

APPARENT DIGESTIBILITY OF FISH MEAL, BLOOD MEAL AND MEAT MEAL FOR *LABEO ROHITA* FINGERLINGS

S. M. Hussain*, M. Afzal*, M. Salim*, A. Javid**, T. A. A. Khichi*, M. Hussain* and S. A. Raza***

Department of Wildlife and Fisheries, Government College University, Faisalabad, Pakistan

*Department of Zoology and Fisheries, University of Agriculture, Faisalabad, Pakistan

**Department of Wildlife and Ecology, University of Veterinary and Animal Sciences, Lahore, Pakistan

***Fish Biodiversity Hatchery Chashma, Mianwali, Department of Fisheries, Punjab, Pakistan

Corresponding Author's email address: drmakhdoom90@gmail.com

ABSTRACT

A feeding trial was conducted to determine the apparent nutrient digestibility of three feed ingredients of animal protein sources for *Labeo rohita* fingerlings. Reference diet was mixed with test ingredients in 70:30 ratios to formulate test diets. Chromic oxide was added as an indigestible marker. Apparent nutrient digestibility coefficient of dry matter and crude fat for blood meal and fish meal was significantly higher than meat meal at $P < 0.05$. The crude protein digestibility values of blood meal (71.90 ± 1.98) were significantly lower than fish meal (80.20 ± 1.27) and meat meal (79.92 ± 2.40). The apparent gross energy digestibility of fish meal (69.30 ± 3.71) was significantly higher from meat meal (61.55 ± 4.63) and blood meal (59.55 ± 5.20). The nutrient digestibility values of fish meal and blood meal for dry matter and crude fat are similar whereas for crude protein the digestibility values of fish meal and meat meal are close to each other. It is concluded from this study that blood meal and meat meal can be included in diets of *Labeo rohita* fingerlings.

Key words: Nutrient digestibility; *Labeo rohita*; Fish meal; Blood meal; Meat meal

INTRODUCTION

Labeo rohita, commonly known as rohu, is the major carp species cultured on large scale. In order to meet the nutrient and energy requirement of fish through practical feeding for economic reasons, information of digestibility coefficients for ingredients is necessary (Jafri and Hassan, 1999). In order to make the intensive monoculture of major carps successful, it is necessary to work out specific feed for each species (Muzammel *et al.*, 2003). A feedstuff may appear from its chemical composition to be an excellent source of nutrients but will be of minute actual value unless it can be digested and absorbed in the target fish species. At the same time with chemical analysis, digestibility determination may allow a more thorough assessment of nutritive value of a particular protein source in a complete fish diet (Plakas and Katayama, 1981). Digestibility is the fraction of the nutrients or energy in the ingested feed stuff that is not excreted in the feces (NRC, 1993) and is the most important aspect in evaluating the efficiency of feedstuffs (Hasan, 2001). The apparent digestibility coefficients (ADC) for dry matter, protein, starch, total phosphorous and energy of the animal protein sources were measured indirectly using chromic oxide (Cr_2O_3) as an inert marker (Sugiura *et al.*, 1998; Bureau *et al.*, 1999).

Fish meal is a major protein source in fish feeds because it is an excellent source of essential nutrients such as indispensable amino acids, essential fatty acids, vitamins, minerals and many growth factors (Zhou *et al.*,

2004). Blood meal (BM), feather meal (FEM), meat and bone meal (MBM) and poultry by-product meal (PBM) have been used effectively in feeds for a variety of fish species, such as rainbow trout (Bureau *et al.*, 2000), red drum (Kureshy *et al.*, 2000), Australian snapper (Quartararo *et al.*, 1998), Nile tilapia (Fasakin *et al.*, 2005), Cuneate drum (Wang *et al.*, 2006), but for major carps species only fish meal is used as animal protein source in their feed. For inclusion of blood meal and meat meal in diets of *Labeo rohita* fingerlings there is a need to study the digestibility of these ingredients. Therefore the aim of this study was to compare the apparent nutrient digestibility of blood meal and meat meal with fish meal for *Labeo rohita* fingerlings.

MATERIALS AND METHODS

The present study was carried out to study the apparent nutrient digestibility of fish meal, blood meal and meat meal for *Labeo rohita* fingerlings. The experiment was conducted in the Fish Nutrition Laboratory, Department of Zoology and Fisheries, University of Agriculture, Faisalabad.

Fish and experimental condition: Two hundred *Labeo rohita* fingerlings procured from Government Fish Seed Hatchery, Faisalabad, were acclimatized to experimental conditions in laboratory for two weeks in V-shaped tanks (UA system) specially designed for the collection of fecal material from water media. During this period the fingerlings were fed once daily to apparent satiation on

the basal diet used in subsequent digestibility study (Allan and Rowland, 1992). The level of dissolved oxygen was maintained by supplying air using air pump through capillary system round the clock.

Feed ingredients and Experimental Diets: The reference diet was prepared to supply adequate levels of required nutrients for normal fish growth. Chromic oxide was used as an inert marker and incorporated at 1% inclusion level in reference diet. The test diets were composed of 70 % reference diet and 30 % of the respective feed ingredient (fish meal, blood meal and meat meal) to be tested. The feed ingredients were finely grounded to pass through 0.5 mm sieve size. All ingredients were mixed in a mixer (laboratory blender) for 5-10 minutes and fish oil was gradually added thereafter. Eighty-five (85 ml) of water was slowly blended into the mix, resulting in suitably textured dough (Lovell, 1989). Pellets were prepared using a hand pelleting machine and were dried in an oven at 60°C. The dry product was cut into pellets of 3 mm size.

Feeding Protocol and Sample Collection: The fingerlings *Labeo rohita* were fed at the rate of 2 % of live wet weight on their prescribed diet twice daily (morning and afternoon). For each experimental diet two replicates were assigned and in each replicate fifteen fish (average weight 12±0.04g) were stocked. After the feeding session of three hours, the uneaten feed was drained out from each tank by opening the valves of the tanks. The tanks were washed completely to remove the particles of diets and refilled with water. The feces were collected from the fecal collection tube of the tank twice a day by opening the valve I and valve II subsequently. Care was taken to avoid breaking the thin fecal strings in order to minimize nutrient leaching. Fecal material of each replicated treatment was dried and stored for chemical analysis. The experiment was lasted for ten weeks for the collection of 4-5 g fecal material of each replicate. The feces were dried in oven, ground and then analyzed for the estimation of nutrient values.

Chemical Analysis of Feed and Feces: The samples of feed ingredients, experimental diets and faeces were homogenized using a motor and pestle and analyzed by standard methods AOAC (1995): moisture was determined by oven-drying at 105°C for 12 h; crude protein (N x 6.25) by micro kjeldahl apparatus; crude fat, by petroleum ether extraction method (Bligh and Dyer, 1995) through Soxtec HT2 1045 system; Gross energy with the help of oxygen bomb calorimeter and Chromic oxide content in experimental diets and feces was measured after oxidation with perchloric reagent by using acid digestion method (Divakaran *et al.*, 2002) through UV-VIS 2001 spectrophotometer at 370nm absorbance.

Calculation of digestibility: An apparent nutrient digestibility coefficient (ADC) for each test diet was calculated by the formula reported in NRC (1993).

Apparent digestibility coefficient of test ingredients was calculated according to Bureau *et al.* (1999).

$$ADC_{\text{test ingredients}} = ADC_{\text{test diet}} + [(ADC_{\text{test diet}} - ADC_{\text{ref.diet}}) \times (0.7 \times D_{\text{ref}} / 0.3 \times D_{\text{ingr}})]$$

Statistical Analysis: Finally, data of digestibility of test diets and test ingredients was subjected to one-way Analysis of variance (Steel *et al.*, 1996). The differences among means were compared by Tukey's honesty significant difference test and considered significant at P<0.05 (Snedecor and Cochran 1991). The SPSS package was used for statistical analysis.

RESULTS

The chemical analysis of feed, feces and estimation of chromic oxide are shown in Table II. Apparent nutrient digestibility coefficients of dry matter, crude protein, crude fat and gross energy of fish meal, blood meal and meat meal are shown in Table III.

It is obvious from the results that in comparison with blood meal and meat meal, the fish meal released least amount of protein and gross energy through feces into aquatic environment (Table II). This decrease in protein and gross energy excretion through feces confirms that fish meal showed better nutrient digestibility on fish meal. On the other hand, meat meal showed the minimum release of crude fat through feces indicating higher crude fat digestibility of meat meal (Table II). Apparent nutrient digestibility coefficients of dry matter and crude fat of blood meal and fish meal were higher than meat meal and the values of fish meal and blood meal were significantly different (P<0.05) from meat meal (Table III). The apparent crude protein digestibility for fish meal (80.20±1.27) and meat meal (79.92±2.40) was higher than blood meal (71.90±1.98). The crude protein digestibility value of fish meal was significantly different from blood meal whereas the difference between fish meal and meat meal was not significant at P<0.05 (Table III). For gross energy, the digestibility coefficient of fish meal (69.30±0.57) was higher than meat meal (61.55±0.63) and blood meal (59.55±0.20). The gross energy digestibility value of fish meal was significantly different (P<0.05) from blood meal and meat meal but the values of meat meal and blood meal were not significantly different (P<0.05) from each other (Table III).

DISCUSSION

The apparent nutrient digestibility coefficients of crude protein, crude fat and gross energy

were higher for fish meal as compared to blood & meat meal except dry matter. The apparent digestibility of dry matter for blood meal was higher than fish meal and meat meal. The results of current study are not in line with Hajen *et al.* (1993). They reported low dry matter digestibility in blood meal and meat meal with high carbohydrate contents as compared to fish meal. The low digestibility of dry matter of fish meal and meat meal in the present study may be due to higher carbohydrate contents as compared to blood meal. The apparent protein digestibility (APD) of fish meal and meat meal was higher than blood meal. The observations of present study concurred with the results of Jalal *et al.* (2000). They reported that digestion coefficient of protein in fish meal (95.13%) was higher than blood and meat meal (84.70%) and superiority of fish meal was due to their balanced amino acid profile. The low APD in blood meal might be due to higher contents of carbohydrates.

Table 1: Ingredients percentage of reference and test diets

Ingredients	Reference Diet (%)	Test Diets (%)
Fish meal	18	12.6
Gluten 60%	30	21
Rice Polish	43	30.1
Fish Oil	4	2.8
Vitamin Premix	1	0.7
Ascorbic Acid	2	1.4
DCP	1	0.7
Chromic Oxide	1	0.7
Test ingredients*	---	30
Total	100	100

(Test ingredients*= Fish meal, Blood meal and Meat meal)

Table 2. Chemical analysis of feed, feces and estimation of chromic oxide (Cr₂O₃).

Feed:

Component	Reference diet (%)	Test Diet I (Fish meal)	Test Diet II (Blood meal)	Test Diet III (Meat meal)
Dry Matter	85.2 ± 0.22	86.04 ± 0.24	86.95 ± 0.38	87.2 ± 0.49
Crude Protein	31.97 ± 0.02	35.86 ± 0.15	39.22 ± 0.07	36.76 ± 0.36
Crude Fat	12.3 ± 0.24	10.65 ± 0.13	9.02 ± 0.05	10.37 ± 0.03
Gross Energy	3.03 ± 0.04	2.42 ± 0.01	3.14 ± 0.02	3.18 ± 0.05
Chromic Oxide	0.88 ± 0.01	0.87 ± 0.02	0.87 ± 0.00	0.88 ± 0.05

Feces:

Dry Matter	84.00 ± 0.55	85.00 ± 0.39	86.23 ± 1.12	86.90 ± 0.79
Crude Protein	7.25 ± 0.23	8.44 ± 0.16	12.74 ± 0.05	11.80 ± 0.21
Crude Fat	1.32 ± 0.04	2.76 ± 0.08	2.55 ± 0.04	1.60 ± 0.01
Gross Energy	1.72 ± 0.01	1.20 ± 0.06	1.70 ± 0.03	1.90 ± 0.06
Chromic Oxide	1.42 ± 0.05	1.44 ± 0.00	1.60 ± 0.02	1.68 ± 0.01

Table 3. Apparent nutrient digestibility coefficient (%) of test ingredients (Mean ± SE, n =3) using chromic oxide as marker.

Test ingredient	Dry Matter %	Crude Protein %	Crude Fat %	Gross Energy K Cal/g
Fish meal	50.15 ± 3.60a	80.20 ± 1.27a	78.30 ± 1.13a	69.30 ± 0.57a
Blood meal	56.85 ± 0.64a	71.90 ± 1.98b	75.30 ± 1.13a	59.55 ± 0.20b
Meat meal	42.35 ± 1.63b	79.92 ± 2.40a	67.40 ± 0.99b	61.55 ± 0.63b

The test ingredients followed by the different letters are significantly different at 0.05 level of significance using Tukey's Test.

The current study showed that the crude fat in fish meal and blood meal was well digested by *Labeo rohita*, where as the digestibility for meat meal was poor. The digestibility of crude fat value in fish meal was slightly lower to the value (81.80%) reported by Jalal *et al.* (2000). However, crude fat digestibility of present study was higher than the value (68%) reported by Gaylord and Gatlin (1996). They concluded that some of the difference in lipid digestibility values for red drum compared to other species might be attributable to differences in techniques used to extract lipid. The

apparent gross energy digestibility (AED) of fish meal was higher as compared to meat meal and blood meal. Similar confirmation was reported by Storebaken *et al.* (1998). They concluded that increased dietary carbohydrate (10-12%) reduced dry matter, energy and fat digestibility but had little effect on protein digestibility for rainbow trout. Generally, freshwater and warm water fish appear to digest carbohydrate more efficiently than carnivorous and cold water fish. The factor affecting AED could possibly due to more leaching of nutrient in animal ingredient. This is in accordance

with the findings of Watanabe *et al.* (1996) that leaching accounted for an increase in digestible energy coefficient for rainbow trout. In the present study it was found that the low cost feed ingredients showed encouraging results and they may be used in *Labeo rohita* diets which will reduce the overall cost of fish feeds and may improve the economics of aquaculture sector. Similar findings for *Labeo rohita* were also reported by Abid and Ahmed (2009a,b), as they concluded that alternative cheaper protein sources can be efficiently used in making cost effective aqua feeds instead of costly fish meal and it will also improve the growth performance and survival rate of *Labeo rohita* fingerlings.

Conclusion: *Labeo rohita* fingerlings digested energy and nutrients of the fish meal more efficiently than blood and meat meal, though the percentage of nutrient digestibility of blood meal and meat meal was comparatively less but the values were somewhat near to standard digestible values of carps. The present findings suggested that blood meal and meat meal can be included in diets of *Labeo rohita* fingerlings.

REFERENCES

- A.O.A.C., (1995). Official Methods of Analysis. 15th Ed., Association of Official Analytical Chemists, Washington, D.C. USA. pp: 1094.
- Abid, M. and M.S. Ahmed, (2009a). Growth response of *Labeo rohita* fingerlings fed with different feeding regimes under intensive rearing. The J. Anim. Plant Sci., 19(1): 45-49.
- Abid, M. and M.S. Ahmed, (2009b). Efficacy of feeding frequency on growth and survival of *Labeo rohita* (ham.) fingerlings under intensive rearing. The J. Anim. Plant Sci., 19(2): 111-113.
- Allan, G.L., and S.J. Rowland (1992). Development of an experiment diet for silver perch (*Bidyanus bidyanus*). Austasia Aqua, 6: 39-40.
- Bligh, E.G. and W.J. Dyer, (1995). A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol. 37: 911-917.
- Bureau, D.P., A.M. Harris and C.Y. Cho (1999). Apparent digestibility of rendered animal protein ingredients for rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 180: 345-358.
- Bureau, D.P., A.M. Harris, D.J. Bevan, L.A. Simmons, P.A. Azevedo and C.Y. Cho, (2000). Feather meals and meat and bone meals from different origins as protein sources in rainbow trout (*Oncorhynchus mykiss*) diets. Aquaculture, 181: 281-291.
- Divakaran, S., G.O. Leonard and P.F. Ian, (2002). Note on the methods for determination of chromic oxide in shrimp feeds. J. Agri. Food Chem., 50: 464-567.
- Fasakin, E.A., R.D. Serwata and S.J. Davies, (2005). Comparative utilization of rendered animal derived products with or without composite mixture of soybean meal in hybrid tilapia (*Oreochromis niloticus* X *Oreochromis mossambicus*) diets. Aquaculture, 249: 329-338.
- Gaylord, T.G. and D.M. Gatlin, (1996). Determination of digestibility coefficients of various feedstuffs for red drum (*Sciaenops ocellatus*). Aquaculture, 139: 303-314.
- Hajen, W.E., R.M. Beames, D.A. Higgs and B.S. Dosanjh, (1993). Digestibility of various feedstuffs by post-juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in sea water. Validation of technique. Aquaculture, 112: 321-332.
- Hasan, M.R., (2001). Nutrition and feeding for sustainable aquaculture development in the third millennium. Bangladesh J. Aqua., 5: 193-219.
- Jafri A.K. and M.A. Hassan, (1999). Energy digestibility coefficients of commonly used feedstuffs in different size-classes of Indian major carps, *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton). Asian Fish. Sci., 12: 155-163.
- Jalal, K.C.A., M.A. Ambak, C.R. Saad, A. Hassan and M.A.B. Abol, (2000). Apparent digestibility coefficients for common major feed ingredients in formulated feed diets for Tropical sport fish, *Tor tambroides* fry. Pak. J. Biol. Sci., 3: 261-264.
- Kureshy, N., D.A. Davis and C.D. Arnold, (2000). Partial replacement of fish meal with meat-and-bone meal, flash-dried poultry by-product meal and enzyme digested poultry by-product meal in practical diets for juvenile red drum. N. Am. J. Aqua., 62: 266-272.
- Lovell, R.T., 1989. Nutrition and feeding of fish. Van Nostrand-Reinhold, New York, USA, pp. 260.
- Muzammel, I., M. Salim and J. I. Sultan, (2003). Effect of different levels of dietary protein on growth performance of *Cirrhinus mirigala* fingerlings under intensive culture system. The J. Anim. Plant Sci., 13(2): 81-82.
- National Research Council (NRC), (1993). Nutrient Requirements of Fish. pp: 114. National Academy Press, Washington, DC, USA.
- Plakas, S.M. and T. Katayama, (1981). Apparent digestibility of amino acids from three regions of the gastro-intestinal tract of carp (*Cyprinus carpio*) after ingestion of a protein and a corresponding free amino acid diet. Aquaculture, 24: 309-314.
- Quartararo, N., G.L. Allan and J.D. Bell, (1998). Replacement of fish meal in diets for Australian

- snapper, *Pagrus auratus*. Aquaculture, 166: 279-295.
- Snedecor, G.W. and W.G. Cochran, (1991), Statistical Methods. 8th Ed. Iowa Stat Univ. Press. Ames, USA. pp: 503.
- Steel, R.G.D., J.H. Torrie and D.A. Dickey, (1996). Principles and procedures of statistics. 3rd McGraw Hill International Book Co. Inc., New York USA, pp: 336-352.
- Storebakken, T., K.D. Shearer, S. Refstie, S. Lagoeki and J. McCool (1998). Interaction between salinity, dietary carbohydrate source and carbohydrate concentration on the digestibility of macronutrients and energy in rainbow trout (*Oncorhynchus mykiss*). Aquaculture, 163: 347-359.
- Sugiura, S.D., F.M. Dong, C.K. Rathbone and R.W. Hardy (1998). Apparent protein digestibility and mineral availabilities in various feed ingredients for salmonid feeds. Aquaculture, 159: 177-202.
- Wang, Y., J.I. Guo, D.P. Bureau and G. Zheng (2006). Replacement of fish meal by rendered animal protein ingredients in feeds for Cuneate drum (*Nibea miichthioides*). Aquaculture, 252: 476-483.
- Watanabe, T., T. Takkeuchi, S. Satoh and V. Kiron (1996). Digestibility energy methodology influence and a mode of calculation. Fish. Sci., 62: 288-292.
- Zhou, Q.C., B.P. Tan, K.S. Mai and Y.J. Liu (2004). Apparent digestibility of selected feed ingredients for juvenile cobia *Rachycentron canadum*. Aquaculture, 241: 441-451.