Pak. j. sci. ind. res., vol. 38, nos. 5-6, May-June 1995

EFFICACY OF FISH SILAGE AND FISH MEAL ON THE GROWTH PERFORMANCE OF NILE TILAPIA, *OREOCHROMIS NILOTICUS* FRY

M.E. Hoq, A.K.M.A. Bhuiyan*, M. Begum and M. Zaher
Fisheries Research Institute, Mymensingh-2201, Bangladesh

(Received October 10, 1993; revised April 18, 1995)

A 50-days feeding trial using *Oreochromis niloticus* fry was conducted to evaluate the performance of fish silage and fish meal prepared from marine trash fish. The fry were maintained on 3 diets, fish silage and fish meal (prepared from same raw materials) and commercial grade fish meal as major dietary protein source at 30% level. On the basis of observed growth rate, food conversion ratio, protein efficiency ratio and net protein utilization, the diet containing fish silage produced the best growth performance. There was no significant difference ($P>0.05$) between diet containing fish silage and laboratory grade fish meal but these were significantly different from commercial grade fish meal diet.

Key words: Fish silage, Fish meal, Growth, *Oreochromis niloticus*.

Introduction

With the intensification of aquaculture (pond based fish farming) in the country, the need for fish feed is increasing day by day. There is growing interest in the silage process in both industrialized and developing countries because of its several advantages over fish meal. A considerable quantity of fish by-catch are being discarded world over including the Bay of Bengal due to very low market value [1]. The use of fish silage as a substitute for fish meal in fish diet has been investigated in many parts of the world [2-4].

In Bangladesh, the concept of fish silage is almost new. Disney [4] opined that significant quantities of raw materials are available in the country for silage production. The pioneer work on silage preparation using locally available ingredients was reported by Bhuiyan *et al.* [6] The present study was conducted to evaluate the performance of fish silage in comparison to fish meal in tilapia diet with locally available feed stuffs.

Material and Methods

Preparation of fish products. Fish silage was prepared from iced 'trash fish' collected from BFDC (Bangladesh Fisheries Development Corporation) fish trawler at Chittagong Fish Harbour. The trash fish is composed of 16 fish species, including Anchovy (*Coilia dussumieri*) and Smooth back herring (*Raconda russelliana*) as the major species. Formic acid (98%) was thoroughly mixed with minced trash fish (3.0% v/w) and stored at a temperature (23-24.5°C) in a plastic container. Liquefaction of acid treated minced fish occurred in 4 days and pH of the ensiling mixture dropped to 3.75 from an initial value of 6.68. Rice bran was added to this liquid silage (1:3 ratio) and the mixture spread as thin layers on trays and then sun-dried. The dried product was than ground to fine particles. The product had an acceptable appearance and odour.

To prepare fish meal, iced trash fish from same batch were sun-dried to about 9% moisture and ground by a lab mill. The largest fish meal producer in the country BFDC produces fish meal in the same way.

Experimental diets. In order to evaluate the efficacy, three diets were formulated each having a single source of protein-commercial grade fish meal (BFDC), laboratory grade fish meal and dried silage. Proximate analysis of the fish products and other dietary ingredients was performed (Table 1).

Table.1: Proximate Composition of Dietary Ingredients (% dry matter basis).

Ingredients	Components					
	Dry matter	Crude protein	Crude lipid	Ash	Crude fibre	NFE[1]
Fish meal (Commercial grade	82.4	50.8	7.6	25.9	1.5	14.1
Fish meal (Laboratory grade)	90.7	63.3	6.0	21.8	1.3	7.6
Dried silage	94.0	37.4	16.0	17.2	8.2	21.2
Sesame oilcake	86.9	27.2	13.2	13.5	11.2	35.0
Table flour	89.7	19.7	0.4	0.4	0	79.5

1 Nitrogen free exractive calculated as : 100 -%(Moisture+Crude protein+Crude lipid+Ash+Crude fibre)

The experimental diets were approximately iso-nitrogenous and iso-caloric (Table 2 and 3). The crude protein level in the diets was maintained at 30% level and energy level at about 383-387 Kcal/100g. Diets were prepared by mixing various ingredients homogenously. Vitamin & mineral premix (Embavit-GS) at 2% level was added to all the 3 diets and α-starch was the source of digestible carbohydrate. Mixed feeds were extruded using a manual pellet machine with a 2 mm diameter and air dried. Samples of diets were subjected to proximate analysis (Table 3).

TABLE 2. COMPOSITION OF EXPERIMENTAL DIETS (%).

Ingredients	Diet-A	Diet-B	Diet-C
Fish meal (Commercial grade)	39.4	-	-
Fish meal (Laboratory grade	-	31.3	-
Dried silage (Silage+Rice bran)	-	-	53.6
Sesame oilcake	32.5	32.5	32.5
Table flour	5.9	5.9	5.9
Soyabean oil	6.0	4.5	-
Vitamin & Mineral premix[1]	2.0	2.0	2.0
α–starch	14.2	23.9	6.1

Vitamin & Mineral premix (active ingredients per 2.5 Kg of premix): Vitamin-A 12,000,000IU; Vitamin-D3 2,000,000 IU; Vitamin-E 15,000 1μVitamin-K3 2g; Vitamin-B1 1g; Vitamin-B2 4g; Vitamin-B6 3g; Nicotinic acid 25g; Pantothenic acid 12g; Vitamin -B12 10mg; Folic acid 0.5g; Biotin 0.05g; Cobalt 0.4g; Copper 8g, Iron 32g; Iodine 0.8g; Manganese 64g; Zinc 40g; Selenium 0.16g; DL-Methionine 50g; Choline chloride 250g; Spiramycine 5g; & BHT 50g.

TABLE 3. PROXIMATE COMPOSITION OF EXPERIMENTAL DIETS USED (% DRY MATTER BASIS).

Components	DietA	Diet-B	Diet-C
Dry matter	90.5	89.0	91.6
Crude protein	29.7	29.8	30.9
Crude lipid	10.8	8.7	8.6
Crude fibre	1.5	1.3	8.2
ASH	22.0	15.9	24.7
NFE	36.0	44.3	27.6
Gross energy (Kcal/100g diet)	383.0	386.5	386.7

Experimental fish and management. Nile tilapia (*Oreochromis niloticus*) fry from nursery ponds of Freshwater Station (FRI), Mymensingh, were stocked in 100 x 80 x 70 cm^3 fibre glass tanks which contained about 280 litres water maintaining a level of 35 cm height with 30 fish per tank. Deep tubewell water was used for the experiment and necessary aeration was provided by central aeration system (blowers). The fish were acclimatized for about 3 days prior to feeding with formulated feeds. Tanks were cleaned daily by siphoning out faeces and/or unutilized feed particles and replacing the siphoned water. A complete change of water was made every 3 days. At the start of the experiment, the average weight of fish ranged from 1.75 to 1.80g and the fry were almost of equal size. The fish were fed experimental diets at the rate of 5% of biomass for 50 days, split in two meals, one at 08.30 and the other at 15.30 hrs. The feeding rate was adjusted every 7 days based on actual body weight. Two replications of feeding trial for each kind of protein-source based feeds were conducted.

Fish were weighed in bulk and counted at weekly interval to determine growth and to adjust rations. Water samples were also collected on weekly basis to determine physico-chemical parameters i.e. temperature, dissolved oxygen, pH using water testing kit (HACH FF-2).

Analytical methods. Feed ingredients, experimental diets and fish carcass were analyzed for proximate composition using standard methods [7].

Statistical methods. Data on weight gain, SGR, FCR, PER, NPU and survival for each treatment were analyzed by one way ANOVA. The mean values were compared according to Duncan Multiple Range Test at 0.05 probability level.

Results and Discussion

Growth responses of tilapia fry fed by 3 experimental diets for 7-weeks are shown in Fig. 1. It appears that growth response was significantly effected by diet-C, containing dried fish silage as a major protein source. Average weight gain, feed consumed, SGR, FCR, PER, Apparent NPU (since no correction was made for the endogenous nitrogen losses during the experiment, results expressed as ANPU) and mortality in the feeding trial are presented in Table 4. All experimental diets sustained excellent fish survival of 97% throughout the 7-weeks rearing period.

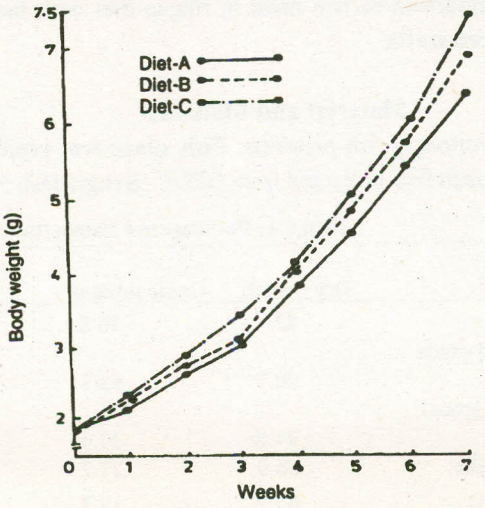

Fig. 1. Mean body weight of *Oreochromis niloticus* fry fed diets containing fish meal and dried silage.

TABLE 4. GROWTH PARAMETERS FOR *OREOCHROMIS NILOTICUS* FRY FED DIFFERENT DIETS FOR 50 DAYS IN FIBRE GLASS TANKS. THE DATA ARE MEANS FROM DUPLICATE TANKS EACH CONTAINING 30 FISH.

Diet	Mean initial wt.(g)	Mean final wt.(g)	Weight gain(g)	% Wt. gain	Feed consumed(g)	SGR (% day)	FCR	PER	NPU (%)	Mortality (%)
A	1.80^{a*}	6.44^{b}	4.64^{b}	257.8^{b}	125.1^{b}	2.54^{b}	1.88^{b}	1.79^{b}	0.84^{b}	3
B	1.75^{a}	6.94^{a}	5.19^{a}	296.6^{a}	131.9^{a}	2.76^{a}	1.73^{b}	1.91^{a}	1.71^{a}	3
C	1.80^{a}	7.38^{a}	5.58^{a}	310.0^{a}	138.3^{a}	2.82^{a}	1.59^{a}	1.87^{a}	1.57^{a}	0

1=Log_e Final wt. -Log_e Initial wt.x 100/ T days; 2=Feed intake/ Live wt. gain; 3=Live wt. gain/Crude protein fed; 4=Body protein at the end of the expt.-Body protein at the start of the expt.x 100/protein intake.* Figures in the same raw having the same superscript are not significantly different (P>0.05).

The per cent of ash in each diet varied depending on the quality of fish meal or fish silage in the diet (Table 3) while other components were more or less same. The fish silage based diet-C produced significantly (P<0.05) better weight gain, SGR, FCR, PER and ANPU and diet-A (commercial grade fish meal) resulted the lowest growth. However, the food conversion ratios observed were good for all the diets. Proximate carcass composition of fish, at the start and at the end of feeding trial (Table 5) showed that dietary treatment did not adversely affect proximate composition of the fish.

TABLE 5. PROXIMATE CARCASS COMPOSITION ANALYSIS (% FRESH WEIGHT BASIS) OF FISH SAMPLES AT THE START AND END OF THE EXPERIMENT.

Components	Initial	Final (Diet-A	Diet-B	Diet-C)
Moisture	73.7	73.3	72.3	72.2
Crude protein	16.7	17.0	17.9	18.4
Crude lipid	2.0	4.3	4.3	3.8
Ash	5.8	4.7	4.8	4.5
Total	98.2	99.3	99.3	98.9

During 7-weeks feeding trial of tilapia fry under laboratory condition the water quality parameters were as follows: temperature (°C) 24.8±2.0, dissolved oxygen (mg/1) 5.4±0.7 and pH 7.7±0.8.

In the present study the better SGR, FCR, PER and ANPU (Table 4) for diet-C than for the diets A and B is of interest. Ali *et al.* [8] also reported the best growth of *Cirrhinus mrigalus* fed diet replacing about 75% of fish meal by dried fish silage prepared with either 90% formic acid or 30% sulfuric acid. They suggested that silage could be an effective replacement of fish meal. The protein level of silage diet (37%, Table 1) is high enough to be considered as a protein source for tilapias which have a high dietary protein requirement of 30-50% [9]. Gonclaves *et al.* [10] also reported that incorporation of silage in the diet resulted in an increase in the SGR, FCR and PER of eel compared to a control diet containing fish and meat meal. The potential of fish silage as a fish feed ingredient depends on its cost compared to fish meal. Considering the economic utilization of trash fish or other animal waste as a protein source in fish diet, preparation of silage based fish feed ingredient is less expensive than fish meal. It was estimated that preparation of one Kg dried silage costs (raw materials, acid price and labour cost) Tk. 19 (US$ 0.45) whereas commercially available fish meal prices Tk. 24 (US$ 0.60). Formic acid is an expensive acid and the cost of silage preparation was greatly reflected by the acid price. However, the cost of silage based feed can be significantly reduced if cheap acid or alternate fermentation (biofermentation) process can be made available.

Marked differences among the crude protein content in the 3 fish products (Table 1) could be due to the quality of raw materials. Preparation of laboratory grade fish meal resulted in increased protein content.

During the feeding trial, the fish readily accepted the diets and very little food remained at the bottom of the tanks. The per cent weight gain was highest in diet-C (Table 4). There was no significant differences between the specific growth rates of tilapias fed the diet-B and diet-C, but a significant differences was observed with the commercial fish meal based diet-A (P<0.05). Feed conversion ratios for the silage and laboratory grade fish meal diet treatments were 1.59 and 1.73 respectively which were significantly different (P<0.05) from those of commercial fish meal diet (FCR 1.88). The FCR values in this study were lower compared to the results of Santiago *et al.* [11]. The highest PER value (P<0.05) was obtained for diet-B in all the three diets i.e. laboratory grade fish meal based diet was more efficiently utilized by tilapia. The result is comparable with the findings of Lapie and Benitez [12].

The carcass composition of fish at the beginning and end of the trial period is shown in Table 5. After feeding protein and lipid increased and moisture and ash decreased in all the 3 groups. This decrease in moisture and ash might be due to the increase of either body protein or lipid or both.

Since growth performance was significantly better in fish silage fed fishes than the fish meal ones and the prospects of preparing silage based feed at lower cost than the others, it may be expected to emerge as a cost effective substitute for fish meal in fish diet. Due to simple preparation and processing method, the production of fish silage diet can ap-

plied at the farmer level. A thorough study has now become important to rightfully assess the quantity of trash fish from marine catch or other animal waste reality available for the production of silage feed which could play an effective replacement for costly fish meal in our aquaculture.

References

1. J.C. Marr, *Twenty-year fishery development plan for Bangladesh*, FAO/UNDP, Bangladesh, 23 (1985).
2. H. Djajasewaka and R. Djajadiredja, *FAO Fisheries Report No. 230*, FAO, Rome, 74 (1980).
3. R.W. Hardy, K.D. Shearer and J. Spinelli, Aquaculture, 28, 35 (1984).
4. J.F. Wood, B.S. Capper and L. Nicolaides, Aquaculture, 44, 27 (1985).
5. J. Disney, *IPFC Occ. Pap. 1979/1*. FAO Regional Office for Asia and the Far East, Thailand, 21 (1979).
6. A.K.M.A. Bhuiyan, M.E. Hoq, N.N. Begum, M. Begum and M. Zaher, *Bangladesh J. Fish.*, 11 (1), 95 (1988).
7. AOAC, *Official Methods of Analysis*, (Association of Official Analytical Chemists, Washington DC, 1975), 12th ed.
8. M.Z. Ali, S. Gheyasuddin, M.Zaher, M.A. Hossain and M.N. Islam, J. Aquaculture Tropics, 9, 247 (1994).
9. K. Jauncay and B. Ross, *A Guide to Tilapia Feeds and Feeding*, (Institute of Aquaculture, University of Stirling, Scotland, UK, 1982), pp.8.
10. J.E. Gonclaves, S. Santos, V.S. Percira, I. Bapista and J. Coimbra, *Aquaculture*, **80**, 135 (1989).
11. C.B. Santiago, M.B. Aldaba, O.S. Reyes and M.A. Laron, ICLARM Conference Proceedings 15, 377 (1988).