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Milk yield and composition from ewes fed raw soybeans and their lambs' performance

Evandro M. Ferreira[a], Marcos V.C. Ferraz Junior[b,c], Daniel M. Polizel[b,c], Fumi S. Urano[b], Ivanete Susin[b], Renato S. Gentil[b], Marcos V. Biehl[b], Janaina S. Biava[a], Alexandre V. Pires[b,c,*]

[a] Department of Animal Science, State University of Ponta Grossa, General Carlos Cavalcanti Avenue, n 4748, Ponta Grossa, Paraná, 84030-900, Brazil
[b] Department of Animal Science, "Luiz de Queiroz" College of Agriculture, University of São Paulo, Pádua Dias Avenue, n 11, PO Box 09, Piracicaba, São Paulo, 13418-900, Brazil
[c] Department of Nutrition and Animal Production, FMVZ, University of São Paulo, Duque de Caxias North Avenue, n 225, Pirassununga, São Paulo, 13635-000, Brazil

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ABSTRACT

This trial aimed to evaluate the effects of increasing levels of raw soybeans on milk yield, composition, and fatty acid profile in ewes, and their lambs' performance. Fifty-six Santa Ines ewes (63.9 ± 0.76 kg BW) were assigned to a randomized complete block design to receive one of the four diets containing 0 (CONT), 70, 140 or 210 g/kg DM of raw soybeans. Isonitrogenous diets (150 g/kg DM of CP) were composed of 400 g/kg DM of *in natura* sugarcane bagasse as roughage source and 600 g/kg DM of concentrate. The experiment lasted from 14 to 56 days of lactation. Once a week the ewes were separated from their lambs and milked mechanically. DMI (1.3, 1.3, 1.5 and 1.2 kg/day) and milk yield (1.0, 1.1, 1.1 and 1.0 kg/day) presented a quadratic effect ($P < 0.05$) including 0, 70, 140 or 210 g/kg DM of raw soybeans on diets, respectively. However, milk yield corrected for fat or fat and protein, as well as content of milk fat, protein, lactose and total solids did not differ. Short (C4-C12) and medium (C14-C16) chain fatty acids decreased, whereas long-chain ($C \geq 17$) fatty acids increased linearly ($P < 0.05$) with raw soybeans supply. Conjugated linoleic acid (CLA; *cis*-9 *trans*-11 and *trans*-10 *cis*-12) increased ($P \leq 0.01$) and the atherogenicity index decreased linearly ($P < 0.05$) with increasing levels of raw soybeans in the diet. Unsaturated:saturated ratio, saturated, unsaturated, monounsaturated and polyunsaturated fatty acids were similar among treatments. There was no difference in lambs' performance in pre or post-weaning periods. Considering that the price of raw soybeans is generally lower than its meal, the inclusion of up to 140 g/kg DM of soybeans is recommended for increasing milk yield, with no detrimental effect on milk efficiency production, milk components and lambs' performance. In addition, it is important to highlight that supplementation of up to 210 g/kg DM of raw soybeans made milk fat healthier for human consumption.

1. Introduction

Milk is the first food that the newborn ingests, and the lamb's survival and development are directly linked to dam milk yield. The

* Corresponding author. Current address: University of Sao Paulo—ESALQ, Animal Science Department, Pádua Dias Avenue, Piracicaba, SP, Brazil.
E-mail address: pires.1@usp.br (A.V. Pires).

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use of nutritional strategies that affect milk yield and composition may contribute to increase the lambs' development, acting as an additional tool to allow the slaughter of young animals, and providing better quality of carcass. In addition, the evaluation of milk yield and composition from Santa Ines breed also provide an opportunity to obtain parameters to investigate maternal ability in this breed. Researches about Santa Ines breed, which is the main Brazilian native beef sheep breed, are necessary to get solid scientific data in order to select it (Ribeiro and González-García, 2016).

Generally, the cost of raw soybeans is lower than the soybean meal due to large worldwide raw soybeans production. Livestock producers might replace soybean meal by raw soybeans, hence supplying protein and fat in diets. Furthermore, fat in the diet has been the focus in several research areas because of the relation between fat intake and health, in both livestocks and humans. For instance, Gandra et al. (2016) found that unsaturated fatty acids modulated innate and adaptive cellular immunity, and trigger a proinflammatory response in dairy cattle. In addition, lipid supplementation in ruminant diet can change the profile of fatty acids in milk that, when consumed by humans, may exert beneficial effects on their health (as reviewed by Lehnen et al., 2015). For example, the fatty isomers of conjugated linoleic acid (CLA), which is an incomplete rumen biohydrogenation product, have shown potential anticarcinogenic activity (Hughes and Dhiman, 2002). The main CLAs associated with beneficial properties for human health are CLAs *cis*-9, *trans*-11 and *trans*-10, *cis*-12, which CLA *cis*-9, *trans*-11 was associated with anticarcinogenic effect and immune system modulation. Whereas CLA *trans*-10, *cis*-12 operates in nutrient partitioning, such as the lipogenesis inhibition, as well as increased growth of muscle tissues (Reviewed by Lehnen et al., 2015). It was shown that products from ruminants (milk/meat) are the main sources of food-CLA; however, decreases in ruminant performance can be associated to lipid levels in diet. Welter et al. (2016) observed that the inclusion of canola oil in dairy cows' diet makes the milk fatty acids profile nutritionally healthier for human diet, however, cows' performance was reduced. In this context, the supply of unsaturated fatty acids from raw soybeans may be an alternative to increase the lipid level on diet, while not affecting dam performance (Gandra et al., 2016). Thus, this trial aimed to evaluate the effects of increasing raw soybeans levels on milk yield and composition, and milk fatty acid profile in ewes, and their lambs' performance.

2. Materials and methods

This study was carried out at the System facilities of the Intensive Production of Sheep and Goats (SIPOC) of Animal Science Department, "Luiz de Queiroz" College of Agriculture, São Paulo University, located in Piracicaba – São Paulo (22° 42′ 24″ S and 47° 37′ 53″ W), Brazil.

2.1. Animals and experimental design

Fifty-six multiparous Santa Ines ewes with an initial body weight (BW) of 63.9 ± 0.76 kg, were blocked according to date of birth, type of birth (single or twin), sex of the offspring and BW. Ewes with their lambs were housed in individual pens (1.3 m × 3.5 m), with a concrete floor, feed bunk, mineral box, and waterer. Forty-eight ewes had single births and eight had twin births, 32 females and 32 males. The experimental period lasted from 14 to 56 days post-partum for ewes, and their lambs were evaluated 14 more days, until 70 days of age.

The ewes were fed with diets containing 400 g/kg DM of *in natura* sugarcane bagasse as forage source, and 600 g/kg DM of concentrate containing 0 (CONT), 70 (7SOY), 140 (14SOY), or 210 (21SOY) g/kg DM of raw soybeans. The diets (Table 1) were isonitrogenous (150 g/kg DM of crude protein) and balanced according to the recommendations of the National Research Council (NRC, 2007).

2.2. Food management, collection of samples and methodologies

The concentrate ingredients of feed were weighed on an electronic scale with a 20 g accuracy (Marte®, LC 100 São Paulo, Brazil) and mixed using a horizontal mixer with a capacity of 500 kg (Lucato®, Limeira, Brazil). In every supply, *in natura* sugarcane bagasse was mixed with concentrate as the sole source of forage in a Casale® mixer feeder wagon. The animals had *ad libitum* access to the feed and fresh water. Daily, the feed was supplied and orts were weighed in order to calculate DM intake (DMI). The orts were re-offered to avoid changes in the relation among diet' ingredients, and discarded once a week. Amounts of feed offered to ewes were calculated according to previous DMI, and adjustments were done when needed, so that refused feed did not exceed 0.1 kg of daily intake. Feeds and orts were sampled weekly, and frozen at − 20 °C for later analysis. Ewes were weighed, for three consecutive days, without fasting, at the beginning and end of the experimental period to determine BW change.

Weekly, the ewes were separated from their lambs, and then milked (Camp Agri, model GL300, São Paulo, Brazil) mechanically according to Polizel et al. (2017) from 2 to 8 weeks postpartum. Milk ejection was stimulated by intravenous application of 10 international units (IU) of oxytocin (Univet, São Paulo, Brazil). The ewes were milked twice with a 3-h interval between milking. The first milking was performed to empty the mammary gland and the milk was discarded. The second one was used to access milk yield in 3 h. The total milk produced in 3 h was weighed, and multiplied by eight to estimate the milk yield per day. Milk production efficiency was assessed using the relation among milk production (g of milk/g of DMI), 6.5% fat-corrected milk (g of fat-corrected milk/g of DM intake) and 6.5% fat- and 5.8% protein-corrected milk (g of fat and protein-corrected milk/g of DM intake). Two samples of milk per ewe (20 mL each) were collected weekly, one of the samples was stored in bronopol Broad Spectrum Microtabs® II (2-bromo-2-nitropropane-1,3-diol, D & F Control Systems®, Inc., Dublin, CA, USA) and the other was stored at −20 °C.