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# Nutrient content of meat and bone meal available in the market of Chittagong district of Bangladesh

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## Abstract

Meat and bone meal (MBM) is a potential source of animal protein for poultry. The study was undertaken to investigate the variations in the chemical composition of MBM available in different feed markets of Chittagong, Bangladesh. Secondary data from one hundred ten different MBM samples were analyzed in triplicate for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and total ash (TA) in the Poultry Research and Training Centre laboratory of Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh during 21st October 2014 to 2nd December 2016. Data were collected, compiled and analyzed. Results indicated that, there were wide ranges of variations in the chemical compositions for different parameters. DM varied from 91.9 to 98.7% and CP varied from 18.5 to 74.5%. Similarly, CF varied from 1.1 to 2.9% and EE varied from 7.5 to 45.0%. TA varied from 4.8 to 33.6%. There was a strong negative relationship between CP and TA (r=-0.831; $R^2$=0.691; P<0.001). However, DM and TA were positively correlated (r=0.374; $R^2$=0.139; P=0.003). It was concluded that, chemical composition of MBM is widely variable. Wet chemistry analysis is suggested before inclusion of MBM in the diets of dairy, poultry and pet animals.

**Key words:** ash, crude protein, crude fiber, dry matter, ether extract, meat and bone meal

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## Introduction

Meat and bone meal (MBM) is a potential feed supplement for dairy, poultry and pet animals (Dale, 1997; Parsons *et al*., 1997; Liu, 2000; Hendriks, 2002; Ziggers, 2010; Jacob, 2015; Moutinho *et al*., 2017). This is a rendered product derived from mammalian tissues including bone, exclusive of added blood, hair, hoof, horn, hide trimmings, manure, stomach and rumen contents except in such amounts as may occur unavoidably in good processing practices (Meeker, 2009). MBM is a good source of protein (48-52%), fat (8-12%) and ash (33-35%) which has widely been utilized as a protein source in animal and pet foods to improve the quality of livestock feed (Kratzer and Davis 1959; Hendriks *et al*., 2002). MBM may contribute up to 30% of the dietary protein supply in poultry and pig ration. Besides being a valuable protein source, MBM also serves as a vital source of energy, calcium, phosphorus and other trace minerals (Hendriks *et al*., 2002) and can successfully replace up to 50% of the dietary fish meal (Yang *et al*., 2004). Raw materials used for MBM come mainly from the slaughter house by-products of pig, cattle and sheep and their main components are residual bone, skin, fat, offal and meat after removal of the edible parts using advanced processing technology and high temperature sterilization to make the organic components more absorbable and palatable to the animals (Parsons *et al*., 1997; Jayathilakan *et al*., 2012). There are different types of MBMs in the market. High quality MBM usually contains a minimum of 50% crude protein. However, low quality MBM contains a minimum of 45% protein (Meat and Livestock Australia, 2003). In poultry diets, MBM is typically limited to less than 5% (Sell, 1996) of the dietary protein content because of high calcium, phosphorus and lysine content. Poultry industry consumes most of the MBM produced in Brazil (Sartorelli *et al*., 2003). The main export markets of MBM are Asia, Australasia, Central South America, Eastern Europe, Mid East Africa, North America and West Europe. MBMs produced in the United Kingdom and Europe show wide variability in the crude protein, fat and ash contents (Skurray and Herbert, 1974; Jayathilakan *et al*.,

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2012). Additionally, true illeal digestibility, biological value and net protein utilization of MBMs are affected by the type of offal used (Dawson and Savage, 1983). Reasonably, there may have considerable variations in the nutrient contents of MBM. In Bangladesh, feed cost alone accounts 60-70% of the total production cost (Bulbul and Hossain, 1989). The high price and non-availability of feed ingredients are two major constraints to the growth and production of poultry. Therefore, it is important to explore high quality feedstuff to enhance optimum productivity of livestock in a cost effective way (Chang *et al*., 2015). MBM, in this regards, may play a vital role by minimizing feed cost. The demand for high quality MBM is increasing gradually in the global market (Muirhead, 1996; Narodoslawsky, 2003). As the production and demand of MBM is increasing day by day, variations in the nutrient contents of MBM are also increasing. For optimum commercial use of MBM in feed, it is essential to ensure chemical composition of MBM. The current study, therefore, aims to investigate variations in the chemical composition of MBM to formulate balanced ration for poultry, pet and other monogastric animals.

## Materials and Methods

### Study area

The study was carried out in the Department of Animal Science and Nutrition, Faculty of Veterinary Medicine, Chittagong Veterinary and Animal Sciences University, Khulshi, Chittagong-4202, Bangladesh during January to June of 2017.

### Collection of data

During January to March, data related to proximate analysis of 110 MBM samples were collected. Name of the company, address, sample ID, receive data, DM, CP, CF, EE and TA parameters were collected from laboratory register during 21$^{st}$ October 2014 to 2$^{nd}$ December 2016. Finally, data were entered into an electronic spreadsheet, sorted and compiled for statistical analysis. Sorting was done according to date of receiving sample. After entering data into the spreadsheet, integrity of the data set was checked. Data missing with CP value (Although contained DM, CF, EE and TA) were not considered for the study purpose. The final database consisted of 110 samples. Out of 110 samples, 62 were selected for linear regression as they contained most of the proximate parameters (DM, CP, EE and TA) of interest.

### Data analysis

Data were analyzed for descriptive statistics (mean, median, mode, maximum, minimum, standard deviation and standard error) for DM, CP, CF, EE and TA. One sample t-test was carried out using reference value to analyze the data in Stata (Stata/SE 14.1, StataCorpLP, 4905 Lakeway Drive, College Station, TX77845, USA). CP was predicted from TA, DM, EE using simple linear regression. Associations between CP, TA, DM and EE were determined using Pearson's correlation coefficient. Statistical significance was accepted at $P<0.05$.

## Results

### Dry matter (DM)

The DM contents did no differ ($p>0.05$) among MBM samples. The average DM content of MBM in this study was 94.1%. The maximum and minimum DM percent were 98.7% and 91.9% respectively (Table 1).

### Crude protein (CP)

The CP contents differed significantly ($p<0.001$) among the supplied samples. The average CP content of MBM was 53.0%. The maximum and minimum CP percent obtained in current study were 74.5% and 18.5% respectively (Table 1).

### Crude fiber (CF)

The CF contents were similar ($p>0.05$) among the samples. The average CF content of MBM was 2.6%. The maximum and minimum CF percent obtained in current study were 2.9% and 1.1% respectively (Table 1).

**Table 1.** Chemical composition (%) of meat and bone meal (N=110).

| Parameter | Min. | Max. | Mean | Median | Mode | STD | SE | P-value |
|---|---|---|---|---|---|---|---|---|
| Dry matter | 91.9 | 98.7 | 94.91 | 95.0 | 95.0 | 1.89 | 0.24 | 0.102 |
| Crude protein | 18.5 | 74.5 | 53.0 | 52.6 | 60.5 | 9.03 | 0.86 | <0.001 |
| Crude fiber | 1.1 | 2.9 | 2.6 | 2.8 | 2.8 | 0.72 | 0.29 | 0.870 |
| Ether extract | 7.5 | 45.0 | 15.6 | 14.1 | 22.0 | 5.98 | 0.75 | <0.001 |
| Ash | 4.8 | 33.6 | 20.0 | 22.7 | 27.0 | 8.91 | 1.13 | <0.001 |

### Ether extracts (EE)

The EE contents differed significantly (p<0.001) among the samples. The average EE content of MBM was 15.6%. The maximum and minimum EE percent obtained in current study were 45% and 7.5% respectively (Table 1).

### Total ash (TA)

The TA content differed significantly (p<0.001) among the samples. The average TA content of MBM in this study was 20.0%. The maximum and minimum TA percent obtained in current study were 33.6% and 4.8% respectively (Table 1).

### Relationship among CP, TA, DM and EE

Regression coefficient for prediction of CP from TA was moderate ($R^2$=0.691) with a negative slope (-0.724). There was a strong reverse relationship (r=-0.831; P<0.001) between CP and TA (Figure 1). However, the CP and DM was weak and negatively correlated (r=-0.047; $R^2$=0.002; P=0.718) (Figure 2). Similarly, association between CP and EE were also negative (r=-0.031; $R^2$=0.000; P=0.813) (Figure 3). In contrast, the relationship between DM and TA was positive (r=0.374; $R^2$=0.139; P=0.003) (Figure 4).

**Figure 1**. Relationship between total ash and crude protein contents in MBM (N=62)

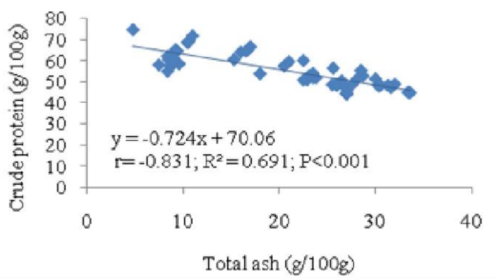



**Figure 2**. Relationship between dry matter and crude protein contents in MBM (N=62)

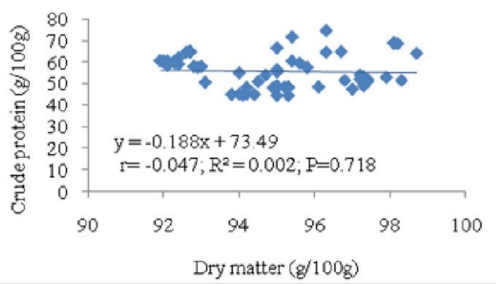



**Figure 3**. Relationship between ether extracts and crude protein contents in MBM (N=62)

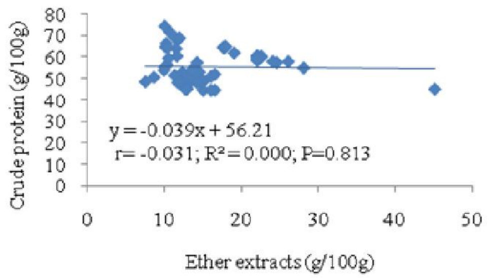
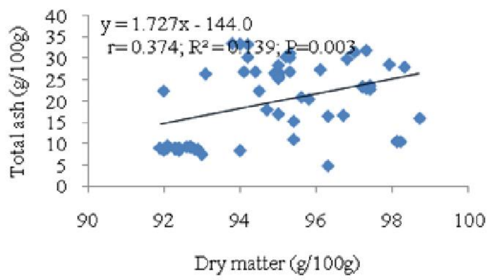


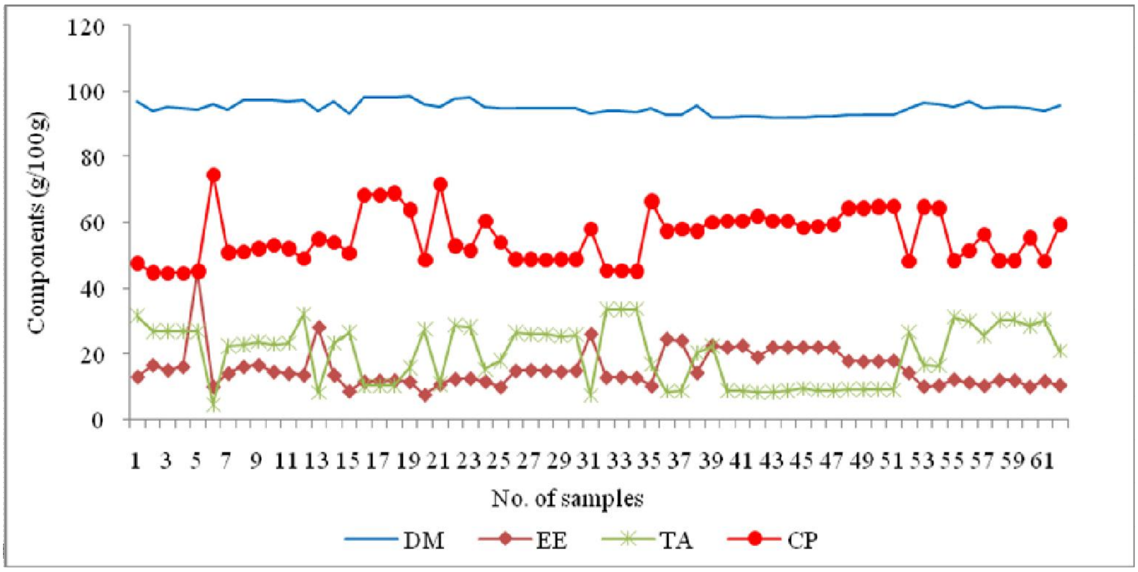

**Figure 4**. Relationship between dry matter and total ash contents in MBM (N=62)




## Discussion

### Variations in the nutrient content of MBM

The chemical composition of MBM may be influenced by the type of raw materials (Bremner, 1976), the rendering process (Kondos and McClymont, 1972; Batterham *et al*., 1986) and the processing conditions (Skurray and Herbert, 1974; Knabe *et al*., 1989; Donkoh *et al*., 1994; Wang and Parsons, 1998; Shirley and Parsons, 2001). In present study, wide ranges of variations in the DM contents of MBM were observed. The results are in line with previous studies where DM was reported to be 95.0% (Wapak, 1848) 95.4% (Hendriks *et al*., 2002), 94.3% (Nash and Mathews, 1971), 95.3% (Hendriks *et al*., 2004). However, the result slightly differs with the findings of other investigators who reported 93.0% (Jacob, 2015), 96.9% (Garcia *et al*., 2006) and 88.8-97.0% (Ziggers, 2010) DM in MBM. Throughout the world, MBM has been used as a good source of protein in poultry, cattle and pet food for many years. However, CP contents in MBM are widely variable. The average CP content in present study was 53% which is in well agreement with earlier studies where it was reported 53.0% (Moutinho *et al*., 2017), 54.0% (Nash and Mathews, 1971) and 49%-52.8% (Ziggers, 2010).




However, the result differs with the reports of other investigators who reported 55.0% (Jacob, 2015), 56.6% (Garcia *et al*., 2006), 56.8% (Hendriks *et al*., 2002), 48%-56% (Parsons *et al*., 1997), 58% (Wapak, 18848) and 56.7% (Hendriks *et al*., 2004).

The CF and EE contents in MBM may also vary. The variations of CF obtained in present study are in line with previous studies where CF was 2.5% (Jacob, 2015). However, the result differs with the findings of other investigators who reported it 4.5% (Wapak, 18848), 12.0% (Nash and Mathews, 1971). Besides, CF, the result of EE is also aligned with earlier studies where EE was 12.2% (Garcia *et al*., 2006). However, the result differs with the findings of other investigators who reported it 7.2% (Jacob, 2015), 10.0% (Hendriks *et al*., 2002), 8.5%-14.8% (Ziggers, 2010) and 10.0% (Hendriks *et al*., 2004).

Remarkable differences among the TA% of different MBM samples were noticed globally. The current result of TA contents is in line with previous studies where TA was 25.3% (Garcia *et al*., 2006). However, the result differs with the findings of other investigators who reported it 27.0% (Moutinho *et al*., 2017), 28.4% (Hendriks *et al*., 2002), 29.2% (Nash and Mathews, 1971), 28.1% (Hendriks *et al*., 2004). Increasing bone ash content has been reported by Dale (1997) and Wang and Parsons (1998) to have a negative effect on protein and energy concentration. Higher ash levels in MBM are associated with a lower nutritional quality of MBM protein (Johnson and Parsons, 1997; Hendriks *et al*., 2002). It is also reported that, a high level of TA in MBM may be a disadvantage as it may interfere with digestion and absorption of amino acids and decrease protein quality (Summers *et al*., 1964; Sathe and McClymont, 1964). High levels of ash in MBM may have negative effects on digestibility of other nutrients such as fat and energy (Liu, 2000). The higher level of ash in MBM can be a challenge to formulate pet food (Olukosi and Adeola, 2009).

**Association between TA, CP and EE**

Typical levels of readily available calcium and phosphorus in MBMs are 7.5% and 5.0. The high levels of ash in MBM are a challenge to formulate ration for pet foods since they contain more than 30.0% protein (Olukosi and Adeola, 2009). Although, increasing levels of ash in meat and bone meal have not been shown to lower protein digestibility, however, it decreases the amount and quality of protein (Butnariu and Caunii, 2013). It also leads to the decreased amount of essential amino acids and a higher proportion of non-essential amino acids (Sulabo and Stein, 2013). Increased ash content has also been shown to have a negative effect on protein and energy concentrations (Dale, 1997; Mendez and Nick, 1998; Wang and Parsons, 1998). It was reported that 83% of the protein in bone is collagen (Eastoe and Long, 1960). Collagen and gelatin are deficient in most of the essential amino acids (Boomgaardt and Baker, 1972; Berdanier, 1998). Therefore, any increase in ash content of the raw materials may have negative effect on protein quality due to its high collagen content and poor amino acid balance.

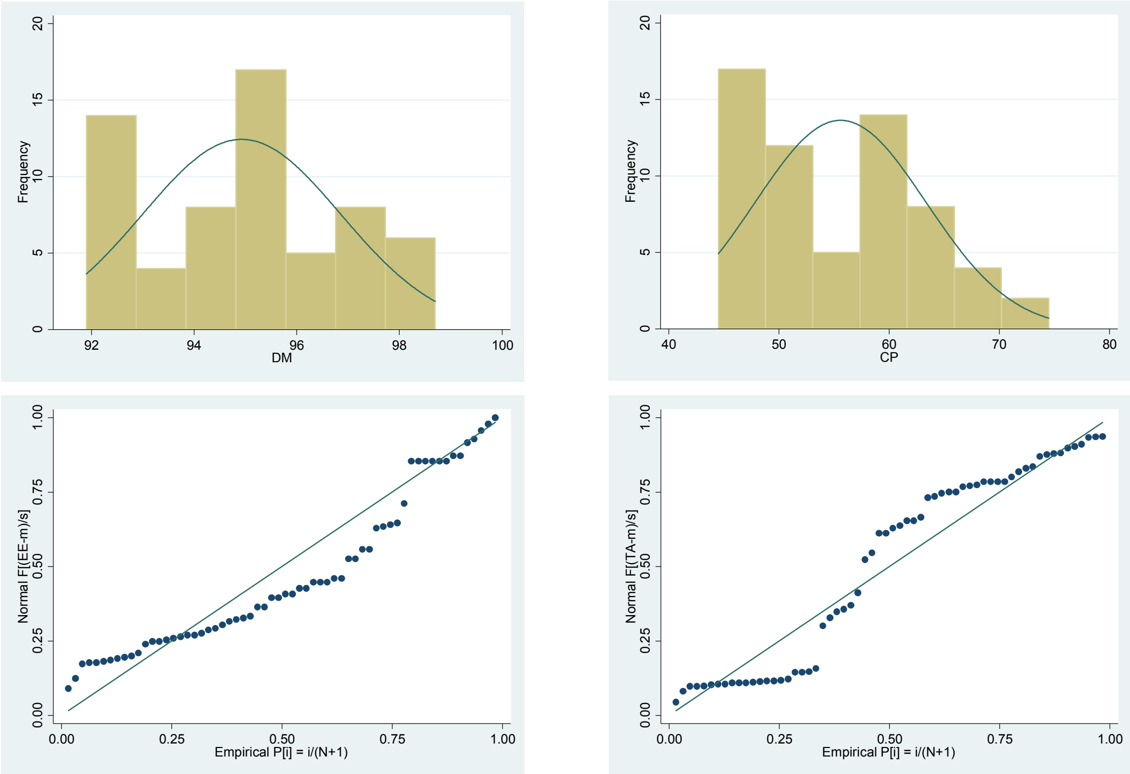



**Figure 6.** Distribution of DM and CP in a normal density curve and EE and TA in a normal probability plot

It is assumed that, some decrease in protein quality with increased ash will occur due to the changes in amino acid concentrations. In addition, an increase in ash could further decrease protein quality if bioavailability of amino acids is reduced. The effects of ash content on amino acid digestibility are unknown. In previous studies, protein efficiency ratio decreased from 1.70 to 1.0 as ash content increased from 24.0 to 35.0% (Johnson and Parsons, 1997; Johnson *et al*., 1998). It was reported that, CP and gross energy content of the MBM decreased as ash contents increased, whereas the Ca and P contents increased as ash content increased (Dale, 1997; Johnson and Parsons, 1997; Johnson *et al*., 1998; Mendez and Nick, 1998; Wang and Parsons, 1998; Shirley and Parsons, 2001; Hendriks *et al*., 2002). It was concluded that, a high level of ash in MBM interferes the digestion and absorption of amino acids (Summers *et al*., 1964; Sathe and McClymont, 1964) and affect the digestibility of other nutrients (carbohydrate, fat and vitamins). Similarly, high levels of dietary calcium available in MBM may tie up dietary fat in the intestine through production of stable calcium soaps, reducing its availability to the chick and consequently the available energy in the diet (Atteh and Leeson, 1983).

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## Conflicts of interest

We, the affiliated authors whose names are mentioned in the manuscript, hereby, clearly certify that, we have NO affiliations with or involvement in any organization or entity with any financial interest or non-financial interests in the subject matter or materials discussed in this manuscript.

## Conclusion

Current study indicates that, the quality of MBM is variable. Therefore, to formulate least cost balanced ration, MBM must be analyzed first in the laboratory and then incorporate it into dairy, poultry and pet rations.

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