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Intake, digestibility, performance, and carcass traits of rams provided with dehydrated passion fruit (*Passiflora edulis* f. *flavicarpa*) peel, as a substitute of Tifton 85 (*Cynodon* spp.)

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ABSTRACT

Two experiments were performed to evaluate the substitution of Tifton 85 (*Cynodon* spp.) hay by dehydrated passion fruit (*Passiflora edulis* f. *flavicarpa*) peel on intake, digestibility, nitrogen balance, and carcass traits in Santa Inês × Dorper rams. In Experiment 1, 12 rams were penned in individual metabolic crates for 21 days to evaluate DMI, nitrogen balance, and digestibility. Four treatments were evaluated: (1) control, with no inclusion of passion fruit peel; (2) 20% substitution of Tifton 85 hay by passion fruit peel; (3) 40% substitution of Tifton 85 hay by passion fruit peel; and (4) 60% substitution of Tifton 85 hay by passion fruit peel ($n = 3$ rams per treatment). In Experiment 2, 20 rams were randomly assigned into individual dry-lot pens for 63 days, and the same treatments from Experiment 1 were randomly assigned to pens ($n = 5$ pens per treatment). Body weight was weekly determined, and at the end of the experimental period, rams were humanely slaughtered, for assessment of carcass traits. No effect ($P > 0.33$) of passion fruit peel inclusion was observed for DM and CP apparent digestibility. However, NDF apparent digestibility had a quadratic effect ($P = 0.01$). Quadratic regression ($P = 0.02$) was observed for nitrogen intake, but no effect ($P > 0.16$) was observed for fecal and urine nitrogen excretion, and nitrogen balance. Daily DMI, DMI as % of BW, and NDF and CP intake had quadratic effect ($P < 0.01$) with level of inclusion of passion fruit peel in the diet. A quadratic regression ($P < 0.01$) was found for thorax circumference, with peak at 38.6%. Commercial cuts and carcass traits were not affected ($P > 0.16$) by substitution of Tifton-85 by passion fruit peel. In conclusion, these experiments indicate that providing passion fruit peel as a substitute of Tifton 85 in diets for Santa Inês × Dorper rams at approximately 30% can be a good option for producers willing to reduce feeding costs, without impairing performance and carcass traits.

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1. Introduction

Utilizing alternative feedstuff in sheep nutrition, such as by-products from fruit processing, could be a good option for producers willing to decrease feeding costs, particularly during extended drought seasons, when forage quality and quantity are impaired. In Brazil, fruit processing is increasing (BRASIL, 2008) and availability of fruit by-products in some regions has also increased. The use of residues from fruit processing (*e.g.*, pineapple by-product) can increase apparent digestibility coefficients of nutrients, and promote satisfactory animal performance (Costa et al., 2007). Passion fruit (*Passiflora edulis* f. *flavicarpa*) is a popular fruit in Brazil, which is the greatest passion fruit-producing country worldwide, producing in 2013 approximately 838,000 tons (IBGE, 2014). Production of passion fruit in the country and its industrial process (juice industry) is not seasonal because production extends throughout the year (Abreu, 2011). A great amount of residues is generated, corresponding to 60%–70% of total fruit weight (Neiva Júnior et al., 2007). These residues are composed by peel and seeds; according to Cruz et al. (2011), passion fruit peel can be utilized as a good-quality roughage for ruminants, provided fresh or dehydrated. In addition, the usage of these by-products is a good option to reduce disposal and, consequently, environment impact.

Data regarding usage of passion fruit by-products, partially or totally substituting traditional roughage feedstuffs for small ruminants are limited. Knowing the nutritive value of these by-products, as well as digestibility, and animal performance, coupled with knowledge of regional availability and price, is important to inform producers aiming to reduce feeding costs, without impairing animal performance. Therefore, we designed a study to evaluate the effects of increasing substitution of Tifton 85 (*Cynodon* spp.) hay by passion fruit peel on digestibility, nitrogen balance, performance, and carcass traits of Santa Inês crossbred rams.

2. Materials and methods

Starting October 2010, two experiments were conducted at the Federal University of Jequitinhonha and Mucuri Valleys ('*Universidade Federal dos Vales do Jequitinhonha e Mucuri*'; UFVJM), Research and Experiment Sector, in Curvelo, Minas Gerais state, Brazil (44°23′ W and 18°49′ S). A total of 32 rams was cared for by acceptable practices in accordance with the guidelines as outlined in the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS, 2010). In addition, the research protocol was reviewed and approved by the UFVJM, Committee of Ethics on the Use of Animals.

2.1. Animals, diets, and handling

2.1.1. Experiment 1

Twelve Santa Inês × Dorper rams (average body weight [BW] = 21 ± 2.1 kg) were housed in individual metabolic crates for 21 days, consisting of a 14-day acclimation period, and 7 days for data collection. Rams were fed a total mixed ration consisting of corn meal, soybean meal, mineral and vitamin premix, and Tifton 85 hay (Table 1). Four treatments were evaluated: (1) control, with no inclusion of passion fruit peel; (2) 20% substitution of Tifton 85 hay by passion fruit peel; (3) 40% substitution of Tifton 85 hay by passion fruit peel; and (4) 60% substitution of Tifton 85 hay by passion fruit peel (n = 3 rams per treatment). Passion fruit peels, obtained from a local fruit processing plant, were dried under the sun (average atmospheric temperature = 26.5 °C) for approximately 84 h, until reached 82%–86% dry matter (DM), and then ground to 1-cm particle size. Diets were formulated to have equal amount of protein and energy, and were provided twice a day (8:00 and 16:00). Rams had free-choice access to the diets.

Table 1
Feed composition of experimental diets (Experiments 1 and 2).

Ingredients	Treatment[a]			
	Control	20%	40%	60%
% (DM basis)				
Tifton 85 hay	60.0	48.0	36.0	24.0
Passion fruit peel	0	12.0	24.0	36.0
Corn meal	29.0	29.2	29.4	29.6
Soybean meal	9.5	9.3	9.1	8.9
Mineral premix	1.0	1.0	1.0	1.0
Limestone	0.44	0.47	0.55	0.63

[a] Four treatments were evaluated: (1) control, with no inclusion of passion fruit peel; (2) 20% substitution of Tifton 85 hay by passion fruit peel; (3) 40% substitution of Tifton 85 hay by passion fruit peel; and (4) 60% substitution of Tifton 85 hay by passion fruit peel.

During the data collection period, offer and orts were recorded, sampled daily and kept at −10 °C until analysis. Composite samples were dried at 55 °C in a forced-air oven for 72 h for DM calculations. In addition, feces and urine were collected daily in the morning, before feeding. Feces were collected using napa bags, adapted onto the rams' body, permitting total collection. The total amount of feces produced per day was weighed, sampled, and frozen for further analyses. For urine collection, an aluminum plate was installed slightly leaned underneath the crate to permit drainage of urine into a plastic bucket, that contained 100 mL of 37% HCl diluted in distilled water, to prevent urine nitrogen losses by volatilization and or fermentation. Approximately 10% were sampled, filtered and kept at −20 °C for further analysis.

2.1.2. Experiment 2

Twenty Santa Inês × Dorper rams (initial BW = 30 ± 2.8 kg) were randomly assigned into individual dry-lot pens located in a covered barn. Each dry-lot pen, with approximately 1.4 m^2 of total area, had a water-, mineral-, and feed-trough available. Rams were kept for 63 days, consisting of a 14-day acclimation period, and 49 days for data collection. Before entering into dry-lot, rams were subjected to a deworming protocol, utilizing 10% albendazole (Albendathor 10, Tortuga Cia. Zootec. Agrária, São Paulo, SP, Brazil).

Body weight was weekly measured to determine average daily gain (ADG). Treatments, similar to Experiment 1, were randomly assigned to pens (n = 5 pens per treatment). Feeding was also performed twice a day. Offer and orts were recorded, sampled daily and kept at −10 °C