Chapter 1

Effect of Special Fish Feed Prepared Using Food Industrial Waste on *Labeo rohita*

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Additional information is available at the end of the chapter

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Abstract

All food processing industries generate wastes of varying nature in significant quantities. Managing these wastes so as to minimize the impact on the environment is the prime concern. The concept of waste has undergone much change in recent times, with the focus being on utilizing the waste materials as inputs for generation of new or reusable products. Vegetable and fruit wastes are generated in significant quantities and are easily available at minimal charge. The comparative utilization of these wastes as a dietary ingredient was assessed employing the *Labeo rohita* fingerlings as the test species. The study was conducted over a period of 60 days. Orange peels and potato peels are characterized, and then, formulation of orange peel feed (OPF) and potato peel feed (PPF) was carried out. Market common fish feed (CFF) was taken as a control. The three test diets were designated as CFF, OPF and PPF. Feeding was done once daily. The water quality parameters such as dissolved oxygen, water temperature pH, total alkalinity, total hardness; calcium hardness and magnesium hardness as well as growth response were monitored at fortnightly intervals. The quality of water was maintained by periodic partial replenishment over the period of study. On termination of the trial, higher growth response was recorded in the PPF treatment. The initial and final weight and length of fishes was recorded. The results shows significant growth in PPF and OPF showed brighter body scales than other two feed. Fishes were very healthy and normal throughout the study period indicating no adverse effect on their health. No infection whatsoever was noted during 60 days of experimental period.

Keywords: Fish feed, *Labeo rohita*, Potato peel waste, Orange peel waste, Nutritional value, Aquaculture

1. Introduction

The global consumption of fish and derived fish products has greatly increased during recent decades [1]. Change in consumer trend could be based on a number of distinct factors; foremost among these is the growing knowledge that fish constitute an important and healthy part of the human diet, mainly owing to the presence of ω-3 polyunsaturated fatty acids (PUFA), which play an essential role in human health [2], but also to the presence of vitamins, minerals and proteins with a high biological value. Consequently, it is a well-known fact that fish represent a high-quality nutritional source [3]. Fish demand is also increasing as a result of the increasing world population, higher living standards and the good overall image of fish among consumers [4]. Fish as a whole has a lot of food potential and can therefore be expected to provide relief from malnutrition, especially in developing countries [2]. It provides superior quality protein to that of meat, milk and eggs and well-balanced essential amino acid profile, necessary minerals and fatty acids [5–7]. In addition to the fact that fish flesh is tasty and highly digestible; it also minimizes the risk of heart diseases and increases life expectancy [7].

Aquaculture is one of the fastest developing growth sectors in the world, and Asia presently contributes about 90% to the global production [8]. Due to proteinous rich dietary and as a source of income, specially for economically weak peoples. However, continued increase in price of fishmeal and disease outbreaks are constraint to aquaculture production and thereby affects both economic development of the country and socio-economic status of the local people in many countries of Asia [9]. However, use of probiotics is one of such methods that are gaining importance in controlling potential pathogens [10].

Fruit processing wastes and vegetable wastes are the potential source of energy in urban areas, which should be exploited to use as ingredients in fish feed. In India, over 35 million tones of fruits and vegetables are processed annually and this resulted in about 10 million tones of wastes [11]. This waste from fruit processing operation constitutes a large untapped source of energy and proteins. Most of these wastes are merely dumped in the fields, which causes pollution. Possible uses of these wastes in animal feed preparation have been suggested by some workers [12]. Utilization of these huge wastes generally escapes the attention of animal nutritionist, especially in case of fish feed. Fish consumption is associated with health benefits because of rich content in proteins of high nutritional value, minerals, vitamins and distinctive lipids.

Very little emphasis has been given to the use of vegetables and fruit processing wastes, which is very cheap, easily available and high in fibre content. In view of above, this study was carried out on the fingerlings of *Labeo rohita*. This study was aimed at formulating fish feeds comprising of by-products and nutritious food industry waste-based materials using quality evaluation by probiotics and assessing the effects on fish treated with this new variety of feed.

2. Fish feed formulation and preparation

Wastes were collected from several food processing industries. About two kg of orange and potato peels wastes were collected and dried for 1 week continuously. After 1 week, it was oven-dried and then pulverized to make into powder form to size 250 μ. The powder was used as media to grow the probiotics. The pure culture of probiotics was inoculated into the filtrate used as media in sterile condition and incubated at 37°C for 24 hrs. After 24 hrs, growth was observed. Calcium carbonate was used to immobilize the probiotics spores grown in media. Experimental diet contained 4% potato peel powder or 4% orange peel powder, 4% calcium carbonate blended with probiotic and 2% starch as binder. The ingredients were same for both feed, except orange peel used orange peel feed (OPF) and potato peel used in potato peel feed (PPF). Market common fish feed (CPF) was considered as control.

3. Experimental setup

The experiment was conducted over a period of 60 days. The fingerlings of *Labeo carps* (Ham.) were obtained from Futala Lake, Nagpur, Maharashtra. *Labeo rohita* fingerlings are selected because of its high nutritional value and easy availability. The experiment was set up in three distinct experimental groups, each group having three replicates, in 09 uniform size glass aquariums (20 L capacity each). Each of the aquariums was stocked with 10 fingerlings. Initial length and weight was recorded before loading of fingerlings in experimental aquarium. Round the clock aeration was provided to all the tubs, with a 2 HP air blower. Prior to feeding of experimental diets, the fish were acclimatized and starved overnight to empty their gut and increase their appetite and reception for new diets. The fish were fed (5% body weight) twice daily at 10.00 and 20.00 h. As the water becomes turbid, water was changed every second day to maintained good water quality/dissolved oxygen content.

Experimental tubs were cleaned manually by siphoning all the water along with faecal matter and left over feed daily. The siphoned water was replaced by an equal volume of fresh chlorine-free tap water.

Water quality was monitored using standard method [13] for temperature, pH, alkalinity, dissolved oxygen, total hardness, calcium hardness and magnesium hardness.

After 60 days of experiment, fish were removed from the aquarium and final length and weight was noted. Then, they were dissected to remove muscle tissue and liver, which are nutritious and edible. Tissues like muscle and liver are separated from the bones and cleaned by dabbing it in filter paper to remove excess water. Thus obtained, tissues were weighed and processed for protein content.

Nutritional indices: The growth response of fish fed with different diets was monitored by noting average gain in weight and length

Average gain in weight: It gives the increase in weight of the animals during the experimental period. It was calculated using the formula.

Average gain in wt. (g) = Average Final wt. (g)—Average Initial wt. (g)

Average gain in length: This gives the increase in standard length during the experimental period. It was calculated using following formula.

Average gain in length (cm) = Average Final length (cm)—Average Initial length (cm)

4. Estimation of protein

Protein Estimation using Lowry's Method. This assay was introduced by Lowry et al. [14]. It is highly sensitive and can detect protein levels as low as 5 μg/ml. This is the most widely used method for protein estimations.

5. Statistical analysis

The experiment was designed in a completely randomized block design with three replications for each treatment. On termination of the experiment, all surviving fishes were collected and length and weight recorded individually. All statistical analysis was performed using IBM SPSS Statistics version 20.

6. Results and discussion

Peel characterization was carried out before preparing the feed (**Table 1**).

Sr. no.	Parameters	Potato peel	Orange peel
1	Protein	4.12 g	1.5 g
2	Carbohydrate	14.2 g	1.5 g
3	Fat	0.79 g	0.02 g
4	Total dietary fibre	2.9 g	10.6 g
5	Calcium	31 mg	97 mg
6	Iron	3.3 mg	0.8 mg
7	Potassium	417 mg	212 mg
8	Sodium	8.7 mg	0.2 mg

Table 1. Peel characterization.

Before initiating the experiment, the peel of potato and orange are characterized (**Table 1**). The results show high content of carbohydrate (14.2 g) and proteins (4.12 g) followed by minerals, that is potassium (417 mg) in potato peels. Whereas in orange peel, it shows high calcium and fibre content.

After peel characterization, it was processed for preparing PPF and OPF. The proximate nutritional values of experimental feed were depicted in **Table 2**. The percentage of moisture is slightly variable, that is 10.3 and 9.5% in PPF and OPF, respectively, whereas the ash content is higher in PPF (32.75%) than in OPF (12.4%). In PPF, protein content (63.98%) is highly followed by carbohydrate (14.2%), fat (8.2%), total dietary fibres (3.65%) and total nitrogen. While in OPF, total dietary fibres posses high content, that is (38.12%) followed by protein (12.6%), carbohydrate (12.6%), fat (2.8%) and total nitrogen (0.41%)

Sr. no.	Parameters	PPF (%)	OPF (%)
1	Ash	32.75 ± 0.4	12.4 ± 0.5
2	Moisture content	10.3 ± 0.7	9.5 ± 0.6
3	Total nitrogen	0.52 ± 0.4	0.41 ± 0.6
4	Fat	8.2 ± 0.1	2.8 ± 0.4
5	Carbohydrate	14.2 ± 0.2	12.6 ± 0.3
6	Total dietary fibres	3.65 ± 0.8	38.12 ± 0.5
7	Protein	63.98 ± 0.2	21.01 ± 0.3

Each value is mean ± SD of triplicate observations

Table 2. Proximate nutritional values of experimental feed.

The water quality during the study period remained in following range: pH 7.4–8.4, alkalinity 140–170 mg/l, dissolved oxygen 6.8–8.0 mg/l, total hardness 120–160 mg/l, calcium hardness 32–53 mg/l and magnesium hardness 6.5–9.4 mg/l. Since fish are poikilotherm, water temperature plays an important role in energy partitioning, protein assimilation and growth [15]. Water temperature was varied from 28 to 30°C. All the water quality parameters were within the permissible limit. However, the recommended values are: pH: 6.7–9.5; alkalinity: 50–300 mg/l; dissolved oxygen: 5–10 mg/l and total hardness: 30–180 mg/l.

During experimental period, morphological and behavioural characteristics of fish were observed. Fishes were swimming actively throughout the entire tank, not just hanging out or laying at the bottom. They consume the fish feed regularly and swim to the surface quickly during feeding time. Fish do not show any white spots or blemishes on their body; fins were not torn, curved or ragged, and eyes were not bulged. Gill movements were very normal and controlled. Fish showed no stomach bulging or fin curving indicating that they were healthy and the feed was not toxic and can be used in aquaculture.

Results of growth performance in 60 days of CFF, PPF and OPF to the *Labeo rohita* fish are depicted in **Table 3**.

Treatments	Experimental groups		
	CFF	PPF	OPF
Initial length (cm)	7.4 ± 0.65	8.1 ± 0.07	7.5 ± 0.38
Final length (cm)	14.6 ± 0.36	16.0 ± 0.13	14.7 ± 0.51
Length gain (cm)	7.2 ± 0.62	7.9 ± 0.05	7.2 ± 0.14
Initial weight (g)	6.7 ± 0.20	7.1 ± 0.08	6.2 ± 0.24
Final weight (g)	23.9 ± 0.39	26.3 ± 0.12	23.0 ± 0.06
Weight gain (g)	16.2 ± 0.56	19.2 ± 0.07	16.8 ± 0.29

Each value is mean ± SD of triplicate observations.

Table 3. Growth performance of *Labeo rohita* fed different test diet treatments.

The mean weight gain of *Labeo rohita* in the three treatments CFF, PPF and OPF was found to be 16.2, 19.2 and 16.8 g, respectively. The highest average live weight gain was found to be obtained in treatment PPF. The average gain in length of *Labeo rohita* in the three treatments CFF, PPF and OPF was found to be 7.2, 7.9, and 7.2 cm, respectively. The highest average gain in length was obtained in treatment PPF.

Sunitha and Rao [16] had reported better weight gain in *Tilipia mossambica* when fed with blue green algae (*Chlorella*, *Anabaena*, *Oscillatoria*, *Nostoc*) grown with the support of mango waste. Hung et al. [17] had also reported that Pangas catfish (*Pangasius pangasius*) has been demonstrated to having a capacity for utilizing plant feedstuff carbohydrates for energy. Therefore, it can be concluded that vegetable wastes have considerable potential for partial replacement with fish meal as supplementary feed ingredients in sustainable aquaculture of *Labeo carps*.

Feed is the single largest item of expenditure to the farmers, accounting for 79–92% of the total production cost in striped catfish (*Platydoras armatulus*) farming [18–20]. In general, two types of feeds are used for striped catfish, wet farm made feeds and pelleted feeds, and these differ in formulation and quality [18–20]. According to Hung et al. [21], the traditional feeding of small scale catfish farming is largely based on trash fish (marine origin) constituting approximately 50–70% of feed formulations. *Pangas* catfish has been demonstrated to have a capacity for utilizing plant feedstuff carbohydrates for energy, but little research has been performed on these fish species with regard to alternative dietary protein source selection [17]. Using plant-based proteins in aquaculture feeds requires that the ingredients possess certain nutritional characteristics, such as low levels of fibre, starch and antinutritional compounds. They must also have a relatively high protein content, favourable amino acid profile, high nutrient digestibility and reasonable palatability [22]. A number of previous studies discuss the suitability of plant protein feeds and/or local agricultural by-products as an alternative protein source in fish feeds [23–28].

Figure 1 shows the total percentage of protein in 60 days exposure. The results shows significant percentage of protein in muscles and liver of *Labeo rohita* fed with PPF followed by OPF and CFF. However, the *Labeo rohita* fed with OPF showed very active behaviour, lustrous body scales and high feeding rate. Feeding rate was calculated on the basis of fish feed left over or settled at the bottom of aquarium. The higher mineral and fibres content in OPF show high quantitative value.

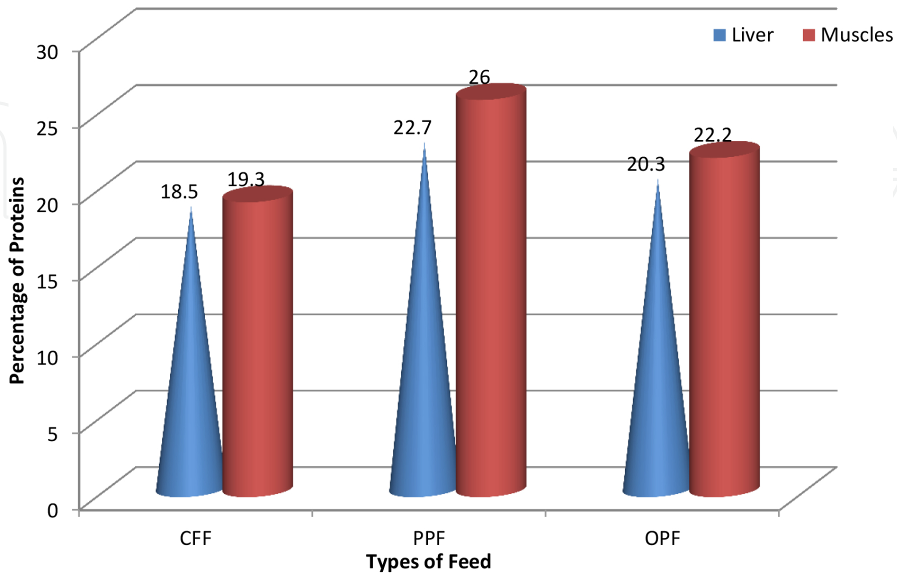

Figure 1. Percentage of protein content in liver and muscles.

7. Conclusion

It is clear from the study that feed prepared for fishes are non-toxic and have good nutritive value of orange and potato peel waste. There appeared no adverse changes morphologically. Comparative studies between CFF, PPF and OPF showed that PPF is very nutritive and helps in the qualitative and quantitative growth of fish. While in OPF and CFF, growth is slow. But *Labeo rohita* fed with OPF showed brighter body scales than other two feed. Fishes were very healthy and normal throughout the study period indicating no adverse effect on their health. No infection whatsoever was noted during 60 days of experimental period.

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