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Effect of the inclusion of artichoke silage in the ration of lactating ewes on the properties of milk and cheese characteristics during ripening

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ABSTRACT

The effect of including artichoke silage in the rations of dairy ewes on milk characteristics and biochemical changes of ripened cheeses was evaluated. Four groups of lactating ewes were fed rations containing 0, 10, 20, or 30% artichoke silage on a dry matter basis. Bulk milk samples were collected 3 times during the feeding period, and semi-hard cheeses were manufactured and sampled during ripening. Milk composition and cheese yield were not affected by diet. Inclusion of 20 and 30% artichoke silage reduced the firmness of the curds at a level only detected by the Gelograph (Gelograph-NT, Gel-Instrumente, Thalwil, Switzerland) probe. Inclusion of artichoke silage in ewes' diet decreased fat and total free fatty acids content of these cheeses and increased total free amino acids content. Despite the effect of diet on cheese ripening characteristics, the overall sensory scores for cheeses corresponding to artichoke silage diets were statistically higher than those for the control cheeses.
Key words: artichoke silage, dairy ewe, milk coagulation, cheese ripening

INTRODUCTION

Semi-intensive and intensive dairy ruminant production is characterized by a high demand and dependence on mixed cereals, which are expensive and require extensive cropland areas. The use of by-products from the vegetable processing industry can be a less expensive source of nutrients suitable for ruminant feeding because of the ruminant's capacity to digest fiber-rich feedstuffs. Furthermore, the use of these by-products can be an alternative for the food industry to diminish waste discharges and to reduce waste management costs.

Artichoke by-products have been traditionally included in the diet of dairy cows in areas with local availability (Martínez et al., 1998). However, the seasonal nature and high water content of this by-product limit its utilization in animal feeding. To address this concern, an evaluation of the ensiling capacity of the artichoke agro-industrial by-product and the phytosanitary, fermentative, and nutritive characteristics of the silage made from these residues has been conducted (Meneses et al., 2007). According to that study, artichoke by-products are suitable for ensiling and can be used as animal feed without health risks. Silages were reported to have an acceptable composition (88 g/kg of CP on a DM basis and 509 g/kg of NDF) and no presence of phytosanitary residues after 12 d of ensiling. Even though several studies deal with the quality of fermentation, content of volatile fatty acids, and the digestibility of artichoke silage (Megías et al., 1991, 1997; Madrid et al., 1999), the literature reports only a few results about the effect of feeding animals with artichoke residues on the quality and composition of milk or meat (Galvano and Scerra, 1983; Bonomi et al., 2004a,b; Marsico et al., 2005). For instance, substitution of alfalfa meal with artichoke leaf meal did not compromise animal health and increased milk production of dairy goats (Bonomi et al., 2004a), and had no effect on milk production and composition when it was offered to dairy ewes (Bonomi et al., 2004b). In another study, diets based on artichoke bracts given to lambs and kids had an effect on meat composition, so that water and protein content increased and the levels of some fatty acids of meat fat were affected (Marsico et al., 2005). Evaluation of other crop by-products has demonstrated that if diets supplemented with these alternative feed resources are carefully formulated and supply the animal nutritional requirements, their use does not compromise milk quality and production in small ruminants (Vasta et al., 2008). It is well known that animal nutrition determines not only the composition of milk but also its technological properties and the quality of derived products. Furthermore, feeding strategies such as type of forage, conservation method,

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Table 1. Ingredients and composition of the experimental rations with 0, 10, 20, and 30% artichoke silage (AS) fed to dairy ewes

	Ration (% AS)			
Item	0	10	20	30
Ingredients (g of DM per day)				
Artichoke silage	0	250	500	750
Barley grains	600	400	200	0
Corn	240	370	499	629
Soybean meal	275	291	308	324
Alfalfa hay	1,050	800	550	300
Barley straw	330	385	441	496
Molasses	40	40	40	40
Vitamin/mineral mixture	75	75	75	75
Total	2,610	2,611	2,613	2,614
Chemical composition[1] (% of DM)				
DM (%)	85.98	56.39	42.04	33.54
CP	14.81	15.52	15.5	14.48
Fat	1.36	1.49	1.25	1.76
Crude fiber	24.01	21.62	21.02	22.19
NDF	43.13	43.04	43.39	43.16
ADF	23.70	23.36	22.56	23.49
Acid detergent lignin	3.02	3.02	2.42	2.90
Ash	9.38	9.11	9.60	10.62
Net energy (MJ/kg of DM)	5.73	5.59	5.60	5.61

[1]Values represent duplicate assays of 4 samples from each ration.

and grass diversity and quality have an effect on the sensory attributes of different types of cheeses (Coulon et al., 2004). Literature about the effect of including nontraditional feedstuffs in dairy ewes on the technological properties of milk and cheese characteristics is limited. For this reason, the aim of the present work was to evaluate the effect of using artichoke silage (**AS**) as a substitute for barley grain and alfalfa hay in the mixed rations of dairy ewes, on milk technological properties, ripened cheese characteristics, and cheese overall sensory perception.

MATERIALS AND METHODS

Animals and Experimental Rations

Forty-eight lactating Guirra ewes were used and previously managed to have one parturition and concentrate lambing within 2 to 3 wk. Six weeks after parturition (weaning period) ewes were mechanically milked twice a day (morning and evening) until the end of lactation. To balance experimental groups for milk production and composition, animals were fed the same ration during a 2-wk preexperimental period (wk 9 and 10) and recorded for daily milk production and milk composition. Animals were then divided into 4 homogeneous groups of equal size and assigned randomly to 1 of 4 experimental rations containing AS at 0 (control), 10, 20, and 30% in substitution of barley grain and alfalfa hay. Ingredients and chemical composition of experimental rations are shown in Table 1. Rations were formulated to be isoenergetic and isoprotein and were given twice daily to animals. After 2 wk for diet adaptation bulk milk sampling was performed from wk 13 to 16 of lactation.

Artichoke residues were obtained from the canning industry and consisted mainly of the bracts and stems of the inflorescence before being scalded. One month before milking, 25 t of artichoke residues was compacted in a bunker silo and ensiled until use. No additives were used and silage had a final pH of approximately 4.0. Silage was preserved by covering it with plastic sheeting during the experimental period. Silage presented final protein, ether extract, and NDF contents of 15.6, 2, and 49% (on a DM basis), respectively.

Milk Sampling and Analysis

Bulk milk samples were collected 3 times during the experimental period from each animal group (total milk samples: 12). Samples comprised a morning and afternoon milking mixture. Milk for physicochemical analyses and SCC was stored at 4°C until analysis (2–4 h), and bulk samples for cheese production were held at 6 to 8°C and processed approximately 15 h later at the pilot plant. Three cheese batches were obtained from each experimental group and further ripened for 60 d.

Milk samples were analyzed for fat, total protein, casein, lactose, and TS, by infrared analysis (Milko Scan FT-120; Foss Electric, Hillerød, Denmark; IDF, 1996).