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Physicochemical and sensory properties of fermented dairy beverages made with goat's milk, cow's milk and a mixture of the two milks

Jacieny Janne Leite Gomes [a], Andreza Moraes Duarte [a], Ana Sancha Malveira Batista [b], Rossana Maria Feitosa de Figueiredo [c], Elisabete Piancó de Sousa [c], Evandro Leite de Souza [a], Rita de Cássia Ramos do Egypto Queiroga [a,*]

[a] Departamento de Nutrição, Centro de Ciências da Saúde, Universidade Federal da Paraíba, Campus I, 58051-900, Cidade Universitária, João Pessoa, Paraíba, Brazil
[b] Coordenação de Zootecnia, Universidade Estadual Vale do Acaraú, Sobral, Brazil
[c] Centro de Tecnologia e Recursos Naturais, Universidade Federal de Campina Grande, Campina Grande, Brazil

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ABSTRACT

Three dairy beverages with different concentrations of cow's and goat's milk and whey with added guava jelly were prepared and stored at 7 °C for 28 days and then evaluated for their physicochemical (total solids, protein, fat, lactose, acidity, pH and syneresis), rheological (viscosity) and sensory characteristics (Quantitative Descriptive Analysis). The dairy beverage made with the milk and whey from cows and goats (Mixed Dairy Beverage – MDB) showed lactose and pH values lower than the beverage made with goat milk and whey (Goat Dairy Beverage - GDB), but higher than those of the beverage made with cow milk and whey (Cow Dairy Beverage – CDB). MDB also exhibited a higher viscosity than GDB and a higher water holding capacity than CDB. All the beverages received similar scores for most of the evaluated sensory attributes, with similar scores for MDB and CDB in terms of purchase intention. The development of dairy beverages with both goat's and cow's milk with added guava jelly is an interesting opportunity to produce a nutritional product that is considered satisfactory by consumers.

1. Introduction

A fermented dairy beverage is made with milk and whey, and it is characterized as an important nutritional source due to the presence of protein with a high biological value that is mostly derived from whey, a major raw material (Sanmartín, Díaz, Rodríguez-Turienzo, & Cobos, 2011). The production of dairy beverages has been increasing worldwide due to their simple production technology and wide acceptance by consumers; they have been characterized as an alternative use for the whey from sheep, goat and cow milk resulting from cheese production (Hernández-Ledesma, Ramos, & Gómez-Ruiz, 2011). The use of technology that allows for the reuse of whey generated during the industrial processing of cheese is of interest because this co-product is one of the most important sources of organic contamination to the environment (Smithers, 2008).

Goat's milk and whey obtained during the production of dairy products have important nutritional properties, such as the presence of organic and nitrogen matter (casein and albumin), minerals and vitamins, as well as lactic ferments, which improve the digestion process and defence against intestinal pathogenic bacteria (Haenlein, 2004; Panesar, Kennedy, Gandhi & Bunko, 2007; Park, Juarez, Ramos, & Haenlein, 2007). Goat's milk has some particular properties that confer technological advantages in comparison to cow's milk, such as a smaller size of fat globules, which provides a smoother texture in derived products, lower amounts of $\alpha s1$-casein, resulting in softer gel products, a higher water holding capacity and a lower viscosity (Haenlein, 2004; Kondyli, Katsiari, & Voutsinas, 2007; Küçükçetin, Demir, Asçi, & Çomak, 2011; Silanikove, Leitner, Merin, & Prosser, 2010; Vargas, Chafer, Albors, Chiralt, & Gonzalez Martinez, 2008). However, the flavour of goat's milk is more intense in comparison to cow's milk, which can restrict the acceptance of its derivatives by consumers. In this context, the production of dairy products using mixtures of milk and whey from goats and cows may be a viable and interesting opportunity for the dairy market, adding value to products and improving their physicochemical and sensory properties, thereby increasing their acceptance by consumers (Küçükçetin et al., 2011; Queiroga et al., 2013; Thompson, 2007).

* Corresponding author. Tel.: + 55 83 32167826; fax: +55 83 32167094.
E-mail addresses: jacienyjanne2009@hotmail.com (J.J.L. Gomes), rcqueiroga@uol.com.br (R.deC.RamosdoE. Queiroga).

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Considering these aspects, the objective of this study was to develop and evaluate the nutritional, rheological and sensory properties of fermented dairy beverages made with mixtures of milk and whey from goats and cows and guava jelly. Some of their quality characteristics were compared with those of dairy beverages produced with the milk and whey from either cows or goats.

2. Material and methods

2.1. Raw-materials

Goat (Alpine breed) and cow (Gir breed) milk used in the manufacture of dairy beverages were obtained from the Department of Goat and Cattle Breeding of the Centre for Humanities, Social and Agrarian Sciences at the Federal University of Paraíba (Bananeiras, Brazil). Whey was generated from the production of a white cheese through enzymatic action, with the addition of 1 g/100 mL of starter culture (R-704, Christian Hansen®, Valinhos, Brazil), 0.5 mL/L calcium chloride (stock solution of 50 g/100 mL) and 0.8 mL/L of commercial rennet (Ha-la Christian Hansen®), according to the procedure described by Embrapa, a Brazilian Company for Agricultural Research (Egito et al., 2009, 6 pp.). Milk and whey were pasteurized (65 °C/30 min) and then stored under refrigeration (7 °C) until analysis at maximum intervals of 24 h.

The dairy beverages were prepared using the thermophilic lactic culture YF-L903 of a defined and lyophilized strain mix composed of *Streptococcus salivarius* subsp. *thermophilus* and *Lactococcus delbrueckii* subsp. *bulgaricus* (Batch 3048996; Christian Hansen®, Valinhos, Minas Gerais, Brazil).

Guava (*Psidum guajava*) fruits at the commercial maturation stage were used in the preparation of jelly. They were acquired from EMPASA (Supply and Services Company of Paraíba, João Pessoa, Brazil). Fruits with no signs of mechanical damage and deterioration that were homogeneous in size and colour were selected and standardized.

2.2. Jelly preparation

The fruits were washed (running water) and sanitized by immersion in sodium hypochlorite (10 ppm) for 15 min. They were then rinsed, peeled, bleached (100 °C/5 min), added to water (20 mL/100 g) and then homogenized using a domestic blender and sieved for separation of the pulp. The pulp obtained was increased by the addition of sucrose (10 g/100 g) and heated (180 °C) until the formation of jelly. The point of formation of jelly was based on the soluble solids, reaching 65 °Brix, according to a specific legislation that recommends a soluble solids content of at least 62 °Brix (Brasil, 1978).

2.3. Manufacture of the fermented dairy beverages

Three different types of fermented dairy beverages with added guava jelly were prepared as follows: CDB was a dairy beverage with 70 g/100 g cow milk and 30 g/100 g cow whey, MDB was a dairy beverage with 35 g/100 g cow milk, 15 g/100 g cow whey, 35 g/100 g goat milk and 15 g/100 g (goat whey) and GDB was a dairy beverage with 70 g/100 g goat milk and 30 g/100 g goat whey.

For the production of the dairy beverages, sucrose was added to milk (10 g/100 g) and then homogenized, heated (90 °C/10 min) and cooled to 43 °C. Pasteurized whey and the thermophilic lactic culture (0.5 g/100 mL) were then added by direct inoculation according to the manufacturer's recommendation. The mixture was transferred to a fermentation chamber (42 °C/4°h) and cooled (4 °C). Guava jelly (30 g/100 mL) was added and gently stirred with a sterile glass stem until it was homogenized. The products obtained were packaged in sterile high-density polyethylene bottles (100 mL) and stored under refrigeration (7 °C) for 28 days.

The same milk and whey batches were used for the preparation of the different dairy beverages. Each beverage was manufactured three times (repetitions), and all the analyses were performed in triplicate. The beverages were evaluated for total solids, protein and fat immediately after manufacture; acidity, lactose, pH, apparent viscosity and syneresis were analysed after 1, 7, 14, 21 and 28 days of storage. The microbiological and sensory aspects were evaluated after 1, 14 and 28 days of storage.

2.4. Quality control of the raw-materials

The total solids, protein, fat, lactose, ash, acidity as lactic acid, pH and density of the goat's and cow's milk and whey were analysed according to methodology recommended by the Association of Official Analytical Chemist Methods (AOAC, 2005). The microbiological evaluation followed the methodology recommended by the American Public Health Association (APHA, 2001, pp. 63–67) to determine the most probable number (MPN) of the total coliforms (MPN/mL) and thermotolerant coliforms (MPN/mL) and to detect *Salmonella* ssp. The physicochemical and microbiological analyses of the raw-materials are presented as mean values obtained for each batch used in the preparation of the dairy beverages.

2.5. Physicochemical and microbiological analysis

The dairy beverages were analysed for total solids, protein, fat and lactose according to the method recommended by AOAC (2005). The pH was measured with a digital potentiometer, and the acidity was determined by titration (AOAC, 2005). Lactose was determined by the method of Fehling (AOAC, 2005), and syneresis was analysed by centrifugation (Gauche, Tomazi, Barreto, Ogliari, & Bordignon-Luiz, 2009). The determination of the microbiological parameters (total and thermotolerant coliforms – MPN/mL and presence of *Salmonella* ssp.) followed the methodology recommended by the American Public Health Association (APHA, 2001, pp. 63–67).

2.6. Apparent viscosity

Apparent viscosity was measured using a Brookfield Viscometer Model DV II + Pro with a thermostatic bath for the temperature control of the samples. Analyses were performed at a temperature of 7 ± 1 °C with a rotation speed of 40 rpm. The results are presented in millipascal-seconds (mPa s).

2.7. Sensory analysis

The dairy beverages were submitted for sensory evaluation by ten panellists (nine females and one male, aged 18–31 years). Selection of members of the sensory panel was based on their capacity to discriminate samples with good reproducibility, the repeatability of the results and the consensus with the team. Samples were described using Quantitative Descriptive Analysis (QDA) (Stone & Sidel, 1993). The sensory evaluation tests were performed in individual booths with controlled temperature and lighting conditions. The panellists received approximately 40 mL of each sample at temperatures between 7 and 8 °C in disposable plastic cups with a capacity of 50 mL, coded with three-digit random numbers. They were also offered biscuits and water to clean their palates. The panellists discussed the formulations presented in monadic form and quantified the perceived intensities of each attribute using a 9 cm unstructured scale ranging from 1 (low) to 9 (high). The attributes were the following: appearance (pink,