

NUTRITIVE VALUE OF FISH MEAL

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ABSTRACT: The study was undertaken to find out the variations in the chemical composition of different types of fish meal available in the metropolitan areas of Chittagong, Bangladesh. Fifteen different types of fish meal samples were collected from study areas. Chemical analyses of the samples were carried out in triplicate for dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extract (NFE), ether extract (EE) and total ash (TA) in the animal nutrition and poultry research and training centre (PRTC) laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh. Metabolizable energy (ME) was estimated mathematically for all samples by using standard formula. Results indicated that, DM, CP, NFE, EE, TA and ME content significantly differed ($P < 0.01$) from one sample to another. However, no significant ($P > 0.05$) variation was found in the CF contents of the samples. DM content varied from 86.7 to 96.7%, CP content varied from 31.3 to 61.2%, EE content varied from 0.8 to 23.5%, NFE content varied from 0.6 to 14.6%, Ash content varied from 13.3 to 36.7% and ME content varied from 1788.4 to 3478.8 kcal/kg. It could therefore be inferred that, the chemical composition of fish meal available in the local market are widely variable. Therefore, every sample needs to be analyzed before use for ration formulation.

Keywords: Chemical Composition, Fish Meal, Metabolizable Energy, Nutritive Value.

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INTRODUCTION

Poultry industry is an emerging agribusiness started during eighties in Bangladesh. Poultry farming is an important sector which provides a large share to the increasing demand for animal protein, cash income and employment opportunities. However, the high price and non-availability of feed ingredients are two major constraints to the growth of commercial poultry enterprises. In Bangladesh, feed cost alone accounts 60-70% of the total production cost (Bulbul and Hossain, 1989). Therefore, it is important to explore quality feedstuff to enhance optimum productivity. About 80% feed stuffs used in poultry ration are imported from different countries. As a result, the cost of feed prepared for poultry using those grains are always high.

Fish meal is a ground solid product that may be obtained by removing most of the water and some of the oil from fish and fish waste (Ruiter, 1995). The main constituents of fish vary little as regards to protein and inorganic matter. Oil and water contents which make up 72-78% of the fish are highly variable in fish meal (Ruiter, 1995). Fish meal is an excellent source of protein. It is considered to be one of the best ingredients for broiler and layer ration since it enhances feed consumption, feed efficiency and egg production (Solangi et al., 2002; Naulia and Singh, 1998). The increasing demand for high quality artificial feed for various farming such as aquaculture, poultry, pig, etc. can be satisfied with fish meal production since this is a source of good quality protein (Hardy and Masumoto, 1990). The nutrient composition of fish meal always vary depending on the type and species of fish, the freshness of the fish before processing and the processing methods. According to NRC (1994), protein content of fish meal varies from 60.0 to 72.3% due to type of fish and its method of preparation. In Asian countries, fish meal is prepared from mixture of trash fish and byproducts of the canning industry resulting in a product of variable composition (Limcangco-Lopez, 1985).



Despite many advantages, the quality of fish meal is often questioned due to variation in preparation and adulteration with cheap diluents such as sand, stone, soil, fine sawdust, horns and hooves, blood meal, animal oil, prawn, poultry byproducts and wastes of tannery (Hossain et al., 2003). This unusual variation in the composition of

fish meal makes a complex situation for the formulation of practical ration. Therefore, current study was conducted to find out the variations in nutrient content of fish meal available in local market.

MATERIAL AND METHODS

Study area

The study was carried out in the peri-urban and urban areas of Chittagong, Bangladesh. The study area has a latitude of 22°21'N, longitude 91°49'E and elevation of 29 m. The area is fairly hot with annual average temperature of 25.1 °C. The variation of daily average temperature is 8.8 °C. Mean monthly temperature has a variation of 9 °C. The hottest month is May having a mean temperature of 28 °C. The coolest month is January which has a mean temperature of 19 °C. The average annual relative humidity of the area is 73.7% and average monthly relative humidity ranges from 58% in January to 86% in August. The area has an average of 2735 mm rainfall per year. There are 135 days per year with more than 0.1 mm of rainfall. The driest weather is in January when an average of 6 mm of rainfall. The wettest weather is in July when there occurs an average of 598 mm of rainfall. The longest day of the year is 13:22 hour long and the shortest day is 10:37 hour long. The current study was carried out during October to November 2013. Livestock and poultry feeds are mostly available in Pahartali, Khatungonja and Karnaphuli markets of Chittagong metropolitan areas. Almost all metropolitan farmers collect their livestock feeds from these three markets. Therefore, these three markets were selected as the study area for collection of sample.

Baseline survey

A baseline survey was conducted in the study area to find out the feasibility for availability of a wide range of fish meal samples. Different types of fish meal sample were identified in the baseline survey. Later on, they were collected in a systematic procedure for study purposes.

Collection of sample

Samples were collected by using simple random sampling technique. Fifteen feed shops were selected randomly having completely different types of fish meal. Approximately 500 grams of each fish meal was purchased from each shop. Samples were wrapped up by polythene bag and preserved in the laboratory for chemical analysis.

Preparation of sample

Samples were chopped uniformly and dried in the sun. Dried samples were subjected to grinding to make it homogenous powder. Later on, it was mixed properly and exposed to shade to cool down for sampling.

Analysis of sample

Chemical analyses of the samples were carried out in triplicate DM, CP, CF, NFE, EE and TA in the animal nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh as per AOAC (2000).

Calculation of ME

All samples were subjected to proximate analysis in triplicate. Later on, Metabolizable energy (ME) available in all the fish meal samples was calculated by using a standard mathematical formula as $ME \text{ (kcal/kg)} = 32.95 (\% \text{ crude protein} + \% \text{ ether extract} \times 2.25 + \% \text{ available carbohydrate}) - 29.20$ as per Lodhi et al. (1976).

Data analysis

Data related to chemical composition of fish meal were compiled by using Microsoft Excel 2007. Chi-square (χ^2) test was performed to analyze the data by using SPSS (2007). Statistical significance was accepted at 5% level ($P < 0.05$).

RESULTS AND DISCUSSION

Chemical composition of fish meal particularly, DM, CP, CF, NFE, EE and TA contents in different fish meal samples have been presented in Table 1. Throughout the world, fish meal has been used as poultry feed for many years. It is popular because of its high nutritional value. Fish meal is an excellent source of highly digestible protein, long chain omega-3 fatty acids (EPA and DHA) and essential vitamins and minerals. It contains all the essential

amino acids in adequate quantities required for poultry (Sing and Panda, 1990). It has high levels of essential amino acids such as lysine which is often deficient in grain products that are the typical base for most animal feeds (Hall, 1992). It also contains vitamins such as B₁₂, choline, niacin, pantothenic acid and riboflavin and is a good source of calcium (Ca), copper (Cu), iron (Fe), phosphorous (P) and other trace minerals.

Fish meal is low in fiber and easy to produce (Hall, 1992). Fish meal has high methionine and cysteine content and a high digestibility and biological value (Keller, 1990). Fish meal has ten times more available Se than soybean meal or maize (Miller et al., 1972). The balanced amino acid profile and high palatability of fish meal provides synergistic effects with vegetable proteins in the other animal diet to promote fast growth and reduce feeding cost (Hardy, 2000; Oliva and Goncalves, 2001).

Dry matter (DM)

The average DM content of fish meal estimated in this study was 92.6 % (Table 2). The maximum and minimum DM percent obtained in current study were 96.7% and 86.7% respectively. The result is in close agreement with earlier studies where it was 92.06% (Rostagno et al., 2011), 92% (Labier and Leclercq, 1994; NRC, 1994), 91.8% (Gohl, 1980) 91.7% (Kifer et al., 1968). However, the result slightly differs with the findings of other investigators (Table 3) who reported it 94.5% (Moghaddam et al., 2007), 90.7% (Devendra, 1979), 90.0% (Verma 2006; Leeson and Summers, 2008; Ruiter 1995, Preston, 2012), 88% (Reddy et al., 2001), 86.0% (Heuser, 1946), 85.1% (McDonald et al., 1995).

Crude protein (CP)

The average CP content of fish meal estimated in this study was 49.2% (Table 2). The maximum and minimum CP percent obtained in current study were 61.2% and 31.3% respectively. The result is in line with earlier studies where it was 55.0% (Verma, 2006), 54.6% (Rostagno et al., 2011), 54.7% (Devendra, 1979), 54.0% (Reddy et al., 2001). However, the result differs with the findings of other investigators who reported it 73.0% (McDonald et al., 1995), 72.0% (Ruiter, 1995; Labier and Leclercq, 1994), 70.5% (Gohl, 1980), 66.0% (Preston, 2012), 65.0% (North and Bell, 1990), 64.2% (NRC, 1994), 62.0% (Kifer et al., 1968), 60.0% (Leeson & Summers, 2008; Hesuer, 1994), 59.1%, (Moghaddam et al., 2007).

Crude fiber (CF)

The average CF content of fish meal estimated in this study was 5.3% (Table 2). The maximum and minimum CF obtained in current study was 10.0% and 5.0% respectively. The result is in close agreement with earlier studies where it was 4.1% (Devendra, 1979). However, the result differs with the findings of other investigators who reported it 1.1% (Gohl, 1980), 1.0% (Preston, 2012; NRC, 1994), 0.9% (Reddy et al., 2001), 0.62% (Moghaddam et al., 2007), 0.5% (North and Bell, 1990).

Ether extract (EE)

The average EE content of fish meal estimated in this study was 10.7% (Table 2). The maximum and minimum EE percent obtained in current study were 23.5% and 0.8% respectively. The result is in close agreement with earlier studies where it was 12.0% (Ruiter, 1995), 10.2% (Kifer et al., 1968). However, the result differs with the findings of other investigators who reported it 22.9% (Moghaddam et al., 2007), 9.0% (Preston, 2012), 7.5% (Rostagno et al., 2011), 7.0% (Reddy et al., 2001; Donald et al., 1995), 5.3% (Devendra, 1979), 5.2% (Gohl, 1980), 5.0% (Heuser, 1946; NRC, 1994), 2.0% (Leeson and Summer, 2008).

Nitrogen free extract (NFE)

The average NFE content of fish meal estimated in this study was 4.9% (Table 2). The maximum and minimum NFE percent obtained in current study were 14.6% and 0.6% respectively (Table 2). The result is in close agreement with earlier studies where it was investigators who reported it, 6.0% (Devendra, 1979), 4.4% (Reddy et al., 2001). However, the result differs with the findings of other 6.4% (Gohl, 1980).

Total ash (TA)

Fish meal has a high biological value in poultry not only as a protein source but also as source of minerals such as Ca and P and trace elements such as Se or I. The average Ash content of fish meal estimated in this study was 21.8% (Table 2). The maximum and minimum TA percent obtained in current study were 36.7% and 3.3% respectively. The result is in close agreement with earlier studies where it was 22.74% (Rostagno et al., 2011), 21.9% (Reddy et al., 2001), 20.0% (Preston, 2012). However, the result differs with the findings of other investigators who reported it 29.8% (Devendra, 1979), 18% (Kifer et al., 1968), 17.0% (Labier and Leclercq, 1994).

16.8% (Gohl, 1980), 14.0 % (Ruiter, 1995), 13.2% (Moghaddam et al., 2007), 10.0% (North and Bell, 1990), 7.4% (NRC, 1994), 5.0% (Heuser, 1946), 2.5% (Verma, 2006).

Table 1 - Chemical composition (%) of individual fish meal

Sample no.	Proximate components (%)						
	DM	ME	CP	CF	NFE	EE	TA
1	86.7	1788.4	36.2	5.0	0.6	8.1	36.7
2	86.7	2228.0	48.2	5.0	2.0	8.1	23.3
3	96.7	2563.6	54.1	5.0	6.0	8.3	23.3
4	90.0	1853.7	36.1	5.0	11.2	4.4	33.3
5	96.7	2161.6	31.3	5.0	14.5	9.2	36.7
6	90.0	2409.1	55.6	5.0	2.2	7.2	20.0
7	96.7	3410.0	50.9	5.0	0.6	23.5	16.7
8	96.7	3478.8	46.6	5.0	9.3	22.5	13.3
9	90.0	2090.5	61.2	10.0	1.3	0.8	16.7
10	90.0	2557.1	58.6	5.0	1.6	8.1	16.7
11	96.7	2436.3	55.8	5.0	1.3	7.9	26.7
12	90.0	2208.8	46.7	5.0	9.9	5.0	23.3
13	96.7	2082.6	52.8	5.0	0.9	4.6	33.3
14	90.0	2730.6	53.9	5.0	8.1	9.7	13.3
15	95.6	2739.8	50.2	5.0	3.6	13.4	23.4

ME=Metabolizable energy (kcal/kg); DM=Dry matter; CP=Crude protein; CF=Crude fibre; NFE=Nitrogen free extract; EE=Ether extract; TA=Total ash

Table 2 - Analytical values for chemical composition (%) of fish meal

Parameter	Statistical range				Sig.
	Maximum	Minimum	Mean	SEM	
DM (%)	96.7	86.7	92.6	1.0	**
CP (%)	61.2	31.3	49.2	2.2	*
CF (%)	10.0	5.0	5.3	0.3	NS
EE (%)	23.5	0.8	10.7	2.4	**
NFE (%)	14.6	0.6	4.9	1.2	**
Ash (%)	36.7	13.3	21.8	2.8	**
ME (kcal/kg)	3478.8	1788.4	2449.3	22.2	***

ME=Metabolizable energy (kcal/kgDM); DM=Dry matter; CP=Crude protein; CF=Crude fibre; NFE=Nitrogen free extract; EE=Ether extract; SEM=Standard error of the mean; NS=Non-significant (P>0.05); **=Significant at 1% level (P<0.01); ***=Significant at 0.1% level (P<0.001)

Table 3 - Chemical composition of fish meal found elsewhere in the world

Investigators	Proximate components (%)					
	DM	CP	CF	NFE	EE	TA
Devendra (1979)	90.7	54.7	4.1	6.0	5.3	29.8
Gohl (1980)	91.8	70.5	1.1	6.4	5.2	16.8
Heuser (1946)	86.0	60.0	-	-	5.0	5.0
Kifer et al. (1968)	91.7	62.0	-	-	10.2	18.0
Labier and Leclercq (1994)	92.0	72.0	-	-	-	17.0
Leeson and Summers (2008)	90.0	60.0	-	-	2.0	-
McDonald et al. (1995)	85.1	73.0	-	-	7.0	-
Moghaddam et al. (2007)	94.5	59.1	0.6	-	22.9	13.2
North and Bell (1990)	-	65.0	0.5	-	-	10.0
NRC (1994)	92.0	64.2	1.0	-	5.0	7.5
Preston (2012)	90.0	66.0	1.0	-	9.0	20.0
Reddy et al. (2001)	88.0	54.0	0.9	4.4	7.0	21.9
Rostagno et al. (2011)	92.1	54.6	-	-	7.5	22.7
Ruiter (1995)	90.0	72.0	-	-	12.0	14.0
Verma (2006)	90.0	55.0	-	-	-	2.5

DM=Dry matter; CP=Crude protein; CF=Crude fibre; NFE=Nitrogen free extract; EE=Ether extract; TA=Total ash

CONCLUSION

Fish meal is a vital component of the traditional maize soybean based broiler and layer ration. There is no doubt that, inclusion of fish meal in livestock ration will substantially enhance production of livestock and poultry. However, current study indicates that the quality of fish meal is variable. Therefore, to formulate least cost balanced ration, if aimed to incorporate, fish meal must be analyzed in the laboratory and then include it into the ration.

Competing interests

The authors declare that they have no competing interests.

REFERENCES

- AOAC (2000). Official Methods of Analysis. Association of Official Analytical Chemists. 17th edn, Gaithersburg, Maryland, USA.
- Blair R (2008). Nutrition and feeding of organic poultry. Cabi Series, CABI, Wallingford, UK.
- Bulbul SM and Hossain MD (1989). Probable problems of poultry feed formulation in Bangladesh. *Poult. Adviser*, 12(3): 27-29.
- Devendra C (1979). Malaysian feeding stuffs. Malaysian Agricultural Research and Development Institute (MARDI), Serdang, Selangor. 45 pp.
- Gohl B (1980). Tropical feeds. FAO Animal Production and Health Series, (12): 529.
- Hall GM (1992). Fish processing technology. In: Ockerman HW (eds). Fishery byproducts. VCH publishers, New York.
- Hardy RW and Masumoto T (1990). Specifications for marine byproducts for aquaculture. Proceedings of the International Conference of Fish Byproducts. Alaska Sea Grant College Program. Anchorage, AK. Pp. 109-120.
- Hardy WR (2000). New Development in Aquaculture Feed Ingredients and Potential of Enzyme Supplements. In: Cruz-Suarez LE, Marine-Ricque, Salazar Tapia-M, Olvera-Novoa MAY and Cereceb-Civera R (eds.) *Advances en Nutricion Acuicola V. Memorias del V symposium Internacional de Nutricion Acuicola*. Merida, Yucatain, Mexico. Pp. 216-226.
- Hartel H, Ebersdobler H and Zucker H (1968). The Effect of Methionine Supplementation in Chick rearing rations with different protein carriers and protein concentrations. *Archives filr geflugelkunde*, 33(5): 332-343.
- Heuser FG (1946). *Feding Poultry*. 2nd edn., John Willy & Sons, Inc. London Chapman & Hall Limited, Cornell University Ithaca, New York.
- Hossain MH, Ahmad MU and Howluder MAR (2003). Replacement of fish meal by broiler offal in broiler diet. *Int. J. Poult. Sci.*, 2(2): 159-163.
- Kabiri A (2006) The Effect of Varying Fish meal Inclusion Levels (%) on Performance of Broiler Chick. *Int. J. Poult. Sci.*, 5(3): 255-258.
- Keller S (1990). Making profits out of seafood wastes. In: Hardy RW and Masumoto T eds. Specifications for marine by-products for aquaculture, Alaska. Pp. 109-120.
- Kifer RR and Snyder DG (1968). Chemical com-position and biological evaluation of fish meal. Proceedings of the Second World Conference on Animal Production. Pp. 470.
- Labie M and B Leclercq (1994). *Nutrition Feeding of Poultry*, Nottingham University Press Nottingham, England.
- Leeson S and Summer JD (2005). *Commercial Poultry Nutrition* 3rd edn., University books Guelph, Ontario, Canada.
- Limcangco-Lopez PD (1985). Legislation and quality control of feeds: The experience of Asian countries. In: Proceedings of the FAO Expert Consultation on the Substitution of Imported Concentrate Feeds in Animal Production Systems in Developing Countries, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.
- Lodhi GN, Daulat Singh and Ichhponani JS (2009). Variation in nutrient content of feedingstuffs rich in protein and reassessment of the chemical method for metabolizable energy estimation for poultry. *J. Agric. Sci.*, 86(2): 293-303.
- March BE, Biely J and Tarr HL (1967). The Effect of Fish meal supplementation of Chicken Breeder Rations on Hatchability. *Poult. Sci.*, 46(6): 1532-1536.
- McDonald P, Edwards RA, Greenhalgh JFD, and Morgan CA, (1995). *Animal Nutrition*, 5th edn., Person Education Ltd. Harlow, United Kingdom.
- Miller D, Soares Jr JH, PE Bauersfeld Jr P and Cuppet SL (1972). Comparative selenium retention by chicks fed sodium selenite, selenomethionine, fish meal and fish solubles. *Poult. Sci.*, 51(5): 1669-1673.
- Moghaddam HN, Mesgaran MD, Najafabadi HJ and Najafabadi RJ (2007). Determination of chemical composition, mineral contents and protein quality of Iranian Kilka fish meal. *Int. J. Poult. Sci.*, 6: 354-361.
- Naulia U and Singh KS (1998). Effect of dietary fish meal and phosphorus levels on the performance, egg quality and mineral balances in layers. *Indian J. Poult. Sci.*, 33(2): 153-157.
- North DM and Bell D (1990). *Commercial Chicken Production Manual*, 4th edn., Chapman and Hall, New York, NY.
- NRC (1994). *Nutrient Requirement of Poultry*. 9th edn., National Academy Press, Washington, DC, USA.
- Oliva, TA and Goncalves P (2001). Partial replacement of fish meal by brewers yeast (*Saccaromyces cerevisiae*) in diets for sea bass (*Dicentrachus labax*) juveniles Aquaculture, 202: 269-278.
- Preston RL (2012). Feed Composition Tables [Online] Available From: <http://beefmagazine.com/datasheet/2012-feed-composition-tables> [Accessed 13th Aug. 2012].

- Reddy RV, Rao SVR And Rao AN (2007). Feed composition Table. In: Reedy RV, Bhosale DT (eds). Hand Book of Poultry Nutrition. New Delhi, India: American Soybean Association.
- Rostagno SH, Albino TFL, Donzele LJ, Gomes CP, Oliveira FR, Lopes CD, Ferreira SA, Barreto TLS and Euclides FR (2011). Composition of Feedstuffs and of Vitamine and Mineral Supplements. In: Rostagno SH (eds.) Brazilian Tables for Poultry and Swine-Composition of Feedstuffs and Nutritional Requirements. 3rd edn., Vicosa, MG, UFV, DZO. pp. 21-94.
- Ruiter A (1995). Fish and fishery products composition, nutritive properties and stability. In: Schmidtdorff W eds. Fish meal and fish oil-not only by-products, United Kingdom, Biddles Limited. 347-376 pp.
- Singh KS and Panda B (1990). Poultry Nutrition. 1st edn., Kalyani Publishers, New Delhi, India.
- Solangi AAA, Memon TA, Qureshi HH, Leghari GM Baloch and MP Wagan (2002). Replacement of fish meal by soybean meal in broiler ration. J. Anim. Vet. Adv., 1(1): 28-30.
- SPSS (2007). SPSS for Windows, Version 16.0, SPSS Inc, Chicago.
- Stata (2009). Stata Statistical Software, Version 11C, TX: StataCorp LP, College Station, USA.
- Verma NV (2006). Text Book of Animal Nutrition. 2nd edn., Kalyani Publishers, New Delhi, India.