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Growth, Carcass Composition and Survival of Striped Cat Fish (*Pangasianodon Hypophthalmus)* Fed with Different Vegetable Waste Incorporated Diets

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Abstract
The experiment aims to study the effect of vegetable wastes like potato peel, cabbage waste and a combination of two in equal proportions as vegetable waste powder (VWP) on growth, carcass composition and survival of striped catfish fingerlings. 210 numbers of fingerlings were distributed in seven experimental groups and fed with isonitrogenous diets viz. T_0 (control diet without vegetable waste), T_1 (10% potato peel powder), T_2 (15% potato peel powder), T_3 (10% cabbage waste powder), T_4 (15% cabbage waste powder), T_5 (10% VWP) & T_6 (15% VWP) for 90 days. Significantly higher body weight gain% (55.67±1.77), daily weight gain (0.083±0.0003) and SGR (0.491±0.001) were obtained in T_6 group. The FCR (3.59±0.14) and PER (0.967±0.03) were significantly better in T_6 group. The survivability was found to be 100% in all the experimental groups. Thus, it has been concluded that supplementation of VWP at 15% level in diets of striped catfish fingerlings can enhance growth.

Keywords: Vegetable waste, Striped cat fish, Growth, Carcass composition

1. Introduction

Aquaculture development serves as an important solution to shortage of animal protein intake in developing countries due to exponential growth of population. In aquaculture feed is the major operational cost for most fish farmers (D'Abramo & Sheen, 1994) [9]. Use of unconventional feed resources becomes the only alternate for reducing feed cost and for maximization of profit from the culture practices. Thus feed formulation by using locally available low cost agricultural, animal husbandry & industrial by-products plays a crucial role in aquaculture feed industry (Tacon, 2002)[23]. In recent years the search of unconventional feed ingredients and study of their nutritional suitability has become a key factor for improving aquaculture feed industry (Watanabe, 2002) [24]. Vegetable wastes and fruit processing wastes are the potential source of energy in urban areas, which should be exploited to use as ingredients in fish feed by utilizing its physico-chemical properties to get high valued products. Use of vegetable protein source as a feed ingredient reduces the feed cost and thereby facilitates sustainable aquaculture (Jimenez-Yan *et al*., 2006) [15]. Though various cereal grains, pulses, oil seed cakes, rice bran and several other agro by products have been reported to be used as ingredients in aqua diets, vegetable wastes are comparably nutritious and are available free of cost in massive quantities (Daniell, 2006) [10].

Striped cat fish (*Pangasianodon hypophthalmus*) has omnivorous feeding habit (Cacot and Pariselle, 1999) [8] and able to utilize a range of alternative feed ingredients of both plant and animal origin. Because of its remarkable growth rate, the fish is being cultured in many states of India particularly in Andhra Pradesh, West Bengal, Kerala and Odisha. Many authors have already reported the use of vegetable and fruit waste as non-conventional feed ingredients in fish feed (Prinsloo and Schoonbee 1987; Deka *et al*., 2003; Belsare and Singh 2007; Baskar *et al*., 2011; Rebecca and Bhavan 2011; Sajitha *et al*., 2011; Foramarzi *et al*., 2012; Bhavan *et al*., 2013) [19, 11, 6, 5, 20, 21, 12, 7]. The vegetable waste are easily available, cheap but somewhat high in fiber and can be utilized by some herbivorous and omnivorous fishes. More over the undigested or partly digested fiber can also enhance the pond productivity. In view of this the present work is designed to study the utilization of vegetable wastes like potato peel and cabbage as a feed ingredient or a substitute of conventional ingredients in the diets of striped cat fish, *Pangasianodon hypophthalmus* fingerlings.

2. Material and methods

Fingerlings of striped catfishes were procured from a local fish farm, Humari Chhatrapur, Ganjam and transported with oxygen packing to the laboratory and kept in FRP tanks of 200 litre capacity. The fishes were acclimatized under aerated condition for a period of 30 days and fed with commercially available floating feeds. After acclimatization, 210 fingerlings of average weight (13.44 ± 0.44g) were randomly distributed in seven experimental groups (ten fish per tank) in triplicates, following a completely randomized design. During the experiment, constant aeration were provided except the period of feeding and one third of total water volume from each tank was exchanged daily.

Vegetable wastes (potato peel and cabbage waste) were collected from Ladies Hostel, College of fisheries, OUAT, Rangailunda and nearby local vegetable market, Mandiapalli. The ingredients were washed properly and sundried. Sundried vegetable wastes were further dried in hot air oven at 50 ˚C for complete moisture removal and then pulverized to get a powder form. The potato peel powder (PPP) and cabbage waste powder (CWP) thus obtained were mixed in equal proportions (1:1) to get vegetable waste powder (VWP). Seven isonitrogenous experimental diets were prepared by using the square method (Hardy, 1980) [14] namely control without vegetable waste (T_0), diet containing 10% PPP (T_1), diet containing 15% PPP (T_2), diet containing 10% CWP (T_3), diet containing 15% CWP (T_4), diet containing 10% VWP (T_5), diet containing 15% VWP (T_6). The ingredient composition of the experimental diets is given in Table 1. The proximate composition of the ingredients and the experimental diets is given in Table 2. The fishes were fed with the experimental diet for a period of 90 days and feeding was done at 5% of the body weight initially and then adjusted accordingly. The daily ration was divided into two equal parts and was fed at 6.00 AM in the morning and 6.00 PM in the evening.

Water quality parameters viz temperature, pH, dissolved oxygen, total alkalinity, hardness were recorded (APHA, 1985) [3] at forth night interval. The proximate composition (Crude protein, ether extract, ash, crude fibre and NFE) of the ingredients, experimental diets and fish tissue were done as per the standard methods of AOAC (1980) [2].

Sampling was done at 15 days interval to access the growth of the fish. The following growth and feed quality parameters were calculated by using the standard formulas

Daily weight gain (DWG) =

$$\frac{\text{Final weight of fish} - \text{Initial weight of fish}}{\text{Total no. of experimental days}}$$

Weight gain % (WGP) =

$$\frac{\text{Final weight of fish} - \text{Initial weight of fish}}{\text{Initial weight of fish}} \times 100$$

Specific growth rate (SGR) =

$$\frac{(\log_e \text{Final body weight} - \log_e \text{Initial body weight}}{\text{Total no. of experimental days}} x100$$

Condition factor (CF) =

$$\frac{\text{Final weight (g)}}{(\text{Final lenghth})^3}$$

Feed conversion ratio (FCR) =

$$\frac{\text{Total dry food intake(g)}}{\text{Total live weight gain(g)}}$$

Protein efficiency ratio (PER) =

$$\frac{\text{Total weight gain (g)}}{\text{Total protein intake (g)}}$$

Apparent net protein utilization (ANPU)=

$$\frac{\text{Final carcass protein} - \text{Initial carcass protein}}{\text{Total protein intake (g)}} \times 100$$

Feed intake ratio (FI) =

$$\frac{\text{Feed consumption}}{\text{Average final weight} \times \text{total no of experimental days}} \times 100$$

The data were statistically analyzed by statistical package SPSS version 20.0, in which data were subjected to one way ANOVA and Duncan's Multiple Range Test (DMRT) to determine the significance differences between the mean values at 5% probability level.

3. Results and discussion

The physico chemical parameters of water like temperature, pH, dissolved O_2, hardness and total alkalinity of the different experimental groups ranged from 23.4^{0}C - 28.5 ^{0}C, 7.3-8.5, 5.4 - 7.9 mg L^{-1}, 225 to 246 mg L^{-1} and 120 to 145 mg L^{-1} respectively during the experimental period of 90 days. The result shows all the parameters were well within the ideal range suitable for culture of the warm water fishes (Jhingran, 1982) [16] and therefore was not thought to have influenced the result of the study.

The proximate composition of the experimental fish was done at the end of the experiment (Table 3). At the end of the experiment the crude protein and crude lipid levels in the muscle of the fish vary significantly ($P<0.05$) among the experimental groups. The highest crude protein (61.00 ±0.14) was found in T_5 group fed with 10% VWP and the lowest value (57.94 ±0.05) was observed in control group. The crude fat content in the carcass of experimental groups showed lower values than the control group (Table 3), which can be related with lower lipid content in the experimental feeds (Table 2) corresponding to incorporation of vegetable wastes. This may also be possible due to energy sparing effect of lipid as the experimental diets contain high undigested fiber than the control group. A similar observation was recorded by Rebecca and Bhavan (2011) [20], where they opined that the lipid level decreases and the crude protein level increases in the post larvae of *Macrobrachium rosenbergii* with increasing incorporation of vegetable waste powder (VWP) in the experimental diets. In the present study, the ash content in the experimental groups were at par with the control group representing a good proportion of minerals in the flesh of *P. hypophthalmus* fingerlings.

In the present investigation significantly higher WGP, DWG and SGR (Table 4) was observed in the treatment groups than the control group suggesting the effect of vegetable waste on growth of *P. hypophthalmus* fingerlings. The highest WGP (55.67 ± 1.77) was found in T_6 group fed with 15% VWP, which was significantly greater than other treatment groups. The lowest WGP (36.81±6.59) was found in T_2 group fed diet with 15% PPP. DWG and SGR showed a similar trend as that of the WGP for different experimental groups. The growth parameters were higher in the experimental group than control group except the T_2 group fed with 15% PPP. This can be supported by the work of Soltan (2002) [22], where he concluded that the replacement of yellow corn by potato by-product meal by 40% did not affect the growth parameters but further increase in the inclusion of potato by product meal decreases the growth parameters in Nile tilapia, *O. niloticus*. Similarly inclusion of sweet potato meal above 15% level reduces weight gain % in *Cyprinus carpio* (Foramarzi *et al*., 2012) [12]. In the present investigation the highest DWG and SGR were obtained in T_6 group fed with 15% VWP followed by T_5 group fed with 10% VWP, indicating better growth. This is in accordance with the findings of Rebecca and Bhavan (2011) [20], where they found higher weight gain and daily growth rate in *M. rosenbergii* post larvae fed with 5 and 15% VWP. In addition Sajitha *et al*., (2011) [21], inferred that better weight gain, SGR was found in juvenile *Penaeus monodon* fed with co-fermented vegetable discard at 9% and 12% level in the diet. In another study, higher yield was obtained in grass carp fed with vegetable waste particularly cabbage waste (Prinsloo and Schoonbee, 1987) [19]. Though the effect of CWP was found to be not significant on WGP, DWG and SGR of thai panagas fingerlings, but it showed a higher value than the control group. This may be due to the omnivorous feeding habit of thai pangas in comparison with herbivorous feeding habit of the grass carp. Higher condition factor (1.11 ±0.06) was observed in control group. Though, the values of condition factor decreases in other treatment groups there is no significant difference (P>0.05) among treatment group.

Many workers have accessed the efficacy of vegetable waste and plant based ingredients on growth of fish and concluded that though the inclusion did not show higher growth in the experimental animals than the control group, it is safe and higher inclusion rate may produce a deleterious effect on the fish health (Belsare and Singh, 2007; Lozano *et al*., 2009; Foramrarzi *et al*., 2012; Guroy *et al*., 2013; Arumugam *et al*., 2013) [6, 17, 12, 13, 4]. Hence, the nutritional quality of vegetable waste as determined by growth indices in the present study was adequate. A significantly better FCR and PER (Table 4) was observed in T_6 group which is followed by T_5 group. There was no significant difference (P>0.05) among T_1, T_2, T_3, T_4 and control groups. The highest FCR (6.28±0.89) was observed in T_2 group fed with 15% PPP. The higher FCR is explained by higher energy requirement for assimilation of more food consumption, which is usually accompanied by reduced nutrient absorption and growth (Meyer-Burgdorff *et al*., 1989) [18]. Lower FCR recorded in 15% VWP supplemented feed for Thai Pangas indicates better growth which can be further confirmed by high weight gain % and SGR in this group. In the present study it is apparent that the feed conversion ratio was better in case of the fish fed with CWP than the fish fed with PPP, which can be further confirmed by the works of Basker *et al*. (2011) [5] who have evaluated the effect of different plant food (carrot, cabbage, brinjal, raddish, beet root and potato) on food utilization and energy budget in *Cyprinus carpio* (Linnaeus) and reported that food conversion efficiency was better in cabbage than in potato peel meal.

The mean values of ANPU varied significantly among different experimental groups. The highest value (65.855±1.951) was recorded in T_5 group followed by T_6 group (54.664±0.520) and the lowest value (20.757±0.572) was found in control group, which is significantly lower than other treatment group. In this study, increased PER and ANPU value in the VWP incorporated diets indicate better utilization of the feed by the experimental animals, which can be supported by the result of Rebecca and Bhavan (2011) [20], where increased PER values were recorded in PL of *M. rosenbergi* fed with VWP incorporated diet up to 15% inclusion, but further inclusion of VWP (25%) decreases the PER value indicating less utilization of the VWP. In the present investigation, the PER values did not differ significantly in the cabbage waste incorporated diets (T_3 and T_4) than the control diet. But, the ANPU values were significantly better in cabbage incorporated diet than the control diet indicating good utilization of the feed ingredients by the fish. To support this result there was no available literature. Further, the increased ANPU values in the experimental groups fed with different vegetable waste at different % inclusion level can be supported by increased crude protein % in the flesh of the experimental animals compared with control diet (Table 3) confirming better utilization of protein for growth by the fish rather for energy purpose. In the present study, the FI (Table 4) was found to be highest in the group fed with 15% CWP (T4) as compared to other groups which may be due to the fact that animals consume more feed to overcome energy insufficiency. This is in agreement with the fact that, there is an inverse relationship between dietary energy and ingestion rate. In the present investigation, though feed intake was found to be lower in the VWP incorporated diet, the growth parameters like weight gain %, SGR and feed quality parameters like FCR, PER were better in these groups indicating good quality of feed (Albrektsen *et al*., 2006) [1]. At the end of the experiment the survival rate was observed to be 100% in all the experimental groups indicates that inclusion of vegetable wastes in the diets of the *Pangasianodon hypophthalmus* fingerlings did not have any adverse detrimental effect on its health.

Table 1: Percentage composition of different ingredients in the Experimental diets

Ingredients	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Soyabean meal	23	23	23	23	23	23	23
GNOC	23	23	23	23	23	23	23
Mustard oil cake	23	23	23	23	23	23	23
Rice polish	12.5	2.5	2.5	2.5	2.5	2.5	2.5
Wheat flour	12.5	12.5	7.5	12.5	7.5	12.5	7.5
Oil	4	4	4	4	4	4	4
Vit-mineral mixture	2	2	2	2	2	2	2
Potato peel waste powder(PWP)	-	10	15	-	-	-	-
Cabbage waste powder(CWP)	-	-	-	10	15	-	-
Vegetable waste powder(VWP)	-	-	-	-	-	10	15

Table 2: Proximate composition of feed ingredients and experimental diets (%dry matter basis)

Ingredients	Moisture	Crude protein	Ether extract	Crude fibre	Total ash	NFE*
GNOC	7.36	43.08	4.76	10.90	7.19	34.07
Mustard oil cake	7.14	30.34	15.32	10.60	6.80	36.94
Soybean meal	11.80	46.00	0.90	7.30	6.70	39.10
Rice bran	8.81	13.90	25.53	9.75	9.44	41.38
Wheat flour	12.60	14.50	3.70	2.70	5.60	73.50
Potato peel meal	7.84	19.22	1.29	12.02	11.36	56.11
Cabbage waste meal	12.34	14.05	1.48	17.22	10.92	56.33
Experimental diets						
T_0	7.85±0.03	28.91±0.02	11.74±0.02	5.08±0.01	10.45±0.04	4.82±0.10
T_1	6.72±0.03	29.14±0.04	10.69±0.04	6.78±0.03	10.21±0.03	43.17±0.12
T_2	6.61±0.04	29.66±0.05	10.1±0.02	6.32±0.03	10.77±0.04	43.15±0.09
T_3	7.31±0.03	29.77±0.03	10.42±0.03	6.99±0.03	9.31±0.02	43.51±0.05
T_4	9.71±0.03	29.92±0.04	10.68±0.02	6.38±0.02	10.55±0.03	42.47±0.06
T_5	7.05±0.03	28.54±0.02	10.44±0.04	6.18±0.03	9.66±0.02	44.88±0.03
T_6	7.31±0.05	28.77±0.02	10.18±0.02	6.47±0.02	10.51±0.02	44.06±0.07

*Nitrogen free extract (NFE) was calculated as (100-%CP-%EE-%CF-%ash)

Table 3: Proximate composition of *P. hypophthalmus* fed with different experimental diets (%dry matter basis) at the end of the experiment

Treatments	Moisture	Crude Protein	Ether extract	Crude fiber	Total Ash
T_0	9.22^{b}±0.06	57.94^{e} ±0.05	8.28^{a}±0.06	0.25±0.06	25.64±0.07
T_1	9.15^{bc}±0.04	58.84^{d} ±0.06	7.75^{b}±0.09	0.19±0.04	24.32±0.05
T_2	9.10^{c}±0.04	58.78^{d} ±0.04	7.41^{c} ±0.17	0.27±0.06	24.97±0.04
T_3	8.69^{e}±0.07	59.58^{c} ±0.58	6.07^{e} ±0.05	0.23±0.06	23.44±0.05
T_4	8.92^{d}±0.09	59.87^{c} ±0.04	6.32^{d} ±0.09	0.28±0.05	24.62±0.04
T_5	8.69^{c}±0.03	61.00^{a} ±0.14	5.97^{ef} ±0.05`	0.26±0.04	24.84±0.02
T_6	9.97^{a}±0.05	60.36^{b} ±0.04	5.85^{f} ±0.04	0.24±0.04	24.50±0.03

* Values sharing same superscript do not differ significantly ($P<0.05$)

Table 4: Growth and feed quality indices of *P. hypophthalmus* fed with different experimental diets at the end of the experiment

Treatments	WGP	DWG	SGR	FCR	PER	ANPU	Feed intake ratio	Condition factor
T_0	39.00^{b}±7.62	0.057^{b}±0.410	0.365^{b} ±0.025	5.87^{a} ±0.49	0.593^{c} ±0.04	20.757^{f} ±0.572	1.821^{b}±0.035	1.11 ±0.06
T_1	41.27^{b}±3.00	0.062^{b}±0.003	0.383^{b}±0.019	5.83^{a} ±0.30	0.590^{c} ±0.03	28.795^{e}±0.601	1.899^{b} ±0.013	1.00 ±0.05
T_2	36.81^{b}±6.59	0.054^{b}±0.007	0.347^{b} ±0.053	6.28^{a} ±0.89	0.545^{c} ±0.07	29.500^{e}±0.388	1.846^{b} ±0.032	1.09 ±0.01
T_3	40.94^{b}±0.39	0.060^{b}±0.001	0.381^{b} ±0.003	5.68^{a} ±0.10	0.591^{c} ±0.01	41.181^{c}±0.433	1.834^{b} ±0.034	1.06 ±0.08
T_4	41.27^{b}±5.82	0.063^{b}±0.007	0.383^{b} ±0.04	6.03^{a} ±0.70	0.558^{c} ±0.06	36.895^{d}±0.345	1.939^{a}±0.025	1.03 ±0.07
T_5	42.98^{b}±0.33	0.062^{b}±0.002	0.397^{b} ±0.002	4.62^{b} ±0.19	0.759^{b} ±0.03	65.855^{a}±1.951	1.544^{c} ±0.060	1.08 ±0.08
T_6	55.67^{a}±1.77	0.083^{a}±0.003	0.491^{a} ±0.001	3.59^{c} ±0.14	0.967^{a}±0.03	54.664^{b}±0.520	1.429^{d} ±0.069	1.08 ±0.10

* Values sharing same superscript do not differ significantly ($P<0.05$)

4. Conclusion

To summaries, it may be concluded that vast amount of vegetable wastes are available and have the potentiality to be used as a feed ingredients by replacing conventional ingredients like rice bran and wheat flour. Vegetable waste powder can be safely used at a level of 15% in the diet of *Pangasianodon hypophthalmus* fingerlings and has a significantly higher growth promoting effect than CWP and PPP.

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