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Full Length Research Paper

Carcass and non-carcass characteristics of sheep fed with açaí seed meal-based diet

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The byproducts of agricultural processes have great potential as a source of low cost animal feed. In this paper we assess the potential of açaí palm (*Euterpe oleracea* Mart.) seed as a food source for sheep. Sixteen non-castrated male sheep with average initial body weight of 22 kg were randomly assigned to one of four diet treatments, using initial body weight as a covariate. The diets consisted of coastcross hay and a variable proportion of açaí seed meal (0, 5, 10 and 15% - DM basis) added to feed concentrate at a ratio 60:40 (roughage:concentrate). The animals were slaughtered at the end of the experiment to measure carcass and commercial cuts dressing of each animal. No treatment effect on carcass, commercial cuts and non-carcass components dressing was detected, but significant effect on daily weight gain and shoulder dressing was observed. Açaí seed meal added to the diet up to 15% in replacement with forage during dry seasons does not seem to compromise carcass and non-carcass components and is therefore a potentially valuable and low cost component of sheep feed.

Key words: By-product, organs, performance, sheep, viscera.

INTRODUCTION

The nutritional management of the animal can affect meat quality and weight, carcass yield and retail cuts, which are extremely important for measuring the animal process of meat production (Lage et al., 2014). Non-traditional by-products of the agricultural industry are a potentially valuable alternative source of animal feed which may decrease dependence on traditional feed products and decrease overall feeding costs (Gomes et al., 2012). One of the most promising alternative sources of ruminant feed is the açai palm (*Euterpe oleracea* Mart.), a native tree from the Brazilian tropical region with strong economic, social, and cultural importance for the northern region of Brazil. Açai, a fruit indigenous to the Amazon, is rich in phytochemicals that possess high antioxidant activities and have anti-inflammatory, anticancer, and anticardiovascular disease properties. However, little is known about its potential effects in animals.

There are several reasons to assume that the by-products of processing may be suitable as a food source for ruminants. From a chemical perspective, seeds (a major byproduct of the pulping process) have an NDF

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Table 1. Ingredients and chemical composition of experimental diets (dry matter basis).

Item	Proportion of açaí seed meal			
	0	5	10	15
Ingredient composition (%)				
Coast cross hay	40.0	35.0	30.0	25.0
Açaí seed meal	-	5.0	10.0	15.0
Corn	37.2	37.1	37.1	37.1
Soybean meal	20.3	20.3	20.3	20.3
Sodium chloride	1.0	1.0	1.0	1.0
Limestone	0.5	0.6	0.6	0.6
Mineral mixture	1.0	1.0	1.0	0.51
Chemical composition (% of DM)				
Dry matter	92.95	92.69	92.44	92.19
Organic matter	94.69	94.77	94.85	94.93
Ethereal extract	2.17	2.17	2.16	2.16
Crude protein	18.61	18.35	18.08	17.81
Neutral detergent fiber	37.37	38.30	39.24	40.17
NDF indigestible	15.81	16.65	17.49	18.34
Lignin	2.50	2.18	1.87	1.56
Non-fibrous carbohydrates	36.54	35.96	35.38	34.79

content of between 40 to 60% based on MS (Gomes et al., 2012). However, the major limitation for using this by-product is the lack of knowledge in animal diets, mostly its influence about quantitative characteristics of sheep carcasses.

There is no published information about the potential use of the byproducts of the açaí processing industry related with carcass quantitative traits, which are extremely important in the meat production system, because they are directly related to the final product. Ranking the total quality of slaughtering animal includes, besides carcass weight and yield, other body weight components (body and viscera organs), defined as non-carcass components (Ebrahimi et al., 2013). Non-carcass components represent up to 40% of body weight of the lambs and are affected by factors such as feeding level.

The aim of this survey is to assess the efficacy of açaí seeds in the diet of sheep, specifically, to evaluate carcass and non-carcass characteristics components in sheep fed diets containing mixtures of açaí seeds and coastcross hay.

MATERIALS AND METHODS

The experiment was conducted in the Universidade Federal Rural da Amazônia – UFRA, Parauapebas, State of Pará, Brazil. All procedures described in this experiment were approved by the Ethics Committee on Animal Use (CEUA).

The study was conducted on 16 non-castrated male sheep of a non-defined breed. The sheep were five months old at the start of the experiment and had an average initial body weight of 22 kg. The experiment lasted 56 days - the first 15 days were used for adaptation to diets and facilities. Animals were weighed at the beginning of the trial and then weighed again every 14 days. At the start of the experiment the animals received an oral de-wormer and an injectable ADE vitamin complex. Each sheep was kept in individual stalls of 2 m by 2.5 m and had free access to feed and water. Four diet treatments were used, all of which were composed by coast cross hay as basal roughage within a 60:40 roughage: concentrate ratio - based on dry matter (DM) content. Hay was supplied grounded (5 cm) and concentrate was composed of corn, soybean meal, calcium limestone, sodium chloride and complete mineral mixture (Table 1).

After processing, the byproduct of the açaí is composed of the mesocarp (mostly fiber) and the endocarp (seed). In order to be used in the experiment the byproduct was first dehydrated in the sun for 72 h until it reached approximately 90% DM. It was then processed in a disintegrator using a sieve with a porosity of 5 mm to create açaí seed meal. The seed meal was then added to coast cross hay at varying proportions to make up the four diet treatments: 0 (control), 5, 10 and 15% (Table 1). These treatments were then added to the concentrate at the recommended ratio. The diet mixtures were given to the sheep twice a day (07:00 a.m. and 05:00 p.m.) and adjusted daily according to the consumption of the previous day - allowing leftovers of approximately 5% of the total from the dry matter provided. The food and leftovers were sampled daily during the fecal collection period. At the end of the sample period a composite sample was made for each treatment, packed in a plastic bag, labeled and frozen at 4ºC for later laboratorial analysis.

Feed, leftovers and feces were processed in knife mill (1 mm) and analyzed for dry matter, organic matter, crude protein, ethereal extract contents according to the methods of the AOAC (1990).and lignin for acid detergent fiber (Van Soest and Robertson, 1985) and neutral detergent fiber (Mertens, 2002).

Previously, the slaughter lambs were fasted (solid food only) for 18-hours up to the established slaughter body weight (SBW). Lambs were desensitized by stunning, followed by the bleeding of carotid arteries and jugular veins. The head, skin, gut and legs were removed. The carcasses were longitudinally split in two half-carcasses and weighed. After the slaughter, the carcasses were

Table 2. Carcass and meat cuts dressing of sheep fed açaí seed meal-based diets.

Item	Proportion of açaí seed meal				CV(%)	P-value	
	0	5	10	15		Linear	Quadratic
Carcass yield							
Body weight slaughter, kg	31.49	31.57	32.32	31.45	5.94	0.451	0.684
Daily weight gain, kg [2]	0.16	0.17	0.19	0.21	13.20	0.045	0.588
Feed Conversion, kg/kg	5.81	6.07	5.77	5.91	-	-	-
Carcass yield, %	46.17	47.36	47.05	48.20	23.57	0.078	0.052
Cold carcass yield, %	45.16	46.36	46.24	47.49	6.58	0.291	0.624
Chilling loss, %	1.99	2.12	1.71	1.49	3.68	0.515	0.861
Commercial meat cuts							
Shoulder, kg[3]	2.69	2.69	3.01	3.00	7.26	0.024	0.959
Neck, kg	1.47	1.29	1.44	1.43	13.25	0.593	0.559
Upper rib (kg)	1.86	1.90	2.13	2.02	9.43	0.120	0.207
Lower rib (kg)	1.66	1.61	1.85	1.90	11.59	0.561	0.964
Loin, kg	1.06	0.96	1.08	1.13	10.60	0.664	0.416
Fat thickness, mm	0.87	0.87	1.50	0.87	40.02	0.077	0.073
Loin eye area, cm^2	12.51	14.42	14.58	12.42	14.67	0.086	0.073

[1] $\hat{y} = 35.36 + 0.062x$ (R^2= 0.03); [2] $\hat{y} = 0.1361 + 0.00552X$ (R^2 = 0.51); [3] $\hat{y} = 2.74 + 0.013X$. (R^2=0.04).

cooled at 4°C for 24 h. After this period, the cold carcass weight (CCW) was recorded. The carcass yield corresponded to the ratio of CCW to SBW, expressed as a percentage.

In the left carcass side, a sectional cut was made on the 13th rib to expose the *Longissimus dorsi* muscle. The perimeter of the *Longissimus dorsi* muscle was measured by drawing its outline in a transparency sheets. A caliper was used to measure the *Longissimus dorsi* muscle fat thickness (FT). The *Longissimus dorsi* muscle was completely removed from the left carcass side. The left side of the carcass was divided into five anatomical regions (shoulder, neck, ribs, loin and leg). The left side of the carcass was dissected into lean, fat, bone and weighed. Percent of total edible offal component was calculated as the sum of blood, lung, trachea, heart, liver, spleen, empty gut, kidney and internal fat (mesenteric, pelvic and kidney) weight to slaughter weight. Percent of total non-edible offal component was calculated as the sum of head, skin, genital organs, gall bladder and gut fill weight to slaughter weight. Percent of total usable product was estimated as the sum of dressing percentage and percent of total edible offal component.

A completely randomized design with four treatments and four replicates was used, using initial body weight as covariate. The data were submitted to orthogonal decomposition of the sum of squares of treatments in contrasts related to the linear, quadratic and cubic effects with later adjustment to linear regression equations. The GLM and REG procedure of the software package SAS was utilized, with 5% as critical level of probability used throughout.

RESULTS AND DISCUSSION

Açaí seed meal consisted, on dry matter basis, of an average of 5.94% of crude protein and 56.19% of neutral detergent fiber, a sufficient proportion of fiber to justify its inclusion as a bulk food constituent in the diet of ruminant animals.

The values found for daily weight gain was significantly different (P<0.05) between the four treatments (Table 2).

Although increasing açaí seed meal increased fiber content, while the lignin content (indigestible fiber content) get reduced (Table 1). This result may have contributed for the better utilization of nutrients by animals, based on a roughage-concentrate ratio of 60:40. Linear effect of dietary açaí seed meal on daily weight was satisfactory. Although some authors have suggested that animals reach greater weight gains when are feedlot from 15 to18 kg (Barros et al., 1994), in this research high values were recorded when sheep were feedlot averaging 22 kg. This result indicates that by-products when properly fed in appropriate proportions may become an important source of nutrients in animal feeding, providing satisfactory performance, and usually with low cost.

Another likely mechanism explaining the increased performance of higher levels of açai seeds in the diet is probably related to palatability, contributing to the stability of the efficiency of the estimated feed transformation into animal product, a parameter measured through feed conversion (Table 2). However, even with stable feed conversion, the intensity of production increased with increased inclusion of açai seed meal in the diet. This evaluation indicates that as higher levels of gain are implemented (with the same conversion), a higher amount of animal product is obtained in less time. Therefore, the palatability effect of the açai seed may constitute a productive advantage favoring its inclusion in diets for ruminant animals.

The values for hot and cold carcass yield and cooling loss were not significantly different (P>0.05) among treatments. The purpose of using alternative feed in livestock diets is to reduce the cost and improve, or at least not affect, carcass variables and performance

Table 3. Mean weight of non-carcass components of sheep fed açaí seed meal-based diets.

Organ (kg)	Proportion of açaí seed meal				CV(%)	P-value	
	0	5	10	15		Linear	Quadratic
Respiratory organs	0.59	0.51	0.64	0.59	19.65	0.887	0.963
Spleen	0.07	0.06	0.11	0.08	27.18	0.059	0.080
Heart	0.14	0.14	0.16	0.16	11.66	0.278	0.486
Liver	0.52	0.48	0.62	0.53	12.79	0.210	0.343
Kidneys	0.10	0.09	0.09	0.10	8.09	0.206	0.136
Internal fat	0.48	0.50	0.38	0.46	44.67	0.606	0.540
Rumen/reticulum	0.71	0.66	0.78	0.79	10.63	0.576	0.999
Omasum	0.17	0.15	0.17	0.17	19.51	0.718	0.629
Abomasum	0.15	0.13	0.16	0.14	17.75	0.644	0.605
Thin intestine	0.63	0.68	0.69	0.60	15.38	0.553	0.530
Larger intestine	0.34	0.32	0.32	0.41	10.50	0.092	0.166
Digestive tract	1.93	1.86	2.05	2.05	9. 71	0.821	0.863
Gut content	6.86	6.40	6.48	6.25	13.93	0.592	0.754

(Tufarelli et al., 2013). In the present study, using an alternative feed ingredient did not impact most of the carcass characteristics examined. This result can be explained by the law of harmony anatomical, because carcasses with similar weights and amounts of fat means that all body areas are in similar proportions (Cutrim et al., 2013).

Chilling loss is the weight difference after carcass cooling and it depends on several factors such as humidity loss and chemical reactions in the muscle. Improving carcass management and storage and fat subcutaneous deposition may likely decrease humidity loss. Despite high-fat content in the carcass which may depreciate its commercial value some subcutaneous fat is needed to reduce chilling losses and also to act as a thermal insulator for the body. Water losses are due to genetic effects such as breed, crossbreeding and fat cover and its distribution (Freitas et al., 2011).The high variation in fat deposition between individual carcasses may likely explains the results of chilling losses noticed in this research (Table 2).

The results found for fat thickness, loin eye area and commercial cuts (Table 2) reflect those found for carcass yield at slaughter, except for shoulder that reflects the behavior observed for body weight gain. Shoulder was the most developed organ due to the average age of animals in the beginning of the experiment and to the slaughtering age, because the animals probably were in the final of the growth curve along the experimental period. Body follows a growth curve so that the head is the first one to develop, followed by the trunk and finally the members (Costa et al., 2011). According to NRC (2007), advancements in physiological maturity of each tissue will have impetus for growth in each stage of the animal life:bone tissue (early) muscle (intermediary) and adipose (late). When the tissue composition of a lamb carcass was analyzed, the developmental aspects of tissue from each anatomical region should be considered separately, because growth occurs early in the shoulder, intermediary in the leg and late in the loin.

No significant difference (P>0.05) on non-carcass components dressing was detected (Table 3). There were no significant differences in heart and respiratory organ weights between the four treatments, because these organs maintain its integrity due to the priority of nutrient utilization, independently of feeding. This effect was also observed by Carvalho and Medeiros (2010) who used diets with different energy levels the authors found no difference between treatments for organ weights. These results corroborate with those found by Cutrim et al. (2012), this may likely be due to the similar age and initial and slaughter weights of animals. So it can be inferred that the organs development is linked to the animal size and consequently non carcass components are not affected by feeding.

Tissues essential for life process (that is, respiration and metabolism) would be expected to be highly developed at birth, whereas tissues associated with locomotion and storage would be lesser developed, and tissues associated with reproduction would be among the latest maturing tissues (Galvani et al., 2014) The visceral organs have markedly different growth rates as compared to other body organs, due likely to the chemical composition of feedstuffs, meanly of energy content (Costa et al., 2013). In this research, diets were formulated to contain similar contents of energy and protein aiming to supply the nutrients for the development of the non carcass components.

Advancements in the pre-stomachs are likely due to the type of feed consumed by the animal. Considering that the rumen-reticulum volume is related to its function (that is, nutrient fermentation), the more forage is added to the animal diet the greater is the rumen-reticulum size. No difference among viscera sizes was detected in this research; this may likely due to the similar dietary roughage proportion. Thus, increasing açaí seed meal levels should not have influenced gut fulfillment enough to affect visceral organs weight, although this by-product contains high content of neutral detergent fiber.

Conclusions

Açaí seed meal added to the diet up to 15% in replacement with forage during dry seasons does not seem to compromise carcass and non-carcass characteristics. As such, açaí seed meal derived as a byproduct of açaí pulp production is a viable alternative for sheep production.

Conflict of Interests

The authors have not declared any conflict of interests.

REFERENCES

Association of Official Analytical Chemists – AOAC (1990). Official Methods of Analysis, 15th ed. AOAC, Arlington.

Barros NN, Figueiredo EAP, Fernandes FD, Barbieri ME (1994). Ganho de peso e conversão alimentar de cordeiros cruza no Estado do Ceará. Pesqui Agropecu Bras. 29(8):1313-1317.

Carvalho S, Medeiros LM (2010). Características de carcaça e composição da carne de cordeiros terminados em confinamento com dietas com diferentes níveis de energia. Rev. Bras. Zootecn. 39(6):1295-1302.

Costa RG, Medeiros GR, Duarte TF, Pedrosa NA, Voltolini TV, Madruga MS (2011). Salted goat and lamb meat: Typical regional product of the city of Petrolina, state of Pernambuco. Small Ruminant Res. 98:51-54.

Costa MRGF, Pereira ES, Silva AMA, Paulino PVR, Mizubutie IY, Pimentel PG, Pinto AP, Rocha JN (2013). Body composition and net energy and protein requirement sof Morada Nova lambs. Small Ruminant Res. 114:206-213.

Cutrim DO, Alves KS, Oliveira LRS, Santos RC, Mata VJV, Carmo DM, Gomes DI, Mezzomo R (2012). Elephant grass, sugarcane, and rice bran in diets for confined sheep. Trop. Anim. Health Prod. 44:1855-1863.

Cutrim DO, Alves KS, Neiva JNM, Oliveira LRS, Mezzomo R, Elias AKS, Mata VJV, Santos RC, Gomes DÍ (2013). Replacement levels of elephant grass by moist pineapple by-product silage in diets of Santa Inês crossbred sheep: performance and digestibility. Trop. Anim. Health Prod. 45:585-592.

Ebrahimi M, Rajion MA, Goh YM, Sazili AQ, Soleimani AF, Schonewille JT (2013). Oil Palm (*Elaeis guineensis* Jacq.) frond feeding of goats in humid tropics. J. Anim. Vet. Adv. 12(4):431-438.

Freitas HS, Alcade CR, Lima LS, Macedo FAF, Macedo VP, Molina BSL (2011). Quantitative characteristics of carcass and meat quality of ¾ Boer + ¼ Saanen and Saanen goat kids fed diets with dry yeast. Rev. Bras. Zootecn. 40(3):630-638.

Galvani DB, Pires CC, Hübner CH, Carvalho S, Wommer TP (2014). Growth performance and carcass traits of early-weaned lambs as affected by the nutritional regimen of lactating ewes. Small Ruminant Res. 120:1-5.

Gomes DI, Véras RL, Alves KS, Detmann E, Oliveira LRS, Mezzomo R, Santos RB, Barcelos SS (2012). Performance and digestibility of growing sheep fedwith açai seed meal-based diets. Trop. Anim. Health Prod. 44:1751-1757.

Lage JF, Paulino PVR, Pereira LGR, Duarte MS, Valadares Filho SC, Oliveira AS, Souza NKP, Lima JCM (2014). Carcass characteristics of feedlot lambs fed crude glycerin contaminated with high concentrations of crude fat. Meat Sci. 96:108-113.

Mertens DR (2002). Gravimetric determination of amylase-treatedneutral detergent fiber in feeds with refluxing in beakers orcrucibles: collaborative study. J AOAC INT. 85:1217-1240.

National Research Council – NRC (2007). Nutrients requeriments of small ruminants. 1. ed. Washington, D.C.: National Academy Press. P 362.

Tufarelli V, Introna M, Cazzato E, Mazzei D, Laudadio V (2013). Suitability of partly destoned exhausted olive cake as by-product feed ingredient for lamb production. J. Anim. Sci. 13(91):872-877.

Van Soest PJ, Robertson JB (1985). Analysis of forages and fibrous foods. ed. (Cornell University Press, Ithaca, NY).