



Nutritional Quality Evaluation of Feeds Developed from Secondary Raw Material from Fish Processing Industry

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Abstract

Fresh head waste of sardine, threadfin bream, anchovy and tilapia was converted into fish meal after cooking and pressing. Whole sardine was used as control sample. Quality analysis of the prepared meal revealed that the protein content was lower for sardine waste (43.1%) and higher for tilapia (62.3%). The fish meal prepared was used as the protein source for preparing feed along with other ingredients. Isoprotenous feed prepared was administered in Wistar strain male albino rats for a period of 31 days and Feed Intake (FI) Protein Efficiency Ratio (PER) and Feed Conversion Ratio (FCR) was estimated. Feed intake was more in threadfin bream waste feed and anchovy waste feed (135.1 g/31 days) which was significantly different from other feeds. The acceptance of feed developed from the waste of fish shows more or less similar to control feed indicating that the waste can be utilized for the development of feed for different animals thereby resolving the problem of environmental pollution.

Keywords: Fish waste utilization, nutritional quality, feeding study

Introduction

India is the second largest fish producing nation in the world, constituting about 5.68% of the global fish production. India is also a major producer of fish through aquaculture and ranks second in the world after China. The total fish production in India during 2017-18 is 10.07 million tonnes (MT) of which nearly 65% was contributed by the inland sector. Globally more than 91 million tonnes of fish and shellfish are caught each year. Annual discard

from the world fisheries is estimated to be approximately 20 million tonnes (25%) per year (Rustad, 2002). Mainly animal wastes have been investigated for use in feed formulation of African catfish (Akegbejo-Samsons, 1999) and other species. Huge volume of waste is generated by the fish processing industry when compared with other industries. The global weighted discard rate is 8% of the total annual fish landings (Kelleher, 2005). Fish processing waste can be used for making good quality poultry feeds, fish feeds and other high protein feeds. Most common method for utilization of processing waste is the manufacture of fish meal/oil, fish silage for the production of organic fertilizers, poultry and aquatic feeds. This would also help the fish processing industry to minimise the waste, reduce pollution and will be a viable option for additional revenue.

Fishmeal is an excellent source of protein for poultry and aquaculture feed. In India, the fishmeal production is confined to the coastal states. The total fish meal production is approximately estimated to be 65000 tonnes comprising 58000 tonnes in Karnataka, 6000 tonnes in Kerala and 1000 tonnes in Tamil Nadu (Ponnusamy et al., 2012). Among the commonly used feed ingredients, fish meal is considered to be the best considering the protein requirement of fish (Alam et al., 1996). Feed is the main input in fish culture and it accounts for about 50-60% of the variable costs of production. As it is the main expenditure in aquaculture, feed has to be given utmost care during preparation and storage. It has been reported that annual local market for commercial fish and shrimp feed is around 35,000 and 30,000 metric tonnes respectively. The cost of feed production can be cut down by utilizing the waste generated from nearby fish markets. The aim of the present work is to carry out nutritional quality evaluation of feeds formulated with different types of fishmeal from fish processing wastes.

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Materials and Methods

The fresh head waste of different species *viz.*, sardine (*Sardinella longiceps*), threadfin bream (*Nemipterus japonicus*) and anchovy (*Stolephorus indicus*) were collected from the fish processing industry, where as the tilapia head waste (*Oreochromis mossambicus*) was obtained from the filleting waste of the fish processing division and fresh sardine was procured from the local market near Cochin. The wastes were converted into fish meal by cooking for 30 min and pressing in the mini fish meal plant of ICAR-Central Institute of Fisheries Technology, Cochin. The cakes were dried to a moisture level of 6-7% in solar dryer with an electrical backup for 10 h at 55°C. Feed was prepared by combining the ingredients such as fish meal, wheat flour, rice bran and vitamin mix as given in Fig. 1 with sufficient quantity of water for mixing to make a dough and finally steaming for 20 min. The steamed mass was pelletized mechanically in the G.L. Extrusion system with single screw of 42 helix angle and dried in the CIFT solar dryer till the moisture is less than 10%.

Feed ingredients other than fish meal were procured from local market near by the institute. Rice bran, wheat flour and vitamin mix of good quality were used for feed preparation. The formulation of feed were done using Pearson’s square method, to get a protein concentration between 25 - 30% in the final feed. All the chemicals used were of analytical grade.

Wistar strain male albino rats of 50 – 65 g, were selected for the study. The animals were housed in polyurethane cages under hygienic conditions and maintained at normal room temperature. The animals were allowed to consume prepared feed and water *ad libitum*. The experiment was carried out

according to the guidelines of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), New Delhi, India and approved by the Institutional Animal Ethics Committee (IAEC).

Experimental protocol: The details of the feeds used are as follows:

Feed 1: Feed incorporated with whole sardine meal was used as control diet.

Feed 2: Feed incorporated with sardine head waste meal

Feed 3: Feed incorporated with tilapia head waste meal

Feed 4: Feed incorporated with thread fin bream head waste meal.

Feed 5: Feed incorporated with anchovy head waste meal diet

After seven days of acclimatization, the animals were divided into five groups each containing four animals. Group 1 was fed with control diet (feed 1), Group 2 fed with feed 2, Group 3 fed with feed 3, Group 4 fed with feed 4 and Group 5 fed with feed 5. Equal amount of feed was given to all the rats throughout the study and its weight gain, feed intake, protein efficiency ratio and feed conversion ratios were studied. The experiment was carried out for 31 days. Gain in body mass is the weight gain of animals during the study. Feed Intake (FI) is the sum of quantity of feed consumed for 31 days. Protein Efficiency Ratio (PER) was calculated based on the weight gain of the test subject divided by its intake of feed protein during the test period. Feed Conversion Ratio (FCR) is the measure of an animal’s efficiency in converting feed mass into the gain in weight was also calculated.

Moisture content was determined by drying the homogenized sample in an oven at 105°C until a constant mass was obtained (AOAC, 2005). Crude protein content was determined by Kjeldahl method (AOAC, 2005). Crude fat content of samples was determined with soxhlet apparatus using petroleum ether as extraction solvent (boiling point 40-60°C) (AOAC, 2005). Ash content was determined by heating the sample in muffle furnace at 600°C for 6-8 h (AOAC, 2005).

The samples were analysed in triplicates and data were reported as means ± standard deviation. All the statistical analysis were performed in IBM SPSS

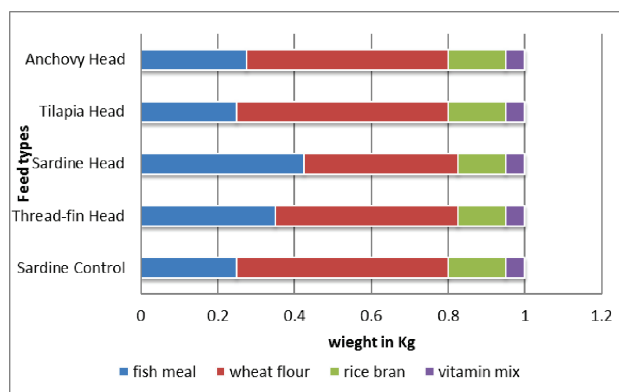


Fig. 1. Ingredients used for feed preparation

Statistics version 21. Means were compared using Tukey's B test at 5% level of significance.

Results and Discussion

In this study, the prepared fish meal was taken as a major protein source in the feed formulation, whereas wheat flour was used as a source of carbohydrate as well as a binding agent. Rice bran is low in protein, however it is cheap and readily available. Vitamin mix comprises of Vitamin A, D and B complex were added in trace amount.

Proximate composition of fishmeal prepared from various fish cutting waste are given the Table 1. Protein content in the fish waste meal samples varied significantly. Crude protein was more in the whole sardine fishmeal (63.4%) and least in sardine waste meal (43.12%). This could be due to the fact that head of sardine contains very less muscle portion unlike many other species and the head is mainly contributed by opercular bones and skull. High content of ash was present in the same sample due to the presence of bone content with high calcium content. Christianah & Deborah (2015) reported 14.2% ash content with 31.5% protein in sardine head waste with 16% moisture content. Tilapia waste meal contained higher protein content

(62.2%) with 5.2% moisture content. The average value of protein content of 54.8% was reported by Dale et Al. (2004) in eight tilapia waste meal samples collected from different counties.

Proximate compositions of fish waste meal incorporated feeds are given the Table 2. Feed formulation was done to result in isoproteinous concentration of 28%. The final protein content was 27.1% in anchovy waste based feed; where it was 28.8% in threadfin bream waste feed. But in case of sardine waste feed, both ash content and fat content was significantly higher when compared to other feed formulations. Fish meal, which accounts for 40-60% of total dietary protein in fish feed (Weerd, 1995), generally promotes growth of fish when it is supplied as primary protein source. The level of crude fat in animal feed ingredients was in the range of 7.6-10.1% as reported by Kavitha et al. (2003).

The observed gain in body mass during the study period remained more or less similar in all the feeds except in case sardine waste feed, which recorded the lowest body weight gain. Weight gain was high for the rats fed with anchovy waste feed (112.3 g) followed by the rats fed with threadfin waste feed (111.7 g), tilapia waste feed (107 g), sardine control

Table 1. Proximate composition of different fish meal from fish and fish waste

| Sl.No. | Fish meal | Moisture (%) | Ash (%) | Crude Fat (%) | Crude Protein (%) |
|--------|----------------------------|--------------------------|---------------------------|---------------------------|---------------------------|
| 1 | Sardine fish meal | 6.18 ± 0.10 ^a | 17.57 ± 0.02 ^a | 11.89 ± 0.21 ^a | 63.40 ± 0.02 ^a |
| 2 | Sardine waste meal | 4.23 ± 0.22 ^b | 35.85 ± 0.15 ^b | 14.35 ± 0.03 ^b | 43.12 ± 0.23 ^b |
| 3 | Tilapia waste meal | 5.97 ± 0.05 ^a | 22.62 ± 0.05 ^c | 8.01 ± 0.32 ^c | 62.29 ± 0.06 ^c |
| 4 | Threadfin bream waste meal | 5.10 ± 0.02 ^c | 34.30 ± 0.16 ^d | 9.88 ± 0.18 ^d | 49.15 ± 0.10 ^d |
| 5 | Anchovy waste meal | 1.42 ± 0.20 ^d | 23.23 ± 0.22 ^e | 20.00 ± 0.01 ^e | 60.95 ± 0.02 ^e |

Different superscripts (a, b, c...) in the same column indicate significant differences between means (p<0.05)

Table 2. Proximate composition of feeds prepared from different fishmeal (%)

| No. | Fishmeal based Fish feed | Moisture | Ash | Crude Fat | Crude Protein |
|-----|----------------------------|---------------------------|---------------------------|--------------------------|---------------------------|
| 1 | Sardine fish feed | 1.99 ± 0.16 ^{ab} | 10.62 ± 0.01 ^a | 3.77 ± 0.01 ^a | 27.60 ± 0.10 ^a |
| 2 | Sardine waste feed | 3.07 ± 0.14 ^c | 19.01 ± 0.11 ^b | 7.62 ± 0.01 ^b | 27.70 ± 0.11 ^a |
| 3 | Tilapia waste feed | 2.38 ± 0.22 ^b | 10.70 ± 0.01 ^a | 3.58 ± 0.13 ^a | 28.18 ± 0.31 ^b |
| 4 | Threadfin bream waste feed | 1.65 ± 0.42 ^a | 15.20 ± 0.04 ^c | 3.67 ± 0.14 ^a | 28.81 ± 0.20 ^c |
| 5 | Anchovy waste feed | 6.50 ± 0.31 ^d | 9.60 ± 0.03 ^d | 5.89 ± 0.21 ^c | 27.10 ± 0.22 ^d |

Different superscripts (a, b, c...) in the same column indicate significant differences between means (p<0.05)

Table 3. Growth performance of wistar albino rats

| Sl. No. | Treatment Groups | Feed Intake (FI) g / 31 days | Gain in body mass g / 31days | Growth performance / day (g) | Feed Conversion Ratio | Protein Efficiency Ratio |
|---------|----------------------|------------------------------|------------------------------|------------------------------|--------------------------|---------------------------|
| 1 | Sardine Control feed | 121.3 ± 2.5 ^a | 106.4 ± 5.7 ^a | 3.41 | 1.14 ± 0.15 ^a | 3.28± 0.22 ^a |
| 2 | Threadfin waste feed | 135.1 ± 2.4 ^c | 111.7 ± 0.5 ^a | 3.79 | 1.21± 0.33 ^a | 2.86 ± 0.24 ^{bc} |
| 3 | Sardine waste feed | 128.2 ± 2.3 ^b | 80.8 ± 10.8 ^b | 2.60 | 1.59± 0.31 ^a | 2.28± 0.33 ^b |
| 4 | Tilapia waste feed | 132.5 ± 2.5 ^{bc} | 107.0 ± 7.3 ^a | 3.45 | 1.24± 0.19 ^a | 2.86± 0.26 ^{bc} |
| 5 | Anchovy waste feed | 135.1 ± 2.3 ^c | 112.3 ± 2.9 ^a | 3.61 | 1.20± 0.12 ^a | 3.07± 0.17 ^c |

Different superscripts (a, b, c...) in the same column indicate significant differences between means (p<0.05)

feed (106.4 g) and low for sardine waste based feed (80.8 g) (Table 3). Inclusion of high quantity of sardine waste meal (42%) to make isoproteinous feed resulted in high ash content in the feed (19%), which might have resulted in low body weight gain in the animals. The graphical representation of weekly gain in body mass was shown in Fig. 2.

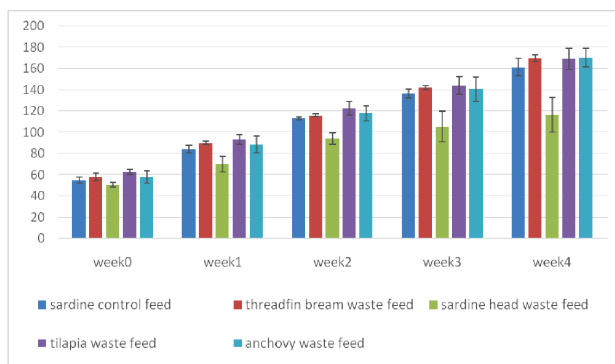


Fig. 2. Weekly Gain in the body mass of wistar albino rats during the study

Feed intake was seen more in the case of threadfin bream waste feed and anchovy waste feed (135.1 g/31 days) which was observed to be significantly different from other feeds (Table 3). The growth performance of the animals per day was also higher in these two groups. Addass et al. (2010) observed lower levels of weight gain in rats when fed with different animal protein supplements. The rats fed with sardine head waste had the lowest body weight gain. Protein Efficiency Ratio (PER) was higher for sardine control (3.28) and anchovy waste feed (3.07) when compared to the other, this might be due to the poor quality of protein present in the fish waste (Table 3). Feed conversion ratio (FCR) was least for control feed (1.14) and there was no significant

difference in the other feeds. Christianah & Deborah (2015) reported the FCR value of 1.37 in African cat fish when fed with 5% sardine waste meal incorporated feed.

The acceptance of feed developed from the wastes of fish is more or less similar to the feed that developed from the meal of whole fish. The FCR of all the feeds developed did not show any significant difference, while the PER was significantly different for whole sardine feed. Wastes from the fish can be converted to fish or poultry feed. About three fourth of the fishmeal and oil are produced from the harvest of small, open-ocean (pelagic) fish such as anchovies, sardines, threadfin breams, mackerel etc. These fishes have short life cycles and are capable of rapid reproduction and stock replenishment. The remaining quarter is generated from the scraps produced when fish are processed for human consumption. Utilizing the fish processing waste to produce high value products will generate additional revenue options from fish processing, besides providing cost effective feeds. It will open more opportunities to the local farmers in India.

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