Biological Values of Hedge Lucerne Meal in Poultry Diets

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Abtract

The objectives of this experiment study were to determine the biological value of hedge lucerne meal (HLM) in poultry diets. The chemical compositions of HLM (DM basis) analyzed by proximate analysis were 18.95%CP, 17.50%CF, 3.13%EE, 44.91%NFE, 7.49%Ash, 1.975%Ca, 0.100%P and 3967 kcalGE/Kg. The lysine, methionine, threonine and tryptophan contents were 1.152, 0.255, 0.953 and 0.233% respectively. HLM contained mimosine at the level of 1.51% and the mixed sample with leaves and stem contained 309 mg/kg of xanthophylls. Apparent metabolizable energy in HLM for adult chicken was 1330 kcal/kg. Digestibility coefficients of dry matter and protein in HLM feed were 65.04 and 34.61% respectively. True digestibility of protein, protein biological value and net protein utilization were 47.71, 63.11and 30.07% respectively.

Keywords: hedge lucerne, *Desmanthus virgatus*, apparent metabolizable energy, protein utilization

Introduction

Hedge Lucerne(*Desmanthus virgatus*) is a shrub belonging to the Mimosaceae family. It has been proposed as an alternative fodder tree the leaves of which could be used as animal feed. However, very little is known about the biological value of hedge lucerne meal for poultry. This study was undertaken to determine the biologial value of hedge lucerne meal for poultry.

Objective

The objective of the experiment was to elucidate the biological value of hedge lucerne meal which was cut at 30 day cutting interval and 50 cm cutting height. In this study, the experiment was separated into two parts 1) The evaluation of apparent metabolizable energy and 2) The evaluation of protein utilization.

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Materials and methods

1.Evaluation of apparent metabolizable energy

A study was carried out to evaluate the apparent metabolizable energy of hedge lucerne meal in adult chicken. Eight 7-week old male Cobb broilers were kept individually in raised floor wire cage in open house. The ingredients compositions of the experimental diets are shown in Table 1. The animals were pre-fed with the experimental diet for 5 days for acclimatization. The experimental period was 4 days thereafter. The animals were allowed to access to feed and water ad libitum and the light was provided 24 hours daily.

The birds were divided into 2 groups of 4 birds each. Each group of the birds was fed different diets, which were modified from Scott *et al.* (1982) as follows:

Diet 1: reference diet.

Diet 2: test diet.

Table 1 Feed ingredients of the chicken diets for metabolizable energy determination

	Diets (kg)	
	Reference	Test
Dextrose	45.70	15.70
Skim milk	53.50	53.50
Hedge lucerne meal	-	30.00
Vitamin-mineral	0.50	0.50
Chromic oxide	0.30	0.30
Total	100.00	100.00

Excreta was collected after five day adaptation period by plastic wrap on tray. Total excreta was collected 1 time a day for 4 days at the same time, in order to avoid the contamination of foreign materials such as feed and feathers. All the samples were dried in an electric oven at 60 ^{o}C for 3 days. Excreta samples were pooled, subsampled and then freeze dried. All samples were then prepared for chemical analysis.

The experimental feeds and excreta were analyzed for Chromic oxide by the method of Suzuki and Early (1991). Gross energy was analyzed by adiabatic bomb calorimeter. Apparent metabolizable energy of hedge lucerne meal was then calculated as follows:

Calculation of metabolizable energy

ME/gm diet = Energy /gm diet – (Excreta energy / gm diet + 8.22 x gm N retained/gm diet)

$$\text{Excreta energy / gm diet} = \text{Energy / gm excreta} \times \frac{Cr_2O_3 \text{ in diet}}{Cr_2O_3 \text{ in Excreta}}$$

$$\text{Gm N retained / gm diet} = \text{N / gm diet} - \text{N / gm excreta} \times \frac{Cr_2O_3 \text{ in diet}}{Cr_2O_3 \text{ in Excreta}}$$

To compute ME of material substituted for glucose, the following equation applies:

$$\text{ME / gm substitute} = 3.64 - \frac{\text{ME / gm reference diet} - \text{ME / gm diet with substitute}}{\text{Proportion of substitute}}$$

2 Evaluation of protein utilization

A study was carried out to examine the protein digestibility and utilization of hedge lucerne meal in adult chicken. Eight 7-week old male Cobb broiler chickens were kept individually in raised floor wire cage in open house. A colostomy method was performed to each bird according to the procedure of Isshiki and Nakahiro (1988). All broilers were allowed to recover from surgery for a period of 2 weeks before being subjected to the study.

The birds were divided into 2 groups of 4 birds each. Each group of the birds was fed different diets as following.

Diet 1: N- free basal diet.

Diet 2: Semi- purified diet containing protein supplied by hedge lucerne meal.

Table 2 Feed ingredients of the chicken diets for protein determination

	Diets (kg)	
	Control	Test
Corn flour	95.7	57.30
Hedge lucerne meal	-	40.00
Oyster shell	1.40	-
Dicalcium phosphate	1.90	1.70
Vitamin – mineral	0.50	0.50
Salt	0.50	0.50
Total	100.00	100.00

Ingredient compositions of the experimental diets are shown in Table 2. The animals were pre-fed with the experimental diet for 5 days for acclimatization. The experimental period was conducted for 4 days thereafter. The animals were allowed to access to feed and water ad libitum and the light was provided 24 hours daily.

The experiments were carried out from January to March 2002 at the Poultry farm, Suranaree University of Technology, Nakorn Ratchasima, Thailand.

In this case, feces and urine were kept separately. Feces were collected after five day of adaptation by plastic wrap on tray. Total feces were collected 1 times a day for 4 days at the same time, in order to avoid the contamination of foreign materials such as feed and feathers. All the samples were dried in an electric oven at 60 ^{o}C for 3 day and measured dry weights. Dried feces samples were pooled, subsampled and then freeze dried. All samples were then prepared for chemical analysis.

Plastic bags collected total urine 3 times a day for 4 days. Subsamples were then kept for the determination of nitrogen component.

The experimental feeds and excreta were analyzed for compositions by the method of proximate analysis (AOAC,1990). Biological value and protein digestibility of the experimental diets were calculated as follows:

1. Apparent digestibility = (I – F) / I x 100
2. Apparent digestible coefficiency of protein = (NI – Fn) / NI x 100

3. True digestibility of protein

= [NI – (Fn –Fnm)] / NI x 100

4. Protein biological value

= [NI – (Fn –Fnm) – Un – Une] / NI- (Fn – Fnm) x 100

5. Net protein utilization

= [NI – (Fn –Fnm) – Un – Une] / NI x 100

I = Feed intake (dry matter)

F = Fecal excrete (dry matter)

NI = Nitrogen intake

Fn = Fecal nitrogen

Un = Urinary nitrogen

Fnm = Metabolic fecal nitrogen

Une = Endogenous urinary nitrogen

Results

Chemical compositions and gross energy contents of hedge lucerne meal are presented in Table 3. The average gross energy content of hedge lucerne meal was 3967 kcal/kg. Under the condition of this study, hedge lucerne meal contained crude protein, ether extract, ash and crude fiber at the levels of 18.95%, 3.13%, 7.49% and 17.50% respectively.

Table 3 The chemical compositions of hedge lucerne meal

Compositions	**Units**
Moisture	8.02%
Crude Protein	18.95%
Ether Extract	3.13%
Ash	7.49%
Crude Fiber	17.50%
NFE	44.91%
Calcium	1.975%
Phosphorus	0.100%
Gross Energy	3967 kcal/kg

The amino acid compositions of hedge lucern meal on dry matter basis are shown in Table 4. The results showed that hedge lucerne had higher contents of glutamic acid than other amino acid. The content of essential amino acid such as lysine, methionine, threonine and tryptophan were 1.152, 0.255, 0.953 and 0.233% respectively. The results of mimosine and xanthophyll determination (Table 5) indicated that hedge lucerne contained toxic mimosine at the level of 1.51% and the mixed sample with leaves and stem contained 309 mg/kg of xanthophyll.

Table 4 The amino acid compositions of hedge lucerne meal

Types	%	Types	%
Aspartic acid	1.760	Cystine	0.476
Serine	1.169	Tyrosine	0.672
Glutamic acid	2.025	Valine	0.907
Glycine	0.942	Methionine	0.255
Histidine	0.436	Lysine	1.152
Arginine	1.116	Isoluecine	0.752
Threonine	0.953	Luecine	1.477
Alanine	1.250	Phenylalanine	0.896
Proline	1.565	Tryptophan	0.223

Table 5 Mimosine and xanthophyll contents in hedge lucerne meal

Contents	**Units**
Mimosine	1.51%
Xanthophyll	309 mg/kg

The result of the apparent metabolizable energy and protein quality of hedge lucerne meal are presented in Table 6 and 7. Apparent metabolizable energy in hedge lucerne meal for adult chicken was 1330 kcal/kg. Digestibility coefficients of dry matter and protein in hedge lucerne meal feed were 65.04 and 34.61% respectively. True digestibility of protein, protein biological value and net protein utilization were 47.71, 63.11 and 30.07 % respectively.

Table 6 Calculation of metabolizable energy of hedge lucerne meal

Analytical values	Diet	Excreta
Reference diet values		
Nitrogen, g/g	0.0127	0.0394
Chromic oxide, mg/g	3.0	16.48
Gross energy, kcal/g	3.840	3.295
Substituted diet values		
Nitrogen, g/g	0.0383	0.0434
Chromic oxide, mg/g	3.0	9.28
Gross energy, kcal/g	3.890	3.675
Reference diet		
Excreta energy /g diet	= 3.295 x 3/16.48 =0.5998	
Nitrogen retained /g diet	= 0.0127-0.0394 x 3/16.48 = 0.0055	
Nitrogen correction	= 0.0055 x 8.22 = 0.0452	
ME of reference diet	= 3.840 – (0.5998 + 0.0452) = 3.195	
Substituted diet		
Excreta energy/g diet	= 3.675 x 3/9.28 = 1.1880	
Nitrogen retained /g diet	= 0.0383 -0.0434 x 3/9.28 = 0.0243	
Nitrogen correction	= 0.0243 x 8.22 = 0.1998	
ME of substituted diet	= 3.890 – (1.1880 + 0.1998) = 2.5022	

Therefore, ME of hedge lucerne meal = 3.64 – (3.195 - 2.5022) / 0.30

= 1.3307 kcal/g

= 1330 kcal/kg

Table 7 Protein determination of hedge lucerne meal in poultry

Items	Units
Apparent digestibility	65.04 %
Apparent digestible coefficiency of protein	34.61 %
True digestibility of protein	47.71 %
Protein biological value	63.11 %
Net protein utilization	30.07 %

Discussion

Under the condition of this study, hedge lucerne meal contained crude protein, ether extract, ash and crude fiber (Table 3) which differed from the results of Chomchai *et al.* (1992) who indicated that the content of crude protein, ether extract, ash and crude fiber of hedge lucerne leaf meal were 19.7, 5.5, 12.8 and 5.2% respectively. The variation in these nutrient composition was influenced by the difference of processing methods.

The amino acid profiles of the hedge lucerne meal (Table 4) were found to closely relate with *Leucaena leucocephala* (D'Mello and Fraser., 1981); *Glircidia sepium* (Chadhokar, 1982) and *Sesbania sesban* (Brown *et al*, 1987). It was low in sulphur-containing amino acids and none had the favorable amino acid balance of soya bean which is normally taken as the poultry industry standard to which other tree legumes are compared. However, synthetic lysine and methionine are now competitively priced and it is not difficult to improve the protein quality of this legume tree meal. With more competitively priced synthetic amino acids coming on the market, they may also be economically incorporated into supplementary hedge lucerne meal diets.

The contents of total mimosine was higher in hedge lucerne than reported previously by Chaiyanukulkitti *et al.*, (1991) and Chomchai *et al.*, (1992). While Gutteridge (1994) suggested that hedge lucerne does not contain mimosine, it foliage could be given to non- ruminant animal with no harmful effects. However, hedge lucerne consists less mimosine than leucaena leaf [2.5% (D'Mello, 1982); 3.36% (Pakyavivat *et al.*1985) and 3.08% (Sriwatavorachi,1989)].

The concentrations of xanthophyll in hedge lucerne meal was closely related to leucaena meal in Thailand of 318 mg/kg DM (Kanto,1986) and 235 mg/kg DM (Khanampan,1991), which were higher than lucerne meal, yellow corn and corn gluten meal (Belyavin and Marangos.1989) but less than in leucaena leaf (D'Mello and Taplin, 1978) and alfalfa leaf meal (Scott *et al.*, 1982). The concentration of pigment in legume tree meals will depend upon the duration and method of drying.

An apparent metabolizable energy value of HLM was not highly related to leucaena leaf meal reported by D'Mello and Acamovic (1982) but comparisons are often difficult because of insufficient detail regarding adjustment to nitrogen balance. The value for leucaena leaf meal agrees with that reported by D'Mello and Acamovic (1982) of 1422 kcal/kg. The study of nutritive value in legume tree meals has been restricted largely to determinations of digestibility of crude protein. Because of this study used more hedge lucerne meal for protein source in diet, though the relatively high fiber content of the stem made hedge lucerne difficult to formulate into poultry diets.

Conclusion

The present determination of apparent metabolizable energy, digestibility coefficient of DM and CP, true digestibility of CP, protein biological value and net protein utilization showed that these values were 1330 kcal/kg, 65.04, 34.61, 47.71, 63.11 and 30.07% respectively.

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