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Effect of the inclusion of citrus pulp in the diet of goats on cheeses characteristics

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ABSTRACT

The differences between the physicochemical (water content, water activity, pH, NaCl, fat, color, and texture) and sensory (descriptive analysis and consumer test) characteristics of cheeses made from the milk of goats fed on a typical control diet and goats fed on a diet incorporating orange pulp were compared. The addition of orange pulp leads to obtain cheeses (i) with a lower pH and water activity, but with a higher fat content, (ii) that are lighter and with a more yellowish-green hue and (iii) higher in color purity, hardness and adhesiveness, although they are less elastic and cohesive. Thus, the incorporation of orange pulp into the goat's diet affected not only the presence of holes in the cheese, but also its hardness, goat taste and salty taste, which were associated with a higher score of consumer acceptance.

1. Introduction

The nutritional needs of animals are met from two major food groups: rich in energy and/or protein concentrates and fibrous foods, mainly forages. It is essential to know the chemical composition of the diet, its nutritional value and the amount in which it can be ingested by goats. Nowadays, because of to the low profitability of the small ruminants sectors, it is very important to reduce the cost of their diet (Garg et al., 2013).

The use of agroindustrial by-products for ruminant feed is an economical and environmentally sound way for food processors to reduce waste discharge and to decrease waste management costs. Historically, the use of agroindustrial by-products in areas where the natural forage is insufficient has been recommended (Martínez and Medina, 1982; Martínez et al., 1998). Actually, its use seems widespread and covers areas where natural forages are surplus. The choice of agroindustrial by-products supplementation should be based on economical (low price), nutritional (dense in nutrients), and toxicological (free of toxins or other substances) considerations. Large amounts of waste from citrus processing for juice extraction are available in Spain. Citrus pulp, the main citrus by-product, is a high energy content by-product that can partly replace cereal grains in animal rations with no adverse effect on milk yield or composition. The use of citrus pulp in formulated feeds depends largely on the availability and its relative cost-effectiveness when compared with other alternative raw materials. Citrus pulp is primarily a feedstuff with low protein and high carbohydrate contents, which differs substantially from the chemical composition

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of conventional raw materials. The nutrient content of citrus by-product feedstuff is influenced by different factors, including the source of the fruit and the type of processing. In general, all citrus by-products are suitable for inclusion in ruminant diets because of their ability to ferment high-fiber feeds in the rumen (Arbabi et al., 2008). The effects of incorporating citrus pulp into cow, sheep and goat diets on the physical quality of the milk has been studied (Bampidis and Robinson, 2006; Jaramillo et al., 2006). However, its effect on physico-chemical and sensory characteristics of the obtained dairy products is important (Scholz, 1995; Lebecque et al., 2001) and, to date, it is not available.

The aim of this study was to compare between cheeses made from the milk of goats fed on a conventional diet and on a diet supplemented with orange pulp. The physico-chemical and sensory properties during cheeses ripening were studied.

2. Material and methods

2.1. Samples

24 Murciano Granadina (a Spanish breed) goats, part of the small-ruminant farm of the Universitàt Politècnica de València (UPV), in the sixth month of lactation were adapted to experimental conditions and for 14 days from, were fed on a control diet. Later, the 24 goats were divided into two groups, according to their productive characteristics and the composition of their milk. These two groups followed a 46-day pilot phase, during which the goats were fed on 2 different although nutritionally equivalent diets, the same control diet (CD) used in the pre-experimental period and a diet incorporating orange pulp (OPD). Randomly, one of the groups was fed in the first 23 days on the CD and the other one on the OPD. The diets were changed in the second period. For each animal, both diets contained 1500 g of alfalfa and 200 g of straw. In addition, the CD contained 1300 g of feed supplement and the OPD included 100 g of feed supplement, 50 g of soy and 2500 g of orange pulp per animal. The CD contained: 17 g protein/100 g of dry matter and a net energy of 0.82 fodder units (FU) (Belloin, 1988). The OPD contained 16.33 g protein/100 g dry matter and a net energy of 0.82 FU units fodder milk/kg dry matter. The components of the diets were supplied by a local company (Piensos y Cereales Noalles S.L., Valencia), and the rations were prepared daily, just before the goats were fed.

2.2. Manufacture of the cheeses

The cheeses were prepared in the cheese factory of UPV. The raw milk was obtained at the same day as the cheeses were manufactured. Upon receipt, the milk was filtered and kept in refrigeration until the start of the processing. The process started by the addition of the commercial starter culture (Laboratorios Arroyo, Santander, Spain) when the milk reached the appropriate temperature setting for the bacteria (28–30 °C). After that, calcium chloride and the rennet (Laboratorios Arroyo, Santander, Spain) were added in order to initiate the formation of a firm curd. After coagulation (about 35 min), the curd was cut with large knives to allow the elimination of the serum. The curd was placed into molds and pressed to facilitate the blending of the curd grains and to accelerate the whey separation. After this stage, the cheeses were salted in brine (22° Baume concentration) to eliminate more whey and to make possible the formation of the cortex. Finally, the cheeses went through a ripening stage of 60 days inside chambers with controlled temperature (11–12 °C) and relative humidity (80–85). The minimum ripening time was in accordance with the current Spanish regulations for making cheeses made from raw milk, which weight less than 1.5 kg (España, 2006). The final products had an average weight of 800 g. Cheeses made from the milk of goats fed on CD are named CCh and those made from the milk of goats fed on OPD are named OPCh.

2.3. Physico-chemical characterization of cheeses

Cheeses were characterized throughout ripening process in the chambers at 1, 40 and 60 days from the start. The crust was removed when preparing the samples for analysis.

2.3.1. Water content

The water content of the cheeses was measured in triplicate following the official AOAC 926.08 method (1997).

2.3.2. Water activity

The water activity (a_w) of the samples, previously homogenized, was measured in triplicate by using a dew point hygrometer (Decagon Devices Inc., Aqualab 4TE, USA).

2.3.3. pH

The pH was measured using a pH meter (Crison Instruments, S.A., Basic 20, Spain) with a penetration electrode. The readings were taken in different parts of the cheese, making a minimum of six readings per sample.

2.3.4. Sodium chloride

An automatic chloride analyzer (Sherwood Scientific, Chloride Analyzer 926, UK) was used to determine the sodium chloride content in the cheeses, following the equipment instructions.

2.3.5. Fat content

The Soxhlet method was used to separate the fat from cheese. It is a little time-consuming and labor intensive method and its validity has been tested by comparing the determinations of fat in cheese products with those analyzed by conventional methods, such as the Roese–Gottlieb, the Gerber, the Schmidt–Bondzynski–Ratzlaff and the Babcock (García-Ayuso et al., 1999; Purcarea, 2009).

2.3.6. Color

Color measurement was done by using a Minolta, CM 3600D (Tokyo, Japan) spectrocolorimeter which provided the CIE-L*a*b* color coordinates (10° observer and D65 illuminant) (Hutchings, 1999). Readings were obtained at room temperature (22 ± 1 °C) directly on the surface of