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Growth and carcass characteristics of Santa Inês lambs fed diet supplemented with physic nut meal free of phorbol ester

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ABSTRACT

The aim of this work was to evaluate the growth performance, carcass traits, hematological and biochemical variables of Santa Inês lambs fed diet supplemented with physic nut (*Jatropha curcas*) meal (PNM). Twenty-four intact male lambs [age: 120 ± 0.98 days; body weight (BW): 19.7 ± 2.4 kg] were assigned randomly to four concentrate mixtures. These mixtures were supplemented with 0 (CON), 100 (PNM100), 200 (PNM200), or 300 (PNM300) g/kg dry matter (DM) of PNM. The concentrate was offered at 1.2% BW, whereas lambs were fed Tifton (*Cyndon dactylon* CV. Tifton-85) hay *ad libitum*. Animals were weighed and blood collected every 15 days. At the end of the experiment, lambs were slaughtered and their carcasses were evaluated. Biochemical and hematological variables were not different among diets ($P > 0.05$). Similarly, dry matter intake was not different among diets ($P > 0.05$) and no acceptability problems were observed for the PNM. Average daily gain and carcass characteristics also did not differ ($P > 0.05$) between the treatments. No clinical symptoms of intoxication by physic nut were detected during the whole experimental period. Therefore, it may be inferred that the non-toxic PNM was shown to be a promising protein source for sheep nutrition and can be used in concentrations of up to 300 g/kg DM in concentrate mixture.

1. Introduction

Agro-industry by-products have been used mainly to reduce production costs, and to offset increasing environmental concerns about less expensive waste management programs (Grasser et al., 1995). Studies have demonstrated that residues of the bio-fuel industry may have satisfactory levels of energy and protein, supplying requirements and substituting commonly used ingredients, such as soybean meal and corn grains. Among these residues, physic nut meal (PNM) is not widely used, as it is regarded as toxic for animals (Abdalla et al., 2008).

It was previously believed that the toxicity of the physic nut is due to the presence of curcin, which has a toxic activity (Ribosome-Inactivating Protein – RIP) similar to the castor bean (*Ricinus communis*) ricin (Felix et al., 2008; Mendonca and Laviola, 2009). However, recent research has shown that the toxicity of physic nut seeds and oil is mainly due to the presence of phorbol ester, and not to curcin (Abdalla et al., 2008).

One of the great advantages of physic nut is its production cycle, which may last for 40 years, maintaining an average productivity of two tons per hectare (Mendonca

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and Laviola, 2009). The physic nut seed has approximately 210 g/kg crude protein (CP) and 400 g/kg ether extract (EE), while PNM has 286 g/kg CP and 142 g/kg EE on dry matter basis (Souza et al., 2009).

Presently, there are more than 30 thousand hectares of physic nut in Brazil, distributed over the Southeast, Center-West and Northeast regions of the country. Considering only the plants that have reached the mature stage, there is a potential for producing more than 90 thousand tons of seeds per year, which would correspond to 58.5 thousand tons of PNM per year (Mendonca and Laviola, 2009).

With new detoxification techniques and varieties of physic nut with zero concentration of phorbol ester (non-toxic), new uses for these residues arise. This protein rich feed (detoxified or non-toxic), which has phorbol ester as its limiting factor, is still not well studied for use as a feedstuff in animal nutrition. Generally, pressed-cakes or meals generated by the oil extraction process do not pass through any kind of value-adding procedure, and their economic and nutritional potential, except for some materials from soybean or cottonseed processing, are unknown (Abdalla et al., 2008; Mendonca and Laviola, 2009).

The objective of this study was to evaluate growth performance, carcass traits, as well as hematological and serum biochemical variables of Santa Inês lambs fed different levels of non-toxic physic nut meal in the diet.

2. Materials and methods

2.1. Study area

The experiment was carried out at the Sheep Management Center, in the Água Limpa Experimental Station of the University of Brasília. The animals were allocated in individual pens of 1.8 m^2 each, disposed in a 240 m^2 shed.

2.2. Animals and diets

Twenty-four male Santa Inês lambs [age: 120 ± 0.98 days; body weight (BW): 19.7 ± 2.4 kg] were divided into four diets (6 lambs/diet). Diets were: (1) control (270 g/kg soybean meal and 730 g/kg ground corn; CON); (2) 220 g/kg soybean meal, 680 g/kg ground corn and 100 g/kg PNM; PNM100; (3) 180 g/kg soybean meal, 620 g/kg ground corn and 200 g/kg PNM; PNM200; and (4) 140 g/kg soybean meal, 560 g/kg ground corn, and 300 g/kg PNM; PNM300. The experimental period lasted for 70 days. The physic nut meal (PNM) that was used in the current study was considered not toxic because phorbol ester was not detected when analyzed according to procedure described by Makkar and Becker (1999). The PNM (Germplasm Bank of Embrapa Agroenergy – CNPAE-169 and CNPAE-170) was purchased from a rural property in Mato Grosso do Sul State and was provided for the experiment by Embrapa Agroenergy after oil extraction by mechanical press.

Each lamb was allocated to an individual pen (1.60 m × 1.15 m). The diets were balanced to offer 180 g/kg of CP and 800 g/kg of total digestive nutrients. The PNM was included in each diet as a substitute of total protein.

Lambs had *ad libitum* access to water and Tifton (*Cyndon dactylon* CV. Tifton-85) hay. The chemical composition of the hay was 872.0, 68.8, 759.0, 410.0, 7.9, 51.0, and 534 g/kg DM, CP, neutral detergent fiber (NDF), acid detergent fiber (ADF), ether extract (EE), ash and total digestible nutrients (TDN), respectively. The concentrate was offered at 1.2% BW. The forage and concentrate mixture were offered separately, so that the PNM intake could be precisely calculated. The chemical analyses of the Tifton hay and concentrates were performed according to AOAC (1995) and Mertens (2002).

Table 1
Chemical composition of concentrates used in the diets.

Nutrient (g/kg)	Diets[a]			
	CON	PNM100	PNM200	PNM300
Dry matter	879.0	883.0	887.0	890.0
Crude protein	201.0	200.8	200.5	200.3
Neutral detergent fiber	108.0	140.0	171.4	200.1
Acid detergent fiber	57.0	70.2	88.4	106.0
Ether extract	35.1	38.9	42.1	45.5
Ash	19.9	18.7	17.9	17.2
Total digestible nutrients[b]	810.0	808.0	807.0	807.0

[a] Control (CON) = 0 g/kg physic nut meal (PNM), 100 g/kg PNM (PNM100), 200 g/kg PNM (PNM200), and 300 g/kg PNM (PNM300).
[b] Calculated according to Harlan et al. (1991).

To calculate dry matter intake (DMI), the leftovers of forage were collected and weighed three times a week. There were no concentrate leftovers. Lambs were weighed fortnightly, before they received the concentrate in the morning, throughout experimental period. After weighing, blood was collected *via* jugular venipuncture using vacuum tubes with and without anticoagulant (EDTA).

The hemogram analyses were performed using an ABX – model 22P ABX micro 60® automatic counter. Biochemical tests (aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), creatinine and albumin) were performed using blood serum and analyses were carried out using commercial biochemical tests kits Labtest® and spectrophotometer Bioplus, model Bio-2000®.

On the last day of the experimental period, the animals were slaughtered so that the carcass characteristics could be evaluated, according to procedures described by Osório et al. (1998). The slaughtering took place after a 16 h fast, following the current regulations in Brazil, Regulation of Industrial and Sanitary Inspection for Products of Animal Origin – RIISPOA (1952). Immediately before the slaughtering, animals were weighed to obtain fasting body weight (FBW). The animals were stunned by electrocution. After bleeding, skinning and evisceration, the viscera were weighed in two groups: Group A (rumen, reticulum, omasum, abomasum and intestines) and Group B (tongue, esophagus, trachea, lungs, heart, liver and kidneys). During slaughter, scrotal circumference was also measured.

The whole animal carcass was used to determine hot carcass weight (HCW), and hot carcass yield (HCY), using the equation: HCY = HCW/FBW × 100. Carcasses were cooled in cold chamber, at temperatures below 4 °C + 2 °C for 24 h and weighed again to obtain cold carcass weight (CCW). Cold carcass yield (CCY) was calculated: CCY = CCW/FBW × 100 and the cooling loss index, CLI = (HCW − CCW)/HCW × 100. A longitudinal cut was made along the vertebral column, splitting the carcass in two parts, which were then weighed. The carcass was cut into the following parts: neck, shoulder, loin, ribs, flank steak, and leg which were weighed individually.

2.3. Statistical analysis

The experiment was conducted in a completely randomized design. The data analysis was carried out by the software SAS v.9.2® (Cary, North Carolina), using the MIXED procedure for measures repeated over time. For the variables measured only once, the GLM procedure was employed using ANOVA analysis. The REG procedure was used to study the effects of increasing PMN in the diet over all the variables evaluated. For all the analysis, the significance level adopted was 5% ($P < 0.05$).

3. Results

The chemical composition of concentrates used in the diet is presented in Table 1. Growth performance of Santa Inês lambs fed diets with or without physic nut meal is shown in Table 2. No significant differences ($P > 0.05$) were observed in DMI, average daily gain (ADG), and feed conversion ratio between diets.