Chapter

Goat and Sheep Milk as Raw Material for Yogurt

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Abstract

Yogurts are prepared by bacterial fermentation of milk using bacterial cultures composed of a mixture of *Streptococcus ssp. thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus*. In the regions where small ruminants are important to the economy, the development of new products may and the diversification of the offer might represent good strategies to attract new consumers since it allows producers to go beyond the usual cheesemaking. Those were the reasons that led to the production of a yogurt that would include different proportions of sheep and goats milk, a final product with the right physicochemical quality properties and sensory attributes. The addition of sheep milk is meant to attract more and more potential consumers and to additionally improve the nutritional value of the product, mainly with respect to the amount of fatty acid and mineral contents. Consumers tend to prefer yogurts made of cow milk, but this work shows that people enjoy and accept yogurts produced with goat and sheep milk as well. Therefore, it seems evident that the milk produced by these small ruminants can be an alternative and has the potential to become a good food product.

Keywords: sheep, goat, milk, yogurt, physicochemical properties, sensory analysis

1. Introduction

Goats and sheep were the first animals to be domesticated by humans for livestock husbandry, about 10,000 years ago [1, 2]. These animals were raised around the world in hundreds of different breeds. There are currently more than 750 million goats and 1000 million sheep [3].

Portugal is one of the largest producers of sheep milk worldwide. However, a substantial part of the goat and sheep milk production comes from family-scale farms and is normally intended for the owners' own consumption.

Even so, a significant part of the national milk production is already fully industrialised and has already generated some products that have been awarded with a protected designation of origin (PDO). Such designation grants them a high economic impact.

This is the case of the famous Serra da Estrela cheese and of the Transmontano goat cheese made of the milk obtained from Serra da Estrela sheep and Serrana goats, respectively.

Milk has a high nutritional value; however, small differences in the composition of the different types of milk may generate large nutritional and technological differences in milk processing industry [4]. Goat milk is quite important since it has high biological value and important nutritional qualities. Its higher digestibility, alkalinity and dietary characteristics make it highly recommended for infant feeding and for adults who are sensitive or allergic to cow milk [5, 6]. These benefits can be attributed to the micellar structure of casein protein in goat milk and to the fact that it contains a large quantity of fatty acids with higher digestibility [5, 7]. On the other hand, sheep milk is characterised not only by its higher total solids, fat, protein and caseins but also by its larger amount of minerals and vitamins [5, 8].

Yogurt has been known to mankind for over 6,000 years. The word "yogurt" seems to be derived from the Turkish word "jugurt" which first appeared in the eighth century [9]. The same author mentions that yogurt comes from the Middle East, where milk was scarce due to the desert environment.

Moreover, in milk technology yogurt and its derivatives are called fermented milk products. This process results from the development of certain microorganisms that modify the normal components of milk. Lactose is partially transformed into lactic acid. In certain milks, it also produces ethyl alcohol. Furthermore, proteins may suffer peptonisation, which improves digestibility [8].

The Food and Agriculture Organisation (1984) defined yogurt as "the coagulated milk product obtained by lactic acid fermentation through the action of *Lactobacillus delbrueckii ssp. bulgaricus* (*Lb. bulgaricus*) and *Streptococcus thermophilus* from milk and milk products. The microorganisms in the final product must be viable and abundant". The *Codex Alimentarius* (Codex STAN 243-2003) specifies that yogurt should contain a minimum of 2.7% (m/m) milk proteins, a maximum of 15% milk fate, a minimum of 0.6% titratable acidity (expressed as % of lactic acid) and a minimum of 107 CFU/g of microorganisms (total microorganisms in the starter culture).

The objective of this work was to address the issue of producing yogurts from goat and/or sheep milk with high consumer acceptability and high nutritional value so customers could be offered a new and alternative product in the competitive market of fermented milk and in a context where cow milk yogurt has the largest market share. In order to support the findings observed in this study, a complementary characterisation of the goat, sheep and cow milks was also carried out.

2. Materials and methods

To support this work, a well-documented research on goat and ewe milks and on their suitability for yogurt making was conducted. The main sources of information were scientific papers and books. A research previously carried out by the authors and that included information about the milk obtained through mechanical milking of Serrana Jarmelista goats and Serra da Estrela sheep in the centre region of Portugal was also considered. Milk was pasteurised at 65°C during 30 minutes and then it was cooled to 4°C.

Yogurt was produced using goat and sheep milk in accordance with experimental group obeying to the following proportions of sheep and goat milk: 100% of sheep milk (O100C0), 80% of sheep milk and 20% of goat milk (O80C20), 50% of sheep milk and 50% of goat milk (O50C50), 40% of sheep milk and 60% of goat milk (O40C60), 20% of sheep milk and 80% of goat milk (O20C80) and 100% of goat milk (O0C100). The lactic bacteria used in the yogurt production were lyophilized *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. Commercial cow milk powder (12%) was added to all the yogurts that were produced.

The yogurt samples were placed in hermetically sealed bottles for fermentation for 12 hours at 45°C. Then, they were refrigerated at 5°C. The total nitrogen content was measured by the micro-Kjeldahl method [10]. Protein was calculated as N × 5.38. The fat content was determined by the Geber's method [11]. Ash content was determined by incinerating the samples for 24 hours at 550°C. Moisture content was determined by drying samples overnight at 105°C [10]. Total solids content was determined using the gravimetric method as the samples were dried in an oven at 105°C for 24 hours [10]. Phosphorus was determined by spectrophotometric UV/VIS, 720 nm [12], and calcium, magnesium, potassium and sodium were estimated using flame atomic spectrophotometry at 750 nm [13]. The determination of fatty acids was done using a gas-chromatographic method (GLC), total titratable acidity was determined by reference method [10] and the pH using the potentiometric method.

For the sensorial analysis of samples, an acceptance test with untrained panellists was used. The panel consisted of 25 tasters who analysed the samples of goat and ewe yogurt. A commercial yogurt produced with cow milk and bought at a local market was analysed as well. The grades awarded by each panellist ranged from 1 to 9, where 1 is "extremely unpleasant" and 9 is "extremely pleasant" for attributes such as sweetness, colour, aroma, flavour, texture and overall assessment. To assess the tasters' overall preference, a last question was asked: "Which sample did you prefer?"

Statistical analysis was performed using the Statistica 12 programme [14] where mean, standard deviation and mode, median, minimum and maximum values were determined.

The findings were analysed using one-way analysis of variance. Means were compared at a 5% level of significance using LSD test to check significant difference. The Kruskal-Wallis test was used to verify the panellists' preferences regarding the different yogurt samples.

3. Goat and sheep milk

Goat milk has a white-matte colour, does not contain β-carotene and has a sweet and pleasant distinctive "freshly milked taste"; however, it can sometimes, at the end of lactation or after a period of storage in a cold environment, acquire a certain flavour one can describe as "animalic". Sheep milk, on the other hand, shows a more marked white opacity and has a distinctive odour originally called "suarda" or "sheepy". This feature is relatively less evident in milk that is stored in good hygienic condition. The intense flavour of goat milk may be due to the release of short-chain fatty acids during the handling of milk [5], and it has a density that ranges between 1.026 and 1.042 with a pH ranging from 6.3 to 6.7 [15]. It is naturally alkaline, unlike cow's milk which is slightly acidic.

The major components of any mammalian milk are water, fat, protein, lactose and minerals [16, 17], as shown in **Table 1** for goat, sheep and cow milk. The water content found in goat milk is similar to cow milk and is approximately 87% [18]. Goat milk also has a higher content of nonprotein nitrogenous substances and contains fewer types of casein than sheep and cow milk [6]. This specific characteristic leads to a weaker structure in goat milk yogurt, unlike sheep milk that has good coagulation capacity [6]. Moreover, the differences in sheep milk caseins are the main factors for curd fitness time to be shorter and rennet coagulation time to be firmer [19]. Goat and sheep milk also contains higher amounts of minerals and vitamins than cow milk [6].

Milk	Fat (%)	Nonfat dry extract (%)	Lactose (%)	Protein (%)	Casein (%)	Ash (%)
Goat	4.25–3.80	8.68–8.90	4.08–4.27	2.90–3.52	2.40–2.47	0.79–0.86
Sheep	7.62–7.90	10.33–12.00	3.70–4.90	5.23–6.21	4.20–5.16	0.90
Cow	3.60–3.70	9.00–9.10	4.70–4.81	3.20–3.50	2.60–2.63	0.70–0.73

Adapted from [5, 6, 39].

Table 1.
Comparison of the physicochemical characteristics of goat, sheep and cow milk.

The micellar structures of sheep and goat milk differ from cow milk in the diameter, hydration and mineralisation. Goat casein micelles contain more calcium and inorganic phosphorus, are less solvated and less stable to heat and lose casein more easily than bovine casein micelles [20]. Lipids appear in the form of smaller-sized globules in goat and sheep milk, contributing to a better digestibility [3]. An intensive research on sheep and goat milk has revealed that lipid components might have a great deal of benefits. Studies focused on trans-acid and conjugated isomers of linoleic acid, since the latter are believed to have beneficial effects on human health while the former seem to have certain negative effects. As for minerals, the differences between the three types of milks are shown in **Table 2**.

Sheep milk is the type of milk that has the highest amount of calcium, phosphorus and magnesium, while goat milk has higher amounts of potassium, chlorine and manganese. Minerals have great importance in the composition of the milk of any species. The most important minerals in the constitution of milk are calcium, sodium, potassium and magnesium [21]. Thus, milk mineral fraction is characterised mainly by its high calcium content linked to casein phosphoserine, and it is the calcium-protein binding that gives milk its irreplaceable character [17].

Calcium and phosphorus are two fundamental elements of the micelle structure of caseins and will condition the stability of the colloidal phase, particularly calcium which is also very important biologically [22].

Mineral constituents	Goat	Sheep	Cow
Calcium (mg)	126–135	193–197.5	120–122
Phosphorous (mg)	97–130	141–158	92–119
Magnesium (mg)	13–16	18–19.5	11–12
Potassium (mg)	181–190	136–138	150–152
Sodium (mg)	38–41	44–51	45–58
Chlorine (mg)	150–160	111–160	100–110
Sulphur (mg)	28	29	32
Iron (mg)	0.07	0.08	0.08
Copper (mg)	0.03–0.05	0.04–0.05	0.02–0.06
Manganese (mg)	0.008–0.032	0.007	0.006–0.02
Zinc (mg)	0.34–0.56	0.57–0.63	0.38–0.53
Iodine (mg)	0.008–0.022	0.020–0.097	0.007–0.021
Selenium (ug)	1.33–2	1.00–3.1	0.96–3
Aluminium (mg)	—	0.05–0.18	—

Adapted from [6, 8, 21].

Table 2.
Mineral constituents of three milks.

4. Microbial cultures used in the yogurt manufacture

Bacterial populations which are traditionally used in the manufacture of yogurt include species such as *Streptococcus thermophilus* (**Figure 1**) and *Lactobacillus bulgaricus* (**Figure 2**). The young cells of *S. thermophilus* are spherical in shape and occur in chains. In the dairy industry, they are often called "cocos". These cultures usually have weak milk clotting because of low acid production. Strains of *S. thermophilus* are commonly used in association with *Lactobacillus delbrueckii* ssp. *bulgaricus*. The latter is commonly referred as "rod" in the dairy industry, and the combination of the two bacterial populations is called the "coconut stick" [23].

When a single population of *Lactobacillus delbrueckii* ssp. *bulgaricus* or *Streptococcus thermophilus* is used, the production of lactic acid and acetaldehyde was greatly reduced when compared to that of combined commercial cultures [24, 25].

In the first fermentation stages of the yogurt, in which the action of those bacteria are evident, *S. thermophilus* grow much faster because of their greater aero-tolerance, whereas at this stage, the populations of *L. bulgaricus* grow more slowly; however, and due to their greater proteolytic activity, these species provides enough peptides to stimulate and guarantee the growth of *S. thermophilus* [23]. The slow growth of *Lactobacillus* populations may be due to the fact that they are microaero-philic [26]. Thus, at the end of the first phase, the growth of *S. thermophilus* slows down because of the high concentration of lactic acid produced. Besides, in this phase the production of formic acid is high enough to stimulate the growth

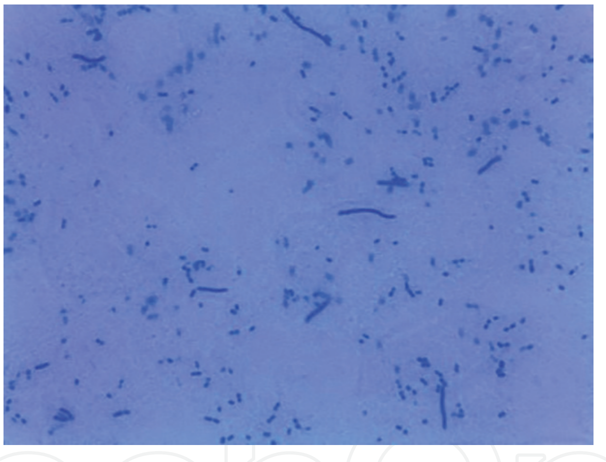

Figure 1.
Streptococcus thermophilus.

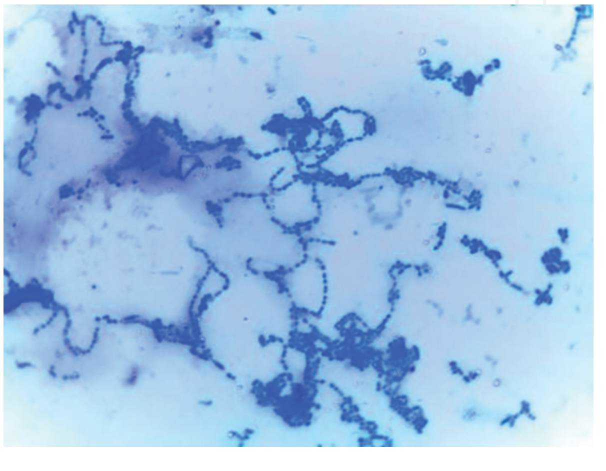

Figure 2.
Lactobacillus bulgaricus.

of *Lactobacillus* [25]. Furthermore, due to this complementary action of the two species, the desirable acidity of the yogurt can be achieved. Sá and Barbosa (1990) [27] report that these two species of microorganisms develop in cooperation at an optimum temperature of 45°C; this temperature can, however, decrease to 42°C.

The optimum ratio between the two species that will enable the existence of the flavour and aroma that are characteristic of the product depends on the properties of the strains used. Nonetheless the most common ratio is approximately 1:1 [28]. The characteristic flavour of yogurt is also related to bacteria, as they produce acetaldehyde, acetone, acetoin and a small amount of diacetyl. Among all these, the best flavour compound of yogurt is acetaldehyde, and *L. bulgaricus* is the bacteria that produce most of that compound. However, and in smaller quantities, *S. thermophilus* also produce acetaldehyde and support its conversation into threonine [29].

It should also be noted that the predominance of any of these species may lead to defects in the final product. The main factors that can affect the proper balance between the two microorganisms are time, incubation temperature and the percentage of inoculum. For example, a shorter incubation time results in a product with lower coccus content and a poorer flavour; on the other hand, a longer incubation time would result in a product with bitter flavour [30].

5. Sheep and goat yogurt

In yogurt made from sheep milk as with those produced with cow milk, homogenisation increases product firmness and reduces product serum separation. Sheep yogurt is characterised by higher values of hardness, adhesiveness and extrusion, such factors are explained [31] by its high solids content.

A research related with the analyses of the microstructure of goat, cow and sheep yogurts observed that in sheep yogurt the protein matrix of milk consists mainly of chains of large individual casein micelles. There were also small and regular voids. As a result, sheep milk produces a stronger gel that is more resistant to deformation [32]. Another study reports that sheep milk has a high viscosity that will influence the firmness of the product and may be caused by an increase in water binding capacity provided by its milk proteins [33]. Moreover, an investigation carried out by [34] shows that sheep milk is used in the production of mixed yogurts—goat milk was also used in the cases depicted—due to the higher amount of protein found in sheep milk that will improve the consistency of goat yogurt. On the other hand, some research [35] found out that goat yogurt has a poorer consistency, hardness and stability when compared, for example, with sheep and cow yogurt. In the case of the protein matrix, casein micelles of small size are bound in thick chains presenting large agglomerates as well as large empty spaces filled with serum or occupied by yogurt bacteria. This yogurt reveals a less compact gel and is therefore more delicate, brittle and less resistant to deformation. These properties affect the results of the instrumental analysis conducted on yogurt texture. This yogurt will then present low texture values and high syneresis values [30]. Several studies have been carried out on the low consistency caused by the presence of goat milk and [36], in a study based on samples of cow and goat milk yogurt and a mixture of the two, found out that as goat milk was added the firmness and consistency of the gel decreased.

The higher porosity of the protein network observed through the analysis of the microstructure and the subsequent lower degree of micellar aggregation also contribute to the mechanics observed, since a gel with low porosity is characterised by a compact matrix, which would contribute to increase the firmness and consistency of the gel. The poor firmness of the gel can still be influenced by the size of the fat globules and their mechanical properties as explained by [37] who reports a positive correlation between poor firmness and the smaller size of the globules.

Goat milk yogurt is less commercially produced, although it has high digestibility and good nutritional and organoleptic properties [6].

6. Effect of the mixture of sheep and goat's milk on yogurt characteristics

The results shown in **Table 3** reveal that the moisture value of goat yogurt is higher than the one observed in sheep yogurt, since the addition of milk powder during yogurt production causes a decrease in available water which consequently generates lower water content in the product [18]. On the other hand, sheep milk has higher solids content, and its addition causes a decrease in the moisture value.

The composition of the yogurt is identical to the composition of the milk that served as its raw material, although there are some differences arising from the bacterial lactose fermentation and the addition of milk powder usually used to increase milk solids and that consequently generates an increase in protein content [38]. Yogurts with goat milk have lower protein values than those produced using sheep milk. This value decreases as the proportion of goat milk in the product increases. [3, 5, 13] also found out that the protein values for goat milk presented values that are between 2.90 and 3.52% lower than those found for sheep milk whose values range between 5.23 and 6.20%. Evidence also showed that the 9.59% protein content obtained for sheep yogurt was lower than that presented in similar studies carried out by other researchers [39–41]. Those studies presented values of 5.05, 6.34 and 4.55% of protein content for sheep yogurt, respectively.

The highest percentage of fat content in sheep's yogurt can reach 80%. Lower percentages of fat content are observed and could be related with several factors such as the animals' diet, the climate, their breed and their lactation stage. Curiously the goat milk yogurt presents contents of approximately 7% of fat, when the expected values are around 5% [6]. This difference may be explained by the breed of the animals.

As it was the case with the fat and the protein values, the highest value of dry extract is found in sheep milk yogurt (24.95%), while 21.17% is the value found in goat milk yogurt. These findings are in accordance with the content of the raw material, since the dry extract content found in sheep milk can reach 19.06%, while in goat milk dry extract may be up to 12.73%. Besides, the ash content is indicative of the amount of minerals present. The results found for goat and sheep yogurt are higher than the values reported by other authors [34]. The addition of powdered milk may be the source of these particularly high values. The maximum acidity value was found in sheep milk yogurt (18.9 ml/100 g) and tends to decrease as the quantity of goat milk increases. These acidity values are not in accordance with the Portuguese standard NP-694. This standard requires a maximum acidity of 13 cm^3/100 g, although this value is reported to cow milk yogurt.

Table 4 shows an increase in the values of mineral contents probably due to the addition of milk powder. The addition of sheep milk caused an increase in phosphorus, calcium and magnesium contents, since this type of milk contains a higher amount of these minerals [5]. These results are in accordance with those obtained by other authors [34].

Centesimal composition	O100C0	O80C20	O60C40	O50C50	O40C60	O20C80	O0C100
Humidity (%)	73.65 ± 0.19	76.20 ± 0.86	76.02 ± 0.17	76.81 ± 0.97	77.89 ± 0.06	77.05 ± 0.43	79.08 ± 0.06
Protein (%)	9.59	8.62	8.68	8.72	8.24	7.32	7.98
Fat (%)	9.33 ± 0.23	8.60 ± 0.20	8.27 ± 0.23	8.20 ± 0.20	8.40 ± 0.20	7.87 ± 0.42	6.93 ± 0.61
Ashes (%)	1.80 ± 0.05	1.68 ± 0.03	1.70 0 ± 0.09	1.71 ± 0.06	1.69 ± 0.14	1.68 ± 0.06	1.77 ± 0.14
Dry extract (%)	24.95 ± 0.77	22.35 ± 0.04	24.67 ± 0.65	23.03 ± 1.24	23.84 ± 2.63	21.00 ± 1.72	21.17 ± 0.24
Nonfat dry extract (%)	20.29 ± 5.82	18.05 ± 6.04	20.53 ± 6.50	18.93 ± 4.56	15.44 ± 2.63	13.13 ± 1.72	14.24 ± 0.24
Acidity (ml/100 g)	18.90	17.90	17.30	16.80	18.33	18.13	17.37

Table 3.
Physical-chemical characteristics.

Minerals	O100C0	O80C20	O60C40	O50C50	O40C60	O20C80	O0C100
Calcium	295.65	316.98	322.403	332.91	180.48	179.8	160.85
Sodium	65.58	144.49	154.91	131.27	56.49	58.65	60.11
Magnesium	22.16	18.19	17.65	16.83	16.85	16.32	15.54
Potassium	223.21	279.09	310.27	331.44	170.78	157.63	162.45
Phosphorous	268	300.29	278.75	191.37	165.85	152.43	140.12

Table 4.
Mineral contents.

7. Fatty acids

Table 5 presents the differences between the saturated and unsaturated fatty acids. The yogurt produced with sheep milk alone presents the highest content of unsaturated fatty acids (30.64%), while yogurts whose composition contains 50% of goat milk and 50% of sheep milk have the highest saturated fatty acid value (71.67%). These values have to do with differences found in the composition of milks and are in accordance with those of [42] who mentions that the proportion of saturated fatty acids in the sheep milk ranges between 68 and 78% and the unsaturated fatty acids proportion is about 31%. However, total unsaturated fatty acids were usually higher in sheep milk. Therefore, in yogurts the percentage of unsaturated fatty acids may increase with the addition of sheep milk, a fact that is in accordance with another of the studies [22] already conducted.

In terms of yogurts' fatty acid content and of the type of milk used to produce them (**Table 6**), evidence showed that saturated pentadecanoic fatty acid (C15: 0) that according to [6] is contained in all samples is lower than would be expected for goat and sheep milk with values of 0.71 and 0.99, respectively.

Milk taken from goats and sheep has a higher amount of short- and medium-chain fatty acids that are responsible for their characteristic flavours.

The quantity of caprylic acid (C8: 0) found in sheep and goat milk is 2.6 and 2.7%, respectively; the quantity of capric acid (C10: 0) is 7.8 and 10%, and the lauric acid (C12: 0) found in both those milks is 4 and 5.5%, respectively. It is also worth mentioning that goat milk has a higher amount of these fatty acids than sheep milk [6]. These authors have observed that as the goat milk concentration increases, the percentage of this capric acid (C10: 0) increases as well. This phenomenon was expected since this was the milk's main component and will play a major role in giving it its distinctive flavour and aroma.

The results obtained show a great quantity of stearic and oleic acids in both milks, and as far as the presence of C18: 0 was concerned, there were no significant differences between the different yogurts. However, sheep milk had a higher amount of C18: 1. As a consequence, the addition of sheep milk as yogurts are being produced will lead to a considerable increase in the percentage of this MUFA.

% Fatty acids	O100C0	O80C20	O60C40	O50C50	O40C60	O20C80	O0C100
Unsaturated	30.64	26.56	29.06	26.75	30.94	28.32	27.55
Saturated	68.46	70.11	70.93	71.67	63.94	66.8	67.57

Table 5.
Differences between the contents of saturated fatty acids and unsaturated in the yogurts.

Fatty acids	O100C0	O80C20	O60C40	O50C50	O40C60	O20C80	O0C100
C10: 0	7.76	8.56	8.63	10.09	9.19	9.49	9.5
C12: 0	4.56	4.9	4.74	5.03	4.66	4.57	4.47
C14: 0	11.75	11.69	11.43	11.36	10.95	10.77	10.61
C15: 0	n.d.	0.62	0.71	0.73	n.d.	0.51	0.6
C15: 1	0.79	1.28	1.26	1.22	1.21	1.16	1.14
C16: 0	24.78	24.85	25.73	25.46	25.04	27.06	27.98
C16: 1	0.83	0.82	1.85	0.86	0.8	0.8	0.9
C18: 0	13.1	12.1	12.34	11.78	11.2	11.49	11.52
C18: 1 oleic	28.63	24.47	25.97	24.76	24.38	22.44	21.32
C18: 2	3.06	3.23	3.32	2.73	2.11	2.5	2.68
CLA	1.18	1.27	1.24	1.13	2.44	1.42	1.51

Table 6.
Fatty acid contents in the yogurts.

As far as linoleic acid is concerned, data are not very consistent, although sheep milk generally has a higher proportion of this acid. However, this fact is not supported by the results.

Evidence showed that conjugated linoleic acid (CLA) content, for both samples, was higher than it would be predicted. It should be noted, however, that goat milk contains a lower proportion of conjugated linoleic acid than sheep milk [11].

The AG content in dairy products presents a variable value range resulting from numerous factors, the most important being the animal's diet and the type of production system [43].

8. Sensory analysis

The sensory analysis was performed by panellists and included yogurts containing 100, 80, 60 and 50% of both sheep and goat milk. The score given by the panellists (**Table 7**) to the sweetness, colour, aroma, taste, texture and their overall appreciation for the different yogurts analysed was not significantly different: most of them were awarded a 7 (pleasant) on a scale of 1 (extremely unpleasant) to 9 (extremely pleasant), as previously mentioned.

		Sweetness	Colour	Aroma	Taste	Texture	Overall appreciation
O100C0	Mean	3.64	7.24	5.00	4.04	6.48	4.76
	Std. dev.	1.73	1.13	1.83	2.17	1.73	1.81
	Mode	4	7	5	Multiple	7	Multiple
O80C20	Mean	4.28	6.96	4.84	4.24	6.12	4.76
	Std. dev.	1.86	1.43	1.77	1.67	1.81	1.56
	Mode	5	7	5	3.	6	3
O60C40	Mean	4.36	6.84	5.20	5.00	5.96	4.92
	Std. dev.	2.29	1.70	2.18	2.08	2.09	2.10
	Mode	3	7	Multiple	6	7	3

		Sweetness	Colour	Aroma	Taste	Texture	Overall appreciation
O50C50	Mean	4.14	7.16	5.38	4.72	6.02	5.12
	Std. dev.	1.92	1.33	1.86	1.99	1.77	1.86
	Mode	Multiple	7	Multiple	4	7	3
O40C60	Mean	4.28	6.76	5.36	4.40	5.76	5.04
	Std. dev.	1.79	1.88	1.82	1.80	1.83	1.72
	Mode	6	7	6	Multiple	6	6
O20C80	Mean	4.52	6.96	5.48	4.84	6.20	5.64
	Std. dev	1.69	1.72	1.53	1.68	1.78	1.38
	Mode	4	7	6	4	Multiple	6
O0C100	Mean	4.60	6.96	5.32	4.88	5.96	5.36
	Std. dev.	1.73	1.51	1.89	1.76	1.72	1.66
	Mode	Multiple	7	7	Multiple	7	6
Cow	Mean	5.10	7.00	5.82	5.58	6.08	5.80
	Std. dev.	2.01	1.46	1.89	2.09	1.84	1.81
	Mode	Multiple	7	Multiple	5	7	Multiple

Table 7.
Mean, standard deviation and mode of sweetness, colour, aroma, taste, texture and overall appreciation.

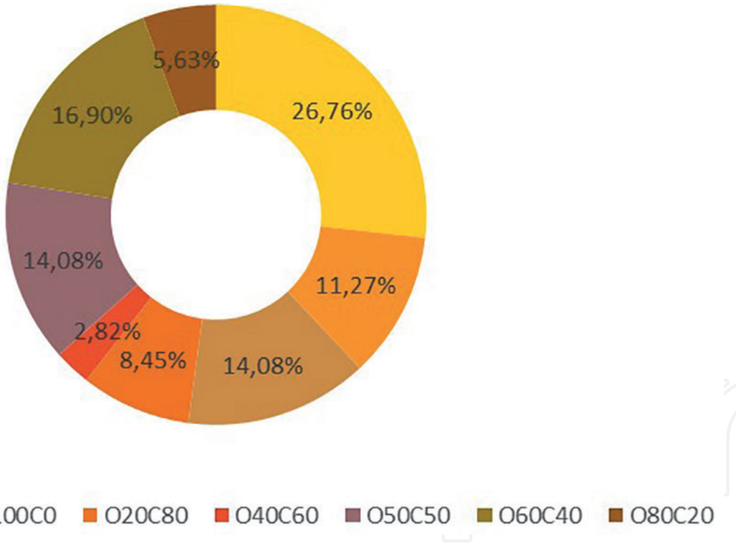

Figure 3.
Yogurt preferences identified by the panellists.

Although there were no significant differences between yogurts, **Figure 3** shows that 26.76% of panellists preferred the commercial yogurt (produced with cow milk). Nevertheless, some of the goat and sheep yogurts assessed were well appreciated.

In the group of yogurts with a greater presence of sheep milk, 16.90% of the panellists preferred the O60C40 yogurt (60% sheep milk and 40% of goat milk). The O100C0 yogurt (100% milk of sheep) and the O50C50 yogurt (50% of sheep milk and 50% goat milk) were chosen by 14.08% of the tasters. Moreover, 11.27% of the panellists chose the yogurt that contained the highest proportion of goat milk, the O0C100 (100% goat milk).

9. Conclusion

Yogurt made of goat and sheep milk represents a firmer and creamier product whose features increasingly attract consumers. These characteristics also increase the nutritional value of the product, mainly because they improve its level of fatty acids and minerals.

The increase in the proportion of sheep milk used in the production of yogurts promotes a significant increase in fat but also tends to increase the proportion of unsaturated fatty acids.

It was observed that the majority of the panellists who took part in the study were quite pleased with the yogurts produced with goat and sheep milk. So, being capable of developing strategies that will help increase the use of goat and sheep milk in yogurts and that will in turn have an important role in attracting more consumers to the product is undoubtedly a challenging endeavour.

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