**Nutritive Value of Fish Meal**



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Submitted to the Faculty of Veterinary Medicine, Chittagong Veterinary and Animal Sciences University in partial of the requirement for the fulfilment of the degree of Doctor of Veterinary Medicine (DVM)

Approved as to style and contents by

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**Nutritive Value of Fish Meal**

**1. Abstract**

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The study was conducted to find out the variations in the chemical composition of different types of fish meal available in different 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 moisture, dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extract (NFE), ether extract (EE) and total ash (TA) in the animal nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh. Metabolizable energy (ME) was calculated 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%, CF content varied from 5.0 to 10.0%, 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.

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**2. 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 rational feedstuff to enhance 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 always stand 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.

**3. Materials and Methods**

**3.1 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 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.

**3.2 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.

**3.3 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.

**3.4 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.

**3.5 Analysis of sample**

Chemical analyses of the samples were carried out in triplicate for moisture, dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extracts (NFE), ether extracts (EE) and total ash in the animal nutrition laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh as per **AOAC (2000).**

**3.6 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 (kcal/kg) = 32·95 (% crude protein + % ether extract × 2·25 + % available carbohydrate)-29·20 as per **Lodhi *et al.* (1976).**

**3.7 Data analysis**

Data related to chemical composition of fish meal were compiled by using Microsoft Excel 2007. Chi-square (χw²) test was performed to analyze the data by using **SPSS (2007)** and **Stata (2009)**. Statistical significance was accepted at 5% level (P<0.05).

**4. Results and Discussion**

Chemical composition of fish meal particularly, dry matter (DM), crude protein (CP), crude fiber (CF), nitrogen free extracts (NFE), ether extracts (EE) and total ash 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.

**Table 1. Chemical composition (%) of individual fish meal**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sample no. | Proximate components (%) | | | | | | |
| DM | ME1 | 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 |

1ME=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

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 soyabean 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)**.

**4.1 Dry matter**

The average dry matter content of fish meal estimated in this study was 92.6 % (Table 2). The maximum and minimum dry matter 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).

**4.2 Crude protein**

The average crude protein content of fish meal estimated in this study was 49.2% (Table2). The maximum and minimum dry matter 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).

**4.3 Crude Fiber**

The average crude fiber content of fish meal estimated in this study was 5.3% (Table 2). The maximum and minimum dry matter percent obtained in current study were 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).

**4.4 Ether extract**

The average ether extract content of fish meal estimated in this study was 10.7% (Table 2). The maximum and minimum dry matter 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).

**4.5 Nitrogen free extract**

The average Nitrogen free extract content of fish meal estimated in this study was 4.9% (Table 2). The maximum and minimum dry matter 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).

**4.6 Total ash**

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 dry matter 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).

**5. 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.

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