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Digestibility of Diets Containing Cara Flour (*Dioscorea trifida* L.) For Laying Hens

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Abstract: The objective of this study was to evaluate the apparent digestibility of nutrients and metabolizable energy of diets containing cará flour using commercial laying hens. A total of 72 birds were used as Hissex White lineage at 23 weeks of age with water and food *ad libitum*. The birds were distributed in a completely randomized design, where the treatments consisted in two levels of inclusion of cará flour (*Dioscorea trifida* L.) in diets (control-0% and experimental treatment-25%, respectively) and six replicates of six birds each. The digestibility of dietary nutrients was determined using the method of total collection of excrements. Data collected were subjected to analysis of variance and means compared by Tukey test at 5% probability. Significant differences were found in reply to treatments ($p<0.05$) for the coefficients of digestibility of dry matter, nitrogen free extract, ether extract and metabolizable energy, being the best results obtained in the experimental diets containing 25% of cara flour in its composition. The inclusion of 25% cara flour in diets for laying hens positively affected the apparent digestibility of nutrients, obtaining better results in the apparent digestibility coefficients and involving mainly on changes in energy metabolism of feed, causing apparent improvement in nutrient passage rate.

Key words: Laying hens, cara, energy, energetic metabolism, alternative food

INTRODUCTION

Many methodologies to assess the digestibility of nutrients in diets for poultry have been the object of studies conducted in the last three decades in the global poultry segment (Hartel, 1986; Albino *et al*., 1992; McNab, 1996; Zelenka, 1997). Among the various methods used in the determination of the energy values of food for birds, stand out from the traditional total excreta collection (Sibbald and Slinger, 1963), the precise feeding (Sibbald, 1976) and quick method (Farrell, 1978). However, the total excreta collection method is still the most widely used to determine the corrected apparent metabolizable energy (AMEn).

The use of a nutrient by the bird depends on the digestion and absorption of macromolecules, which requires enzymatic hydrolysis. The availability of energy from the metabolism of carbohydrates regardless if from purified source or ingredients rich in this nutrient, lower on the first day of age of the birds, is highly dependent on age, due to the amylase activity profile in the pancreas and intestine slender (Donaldson *et al*., 1992). According to Andriguetto (1999), the digestibility can be defined as the fraction of the consumed food is not recovered in the faeces. When this fraction not recovered in faeces is expressed as a percentage of intake, gives the digestibility coefficient (DC). Difficulties in determining the digestibility of nutrients in birds are larger compared to other animals, because the faeces and urine are removed together causing a mixing of the urinary fecal nitrogen. In this situation, one obtains the metabolization of nutrients, which are expressed in total metabolized nutrients, apparent or accurate.

The food chemistry directly influences the metabolizable energy content, which in turn, besides being used to evaluate the nutritional value of food, is the best measure to express the available energy of the food and the energy required by the birds (Nascimento *et al*., 1998).

The knowledge of the energy content of food is indispensable in feed formulation for monogastric, it's necessary to provide an adequate amount of energy and nutrients so that these animals can express the most of their productive potential (Oliveira Neto *et al*., 2000).

The cara (*Dioscorea trifida* L.) is a species of edible yam originating in South America, which together with other important species economically the genus Dioscorea, is maintained by small traditional farmers. Your tubers have in their composition carbohydrates, proteins, minerals and vitamins as well as antimicrobial, diuretic and energizing properties (Ramos-Escudero *et al*., 2010).

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The carbohydrate digestion takes place both in the lumen as in brush border membrane of enterocytes of the small intestine. The pancreatic amylase enzyme hydrolyzes the starch of diet in oligosaccharides (maltose, maltotriose) and dextrins. The end digestion of these products, as well as hydrolysis of the disaccharides (sucrose, trehalose and lactose) occurs in the membrane of the enterocytes disaccharidases (Chotinsky *et al*., 2001). Thus, the aim of this study was to evaluate the apparent digestibility and metabolizable energy of cará flour in diets of commercial laying hens.

MATERIALS AND METHODS

The experiment was conducted in the Poultry Sector of the College of Agrarian Sciences, located in the southern sector of the university campus in the Federal University of Amazonas (UFAM), Manaus-AM, Brazil, with geographic coordinates of latitude 3°06' 14'' S, longitude 59°58' 46'' W. According to the classification proposed by Kappen, the climate is classified as tropical hot and humid, with average annual rainfall of 2.286 mm and average temperature between 27-29°C (INMET, 2014).

The experimental aviary used has asbestos cement roof measuring 17.0 m long, 3.5 m wide and 3.20 m of ceilings, with a row of wire cages on each side, feeders type trough and drinkers type nipple. All birds were weighed at the beginning of the experiment for standardization of parcels and showed average weight of 1.65±0.074 kg.

The experimental period was 12 days, with 7 days of adaptation of birds to feed and the facilities and another 5 days for stool collection and data according to the proposal methodology for Rodrigues *et al*. (2005) and Sakomura and Rostagno (2007).

During the experimental period, the birds receive 16 hours of light (natural+artificial). The temperature and relative humidity inside the shed were recorded twice daily (9 and 15 hs) through a digital thermohygrometer positioned at the level of the birds and showed means of 33.4°C and 82.6%, respectively.

72 layer hens Hissex White were used at 23 weeks of age housed in 12 cages sized in 1.0 x 0.45 m x 0.45 m with internal partitions 0.50 m in the length direction. The birds were distributed in a completely randomized design with the treatments consisted of two levels of inclusion of cará flour (*Dioscorea trifida* L.) in diets (control treatment-0% and experimental treatment-25%, respectively) and six replicates of six birds each.

The chemical composition of cará flour was determined in fish nutrition laboratory of Instituto Nacional de Pesquisas da Amazonia-INPA according to the methodology proposed by Silva and Queiroz (2002) and the results are shown in Table 1.

The isonutritives diets were formulated according to the amounts of the ingredients provided by the Brazilian Tables for Poultry and Swine (Rostagno *et al*., 2011), except cara flour composition and are shown in Table 2.

Table 1: Chemical composition of cara flour

Fractions	Composition
Dry matter, (%)	95.54
Crude protein, (%)	2.65
Crude fiber, (%)	2.69
Neutral detergent fibre, (%)	7.45
Acid detergent fibre, (%)	3.64
Ethereal extract, (%)	0.31
Mineral matter, (%)	3.23
Nitrogen free extract, (%)	86.66
Gross energy, (Kcal/kg)	3730.73
Metabolizable energy, (Kcal/kg)	3489.81

Table 2: Composition of the experimental diets containing cara flour

	---------- Experimental diets ----------	
Ingredients	Reference diet	Diet with 25% of Cara flour
Corn 7,88%	62.303	33.847
Soybean Meal 46%	25.657	29.051
Cara Flour	0.000	25.000
Calcareous	9.239	9.196
Fosfato bicalcico	1.695	1.751
Premix Vit. Min.[1]	0.500	0.500
Salt	0.350	0.350
DL-Met 99	0.256	0.305
Total (kg)	100.00	100.00
Nutrients	---------- Nutritional Levels ----------	
Metabol energy, (kcal/kg)	2.697	2.705
Crude Protein, (%)	17.000	17.000
Methionine+Cystine, (%)	0.786	0.786
Methionine, (%)	0.518	0.547
Calcium, (%)	4.000	4.000
Available phosphorus, (%)	0.400	0.400
Sodium, (%)	0.156	0.151

[1]Assurance levels per kilogram of product: Vitamin A 2.000.000 UI, Vitamin D3 400.000 UI, Vitamin E 2.400 mg, Vitamin K3 400 mg, Vitamin B1 100 mg, Vitamin B2 760 mg, Vitamin B6 100 mg, Vitamin B12 2.400 mcg, Niacin 5.000 mg, Calcium Pantothenate 2000 mg, Folic Acid 50 mg, Cocciostatic 12.000 mg, Hill 50.000 mg, Copper 1.200 mg, Iron 6.000 mg, Manganese 14.000 mg, Zinc 10.000 mg, Iodine 100 mg. Selenium 40 mg. Vehicle Q.S.P. 1.000 g

The digestibility of dietary nutrients was determined using the total collection of excrements. These were collected twice a day, beginning in the morning and in late afternoon and then packed in airtight bags identified as treatment and stored in a freezer to be frozen. At the end of the excreta collection period, the samples were thawed at ambient temperature, homogenized and destined for chemical analysis, following the techniques described by Silva and Queiroz (2002).

After these analyzes, it was determined the nutrients digestibility coefficients and coefficients of metabolization of energy of the diets studied as conventional technique Matterson for evaluation of foods (Sakomura and Rostagno, 2007), except for the determination of the energy coefficients that followed the methodology proposed by Junior *et al*. (1998) and Rostagno *et al*. (2011).

The data collected were subjected to analysis of variance and means compared by Tukey test at 5% probability, using the computer program Statistical Analysis System SAS (2008).

RESULTS AND DISCUSSION

The results of the variables related to the apparent digestibility coefficients of nutrients of the experimental diets are shown in Table 3. Significant differences were found in reply to treatment ($p<0.05$) for the digestibility coefficients of dry matter, of extract nitrogen free and of ether extract, being the best coefficients obtained with the experimental diet containing 25% of cara flour in its composition.

The results obtained can be attributed to intrinsic differences in the nutritional composition of cara flour upon other foods. Although the digestive process in adult birds is complete physiologically (Macari *et al*., 2002), the presence of high energy in the experimental diets may have increased intestinal motility stimuli in such a way to increase the absorption efficiency of the digestive tract.

In the ether extract and nitrogen free extract or energy fraction of the feed, according to Van Soest (1994), the generation of volatile fatty acids, energy metabolism and other beneficial products generated by the microbial biomass can be very limited and variable depending on the symbiosis with the host or of complexity of fiber polysaccharides, i.e., metabolism of fats is in part attributed to the relationship between microbial flora of animals with the host concomitantly with enzymes action for transformation of fat molecules. The presence of fat in the diet can increase the use of energy from other components of the diet and increase the transit time of food through the gastrointestinal tract, promoting greater digestion and better absorption of food nutrients (Mateos *et al*., 1996).

No significant differences were found ($p>0.05$) for the digestibility coefficients for crude protein, crude fiber and mineral matter. Even in low range, the fiber content is also presented as a factor influencing the results to variation in digestibility coefficients of apparent metabolizable energy, where according to Classen (1996), the soluble fraction of the fiber produces negative effects on the use of nutrients by the birds, associated with increased intestinal viscosity and the morphological and physiological changes in the digestive tract, changing considerably in the use of nutrients and consequent change in its passage rate in the gastrointestinal tract.

According to Sakomura *et al.* (1998, 2004) with increasing fat content in the feed can occur benefits related to extra caloric effect of fats which consists of increasing the nutrient availability of other feed ingredients and the fat extrametabolic effect that results in improved energy efficiency due the increase in net energy ratio due to the lower heat increment of fats.

The results of the digestibility coefficients of apparent metabolizable energy and metabolization of apparent metabolizable energy of the experimental diets are shown in Table 4. Significant differences were found between treatments ($p<0.05$) for the digestibility coefficients of apparent metabolizable energy to the diet containing 25% of cara flour showing better results.

Table 3: Apparent digestibility coefficients of diet control and experimental diet (containing 25% of cara flour) for commercial laying hens

Digestibility coefficients (%)	Reference diet	Diet with 25% of cara flour	P-value	CV (%)
Dry matter	66.68^{b}	69.62^{a}	0.05*	3.33
Crude protein	72.51	74.93	0.21^{ns}	2.54
Crude fibre	72.24	74.68	0.19^{ns}	2.58
Nitrogen free extract	63.98^{b}	67.15^{a}	0.04*	3.74
Ethereal extract	76.48^{ab}	78.55^{a}	0.05*	2.07
Mineral matter	66.86	69.78	0.22^{ns}	3.31

CV: Coefficient of variation; *Means followed by lowercase letters in the line differ by 5% of Tukey test ($p<0.05$); ns: not significant

Table 4: Digestibility coefficients of apparent metabolizable energy and the apparent metabolization of metabolizable energy of the control diet and the experimental diet (containing 25% of cara flour) for commercial laying hens

Digestibility coefficients (%)	Reference diet	Diet with 25% of cara flour	P-value	CV (%)
AMEn[1]	2999.18^{b}	3053.47^{a}	0.05*	3.33
CMAMEn[2]	91.16	91.35	0.24^{ns}	2.86

CV: Coefficient of variation; *Means followed by lowercase letters in the line differ by 5% of Tukey test ($p<0.05$); ns: not significant

[1]Apparent Metabolizable Energy (Rostagno *et al*., 2011)

[2]Coefficient of metabolization of Apparent Metabolizable Energy (Junior *et al*., 1998)

Lima *et al.* (2007) according to the results obtained in their work with coconut meal digestibility in feed for laying hens, assures that the increase in digestibility and registered ME values can be attributed to the increased amount of fat in the diets.

In relationship of the values of AMEn with fiber of diet, the results of this study show increased availability of the energy diet with higher fiber content compared to the works of Carre *et al.* (1995), Francesch *et al.* (2002) and Pinheiro *et al.* (2008).

The results obtained for energy quality of diets with cará flour indicate that attention should be paid to the composition and values of MS of the product, because of the changes that were promoted in nutrient digestibility evaluated as observed in studies with other alternative foods (Leeson *et al*., 1991; Leeson *et al*., 1992).

Thus, besides the evaluation of the metabolizing of nutrients and energy, nutritional evaluation of alternative foods with poultry lineages for egg production on an industrial scale is an investigative action of great technical and scientific value, considering the lack of information on the Brazilian regional diversity which in many cases is not fully exploited.

Conclusion: The inclusion of 25% of cará flour in diets to laying hens positively affected the apparent digestibility of nutrients, obtaining better results in the digestibility of dry matter, ether extract, nitrogen free extract and metabolizable energy of nutrients. The cara flour mainly

provides changes in energy metabolism of feed, promoting apparent improvement in nutrient passage rate.

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