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# Protein Digestibility of Some Low-Cost Feedstuffs in Fingerling Indian Major Carps

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## Abstract

Apparent protein digestibility (%) of some low-cost feedstuffs is reported for fingerling Indian major carps, *Labeo rohita, Cirrhinus mrigala* and *Catla catla*. Significant differences ($t<0.05$) were observed in the digestibility of feedstuffs. Among the feedstuffs tested, protein from plant sources showed higher digestibility for the three carp species. The highest digestibility (93-94%) was noted for soybean oil cake. Values for other plant origin feedstuffs ranged between 81 and 90%. Digest-ibility of proteins from fish meal and slaughterhouse offal was relatively low (74-76%).

## Introduction

The nutritive value of a feedstuff is related not only to its nutrient content but also to its digestibility, and foremost among these is the availability of protein in a digestible form (De Silva et al. 1988). Protein is useful only if it can be digested and the various degradation products absorbed efficiently by the fish (Ash 1985). Since the ability to digest protein from a particular feedstuff varies greatly with fish species, it is considered desirable to assess the protein digestibility of different feedstuffs for optimum inclusion in formulated diets. Several attempts have been made to quantify digestible protein in a wide variety of feedstuffs fed to various fish species (Kirchgessner et al. 1986; Law 1986; Eid and Matty 1989; Hossain and Jauncey 1989; De Silva et al. 1990; Singh 1992).

This paper reports the apparent protein digestibility of some locally available low-cost feedstuffs, which are primarily products of agro-based industries and wastes from slaughterhouse and fish market, for fingerling *Labeo rohita, Cirrhinus mrigala* and *Catla catla,* using chromic oxide ($Cr_2 0_3$) as an external digestibility marker. Doubts have been raised in the recent past with respect to the use of chromic oxide as a digestibility marker due to its apparent differential passage along the gastrointestinal tract (Bowen 1978). Although the use of indigenous markers are gradually gaining favor (Buddington 1979, 1980; Lobel and Ogden 1981; De Silva and Perera 1983; Pandian and Marian 1985), chromic oxide continues to be the most commonly used method for fish digestibility trials.

## Materials and Methods

Based on the gross protein requirement of Indian major carps (Khan 1991), a casein-gelatin reference diet (CP 40%) was prepared using 1% chromic oxide as an external marker. The composition of mineral and vitamin premixes, and the method of preparation of moist diets were according to Halver (1989). Test diets (with 1% chromic oxide) were prepared by mixing the test ingredient (30%) with the reference diet (Cho et al. 1982). Proximate composition of the reference and test diets, and the individual test ingredients are given in Tables 1 and 2. Trash fish and goat offal, obtained fresh from the local fish market/ slaughterhouse, were cooked (80°C), dried and powdered before being used as test ingredients.

The proximate composition of feedstuffs and the diets was determined using standard techniques (AOAC 1984). Crude protein (N x 6.25) was determined by Kjeldahl method, and crude fat was quantified through soxhlet exhaustive extraction technique using petroleum ether (40-60°C BP) as the solvent. Ash was estimated by incineration — a weighed amount (2-5 g) of dried sample in a muffle furnace (600°C). Crude fiber was determined using acid-alkali hydrolysis, and ignition (550°C) of the dried sample for 2 h. N-free extract (NFE) was determined by difference. Chromic oxide was estimated using the acid digestion technique (Furukawa and Tsukahara 1966).

Fingerling *L. rohita* (4.0-6.0 cm; 1.5-2.0 g), *C. mrigala* (3.0-5.0 cm; 1.2-1.9 g) and *C. catla* (2.4-2.9 cm; 0.8-1.2 g) obtained from the State Fish Cooperative Seed Production Centre, Kolahar, Mathura, India, were stocked separately in triplicate groups of 25 fish each, in 70-1 polyvinyl circular troughs fitted with a

Table 1. Proximate composition (%)* of reference and test diets fed to Indian major carps. The reference diet consisted of vitamin-free casein 38%, gelatin 9%, dextrin white 32%, oil 7%, mineral mix 4%, vitamin mix 1%, $\alpha$ - cellulose 8%, and chromic oxide 1%.

| | Crude protein | Ether extract | Ash | Crude fiber | NFE |
|---|---|---|---|---|---|
| Reference diet (RD) | 43.7± 0.55 | 7.4±0.35 | 4.6±0.10 | 7.5±0.08 | 36.7±0.90 |
| RD + 30% soybean oil cake | 47.0±0.32 | 5.4±0.30 | 5.5±0.11 | 8.0±0.10 | 33.1±0.46 |
| RD + 30% sesame oil cake | 41.1±0.48 | 7.2±0.30 | 6.5±0.11 | 10.0±0.13 | 34.2±0.47 |
| RD + 30% mustard oil cake | 42.1±0.34 | 8.3±0.49 | 5.9±0.35 | 8.6±0.11 | 34.1±0.61 |
| RD + 30% groundnut oil cake | 45.7±0.36 | 7.4±0.26 | 5.4±0.10 | 8.0+0.07 | 33.2+0.78 |
| RD + 30% wheat bran | 35.9+0.27 | 6.8+0.15 | 5.3+0.06 | 8.7+0.08 | 40.8+0.81 |
| RD + 30% rice polish | 33.8+0.38 | 9.0+0.24 | 4.9+0.07 | 7.9+0.05 | 42.4+0.79 |
| RD + 30% pigeonpea dust | 35.5+0.38 | 6.0+0.26 | 4.8+0.05 | 13.7+0.10 | 38.5+0.64 |
| RD + 30% fish meal | 49.2+0.47 | 8.9+0.31 | 5.5+0.06 | 5.6+0.06 | 30.1+0.52 |
| RD + 30% offal meal | 55.1+0.49 | 8.4+0.24 | 4.3+0.07 | 5.5+0.05 | 26.4+0.54 |

*Dry weight basis; ± SEM (n = 5)

Table 2. Dry matter and proximate composition (%) of feedstuffs tested for the apparent protein digestibility (%) in Indian major carps.

| | Dry matter | Crude protein | Ether extract | Ash | Crude fiber | NFE |
|---|---|---|---|---|---|---|
| Soybean oil cake (*Glycine max*, soil. extd.) | 93.0±0.40 | 51.1±2.09 | 0.7±0.16 | 7.1±0.12 | 8.5±0.17 | 25.6±1.03 |
| Sesame oil cake (*Sesamum indicum*) | 97.2±0.49 | 34.2±0.97 | 6.7±0.21 | 10.5±0.14 | 15.4±0.25 | 30.4±0.91 |
| Mustard oil cake (*Brassica* sp.) | 93.2±0.79 | 35.9±1.00 | 9.6±0.79 | 8.3±0.09 | 10.5±0.22 | 28.9±1.51 |
| Groundnut oil cake (*Arachis hypogaea*) | 93.7±0.83 | 47.4±1.15 | 5.8±0.95 | 6.8±0.43 | 8.3±0.27 | 25.4±0.80 |
| Wheat bran (*Triticum aestivum*) | 89.3±0.35 | 15.8±0.41 | 4.9±0.10 | 6.2±0.08 | 10.3±0.20 | 52.1±1.86 |
| Rice polish (*Oryza sativa*) | 90.2±0.62 | 9.9±0.49 | 11.6±0.52 | 5.2±0.17 | 8.0±0.17 | 55.5±0.79 |
| Pigeonpea dust (*Cajanus cajan*) | 90.9±0.74 | 14.0±0.43 | 2.4±0.37 | 5.4±0.05 | 25.7±0.28 | 43.4±1.13 |
| Fish meal (miscellaneous species) | 92.0±0.85 | 58.2±1.53 | 11.5±0.51 | 7.1±0.44 | 1.1±0.08 | 14.1±0.92 |
| Slaughterhouse waste (goat offal) | 93.8±0.31 | 78.0±0.82 | 10.2±0.17 | 3.5±0.01 | 1.0±0.01 | 1.1±0.69 |

± SEM (n = 5)

flow-through system. Fish were acclimated to the reference diet for 10 d prior to feeding the test diets. The average water temperature and water exchange rate were 27±1°C and 1.0-1.5 $l.min^{-1}$, respectively. Fish were fed to satiety the test and reference diets in the form of a moist cake (50% moist) once daily at 0800 h under natural photoperiod. Uneaten food, if any, was siphoned as soon as the fish stopped active feeding. In each run, fish were accustomed to the diet and dietary regime for a week prior to the commencement of fecal collection. Fecal collections were made using a fine polythene mesh filter 10 h after feeding, by immediate siphoning for 2 h. Soon after collection, the feces were frozen. Fecal collections of 5 d were pooled. Three such samples collected over a period of 15 d were frozen until the end of the trial.

The apparent protein digestibility (%) of the reference and test diets and that of the test ingredient was determined using the method of Cho et al. (1982).

## Results and Discussion

The apparent protein digestibility of the reference and test diets for fingerling *L. rohita*, *C. mrigala* and *C. catla* are given in Table 3.

With few exceptions, protein digestibility of individual feedstuffs showed significant (t<0.05) difference among the three species (Table 4). The results

Table 3. Apparent protein digestibility (%) of reference and test diets.

| | *L. rohita* | *C. mrigala* | *C. catla* |
|---|---|---|---|
| Reference diet (RD) | 97.0±1.66 | 95.3±2.40 | 98.8±0.10 |
| RD + 30% soybean oil cake | 97.5±0.59 | 93.7±1.15 | 97.4±0.11 |
| RD + 30% sesame oil cake | 92.8±1.17 | 93.6±0.90 | - |
| RD + 30% mustard oil cake | 92.6±0.27 | 93.6±0.32 | 94.6±0.48 |
| RD + 30% groundnut oil cake | 94.7±0.79 | 93.2±0.78 | - |
| RD + 30% wheat bran | 95.8±0.31 | 93.6±0.37 | 95.1±0.40 |
| RD + 30% rice polish | 94.8±0.18 | 90.1±2.32 | - |
| RD + 30% pigeonpea dust | 94.1±1.58 | 91.2±0.82 | - |
| RD + 30% fish meal | 91.2±0.19 | 88.8±0.29 | 92.0±0.06 |
| RD + 30% offal meal | 90.4±0.20 | 88.7±0.12 | - |

± SEM (n = 3)

indicate efficient digestion of plant proteins by these species. The protein digestibility of soybean cake was the best (93-94%), followed by sesame (*Sesamum indicum*) and mustard (*Brassica* sp.) oil cakes (87-90%). For other plant feedstuffs, the values were 81-90%. Protein from fish meal and slaughterhouse waste was digested only to the extent of 74-76%.

In culture situations, Indian major carps are generally fed diets formulated on an empirical basis. Traditionally, these fish are fed a mixture of rice bran and various varieties of oil cakes, the latter forming the major dietary protein source in feeds for these species. There is, however, increasing emphasis on developing low-cost complete artificial feeds for these species using agricultural and fishery by-products. Evaluation of digestibility of such feedstuffs is considered essential for their effective incorporation in fish diets.

Nutritional value of a wide range of locally available feedstuffs (Jafri et al. 1992) indicates that a good number of such feedstuffs are rich in their protein and energy contents. The high protein digestibility of plant origin feedstuffs, in comparison to animal-based feedstuffs, may be related to the omnivorous/herbivorous feeding habit of the above fish species. The finding strengthens the view that the enzyme system in cyprinids, which have a long gut, is better equipped to digest and absorb nutrients from plant feedstuffs (Smith 1989). Recently, Singh (1992) has observed high digestibility (86-92%) for plant proteins in yearling *C. mrigala* and grass carp, *Ctenopharyngodon idella*. Hanley (1987) has also reported higher digestibility coefficient for soybean than fish meal in omnivorous tilapia, *Oreochromis niloticus*; whereas Lorico-Querijero and Chiu (1989) recorded high availability of both plant and animal proteins for this species. Law (1986) has reported 96 and 91% protein digestibility for soybean and fish meal, respectively, in the grass carp; while in the eel, *Anguilla anguilla*,

Table 4. Apparent protein digestibility of feedstuffs in Indian major carps. Figures having the same superscript in each row are significantly different (t>0.05).

| Feedstuffs | *L. rohita* | *C. mrigala* | *C. catla* |
|---|---|---|---|
| Soybean oil cake (sol. extd.) | 94.0[a] ±0.55 | 92.8[a] ±2.55 | 94.1[a] ±0.30 |
| Sesame oil cake | 89.1[a] ±3.20 | 89.6[a] ±2.46 | - |
| Mustard oil cake | 88.2[ab] ±0.74 | 89.5[a] ±0.86 | 86.6[b] ±1.07 |
| Groundnut oil cake | 83.8[a] ±0.73 | 88.2[b] ±2.13 | - |
| Wheat bran | 88.1[a] ±0.26 | 89.6[a] ±1.01 | 86.5[b] ±0.77 |
| Rice polish | 88.3[a] ±0.50 | 84.4[b] ±1.28 | - |
| Pigeonpea dust | 86.3[a] ±1.57 | 81.2[b] ±1.78 | - |
| Fish meal | 74.1[a] ±1.00 | 73.6[a] ±0.80 | 76.1[b] ±0.18 |
| Slaughterhouse waste (goat offal) | 73.6[a] ±0.56 | 73.5[a] ±0.33 | - |

± SEM (n = 3)

these two feedstuffs were 94% digestible (Schmitz et al. 1984). In channel catfish, *Ictalurus punctatus*, it is reported that although feedstuffs like soybean and peanut meal were less digestible than fish meal, the mean apparent protein digestible coefficient of plant protein was much higher than that of animal protein. Compared to the values quoted for channel catfish (Wilson and Poe 1985), soybean and fish meal, with the exception of peanut meal, showed lower protein digestibility values in fingerling Indian major carps. In *Cyprinus carpio*, on the other hand, Hossain and Jauncey (1989) reported higher protein digestibility for fish meal, and lower values for sesame meal and mustard oil cake than the values recorded for these feedstuffs for Indian major carps. Variations in protein digestibility reported for different fish species may be due to differences in the method of processing the feedstuffs, besides digestive physiology of the concerned species. The information thus obtained on the protein digestibility of low-cost feedstuffs will be useful in formulating practical rations for the culture of Indian major carps semi-intensively and/or intensively.

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