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Intake, digestibility, performance, carcass characteristics and meat quality of lambs fed different levels of crambe meal in the diet

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ABSTRACT

The aim of this study was to determine the effect of different levels of crambe meal (CM) in the diet as a substitute for soybean meal on feed intake, growth performance, blood parameters, carcass characteristics and meat quality of lambs. A total of 80 sheep predominantly from the Texel breed, 40 male (23.3 ± 0.98 kg) and 40 female (22.1 ± 0.95 kg) lambs, were fed 0, 64, 128 or 192 g/kg dry matter (DM) CM in the total mixed diet. Intake of DM increased in parallel with the level of CM inclusion in the diet and there was no effect of CM on digestibility and weight gain. The feed to gain ratio decreased as levels of CM increased in the diet. Yields of carcass and commercial cuts were similar among diets. The proportion of muscle and the muscle to bone ratio tended to decrease with higher CM level in the diet. Male and female lambs responded similarly to CM levels except for subcutaneous fat where there was a greater decrease in carcass of male than female lambs with increasing CM dietary level. Chemical composition and quality of the longissimus dorsi were similar among diets. These data suggest that there are no ill effects on carcass quality and animal performance when CM is provided at up to 192 g/kg DM in the diet of growing lambs fed a forage to concentrate ratio of 350–650.

1. Introduction

Crambe (*Crambe abyssinica* Hochst), an annual herb of the family Cruciferae native to the Mediterranean region, has been introduced in many countries as a new source of industrial oil having a high erucic acid content (Liu et al., 1993). Crambe meal (CM) is the high-protein, low-fat residue obtained after extraction of oil from whole crambe seeds with organic solvents.

Abbreviations: ADF, acid detergent fiber; CM, crambe meal; CP, crude protein; DM, dry matter; aNDF, neutral detergent fiber; NFC, non-fibrous carbohydrates.

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Table 1
Ingredient composition of the total mixed diets.

	g/kg dry matter crambe meal			
	0	64	128	192
Sorghum silage	350	350	350	350
Ground corn	408	390	372	354
Soybean meal	211	169	127	85
Crambe meal	0	64	128	192
Mineral supplement[a]	31	27	23	19

[a] Contained (as fed basis): 150 g/kg of Ca, 90 g/kg of P, 50 g/kg of S, 72 g/kg of Na, 20 mg/kg of Co, 250 mg/kg of Cu, 2000 mg/kg of Fe, 28 mg/kg of I, 600 mg/kg of Mn, 9 mg/kg of Se, 900 mg/kg of F, and 1800 mg/kg of Zn.

Concentration of crude protein (CP) in CM of the FMS-Brilhante variety is lower than that of soybean meal (371 *versus* 507 g/kg dry matter (DM), respectively) and neutral detergent fibre (aNDF) concentration is higher in CM than soybean meal (393 *versus* 230 g/kg DM, respectively; Ítavo et al., 2015). As feeds rich in cellulose and hemicellulose are better adapted to the gastrointestinal tract of ruminant than non-ruminant animals, this makes CM a more suitable feed ingredient for the former. Moreover, CM contains glucosinolates and ruminants tolerate high glucosinolate meals better than non-ruminant animals (Bell, 1984).

Crambe meal has been used in the diet of livestock. For example, CM substituted for soybean meal as the protein source in backgrounding and finishing diets of beef cattle diets (Anderson et al., 1993) and feeding up to 58.8 g/kg DM CM to beef steers had no effect on digestibility of the diet and feed intake (Caton et al., 1994). Conversely, replacing 0, 22, 44 and 64% of protein from soybean meal by that of crambe cake in high concentrate diets decreased DM digestibility and feed intake of growing lambs (Canova et al., 2015). Other results suggest that diets with CM do not influence carcass composition in quite the same manner as those with soybean meal. Indeed, beef steers fed no CM tended to have less marbling than those fed a diet with CM substituting for all soybean meal as the protein source, and the longissimus dorsi area of steers fed no CM was 2 cm^2 larger than that of animals fed CM (Anderson et al., 1993). However, to our knowledge, there is no information on the effects of dietary CM level on quality and characteristics of lamb carcasses.

Although sheep production has expanded in Brazil focusing on lamb meat, sheep farmers face many technical difficulties to produce quality lambs at viable costs (Raineri et al., 2015). The Texel breed is recommended for mating with other breeds, and it is common to slaughter both females and males in this type of production (Soares et al., 2012). Slaughter weight of both females and males has important economic values in a Brazilian production system of meat lamb (Lôbo et al., 2011), thus it is primordial to determine the response to dietary feeding regimens according to lamb gender. Therefore, the objectives of the experiment were to determine the effect of different proportions of CM in the diet as a substitute for conventional soybean meal on feed intake and digestibility, growth performance, blood parameters, carcass characteristics and meat quality of lambs. The interaction between diet and sex of lamb also was determined. The hypotheses were that CM level in the diet has no effect on carcass and meat characteristics and that the response to CM level is similar for male and female lambs.

2. Materials and methods

The feeding experiment was carried out at the Model farm of the Brazilian Company of Agricultural Research – Embrapa Beef Cattle and analyses were performed at the Laboratory of Biotechnology and Animal Nutrition, Dom Bosco Catholic University and Laboratory of Animal Nutrition, Federal University of Mato Grosso do Sul, in Campo Grande, Brazil. This work was approved by the "Local Ethical Committee for use of animals in experiments". Animals were cared for according to the guidelines of the Ethics, Bioethics and Animal Welfare Committee of the Brazilian Conselho Federal de Medicina Veterinária (2010).

2.1. Lambs, experimental design, and diets

A total of 80 lambs predominantly from the Texel breed, 40 non-castrated males averaging 23.3 ± 0.98 kg and 40 females averaging 22.1 ± 0.95 kg, were weaned at 90 days of age from the Embrapa flock. Upon weaning, all lambs received a 2-mL intramuscular injection of antibiotic (Coccifin, Ouro Fino Saúde Animal, Ouro Fino, Cravinhos, SP, Brazil) to prevent coccidiosis. Lambs also were given an anthelmintic treatment (Cydectin, Fort Dodge Saúde Animal Ltda., São Paulo, SP, Brazil) upon weaning and 28 days later. Right after weaning, lambs were randomly allotted to 8 pens (6 m × 5 m) of males and 8 pens of females with 5 animals per pen. Each pen (30 m^2) provided adequate feeding space and drinking facilities. Pens within sex were assigned randomly to 4 experimental diets consisting in four proportions of CM (0, 64, 128 and 192 g/kg DM) in the total mixed diet.

Lambs were housed in sheds made from clay tiles, with a ceiling height of 2.5 m and concrete paving. Straw was used for bedding. Diets (Tables 1 and 2) were formulated to meet the NRC (2007) requirements for finishing lambs with an average body weight of 20 kg, a potential gain of 250 g/day and an estimated DM intake of 1 kg/day. Diets were fed for *ad libitum* intake at 09:00 and 15:00 h. Sorghum silage was used as roughage at a forage to concentrate ratio of 350:650 on a DM basis.

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