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Sensory profile and physicochemical parameters of cheese from dairy goats fed vegetable oils in the semiarid region of Brazil

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ABSTRACT

The supplementation of vegetable oils in the diets of dairy goats may enhance to improve nutritional and sensory qualities of goat milk and cheese. Cheese was made from milk of crossbred Saanen × French Alpine goats fed diets containing 4% vegetable oils (faveleira oil, sesame oil or castor oil), and physicochemical parameters, texture profile, colour and fatty acids of the goat cheeses were analysed. The sensory attributes of the goat cheese were analysed using quantitative descriptive analyses. The cheeses exhibited similar physicochemical and sensory attributes ($P \geq 0.05$) regardless of the animals' diets. For cheeses made from the milk of goats fed sesame oil, the hardness was lower, and the cheeses were softer than the control ($P < 0.05$). Faveleira oil and sesame oil positively affected the fatty acid profile of the cheese. In general, the addition of different oils to the diets of dairy goats did not promote changes in the sensory quality of the cheese produced and can be used as a dietary supplement.

1. Introduction

In Europe, goat cheese is much appreciated, and its consumption is part of the local culture, which is not the case in Brazil. Goat milk production is a dynamic and growing industry that is fundamental to the wellbeing of hundreds of millions of people worldwide and is an important part of the economy in many countries. In addition, the studies demonstrate that this milk is also rich in microcomponents (fatty acids, vitamins), in volatile compounds (flavours, terpenes), and phenolic compounds, favourable to human nutrition and health (Silanikove et al., 2010).

Because of its nutritional characteristics, researchers have attempted to improve the physicochemical characteristics of goat milk, especially by inducing changes through addition of different sources of fat in the diets of dairy

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goats (Queiroga et al., 2010). In this context, vegetable oils have been used to increase dietary energy density and to improve the quality of goat milk and its derivatives. However, there are limiting factors in the use of vegetable oils in the diets of ruminants. The oil content should not exceed 7% of the ethereal extract in dry matter (NRC, 2007).

Some studies have reported positive effects of lipid supplementation on milk quality in goats. Sanz Sampelayo et al. (2007) reported that lipid supplementation in dairy goats causes no changes in energy consumption or milk production but significantly increases the fat content of milk in most cases. In addition, the presence of unsaturated fatty acids in feed may have positive effects, such as inhibiting the production of methane and ammonia in the rumen and increasing the efficiency of microbial synthesis (Mohammed et al., 2004). Some studies have shown that dietary supplementation with fodder and oils improve the quality and sensory attributes of milk (Bernard et al., 2009; Chilliard et al., 2003; Palmquist and Griinari, 2006) and cheese (Cabiddu et al., 2006; Santos et al., 2012).

Among the existing lipid sources, faveleira oil (*Cnidoscolus quercifolius* or *C. phyllacanthus*), sesame oil (*Sesamum indicum* L.) and castor oil (*Ricinus communis* L.) have received special attention for their wide applicability, availability and high levels of unsaturated fatty acids, but their effects as supplements in animal diets and on changes in cheese attributes are still poorly understood. The seeds of faveleira (50–70% oil) stand out due to the presence of unsaturated fatty acids, especially linoleic acid (C18:2n6 *cis*), which accounts for 41.6% of linoleic (Santos et al., 2005). Castor seeds show crude oil levels ranging from 35 to 55%, where 90% is ricinoleic acid (C18:1 *cis*-9,12-OH), giving this oil typical features, such as high viscosity over a wide range of temperatures, oxidative stability, a low freezing point, and total solubility in low-molecular-weight alcohols (Berman et al., 2011). Sesame seeds, which contain up to 60% oil and 17–23% protein, produce oil rich in unsaturated fatty acids and the presence of antioxidants such as sesamin, sesamolin, and sesamol (Suja et al., 2004).

The objectives of the present study were as follows: to evaluate the effect of supplementation of three vegetable oils (faveleira, sesame and castor) on the milk composition of dairy goats raised in Brazilian semiarid region and to characterise rheological properties, colour, fatty acids and sensory properties of goat cheese produced from different dietary treatments.

2. Materials and methods

2.1. Animals and experimental rations

The cheese was made from the milk of crossbred Saanen × French Alpine goats, which were hand milked, kept in confinement and fed diets prepared according to NRC (2007) requirements (Table 1). Four diets were used in the study: Treatment 1, basal diet without the addition of vegetable oil to the dry matter; Treatment 2, basal diet plus 4% faveleira oil; Treatment 3, basal diet plus 4% sesame oil; and Treatment 4, basal diet plus 4% castor oil.

The trial lasted 76 days and followed a Latin square design (4 × 4) with 8 animals distributed into two for each treatments, with four treatments and four processing periods, being which the first 15 days of each period were used for adaptation to the diet and for the four days following the collection of milk samples.

2.2. Cheese samples and production technology

In each period, the cheeses were made using 10 L of goat milk per treatment, and they were pasteurised at 65 °C (±1 °C) for 30 min followed by cooling to 37 °C (±2 °C) and coagulation with additives in the following sequence: 0.25 mL L^{-1} 85% lactic acid solution; 0.1 g L^{-1} lyophilised lactic starter culture with *Lactococcus lactis* subsp. *cremoris* and *Lactococcus lactis* subsp. *lactis* (Christian Hansen Ind. & Com. Ltd., Valinhos, SP, Brazil); 0.5 mL L^{-1} 50% calcium chloride; and 0.9 mL L^{-1} commercial coagulant (Ha-La®, Christian Hansen Ind. & Com. Ltd., Valinhos, SP, Brazil). After 40 min of rest, the curd was gently cut into cubes, drained, and salted in brine (9 g L^{-1} NaCl). The cheese mass was then distributed into 250 g perforated moulds, pressed for 4–6 h at room temperature, vacuum packed and stored under refrigeration 4 ± 1 °C for 7 days. Four cheeses manufactured were 250 g for each treatment, in which a part was designed to sensory analysis and partly other analysis.

2.3. Physicochemical analysis

Physicochemical analyses were performed in accordance with the following procedures recommended by AOAC International (2000): 991.20 for protein; 989.04 for lipids; 935.42 for ash; 981.12 for pH; and 978.18 for water activity. The moisture content from the samples was determined following the international standard method (IDF, 1958).

2.4. Texture analysis

Texture profile analysis (TPA) were performed using a TA-XT2i texturometer (Stable Micro Systems, Survey, UK) coupled to a stainless steel spherical probe (P/1S) 1 inch in diameter (Extralab Brazil, São Paulo, Brazil). Cheeses were cut into cylindrical shapes (50 mm in diameter and 25 mm in height) and analysed in triplicate for each treatment.

The conditions for texture analysis based on the procedure of Andrade et al. (2007) were as follows: 1.0 mm/s speed, 50% compression, 5.0 g contact force, and 5 s between cycles. The texture parameters of hardness, cohesiveness, adhesiveness, springiness and chewiness were analysed using Texture Expert for Windows 1.20 software (Stable Micro Systems).

2.5. Colourimetric analysis

The determination of instrumental colour was performed on a CR-400 colourimeter (Minolta, Osaka, Japan) using the CIELAB system colour scale ($L^*a^*b^*$) with a D65 illuminant (standard daylight) and measuring angle of 10. The L^*, a^* and b^* parameters were determined according to the International Commission on Illumination (CIE, 1996). Using reference plates, the apparatus was calibrated in the reflectance mode with specular reflection excluded. A 10 mm quartz cuvette was used for the readings. Measurements were performed in triplicate on the external and internal of each piece of cheese immediately after unpacking.

2.6. Fatty acid analysis

For all the samples analysed, lipid extraction was performed according to the technique of Folch et al. (1957). For the analysis of fatty acids, saponification and esterification of the cheeses were performed according to the method of Hartman & Lago (1973).

The esterified samples were analysed with a gas chromatograph (Varian 430-GC) with a flame ionisation detector (FID) and fused silica capillary column (CP WAX 52 CB Varian; 60 mm × 0.25 mm, 0.25 μm film thickness). Helium was used as the carrier gas (flow rate of 1 mL min^{-1}). The initial oven temperature was 100 °C, and the temperature was programmed to reach 240 °C by increasing 2.5 °C per min for 20 min. The injector and detector temperatures were maintained at 250 and 260 °C, respectively.

An aliquot (1.0 μL) of each esterified extract was injected into a split/splitless type injector at 250 °C, and the chromatograms were recorded using Galaxie Chromatography Data System software. Fatty acids were identified by comparing the retention time of the methyl esters with Supelco ME19-Kit standards (Fatty Acid Methyl Esters C6-C24). The results were quantified by standardisation of the areas of methyl esters and are expressed as percentages of the area.