

Metabolizable Energy and Chemical Composition of Poultry by-Product Meal

Research Article

A. Zarei^{1*}, M. Mohammadi¹ and B. Hemmati¹¹ Department of Animal Science, Karai Branch, Islamic Azad University, Karai, Iran

Received on: 25 Dec 2013

Revised on: 17 Jan 2014

Accepted on: 30 Jan 2014

Online Published on: Dec 2014

*Correspondence E-mail: a-zarei@kiau.ac.ir

© 2010 Copyright by Islamic Azad University, Rasht Branch, Rasht, Iran

Online version is available on: www.ijas.ir

ABSTRACT

This study was conducted to determine the chemical composition and metabolizable energy of poultry by-product meal (PBPM) from two slaughterhouses in Iran. Samples were analyzed for dry matter, crude protein, ash, ether extract and gross energy. The amounts of calcium, phosphorus, sodium, potassium, Magnesium, Iron, Manganese, copper and Zinc were determined. The apparent metabolizable energy (kcal/kg) (AME), apparent metabolizable energy corrected for nitrogen (kcal/kg) (AMEn), true metabolizable energy (kcal/kg) (TME) and true metabolizable energy corrected for nitrogen (kcal/kg) (TMEn) were determined based on sibbald's procedure. For this purpose, twelve 230-day old New Hampshire males were used. There was no significant difference ($P < 0.05$) between kinds of metabolizable energies in samples. The standardized digestible amino acid content also determined. The highest and lowest amount belongs to leucine and tryptophan. Results from this study showed there is different between two samples of PBPM.

KEY WORDS AME, AMEn, amino acid, chemical composition, poultry by-product meal (PBPM), TME, TMEn.

INTRODUCTION

Poultry by-product meal (PBPM) is a valuable animal protein source in poultry rations. Although PBPM primarily considered as a source of protein, it also contains substantial quantities of energy, calcium, highly available phosphorus and essential fatty acids (Kristein, 2005; Dozier, 2000; Waldroup and Adams, 1994; Sell and Jeffry, 1996; Waldroup, 1999). Protein, ash and fat contents, protein quality and amino acid digestibility of PBPM can vary greatly depending on processing system (extraction by pressure or by organic solvents), processing temperature and duration and raw material sources (Johnson and Parsons, 1997; Parsons *et al.* 1997; Wang and Parsons, 1998; Shirley and Parsons, 2000; Shirley and Parsons, 2001). Increasing in bone or ash content has been showed to have a negative effect on protein and energy concentrations (Dale,

1997; Mendez and Dale, 1998; Wang and Parson, 1998). The ME content and the nutrient digestibility of PBPM are affected by many factors such as origin, processing methods of the product, levels of feeding and methods for measuring digestibility (Johns *et al.* 1986; Ravindran and Bryden, 1999). While protein, moisture, fat and other components can be quickly ascertained by proximate analysis, metabolizable energy determination requires more elaborate assays. Although TMEn is a better indicator for energy requirements in poultry but because of some limitations on TMEn (such as inadequately that exist for the necessary information), AME_n has been accepted for poultry and is common now (Cole and Haresign, 1989; NRC, 1994; Sibbald, 1987; Wolynetz and sibbald, 1984). Pesti *et al.* (1986) reported a high negative correlation between AME_n and ash / calcium content and a high positive correlation between ME_n and gross energy. Therefore, the aim of this

study was to determine the chemical composition, amino acids and types of metabolizable energy of two samples of poultry by-product meal (PBPM) and comparison with each other.

MATERIALS AND METHODS

Two samples of PBPM from different slaughterhouse were collected and sent to the laboratory. Samples were analyzed for dry matter (DM), crude protein (CP), gross energy (GE), Ash, ether extract (EE), calcium (Ca), phosphorus (P), sodium (Na), potassium (K), magnesium (Mg), iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn). DM, CP, Ash and EE were determined by proximate analysis (AOAC, 2000). Ca, P, Na, K, Mg, Fe, Mn, Cu and Zn were determined by atomic absorption spectrophotometry. GE content was determined in an adiabatic bomb calorimeter. To determine amino acids, near infrared reflectance (NIR) was used. Twelve New Hampshire males with similar body weight (35±5) were used for determination of metabolizable energy by Sibbald (1986) procedure. The birds were kept in individual wire cages (40×45×40 cm). At the start, birds were not fed for 24 hours but water was available ad lib. Then, by using a tube and a rod each bird was force-fed with 30 g samples except four of them that were used as controls for endogenous energy and returned to their cages. After force -feeding, just water was available for next 48 h. Poultry excreta were collected by trays under the cages. Excreta samples were analyzed for DM, EE, nitrogen, ash (AOAC, 2000) and GE determined in an adiabatic bomb calorimeter. Finally data used for calculation of, AME, AMEn, TME and TMEn with as follow and comparison of two sample with t-test method was performed (SPSS, 2011).

$$\begin{aligned} \text{AME} &= [(F_i \times \text{GE}_f) - (E \times \text{GE}_e)] / F_i \\ \text{AMEn} &= [((F_i \times \text{GE}_f) - (E \times \text{GE}_e)) - (\text{NR} \times K)] / F_i \\ \text{TME} &= [((F_i \times \text{GE}_f) - (E \times \text{GE}_e)) + (\text{FE}_m + \text{UE}_e)] / F_i \\ \text{TMEn} &= [((F_i \times \text{GE}_f) - (E \times \text{GE}_e)) - (\text{NR} \times K) + (\text{FE}_m + \text{UE}_e) + (\text{NR}_0 \times K)] / F_i \\ \text{NR} &= (F_i \times N_f) - (E \times N_e) \end{aligned}$$

Where:

AME: apparent metabolizable energy (kcal/g).

AMEn: apparent metabolizable energy corrected for nitrogen (kcal/g).

TME: true metabolizable energy (kcal/g).

TMEn: true metabolizable energy corrected for nitrogen (kcal/g).

F_i : feed intake (g).

E : excreta (g).

GE_f : gross energy of feed sample (kcal/g).

GE_e : gross energy of excreta (kcal/g).

FE_m : metabolic faecal energy (kcal/g).

UE_e : indigenous urinary energy (kcal/g).

NR: nitrogen retention (g).

N_f : feed nitrogen (%).

N_e : faecal nitrogen (%).

NR_0 : nitrogen retention at zero level for control group (g).

K : nitrogen retention corrected coefficient (8.37 kcal/g for each g N).

RESULTS AND DISCUSSION

In the present study AME, AMEn, TME and TMEn in PBPM showed in Table 1. In this study the comparison of two samples using t-test was performed and significant difference between the two samples in the types of energy metabolism was not observed. All kinds of metabolizable energy in sample B were greater than sample A. The values of TMEn were less than of values from Jafari *et al.* (2011a) and were more than NRC (1994).

TMEn amount of poultry by-product meal (PBPM) in sample B is 3595 kcal/kg that with the amounts reported by the Jafari *et al.* (2011a) is equal and from sample A (3131 kcal/kg) is more both samples A and B from the amount reported by Kalvandi *et al.* (2011) (3696 kcal/kg) are less. The reason for this is difference in chemical composition and crude energy.

TME amount of PBPM in sample B is higher than sample A and both samples A and B from the amounts reported by the Geshlog *et al.* (2010) and Robbins and Firman (2006) (3031 and 2643 kcal/kg, respectively) are more. The reason for this is difference in chemical composition and crude energy.

The amount of TMEn will be higher than AMEn that is consistent with results Jafari (2010b). This difference is due to endogenous energy or bird maintenance costs that have not the source of oral and fecal fraction of energy. Therefore, because the maintenance costs don't appear in energy metabolism, then its value will be true of metabolism energy (Sibbald, 1989).

TME was also much higher than TMEn that is consistent with results Jafari (2010b). The reason is because of the increased nitrogen excretion in hungry rooster was significantly reduced by the amount TMEn.

The gross energy of sample B was higher than sample A (Table 2). These values in both of samples are higher than values from Najafabadi *et al.* (2007) and Pesti *et al.* (1986). They reported that values from different samples were 5645 and 4842 kcal/kg, respectively. However in this study values were more than 6000 kcal/kg. The dry matter in these two samples was 96.62% in sample A and 92.96% in sample B. These values are lower than values reported by Najafabadi *et al.* (2007). Resulted that mean of dry matter of 10 samples from different slaughterhouse was 94.8%.

Table 1 Comparison of mean metabolizable energy in two samples of poultry by-product meal (PBPM) (kcal/kg)

Treatments	AME	AMEn	TME	TME _n
Sample A	3497±561.68	2737±528.32	4254±582.17	3131±507.32
Sample B	3749±766.06	3147±732.38	4606±819.53	3595±822.44
P-value	0.711	0.536	0.631	0.503

AME: apparent metabolizable energy; AME_n: apparent metabolizable energy corrected for nitrogen; TME: true metabolizable energy and TME_n: true metabolizable energy corrected for nitrogen.

Other scientists (Bhargava and O'Neil, 1975; Senkoylu *et al.* 2005; Cassio *et al.* 1989; Pesti *et al.* 1986) resulted values between 93-95.5%. However Han and Parsons (1990) reported dry matter of PBPM 90.86%.

Results from experiments show there is variation between samples from standpoint of nutritional value. Method of sample preparation, % of bone, meat, feathers, temperature and pressure during process and other factors effect on sample quality.

Table 2 Composition of DM, CP, Ash, EE and GE in two samples of poultry by-product meal (PBPM)

Treatments	DM (%)	CP (%)	Ash (%)	EE (%)	GE (kcal/kg)
Sample A	96.62	62.8	4.55	21.75	6119
Sample B	86.73	51.37	5.85	29.15	6220

DM: dry matter; CP: crude protein; EE: ether extract and GE: gross energy.

Crude protein in sample A was greater than sample B (62.8 and 51.37%, respectively). These values are according to values from Hosseinzadeh *et al.* (2010), NRC (1994), Janmohammadi *et al.* (2009) and Han and Parsons (1990) however they were lower than values from Pesti *et al.* (1986) and Bhargava and O'Neil (1975) (61.2 and 70.3%, respectively). Due to feather existence in the samples and variability in the source is used that made difference.

Crude fat value of poultry by-product meal (PBPM) in sample B is higher than sample A (29.15 vs. 21.75%). Crude fat in sample B from the values reported by Najafabadi *et al.* (2007), Jafari *et al.* (2011a) and Geshlog *et al.* (2010) that reported the 23.4, 21.57 and 23.8% respectively, is more and sample A is less than this amount. The values of A and B samples provided by Dozier and Dale (2005), Senkoylu *et al.* (2005) and Samli *et al.* (2006) were (13.5, 11.8 and 11.8%, respectively). High crude fat is due to lack of refining system fat in the slaughterhouse that fat has been not being removed from the product.

Gross energy value of PBPM in sample B is higher than sample A (6220 vs. 6119 kcal/kg). The amounts of gross energy in both sample A and B from the amounts reported by the Najafabadi *et al.* (2007), Robbins and Firman (2006) and Jafari *et al.* (2011a) (5646, 4624 and 5619 kcal/kg, respectively) are more and sample A is consistent with results of Geshlog *et al.* (2010) reported 6130 kcal/kg. High gross energy is due to high crude fat in this sample that crude fat in Iran samples are more than other countries.

Ash content of samples was different. These results were same to results from Hosseinzadeh *et al.* (2010), Janmohammadi *et al.* (2009), however they were lower than values from Han and Parsons (1990), Pesti *et al.* (1986), Senkoylu *et al.* (2005) and Cassio *et al.* (1989).

Chemical composition values were different in samples and were different from results of other scientists (Table 3). Calcium amount of PBPM in sample A is higher than sample B (1.49 vs. 1.02%). Calcium of both samples A and B from the amounts reported by NRC (1994), Najafabadi *et al.* (2007), Robbins and Firman (2006) (3, 3.51 and 5.16%, respectively) is less but sample B from the amounts reported by Hosseinzadeh *et al.* (2010), Geshlog *et al.* (2010) and Sahraei *et al.* (2010) that is 1.3% more and those are higher sample A. Because chicken foot has feed intake in Iran and also because of high fat, reduce levels of other nutrients and because poultry by-product meal contains feather, so it can also cause dilution of the minerals calcium and phosphorus.

Magnesium amount both samples A and B is 0.1% that consistent with results of Najafabadi *et al.* (2007) reported 0.06% and from the amounts reported by the Dozier *et al.* (2003) and NRC (1994) that reported the 0.15 and 0.22% respectively are less. The reason is that there is magnesium in skeletal tissues and foot has feed intake in Iran and don't use in slaughter, so this amount is less.

Sodium amount of poultry by-product meal (PBPM) in sample A is higher than sample B (1.31 vs. 0.73%) and both samples A and B are more from the amounts reported by NRC (1994), Najafabadi *et al.* (2007) and Robbins and Firman (2006) (0.4, 0.52 and 0.56%, respectively).

Potassium amount of PBPM in sample A is higher than sample B (0.16 vs. 0.55%) and these values are different from values reported by NRC (1994) and Dozier *et al.* (2003) (0.55 and 0.51%, respectively) and both samples A and B from the amount reported by Najafabadi *et al.* (2007) 0.31%.

There is potassium in interceptive like the heart, intestines, liver, and gizzard and being high may be due to changes in the composition of these products.

Iron amount of PBPM in sample A is higher than sample B (1308.5 vs. 945 mg/kg) and both samples A and B from the amount reported by NRC (1994) and Najafabadi *et al.* (2007) (440 and 623 mg/kg, respectively) are more.

Because blood contains large amounts of iron, and after cutting the tissue may mixed with poultry by-product meal used with blood. These numbers are different. Copper amount of poultry by-product meal (PBPM) in sample B is higher than sample A (12.9 vs. 10.6 mg/kg) and samples A consistent with results of Najafabadi *et al.* (2007) reported 9.3 mg/kg and form the amounts reported by NRC (1994) and Dozier *et al.* (2003) (14 and 22 mg/kg, respectively) is less.

This is because the liver is a large amount of copper and because it has feed intake in Iran, so it is less than other countries.

Manganese amount of PBPM in sample A is higher than sample B (49.1 vs. 15.1 mg/kg) and both samples A and B from the amount reported by NRC (1994) are more and sample B form the amounts reported by the Najafabadi *et al.* (2007) and Dozier *et al.* (2003) (16.5 and 19 mg/kg, respectively) is more. There are manganese and zinc in all tissues and organs of the body and changes in use levels for poultry by-product meal are the reason of this difference. The amount of different amino acids in sample A is higher than sample B (Table 4) and dboth samples A and B from the amounts reported by Azman and Dalkilic (2006) are less.

Table 3 Composition of major and trace minerals in two samples of poultry by-product meal (PBPM)

Treatments	Ca %	P %	Na %	K %	Mg %	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Sample A	1.49	1.293	1.31	0.16	0.10	1308.5	49.1	10.6	71.2
Sample B	1.02	1.208	0.73	0.55	0.10	945	15.1	12.9	66.6

Table 4 Composition of standardized digestible amino acid in two samples of poultry by-product meal (PBPM) (DM basis)

Treatment	Met	Cys	Met+Cys	Lys	Thr	Try	Phe	Arg	Iso	Lue	Val	His
Sample A	0.606	0.943	1.562	1.675	1.607	0.385	1.930	2.268	1.637	3.259	2.223	0.816
Sample B	0.496	0.776	1.277	1.225	1.265	0.316	1.571	1.785	1.253	2.616	1.789	0.663

The reason for this difference is due to amount of crude protein in the samples A, B by the Azman and Dalkilic (2006) (62.8, 51.37, 64.58 and 58.6%, respectively). Wang and Parsons (1998) showed that there is variation between samples of PBPM from one slaughter house to another and even one party of slaughter to another. Amino acids amount may eliminate due to process and high heat and reduce the amount of it.

CONCLUSION

Results from this study showed there are great variations between samples from different plant. This is due to method of processing and components of samples (bone, feather, fat and other component). It is recommended that for using PBPM in poultry diets, each sample must naturally be analyzed before formulation.

ACKNOWLEDGEMENT

We offer our thanks to chairman, vice president and personals of Karaj Islamic Azad University, Iranian Animal Science Research Institute that had brought these research possibilities.

REFERENCES

- AOAC. (2000). Official Methods of Analysis. Vol. I. 15th Ed. Association of Official Analytical Chemists, Arlington, VA.
Azman, M.A. and Dalkilic B. (2006). The effect of poultry by-

product meal on the performance of broiler chicks. *Indian J. Poult. Sci.* **83**, 873-875.

Bhargava K.K. and O'Neil J.B. (1975). Composition and utilization of poultry by-product meal hydrolyzed feather meal in broiler diets. *Poult. Sci.* **54**, 1511-1518.

Cassio X., Mendonca J.R. and Jensen L.E.O.S. (1989). Effect of formulating diets with different-assigned energy data for poultry by product meal on the performance and abdominal fat content of finishing broilers. *Poult. Sci.* **68**, 1672-1677.

Cole D.J.A. and Haresign W. (1989). Recent Development in Poultry Nutrition. Butterworths, London.

Dale N. (1997). Metabolizable energy of meat and bone meal. *J. Appl. Poult. Res.* **6**, 169-173.

Dozier W.A. (2000). Economically and ecologically sound poultry nutrition: how to manage dietary phosphorous in environmentally sensitive areas. *Feed Manag.* **51**, 27-29.

Dozier W.A., Dale N.M. and Dove C.R. (2003). Nutrient composition of feed-grade and pet food-grade poultry by product meal. *J. Appl. Poult. Res.* **12**, 526-530.

Dozier W.A. and Dale N. (2005). Metabolizable energy of feed-grade nd pet food-grade poultry by product meals. *J. Appl. Poult. Res.* **14**, 349-351.

Geshlog M., Jonmohammadi H., Taghizadeh A. and Rafat A. (2010). Effects of poultry by-product meal on egg quality of laying hens. Pp. 443-446 in Proc. 4th Cong. Anim. Sci., Iran.

Han Y. and Parsons C.M. (1990). Determination of available amino acid and energy in alfalfa meal feather meal and poultry by-product meal by various methods. *Poult. Sci.* **69(9)**, 1544-1552.

Hosseinzadeh M.H., Ebrahimnezhad Y., Janmohammadi H., Ahmadzadeh A.R. and Sarikhan M. (2010). Poultry by-product meal: influence on performance and egg quality traits

- of layers. *Int. J. Agric. Biol.* **12(4)**, 547-550.
- Jafari M., Ebrahimnezhad Y., Hanmohammadi H., Nazeradl K. and Nemati M. (2011a). Evaluation of protein and energy quality of poultry by-product meal using poultry assays. *African J. Agric. Res.* **6(6)**, 1407-1412.
- Jafari M. (2011b). Using PBPM in broiler chickens diet based on digestible amino acids. Ph D. Thesis. Islamic Azad Univ., Shabestar, Iran.
- Janmohammadi H., Taghizadeh A., Moghadam G.A., Pirani N., Ostan S., Gheshlog M. and Sahraei M. (2009). Nutritive value of poultry by-product meal from Iran in broiler feeding. British Society of animal Science, Annual meeting. Annual Meeting, Southport, UK.
- Kalvandi O., Janmohammadi H. and Sadeghi G. (2011). Determination of protein quality and true metabolizable energy of high oil poultry by-product meal. *African J. Agric. Res.* **6(6)**, 1983-1989.
- Kristein D. (2005). Purchasing guide ling for meat and bone meal. http://national_by-products.com/files/Mwpoultry3-15-05.pdf. Accessed Jan. 2006.
- Johns D.C., Low C.K. and James K.A.C. (1986). Comparison of amino acid digestibility using the ileal digests from growing chickens and cannulated adult cockerels. *Br. Poult. Sci.* **28**, 397-406.
- Johnson M.L. and Parsons C.M. (1997). Effect of raw material source, ash content and assay length on protein efficiency ratio and net protein ratio values for animal protein meals. *Poult. Sci.* **76**, 1722-1727.
- Mendez A. and Dale N. (1998). Rapid assay to estimate calcium and phosphorous in meat and bone meal. *J. Appl. Poult. Res.* **7**, 309-312.
- Najafabadi H.J., Moghaddam H.N., Pourreza J., Shahroudi F.E. and Golian A. (2007). Determination of chemical composition, mineral contents and protein quality of poultry by-product meal. *Int. J. Poult. Sci.* **6(12)**, 875-882.
- NRC. (1994). Nutrient Requirements of Poultry, 9th Rev. Ed. National Academy Press, Washington, DC.
- Parsons C.M., Castsnon F. and Han Y. (1997). Protein and amino acid quality of meat and bone meal. *Poult. Sci.* **76**, 361-368.
- Pesti G.M., Faust L.O., Fuller H.L. and Dale N.M. (1986). Nutritive value of poultry by-product meal. Metabolizable energy values as influenced by method of determination and level of sub situation. *Poult. Sci.* **65**, 2258-2267.
- Ravindran V. and Bryden W.L. (1999). Amino acid availability in poultry *in vitro* and *in vivo* measurements. *Australian J. Agric. Res.* **50**, 889-908.
- Robbins D.H. and Firman J.D. (2006). Evaluation of the metabolizable energy of poultry by-product meal for chicken and turkeys by various methods. *Int. J. Poult. Sci.* **5(8)**, 753-758.
- Sahraei M., Ghanbari A. and Lotfollahian H. (2012). Effect of poultry by product meal on performance parameters, serum uric acid concentration and carcass characteristics. *Iranian J. Appl. Anim. Sci.* **2(1)**, 73-77.
- Samli E.H., senkoylu N., Ozduven L., Akyurek H. and Amgma A. (2006). Effect of poultry by-product meal on laying performance, egg quality and storage stability. *Pakistan J. Nutr.* **5(1)**, 06-09.
- Sell J.L. and Jeffry J. (1996). Availability for poults of phosphorus from meat and bone meals of different particle sizes. *Poult. Sci.* **75**, 232-239.
- Senkoylu N., Samli H.E., Akyurek H., Agama A. and Yasar S. (2005). Performance and egg characteristics of laying hens fed diets incorporated with poultry by-product and feather meals. *J. Appl. Poult. Res.* **14**, 542-547.
- Sibbald I.R. (1986). Metabolizable energy evaluation of poultry diets. *Rec. Adv. Anim. Nutr.* **30**, 12-15.
- Sibbald I.R. (1987). The effect of grinding on the true metabolizable energy value of hull-less barley. *Poult. Sci.* **61**, 2509-2511.
- Sibbald I.R. (1989). Estimation of bioavailable amino acids in feeding stuffs for poultry and pigs: a review with emphasis on balance experiments. *Can. J. Anim. Sci.* **67**, 221-271.
- Shirley R.B. and Parsons C.M. (2000). Effect of pressure processing on amino acid digestibility of meat and bone meal for poultry. *Poult. Sci.* **79**, 1175-1181.
- Shirley R.B. and Parsons C.M. (2001). Effect of ash content on protein quality of meat and bone meal. *Poult. Sci.* **80**, 626-632.
- SPSS Inc. (2011). Statistical Package for Social Sciences Study. SPSS for Windows, Version 20. Chicago SPSS Inc.
- Waldroup P.W. and Adams M.H. (1994). Evaluation of the phosphorous provided by animal proteins in the diet of broiler chickens. *J. Appl. Poult. Res.* **3**, 209-216.
- Waldroup P.W. (1999). Nutritional approaches to reducing phosphorus excretion by poultry. *Poult. Sci.* **78**, 683-691.
- Wang X. and Parsons C.M. (1998). Effect of raw material source, processing system and processing temperatures on amino acid digestibility of meat and bone meals. *Poult. Sci.* **77**, 834-841.
- Wolynetz M.S. and Sibbald I.R. (1984). Relationships between apparent and true metabolizable energy and the effects of a nitrogen correction. *Poult. Sci.* **63**, 1386-1399.