests that the SWM diets, which led to significantly higher (P<0.05) growth and nutrient utilization than the other two diets in common cat fish (Clarias batrachus) will be helpful towards the development of pond culture of these fish species.

KEYWORDS

Biomass, gonad, isonitrogenous, isocaloric, walking-catfish (Clarias batrachus).

INTRODUCTION

Fish feed generally constitutes 60–70% of the operational cost in intensive and semi- intensive aquaculture system (Singh et al., 2006).It is needed to minimize the feed cost through the use of newer and cheaper sources of feed ingredients and by replacing the use of costly fish meal. This approach has already been considered as best way to reduce the total financial problems of aquaculture. Proper selection of feed ingredients for using with fish feed is very important because it must play a major role in maintaining its ultimate nutritional as well as economic success. The feed, generally used in third world countries for aquaculture is quite expensive, irregular and short in supply. These feeds are sometimes containing with pathogen as well as harmful chemicals that can cause different health hazards of human being. Naturally, the development of healthy, hygienic and low cost fish feed is needed and that which will be affordable for all fish farmers.

Nowadays, man and his domestic animals compete for the same foodstuffs. For both economic and practical reasons, fish feed should be prepared using locally available protein sources, preferably from those unsuitable for human consumption (Hossain and Jauncey, 1989b). It is, therefore, very crucial to find an alternative (Jauncey and Ross, 1982) to reduce feeding cost, and to make aquaculture a viable and attractive venture. Next to fishery by-products, terrestrial vertebrate by-products usually constitute the second major source of animal protein within aqua feed for warm water fish species (Tacon, 1993a). It has been considered that elder silkworms are the good source of protein for fishes. Due to easy availability (sericulture farm) and low cost, it is very advantageous for using the animal by-products in aquaculture. House fly larvae, earthworms and garden snails are now going to replace the use of fish meal and other animal protein sources in diet and also they have been considered as major protein sources for Indian major carps and other such fishes.

However, Magur (*Clarias batrachus*) can greatly tolerate the salinity of water and that's why it is most favored in aquaculture. The quality of Magur as a food fish includes high levels of protein (60%) combined with calcium (8%) and phosphorus (4.2%) as well as its neutral taste and firm texture play an important role for its selection in our experiment. In this study we attempted to test our formulated feed in Magur.

MATERIAL AND METHODS

EXPERIMENTAL SET UP

Fingerlings of Clarias batrachus were collected from local fish merchants, Badkulla, West Bengal, India. All the fingerlings with mean initial weight and length of 5.0± 0.5 g and7.0 ± 0.5 cm were divided into twelve groups comprising fifty individuals in each. After treating with potassium permanganate solution (1 mg L–1) to remove external parasites the fish fingerlings were allowed to acclimatize in a tank for two days, and seven days prior to the start of the experiment. The weight of each group of fingerlings also was counted to record the initial biomass of fishes. Twelve rectangular cement tanks (1000 L) were selected to stock each group of fishes and then they were treated with four different types of feeds. To maintain the static water system the bottom of the tank was filled with local agricultural soil (pH 6.4 ± 0.05). 90 day feeding experiment was carried by allocating triplicate tanks for each dietary treatment. By maintaining all of water quality parameters the proper water (Dechlorinated, temperature 30 ± 4 °C, pH 7.2 ± 0.05, free CO_2 0.5±0.01 mg L^{-1}, available nitrogen 0.6±0.05 mg L^{-1} and dissolved oxygen (DO) 6 mg L^{-1}) was supplied in the experiment.

FEED FORMULATION AND PREPARATION

Having very low cost the principal feed ingredients were easily collected from local sericulture farm, own laboratory and garden respectively. Due to presence of significant amount of crude protein (above 30%) these substances were used as feed ingredients though these are economically cheap. Biochemical composition of silkworm, housefly larva, earthworm and garden snail used for feed for *Clarias batrachus* are shown in **Table 1**.

By maintaining isonitrogenous (30 g 100 g^{-1}) and isoenergetic (4Kcal g^{-1}) feed formulations the experimental diets were prepared for growth trial of fishes. The aim of choosing this nutrient level, particularly protein, was to reflect the practical diets used in India. Diet formulations are presented in Table 2. Diets containing silkworm, housefly larva, earthworm and garden snail as key ingredients were designated as SWM, MGM, VRM and MCM respectively. The common ingredients as mustard oil cake, wheat flour, rice bran, and egg shell dust and vitamin premix were mixed in every feed tested. Due to presence of balanced nutritional value these ingredients were used to minimize the deficiency of lipid, protein and other nutrients in formulated feed. Wheat flour was selected as binder. Due to presence of huge amount of calcium and easy availability without any cost, the egg shell dust was mixed with the diets to fortify it. Calcium has important role in development of bones and it also can be remembered that large quantities of calcium is needed for developing fishes. For proper nutrition different ingredients must be mixed thoroughly and it can be done by using a food mixer (A200

Hobart Ltd).To determine the particular proportion of different feed ingredients Pearson's square method was used. The mixture of feed ingredients was given the shape of pellets using a Pellet Mill (Model CL2) with a 1.2 mm die. The resulting pellets after drying for 48 h at 50 ºC and packing in polythene bags were kept in dry and cool place.

Feeding

The fishes were fed twice daily, at 09.30 am and 4.30 pm for everyday throughout the experiment. The feed was given in a feeding bag, hanging from an iron rod in four corners of each tank. Regularly, the left over feed was removed and dried in a hot air oven at 100°C. Feed consumption was estimated by subtracting the weight of the unconsumed feed from weight of feed samples, and unconsumed feeds were the weight of the feed offered. Fish, an electric balance to an accuracy of 0.1 mg. weighed on.

Growth calculation

Growth and nutrient utilization were determined in terms of feed intake (FI), specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), energy retention (ER) and hepatosomatic index (HSI) as follows:

FI (g fish-1 day-1) = Total feed intake per fish/number of days
SGR (% day-1) = 100 × (ln [final body weight] - ln [initial body weight])/no. of Days
FCR = feed intake/live weight gain
PER = live weight gain/crude protein intake
ER (%) = 100 × (final fish body energy - initial fish body energy)/gross energy Intake
HSI (%) = 100 × (liver weight/total body weight)

Gonad estimation

Gonad weight was measured at day 50 (development of gonad marked on day 55) to day 90. Females from each treatment were sacrificed to study the appearance of ovary. The ovaries were first removed, weighted and then gonadosomatic index (GSI) was computed according to the formula of Dahlgren (1979):

GSI (%) =100 × (weight of gonad /total body weight)

Analysis

Feeds and carcass samples were analyzed following standard procedures (AOAC, 1990): dry matter (DM) after drying at 105°C for 24 h; crude protein (CP) by Kjeldahl method (N × 6.25) after acid hydrolysis, crude lipid (CL) after extraction with petroleum ether by Soxhlet method; total ash by igniting at 550°C for 3 h in muffle furnace. Organic matter (OM) was calculated by subtracting total ash from DM. Crude fibre was determined using a moisture free defatted sample which was digested by a weak acid followed by a weak base using the Fibertec System 2021 (FOSS, Denmark). Nitrogen-free extract was determined by subtracting the sum of crude protein, crude lipid, crude fibre and ash from DM. Gross energy was determined using a Bomb Calorimeter Model-DFU 24. The sample was combusted in a chamber pressurized with pure oxygen and resulting heat measured by increase in the temperature of the water surrounding the bomb.

The water quality parameters like temperature, pH, dissolved oxygen, sechi disc transparency, available nitrogen and available phosphate were analysed twice in a week, following standard procedures (APHA, 1989). Data were analysed using one-way ANOVA (Snedecor and Cochran, 1967), and differences between the means of treatments were examined using Duncan's multiple range tests.

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Pathological Studies:

Pathological studies were made on cultured fish through a trained fish pathologist.

Statistical analysis

Student's t test was used to determine the significance of differences in mean gonad weight and remaining period among experimental groups. One-way ANOVA was used to find the significant effects of feed type and rearing period on the feed and growth rates and also to test the significance of feed type on production of young (Zar, 1974).

RESULTS

The highest (26.9g) growth in weight of fish was observed in the SWM applied series followed by MGM (22.9g), VRM (18.4g) and MCM (16.6g) (**Fig 1**) applied series. The length of fish was maximum (19.6cm) in SWM fed treatment and minimum (12.75cm) in MCM fed treatment (**Fig 2**).

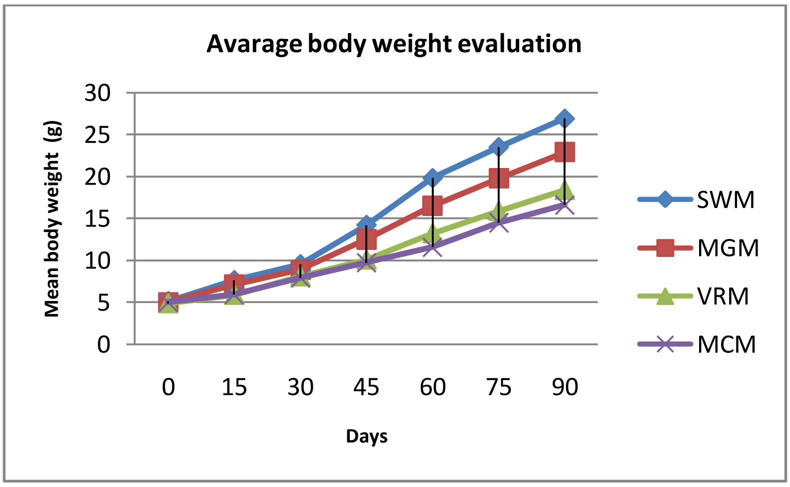

Fig 1: Mean body weight (g) evolution *Clarias batrachus* fed with SWM, MGM, VRM, MCM diets

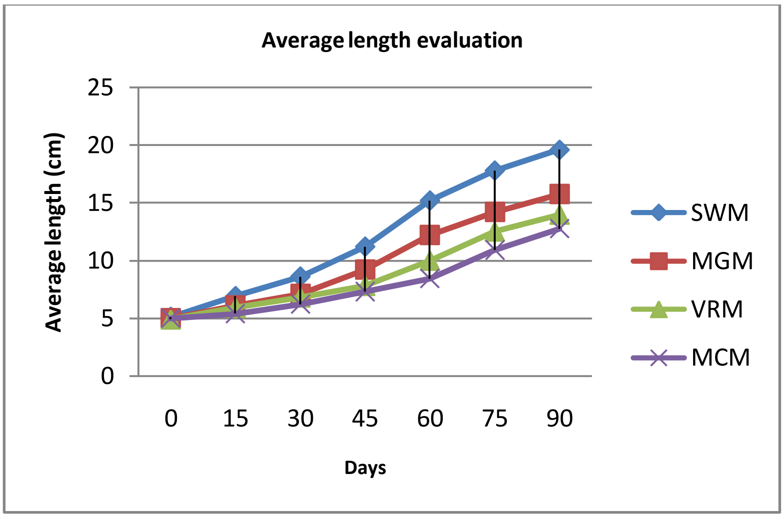

Fig 2: Average length (cm) of *Clarias batrachus* fed with SWM, MGM, VRM, MCM diets

The amount of feed intake was highest (0.60) in SWM provided treatment followed by MGM (0.55), VRM (0.46) and MCM (0.44) provided treatment. As expected the feed conversion ratio (FCR) was lowest (2.48) in SWM followed by MGM (2.78), VRM (3.11) and MCM (3.41).The specific growth rate was highest (1.83) in SWM fed treatment and lowest (1.32) in MCM fed treatment. The protein efficiency ratio (PER) was significantly differed among (P<0.05) different treatments. The PER value is highest (1.34) in SWM fed treatment and lowest (0.97) in MCM fed treatments. The energy retention (ER) value was highest (34.31) in SWM supplied treatment followed by MGM (28.02), VRM (20.99) and MCM (18.26) supplied treatment.

The hepatosomatic index (HSI) was highest (1.64) in SWM fed treatment series and lowest (1.48) in MCM fed treatment series. The highest (1.61) value of gonadosomatic index (GSI) was observed in SWM fed treatment and the GSI values varied significantly (P<0.05) with MGM (1.22), VRM (1.12) and MCM (1.08) fed treatment (**Table 3**).

Table 1: Biochemical composition of Silkworm, House fly larva, Earthworm and Garden snail used for feed for *Clarias batrachus*

Ingredient (%)	Silkworm	House fly larva	Earthworm	Garden Snail
Dry matter	92.83	91.12	91.56	90.50
Organic matter	81.29	80.45	82.09	81.52
Crude protein	40.45	37.58	36.25	35.70
Crude lipid	9.92	9.67	8.82	8.90
Ash	11.75	10.60	9.65	10.25
Nitrogen free extract	20.70	26.12	31.45	28.56
Crude fibre	8.69	8.89	9.79	8.99
Gross energy (Kcal g^{-1})	3.74	3.52	3.63	3.25

Table 2: Formulation and composition of the experimental diets (%)

Sl. no	Name of feed	Ingredients	% of ingredient in formulated feed	% of crude protein	% of lipid	% of carbohydrate *	Calorific value of feed (kcal/g)
1	SW M	Dry silkworm dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	45 10 34 10 01	30.25	9.2	11.2	4.1
2	MGM	Dry house fly larva dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	47 10 32 10 01	30.11	9.0	12.3	4.0
3	VRM	Dry earthworm dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	46 09 34 10 01	30.21	9.2	11.2	4.1
4	MCM	Dry Garden snail dust Rice bran MOC Wheat flour Egg shell dust and vitamin premix (3:1)	47 10 32 10 01	30.10	9.1	11.7	4.1

*** Carbohydrates calculated by difference.**

Table 3: Growth performance and nutrient utilization of *Clarias batrachus* fed SWM, MGM, VRM, MCM(mean ± SD)

	SWM	MGM	VRM	MCM
Mean Initial weight(g)	5.11±0.05 [a]	5.10±0.07 [a]	5.06±0.07 [a]	5.00±0.05 [a]
Mean Final weight(g)	26.9±0.25 [a]	22.9±0.30 [b]	18.4±0.60 [b]	16.6±0.76 [b]
Mean Final weight gain(g)	21.79±0.20 [a]	17.8±0.23 [b]	13.34±0.53 [b]	11.6±0.71 [b]
% weight gain	426.41±2.06 [a]	349.01±2.75 [b]	263.63±2.20 [b]	232±2.70 [b]
Initial length (cm)	5.1±0.12 [a]	5.0±0.10 [a]	4.9±0.12 [a]	5.0±0.09 [a]
Final length (cm)	19.6±0.11 [a]	15.75±0.11 [b]	13.96±0.12 [b]	12.75±0.10 [b]
Feed intake(g fish^{-1} day^{-1})	0.60±0.07 [a]	0.55±0.06 [b]	0.46±0.07 [b]	0.44±0.08 [b]
Specific growth rate (%day^{-1})	1.83±0.07 [a]	1.65±0.05 [b]	1.42±0.03 [b]	1.32±0.04 [b]
Feed conversion ratio	2.48±0.07 [a]	2.78±0.08 [b]	3.11±0.07 [b]	3.41±0.06 [b]
Protein efficiency ratio	1.34±0.05 [a]	1.19±0.07 [b]	1.07 ±0.07 [b]	0.97±0.07 [b]
Energy retention (%)	34.31±0.07 [a]	28.02±0.05 [a]	20.99±0.06 [b]	18.26±0.07 [b]
Hepatosomatic index	1.64±0.08 [a]	1.59±0.07 [a]	1.51±0.06 [a]	1.48±0.06 [a]
Gonado somatic index	1.61±0.07 [a]	1.22±0.08 [b]	1.12±0.09 [b]	1.08±0.09 [b]
Mortality rate (%)	3 [a]	8 [b]	6 [b]	9 [b]

***Different superscript letters in the same row indicate significantly statistical differences (P<0.05).**

Table 4: Whole body proximate composition of *Clarias batrachus* fed with SWM, MGM, VRM ,MCM (%fresh weight basis, mean±SD)

	Initial	SWM	MGM	VRM	MCM
Moisture	75.46	69.92±1.26 [a]	73.75±1.25 [b]	76.12±1.24 [b]	78.35±1.25 [b]
Crude protein	10.90	14.35±0.54 [a]	11.65±0.52 [b]	11.23±0.50 [b]	11.03±0.50 [b]
Crude lipid	5.87	6.27±0.08 [a]	5.99±0.09 [a]	5.94±0.07 [a]	5.93±0.06 [a]
Ash	4.89	5.01±0.06 [a]	5.25±0.07 [a]	5.30±0.08 [a]	5.35±0.06 [a]
Gross energy (Kcal g^{-1})	3.90	4.01±0.06 [a]	4.00±0.07 [a]	4.01±0.07 [a]	4.01±0.06 [a]

***Different superscript letters in the same row indicate significantly statistical differences (P<0.05).**

Table 5: Limnological and hydrobiological parameters (Average value) studied during the experiment

Sl. No.	Limnological parameters	(SWM) (Silk Worm Meal)	MGM (Mag meal)	VRM (vermimeal)	MCM (molluscan meal)
1	Temperature (°C)	23.60±1.1	23.14±1.4	23.16±1.7	23.28±1.7
2	pH	7.18± 0.6	7.11± 0. 5	7.09± 0.55	7.07± 0.55
3	Sechi disc transparency (m)	0.75±0.06	0.65±0.08	0.6±0.07	0.6±0.07
4	DO (mg.l^{-1})	5.9±0.9	7.5±0.7	6.7±0.5	6.1±0.5
5	CO_2 (mg.l^{-1})	0.7±0.05	0.45±0.03	0.65±0.09	0.55±0.09
6	Available Nitrogen (mg.l^{-1})	0.85±0.06	0.65±0.09	0.75±0.05	0.70±0.05
7	Available Phosphate (mg.l^{-1})	0.20±0.011	0.19±0.015	0.23±0.019	0.25±0.019

In every treatment the moisture content of fish was improved than the initial. The moisture content was significantly (P<0.05) low in SWM fed fish than the other three feeds tested. It was lowest (69.92) in SWM fed treatment followed by MGM (73.75), VRM (76.12) and MCM (78.35) fed treatments (Table 4). The amount of crude protein (CP) was highest (14.35) in SWM fed fish followed by MGM (11.65), VRM (11.23) and MCM (11.03) fed fish. The lipid content was not differ significantly (P<0.05) high (6.27) in SWM fed treatment followed by MGM (5.99), VRM (5.94) and MCM (5.93) fed treatment. The ash content was high (5.35) in MCM fed treatment followed by VRM (5.30), MGM (5.25) and SWM (5.01) fed treatment. The gross energy was highest (4.01) in SWM fed treatment and lowest (4.00) in MGM fed trial.

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Disease resistance

Significant difference was observed ($P<0.05$) in the number of fish showing open sores, tail and fin rot diseases in the treatment series as the numbers were less in the SWM treated series when compared with other two treatments. The lowest mortality was found in SWM treated series (**Table 3**).

DISCUSSION

The physio-chemical parameters of water throughout the experiment was suitable as required by *Clarias batrachus,* indicating that these feed was also suitable for utilization and will be favorable for further using in magur farming ponds. Being very similar in all tanks the water quality parameters such as temperature, pH, sechi disc transparency, dissolved oxygen, free CO_2, available nitrogen and available phosphate as shown in **Table 5** were ignored in measuring their effects on growth of experimental fishes as well as in evaluating the efficiency of the feeds.

In this treatment series the fishes that gained the highest weight were administrated with SWM feed indicating that fish can consume the feed properly. According to the results it can be said that the cultured fishes greatly accepted the SWM feeds. Due to its higher palatability the SWM feed was accepted as potential feed among the fishes. The fishes can convert these feed into their body mass by easily digesting the SWM feed due to presence of low FCR in it. Results indicate that tested value of FCR is lower (2.48) indicating that it is a better quality of product in the market for aquaculture. The study also show that SWM feed treatment results higher protein ($P<0.05$) efficiency ratio than the other feed treatments as MGM,VRM and MCM and this result vividly indicates that better quality of protein can be found in case of SWM. In this result the highest (34.31) ER value also can be seen for SWM and it tells about the good efficiency of SWM as well as of its energy retention. The reproductive functions are affected by GSI value of feed and hence higher GSI value proves that SWM has better impact on gonads. Due to lower mortality rate in SWM than other three meals it is considered that SWM feed is significantly a better choice of the feed among the fishes from beginning of feed administration. It has been calculated that moisture content was lower in SWM than the others from the beginning of administration of the various test feeds and it also says that SWM improves the flesh content of the test fish. The protein content was high in SWM fish feed and it also can be converted into body protein in a higher ratio than MGM, VRM and MCM.

CONCLUSION

In conclusion, it could be said that animal byproduct meals (SWM, MGM, VRM and MCM) are suitable replacement for market available fish feed for *Clarias batrachus* diets and replacement did not show any negative effect on fish growth performance cultured in static water conditions. Applying these feed fish farming becomes more profitable to the poor fish farmers by lowering the feed costs to a certain degree.

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REFERENCES

1. Mollah MF and Alam MS (1990). Effects of different levels of dietary carbohydrate on growth and feed utilization of catfish (Clarias batrachus) fry. Indian Journal of Fisheries, 37: 243-249.
2. Chakrabarty D, Das SK, Das MK, Bag MP (2010). Assessment of Vermicompost as Direct Application Manure in Fish Farming Ponds. Turkish J. Fisheries Aquat. Sci. 10: 47-52.
3. Cengiz EI, Unlu E, Bashan M (2003). The effect of dietary fatty acids on the fatty acid composition in the phospholipids fraction of Gambusia affinis. Turkish J. Biol. 27, 145–148.

4. Giri SS, Sahoo SK, Sahu AK, Mukhopadhyay PK (2000). Nutrient digestibility and intestinal enzyme activity of Clarias batrachus (Linn.) juveniles fed on dried fissh and chicken viscera incorporated diets. Bioresource Technology 71 (2000) 97–101.
5. Sahoo, J. K., Chand, B. K., Das, S. K. and Saksena, D. N. 2002. Length-weight relationship of indian major carps under different aquafarming systems in Ganjam district, Orissa. Indian J. Anim. Hlth. 41: 89-94.
6. Christensen JH, Skou HA, Fog L, Hansen V (2001). Marine n-3 fatty acids, wine intake, and heart rate variability in patients referred for coronary angiography. Circulation, 103: 651-657.
7. Firdaus S, Jafri AK, Khan MA (2002) Effect of dietary levels of mineral mixture on the growth, body composition and haematology of catfish, Heteropneustes fossilis Bloch. J Aquac Trop 17:273–281
8. Boon, J.H., McDowell, T. and Hedrick, R.P. 1988. Resistance of the African (Clarias gariepinus) and the Asian catfish (Clarias batrachus) to channel catfish virus. Aquaculture, 74: 191-194.
9. Al-Hafedh YS, Ali SA (2004) Effects of feeding on survival, cannibalism, growth and fed conversion of African catfish, Clarias gariepinus (Burchell) in concrete tanks. J Appl Ichthyol 20:225–227. doi:10.1111/j.1439-0426.2004.00544.x
10. Biswas G, Jena JK, Singh SK, Patmajhi P, Muduli HK (2006) Effect of feeding frequency on growth, survival and feed utilization in mrigal, Cirrhinus mrigala, and rohu, Labeo rohita, during nursery rearing. Aquaculture 254:211–218. doi:10.1016/j.aquaculture.2005.08.001
11. Britz, P.J. 1991. The utility of homoplastic pituitary glands for spawning induction of the African catfish (Clarias gariepinus) in commercial aquaculture in Africa. Water SA, 17: 237-241.
12. Tian X, Qin JG (2004) Effects of previous ration restriction on compensatory growth in barramundi Lates calcarifer. Aquaculture 235:273–283. doi:10.1016/ j.aquaculture. 2003.09.055
13. APHA., 1989. Standard methods for the examination of water and wastewater. APHA, New York, p 1193
14. AOAC., 1990. Official Methods of Analysis of the Association of Official Analytical Chemists. Helrich, K., (Ed.) 15 edn, Arlington, VA, USA:
15. A. Bhattacharya. S. Bhattacharya. Induction of oxidative stress by arsenic in C batrachus: involvement of peroxisomes. Ecotoxicol Environ Saf.2007; 66(2):178-87.
16. T, Majumdar. D, Ghosh. S, Datta. C, Sahoo. J, Pal .S, Mazumder. An attenuated plasmid-cured strain of Aeromonas hydrophila elicits protective immunity in C batrachus L. Fish Shellfish Immunol. 2007; 23(1):222-30.
17. K, Dash. K, Saha. AK, P&ey. AK, Jain. A, Mukherjee. Ultra-structural observations on the lymphoid organs of the freshwater catfish, C batrachus.J Environ Biol.2003; 24(3):265-9.

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