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Full Length Research Paper

Evaluation of growth performance of tilapia (*oreochromis mossambicus*) using low cost fish feed

Mukti Pada Bag[1], Subhas Chandra Mahapatra[2], Pavuluri Srinivasa Rao[3] and Debajyoti Chakrabarty[4 *]

[1]Indian Institute of Technology, Rural Development Centre, Kharagpur, Paschim Medinipur, India.
[2]Indian Institute of Technology, Rural Development Centre, Kharagpur, Paschim Medinipur, India.
[3]Indian Institute of Technology, Agricultural and Food Engineering Department, Paschim Medinipur, West Bengal, India.
[4]Krishnagar Government College, Department of Zoology, Krishnagar, Nadia, India.

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A comprehensive trial was undertaken to assess the effect of various types of low cost non-conventional fish feed on the biomass conversion rate as well as on gonad (ovarian) weight in Mozambique tilapia, *Oreochromis mossambicus*. Three groups of juvenile fish (5.0 ± 0.15 g; 4.5 ± 0.12 cm) were fed with three different types of feeds with earthworm meal (EWM), slaughter house offal meal (SOM) and hydrated poultry feather meal (PFM). These fish feeds were isonitrogenus (30 g 100 g^{-1}) and isocaloric (4 Kcal g^{-1}) in nature. The EWM made with dry earthworm dust, rice bran, mustard oil cake and eggshell powder proved to be the best and economical feed among the three feed tested. Significant difference (P<0.05) in body weight gain, protein efficiency ratio and gonadosomatic index were observed among fish fed the EWM, SOM and PFM diets. No significant differences (P<0.05) in feed conversion ratio, energy retention and hepatosomatic index were observed. Among the dietary treatment groups, significantly lower (P<0.05) moisture content of body and higher whole-body protein were also found in EWM diets. The earth-worm possibly contained better quality of protein which in turn influenced somatic as well as reproductive growth of those fish. The study suggests that the EWM diet, which led to be significantly higher (P<0.05) growth and nutrient utilization than the other two diets in tilapia, *O. mossambicus,* may be used for pond culture of this species.

Key words*: Oreochromis mossambicus,* non-conventional, biomass, gonad, isonitrogenous and isocaloric

INTRODUCTION

Fish feed generally constitutes 60–70% of the operational cost in the intensive and semi- intensive aquaculture system (Singh *et al*., 2006). The need to minimize feed cost through the use of newer and cheaper sources of feed ingredients, has already been considered. Selection of feed ingredients for use as a fish feed will play a major role in matching its ultimate nutritional in addition to economic success. Generally, in third world countries the feed used in aquaculture is quite expensive, irregular and short in supply. These feeds are sometimes adulterated, contaminated with a pathogen as well as containing harmful chemicals on human health. Naturally, there is a need for the development of healthy, hygienic fish feed, which will be affordable for fish farmers.

There is high competition for the same foodstuffs between man and his domestic animals. For both economic and practical reasons, fish feed should be prepared to be use locally available protein sources, preferably from those unsuitable for human consumption (Hossain and Jauncey, 1989). 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 constituted the second major source of animal protein within aquafeed for warm water fish species (Tacon, 1993). Earthworm has been found to be a good source of protein (Guererro, 1981; Tacon *et al*.,1982;

*Corresponding Author's E-mail: drdc64@gmail.com
Tel.: +91.347 225 60 46; Fax: +91.347 2252 810;

Table 1: Biochemical composition of Earthworm, slaughter house offal and hydrated poultry feather used for feed for Tilapia (*O. mossambicus*)

Ingredient (%)	Earthworm	Slaughter house offal	Hydrated poultry feather
Dry matter	92.54	91.09	91.76
Organic matter	80.69	80.39	82.06
Crude protein	40.43	36.56	32.29
Crude lipid	9.87	9.57	8.65
Ash	11.85	10.70	9.70
Nitrogen free extract	21.60	25.27	31.23
Crude fiber	8.79	8.99	9.89
Gross energy (Kcal g^{-1})	3.85	3.54	3.61

Hilton, 1983) and its use as fish bait is well known in fishing. Another advantage of using these animal by-products is their easy availability in the locality and low cost. Several workers have attempted to replace fish meal and other animal protein sources in the diet with slaughter house waste (Nandeesha *et al.,* 1991; Jadhav and Rao, 1991; Khan and Jafri, 1992; Paul *et al*., 1997) poultry offal (Hassan and Khan, 1999) for Indian major carps and other such fish. But these fish are not very hardy, difficult to culture and do not breed in captivity.

However, Tilapia (*Oreochromis mossambicus*) is most favored in aquaculture due to its tolerances. These include ease of breeding in captivity, tolerance to both crowding and relatively poor water quality and low susceptibility to diseases. The quality of Tilapia as a food fish includes white flesh, neutral taste and firm texture. In our present attempt, we tested our formulated feed in tilapia.

MATERIAL AND METHODS

Experimental set up

Nine groups of tilapia fingerlings comprising fifty individuals (Weight 5.0–5.5 g and Length 4.0-4.5 cm) were obtained from Balarampur fish farm, West Bengal, India. The fish fingerlings were treated with potassium permanganate solution (1 mg L^{-1}) to remove any external parasites and were acclimatized in a tank for seven days. Each group of fingerlings also was initially weighed to record the initial biomass. They were stocked in 9 rectangular cement tanks (1000 L), and three different feed were administered. Triplicate tanks were allocated for each dietary treatment. The water system was static in nature, and the bottom of the tank was filled with local agricultural soil (pH 6.4 ± 0.05). The experiment was conducted for 90 days. Dechlorinated well water (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 used in the experiment.

Feed formulation and preparation

The principal feed ingredients were collected from vermicompost farm, slaughter house and poultry farm respectively at very low cost. These substances were economically cheap but contained significant amount of crude protein (above 30%). Biochemical composition of earthworm, slaughter house offal and hydrated poultry feather used for feed for tilapia are shown in table 1.

Diets used for growth trial were so prepared that feed formulations remain almost isonitrogenous (30 g 100 g^{-1}) and isoenergetic (4Kcal g^{-1}) in nature. The choice of these nutrient levels, particularly protein, was intended to reflect the practical diets used in India. Diet formulations are presented in table 2. Diets containing earth-worm, slaughter house offal and hydrated poultry feather as the key ingredient were designated as EWM, SOM and PFM respectively. The mustard oil cake, wheat flour, rice bran, egg shell dust and vitamin premix were the common ingredient in every feed tested. These ingredients were used to compensate lipid, protein and ash deficiency in formulated feed. Wheat flour was selected as a binder. Each feed was fortified with egg shell dust, which is available free of cost for calcium supplement. This was added keeping in mind that the developing fish needs huge quantity of calcium for its bone development. The different ingredients were thoroughly mixed using a food mixer (A200 Hobart Ltd). The proportion of different feed ingredients was determined by using Pearson’s square method. The mixture was given the shape of pellets using a Pellet Mill (Model CL2) with a 1.2 mm die. The resulting pellets were dried for 48 h at 50 ºC and then packed in polythene bags and kept in dry and cool place.

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	EWM	Earthwarm dust	46	30.23	9.2	11.2	4.1
		Rice bran	09				
		MOC	34				
		Wheat flour	10				
		Egg shell dust and vitamin premix (3:1)	01				
2	SOM	Dry slauter house offal dust	47	30.11	9.0	12.3	4.0
		Rice bran	10				
		MOC	32				
		Wheat flour	10				
		Egg shell dust and vitamin premix (3:1)	01				
3	PFM	Hydrated poultry feather dust	48	30.05	9.1	12.7	4.1
		Rice bran	10				
		MOC	31				
		Wheat flour	10				
		Egg shell dust and vitamin premix (3:1)	01				

* Carbohydrates calculated by difference.

Feeding

The feed was given in a feeding bag hung from an iron rod at 09.30 am and 4.30 pm on everyday for 1 h in four locations in each tank. Unconsumed 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 the weight of the feed offered. Fish, feed samples, and unconsumed feeds were weighed on an electric balance to an accuracy of 0.1 mg.

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 an 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 the muffle furnace. Organic matter (OM) was calculated by subtracting total

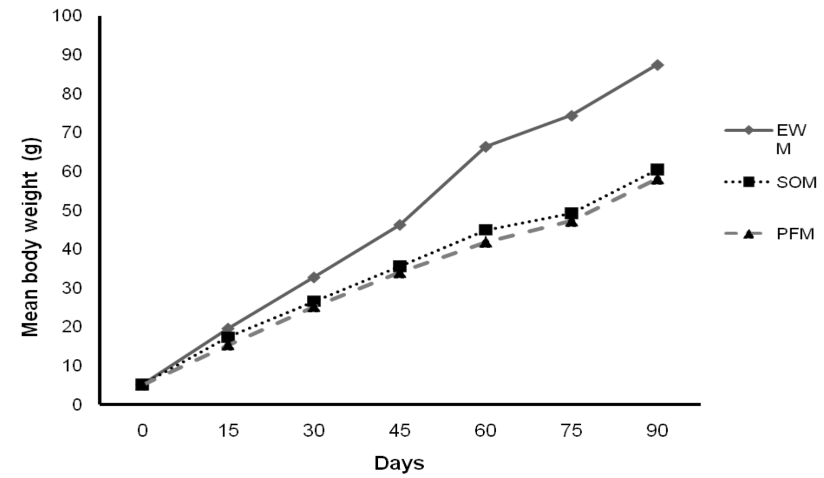

Figure 1: Mean body weight (g) evolution *O.mossambicus* fed EWM, SOM and PFM diets

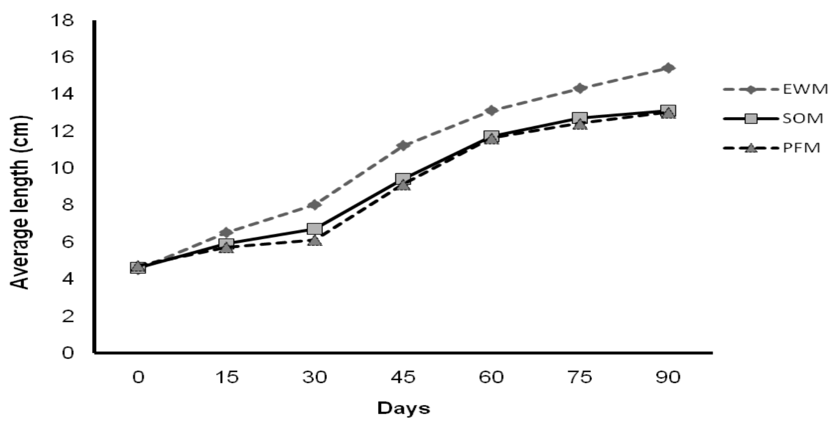

Figure 2: Average length (cm) of *O.mossambicus* fed on EWM, SOM and PFM diet

ash from DM. Crude fiber 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 fiber 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 an 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.

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 (86.66g) growth in weight of fish was observed in the EWM applied series followed by SOM (59.00g) and PFM (57.33g) (Fig.1) applied series. The length of fish was maximum (15.4cm) in EWM fed treatment and minimum (13.0cm) in PFM fed treatment (Fig. 2).

The amount of feed intake was highest (1.98) in EWM provided treatment followed by SOM (1.35) and PFM (1.32) provided treatment. This was 46.66 % higher than SOM and 50 % higher than PFM and as expected the

Table 3: Growth performance and nutrient utilization of *O.mossambicus* fed EWM, SOM and PFM diets (mean±SD)

	EWM	SOM	PFM
Initial weight(g)	5.11±0.05 [a]	5.10±0.07 [a]	5.06±0.07 [a]
Final weight(g)	86.66±1.25 [a]	59.00±1.28 [b]	57.33±1.26 [b]
Initial length (cm)	4.5±0.10 [a]	4.6±0.11 [a]	4.5±0.12 [a]
Final length (cm)	15.4±0.11 [a]	13.1±0.11 [a]	13.0±0.12 [a]
Feed intake(g fish^{-1} day^{-1})	1.98±0.08 [a]	1.35±0.08 [b]	1.32±0.09 [b]
Specific growth rate (%day^{-1})	1.06±0.07 [a]	0.60±0.07 [b]	0.58±0.05 [b]
Feed conversion ratio	2.19±0.07 [a]	2.25±0.09 [a]	2.28±0.08 [a]
Protein efficiency ratio	1.72±0.05 [a]	1.31±0.04 [b]	1.30±0.05 [b]
Energy retention (%)	20.54±0.23 [a]	20.00±0.25 [a]	19.73±0.19 [a]
Hepatosomatic index	1.73±0.08 [a]	1.71±0.07 [a]	1.70±0.06 [a]
Gonadosomatic index	1.64±0.07 [a]	1.04±0.08 [b]	1.01±0.09 [b]
Mortality rate (%)	4 [a]	8 [b]	8 [b]

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

Table 4: Whole body proximate composition of *O.mossambicus* fed with EWM, SOM and PFM diets before and after the experiment (%fresh weight basis, mean±SD)

	Initial	EWM	SOM	PFM
Moisture	75.91	70.08±1.26 [a]	74.96±1.25 [b]	75.28±1.24 [b]
Crude protein	11.01	14.78±0.54 [a]	11.65±0.52 [b]	11.03±0.50 [b]
Crude lipid	5.92	6.08±0.08 [a]	5.98±0.09 [a]	5.93±0.07 [a]
Ash	4.95	5.01±0.06 [a]	5.25±0.07 [a]	5.30±0.08 [a]
Gross energy((Kcal g^{-1}))	3.90	4.01±0.06 [a]	4.00±0.07 [a]	4.01±0.07 [a]

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

feed conversion ratio (FCR) was lowest (2.19) in EWM followed by SOM (2.25) and PFM (2.28).The specific growth rate was highest (1.06) in EWM fed treatment and lowest (0.58) in PFM fed treatment. The protein efficiency ratio (PER) was significantly differed among (P<0.05) different treatments. The PER value is highest (1.72) in EWM fed treatment and lowest (1.30) in PFM fed treatments. The energy retention (ER) value was highest (20.54) in EWM supplied treatment followed by SOM (20.00) and PFM (19.73) supplied treatment.

The hepatosomatic index (HSI) was highest (1.73) in EWM fed treatment series and lowest (1.70) in PFM fed treatment series. The highest (1.64) value of gonadosomatic index (GSI) was observed in EWM fed treatment, and the GSI values varied significantly (P<0.05) with SOM (1.04) and PFM (1.01) fed treatment (Table 3).

In every treatment, the moisture content of fish was improved than the initial. The moisture content was significantly (P<0.05) low in EWM fed fish than the other two feeds tested. It was lowest (70.08) in EWM fed treatment followed by SOM (74.96) and PFM (75.28) fed treatments (Table 4). The amount of crude protein (CP) was highest (14.78) in EWM fed fish followed by SOM (11.65) and PFM (11.03) fed fish. The lipid content was not differed significantly (P<0.05) high (6.08) in EWM fed treatment followed by SOM (5.98) and PFM (5.93) fed treatment. The ash content was high (5.30) in PFM fed treatment followed by SOM (5.25) and EWM (5.01) fed treatment. The gross energy was highest (4.01) in EWM fed treatment and lowest (4.00) in SOM fed trial.

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 EWM treated series when compared with

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

Sl. No.	Limnological parameters	**ETM (Earth warm meal)**	**SOM (Slaughter house offal meal)**	**PFM (Hydrated poultry feather meal)**
1	Temperature (°C)	23.60±1.1	23.14±1.4	23.16±1.7
2	pH	7.18± 0.6	7.11± 0. 5	7.09± 0.55
3	Sechi disc transparency (m)	0.75±0.06	0.65±0.08	0.6±0.07
4	DO ($mg.l^{-1}$)	5.9±0.9	7.5±0.7	6.1±0.5
5	CO_2 ($mg.l^{-1}$)	0.7±0.05	0.45±0.03	0.65±0.09
6	Available Nitrogen ($mg.l^{-1}$)	0.85±0.06	0.65±0.09	0.75±0.05
7	Available Phosphate ($mg.l^{-1}$)	0.20±0.011	0.19±0.015	0.23±0.019

other two treatments. The lowest mortality was found in EWM treated series (Table 3).

DISCUSSION

Throughout the experiment, water quality in all treatments remained within the favorable range required by tilapias (Ballarin and Hatton, 1979) indicating that these feed could be utilized in the tilapia farming pond. 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 found to be very similar in all the tanks and hence their effects on growth of the experimental fish were ignored in evaluating the efficiency of the feeds.

The highest weight gain was observed in the treatment series administration with EWM feed. This indicates that fish can consume the feed well. The results show high acceptability for the EWM among cultured tilapia. This was possibly due to their higher palatability and preference of the fish to take it as their potential food. The low FCR of EWM indicates that fish can easily digest the feed and convert these feed into their body mass. The tested value of FCR showed lower (2.19) indicating a favorable effect on the market the quality of product. The protein efficiency ratio was significantly ($P<0.05$) high in EWM fed treatments than SOM and PFM fed treatments, which vividly indicate the quality of protein is better in case of EWM. The highest (20.54) ER value again indicates the good efficiency of EWM in terms of energy retention. The higher value of GSI indicates that the EWM has the better impact on the reproductive function. The EWM and SOM contain iron in their haemoglobin part where as PFM was inferior in iron content. This has the negative impact on PFM as fish feed. The mortality of fish was significantly lower in EWM than other two meals indicating a better choice of the feed among the fish from beginning of feed administration. After the administration of the various test feeds, the moisture content was lower in EWM indicating improvement in flesh content of the test fish. The protein content was high in EWM fed fish as the feed was converted into body protein in a higher ratio than SOM and PFM.

CONCLUSION

In conclusion, it could be said that animal byproduct meals (EWM, SOM and PFM) are suitable replacement, for market available fish feed for *O. mossambicus* diets and replacement did not show any negative effect on fish growth performance cultured in static water conditions. By applying this feed fish farming becomes more profitable to the poor fish farmers by lowering the feed costs to a certain degree.

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