Energy Values of Traditional Ingredients and Sugarcane Yeast for Laying Hens

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ABSTRACT

An experiment was conducted to determine the chemical composition and apparent metabolizable energy (AME) and apparent metabolizable energy corrected for nitrogen balance (AMEn) values of corn, soybean meal (SBM), soybean oil (SO) and sugarcane yeast (SY) (*Saccharomyces cerevisiae*). A metabolism trial was performed with 120 Dekalb White laying hens at 65 weeks of age, using the method of total excreta collection. Birds were housed in metabolism cages and distributed according to a completely randomized design into five treatments with, six replicates of four birds each. The experimental period consisted of four days of adaptation and four days of excreta collection. The experimental diets included: a reference diet based on corn and SBM and four test diets containing 40% corn, 30% SBM, 10% SO or 30 % SY. The chemical compositions of the tested ingredients, expressed on "as-is" basis were: 86.9, 87.29, 87.32 and 99.5% dry matter; and 3.51, 2.08, 99.31 and 0.03 ether extract for corn, SBM, SO and SY, respectively. Corn, SBM, and SO presented 7.33, 43.61 and 24.64% crude protein, and 0.58, 5.07 and 6.77% ash, respectively; and crude fiber contents of corn and SBM were, respectively, 2.24% and 3.56%. The following AME and AMEn (kcal/kg dry matter) values were obtained: 3,801 and 3,760 kcal/kg for corn, 2,640 and 2,557 kcal/kg for SBM, 8,952 and 8,866 kcal/kg for SO, and 1,023 and 925 kcal/kg for sugarcane yeast, respectively.

INTRODUCTION

Despite the ongoing research on the use of unconventional feedstuffs poultry diets, feed formulations are still primarily based on corn and soybean meal, which are the main sources of protein and energy. However, in order to obtain better energy balance, it is necessary to include vegetable oils and/or fats in the diet (Pucci *et al.*, 2003; Silva *et al.,* 2009a,b). The nutrition of laying hens is an important tool to ensure the high levels of production achieved by modern commercial strains (Rabello *et al.,* 2007; Silva *et al.,* 2009b). Feed metabolizable energy is a very important factor to be considered.

Oils and fats are ingredients used as concentrated energy sources and allow the formulation of high energy diets for poultry (Rabello *et al.,* 2007; Silva *et al.,* 2009b). Fat is usually introduced in the feed formula because of its energy content. However, fats have several other advantages that have not been considered, although very important. From the economic point of view, it is necessary to take into account their caloric value (2.25 times greater than that of other feedstuffs); feed savings due to improvements of feed conversion; and the possibility of

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the effective use of fats in low-cost diets (Mazalli *et al.,* 2004; Silva *et al.,* 2009b). A comparison of vegetable oils and animal fats showed that the use of vegetable oils for poultry is metabolically important due to their high unsaturated fatty acid content, particularly oleic, linoleic and linolenic acids (Mazalli *et al.,* 2004; Rabello *et al.,* 2007).

Soybean meal is a highly available protein feedstuff in the domestic market because of the significant production of soybeans and its processing for oil extraction. Soybean meal it is the main protein source used for monogastric feeds. Among plant protein feedstuffs, the protein of soybean meal has an excellent amino acid profile (Café *et al.,* 2000).

Nutritionist are constantly seeking to formulate economically viable and efficient feeds, increasing the need for research related to the chemical composition and digestibility of nutrients of feedstuffs (Nunes *et al.,* 2005; Silva *et al.,* 2010).

Considering that poultry regulate their feed intake according to their metabolizable energy intake, it is very important determine the metabolizable energy values of feedstuffs (Rostagno *et al.,* 2005). Thus, this experiment was conducted to determine the chemical composition and metabolizable energy values of corn, soybean meal (SBM), soybean oil (SO) and sugarcane yeast (SY) for commercial laying hens.

MATERIAL AND METHODS

A metabolism trial was conducted at the experimental layer house of the Department of Animal Science of the Federal Rural University of Pernambuco. One hundred and twenty 65-week-old Dekalb White hens were housed in cages measuring 1.00×0.40×0.45 cm. Five treatments with six replicates of four birds each, distributed according to a completely randomized design were used. The birds were uniformly distributed in the experimental units, considering body weight and egg production.

Birds were fed a basal diet (BD) consisting of corn and SBM, formulated to meet their nutritional requirements, according to Rostagno *et al.* (2005), as shown in Table 1. The test diets (TD) were obtained by replacing BD with the test ingredient on "as fed" basis. The treatments consisted of one BD and four TD (TD1=40% corn+60% BD; TD2=30% SBM+70% BD; TD3= 30% SY+70% BD or TD4=10% SO+90% reference diet).

Table 1 - Composition of basal diet on "as fed" basis

Feed ingredients (%)	
Corn	60.047
Soybean meal 45%	26.414
Dicalcium phosphate	1.375
Limestone	9.837
Soybean oil	1.573
Salt	0.334
DL-Methionine 99%	0.020
Vitamin, mineral and amino acid suplemment[1]	0.400
Total	100.000
Nutritional composition [2]	
Metabolizable energy, Mcal/kg	2.77
Crude protein, %	17.00
Calcium, %	4.20
Available phosphorus, %	0.35
Digestible lysine, %	0.80
Digestible methionine+cystine, %	0.61
Digestible threonine, %	0.58
Potassium, %	0.66
Sodium, %	0.15
Linoleic acid, %	2.12

[1]Vitamin, mineral, and amino acid supplement (composition/kg of product): Vit. A: 2,000,000 IU, Vit. D3: 575,000 IU, Vit. E: 3,750 mg, folic acid: 125 mg, calcium pantothenate: 1,750 mg, biotin: 3.75 mg, niacin: 5.000 mg, pyridoxine: 425mg, riboflavin: 750 mg, thiamine: 50 mg, vit. k3: 250 mg, vit.b12: 2,500 mcg, choline: 52.19 g, selenium: 62.5 mg, iron: 7,500 mg, copper: 19,750 mg, manganese: 15,000 mg, zinc: 15,000mg, iodine: 250 mg, methionine: 247.5 g, colistin: 2,000mg. [2] Values calculated according to the table Rostagno *et al.* (2005), expressed as percentages.

The method of total excreta collection was applied to determine apparent metabolizable energy (AME) and apparent metabolizable corrected for nitrogen (AMEn) values of each ingredient. Feed and water were provided *ad libitum* throughout the experimental period, which included four days of adaptation and four days of total excreta collection. Powdered ferric oxide was included in the feed as fecal marker of the beginning and end of the total excreta collection at 1.0% of the diet. At the end of the experiment, test diet intake was recorded per experimental unit.

During the period of excreta collection, trays lined with plastic were placed under the floor of each cage to prevent any losses. Excreta were collected twice daily (08:00 am and 4:00 pm), placed in duly identified plastic bags, and stored in a freezer at -20° C until the end of the collection period. Minimum and maximum temperatures were also recorded inside the house during the experiment.

At the end of the experiment, fecal samples were thawed, weighed, homogenized per experimental unit, and aliquots were removed for laboratory analyses. Samples taken from the pool of excreta were pre-dried in a forced-ventilation oven at ± 55° C for 72 h. The analyses of the ingredients were performed

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at the Animal Nutrition Laboratory of the Department of Animal Science of the Federal Rural University of Pernambuco (dry matter, nitrogen, ether extract, ashes, and crude fiber) and Federal Rural University of do Semi-Arid (gross energy). The analyses were determined according to Silva & Queiroz (2006). Crude protein was calculated nitrogen content ×6.25.

Based on laboratory results, the coefficient of apparent metabolizability of dry matter (CDM), and feedstuff AME and AMEn were calculated according to the equations proposed by Matterson *et al.* (1965). Based on the GE and AMEn contents of the diets and the feedstuffs, the coefficients of gross energy metabolizability were calculated as CME= (AMEn/GE)×100.

Results were analyzed using SAS statistical package (User's Guide, 2008). Data were subjected to a descriptive statistics and one-way ANOVA and subsequently to the test of Tukey for multiple comparisons in order to assess the statistical significance of differences between all possible pairs of means.

RESULTS AND DISCUSSION

The chemical composition of the feedstuffs is shown in Table 2. The obtained corn and SBM DM contents are consistent with the values reported by Maia *et al.* (2002), of 87.04% for corn and 87.44% for SBM. The obtained SO DM value is in agreement with the 99.30% reported by Pucci *et al.* (2003) . Sugarcane yeast DM value were higher than those reported in literature, of 92.23% (Faria *et al.*, 2000), 95.75% (Furlan *et al.*, 2003) and 90.85% (Rostagno *et al.*, 2011).

Corn crude protein (CP) was close to the finding of 7.51% (Pucci *et al.,* 2003), but lower than 8.40% (Maia *et al.,* 2002), 8.5% (Furlan *et al.,* 2003), 9.77% (Silva *et al.,* 2009a). The determined SBM CP values

are in agreement with the values of 49.4 and 44.5% reported by Marques *et al.* (2000) and Silva *et al.* (2009a), respectively.

The obtained corn´s ether extract (EE) contents are consistent with those reported in literature, between 3.80% (Maia *et al.*, 2002) and 5.08% (Silva *et al.*, 2009a), which latter value was obtained with low-density corn. The obtained EE results agree with the findings of Rostagno *et al.* (2011), of 99.60% EE, and of Silva *et al.* (2009a), of 99.24%. The determined sugar cane yeast´s EE content was lower than that obtained by other authors, of 0.48% (Rostagno *et al.* (2011) and 0.74% (Maia *et al.*, 2002).

Crude fiber (CF) content of corn was close to the value of 2.48%, whereas SBM was lower than the 4.23% obtained by Maia *et al.* (2002). Literature values of corn´s ash content range from 1.05% for high-density corn to 1.60% for low-density corn (Silva *et al.*, 2008). Also, SBM´s ash content was reported between 5.90% (Rostagno *et al.*, 2011) and 6.3%, (Pozza *et al.*, 2006). SY´s ash content reported by Silva *et al.* (2008) was 11.14%, whereas Rostagno *et al.* (2011) found 3.36%.

The contents of the GE of Corn, SBM and SO obtained in the present study were consistent with those found by Rostagno *et al.* (2011) of 3,925, 4,079 and 9,333 kcal/kg, respectively, and also with Silva *et al.* (2009a) ,of 3,875 and 4,172 kcal/kg for corn and SBM, respectively. Faria *et al.* (2000) found 4,157 kcal/kg GE for SY, which was higher than that obtained in the present study.

One of the explanations for the differences in yeast´s chemical composition, according to Salgado (1976), is that the number of times sugarcane is washed with water to remove impurities from yeast milk or vat bottom during alcohol distillation may significantly change its composition. The production method, which in turn varies with substrate, microorganism, and

Table 2 – Feedstuff chemical composition and gross energy content, on "as-fed" and dry matter basis (DM).

Composition, %	Ingredients							
	Corn		Soybean meal		Soybean oil		Sugar cane yeast	
	As-fed	DM	As-fed	DM	As-fed	DM	As-fed	DM
Moisture	13.1		12.71		0.5		12.68	
Dry matter	86.9		87.29		99.5		87.32	
Crude protein	7.33	8.43	43.61	49.96	-		24.64	28.22
Ether extract	3.51	4.04	2.08	2.38	99.31	99.81	0.03	0.03
Crude fiber	2.24	2.58	3.56	4.08	-		-	
Ash	0.58	0.67	5.07	5.81	-		6.77	7.75
Gross energy, kcal/kg	3,895	4,482	4,178	4,790	9,109	9,155	3,945	4,520

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drying method, also contributes to changes in yeast chemical composition (Freitas *et al.*, 2013). Relative to corn and SBM, cultivar and processing method may also affect their chemical composition.

Table 3 shows the means and standard deviations of feed intake (FI), coefficient of apparent metabolizability of DM (CDM) and AME and AMEn values of the experimental diets, on DM basis.

The test diets containing 40% corn grains and 30% SBM promoted statistically lower feed intake compared with the BD. The TD with of the 10% SO diet was close to those two diets (corn and SBM).

The high energy and protein levels of the test diets limited feed intake. However, the feed intake of the 10% SO diet was not different from the other diets, except for the SY diet, which feed intake was significantly different from the other test diets. However, the higher intake of the feed with SY inclusion may be explained by the fact that this feed was nutritionally imbalanced, and therefore, birds ate more to meet nutritional needs compared with those fed the BD.

The highest CDM values were obtained with 40% corn inclusion and 10% SO inclusion in the diets, but the latter was the only one not statistically different from the BD. The diet with 30% SY inclusion presented the lowest CDM, and was statistically different from the other treatments.

Under *ad libitum* intake, AME values are higher than AMEn values when nitrogen retention is positive (Wolynetz & Sibbald, 1984); therefore, the amount of N retained in this study was greater than zero, and consequently, AME exceeded AMEn, with means of 3,342 kcal/kg and 3,231 kcal/kg, respectively. AME values were different among the tested diets, except for the diet with 40% corn and 30% SBM, which was not different from the BD. However, the diet with 10%

SO presented the highest AME value (4,127 kcal/kg), whereas the SY diet had the lowest AME value (2,584 kcal/kg).

Table 4 shows the means and standard deviations of CDM, AME, AMEn and CME of corn, SBM, SO and SY submitted to the different substitutions. Data are expressed on DM basis.

The CDM was not different among the feed ingredients, with corn presenting the highest and SY the lowest values, with 87.86% and 28.94%, respectively. The obtained AMEn values accounted for about 98.1 and 96.8% of the AME value obtained for corn and SBM. The AMEn of SY represented approximately 96.1% of the value obtained for the AME. These ratios were similar to the values obtained by Franqueira *et al.* (1979) and Albino *et al.* (1981).

The coefficient of apparent metabolizability of gross energy of corn are close to the values found by Vieira *et al.* (2007), who reported a range of 75 to 88%, which variation, according to the authors, is related to corn grain texture. As for SBM, the obtained value was higher than the 43.5% reported by Pozza *et al.* (2006) in layers. The CME of SY was lower than that obtained with corn and SBM. The low AME and AMEn values of SY may be related with SY indigestible cell wall, which reduces the bioavailability of proteins. The presence of physiologically-active substances and allergens, such as high nucleic acid concentration in disrupted cells are problematic. The association of protein with nucleic acid is not desirable as it may induce the elevation of blood uric acid (Knorr *et al.,* 1979).

There is a wide variation in the utilization of ingredients with high fiber and fat in levels ingredients can provide larger variation in use of its energy (Silva *et al.*, 2009a). In present study, the largest difference was found in SO energy value. The information provided

Table 3 – Means and standard deviation (SD) of feed intake, coefficient of apparent metabolizability of dry matter and energetic values of the experimental diets on "dry matter" basis.

Diets, %	Feed intake g/unit	CDM %	AME kcal/kg	AMEn kcal/kg
BD	1,481±56.4 [bc]	75.12±1.2 [c]	3,298±28 [bc]	3,186±45 [b]
BD+40% Corn	1,172±184.6 [a]	83.10±7.3 [d]	3,602±260 [c]	3,504±226 [c]
BD+30% SBM	1,225±171.4 [a]	66.38±1.1 [b]	3,102±35 [b]	2,999±31 [b]
BD+10% SO	1,343±165.7 [ab]	78.14±10.1 [cd]	4,127±308 [d]	3,987±261 [d]
BD+30% SY	1,604±76.7 [c]	60.16±3.1 [a]	2,584±95 [a]	2,481±83 [a]
Means ± SD	1,365±57.73	72.58±1.48	3,342±8	3,231±7
F	9.59	39.01	56.88	74.23
CV, %	10.36	4.99	5.58	4.95

Means within a column lacking a common superscript [a,b,c,d] differ p<0.05. CDM, coefficient of apparent metabolizability of dry matter; AME, apparent metabolizable energy; AMEn apparent metabolizable energy corrected for nitrogen balance. BD, basal diet; SBM, soybean meal; SO, soybean oil; SY, sugarcane yeast; CV, coefficient of variation.

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Table 4 – Means and standard deviation (SD) of feed intake, coefficient of apparent metabolizability of dry matter and energetic values of the experimental diets on "dry matter" basis.

Ingredients	CDM	AME	AMEn	CME
	%	kcal/kg	kcal/kg	(%)
Corn	87.86±3.16	3,801±129	3,760±120	83.90±2.68
Soybean meal	45.79±3.52	2,640±119	2,557±103	53.43±2.15
Soybean oil	-	8,952±237	8,866±201	97.33±2.85
Sugarcane yeast	28.94±2.42	1,023±87	925±77	20.47±1.58
Means	54.2	2,488	2,414	52.6
SE	1.25	0.05	0.04	0.89
CV, %	5.66	4.54	4.15	4.16

CDM, coefficient of apparent metabolizability of dry matter; AME, apparent metabolizable energy; AMEn apparent metabolizable energy corrected for nitrogen balance. SE, standard error of the mean; CV, coefficient of variation.

in feedstuff tables should only be used as guidelines, because the anti-nutritive compounds in ingredients may affect nutrient utilization, depending on bird class and age (Silva *et al.*, 2009a). The results demonstrated that laying hens can best utilized the use best energy of traditional ingredients studied.

CONCLUSIONS

The chemical composition and gross energy content of the ingredients tested showed little variation compared with literature data. The apparent metabolizable energy corrected for nitrogen values determined for corn, soybean meal, crude soybean oil and yeast sugar cane were 3,267, 2,232, 8,822, and 808 kcal/kg on "as fed" basis, respectively.

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