J. Dairy Sci. 99:1–11
http://dx.doi.org/10.3168/jds.2015-9472

Effect of rice bran as a replacement for oat grain in energy and nitrogen balance, methane emissions, and milk performance of Murciano-Granadina goats

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ABSTRACT

The objective of this experiment was to study the effects of substituting oat grain with rice bran on energy, nitrogen and carbon balance, methane emissions, and milk performance in dairy goats. Ten Murciano-Granadina dairy goats in late lactation (46.1 ± 3.07 kg) were assigned to 2 treatments in a crossover design, where each goat received both treatments in 2 periods. One group of 5 goats was fed a mixed ration with 379 g of oat grain/kg of dry matter (O diet) and the other group of 5 goats was fed a diet that replaced oat grain with 379 g/kg dry matter of rice bran (RB diet). Diets were formulated to be isoenergetic and isoproteic, so bypass fat was added to reach the same amount of energy in both diets. The goats were allocated to individual metabolism cages. After 14 d of adaptation, feed intake, total fecal and urine outputs, and milk yield were recorded daily over a 5-d period. Then, gas exchange measurements were recorded individually by a mobile open-circuit indirect calorimetry system using a head box. Dry matter intake was different for both diets [1.83 ± 0.11 vs. 1.61 ± 0.08 (means ± SD), for O and RB, respectively]. Metabolizable energy intake and heat production were not significantly different between diets, with average values of 1,254 [standard error of the mean (SEM) = 110.0] and 640 (SEM = 21.0) kJ/kg of $BW^{0.75}$, respectively. Significant differences were found in milk fat content (5.3 and 6.9%, SEM = 0.36; for O and RB, respectively) and milk fatty acids: medium-chain fatty acids (17.17 vs. 12.90 g/100 g, SEM = 0.969; for O and RB, respectively) and monounsaturated fatty acids (20.63 vs. 28.29 g/100 g, SEM = 1.973; for O and RB, respectively). Enteric CH_4 emission was lower for the RB diet (23.2 vs. 30.1 g/d, SEM = 2.14; for O and RB, respectively), probably because of the higher lipid content in RB diets than O diets (11.7 vs. 4.1%, respectively). Lactating goats utilized RB without detrimental effects on energy metabolism. Higher milk fat and lower CH_4 emissions were observed with the RB diet compared with the O diet.
Key words: lactating goat, rice bran, energy balance, methane emissions

INTRODUCTION

Most of the concentrates for dairy ruminants are based on cereals. Cereal grains are the most common sources of readily available energy for livestock and comprise up to 60% of the total diet for high-yielding dairy ruminants. On the other hand, given the ability of ruminal microorganism to degrade fiber, some byproducts of other agricultural and industrial process are used to replace cereal (starch is replaced with highly digestible fibers as a main source of energy). One such byproduct is rice bran, with an estimated world production of 50 million tonnes (FAOSTAT, 2014).

Rice bran is obtained from the grain milling process, representing 5 to 8% of the total grain. Chemical analysis of rice bran varies widely, containing 11 to 14% CP, 16 to 21% NDF, and 21 to 28% of starch and minerals such as iron (0.015%), phosphorus (1.35%), and magnesium (0.80%). Rice bran differs from other byproducts in having higher levels of ether extract (**EE**), at 12 to 18%. The main fatty acids in rice bran oil are palmitic (21–26%), linoleic (31–33%), and oleic (37–42%) acids (Warren and Farrell, 1990; Oliveira et al., 2011).

Rice byproducts (rice straw, rice bran, heat rice bran, defatted rice bran) have been studied in cattle, sheep, and steers (Forster et al., 1994; Cao et al., 2010; Zhao et al., 1996). The effects of including rice bran in mixed diets upon intake, digestibility, energy, N and C balance, and milk performance of lactating goats have not been well investigated. Therefore, our aim was compare 2 mixed diets containing the same forage and replacing oat grain with rice bran in the concentrate.

MATERIALS AND METHODS

The experimental procedures were approved by the Committee on Animal Use and Care at the Polytech-

Received February 16, 2015.
Accepted September 16, 2015.
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Table 1. Ingredients and chemical composition (means ± SD) of the mixed diets

Item[1]	Oat (O)	Rice bran (RB)	Diet[2]	
			O	RB
Ingredients, g/kg of DM				
Alfalfa hay			350	350
Oats	1,000		379	
Rice bran		1,000		379
Barley			182	197
Soy meal (44% CP)			64	29
Bypass fat			15	33
Calcium carbonate			3.3	3.3
Sodium chloride			1.2	4.1
Premix			5.4	5.4
Chemical composition, % of DM				
DM	90.0 ± 5.4	89.7 ± 3.6	88.8	89.1
Ash	2.9 ± 0.2	8.2 ± 0.4	7.9	9.7
OM			92.1	90.3
CP	8.4 ± 0.4	13.8 ± 0.8	15.3	16.1
Ether extract	4.9 ± 0.3	13.9 ± 0.8	4.1	11.7
NDF	31.2 ± 1.9	17.9 ± 0.9	27.2	22.8
ADF	17.1 ± 0.5	9.1 ± 0.4	12.4	10.4
NFC[2]			45.5	39.8
Starch	37.0 ± 1.9	27.1 ± 1.4	28.2	21.6
Carbon			43.5	44.6
Gross energy, MJ/kg of DM			17.9	19.4

[1]Bypass fat of palm fatty acid distillate (Norel Animal Nutrition, Norel S.A., Spain). Premix (NACOOP S.A., Madrid, Spain) composition (per kg of premix): Se, 40 mg; I, 250 mg; Co, 80 mg; Cu, 3,000 mg; Fe, 6,000 mg; Zn, 23,400 mg; Mn, 29,000 mg; S, 60,000 mg; Mg, 60,000 mg; vitamin A, 2,000,000 IU; vitamin D_3, 400,000 IU; vitamin E, 2,000 mg; nicotinic acid, 10,000 mg; choline, 20,300 mg.

[2]NFC = 100 − (NDF + ash + CP + ether extract).

nic University of Valencia (Valencia, Spain) and follow the codes of practice for animals used in experimental works proposed by the European Union (2003).

Animals and Diets

The experiment was conducted at the Animal Science Department Experimental Farm (ACUMA Research Center, Valencia, Spain). Ten multiparous mature Murciano-Granadina dairy goats in late lactation were selected and divided into 2 homogeneous groups of 5 goats based on similar BW (46.1 ± 3.07 kg of BW), milk production in previous lactations (661.5 ± 44 kg of milk per 210 ± 30 d of lactation, on average), and milk yield at the beginning of the experiment (2,375 ± 375.1 g of milk per day, on average), in a crossover design (2 treatments crossed with 2 periods). Treatments consisted of 2 different mixed rations (Table 1). Goats were fed daily with 0.800 kg of alfalfa hay and 1.5 kg of concentrate (the forage:concentrate ratio was 35:65, expressed as percentage). The concentrate and premix were mixed and pelleted. One group was fed concentrate with 379 g/kg of DM of oat grain (**O** diet) and the other with rice bran (**RB** diet). Nutrient requirements followed the recommendations of Lachica and Aguilera (2003) and Calsamiglia et al. (2009) for goats in lactation. In an attempt to feed isoenergetic diets, bypass fat was added to each diet; that is, diets were formulated on an energy basis using book values for chemical composition of ingredients (FEDNA, 2010). The chemical composition of oats, rice bran, and the whole mixed diet (forage and pelleted concentrate) is reported in Table 1. After feed manufacturing and chemical analyses of diets, we found that the diets were not isoenergetic and that the RB diet had greater gross energy value. Half of the daily ration was offered at 0800 h and half at 1600 h. Goats had free access to water.

Experimental Schedule and Measurements

Apparent total-tract digestibility, gas exchange, energy partitioning, C and N balance, oxidation of nutrients, and milk composition and yield were determined. The experiment was conducted in a crossover design in two 30-d periods. During the adaptation period, goats were fed the experimental diets in pens for 7 d and then allocated to individual metabolism cages at thermoneutrality (20–23°C determined by Hobo data loggers, Onset Corp., Cape Cod, MA) for another 7 d. Next, data on amounts of feed offered and refused and total fecal, urine, and milk outputs were recorded daily for each goat during a 5-d period; BW was recorded at the beginning and end of the period. Feces were col-