Bangladesh J. Fish. Res., 1(1) : 65-72
Bangladesh Fisheries Research Institute

Digestible protein and energy value of fish meal, dextrin, fish oil and soybean oil for Thai sharpunti (*Puntius gonionotus* Bleeker)

M. A. Hossain, M.M. Rahman[1] and S. C. Chakraborty[1]

Department of Aquaculture
Bangladesh Agricultural University Mymensingh-2202, Bangladesh
[1]Department of Fisheries Technology, BAU, Mymensingh

Abstract

A laboratory trial was conducted to determine the digestible protein and energy value of fish meal, dextrin, fish oil and soybean oil for Thai sharpunti (*Puntius gonionotus* Bleeker). A reference diet containing 35% protein was formulated in which fish meal was the sole source of protein. Five test diets were formulated using reference diet and individual test ingredients (fish meal, dextrin, fish oil and soybean oil). Each treatment had three replicates with 15 fish per replicate. Fish were fed twice daily at the rate of 5% of their body weight. The result of the study indicated that the dietary protein in both reference and test diets were well digested and the apparent protein digestibility (APD) values of test diets ranged between 82.81 and 85.99%. The APD value of fish meal protein was 88.05%. The apparent digestible energy (ADE) value for the test ingredients ranged between 70.79 and 85.80% with soybean oil having the highest and fish meal the lowest value. The ADE values calculated in terms of Kcal/g of ingredients were 3.68, 3.22, 4.38 and 4.44 Kcal/g for fish meal, dextrin, fish oil and soybean oil respectively.

Key words : *P. gonionotus*, Protein, Energy, Fish meal

Introduction

In feed formulation and manufacture, it might be useful to have an understanding on the digestibility of main ingredients of a diet as well as the whole diet. It appears that the ingredients in question could be treated as a diet and usual digestibility determination method could be used to determine its digestibility. This is not always possible. For example, the ingredient by itself might not behave in the same way as it would as a component of a compounded diet. Alternately, the fish may not ingest the ingredients itself. Ingredients with low protein can not be used as a single protein source in a diet.

Again, for determination of optimum digestible protein to energy ratio, digestibility of protein and energy of each of the ingredient is necessary.

The method that is presently used for estimating digestibility of an ingredient was first introduced by Cho *et al.* (1974) in which a reference diet and a test diet is used. Test diet is prepared by mixing 30% or 20% of the ingredients to be tested with the reference diet. The present study was undertaken to determine the digestible protein and energy value for fish meal, dextrin, fish oil and soybean oil for Thai sharpunti (*Puntius gonionotus* Bleeker).

Materials and methods

The experimental system used in the study consisted of 15 glass aquaria of 55 l capacity. All the aquaria were kept on 1 m high platform to facilitate better observation and accessibility. An adequate level of dissolved oxygen in each aquarium was maintained through artificial aeration.

Fry of Thai sharpunti, *P. gonionotus* (Bleeker) were collected from Freshwater Station, Fisheries Research Institute (FRI), Mymensingh. After receiving fry were given prophylactic treatment with 0.5 ppm $KMnO_4$ solution for 30 minutes. Before starting the experiment, fish fry were acclimated to the experimental system for one week. The fry were fed with formulated feed containing 35% protein during acclimation period.

There were five treatments each with three replicates. Uniform sized fingerlings of Thai sharpunti were randomly distributed at the rate of 15 fish per aquarium with a mean initial weight of 4.5g. Water in each aquarium was changed partially twice daily during the removal of uneaten food or faeces.

For formulation of experimental diets, fish meal was collected from Saudi Bangla Fish Feed Ltd, Bhaluka, Mymensingh which was originally imported from Singapore. Cod liver oil was used as fish oil (Seven Seas, British Cod Liver Oils Ltd, England). Good quality soybean oil was collected from Mymensingh local market. Dextrin, alpha-cellulose and carboxymethyl cellulose were obtained from Sigma Chemical Company, England. Mineral and Vitamin premixes (Embavit Fish Premix) was collected from Rhone Poulenc (Bangladesh).

Prior to the formulation of diet, the fish meal was analysed and the proximate composition (% dry matter) was protein 65.18%, lipid 11.24%. ash 21.51%, crude fibre 0.50% and nitrogen free extract 1.57%. A basal or reference diet was formulated using fish meal as the sole source of protein (Table 1). Test diets were formulated using reference diet and individual test ingredients (Table 2). Formulated diets contained 0.5% chromic oxide to study protein digestibility. Diets were prepared by using a Hobart pellet mill (Hobart A200). Diets were subjected to proximate composition analysis and the results are shown in Table 3.

Table 1. Composition of basal or reference diet

Ingredients	Percent of ingredients
Fish meal	53.70
Dextrin	33.30
Alpha-cellulose	10.00
Binder (CMC)[1]	2.00
Vitamin-mineral premix (Embavit)[2]	1.00
Total	100.00

[1] *Carboxymethyl cellulose (high viscosity)*
[2] *Obtained from Rhone poulenc (Bangladesh)*

Table 2. Formulation of test diets

Ingredients	Diets (%)				
	Reference	Fish meal	Dextrin	Fish oil	Soybean oil
Basal mixture	99.50	79.67	9.67	89.50	89.50
Fish meal	-	19.83	-	-	-
Dextrin	-	-	19.83	-	-
Fish oil	-	-	-	10.00	-
Soybean oil	-	-	-	-	10.00
Chromic oxide	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00

Table 3. Proximate composition of the experimental diet (% dry matter)

Components	Diets				
	Reference	Fish meal	Dextrin	Fish oil	Soybean oil
Dry matter	96.32	96.62	95.92	6.12	7.08
Protein	38.57	42.22	30.94	34.73	32.45
Lipid	4.09	5.26	4.12	12.55	14.70
Ash	13.71	17.55	11.34	13.12	12.94
Crude fibre	9.38	8.46	7.79	9.20	9.48
NFE[1]	34.25	26.51	45.81	30.40	30.43
Chromic oxide	0.49	0.49	0.50	0.48	0.48
Gross energy (Kcal/g)	4.49	4.49	4.56	5.20	5.18

[1] *Nitrogen free extract calculated as 100 - %(moisture + protein + lipid+ash + crude fibre)*

Fish were fed experimental diets in the morning (at 9.00 h) and afternoon (at 17.00 h) daily at the rate of 5% of their body weight.

Faeces collection started four days after feeding to allow evacuation of all previously ingested material. Uneaten food or faeces were removed from each aquarium by siphoning after 30 minutes of feeding. Faeces were collected separately for each replicate twice daily in the morning and afternoon for four weeks. Collected faeces were dried in an oven at 60°C and kept in air- tight container for subsequent chemical analysis.

The water quality parameters such as temperature, pH and dissolved oxygen were monitored weekly and the ranges were temperature 27.5-32°C; pH 6.8-7.4 and dissolved oxygen 6.2-7.4 mg/l.

Proximate composition of the dietary ingredients, diets and faeces were analysed according to AOAC (1980). Energy content in feed and faeces were analysed by a Adiabatic Bomb Calorimeter. Chromic oxide content was determined following the wet-digestion technique of Furukawa and Tsukahara (1966). Estimates of the apparent nutrient digestibility of experimental diets were derived from the following equation (Maynard and Loosli 1969).

Apparent nutrient digestibility

$$=100 - \left(100 \times \frac{\%\ \text{Chromic oxide in feed}}{\%\ \text{Chromic oxide in faeces}} \times \frac{\%\ \text{nutrient in feed}}{\%\ \text{nutrient in faeces}}\right)$$

The apparent nutrient digestibility of the feed ingredients were estimated using the following equation (Cho *et al.* 1982).

$$\frac{100}{20}\left(\frac{\text{digestibility coefficient}}{\text{of test diet}} - \frac{80}{100}\ \frac{\text{digestibility coefficient}}{\text{of reference diet}}\right)$$

Statistical analysis of the data was performed by analysis of variance (ANOVA) followed by Duncan's New Multiple Range Test (Duncan 1955).

Results

The proximate composition of the experimental diets are shown in Table 3. The protein, lipid and energy content in different diets ranged between 32.45 to 42.22%, 4.09 to 14.70% and 4.49 to 5.20 Kcal/g respectively.

The protein, energy and chromic oxide content in faeces of fish fed experimental diets are shown in Table 4. The protein content was highest in faeces fish of fed reference diet whilst fish fed reference + soybean oil diet produced the lowest (14.14%) faecal protein.

Table 4. Protein, energy and chromic oxide content in faeces of fish fed experimental diets

	Diets				
	Reference diet	Ref. + Fish meal	Ref. + Dextrin	Ref. + Fish oil	Ref. + Soybean oil
Protein (%)	18.05	18.10	16.79	17.19	14.18
Chromic oxide (%)	1.57	1.53	1.58	1.44	1.44
Energy (Kcal/g)	4.44	4.48	4.44	4.48	4.44

The apparent protein digestibility (APD) and apparent digestible energy (ADE) value of the test diets are shown in Table 5. There was no significant difference ($P>0.05$) between the APD values of reference diet, reference + fish meal diet and reference + soybean oil diet. But these values were significantly ($P>0.05$) higher than those of reference + dextrin diet and reference + fish oil diet.

Table 5. Apparent protein digestibility and digestible energy value of experimental diets

	Diets				
Reference diet	Ref. + Fish meal	Ref. + Dextrin	Ref. + Fish oil	Ref. + Soybean oil	± S.E[2]
APD(%) 85.10[a1]	85.89[a]	82.82[b]	82.81[b]	84.82[a]	0.36
ADE(%) 68.50[a]	70.36[a]	69.19[a]	70.08[a]	70.23[a]	0.53

[1] *Figures in the same row having the same superscripts are not significantly different (P>0.05)*

[2] *Standard error of treatment mean calculated from the residual mean square in the analysis of variance*

There was no significant ($P>0.05$) differences between the ADE values of reference diet and test diets which ranged between 68.50 and 70.36%. The APD value of fish meal and ADE value of test ingredients such as fish meal, dextrin, fish oil and soybean oil are shown in Table 6. There was no significant difference ($P>0.05$) between the ADE of fish oil and soybean oil. But there was significant ($P<0.05$) difference between the ADE value of fish meal (74.69%) and dextrin (70.79%). The digestible energy (DE) values of fish meal, dextrin, fish oil and soybean oil calculated in terms of Kcal/g of the ingredients are also shown in Table 6. These values were 3.68, 3.22, 4.38 and 4.44 Kcal/g for fish meal, dextrin, fish oil and soybean oil respectively.

Table 6. Apparent protein digestibility (APD) and apparent digestible energy (ADE) values for test ingredients

	Ingredients				
	Fish meal	Dextrin	Fish oil	Soybean oil	± S.E[2]
APD(%)	88.05	-	-	-	-
ADE(%)	74.69[c1]	70.79[d]	84.30[a]	5.80[a]	0.48
DE (Kcal/g)	3.68[c]	3.22[a]	4.38[a]	4.44[a]	0.03

[1].*Figures in the same row having the same superscripts are not significantly different (P>0.05)*

[2]*Standard error of treatment means calculated from the residual mean square in the analysis of variance*

Discussion

The protein, lipid and NFE content varied between experimental diets due to the variation in the amount of test ingredients mixed with the reference diet. The ranges of water quality parameters monitored during the study period were well within the limit for fish life and could not have hampered the growth of fish (Jhingran 1983).

The result of the present study indicated that the dietary protein in both reference and test diets were well digested. The APD value of the reference diet in the present study is 85.10%. This value is similar to the value reported by Law (1984) and Khan (1994) for reference diet consisting of fish meal, soybean, copra cake, maize and rice bran for jelawat (*Leptobarbus hoevenii*) and tropical catfish (*Mystus nemurus*). The APD values of the test diets ranged between 82.81 to 85.99%. The high APD values obtained in the test diets may be due to the fact that all the test diets contained more than about 80% of the reference diet and in reference diet fish meal was the only source of dietary protein. According to NRC (1977) carp can digest up to 95% of the protein in fish meal. However, the value can decrease to 80-85% depending on the origin and processing of the fish meal used (Ogino and Chen 1973). Brown *et al.* (1985) reported an APD value of 86% for fish meal in channel fish.

In the present study, there was no significant (P>0.05) difference between the ADE value of reference diet and test diets and the values ranged between 68.50 and 70.36%. Khan (1994) reported an ADE value of 78.5% for a reference diet for *Mystus nemurus* which is higher than the value obtained in the present study (68.50%). However, ADE (68.50%) value obtained in the present study is similar to the value of 69.41% reported by Law (1984) for Jelawat (*L. hoevenii*).

The APD value of fish meal was calculated from the formula by Cho *et al.* (1982) used to calculate apparent digestibility value for test ingredients. The APD value of fish meal in this study is 88.05% which is slightly lower than the APD value of fish meal (90.81%) reported by Law (1986) for jelawat (*L. hoevenii*) but

higher than the value reported by Khan (1994) for catfish (*M. nemurus*). Nandeesha *et al.* (1991) reported a higher APD value of 90.40% for fish meal in *Catla catla* using fish meal as 30% of the reference diet. On the other hand, Hasan *et al.* (1990) reported a somewhat lower APD value of 79% for fish meal in *Labeo rohita.*

The ADE value for fish meal in the present study is similar to the value (74%) reported for rainbow trout by Windell *et al.* (1978) but lower than the value obtained by Smith *et al.*(1980) 95% and Cho *et al.* (1982) 91% for the same species. Khan (1994) also reported a somewhat higher ADE value (77.88%) for fish meal in catfish (*M. nemurus*).

The ADE value of fish oil and soybean oil were significantly higher than ADE of fish meal and dextrin (Table 6). The higher ADE value of fish oil and soybean oil might be related to the high lipid digestibility of fish oil and soybean oil. Hossain *et al.* (1992) reported 89.96% and 93.24% digestibility of lipid in fish meal and soybean meal diet respectively for tilapia (*Oreochromis mossambicus*). Singh (1991) reported a lipid digestibility of 92.10 to 98.10% for feedstuff and pelleted feed of plant origin *Cirrhinus mrigala* yearlings. He also reported a lipid digestibility of 87.10 to 96.70% for conventional and unconventional feedstuff of plant origin in grass carp *(Ctenopharyngodon idella)*

The ADE value of dextrin was the lowest (70.79%) which might be related to the digestibility of dextrin as carbohydrate source in fish feed. Hasting (1969) reported a digestion coefficient of 74.8% for dextrin as carbohydrate source in rainbow trout diet.

The result of the present experiment indicated that fish meal, fish oil, soybean oil and dextrin used as fish feed ingredients have been well digested by Thai sharpunti as dietary protein, lipid and carbohydrate source respectively. The digestible energy values in terms of Kcal/g of the ingredients are 3.68, 3.22, 4.38 and 4.44 Kcal/g for fish meal, dextrin, fish oil and soybean oil respectively.

Acknowledgements

The authors would like to acknowledge the financial support of the ODA-BAU link project in carrying out the research work.

References

AOAC, 1980. *Official Methods of Analysis*. W. Horwitz (ed.). Association of Official Analytical Chemists, 13th edition. Washington, D.C.

Brown, P.B., R.J. Strange and K.R. Robbins, 1985. Protein digestibility co-efficient for yearling channel catfish fed high protein feedstuffs. *Prog. Fish. Cult.*, **47**: 94-97.

Cho, C.Y., H.S. Bayley and S.J. Slinger, 1974. Partial replacement of herring meal with soybean meal and other changes in a diet for rainbow trout (*Salmo gairdneri*). *J. Fish. Res. Board Canada.*, **31**: 1523-1528.

Cho, C.Y., S.J. Slinger and H.S. Bayley, 1982. Bioenergetics of salmonid fishes: Energy intake, expenditure and productivity. *Comp. Biochem. Physiol.*, **73**(B): 25-41.

Duncan, D.B., 1955 Multiple Range and Multiple F-Tests. *Biometrics*, **11**: 1-42.

Furukawa, A. and H. Tsukahara, 1966. On the acid digestion method for determination of chromic oxide as an indicator substance in the study of digestibility in fish. *Bull. Japan Soc. Sci. Fish.*, **32**: 502-506.

Hastings, W.H., 1969. *Nutritional score. In:* Fish in Research (eds. O. W. Neuhans and J.E. Halver). Academic press. New York. pp. 263-292.

Hossain, M.A., N. Nahar, M. Kamal and M.N. Islam, 1992. Nutrient digestibility coefficients of some plant and animal proteins for tilapia (*Oreochromis mossambicus*). *J. Aqua. Trop.*, **7**: 257-265.

Hasan, M.R., M. Moniruzzaman and A.M. Omar Farooque, 1990. Evaluation of leucaena and water hyacinth leaf meal as dietary protein sources for the fry of Indian major carp *Labeo rohita* (Hamilton). *In* : R. Hirano and I. Hanyu (eds.) *The Second Asian Fisheries Forum*, Asian Fisheries Society, Manila, Philippines. pp. 275-278.

Jhingran, V.G., 1983. Fish and Fisheries of India. Hindustan Publishing corporation. Delhi, 666 pp.

Khan, M.S., 1994. Apparent digestibility coefficient for common feed ingredients in formulated diets for tropical catfish, *Mystus nemurus* (Cuvier and Valenciennes). *Aquacult. Fish. Manage.*, **25**: 167-174.

Law, A.T., 1984. Nutritional study of Jelawat, *Leptobarbus hoevenii* (Bleeker), fed on pelleted feed. *Aquaculture*, **41**: 227-233.

Law, A.T., 1986. Digestibility of low cost ingredients in pelleted feed by grass carp (*Ctenopharyngodon idella*). *Aquaculture*, **51**: 97-103.

Maynard, L.A. and J.K. Loosli (eds.), 1969. Animal Nutrition. 6th edition. McGraw Hill Book Company. 613 pp.

Nandeesha, M.C., G.K. Srikanth, P. Keshavanath and S.K. Das, 1991. *Protein and fat digestibility of five feed ingredients by an Indian major carp, Catla catla (Ham.). In:* S.S. De Silva (ed.) Fish Nutrition Research in Asia. Special Publication No. 5. Asian Fisheries Society. Manila, Philippines. pp. 75-81.

NRC, 1977. Nutrient Requirements of Warmwater Fishes. National Academy of Science, Washington, D. C. 78 pp.

Ogino, C. and M.S. Chen, 1973. Protein nutrition in fish III. Apparent and true digestibility of dietary protein in carp. *Bull. Japan Soc. Sci. Fish.*, **39:** 649-651.

Smith, R.R., M.C. Peterson and A.C. Allred, 1980. Effect of leaching on apparent digestion coefficients of feedstuffs for salmonids. *Prog. Fish. Cult.*, **42**: 195-199.

Windell, J.T., J.W. Foltz and J.A. Sarokon, 1978. Effect of fish size, temperature and amount fed on nutrient digestibility of a pelleted diet by rainbow trout, *Salmo gairdneri. Trans. Am. Fish. Soc.*, **107**: 613-616.

(Manuscript received 27 December 1996)