



Acta Scientiarum. Animal Sciences

ISSN: 1807-8672

Editora da Universidade Estadual de Maringá - EDUEM

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Acta Scientiarum. Animal Sciences, vol. 42, e46926, 2020

Editora da Universidade Estadual de Maringá - EDUEM

DOI: <https://doi.org/10.4025/actascianimsci.v42i1.46926>

Available in: <https://www.redalyc.org/articulo.oa?id=303162575038>

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Açaí meal on diet digestibility for commercial laying hens

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ABSTRACT. This study aimed to evaluate açai meal in diets for commercial laying hens on apparent nutrient digestibility and apparent metabolizable energy. A total of 72 Hissex White laying hens (52-wks-old) were distributed in a completely randomized design, where treatments consisted of a control diet and an experimental diet (25% açai meal) with six replicates of six birds each. Data collected were subjected to polynomial regression at 5%. Differences ($p < 0.05$) were detected in digestibility of all evaluated nutrients. Hens fed diets with 25% açai meal presented worse ($p < 0.05$) metabolization and use of energy content. It can be concluded that hens fed diets containing açai meal presented better use of crude protein, non-fiber carbohydrates and mineral matter. However, there was worse use of dry matter, fiber carbohydrates and ether extract. This result directly affected the energy metabolism of the birds. The inclusion of açai meal reduced the energy use.

Keywords: alternative food; nutritional use; metabolizable energy; agroindustrial waste.

Received on March 10, 2019.
 Accepted on October 22, 2019.

Introduction

Egg is one of the most complete foods in the human diet, with a rich composition of vitamins, minerals, fatty acids and proteins of excellent biological value (Rêgo et al., 2012). Nevertheless, when egg quality is unsatisfactory, there may be economic losses to industries until health damage to consumers (Vilela et al., 2016).

In this context, Brazilian poultry production stands out each year as an important international economic activity, being uniform and without geographical boundaries (Batalha et al., 2018). However, one of the obstacles faced by this sector in some Brazilian regions is the high dependence on corn and soybean meal, which tends to increase the cost of feed production (Cruz & Rufino, 2017).

This increasing demand for conventional feed used in poultry diets coupled with the high cost and their increasing use for human consumption, are the factors that have encouraged researchers in the search for so-called alternative feeds, especially ideal substitutes for corn (energy source) and soybean meal (protein source) (Hanna et al., 2013). Research has been conducted with alternative ingredients that have the potential for inclusion or substitution of conventional ingredients in poultry feed to minimize feed costs, which represent about 70% of total production costs (Cruz et al., 2016).

Amazon has innumerable native plant species with economic, technological and nutritional potential. These characteristics have attracted interest for scientific studies in several livestock areas (Hanna et al., 2013). Among these, açai stands out as the most important fruit in northern Brazil, mainly due to its nutritional characteristics (Cedrim et al., 2018).

Açaí pulp is the main product of the palm tree, classified into two species: *Euterpe oleracea* Mart., found in the Eastern Amazon, in the States of Amapá, Maranhão, Pará and Tocantins; and *Euterpe precatoria* Mart., which occurs on dry land or floodplains of the Western Amazon rivers in the States of Acre, Amazonas and Rondônia (Lima et al., 2014).

And despite the economic importance of açai pulp, it represents only 10% total mass of the fruit, and leftovers are discarded by the industry, and managed as agroindustrial waste. And due to the large volume of açai production in northern Brazil, there is a considerable amount of waste improperly disposed. All of this has the potential to produce byproducts and be used in livestock (Santos & Granjeiro, 2012).

From the above, the present study aimed to evaluate the digestibility of açai meal in the diet for light commercial laying hens.

Material and methods

The study was conducted at the facilities of the Poultry Sector of the School of Agrarian Sciences of the Federal University of Amazonas, Manaus, State of Amazonas, Brazil. All experimental procedures were previously evaluated and approved by the Ethics Committee on Animal Experimentation (CEUA) of the Federal University of Amazonas (protocol number 040/2018).

The experimental period lasted 12 days, considering seven days for bird adaptation to diets and facilities and more five days to collect feces and data according to the methodology proposed by Sakomura and Rostagno (2016). Seventy-two 52-week-old Hisex White laying hens were housed in 12 cages sized 1.0m in length, 0.45m in depth, 0.45m in height with 0.50m internal partitions. Birds were weighed to standardize the plots, presenting an average weight of 1.56 ± 0.058 kg.

The raw material called açai waste (seed + peel) was collected directly from the açai processing agroindustry located in Manaus, State of Amazonas. This product was the result of the last stage of filtration and pulping of the fruit via industrial processing.

The material was stored in 50 kg polyethylene drums in a dry environment under controlled temperature to prevent spoilage, and was immediately transported to the Poultry Sector for processing. Then, the material was selected in order to discard foreign objects and decomposing materials, then dried in the sun for 8 uninterrupted hours and then ground until homogeneous, thus obtaining the product called açai residue meal. The product obtained was identified, bagged and stored in a dry and ventilated place to be used to prepare the experimental diets.

Before the field experiments, the proximate composition of the açai meal was determined at the facilities of the Forage and Pasture Laboratory, Faculty of Agricultural Sciences, Federal University of Amazonas. Analyses were performed according to the methodology proposed by Silva & Queiroz (2002) for all the main parameters of evaluation of the proximate composition according to the Weende system (Dry matter - DM, Ether Extract - EE, Crude Protein - CP, Mineral Matter - MM, Crude Fiber - CF and Non-Nitrogen Extract - NNE), with the results listed in Table 1.

Table 1. Proximate composition of açai residue meal.

Proximate composition	Values
Dry matter, %	89.12
Crude protein, %	5.25
Ether extract, %	4.12
Mineral matter, %	6.64
Crude fiber, %	25.30
Non-nitrogen extract, %	58.69
Gross energy, kcal kg ⁻¹	5,389.16
Metabolizable energy, kcal kg ⁻¹	2,838.18

¹ Determined by the method for calculation of apparent metabolizable energy as described by Rostagno et al. (2017), obtaining the value in kcal kg⁻¹.

Isonutritive diets (Table 2) were formulated by the computer software SUPERCAC (2008) to meet the nutritional requirements of the animals and according to the values of the ingredients provided by the Brazilian Tables for Poultry and Swine (Rostagno et al., 2017), except for composition of the açai residue meal, which used the values obtained in the physical and chemical characterization of the product.

Dietary nutrient digestibility was determined using the total feces collection method. Feces were collected with trays coupled under the floor of the cages and lined with plastic, twice a day, early in the morning (08:00 hours) and late afternoon (16:00 hours), and then packed in airtight bags identified according to treatment and stored in a freezer.

At the end of the excreta collection period, samples were thawed at room temperature, homogenized by experimental unit and a composite sample was taken for drying in a forced ventilation oven at 55°C for 72 hours. They were then ground and together with the experimental diets sent for analysis of dry matter, crude protein, ether extract and crude fiber and ashes, according to the techniques described by Silva and Queiroz (2012).

After the analyses, the nutrient digestibility coefficients and feed energy metabolism coefficients were determined. Matterson conventional technique was used for food evaluation (Sakomura & Rostagno,

2016), except for the determination of energy coefficients that followed the methodologies proposed by Rostagno et al. (2017).

The collected data were tested by variance analysis (ANOVA), and then subjected to Tukey's test ($p < 0.05$), using the computer software Statistical Analysis System (SAS, 2008).

Table 2. Composition of diets used in the digestibility test.

Ingredients	Levels of açai residue meal	
	0%	25%
Corn (7.88%)	63.97	29.55
Soybean meal (46%)	23.51	27.17
Açai residue meal	0.00	25.00
Calcitic limestone	9.60	9.73
Dicalcium phosphate	1.98	1.78
Vit. Min. supplement ¹	0.50	0.50
Salt	0.35	0.35
DL-methionine (99%)	0.09	0.12
Soybean oil	0.00	5.80
Total	100.00	100.00
Nutrient	Nutritional levels	
Metabolizable energy, kcal.kg ⁻¹	2,750.50	2,750.50
Crude protein, %	16.00	16.00
Calcium, %	4.20	4.20
Available phosphorus, %	0.45	0.45
Crude fiber, %	2.50	8.42
Methionine, %	0.35	0.35
Methionine + cystine, %	0.60	0.56
Lysine, %	0.80	0.82
Threonine, %	0.62	0.58
Tryptophan, %	0.19	0.19
Sodium, %	0.15	0.15

¹ Guarantee levels per kg of product: Vitamin A 2,000,000 IU, Vitamin D3 400,000 IU, 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 2,000 mg, Folic acid 50 mg, Coccidiostatic agent 12,000 mg, Choline 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.

Results and discussion

The results regarding the apparent nutrient digestibility coefficients of the diets are listed in Table 3. Differences ($p < 0.05$) were detected in the digestibility of all evaluated nutrients.

Table 3. Apparent digestibility coefficients of the control diet and experimental diet containing 25% açai meal (FRA) for light commercial laying hens.

Digestibility coefficients (%)	Experimental diets		p-value	CV (%)
	Control	25% FRA		
Dry matter	69.30 ^a	69.23 ^b	0.01*	1.91
Crude protein	49.00 ^b	52.22 ^a	0.03**	15.27
Fiber carbohydrates	79.79 ^a	71.85 ^b	0.03**	4.01
Non-fiber carbohydrates	60.18 ^b	70.94 ^a	0.04**	13.90
Ether extract	63.77 ^a	61.99 ^b	0.05**	19.11
Mineral matter	48.75 ^b	50.64 ^a	0.01*	8.57

CV – Coefficient of variation; * Significant effect ($p < 0.01$). ** Significant effect ($p < 0.05$).

Hens fed diets containing 25% açai meal showed better utilization of crude protein, non-fiber carbohydrates and mineral matter. However, birds fed with these diets showed worse use of dry matter, fiber carbohydrates and ether extract.

As for nutrient digestibility, there was better utilization of crude protein, non-fiber carbohydrates and mineral matter in birds that consumed diets containing açai meal. And with the exception of mineral matter, both crude protein and non-fiber carbohydrates are nutrients highly dependent on the enzymatic digestion process (Rufino et al., 2017). Thus, any change in diets that interfere with these processes can lead to better or worse use of these nutrients (Cruz & Rufino, 2017).

In this case, the inclusion of açai meal and consequently the increase in the fiber content of the diets, provided a better utilization of these nutrients, which can be attributed to the positive effect that the fiber

has on the development and functionality of the gizzard. In this case, through the activity of grinding and retention of food in the organ until it reaches an approximate size of 0.1 mm (Rufino et al., 2017), there is an increase of the contact surface of nutrients with gastric secretions, as well as gastroduodenal reflux, which, in addition to increasing the release of cholecystokinin stimulating the secretion of pancreatic enzymes, provide longer activity of digestive enzymes improving digestibility and nutrient absorption (Mateos et al., 2012).

In contrast, there was a different behavior in the utilization of nutrients that are not totally dependent on enzymatic digestion, such as dry matter, which represents the nutrients in general, fiber carbohydrates and ether extract, which represents fat. In this case, there was a worse utilization of these nutrients, which can be attributed to both the high content of dietary fiber in relation to the control diet and the type of fiber that was used, especially soluble fiber.

This type of fiber has a high capacity to absorb water and form gelatinous substances in the intestinal tract, impairing both the mixture of food ingested with digestive juices and the access of enzymes to food nutrients, inhibiting digestion and absorption of nutrients in general (Rufino et al., 2017). Kunrath et al. (2010) also state that the choice of a product of plant origin, especially from an alternative nature, is directly related to the type and content of fiber present in this raw material. Higher contents of peel in the meals of these ingredients may result in higher fiber contents, especially cellulose, hemicellulose and pectin.

And according to Braz et al. (2011), non-starch polysaccharides, such as hemicelluloses, pentosans and β -glucans, and oligosaccharides, such as raffinose and stachyose, may also cause problems to animal nutrient digestibility due to their structural properties. Rufino et al. (2017) include in this group pectins, stating that all these structural components may have anti-nutritional effects in feed for poultry, especially young birds.

The results regarding the energetic metabolism of the diets are listed in Table 4. Laying hens fed diets containing 25% açai meal presented worse ($p < 0.05$) metabolization and utilization of energy content. The behavior observed in nutrient utilization was reflected in energy metabolism, where any changes in nutrient utilization directly related to energy production affect the entire energy metabolism (Rufino et al., 2017). This finding was verified both in the energy metabolized by the animal, and in the percentage utilization of this energy in relation to the content supplied in the experimental diets.

Table 4. Apparent Metabolizable Energy (MEa) and Apparent Metabolizable Energy Metabolization Coefficient (CMEMa) of the control diet and experimental diet containing 25% açai meal (FRA) for light commercial laying hens.

Digestibility coefficient (%)	Experimental diets		p-value	CV (%)
	Control	25% FRA		
EMa	3,644.06 ^a	3,422.29 ^b	0.01*	2.70
CMEMa	94.92 ^a	91.54 ^b	0.01*	2.73

CV – Coefficient of variation; * Significant effect ($p < 0.01$).

Tavernari et al. (2010) reported that variations in metabolizable energy values for birds fed high-fiber cereal-based diets are directly related to the digesta passage rate and utilization of nutrients absorbed especially in the small intestine through crypts and villi. Wesendonck et al. (2013) complement by stating that the inclusion of high fiber ingredients in diets for monogastric animals causes significant changes in the digestive metabolism of poultry, affecting from voluntary feed intake to nutrient utilization by metabolism.

Van Soest (1994) argues that with increasing dietary content of soluble fiber, there is an increase in intestinal viscosity and a subsequent decrease in the contact of the enzyme with the digesta and a decrease in the rate of passage. And this set of factors causes lower nutrient utilization and increased fecal excretion.

Conclusion

In conclusion, laying hens fed diets containing açai meal showed better utilization of crude protein, non-fiber carbohydrates and mineral matter. However, animals obtained worse use of dry matter, fiber carbohydrates and ether extract. This result directly affected the energy metabolism of the birds, where the inclusion of the açai residue meal reduced the energy use.

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