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Growth response of Catla (*Catla catla*) fed Vegetable and fruit processing Waste based Diets

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Abstract

A feeding trial was conducted for 90 days in outdoor circular cement cisterns to evaluate the utilization of vegetables and fruits processing wastes as feed ingredient in the diet of Catla catla fingerlings. Three different test diets were prepared by replacing clam meal with either fruit waste @10 % (T2), vegetables waste @10% (T3), combination of fruit waste (5%) and vegetable waste (5%) (T3). The basal diet without fruit or vegetable waste served as the control (C, The crude protein level of the diets was maintained at around 30%. Each diet was tested in triplicate, being fed to fishes in a set of three tanks each. The study was conducted in cement cisterns of capacity 300 l. Stocking was done with fingerlings of catla @ 6nos. / cistern. Completely randomized design was adopted for the study. Feeding was done @ 5% of the body weight once daily. The water quality parameters in the cisterns were monitored by fortnightly sampling. Fish growth was also assessed by periodic sampling, the quantity of feed given being readjusted based on the increase in weight. On termination of the study, all surviving fishes were collected and their length and weight recorded. Feed ingredients, formulated feeds and fish tissue were analysed for proximate composition employing standard methods. In the present study, best growth of catla in terms of average weight gain (29.99g), SGR (1.87), FCR (2.58) was obtained on diet T3 containing 5% fruit waste and 5% vegetables waste. Survival rate was good in all the treatments with mean survival value ranging from 83.33% to 100%. The results suggest the possibility of utilizing a combination of vegetable and fruit processing wastes in diets for catla. Further studies on the use of ensiled fruit and vegetable processing wastes in diets for catla is warranted.

Keywords: Fruit waste, vegetable waste , formulated diet, Catla (*Catla catla*), SGR, FCR, organoleptic quality.

Introduction

Sustainable and successful fish culture mainly depends upon the use of adequate, economically viable and ecofriendly feeds. Feed is the single largest expenditure in semi-intensive and intensive fish culture and feed cost accounts about 30-70% of the total for operating expenditure in fish culture[1]. Animal based feed ingredients like fish meal, clam meal, crab meal, etc. are often the major sources of protein in fish feeds. However, recently the major problem confronting the fish farming industry is the increasing cost of animal based feed ingredients. The replacement of animal based feed ingredients with locally available and cheaper plant feedstuffs has become highly essential for the future development of the aquaculture sector. For culturing fish in captivity, obviously nothing is more important than the sound nutrition and adequate feeding[2].

Fruit processing waste and vegetable wastes are the potential source of energy in urban areas, which could be exploited as ingredients in fish feed. In India, over 35 million tons of fruits and vegetables are processed annually and this results in about 10 million tons of wastes[3]. Most of these wastes are merely dumped in fields, which often causes extensive pollution. Possible use of these wastes in animal feed preparation have been suggested by Patel *et al.*[4]. As of now, relatively very little emphasis has been given to the use of these fruit / vegetable processing wastes, which are very cheap and easily available in fish feeds.

The present study was aimed at assessing the growth performance of catla on fruit and vegetable processing waste based diets. The study is of significance in the context of the urgent necessity for devising environment friendly measures for waste management and the potential utility of these agro wastes in practical cost effective aquafeeds.

Material and Methods

The study was conducted in outdoor circular cement cistern of 300 litre capacity in the farm of the Kerala University of Fisheries and Ocean Studies, Panangad, Kochi, Kerala. Fingerlings of catla obtained locally were used for the study. The ingredients used in feed formulation were clam meal, rice bran, groundnut oilcake, wheat flour, vegetable processing waste and fruit processing waste.

Prior to initiation of the study the cisterns were repaired, cleaned manually and sundried. The tanks were covered with wide meshed nylon nets to prevent extraneous matter like leaves from falling into the culture cisterns, to prevent leaping out of fish and also to protect the fishes from predation by birds. Water

was filled in the tanks to a height of 50 ± 5 cm. Water quality was maintained by periodic partial replenishment as required.

Before commencement of the experiment, the fishes were acclimatized to the experimental diets for a week, after which the fish were transferred to the experimental tanks. Feeding was done @ 5% of body weight once daily. Leftover feed of the previous day, if any, was removed prior to feeding, sun dried and the weight noted. After every fortnightly sampling, the quantity of feed given to fish was readjusted according to the increased fish weight.

Completely randomized design was adopted for the study. Each diet was given to fishes in a set of three cisterns each. Stocking was done @ 6 fingerlings of catla per cistern.

The experimental diets were formulated by replacing clam meal with vegetable discard / fruit processing waste. Three experimental diets were formulated namely T_1, T_2 and T_3. The diet T_1 had 10% vegetable waste incorporated, T_2 had 10% fruit waste incorporated while diet T_3 had a combination of 5% vegetable processing waste and 5% fruit processing waste. The clam meal based control diet (C) was devoid of vegetable discard / fruit processing waste (table 1).

Vitamin and mineral mix (Supplevit-M, Sarabhai Chemicals, Baroda, India); A 2.5 kg pack contained vitamin A, 5,000,000 IU; vit D3, 1,000,000 IU; vit B2, 2 g; vit E, 750 IU; vit K, 1 g; cal.pantothenate, 2.5 g; nicotinamide, 10 g; vitamin B12, 6 g; choline chloride 150 g; calcium, 750 g; manganese, 27.5g; iodine, 1 g; iron, 7.5 g; zinc, 15 g; copper, 2 g; cobalt, 0.45 g; vit C, 300 mg/ kg diet

Proximate Analysis of ingredients, feeds and formulation of experimental diets: Dry matter was estimated by drying in a hot air oven at 105°C until constant weight; ash content by incineration in a muffle furnace at 600°C for 6 hrs; crude protein (N x 6.25) by Kjeldahl method after acid digestion; lipid by petroleum ether extraction in a Soxhlet apparatus. Proximate composition of feed ingredients, feeds and fish tissue was estimated by AOAC[5,6] procedure as follows.

Table-1
Ingredient proportion of the formulated feed

Ingredient \ Treatment	C	T_1	T_2	T_3
Clam meal	25	15	15	15
Groundnut oil cake	24	24	24	24
Rice bran	40	40	40	40
Wheat flour	10	10	10	10
Vegetable discard	-	10	-	5
Fruit waste	-	-	10	5
Supplevit- M*	1	1	1	1

Table-2
Proximate composition of feed ingredients (%)

Ingredient \ Parameter	M	CP	CF	Ash	NFE
CM	8.56	54.60	10.51	10.12	15.68
GOC	10.24	40.50	7.57	6.25	27.32
WF	6.11	16.52	4.12	11.02	50.69
RB	7.72	13.90	0.85	12.17	43.83
VW	7.20	15.75	2.15	11.24	55.24
FW	6.75	22.23	3.12	7.03	42.95

CM= Clam meal, GOC= Groundnut oil cake, VW= Vegetable discard, FW= Fruit waste, WF= Wheat flour and RB= Rice bran.
M= Moisture, CP= crude protein, CF= crude fat and NFE= nitrogen free extract.

Table-3
Proximate composition* of the formulated feed

Ingredient \ Treatment	C	T_1	T_2	T_3
M	12.70	12.74	12.57	12.89
CP	30.92	25.15	27.69	26.09
CF	4.96	4.04	4.16	3.91
Ash	9.41	9.83	9.32	9.65
NEF	30.80	36.00	33.24	34.70

M= Moisture, CP= crude protein, CF= crude fat, NFE= nitrogen free extract

For preparing the diets, require proportion of all ingredients except vitamin mix were weighed and mixed well. To this, the required quantity of water (1: 1.25 w/v) was added and the ingredients were mixed thoroughly to make a smooth dough. The prepared dough was cooked under pressure for 30 minutes. Cooked dough was cooled rapidly and to this, accurately weighed quantity of Supplevit -M @ 1% was added and mixed well. Pelletizing was done in a hand-operated extruder with a diameter of 2 mm in the die. Pelletized feeds were dried in a hot air oven at 60 ^{o}C for 12 hours to a moisture content of less than 10%. The dried pellets were cooled to room temperature and stored in airtight containers. Proximate analysis of the experimental feeds was done initially and also after a storage period of 3 months.

Proper care was taken to maintain good water quality throughout the experimental period by periodic partial replenishment as required. Water sample were collected from all the experimental cisterns in morning hours on the day of sampling. Water quality parameters *viz*., temperature, pH, dissolved oxygen, alkalinity and ammonia were monitored at fortnightly intervals following standard procedures recommended by APHA[7].

Fishes were sampled at fortnightly intervals to record the increments in weight of individual fishes in each cistern.

All surviving fish were collected, their weight estimated individually and the following parameters are calculated

Specific growth rate: % SGR was calculated using the following formula.

$$\text{SGR} \quad (\%) \quad = \frac{\ln\ (W2) \quad - \ln\ (W1)}{\text{Time} \quad \text{interval} \quad \text{in} \quad \text{days}} \times 100$$

Survival rate: The survival rate of fishes was expressed in terms of percentage. This was calculated as follows:

$$\text{Survival} \quad (\%) \quad = \frac{\text{Final} \quad \text{Number} \quad \text{surviving}}{\text{Initial} \quad \text{Number} \quad \text{stocked}} \times 100$$

Feed conversion ratio (FCR)
FCR was calculated by dividing the total feed intake by net gain weight

$$\text{FCR} \quad = \frac{\text{Total} \quad \text{feed} \quad \text{Intake(g)}}{\text{Net} \quad \text{Biomass} \quad \text{gain(g)}}$$

Carcass composition of fishes fed the different treatments was analyzed on termination of the experiment. Flesh was collected from the trunk region of several fishes of each treatments and the pooled samples were used for analysis of moisture, crude protein, crude fat, CHO and ash following AOAC (1995) methods[6].

Statistical analysis: The experiment was designed in a completely randomized design with three replications for each treatment. The average fortnightly gain in weight for each species was subjected to a two way analysis of variance (ANOVA). The treatment means were tested using Duncan's multiple range test[8].On termination of the experiment fishes were collected and the weight recorded individually. The results obtained were statistically analyzed employing ANOVA and Duncan's multiple range test[8]. The statistical analysis was defined at 5% (.05) level of significance. All statistical analyses was performed using IBM SPSS Statistics version 20

Results and Discussion

The results obtained in the present study showed that fish fed on clam meal (C) gained 25.27g while fish fed the 10% vegetable waste (T_1) gained 27.16g, 10% fruit processing waste (T_2) gained 27.99g and those fed the diet containing the combination of 5 % vegetable waste + 5 % fruit waste (T_3) gained 29.22 g over the period of study. The average daily gain in weight in different treatments was noted to be 0.30g in T1, 0.31g in T2 and 0.33g in T3 treatments respectively. Survival was good in all treatments, being 100% in T_2. The lowest survival was recorded in the control. Researchers have reported that the fingerling of *L. rohita* grew best and recorded superior FCR on pineapple waste based diet, as compared to diets based on other fruit processing wastes like orange waste and sweet lime waste. Survival of all the groups ranged between 97-100 %, which

were statistically insignificant ($p>0.05$), indicating that the fruit processing wastes did not have any adverse/detrimental effect on health. Organoleptic properties of the fish fed the different fruit processing wastes was not adversely affected[9]. Bhavan *et al.*[10] reported that a diet containing 10% apple waste along with the basal ingredients led to best weight gain, SGR and FCR followed by diets containing grape processing waste after crushing and peel as well as remains of orange after crushing, in the freshwater prawn.

Rajadevan and Schramm[11] assessed the growth of grass carp on diets containing cabbage and kikuyu grass. Cabbage gave the best growth and FCR. Grass carp showed positive growth response on both diets, but grew best when fed cabbage, with a mean gain of 0.09 g per day as compared to mean gain of 0.02 g per day on kikuyu grass feed. Replacement of soybean meal by moringa leaves @ 20 and 50 %, was conducted in diets for the common carp. 20% moringa leaf diet gave best result in *Cyprinus carpio*. Average daily gain (g/fish/day) was recorded as 0.81 ± 0.11 and 0.56 ± 0.73 g/ fish/ day in the 20 % and 50% moringa leaf diet respectively. 100 % survival rate was obtained in fish fed both diets[12].

% SGR recorded in T_3 was significantly different ($p<0.05$) than all other groups (table-6). However, growth rate of control group was not significantly different from that in the T_1 and T_3 groups. Better growth rate recorded on the T_3 diet, may be due to better utilization of combination of vegetable waste and fruit processing waste incorporated in this diet. Deka *et.al.*[9] reported that the pineapple waste based diet led to significantly better % SGR, as compared to that on the fish meal based control diet. Growth response on the sweet lime and the orange waste based diet was not significantly different from the control in trials employing *L. rohita*. Though not much literature is available in this regard, the superior growth profile on the pineapple based diet could be due to the presence of a proteolytic enzyme 'bromolein' that is present in pineapple, which could have facilitated better utilization of protein[13].

In the present study, FCR of fish fed the different test diets, showed the same trend as that of the growth profile. Better food utilisation efficiency was obtained in the T3 group, probably due to the presence of 'bromolein' as discussed earlier. However, Deka *et al.*[9] in their trials employing rohu, sweet lime and orange waste incorporated diets, led to FCR similar to that on the control diet.

In the present experiment growth, FCR, SGR and weight gain per day was highest on the diet with a combination of vegetable waste and fruit processing waste followed by the diets with vegetable waste alone and fruit waste alone. Clam meal gave the poorest growth.

Statistical analysis of the growth data showed that specific growth rate of T3 was highly significant as compared to that on the control. Better FCR was recorded on T 3, T2 and T1 treatments as compared to the control diet, C. Better performance on plant protein sources as compared to fish meal has been reported by McCoy, 199013 and Keshavappa, 19908.

Table-4
Water quality parameters in different treatments over of study period

Parameter \ Treatment	C	T_1	T_2	T_3
Temperature	27.78	27.71	28.09	27.66
pH	7.85	7.99	7.94	8.00
DO (ppm)	5.57	5.69	5.69	5.68
Alkalinity (ppm)	52.42	53.04	54.34	53.48
Ammonia (ppm)	0.070	0.064	0.075	0.061
Nitrite (ppm)	0.497	0.702	0.717	0.923
Nitrate (ppm)	0.957	1.152	1.271	1.509

Table-5
Carcass composition (%) of *Catla catla* under different treatments

Composition \ Treatment	C	T_1	T_2	T_3
Moisture	75.09	76.42	75.50	76.00
Crude protein	17.55	16.85	17.12	17.00
Crude fat	5.02	4.55	4.82	4.72
Crude carbohydrate	1.06	1.10	1.21	1.13
Ash	1.28	1.08	1.35	1.15

Table-6
Growth performance of catla fed different test diets

Parameters	C	T_1	T_2	T_3
Initial wt (g)	6.5^{a}± 0.50	7^{a} ± 50	6.66^{a} ± 0.28	6.66^{a} ± 0.28
Final wt (g)	32.22^{a} ± 0.78	34.16^{b} ± 0.43	$34.66^{b, c}$±0 .50	35.88^{c} ± 0.91
Weight gain%	395.69	388	420.27	438.73
SGR%	1.77 ± 0.06	1.76 ± 0.06	1.82 ± 0.03	1.87 ± 0.02
FCR	2.74 ± 0.11	2.69 ± 0.11	2.63 ± 0.07	2.58 ± 0.05
Survival (%)	88.88	100	94.44	94.44

Mean values with same superscript in the row are not statistically significant (p>0.05).

Biochemical composition of fish muscle: The study of biochemical composition of fish is of paramount importance as the carcass composition allows the determination of optimum feeding rations.

The moisture content of fish fed on various feeds ranged from 75.09 (control) to76.42 (10% Vegetable waste). An inverse relationship with fat content of fish is indicated, as reported by Love[14].

Protein synthesis was in the order of control> 10% FW> 5% VW + 5% FW> 10% VW. A positive correlation of protein synthesis to the amount of protein in the feed has been reported in common carp by Jayaram and Shetty[15]. The same pattern has also been observed in the present study.

Fat content observed was maximum in fish fed on 10% fruit processing waste diet based diet (4.82) while it was the lowest for the fish fed on 10% vegetable waste diet (4.55) and control gave best fat % (5.02), The positive correlation between dietary lipid level and deposition of fat in the fish flesh has been observed by Buckly and Groves[16] and Reinitz and Hitzel[17]. The same pattern has also been observed in the present study, the order of fat deposition being control > 10% fruit processing waste > 5% vegetable waste and 5% fruit processing waste > 10% vegetable waste.

Conclusion

The highest weight gain was achieved by combination of 5% vegetable waste and 5% fruit processing waste followed by 10% fruit processing waste, 10% vegetable waste and control. Fish in the 5% vegetable waste and 5% fruit processing waste treatment showed faster growth leading to highest average weight on termination. The trend in weight gain was more or less similar to the fish fed on the 10% fruit processing waste and 10% vegetable waste diets. Fish in control treatment showed poor growth throughout the experimental period.

As is evident from the growth response, use of a combination of vegetable waste and fruit processing waste appears to be a better proposition than the dietary incorporation of either source alone in diets for catla. The possibility of complete substitution of clam meal by vegetable / fruit processing wastes in diets for catla requires a more detailed study.

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