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Use of Fermented Fish Ensilage in the Diets of *Etroplus suratensis* (Bloch)

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A feeding experiment was conducted to assess the ability of *Etroplus suratensis* (Bloch) to utilize diets containing fish ensilage as a major protein source. Attempt was also made to find out whether the neutralization of the fermented ensilage influenced the growth of *E. suratensis* or not. No significant difference in the survival rate of fish fed with various feeds was noticed (P(0.05). However, significant difference could be observed in specific growth rate,(P<0.01), food conversion efficiency and protein efficiency ratio (P<0.05). The study revealed that the diets containing fish ensilage, either neutralized with calcium hydroxide or without neutralization, could yield better weight gains (86.25% and 89.08% respectively) than other feeds. *E. suratensis* could utilize diets containing fish ensilage as the major source of protein for growth. While ensilage - based diet neutralized with sodium hydroxide recorded lower weight gains (80.87%) the effect was more adverse when potassium hydroxide was used as the neutralizing agent (56.18%).

Key words: Fermented ensilage, neutralization, feed, *Etroplus suratensis*, growth rate

Etroplus suratensis (Bloch), commonly called as pearl spot, is widely distributed in estuaries, backwaters and brackishwater lakes of India. Pearl spot is highly palatable and possesses an excellent nutritional profile with a good combination of all essential amino acids (Mukundan & James, 1978). Ability to utilize supplementary diets (Jayasinghe *et al.*, 1985) and rapid growth rate (Vijayaraghavan *et al.*, 1981) make *E. suratensis* an ideal species for culture.

Success of many commercial farming practices depends to a large extent on the development of low cost and nutritionally balanced diet. One of the most promising ways to reduce feed cost is to use fish ensilage as a major protein source in fish diets. Fish ensilage production is neither capital nor energy intensive when compared to fish meal production. The use of fish ensilage has been proved to be effective in the feeds of salmon (Crampton *et al.*, 1982; Jackson *et al.*, 1984) and in Indian major carps (Srinivasan *et al.*, 1982). The present study was undertaken (i) to assess the ability of *E. suratensis* to utilize fish ensilage as a major protein source in its diet, (ii) to examine whether the neutralization of the fermented ensilage is necessary or not in the feed preparation of *E. suratensis* and (iii) to elucidate the effects of use of various alkalis for the neutralization of silage on the growth of pearl spot.

Materials and Methods

Juveniles of *E. suratensis* collected from the brackishwater estuary, were brought to the laboratory and gradually acclimatised to freshwater over a period of 15 days. During the acclimatization period, the fish were fed with pellet diet containing 25% protein. Juveniles of uniform size of about 7 g were randomly stocked at the rate of 12 fish per tank in twelve circular plastic tanks each with a capacity of 50 litres.

Compressed air was continuously supplied through air stones to all the rearing tanks. Water samples were analysed every day for temperature), pH and ammonia nitrogen (APHA, 1995).

In the present study, fish ensilage was prepared by biological fermentation using minced silver belly (*Leiognathus* spp.). Molasses (15% of the mince) was used as carbohydrate source for the production of lactic acid through fermentation. Water was added (30%, v/w) as well as sodium chloride, (1%) and the mixture was made into a slurry and boiled for 30 min to inactivate endogenous enzymes involved in the hydrolysis of protein and then cooled to room temperature. A one day old fermented cabbage was added (5% of the minced flesh) to effect fermentation. The slurry was stored in plastic containers with air-tight lids and allowed to ferment at room temperature. The pH of the contents reached 4.4 in 48 h indicating sufficient fermentation. The ensilage was then dried at 60°C to bring down the moisture level to 10% for further use in the test feeds.

Six isonitrogenous (25%) feeds were prepared following the 'square method' (Hardy, 1980). While diet 1 was formulated to contain fish meal as the major protein source and served as control, diet 2 was formulated with ground nut oil cake as the major source of protein. The remaining four feeds (diets 3-6) were prepared using fish ensilage as the major protein source (Table 1). The dry ingredients were pulverized to fine particles and mixed thoroughly in a mixer until homogenous. The pH of these diets 4,5 and 6 was adjusted to 6.8±0.1 by adding the required quantity of sodium hydroxide (diet 4), calcium hydroxide (diet 5) and potassium hydroxide (diet 6) and mixed using distilled water. All the diets were made as dough of good consistency and were steam cooked for 10 min with intermediate stirring. They were then passed through a hand pelletiser to obtain pellets

Table 1. Percentage of ingredients and proximate composition of the experimental diets

	Test diets					
	1	2	3	4	5	6
Ingredients %						
Fish meal	40.00	-	12.70	12.70	12.70	12.70
Fish ensilage	-	-	27.50	27.50	27.50	27.50
Groundnut oil cake	-	62.00	-	-	-	-
Rice bran	43.00	21.00	42.80	42.80	42.80	42.80
Tapioca flour	10.00	10.00	10.00	10.00	10.00	10.00
Cod liver oil	1.00	1.00	1.00	1.00	1.00	1.00
Soybean oil	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin mix[1]	2.00	2.00	2.00	2.00	2.00	2.00
Mineral mix[2]	3.00	3.00	3.00	3.00	3.00	3.00
Proximate composition (as % dry matter)						
Crude protein (N x 6.25)	25.21	25.23	25.17	25.01	24.98	25.20
Ether extract	7.76	8.60	7.20	7.30	7.18	7.25
Ash	15.45	9.23	15.30	14.80	15.10	15.20
Nitrogen free extract[3]	36.00	38.70	37.80	37.75	37.60	38.00
Estimated ME[4] (Kcal. $100g^{-1}$)	294.33	310.05	295.61	295.52	293.52	296.80

1 - Vitamin mix No.10 (New, 1987);

2 - Mineral mix No.5 (New, 1987);

3 - By difference;

4 - Metabolizable energy (ME) was estimated based on the physiological values of fish: Protein, 4.5 $Kcal.g^{-1}$; Carbohy drate, 3.3 $Kcal.g^{-1}$; fat 8.0 $Kcal.g^{-1}$; (Brett & Groves, 1979)

Table 2. Proximate composition of the ingredients used in the experimental diets

Ingredients	Moisture (%)	Protein (%)	Fat (%)	Nitrogen* Free extract (%)	Ash (%)
Fish meal	9.90±1.02	63.10±2.05	7.90±0.25	0.02	19.08±1.05
Fish ensilage (dried)	10.01±2.03	60.25±1.06	5.20±0.15	0.95	23.59±0.55
Groundnut oil cake	7.34±1.35	42.00±2.15	5.52±0.17	29.04	15.24±1.07
Tapioca flour	9.50±1.30	2.00±0.75	3.00±0.01	79.50	6.00±0.65
Rice bran	2.00±0.35	9.25±1.25	10.55±0.05	59.20	19.00±0.05

* By difference

of 3 mm dia. The pellets were air dried for 2 h and then oven dried at 70°C for 12 h to obtain a moisture content of approximately 8%. Each of the six diets was fed to duplicate groups of fish in a completely randomized design. The fish were fed three times a day (9.00; 12.00; 15.00 h) at the rate of 10% of the body weight per day. Fish in each tank were weighed individually once in 2 weeks and the quantity of feed was adjusted after each weighing. Mortality if any, was recorded every day and the amount of feed was adjusted accordingly. Everyday, before fresh feeding, the uneaten feeds were collected, oven dried, weighed and the actual weight of diet consumed in each tank calculated. The experiment was conducted for 70 days. Proximate composition of the feed ingredients and experimental diets were analyzed following the standard methods of AOAC (1980).

The average growth data of the duplicate groups of each treatment were used for statistical analysis. The weight gain, specific growth rate, feed conversion efficiencies, protein efficiency ratios and survival rates were calculated for the different feeds studied. The results were tested using one-way analysis of variance.

Results and Discussion

The proximate composition of the feed ingredients and the formulated feed is given in Table 2. The weight gain, specific growth rate (SGR), feed conversion efficiency (FCE), protein efficiency ratio (PER) and survival rate of *E. suratensis* fed with various experimental feeds are presented in Table 3. The highest weight gain (89.08%) was recorded for fish fed ensilage based feed which was neutralized with $Ca(OH)_2$ (diet 5). However, the weight gain was not significantly higher ($P>0.01$) than those given non-neutralized ensilage diet (diet 3) (86.25%) or fish meal based control diet (diet 1) (85.66%). While fishes fed ensilage based

Table 3. Percent weight gain, specific growth rate (SGR), feed conversion efficiency (FCE), protein efficiency ratio (PER) and survival rate of *Etroplus suratensis* fed various test diets for 10 weeks

Test diets	Average initial Weight (g) ± s.e	Average final weight (g) ± s.e	Percent weight gain* ± s.e	SGR* ± s.e	FCE** ± s.e	PER** ± s.e	Percent** Survival rate ± s.e
1	7.7402±0.073	13.743±0.218	85.66±1.12^{d}	0.884±0.009^{d}	0.256±0.015^{b}	1.025±0.060^{b}	95.84±4.17^{b}
2	7.7250±0.126	12.200±0.288	68.26±1.05^{b}	0.231±0.013^{ab}	0.924±0.052^{at}	91.67±8.34^{ab}	
3	7.7161±0.092	13.338±0.243	86.25±1.00^{d}	0.889±0.08^{d}	0.254±0.012^{b}	1.014±0.049^{b}	95.84±4.17^{a}
4	7.7192±0.074	13.008±0.168	80.87±0.41^{c}	0.246±0.004^{c}	0.246±0.019^{b}	0.982±0.076^{b}	91.67±0.00^{a}
5	7.300±0.105	13.297±0.237	89.08±0.53^{d}	0.910±0.004^{d}	0.270±0.016^{b}	1.081±0.064^{b}	95.84±4.17^{a}
6	7.233±0.075	11.297±0.141	56.18±0.33^{a}	0.637±0.003^{a}	0.164±0.006^{a}	0655±0.024^{a}	95.84±4.17^{a}

* Column means not sharing the same superscript are significantly different at 1% level
** Column means not sharing the same superscript are significantly different at 5% level

diet neutralized with NaOH showed significantly lower ($P<0.01$) weight gains (80.87%) than those fed control diet (diet 1), the lowest weight gain (56.18%) was recorded in fish fed ensilage based diet neutralized with KOH (diet 6) ($P<0.01$). The animals fed on plant protein diet registered low weight gains (68.26%) compared to the control and non-neutralized fish ensilage based diets.

The significantly higher ($P<0.01$) weight gains recorded in fish fed fish meal and ensilage based diets over those fed the diet containing plant protein indicates the need for animal protein in the diets of *E. suratensis.* This may be due to the fact that both fish meal (New, 1987) and fish ensilage (Jackson *et al.*, 1984) have a well balanced amino acid pattern, which is essential in the dietary protein for the synthesis of new proteins, while most plant proteins like groundnut oil cake contain inadequate levels of one or more of the essential amino acids, particularly methionine (Lim & Dominy, 1989).

Weight gains of fishes fed on diet 3 and diet 5 were on par with or slightly higher than those given the control feed (diet 1). This indicates the possibility of replacing fish meal with fish ensilage in the diet of *E. suratensis* either without neutralization or after neutralization with $Ca(OH)_2$. Similar results have been reported in several fish species including Indian major carps (Srinivasan *et al.*, 1985), salmon (Crampton *et al.*, 1982; Jackson *et al.*, 1984), catfish (Wee *et al.*, 1986) and rainbow trout (Stone *et al.*, 1989). It has been pointed out that the simpler peptides present in ensilage are easily assimilable by fish (Stone & Hardy, 1986).

The feed conversion efficiency (FCE) of fishes fed the various test feeds are given in Table 3. Although fish fed the ensilage based diet neutralized with $Ca(HO)_2$ showed the best feed conversion efficiency (0.27), it was not significantly higher ($P>0.05$) than those fed control feed (0.256), non neutralized ensilage feed (0.254) and ensilage neutralized with NaOH (0.246). The FCE of plant protein diet and ensilage diet neutralized with KOH was significantly lower than that of other feeds ($P<0.05$). The lowest FCE (0.164) was recorded for fish fed the ensilage diet neutralized with KOH. This value was even lower than that recorded for fish given feed containing only plant proteins (0.231).

Except the group fed the ensilage based diet neutralized with KOH, all others recorded almost similar FCE and PER values indicating the harmful effects of addition of KOH for neutralizing fermented ensilage in feed preparation. The higher FCE and PER values recorded in general for the silage based diets also reveal that *E. suratensis* can efficiently utilize the diets containing fish silage as a major protein source. The survival rates of fish fed the different test diets were generally high and ranged between 91.67% and 95.84% (Table 3). The small variations observed in the survival rates of the various groups did not seem to be related to the type of test diets used.

While neutralization of the ensilage using $Ca(OH)_2$ slightly improved its nutritional value than the non-neutralized silage diet, use of NaOH and KOH reduced the weight gains of fish to levels even lower than those recorded for fish fed the control and plant-protein diets. Although exact mechanism for the growth depression is not clearly known, a probable reason may be that KOH and NaOH affect the protein of the diet and hence lower its nutritional quality. The levels of calcium, sodium and potassium in fish diets are of particular significance since all these elements have important roles to play for the maintenance of life of fish. While calcium is a chief constituent of bones and selected tissues, sodium and potassium serve in vital functions by controlling osmotic pressures and acid-base equilibrium in fishes (Lall, 1989). Excess or inadequate levels of these ions in the diet may affect normal functioning of the body, an understanding of which demands further research in this aspect. However, at this stage it can be concluded that fermented fish ensilage does not require neutralization to serve as protein source in the diet of *E. suratensis* although neutralization with calcium hydroxide slightly improves its nutritional value.

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