Small Ruminant Research 123 (2015) 17–21

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Short communication

Productive performance and oxidative status of sheep fed diets supplemented with coffee pulp

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ARTICLE INFO

Article history:
Received 8 December 2013
Received in revised form
23 September 2014
Accepted 23 September 2014
Available online 2 October 2014

Keywords:
Sheep
Coffee pulp
Antioxidants
Productive performance

ABSTRACT

Productive performance, rumen fermentation and oxidative status of sheep fed diets supplemented with coffee pulp ensiled with 5% molasses were evaluated. Thirty-four Black-belly cross-breed sheep, 6 months old, mean weight 21.2 ± 0.63 kg, were assigned to three treatments T0: control treatment ($n = 11$), T1: treatment with 8% coffee pulp in the diet ($n = 12$), and T2: treatment with 16% coffee pulp in the diet ($n = 11$). Coffee pulp at the levels evaluated did not affect daily weight gain, feed intake, and feed conversion ($P > 0.05$). However, water intake, acetic acid, butyric acid, and total volatile fatty acids significantly increased ($P < 0.05$) with the 16% coffee pulp diet. No differences ($P > 0.05$) were observed in the antioxidant capacity of the sheep's plasma; however, lipid peroxidation was lower for sheep fed with 16% coffee pulp. The present study concluded that a supplemented sheep diet with coffee pulp up to 16% coffee pulp did not affect their productive parameters but reduced oxidative stress.

1. Introduction

Coffee pulp has been used as feed for different animal species (Ferreira et al., 2000), but due to the presence of compounds such as tannins and caffeine (Ferreira et al., 2001), its inclusion in the diet of animals has been limited. However, some phenol compounds have also been found (Ramírez-Coronel et al., 2004). These compounds have proven to be powerful antioxidants (Sroka and Cisowski, 2003). Currently, meat animals are fed high quantities of grains to increase weight gain and reduce finalization times. Nevertheless, including grains in the diet has been found to increase oxidative stress in animals (Mercier et al., 2004). Because of this, coffee pulp, besides having nutrients necessary for animal feeding, could protect animals from oxidative stress. The objective of this work was to evaluate the productive performance, rumen fermentation, and

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http://dx.doi.org/10.1016/j.smallrumres.2014.09.008
0921-4488/

Table 1
Ingredients and chemical composition of the experimental diet.

Ingredient (%)	Treatments		
	T0	T1	T2
Alfalfa residue[a]	57.57	48.53	39.50
Ground sorghum grain	25.24	22.76	21.20
Soybean meal	14.18	17.69	20.20
Molasses	2.00	2.00	2.00
Mineral mix[b]	1.00	1.00	1.00
Ensiled coffee pulp	0.00	8.00	16.00
Composition on dry matter basis			
DM	83.73	86.32	86.74
CP	17.05	17.03	17.12
ADF	24.63	21.083	21.21
NDF	37.32	32.36	31.47
FRAP (μg trolox g^{-1} DM)	32.20	37.58	40.25

T0: control, T1: 8% coffee pulp, and T2: 16% coffee pulp.
DM: dry matter, CP: crude protein, ADF: acid detergent fiber, NDF: neutral detergent fiber.
[a] Alfalfa residue: alfalfa left after harvesting.
[b] Composition of the mineral mix: calcium 150 g/kg, phosphorus 70 g/kg, sodium chloride 120 g/kg, manganese 2.5 g/kg, zinc 4.5 g/kg, copper 0.5 g/kg, and iron 3.5 g/kg.

oxidative state of sheep fed with different levels of coffee pulp.

2. Materials and methods

2.1. Silage and coffee pulp analysis

Coffee (*Coffea Arabica*) pulp was ensiled with 5% molasses, fermented for two months, and sun-dried. The coffee pulp used contained 14.47% ash, 11.16% crude protein, 51.95% NDF, 43.93% ADF, 13.16 lignin, 0.50% caffeine and antioxidants such as chlorogenic acid (5.61%), caffeic acid (1.47%) and gallic acid (0.26%).

2.2. Animals

Thirty-four 6-month-old Blackbelly male cross-breed sheep, average weight 21.2 ± 0.63 kg, were used. They were dewormed with 1 mL 50 kg^{-1} BW Ivermectin and given 3 mL of metabolic stimulant (catosal®). The sheep were randomly assigned to three treatments; T0: control ($n = 11$), T1: diet with 8% dry base coffee pulp ($n = 12$), and T2: diet with 16% dry base coffee pulp ($n = 11$). Ingredients were adjusted to meet the requirements of the NRC (1985) (Table 1). The sheep were given 12 days for adaptation to the diet, followed by a fattening period of 56 days.

2.3. Productive variables

Sheep were kept separate in 1.2 m × 1.1 m pens. Daily weight gain (DWG), feed intake (FI) and feed conversion (FC) were calculated. Water intake and refusals were measured daily using a 1 L test tube, graduated in milliliters.

2.4. In vivo digestibility

At the end of the fattening period, five sheep from T0, six from T1, and five from T2 were separated to determine in vivo digestibility. Feces collection bags were fitted on the sheep for 8 days, the first day was for adaptation, and the remaining 7 days total feces were collected in the morning and in the afternoon. The feces were weighed and frozen at −4 °C. At the end, the individual samples were mixed and a half kg sample from each sheep was taken for analysis.

Digestibility was determined as the difference between weight of ingested feed and weight of feces (Harris, 1970).

2.5. pH, VFAs, and ammonia nitrogen

After the fattening process, another five sheep from each treatment were slaughtered after 12 h fasting; rumen liquor was obtained immediately and pH was measured. Eight milliliters of the rumen liquor was mixed with 2 mL metaphosphoric acid at 25% to determine VFA and ammonia N. The samples were then frozen at −20 °C until analysis. Volatile fatty acids were analyzed by gas chromatography using the Erwin et al. (1961) technique.

Ammonia nitrogen was determined using the McCullough (1967) technique, and concentration was measured through absorbance in an ultraviolet light spectrophotometer at 630 nm.

2.6. TBARS and FRAP

The antioxidant capacity of the diets is shown in Table 2.

At the beginning of the fattening period, 10 animals were randomly sampled for blood plasma. Ten animals of each treatment were sampled at the end of this period. The samples were centrifuged at 3500 rpm for 10 min at 4 °C, plasma was deposited in cryostat tubes and stored in liquid nitrogen at −196 °C until analysis.

The antioxidant capacity of the plasma was measured using the FRAP technique by Benzie and Strain (1996). The pattern curves were done with different trolox (6-hydroxy-2-5-7-8-tetramethylchroman-2-carboxylic acid) concentrations, which is a water soluble equivalent of vitamin E.

TBARS (thiobarbituric acid reactive substances) analysis was done according to the technique described by Ohkawa et al. (1979). The samples were read in a Thermo Scientific UV-V15 spectrophotometer. Sample analyses were carried out twice. The results were interpreted as MDA, which is a by-product of lipid peroxidation.

2.7. Statistical analysis

A completely random design with three treatments was used. Data were analyzed by analysis of variance, for DWG, FI and FC; initial weight was used as covariable in the following model:

$$Y_{ij} = \mu + T_i + \beta_0(P_i - p_i)k + E_{ij}$$

where Y_{ij} = response of the ith treatment to the jth repetition, μ = general mean, T_i = effect of the ith treatment, β_0 = lineal regression coefficient, $(P_i - p_i)k$ = kth initial weight covariable and E_{ij} = experimental error. Means were compared with the Tukey test. Statistical analyses were done using the SAS version 9 (2002) software.

Table 2
Weight gain, feed intake, feed conversion, and water intake of sheep fed 0, 8 and 16% of coffee pulp in the experimental diet.

	Treatments			SEM
	T0	T1	T2	
Initial weight (kg)	20.89	21.2	21.71	0.63
Final weight (kg)	30.34	31.25	32.20	0.70
FI (g d^{-1})	1189.90	1217.80	1227.00	15.80
DWG (g)	169.13	179.67	186.80	3.91
FC	7.06	6.82	6.64	0.11
Water intake (mL d^{-1})	2514.06[b]	2616.93[b]	2918.53[a]	52.7

T0: control, T1: 8% coffee pulp, and T2: 16% coffee pulp.
FI: feed intake, DWG: daily weight gain, FC: feed conversion.
[a,b] Different letters in the same row indicate differences ($P < 0.05$).

3. Results

3.1. Productive variables

No differences ($P < 0.05$) were observed in FI, DWG and FC when coffee pulp inclusion in the diet increased. Although sheep in group T1 consumed more water (102.87 mL) than those in group T0, the difference did not reach a significant level ($P < 0.05$). When the inclusion level was raised to 16% in the diet, an increase ($P < 0.05$) of 404.47 mL was observed with respect to the control treatment (Table 2).