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Evaluation of Metabolizable Protein and Metabolizable Energy Values of Wolffia Meal [*Wolffia globosa* (L). Wimm.] in Broilers

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Abstract: This study was conducted to investigate the metabolizable protein and metabolizable energy values of Wolffia meal in broilers. Twenty-four three-week-old broilers were divided into 2 groups of 12 birds each and kept individually in metabolic cages where the excreta could be collected. Birds in each group were randomly fed basal diet or basal diet mixed Wolffia meal at the ratio of 80:20. Their excreta were collected daily for 7 days. Diets and excreta of birds were analyzed for crude protein and gross energy. The metabolizable protein and metabolizable energy of Wolffia meal were estimated by using different methods. The results showed that metabolizable protein and metabolizable energy values of Wolffia meal in broilers were 34.46% of protein intake and 1,047.8 kcal/kg, respectively.

Key words: Wolffia meal, duckweed, metabolizable protein, metabolizable energy, poultry

INTRODUCTION

In poultry rearing, feed costs account for 60-70% of the total cost of either egg or poultry meat production and protein accounts for 15% of feed cost (Ahammad *et al.*, 2003). Presently, the cost of imported protein sources in animal diets is rapidly rising. Thus, the utilization of locally produced protein sources is desperately required. Wolffia meal (*Wolffia* sp.) is a member of the duckweed family *Lemnaceae*, consisting of 5 genera: *Landoltia*, *Lemna*, *Spirodela*, *Wolffia* and *Wolffiella* (Les *et al.*, 2002). Wolffia meal is the world's smallest flowering plant; it is without leaves or roots and is a small circular floating weed about 0.5-1.5 mm in length that lives in ponds, swamps and quiet streams (Lemon *et al.*, 2001; Bajguz and Asami, 2005). Wolffia meal contains high quality protein and closely resembles animal protein and soybean meal in this aspect (Skillicorn *et al.*, 1993). Wolffia meal is very rich in crude protein content (29.9-36.5% DM) (Rusoff *et al.*, 1980; Huque *et al.*, 1996). The amino acid profile of Wolffia meal is similar to that of soybean and rich in β -carotene and xanthophylls (Rusoff *et al.*, 1980; Skillicorn *et al.*, 1993). Wolffia meal, therefore, probably could be used as protein replacement in poultry diets. Generally, proper utilization of Wolffia meal requires accurate Metabolizable Energy (ME). The ME value of duckweed was previously reported to range from 1,200 to 2,887 kcal/kg in poultry (Hill *et al.*, 1960; Islam *et al.*, 1997; Ahammad *et al.*, 2003; Khandaker *et al.*, 2007). However, Metabolizable Protein (MP) and ME values of Wolffia meal have never been directly reported in broiler chicks. This study, therefore, was conducted to

investigate MP and ME values of Wolffia meal [*Wolffia globosa* (L). Wimm.] in broilers using different methods proposed by Church and Pond (1988).

MATERIALS AND METHODS

Fresh cultivated Wolffia meal [*Wolffia globosa* (L). Wimm.] was purchased from a local producer and dried under sunlight for 2 days. Dried Wolffia meal was ground through a 2 mm screen prior to diet preparation. Twenty-four three-week-old broilers were divided into 2 groups; each group consisted of 12 birds. Birds were kept individually in metabolic cages where their excreta could be totally collected. The basal diet was formulated to meet all nutritional needs for three-week-old broilers recommended by NRC (1994), containing 20% crude protein and 3,200 kcal/kg ME (Table 1). The birds in the control group received a basal diet. The birds in the tested group were fed a mixture of basal diet and dried Wolffia meal, consisting of 29.61% crude protein and 3,820 kcal/kg gross energy, in the ratio of 80:20. During a 5 day preliminary period, the birds were fed diets *ad libitum*. Feed intake was recorded daily. In a 7 day experimental period, the birds were offered 80% of feed intake in a preliminary period. The excreta of birds were collected at 9.00 a.m. and 5.00 p.m. for seven consecutive days. The daily excreta of individual birds were weighed, sprayed with 10% sulfuric acid and frozen at -20°C. At the end of the experimental period, the excreta of each bird was pooled and dried at 60°C. Diets and excreta of birds were analyzed for total nitrogen by Kjeldahl method (AOAC, 1999) and gross energy by adiabatic bomb calorimeter (Gallenkamp Autobomb,

Table 1: Ingredient and chemical composition of basal diets

Ingredients	Proportion (%)
Corn	57.30
Rice bran	4.00
Soybean meal	25.00
Fish meal	6.00
Soybean oil	5.40
Dicalciumphosphate	0.50
Oyster shell	1.30
Salt	0.25
Premix*	0.25
Total	100.00
Calculated value	
Metabolizable energy (kcal/kg)	3,203.03
Crude protein (%)	20.24
Ether extract (%)	8.54
Crude fiber (%)	3.53
Calcium (%)	0.91
Total phosphorus (%)	0.57
Available phosphorus (%)	0.36
Lysine (%)	1.14
Methionine (%)	0.38
Methionine + Cystine (%)	0.70

*Vitamin-mineral premix provide (per kg diet): 10,000 IU vitamin A, 20,000 IU vitamin D₃, 11 mg vitamin E, 1.5 mg vitamin K₃, 1.5 mg thiamin, 4 mg riboflavin, 10 mg pantothenic acid, 0.4 mg folic acid, 4 mg pyridoxine, 22 mg niacin, 0.4 mg colabamin, 0.1 mg biotin, 60 mg Fe, 70 mg Mn, 50 mg Zn, 8 mg Cu, 0.5 mg Co, 0.7 mg I, 0.1 mg Se

CBA-350-K, London, UK) using benzoic acid as a standard according to the method of Amerah *et al.* (2008). Metabolizable protein and ME values of Wolffia meal was estimated using a different methods (Church and Pond, 1988) as demonstrated in the following equation:

Nutrient metabolizable of test feed =

$$\frac{\{A - (B \times \text{Fraction of nutrient in basal} + \text{Test feed})\}}{\text{Fraction of nutrient from test feed in basal} + \text{test feed}}$$

A = Nutrient metabolizable of basal + test feed

B = Nutrient metabolizable of basal

Statistical analysis: The experimental data were analyzed using the t-test procedure of SAS (1996). Values of $p < 0.05$ were taken as significant.

RESULTS AND DISCUSSION

The estimated MP value of Wolffia meal in broilers was 34.46% of protein intake (Table 2). This MP value was lower than that of soybean meal (85% of protein intake) in chickens (Pond *et al.*, 2005). Wolffia meal was lower in lysine, isoleucine and arginine contents as compared to those of soybean meal (Chantiratikul *et al.*, 2010). Thus, the MP value found in the present study could be explained by amino acid imbalance in Wolffia meal. Increased catabolism of amino acid in the liver is caused by an amino acid imbalance in feedstuff (Pond *et al.*, 2005), reflecting protein synthesis reduction and

Table 2: Protein balance of broilers fed basal and mixed diets and estimated Metabolizable Protein (MP) of Wolffia meal

Parameters	Basal diet	Mixed diet	SEM
Feed intake (g/d)	73.05	67.61	1.70
Protein intake (g/d)	14.50	14.56	0.29
Protein excretion (g/d)	7.35	7.82	0.30
Protein retention (g/d)	7.14	6.74	0.27

Estimated MP of Wolffia meal = 34.46% of protein intake

Table 3: Energy balance of broilers fed basal and mixed diets and estimated Metabolizable Energy (ME) of Wolffia meal

Parameters	Basal diet	Mixed diet	SEM
Feed intake (g/d)	73.05	67.61	1.70
Energy intake (kcal/d)	332.68 ^a	296.19 ^b	0.03
Energy excretion (kcal/d)	91.96	103.57	0.02
Energy retention (kcal/d)	240.72 ^a	192.62 ^b	0.03

Estimated ME of Wolffia meal = 1,047.80 kcal/kg.

^{ab}Means in the same row with different superscripts are significantly different ($p < 0.05$)

increasing the excretion of unchanged amino acid (Salmon, 1958). These metabolic effects of the amino acid imbalance probably caused the low MP value of Wolffia meal in broilers.

Energy intake and energy retention of broilers fed mixed diet decreased significantly ($p < 0.05$) when compared with that of broilers fed a basal diet. The estimated ME value of Wolffia meal was 1,047.8 kcal/kg in broilers (Table 3). This ME value of Wolffia meal was lower than that of soybean meal in poultry (2,230 kcal/kg) (NRC, 1994) and in roosters (2,459 kcal/kg) (Leske and Coon, 1999). Generally, ME value of protein sources usually used as feedstuffs in poultry diets ranged from 1,364 to 3,575 kcal/kg (Bellaver *et al.*, 2004; Nadeem *et al.*, 2005). Furthermore, the ME value of Wolffia meal in this study was lower than that of the duckweed previously reported in broilers (1,200-1,302 kcal/kg) (Hill *et al.*, 1960; Islam *et al.*, 1997) and in roosters (2,000 kcal/kg) (Haustein *et al.*, 1990). The ME is affected by many factors such as age and species of animal, fiber content in feed and enzyme inhibitor in feedstuff (McDonald *et al.*, 1995). Decreased nutrient utilization in animals fed high fiber content diet was generally due to increasing the rate of passage of diet in the digestive tract (McDonald *et al.*, 2002). Rusoff *et al.* (1980) found fiber content of Wolffia meal (11.0%) was higher than that of *Lemna* and *Spirodela* (8.8-9.4%). Additionally, Villamide and San Juan (1998) reported that ME contents of sunflower seed meal decreased when its crude fiber, neutral detergent fiber and acid detergent fiber increased. The lower ME value of Wolffia meal, compared to that of other duckweed genera, was probably due to higher fiber content. The finding demonstrated that ME level should be seriously considered when Wolffia meal is used as protein source in the diets of broiler.

Conclusion: Metabolizable protein and metabolizable energy values of Wolffia meal in broilers were 34.46% of protein intake and 1,047.8 kcal/kg, respectively.

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