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TRUE METABOLIZABLE ENERGY AND DIGESTIBILITY OF FIVE *Vigna unguiculata* VARIETIES IN CHICKENS

[ENERGÍA METABOLIZABLE VERDADERA Y DIGESTIBILIDAD DE CINCO VARIEDADES DE *Vigna unguiculata* EN POLLOS DE ENGORDA]

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SUMMARY

This study was carried out to evaluate the effect of heat-treatment on grain true metabolizable energy (TME), dry matter and gross energy digestibilities of five *Vigna unguiculata* varieties: H82, T782, TM97, C666 y XL. The grain of the former three varieties were heat-treated, and offered raw or cooked, whereas grain of the late two varieties were used only row, resulting in a total of eight treatments. The heat treatment consisted of watering the grains with boiling water for 30 minutes and drying at 60°C. Forty-five Hubbard male chickens (2.1 ± 0.2 kg) housed in individual wire pens were used to evaluate the treatments. Five chickens from each treatment were fed 40 g of treated grain in mash form, using the force-feeding technique. Additionally, five fasted chickens were used to calculate the endogenous energy and DM losses. The data were submitted to an analysis of variance according to the randomized statistical model; to evaluate the effect of heat treatment orthogonal contrasts were performed. There were no significant differences in all the variables neither among varieties nor between heat treatments (P>0.05). TME values in this study were similar to those found in the literature and equivalent to the TME value of soybean meal, a conventional feedstuff used in the poultry industry.

Key words: True metabolizable energy; *Vigna unguiculata*; chickens.

RESUMEN

El presente estudio se realizó con el objetivo de evaluar el efecto de tratamiento de calor sobre la energía verdadera metabolizable (EVM), y la digestibilidad verdadera de la materia seca y de la energía bruta del grano de las siguientes variedades de *Vigna unguiculata*: H82, T782, TM97, C666 y XL. Las primeras tres variedades fueron tratadas con agua hirviendo por 30 minutos, secadas a 60 °C y utilizada ya sea cocida o cruda, mientras que las últimas dos variedades fueron usadas crudas, generándose así ocho tratamientos. Dichos tratamientos se evaluaron utilizando 45 pollos Hubbard (2.1± 0.2 kg), los cuales fueron mantenidos en jaulas de alambre individuales. Cinco pollos por cada tratamiento fueron alimentados, utilizando la técnica de alimentación forzada, con 40 g del grano y ofrecido en forma de harina. Adicionalmente se utilizaron cinco pollos dietados para calcular las pérdidas de energía y materia seca. Los datos fueron sometidos a un análisis de varianza de acuerdo un modelo completamente al azar; se realizaron contrastes ortogonales para evaluar el efecto del tratamiento de calentamiento de la semilla. No se encontró diferencias significativas (P>0.05) en todas las variables por efecto de las variedades y los tratamientos de calor. El valor de la EVM encontrada en este estudio es similar al reportado en la literatura y es equivalente a EVM de la pasta de soya, alimento convencional en la industria avícola.

Palabras clave: Energía metabolizable verdadera; *Vigna unguiculata;* pollos.

INTRODUCTION

The commercial poultry production system in Latin America is similar to that found in developed countries, and thus is based on imported cereals as for feeding (Cino, 1997). This leads to both expensive animal production and environmental impacts, mainly in the tropical areas. The research into alternative sources for animal feeding is an important task for those countries importing cereals. There are several tropical plants with great potential as feedstuffs. Díaz y Padilla (1998) reported that some genus of legumes

such as *Vigna*, *Canavalia* and *Stizolobium* are almost free from plagues and diseases. Therefore, these tropical plants constitute potential sources for animal feeding. *Vigna unguiculata* is adapted to different soil types, with a range of grain and forage yield from 1.5 to 2.5 t DM/ha and from 2.5 to 6.0 t DM/ha, respectively. CIDICCO (1997) suggested the use of *Vigna* as a covering crop in agricultural areas where it also represents a source of both grain and forage for the dry season. Bubenheim *et al.* (1990) reported that *Vigna* contained 30.9% and 55.5% of crude protein and carbohydrates, respectively; Trompiz *et al*. (2002) also reported 24.2 and 67.9% for the same nutrients, respectively. CIDICCO (1997) described that the total carbohydrates in that legume ranged from 56 to 68%; Augustin y Klein (1989) reported an average of 63.4 % for total carbohydrates in this legume, thus this genus is not only a good source of protein but also a potential source of energy for both human and animals (Piergiovanni *et al*., 1990).

Lon-Wo (1997) pointed out that *Vigna* can be incorporated into alternative feeding systems in the tropics for poultry production, and finding the correct treatment combination remains a challenge. Some experimental work has reported up to 160 g/kg in broiler diets without negative effects on animal performance (Trompiz *et al*., 2002; Miranda-Lopez *et al*., 2007). *V. unguiculata* is a tropical legume introduced in the Peninsula of Yucatan, Mexico, where it has been grown for many years. However, information regarding its nutritive value is scarce. The objective of the current study was to evaluate the effect of heat-treatment on grain true metabolizable energy values (TME), true digestibilities of dry matter (DMD) and gross energy (GED) in five varieties of *V. unguiculata* using chickens.

MATERIAL AND METHODS

This study was carried out at the Faculty of Veterinary Medicine and Animal Science (University of Yucatan) under tropical conditions (Awo) with an average temperature of 26° C (Duch, 1988). The following five varieties were evaluated: H82, T782, T97, C666 and XL, being the first 3 varieties heat-treated. The heat treatment consisted of watering the grains with boiling water (100° C) for 30 minutes and then oven drying (60° C). Both the raw (untreated) and treated grains were milled and sieve (1.5 mm particle size). A total of 8 treatments were evaluated: 1. H82 cooked; 2. H82 raw; 3. T782 cooked; 4. T782 raw; 5. T97 cooked; 6. T97 raw; 7. C666 raw; 8. XL raw. Samples were analysed for dry matter (DM), crude protein (CP), ash and crude fibre contents following the methods described by AOAC (1980); the gross energy determinations were carried out in a Parr adiabatic calorimetric pump (Parr-328).

Forty five male Hubbard chickens (8 week-old; 2.1 ± 0.2 kg average body weight) were housed in wire individual pens (0.4 x 0.4 m) provided with individual feeders and drinkers. Five fasted chickens per treatment were tube-fed with 40 g in mash form, according to Sibbald (1976). The fasting period was 48 h and after the first 24 h they received 50 ml (50% w/w) glucose solution. The birds were offered water *ad libitum*. After tube-feeding, excreta collection per bird was carried out for 48 h. The excreta were oven dried (60°C) for gross energy determination (Parr-328).

In order to calculate the endogenous energy and DM losses, the excreta from five fasted chickens were collected for 48 h. Data from both DMD and GED were transformed to the arcsine function, and analysed as a completely randomised design; comparison between means were made according to Duncan multiple range (Duncan, 1955), when the analysis of variance was significant ($P<0.05$). With the purpose of determining the effect of heat on the dependent variables, orthogonal contrasts were calculated in those varieties submitted to heat treatment. The statistical analyses were carried out using the SAS software (1989).

RESULTS AND DISCUSSION

The chemical composition of treatments is shown in Table 1. CP ranged from 228 to 249 g/kg. Gross energy ranged from 4263 to 4379 kcal /kg. There were not significant differences ($P>0.05$) between the varieties under study (Table 2) for all dependent variables, however, some varieties such as C666 and XL showed numerically higher means than the other varieties. There was no significant effect of the heat treatment although in Table 3 is observed a slight beneficial trend from such treatment.

CP content of *V. unguiculata* varieties found in the current study is in agreement with CIDICCO (1997), who reported means ranging from 230 to 300 g/kg, depending on both the geographic area and the variety under study (Emebiri, 1991).

V. unguiculata contains some anti-nutritional factors (Pusztai, 1989), such as lectins and trypsin inhibitors (Pusztai *et al*., 1992; D´Mello, 1995). The agglutination of blood cells and the inhibition of enzymatic activity in the intestinal lumen, consequently an impaired nutrient absorption are some of negative effects (Liener, 1989). There was no significant effect of heat treatment probably due to the few replicates used, but a positive trend was observed. This trend was in agreement with D'Mello (1995), who found that the metabolizable energy value of heat-treated *V. unguiculata* in chickens was higher (12.7

MJ /kg) than that value when the legume was given without heat treatment (11.4 MJ /kg).

There is evidence that indicates the genus *Vigna* contains tannins (Miranda-Lopez *et al*., 2007), a phenolic compound, ranging from 4.2 to 7.8 g /kg (D'Mello, 1995), which being thermo-stable can not be removed by the heat treatment and, consequently, affecting the energy digestibility in both the heat-treated and the untreated varieties of *Vigna* (Wiseman and Cole, 1988; Jansman, 1993). The low nitrogen retention by birds consuming high dietary levels of tannins leads also to low values of metabolizable energy in the diets (D´Mello and Acamovic, 1989).

Table 1. Grain chemical composition (g/kg as-fed dry basis) of *V. unguiculata* varieties (grain heat-treated where indicated).

Variety	Dry matter	Crude protein	Ash	Crude fibre	Gross Energy kcal /kg
H82					
Treated	875.0	248.0	28.0	56.0	4335.5
Raw	884.0	248.0	31.0	72.0	4379.6
T782					
Treated	894.0	228.0	24.0	62.0	4289.8
Raw	887.0	232.0	27.0	60.0	4300.4
TM97					
Treated	901.0	241.0	26.0	72.0	4287.4
Raw	868.0	237.0	31.0	59.0	4337.2
C666 Raw	875.0	249.0	27.0	60.0	4263.5
XL Raw	883.0	244.0	29.0	39.0	4290.3

Table 2. Grain true digestibility of dry matter, organic matter, gross energy and true metabolizable energy of *Vigna unguiculata* varieties (grain heat-treated where indicated).

Variety	Digestibility (%)			True metabolizable energy, kcal/ kg
	Dry matter	Organic matter	Gross energy	
H82				
Treated	0.550	0.550	0.659	2856.5
Raw	0.482	0.475	0.637	2790.5
T782				
Treated	0.577	0.579	0.706	3030.0
Raw	0.538	0.531	0.660	2821.8
TM97				
Treated	0.645	0.644	0.723	3103.0
Raw	0.569	0.561	0.682	2958.8
C666 Raw	0.500	50.22	0.597	2549.0
XL Raw	0.515	50.61	0.611	2625.3
P-value	0.351	0.260	0.135	0.139
SE	0.045	0.043	0.029	125.33

Table 3. Effect of heat-treated on the true digestibility of the dry matter, organic matter and gross energy and on the true metabolizable energy of *V. unguiculata* grain.

Treatment	Digestibility (%)			True metabolizable energy, kcal/ kg
	Dry matter	Organic matter	Gross energy	
Treated	59.1	59.1	69.6	2997.0
Raw	53.0	52.3	65.9	2854.3
SE	2.5	2.4	16.4	70.8

There are diverse anti-nutritional effects of tannins in birds and pigs, which are not all well-known. The main effect is a reduction on both voluntary feed intake and digestibility of proteins and carbohydrates. This is basically a consequence of the tannins interaction with either dietetic fibre or protein developing complexes resistant to the digestive enzymes (Mueller-Harvey, 1999). Vernon (1999) pointed out that high amounts of tannins consumption, e.g. 1.03 g/day, are required to have negative effects on birds. In this study, *V. unguiculata* varieties showed higher true metabolizable energy values than those reported by Tshovhote *et al*. (2003), for three *Vigna* varieties, working with cockerels, a more mature bird. In addition, those values are comparable to TME values obtained from soybean meal (NRC, 1994).

CONCLUSIONS

The results suggest that this legume is a potential acceptable energy source for poultry diets. More research on the variety selection of this legume and on the identification of both its anti-nutritional factors and treatments to improve its nutritional value are required.

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