Physico-chemical Characteristics of Goat Milk from Tuzla Canton

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ARTICLE INFO

Article History:
Accepted: 05 May 2024
Published: 22 May 2024

Publication Issue
Volume 9, Issue 3
May-June-2024

Page Number
01-08

ABSTRACT

Physical chemical milk is an emulsion of milk fat in an aqueous solution of proteins, milk sugar and mineral salts. The high molar conductivity of goat milk samples compared to cow's milk indicates a high content of mineral substances. That goat milk is rich in total proteins is also indicated by the protein content in the samples, which are higher than the cow's milk samples. However, higher fat content was recorded in cow's milk samples, which also results in higher surface tension of cow's milk. The freezing point and refractive index of goat milk are higher compared to literature data and cow milk samples. The acidity of goat's milk comes from the acidic properties of casein, citrate, phosphate, etc. it is lower than cow's milk and is in accordance with literature data. The viscosity of pasteurized goat's milk at all temperatures is also higher than that of cow's milk.

Keywords: Physico-Chemical Characteristics, Goat Milk

I. INTRODUCTION

Milk is white liquid food secreted by the mammary glands of mammals [1a]. Milk is a complex mixture of compounds, that is, water, fat, protein, lactose, enzymes, minerals, organic acids, and vitamins with some being particularly important at certain life stages [2], [3]. For every mammal spiece is unique
and specifically tailored to the requirements of that animal [4]. Milk has been produced from livestock for human consumption since antiquity [5]. Cow’s milk is consumed daily by billions of people worldwide [6]. Cows’ milk consumption varies around the world, with an average of 10–212 kg per person per year [1b]. In addition to milk, several dairy products such as cream, butter, yogurt, kefir, and cheese have been produced and consumed worldwide for millennia [7]. More than any other mammalian farm animal, the goat is a main supplier of dairy and meat products for rural people, which is one of the three aspects of demand for goat milk: home consumption [8]. Goat milk has been an important part of human nutrition for millennia, in part because of the greater similarity of goat milk to human milk, softer curd formation, higher proportion of small milk fat globules, and different allergenic properties compared with cow milk [9]. Goat milk differs from cow by a higher content of non-protein nitrogen, a smaller proportion of coagulating proteins, with greater variability of physical and chemical properties, lower thermostability and a different lipolytic system [10]. Goat’s milk is significantly more digestible than cow’s milk, which is attributed to the range of the physico-chemical properties of most of the ingredients: smaller diameter of fat droplets, higher proportion of short i medium-chain fatty acids, a higher proportion of easily digestible protein fractions (whey proteins) and a higher share of non-protein nitrogen, and less casein with a smaller micelle diameter, a higher share vitamin A, and vitamin D and nicotinic acid, a higher proportion of soluble Ca, Mg, inorganic P, as well as Fe, which are found in a form with better bioavailability than in cow’s milk. [11]. Goat milk has a greater buffering capacity, and has specific therapeutic properties in human nutrition and medicine [12].

The fundamental objective of knowing the chemical composition of milk is given by the importance of goat’s milk not only as pure food, but for the elaboration of secondary productions: powdered milk, cheeses, cream cheese, cottage cheese, sweets, ice cream, butter, dairy serums, yogurt and beauty products such as soaps and facial creams [13]. Goat milk and such products from goat milk are more expensive than similar products derived from bovine [14]. The global production of goat milk is growing, with most goat milk being used fresh or in processed products such as cheese or yoghurt [15]. Goat milk is important for prevention of cardiovascular disease, cancer, allergy and microorganism and used for stimulation of immunity [16]. Goat milk versus cow's milk contains in abundance protein, fatty acids, and minerals [17]. Goat milk contains a similar amino acid profile to cow and human milk except for a lower concentration of cysteine. Dairy protein is a good source of essential amino acids for muscle protein synthesis and thus helps to maintain the metabolically active muscle mass during weight loss [18]. According to Lad et al. 2017, fat of the goat milk has higher physical properties i.e. surface tension, viscosity and specific gravity as compared to cow milk [19]. In goat milk the lipid globules are significantly smaller than in cow milk, thus affects the viscosity of milk and are of importance for the process and manufacturing products. Density of goat milk is comparable to that of cow milk, while it has higher specific gravity, viscosity, titratable acidity, but lower refractive index and freezing point than cow milk [20].

II. METHODS AND MATERIAL

Samples collection

A total of 4 milk samples, 2 samples each of pasteurized cow's and goat's milk and 2 samples of raw cow’s and goat’s milk, were collected from the market in the city of Tuzla, Tuzla Canton. The samples were stored in a refrigerator at ± 4 °C, and the physical and chemical analysis was performed in a short period of time.
Determination of viscosity

Viscosity was measured with an Ostwald viscometer based on the speed of liquid outflow through the capillary.

Determination of surface tension

The determination of the surface tension of the milk was carried out using a stalagmometer, on the lower part of which there is a capillary tube with a flattened bottom, which enables uncapping. Below and above the bell-shaped part of the pipette are markings that define the volume of liquid that is extracted from the stalagmometer.

Determining the freezing point

The freezing point of milk is the temperature at which milk changes from a liquid to a solid aggregate state and its normal value is $-0.55 \, ^\circ C$. Depending on the amount of lactose and mineral substances, the freezing point can vary from $-0.52$ to $-0.56 \, ^\circ C$, and the value of the freezing point below and above these limits indicates the addition of water in the milk. Determining the freezing point of milk was performed with Bekman's apparatus.

Determination of refractive index

The refractive index was determined using an Abbe refractometer, which is easy to handle and gives sufficiently accurate results.

Determination of the pH value of milk

The procedure was carried out by measuring with a combined glass electrode, which involves immersing the electrode in milk, where the instrument measures the potential difference, or pH value. After homogenization, the milk sample was transferred to a laboratory beaker and the pH value was measured. The measurement was made with a pH meter GLP 21 CRISON with a resolution of 0.1, 0.01, 0.001.

Determination of milk acidity by Soxlet Henkel

It represents the amount of NaOH of a certain concentration that is needed to neutralize the acidity of milk. Acidity was expressed in degrees of Soxlet Henkel (°SH).

Determination of molar conductivity

Molar conductivity was determined by immersing the electrode in a solution of homogenized milk at the appropriate temperature. A CRISON conductometer was used.

Determination of water and dry matter content

After homogenization of the sample on an analytical balance and weighing on an analytical balance with an accuracy of 0.0001 g, the sample was transferred to a drying oven to a constant mass. The drying process was carried out in an electric dryer with a thermoregulator to a constant mass at atmospheric pressure.

Determination of proteins

The formol titration method of Sörensen has been found to be of great usefulness [1]. It is based on the titration of amino acids from milk with a standard NaOH solution, known concentration in present of the formaldehyde.

Reaction:
\[ \text{RCH(NH}_2\text{)COOH} + \text{HCHO} + \text{NaOH} \rightarrow \text{RCH(NHCH}_2\text{OH)COONa} + \text{H}_2\text{O} \]

Determination of lipids

The fat content is the most important data for assessing the quality of milk and must not be less than 2.2%. The method of fat determination according to Geber is based on the chemical dissolution of casein and the protective membrane globule of milk fat, the separation of the released milk fat by centrifugation, and the determination of the amount of fat collected in a special tube with a scale.
Determination of total ash

The method is based on burning the sample in a muffle furnace at a temperature of 550 °C, until all the organic matter is burned. After heating the crucible, 5 g of the milk sample was weighed with an accuracy of 0.0001 g. First, the sample was burned on an electric heater, until the sample was carbonized, and then the crucibles with the sample were transferred to a preheated muffle furnace at 550 °C and annealed for 180 min. The cooled crucibles were weighed on an analytical balance.

It is important to note that all analyzes were performed in triplicate.

III. RESULTS AND DISCUSSION

Fig 1. Viscosity of raw and pasteurized goat’s and cow’s milk as a function of temperature

The viscosity of colloidal systems depends upon the volume occupied by the colloidal particles. Changes in the caseinate micelles produced by either raising or lowering the pH results in increased viscosity [21]. Increasing the temperature decreases the viscosity of all milk samples. According to Mulder and Walstra the effect of temperature on milk viscosity is ambiguous [22].

Fig 2. Density of raw and pasteurized goat’s and cow’s milk as a function of temperature

Density values (kg/m³) for milk samples at different temperatures (25, 35 and 45 °C) decreased with increasing temperature, except for the pasteurized cow’s milk sample.

Fig 3. Surface tension of raw and pasteurized goat’s and cow’s milk as a function of temperature 25 °C

The surface tension of milk samples at room temperature for raw cow’s milk had a value of 58.79±1.187 mN/m and this is the highest recorded value compared to all other samples, which is visible in the graph, while a slightly lower value was recorded for raw goat’s milk. The lowest value of surface tension was 52.171±0.809 mN/m.
The freezing point of raw goat's milk was -0.561±0.002 °C, while the value of pasteurized goat's milk was -0.552±0.005 °C. The value of raw cow's milk was -0.517±0.006, while the value of pasteurized cow's milk was -0.530±0.014 °C. According to Biadała and Konieczny, in 2017 the freezing point was -0.556 for goat's milk, while values from -0.530 to -0.570 were for cow's milk [23].

The pH values of the milk samples in this research work were in the area close to the neutral value. The lowest pH value was recorded in raw goat's milk and was 6.23±0.064, while the highest value was recorded in raw goat's milk and was 6.46±0.183. According to Bashir et al. the pH value of fresh cow's milk was 6.69±0.8 [24].

Milk acidity is expressed according to Soxlet - Henkel (°SH) and these values ranged from 4.5±0.280 for pasteurized cow's milk, which is also the lowest recorded value, to 6.15±0.091 for raw cow's milk, which is also the highest recorded value.
The molar conductivity values ranged from 4.40±0.056 ms/cm for raw cow’s milk to 5.21±0.046 ms/cm for raw goat’s milk. The molar conductivity values of pasteurized milk also had similar values to those of raw milk, respectively.

The protein content of raw goat’s and cow’s milk had similar values, and a slightly higher protein content of goat’s milk was observed and this value was 4.66±0.183%. In pasteurized goat’s milk, the protein content was higher than that of cow’s and amounted to 4.32±0.184%.

The water content of raw goat’s milk is slightly higher than the water content of raw cow’s milk, while for pasteurized goat’s milk this value is lower than raw cow’s milk. The highest water content compared to other samples was recorded in raw goat’s milk and this value was 88.07±1.510%. According to Abdel Hameed, the water content of 50 analyzed goat milk samples ranged from 86.7% to 90.51% [25].

The fat content of raw goat’s milk was 2.63±0.106%, while the fat content of raw cow’s milk was significantly higher. However, a lower value of the fat content of pasteurized goat milk was observed, and this value was 2.43±0.106%. Sawaya et al. 1984 in their study reported that for two breeds of goats Masri and Aardi, the fat content was (2.83%, 3.06%) [26].
The ash content in raw goat’s milk was 0.76±0.055%, while the value was slightly lower for the sample of raw cow’s milk. It is also evident from the obtained results that the ash content in pasteurized samples in both milk samples had lower values, so the sample of pasteurized goat’s milk had values of 0.714±0.00, while the value of pasteurized cow’s milk was 0.718±0.000. Chen et al. 2014 reported that the ash content in cow’s milk changed during the seasons, so the highest recorded value was determined in August and was 1.03%, while in the winter period this value was 0.53% [27]. According to Park, in 2010 the fat content of cow’s milk was 0.7%, while the ash value of goat's milk was 0.8% [28].

**IV. CONCLUSION**

The results of the analyzed physical and chemical parameters showed that goat and cow’s milk is in accordance with literature data as well as other research data.

**V. REFERENCES**

[21] approached: (02.05.2024.)
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