

DETERMINATION OF THE METABOLIC ENERGY VALUE OF SOME LEAF MEAL KINDS ON LUONG PHUONG BROILER CHICKENS

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Abstract

A study on the determination of metabolic energy of *cassava* leaf meal (CLM), *leucaena leucocephala* leaf meal (LLM), *stylosanthes guianensis* grass meal (SGM), *Moringa oleifera* leaf meal (MLM) and *Trichanthera gigantea* leaf meal (TLM) with corrected energy based on the nitrogen retention of the diet dry matter in the chicken body was conducted on 120 Luong Phuong broiler chickens from 43 to 49 days of age. The chickens were divided into 6 groups with 20 chickens per group. This study was carried out based on 2 diets: i) a basal diet without the inclusion of leaf meal and ii) an experimental diet consisting of 80% basal diet and 20% leaf meal. Based on the metabolic energy of the 2 diets, the metabolic energy of leaf meal was calculated. The results showed that the metabolic energy value of 1 kg dry matter of CLM, LLM, SGM, MLM and TLM was 2.185 kcal; 2.415 kcal; 1.835 kcal; 2.480 kcal and 1.935 kcal respectively. The formulation of a diet based on the metabolic energy value of the feed ingredients was recommended in order to obtain optimum performance of broiler chickens.

Keywords: corrected metabolic energy, leaf meal kinds

Introduction

The production of colored feather chickens is quite developed in Vietnam, which accounts for 70 – 80% of the total chicken meat production (Department of livestock production, MARD, 2016). Colored feather chickens are slow in daily gain; however, their meat is more tender, tastier and thus highly preferred by local consumers. In order to achieve high quality chicken meat, chicken producers need to follow one of these rearing practices: i) Free range production in which the chickens can consume a certain amount of green forage, ii) Intensive rearing with complete mixed feed and supplementation of green forage, iii) Intensive rearing with supplementation of leaf meals into diet. Because green forage and leaf meals contain pigments, they can improve color of chicken skin and egg yolk as well as the taste of meat and eggs (Latscha, 1990; Williams, 1992; Sirri et al., 2007; Hien et al., 2016). The third rearing practice is more preferable because leaf meals are hygienically safer and healthier than fresh leaves and forage. For the above reasons, it is necessary to conduct researches on green fodders with high leaf yield, protein and pigment content in order to produce high quality leaf meal for poultry feed supplement. According to Hien et al. (2008), Hoan (2012), Ngoc (2012), Hien and Trung (2016), such green fodders as *Casava*, *L. leucocephala*, *S. guianensis*, *M. oleifera*, *T. gigantea* have yields of 6.05 to

9.83 tons/ha/year, crude protein content of leaf meals from 19 to 37%, pigment content in dry matter from 250 to 700 mg/kg. Therefore, these forages have been focused in order to produce quality leaf meals supplemented into chicken diets. The experiment on determination of metabolic energy value was carried out in order to set up a fundamental principle for leaf meal inclusion/supplement into the colored feather chicken diet.

Materials and methods

Leaf meal kinds used in this experiment included *Cassava* leaf meal (CLM), *Leucaena leucocephala* leaf meal (LLM), *stylosanthes guianensis* grass meal (SGM), *Moringa oleifera* leaf meal (MLM) and *Trichanthera gigantea* leaf meal (TLM).

Experimental animals were the colored feather Luong Phuong chicken breed, which is a slow growing breed, but gives tasty meat and is commonly raised in Vietnam.

The experiment was carried out at Thai Nguyen University of Agriculture and Forestry's Poultry Farm, Vietnam. The trial accommodated 120 Luong Phuong broilers from 43 to 49 days of age, which were divided into 6 groups consisting of 20 chickens per group. Each group was subdivided into 5 subgroups consisting of 4 chickens each (2 males and 2 females). The chickens in subgroups (4 birds each) were grouped in an experimental cage with a controlled daily feed intake and feces excretion measurement.

The 6 groups were provided with 6 experimental diets including basal diet (BD) without inclusion of leaf meal, experimental diet 1, 2, 3, 4 and 5 (ED1, 2, 3, 4 and 5) consisting of 80% BD and 20% of CLM, LLM, SGM, MLM and TLM, respectively.

The basal diet was formulated from ground yellow maize (57.2%), rice bran (10.0%), soybean meal (23.0%), fish meal (6%), methionine (0.1%), salt (0.5%), DCP (2.2%), premix vitamins (0.5% and premix minerals (0.5%). The basal diet's nutrient content of metabolic energy (ME) and crude protein (CP) met the nutrients requirement for colored feather broiler chickens from 43 – 70 days of age.

The tested leaf meal kinds were processed as follows: Fresh leaves were separated from stems, sun-dried to achieve less than 10% humidity content, then the ground leaf meals were screened with 1mm mesh screen before being mixed into the basal diet.

The tested leaf meal kinds and basal diet were analyzed for chemical content prior to the experiment; the results are presented in Table 1.

Table 1. Chemical compositions of experimental leaf meal kinds and basal diet (%)

LM and BD	DM	CP	EE	CF	Ash	NFE	GE (kcal/kg)
CLM	90.56	21.64	6.86	13.29	8.64	40.13	4196
LLM	90.65	25.23	4.26	7.63	8.54	44.99	4085
SGM	90.42	16.81	1.96	28.22	8.68	34.75	3945
MLM	90.68	33.64	6.23	8.32	9.41	33.08	4290
TLM	90.47	23.60	3.48	9.36	17.56	36.47	3654
BD	89.56	18.46	8.03	3.61	7.36	52.10	4161

The experiment was performed in 7 days. During the first 4 days, the birds were given time to adapt to the cage and diets. At 4:00 p.m. on day 4, they were restricted from feed; from 8:00 a.m. of day 5, the experimental diets were given to birds; at 4:00 p.m. on day 7, the birds were restricted from feed. At 8:00 a.m. of the 8th day, the last birds' droppings were collected. During the experimental period (from day 5th to 7th), fecal samples were collected twice a day and stored at minus 20 degree C (-20°C). Fecal samples were collected from birds in the same cage (subgroup) and were stored and mixed together for analysis.

The following parameters were analyzed: Chemical compositions of leaf meal kinds and basal diet, gross energy of the diets (GE_d) and that of the excreta (GE_e), acid insoluble ash of the diets (AIA_d) and that of excreta (AIA_e), Nitrogen content of the diets (N_d) and that of the excreta (N_e).

The chemical analysis was done following A.O.A.C. (1990). Acid insoluble ash analysis was performed after Keulen and Young (1977).

The chemical analysis, AIA and gross energy determination of diets and fecal samples were performed at the Institute of Life Science; each analysis was performed in pentad.

Based on the chemical analysis results, the metabolic energy value (ME) of leaf meal kinds was calculated using the following method:

- a) The metabolic energy calculation (before correction) of the diets

$$ME_d = GE_d - (GE_e \times AIA_d / AIA_e) \text{ (Scott and Hall, 1998)}$$

Where: ME_d is ME of diets before corrected in kcal/kg DM

GE_d is gross energy of the diets (kcal/kg DM)

GE_e is gross energy of the excreta (kcal/kg DM)

AIA_d is acid insoluble ash content in diets (%DM)

AIA_e is acid insoluble ash content in excreta (%DM)

- b) Calculation of nitrogen retention in the chicken's body after consuming 1kg DM of diet

$$NR = [N_d - (N_e \times AIA_d / AIA_e)] \times 1000 / 100 \text{ (Lammers et al., 2008)}$$

Where: NR is amount of nitrogen retained (g/1 kg DM of diet)

N_d is proportion of nitrogen content in diet (% DM)

N_e is proportion of nitrogen content in excreta (% DM)

- c) Correction of Metabolic energy

$$C = NR \times 8.22$$

where: C is the metabolic energy need to be corrected (kcal/kg DM of feed); 8.22 is the energy of 1 gram uric acid (kcal/g)

- d) Metabolic energy correction of the diets

$$ME_N = ME_d - C$$

Where: ME_N is corrected ME (kcal/ kg DM of feed)

e) Calculation of corrected ME of 1 kg DM of leaf meal ($ME_{N \text{ of LM DM}}$)

$$Y_1 = [ME_{N \text{ of ED}} - (ME_{N \text{ of BD}}) \times (100\% - S\%)] \times 100/S \text{ (Hien et al., 2013)}$$

Where: $ME_{N \text{ of ED}}$ and $ME_{N \text{ of BD}}$ are in 1kg diet dry matter; S is % leaf meal inclusion in diets (in this experiment S = 20 %); Y_1 is $ME_{N \text{ of LM DM}}$

f) Calculation of corrected ME of 1 kg leaf meal in air dried condition ($ME_{N \text{ of LM}}$)

$$Y_2 = (Y_1 \times \% \text{ DM in LM}) : 100 \text{ (Hien et al., 2013)}$$

Where: Y_2 is $ME_{N \text{ of LM}}$; leaf meal in air dried condition contains about 10% moisture

Results and Discussion

The chemical compositions of the diets

The chemical compositions of the basal diet and 5 experimental diets after addition of 1.5% insoluble ash are presented in Table 2.

Table 2. Chemical composition of diets

Diets	DM	CP	EE	CF	Ash	NFE	GE (kcal/kg)
BD	89.72	18.18	7.91	3.56	8.75	51.32	4099
ED1	89.91	18.81	7.68	5.46	9.00	48.96	4105
ED2	89.93	19.52	7.17	4.34	8.98	49.92	4084
ED3	89.88	17.86	6.72	8.40	9.01	47.89	4056
ED4	89.93	21.18	7.56	4.48	9.15	47.56	4124
ED5	89.89	19.20	7.02	4.68	10.76	48.23	3997

Results presented in Table 2 showed that there were unremarkable variations of nutrients content among experimental diets. However, it was notable that within diets containing leaf meals, the CP content of ED2 and ED4 and fat content of ED1, ED2 and ED4 were higher than that of other experimental diets. These nutrients contained high gross energy, thus they markedly influenced the gross energy value of the diets.

Results shown in Table 2 can be used to explain the result of gross energy, metabolic energy and nitrogen retention determination of the diets in the next steps.

Determination of ME content of the diets before correction

In order to calculate the metabolic energy of the diets before correction (ME_d), the first step was to determine gross energy content of the diets (GE_d) and that of excreta (GE_e), acid insoluble ash content of the diets (AIA_d) and that of excreta (AIA_e), then calculate ME_d followed by the given formulation. The analytical results are presented in Table 3.

Based on the GE content and AIA content in the diets and excreta (Table 3) and the formula: $ME_d = GE_d - (GE_e \times AIA_d/AIA_e)$, the metabolic energy value of the diets before correction (ME_d) was calculated as follows:

$$ME_d \text{ BD} = 4569 - (3216 \times 0.352) = 3437$$

$$ME_d \text{ ED1} = 4566 - (3480 \times 0.391) = 3205$$

$$ME_d \text{ ED2} = 4541 - (3425 \times 0.374) = 3260$$

$$ME_d \text{ ED3} = 4513 - (3514 \times 0.393) = 3132$$

$$ME_d \text{ ED4} = 4586 - (3393 \times 0.384) = 3283$$

$$ME_d \text{ ED5} = 4447 - (3271 \times 0.394) = 3158$$

The calculation results are presented in Table 3.

Table 3. Gross energy, AIA of diets, excreta and ME_d of diets

Groups	GE_d	GE_e	AIA_d (1)	AIA_e (2)	(1)/(2)	ME_d
BD	4596	3216	1.90	5.40	0.352	3437
ED1	4566	3480	1.90	4.86	0.391	3205
ED2	4541	3425	1.88	5.03	0.374	3260
ED3	4513	3514	1.89	4.81	0.393	3132
ED4	4586	3393	1.91	4.97	0.384	3283
ED5	4447	3271	1.93	4.90	0.394	3158

Note: The unit of GE_d , GE_e , ME_e , is kcal/kg DM; that of AIA_d , AIA_e is % DM; (1)/(2) is AIA_d/AIA_e

Data presented in Table 3 showed that gross energy content of ED1, ED2, ED4 was higher than that compared to ED3 and ED5. It can be explained that the diets ED1, ED2 and ED4 had higher CP, EE and NFE contents than the rest of the experimental diets (see Table 2).

The AIA content of the experimental diets was similar among groups because all diets contained 80% of the basal diet.

The AIA content in excreta was different among the diets. This content was higher in birds fed with BD, ED2 and ED4, and was lower in birds fed ED1, ED3 and ED5. This can be explained as diets with higher digestibility and absorption would leave lesser nutrients content in excreta, which resulted in higher AIA in excreta and vice versa.

Based on the calculation formulas for ME_d , it can be seen that those containing lower AIA_d/AIA_e ratio resulted in higher of ME_d and vice versa. The experimental data had proved that the ED2 and ED4 containing lower AIA_d/AIA_e ratio showed higher ME_d ; whereas, the other diets containing higher ratio of AIA_d/AIA_e showed lower ME_d .

Data shown in Table 3 also demonstrated that the ME_d content of ED2 and ED4 was higher and that of ED1, ED3 and ED5 was lower because LLM and MLM contained higher ME, that content of CLM, SGM and TLM was lower.

Needed Correction of metabolic energy (C)

In order to correct ME content in poultry, there are several necessary steps: Step 1: Determination of Nitrogen content in the diet (N_d) and Nitrogen content in excreta (N_e); Step 2: Determination of Nitrogen retention (NR) after birds consuming 1000 g DM followed by the formula $NR = [N_d$

– $(N_e \times AIA_d/AIA_e)] \times 1000/100$; and the last step the ME needed correction was followed by formula: $C = NR \times 8.22$. The calculation data are presented in Table 4.

Based on N_d , N_e contents (Table 4), AIA_d/AIA_e (Table 3), the Nitrogen retention in the chicken's body (NR) fed with different diets was calculated as follows (g/kg DM diet):

$$NR \text{ in BD fed birds} = [3.242 - (5.661 \times 0.352)] \times 10 = 12.49$$

$$NR \text{ in ED1 fed birds} = [3.347 - (5.412 \times 0.391)] \times 10 = 12.31$$

$$NR \text{ in ED2 fed birds} = [3.474 - (5.714 \times 0.374)] \times 10 = 13.37$$

$$NR \text{ in ED3 fed birds} = [3.179 - (5.059 \times 0.393)] \times 10 = 11.91$$

$$NR \text{ in ED4 fed birds} = [3.768 - (6.013 \times 0.384)] \times 10 = 14.59$$

$$NR \text{ in ED5 fed birds} = [3.418 - (5.452 \times 0.394)] \times 10 = 12.70$$

Results of Nitrogen retention calculation in the chicken's body fed with different diets are presented in Table 4.

Data presented in Table 4 showed that Nitrogen content in ED2 and ED4 in dry matter basis was higher, leading to the higher Nitrogen retention in the chicken's body. On the contrary, the Nitrogen content in ED1, ED3 and ED5 was lower, thus the Nitrogen retention in the chicken's body was lower.

Table 4. Nitrogen retention of diets and metabolic energy needed correction

Diets	N_d	N_e	(1)/(2)	NR	C
BD	3.242	5.661	0.352	12.49	103
ED1	3.347	5.412	0.391	12.31	101
ED2	3.474	5.714	0.374	13.37	110
ED3	3.179	5.059	0.393	11.91	98
ED4	3.768	6.013	0.384	14.59	120
ED5	3.418	5.452	0.394	12.70	104

Note: The unit of N_d , N_e is % DM, that of NR is g/kg DM, that of C is kcal; (1)/(2) is AIA_d/AIA_e ; C is Metabolic energy needed correction.

The ME needed correction content of the diets was positively correlated with Nitrogen retention. Thus, the ME needed correction content of ED2 and ED4 was higher than that of other diets (ED1, ED3 and ED5).

The corrected metabolic energy content

Based on the amount of metabolic energy needed to be corrected of the diets presented in Table 4, the correction of metabolic energy content in the diets was calculated as $ME_N = ME_d - C$, results are presented in Table 5.

Table 5. Metabolic energy of diets

Diets	ME _d	C	ME _N
BD	3437	103	3334
ED1	3205	101	3104
ED2	3260	110	3150
ED3	3132	98	3034
ED4	3283	120	3163
ED5	3158	104	3054

Note: The unit of ME_d, ME_N and C is kcal/kg DM

Data presented in Table 5 showed that the diets containing CLM, LLM and MLM (ED1, ED2 and ED4) had higher metabolic energy value than the diets containing SGM and TLM (ED3 and ED5). This allowed to anticipate that CLM, LLM and MLM had higher metabolic energy value than SGM and TLM.

Metabolic energy of leaf meals

Based on the metabolic energy content of diets presented in Table 5, the metabolic energy content of leaf meals in dry matter basis was calculated followed by ME_N leaf meal DM = [ME_N of ED – [ME_N of BD X (100 % - S %)] x 100/S. In this experiment, S was 20%. The calculation data is presented in Table 6.

Table 6. Metabolic energy of tested leaf meals (kcal)

Leaf meal	Air dry leaf meal	DM
Cassava	1978	2185
Leucaena leucocephala	2189	2415
Stylosanthes guianensis	1659	1835
Moringa oleifera	2249	2480
Trichanthera gigantea	1751	1935

Data in Table 6 presents 2 types of data: *i*) metabolic energy content of leaf meal in air dry condition (containing about 10% moisture) and *ii*) Metabolic energy content of leaf meal dry matter. In reference to data presented in Table 2, it can be seen that CLM, LLM and MLM had higher protein and lipid contents, thus, resulted in higher metabolic energy value. SGM had the

lowest protein and lipid contents and TLM had higher total ash content, thus, these two kinds of leaf meal had lower metabolic energy content.

Conclusions

The corrected metabolic energy content by the nitrogen retention of the diet dry matter in the chicken's body of CLM, LLM, SGM, MLM and TLM based on air dry condition (with about 10 % humidity) was 1.978; 2.189; 1.659; 2.249 and 1.751 kcal/kg, respectively. The metabolic energy content based on dry matter basic was 2.185; 2.415; 1.835; 2.480 and 1.935 kcal/kg. The results of this study can be used to calculate the metabolic energy content of the diets when these tested leaf meals are to be included into chicken diets.

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