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Biochemical Composition and Nutritive Value of Common Fish Feeds Available in Cochin Area†

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The biochemical composition of some of the feeds used in aquaculture is reported. Four grower feeds and 19 other locally available feeds were used for the study. Moisture content varied from 6.3-12.4%; and protein content from 22.4 to 46.9% and mineral content varied from 5.3 to 24.2%. Some of the feeds were found to be very low in fat content (1%). Variations in the proportions of the amino acids in the grower feeds were to a limited extent only. But fatty acid analysis showed great variation among the grower feeds. $C_{18:0}$ was not detected in two of the samples. Detectable amount of $C_{18:3}$ was not present in any of the samples analyzed. The level of $C_{20:5}$ was very low in one of the samples and the same feed was with low level of $C_{22:6}$ (1.7%). The study points out the need for formulating the fish feed on the basis of the nutritional requirements of fish.

Key words: Fish feeds, amino acid composition, fatty acid profile

Aquaculture has assumed the status of a fast growing industry over the recent past, with rapid developments in seed production, breeding techniques, hatchery technology and technology for nutritive feeds. In aquaculture, many kinds of formulated supplementary fish feeds are used. The primary objective of feed formulation is to provide the species under culture with a nutritional diet to yield optimum production at minimum cost (Reddy & Rao, 1999).

Even though various commercial fish feeds are available in the market the nutritive value of most of the feeds is not known. Hence in the present study, attempts were made to determine the biochemical composition and nutritional quality of some of the locally available fish feeds. Since grower feeds are playing an important role not only in enhancing the growth rate but also in maintaining good health of the fish in aquaculture, it is necessary to carry out detailed biochemical analyses. For that purpose four important grower feeds were selected and their amino acid composition and fatty acid profile were determined.

Materials and Methods

Feed samples 1-4 were grower feeds, procured from a leading feed manufacturer. Samples of ordinary fish feeds (5-23) were obtained from the market. Feeds were finely powdered and were analyzed for moisture content, crude protein, crude fat and ash content according to standard AOAC procedures (1990).

Amino acid composition of four grower feeds (sample 1-4) was determined by hydrolyzing the samples in 6N HCl for 24 h at 110^0C. The acid was removed by vacuum evaporation, made up to a known volume with 0.05N HCl and then analyzed

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using HPLC (Ammu *et al.*, 1994). Tryptophan content of the samples was determined after alkali hydrolysis (Sastry & Tummuru, 1985).

Lipid extraction was done using Bligh and Dyer method (1959) and the fatty acid profile of the feed samples was determined by GLC, using packed column, 2mx1/8i.d., packed with 15% OV 275, on chromosorb w, flame ionization detector and carrier nitrogen (Metcalfe *et al.*, 1966). Identification and quantification of fatty acids were done using Sigma standards.

Results and Discussion

Moisture content of the feeds ranged from 6.3 to 12.4% (Table 1). The amount of moisture is an index of economic value, stability and quality of feed (Park, 1996). A very small change in the moisture content can exert a large influence on the stability of the feed during storage (Jain, 1998). As large-scale production of pelleted feeds often necessitates storage for a considerable period, the moisture content should be kept as minimum as possible, to prevent the growth of microorganisms and subsequent production of toxins (Gomez *et al.*, 1997).

Table 1. Proximate composition of the fish feeds available in Cochin area

Feed No	Moisture (%)	Protein (% of dry matter)	Crude fat (% of dry matter)	Ash (% of dry matter)
1	6.4	39.5	6.5	10.5
2	7.8	27.9	4.1	6.2
3	7.9	45.3	7.5	11.1
4	6.3	46.0	8.5	9.7
5	8.8	24.3	6.9	16.7
6	12.2	28.3	1.4	17.6
7	12.4	46.1	4.3	9.8
8	8.5	34.5	5.2	11.6
9	8.4	30.0	4.8	10.7
10	9.4	26.2	3.4	24.2
11	11.8	31.9	1.0	23.1
12	10.1	36.9	6.1	8.6
13	9.6	25.2	2.9	16.0
14	10.1	35.2	6.4	12.0
15	8.99	42.2	8.9	9.7
16	9.1	37.5	5.9	11.3
17	10.4	37.7	7.1	12.3
18	10.7	40.8	3.9	10.8
19	9.7	22.4	4.8	5.3
20	11.3	38.4	6.2	10.9
21	9.7	46.9	5.2	14.1
22	11.0	44.2	5.9	10.1
23	9.9	39.4	6.5	11.7

Protein is a structural component as well as a source of energy for aquatic organisms (Rath, 1993). Juvenile fishes require higher levels of protein for growth (Wilson, 1989). Studies conducted on the requirements of protein (Hafedh, 1999; El-Sayed & Teshima, 1991), showed that fishes had a high dietary requirement for protein ranging from 35-55% which was equivalent to 45-70% of the gross energy content of the diet. In the present study, the protein content varied widely from 22.4 to 46.9%. Of the 23 feeds analyzed, 9 samples had less than 35% protein. These wide variations in the proportion of protein in the feed indicated that the formulation of the feed was not based on the scientific facts and no care might have been taken to optimize level of protein in the feeds.

Lipids are playing an important role in energy production and serving as a source of the essential fatty acids for normal growth and survival of the fishes (Rath, 1993). Besides this they are also carriers of fat-soluble nutrients like vitamin A, D, E and K. Since lipids are important in providing energy and determining the flavor and textural properties of food, their content may affect these properties of the feed also. Further incorporation of lipid in these diets could be beneficial in increasing

the dietary energy level and in improving protein-sparing action of lipids. In the present study maximum fat content observed was 8.9 (Table 1). Some of the feeds had very low lipid content (about 1% only). According to Cowey & Sergent (1979), lipids not less than 10% and not more than 20% can be added to fish diets to attain better growth and body composition. Minerals are required in small quantity in the diet and they are very important for the proper functioning of the living system. They are to be supplied through the diet since they cannot be synthesized within the body (Agrawal, 1999). Since trace elements are growth stimulants (Rath, 1993), it is necessary to supplement fish feed with the required minerals at proper levels for better growth. A higher requirement for minerals has been reported to associate with fresh water fishes when compared to marine fishes, as the seawater is rich in most of the essential minerals (Agrawal, 1999). In the present study the mineral (ash) content varied from 5.3 to 24.2% (Table 1).

Table 2. Amino acid composition of the fish feeds (g/16g N_2) in Cochin area

Amino acid	Feed			
	1	2	3	4
Aspartate	9.5	10.7	9.6	10.5
Threonine	3.8	3.1	3.6	3.5
Serine	4.3	4.8	4.3	4.8
Glutamate	18.1	24.9	20.0	20.1
Proline	5.2	5.4	5.1	4.6
Glycine	3.5	5.5	6.1	7.0
Cysteine	-	-	0.4	0.3
Alanine	6.4	6.1	6.4	7.4
Valine	4.5	2.3	3.4	3.2
Methionine	2.3	3.3	2.5	2.4
Isoleucine	6.2	2.9	4.5	4.0
Leucine	7.6	5.7	7.9	7.8
Tyrosine	2.9	2.6	2.3	1.9
Phenylalanine	4.2	4.1	4.0	4.0
Histidine	3.3	2.6	3.1	2.6
Lysine	5.0	1.6	2.2	1.7
Arginine	6.2	5.2	6.3	5.8
Tryptophan	2.0	2.2	1.9	1.5

ANOVA single factor was used for statistical analyses, significant level $p<0.05$, $n=6$

Availability of the essential amino acids is the factor that decides the quality of the protein. Therefore information on the amino acid composition of the feed is very important for assessing its nutritional quality. Table 2 shows the amino acid composition of the four of the 23 feeds and the data show that variations in the proportions of the amino acids were to limited extent only. Branched amino acids showed significant change in their levels in different feeds. Isoleucine was found to vary to a greater extent in all the feeds analyzed, from a minimum isoleucine level of 2.9% to a maximum 6.2%. The lower availability of isoleucine, an essential amino acid, in feeds may affect the growth of the aquatic animals. The proportion of aromatic amino acid, phenylalanine was almost constant in all feeds. Among the basic amino acids, lysine content varied from 1.6% to 5.0%. Even though lysine is an essential amino acid, the higher content of this amino acid in feeds cannot be regarded as favorable as it is an antagonist to arginine (Berge *et al.*, 2002). There was significant difference in the level of histidine. Some degree of variations was noticed in the levels of sulfur containing amino acids. Methionine content varied from 2.3 to 3.3%, while cysteine was not detected in two of the feeds. Sulfur containing amino acids should be given to the fish through the diet (Rath, 1993). Cysteine can be synthesized from methionine if the latter is present in sufficient quantity (Murthy & Varghese, 1998). In the present study, such a possibility is not observed, as the methionine content is not that much high. The imino acid, proline, also did not show much deviation

in its concentration. The level of glutamic acid was comparatively high (18.1-24.9%). Since glutamic acid is a non-essential amino acid, the elevated level of this amino acid in the feed will not be of any special significance as far as its nutritive value is concerned.

Fatty acid analysis of the samples showed that there were significant differences in the proportion of the various fatty acids in the feed samples except in the cases of $C_{16:1}$ and $C_{18:1}$ (Table 3). $C_{18:0}$ was not detected in 2 samples whereas the other two samples contained 3.5-3.6%. $C_{18:2}$ was present to the extent of 38.2% of total fatty acids in one sample while the proportion of this acid was in the range of 21-23% in the other samples. Linoleic acid is an essential fatty acid, which must be given through the diet (Merican & Shim, 1996).

Table 3. Fatty acid composition of the fish feeds (in percentage of total fatty acids) available in Cochin area

Fatty acid	Feed			
	1	2	3	4
$C_{14:0}$	3.8	1.4	3.6	3.9
$C_{15:0}$	-	-	0.2	-
$C_{16:0}$	19.3	17.7	17.9	20.0
$C_{16:1}$ n7	5.9	3.8	5.5	4.7
$C_{17:0}$	-	0.5	0.8	0.7
$C_{18:0}$	3.6	-	-	3.5
$C_{18:1}$ n9	17.8	23.8	20.7	19.2
$C_{18:2}$ n6	23.4	38.2	21.4	22.3
$C_{18:3}$ n6	-	-	-	-
$C_{18:4}$ n3	0.3	-	0.3	-
$C_{20:1}$ n9	3.7	2.6	4.8	4.8
$C_{20:4}$ n6	0.8	0.4	0.8	0.5
$C_{20:5}$ n3	7.3	2.8	11.1	9.1
$C_{22:6}$ n3	5.9	1.7	7.2	6.0
$C_{24:1}$	0.4	-	0.4	0.2
Others	7.8	7.1	5.3	5.1

ANOVA single factor was used for statistical analyses, significant level $p<0.05$, $n=6$

This fatty acid is also important in the sense that higher polyunsaturated fatty acids (n-6 fatty acids) such as arachidonic acids are formed from this fatty acid by chain elongation and desaturation (Owen *et al.*, 1975). Low concentration of this fatty acid will result in decrease in the rate of growth and weight gain. Fatty acids such as $C_{20:5}$ and $C_{22:6}$, belonging to n-3 groups are of particular importance for fishes for achieving better growth rate, feed conversion and to avoid certain pathological conditions (Glencross & Smith, 2001). It is also important to note that marine fishes have a limited ability to elongate and desaturate linolenic acid ($C_{18:3}$) making it essential to supply the higher polyunsaturated fatty acids through the feed (Takeuchi *et al.*, 1990). In the present study, detectable amount of $C_{18:3}$ was not present in any of the samples analyzed. $C_{20:5}$ was present in the range of 2.8-11.1%. The feed having the lowest $C_{20:5}$ content was also deficient in $C_{22:6}$ (1.7%). The balance of n-3 and n-6 fatty acid is an important factor in fatty acid nutrition (Glencross *et al.*, 2002).

The results of this study indicate that there are wide variations in the biochemical compositions of the feeds available in the market. There seems to be no standards in formulating the feed and the proportions of vital ingredients viz, proteins, lipids, minerals etc in these feeds are not determined by any scientific principles.

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