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STUDY ON SOME PHYSICOCHEMICAL PARAMETERS IN GOAT'S MILK AND WHITE BRINED CHEESE IN THREE GOAT BREEDS

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Abstract

The main physicochemical parameters of goat milk of three breeds-Bulgarian White Dairy (BWD) and its crosses with Anglo-Nubian (BWDxAN) and Togenburg (BWDxTG) for lactation period were studied and three batches of white brined cheese produced from the milk breed were prepared. Goat's milk processed into white brined cheese from the studied breeds of goats reared in one herd is characterized by the lowest content of dry matter (DM) - 13.03%, milk fat- 4.91%, solids non fat (SNF) - 8.32%, total protein - 2.97%, casein - 2.03%, calcium - 0.139% and density - 28.2ºG, in BWD breed compared to its crosses. In the cheese at the 24-th hour of production, the water content is the lowest in the milk cheese of the BWD breed-53.34%, and the values for protein and milk fat 15.16%, 24.0% are the highest in the batch produced from the milk of the same breed. In mature white brined cheese on the 45-th day of production, the water and protein content decreased in all three batches compared to the 24-hour cheese, while the values for milk fat, fat content in the dry matter, water in the non-fat residue and salt in the aqueous phase rises.

Key words*: goat, milk, physicochemical composition, white brined cheese.*

INTRODUCTION

In terms of chemical composition and biological properties, milk is one of the most complete products of animal origin, rich in nutrients and biologically active substances. Its composition and properties are closely related to its hygienic, nutritional, technological and organoleptic characteristics, corresponding to the main ingredients (fats, protein, lactose) and some other components contained in milk such as minerals, vitamins, cholesterol, terpenes (Morand-Fehr et al., 2007), as well as diverse cells, including glandular epithelial cells and leukocytes, including macrophages, neutrophils and lymphocytes. As noted by Raynal-Ljutovac et al. (2005), protein and fat are the most important indicators of raw milk, as well as the main technological criteria due to their contribution to cheese yield, taste and other characteristics of dairy products.

Goat's milk is characterized by good digestibility, alkalinity, buffering capacity and certain therapeutic characteristics valuable for medicine and human nutrition (Haenlein, 2007; Park et al., 2007).

Goat's milk is characterized by a large variation in chemical composition, technological and hygienic indicators, depending on various factors - genetic factors, climatic conditions, conditions and method of cultivation and more (Plakantara et al., 2010).

The cheese composition changes depending on the lactation phase and corresponds to the changes in the milk composition. Cheese made from milk obtained at the end of lactation has a higher content of fat, protein and dry matter, which corresponds to higher values of these indicators in milk during this phase of lactation (Soryal et al., 2005). The milk production season also has an impact on the variation of the chemical and coagulation characteristics of milk (Zullo et al., 2005). Even the time of milking during the day affects the milk's potential for cheese production. The milk obtained during the morning milking is characterized by better coagulation qualities, higher coagulation rate and better consistency of the curd (Zullo et al., 2005).

Kondyli et al. (2016) found for white brined goat's milk cheese from the 48th hour of production to the 60th day, respectively, a

slight increase in water content values (54.56-55.47%), milk fat (25.13-25.50%), and fat content in dry matter (55.31-57.30%), while the protein content decreased from 17.45 to 16.01%.

The objective of the present study was to monitor changes in some physicochemical parameters in goat's milk and the resulting white brined cheese on the 24th hour and 45th day of the maturation process, respectively, in three groups of goats Bulgarian White Dairy (BWD) breed. and its crossings with Anglo-Nubian (BWDxAN) and Toggenburg (BWDxTG) for lactation period.

MATERIALS AND METHODS

The experiments were conducted at the Experimental Base at the Research Institute of Mountain Stockbreeding and Agriculture, Troyan. Experimental animals raised in one herd of three groups were used - Bulgarian White Dairy goat breed and its crossings with Toggenburg and Anglo-Nubian. The animals are aged from 3 to 5 years (second-fourth lactation), and the kiddings were in February. The rearing system is stable-pasture, and during the period April-November the animals were on a natural pasture of transitional type and in stable, during the rest of the year.

The milk samples for analysis were taken from morning milking at the beginning, middle and end of the lactation period (April-June-September), for which purpose the animals were milked manually, observing the necessary hygienic conditions. Nine samples of aggregate milk (3 x 3 pieces) during the lactation period of TNMO the three groups of animals were examined to determine the content of dry matter, milk fat, dry fat-free residue (DFR), protein, casein, non-casein protein, lactose, calcium (Ca), density, titratable and active acidity, coagulation, total number of microorganisms (TNMO) and total number of somatic cells (TNSC). The samples were analyzed in the technological laboratory for milk and dairy products at RIMSA - Troyan. Three batches of white brined cheese were prepared from the aggregate samples of goat milk from the three groups of animals at the beginning, middle and end of the lactation period (9 batches in total) under laboratory conditions, according to the methodology described by Peychevski et al. (1988) without standardization of milk. Samples of the obtained batches of cheese were examined on the 24th hour and on the 45th day of the ripening process.

The following milk parameters were tested on the Milko-Scan FT 120 (Foss Electric):

*Chemical indicators:*Dry matter, Milk fat, Dry fat-free residue, Total protein, Casein protein, Lactose, Calcium - complexometric (Kondratenko et al., 1981); Non-casein protein - by calculation;

Physical indicators: Density - with lactodensimeter, BDS 1110-73; Titratable acidity - by the Turner method, BDS 1111-80; Active acidity (pH) - potentiometrically; Coagulability - according to Dimov et al. (1974); Syneresis of the rennet coagulum - by the method of Shidlovskaya (1979), modified by Peychevsi (1983);

Microbiological parameters of milk

The tests for TNMO and TNSC were performed in the *Alimenti* Testing Laboratory at D&V Consult OOD, Tsaratsovo village, Municipality of Plovdiv; Total number of microorganisms (TNMO) - BDS ENISO 4833-1: 2013; Total number of somatic cells (TNSC) - BDS ENISO 13366-1: 2008;

Dry matter, milk fat, total protein, water content, salt of cheese were examined on Food Scan device (Lab, 78800)

Milk fat in dry matter (MFDM), water in the fat-free residue (WNFR), salt in the aqueous phase (SAP) were found by calculation (Lawrence & Gilles, 1980).

Titratable acidity - by the method of Turner, BDS 1111-80;

The variational-statistical data processing was done through Statistica software package, and the graphic - through Excel. The mean values of the groups in the individual studies were compared according to the tables of the Student-Fisher t-test.

RESULTS AND DISCUSSIONS

Differences in the level of milk productivity and milk composition are influenced by genetic and physiological factors such as breed, individual characteristics, lactation phase, animal husbandry, climate, botanical

composition of grassland (Scintu & Piredda, 2007). The goat's milk tested has physico-chemical characteristics specific to the species studied and meets the requirements of Regulation 853/2004 (Table 1).

Table 1. Composition and properties of goat's milk processed into white brined cheese (n = 3)

Indicators	Groups		
	BWD	BWD x TG	BWD x AN
	x ± Sx	x ± Sx	x ± Sx
Dry matter, %	13.03±0.316	13.51±0.443	13.62±0.400
Milk fat, %	4.91±0.409	4.97±0.354	5.19±0.302
Dry fat-free residue, %	8.32±0.085a*	8.76±0.129b*	8.63±0.101
Protein, %	2.97±0.129	3.26±0.081	3.38±0.101
Casein, %	2.03±0.062	2.14±0.061	2.20±0.035
Non-casein, %	0.87±0.058	1.12±0.092	1.18±0.081
Lactose, %	4.37±0.255	4.51±0.196	4.25±0.222
Ca, %	0.139±0.007	0.148±0.003	0.144±0.004
Ratio K/M	0.413±0.023	0.430±0.028	0.424±0.043
Density, $^{o}G_{20/4^{o}C}$	28.2±0.402	29±0.343	28.3±0.365
Titrable acid, ^{o}T	15.17±1.093	15.33±0.726	14.83±0.928
Active acidity, pH	6.48±0.050	6.50±0.047	6.53±0.052
Curdling, s	294±0.120	285±0.128	283±0.145
TNMO cfu/ml	8.40 x 10^5±0.436	6.27 x 10^5±0.467	7.13 x 10^5±0.549
TNSC n/ml	1.90 x 10^5±0.436	1.67 x 10^5±0.418	2.13 x 10^5±0.406

Note: a - BWD; b - BWD/BWD x TG; *P≤0.05

The composition and properties of the cheese depend mainly on the composition and properties of the milk from which it has been produced (Peychevski, 1983). The main ingredients characterizing the cheese as a food product are milk fat, dry fat-free residue and water content, the latter affecting the taste, texture, structure and type of cheese (Chomakov et al., 2000).

The highest results for dry matter were reported in BWD x AN - 13.62% and BWD x TG - 13.51% compared to BWD breed - 13.03%, which is close to the values obtained by Soryal et al. (2005) for Nubian goats - 13.45%, raised in the USA and lower than those of Narangerel et al. (2016) - 15.23% for goats in Mongolia.

Milk fat, dry fat-free residue and protein score high in BWD x AN (5.19%, 8.63%, 3.38%) and BWD x TG (4.97%, 8.76%, 3.26%) compared to BWD breed, which is lower than mean values for DFR and protein - 9.1% and 3.60% found by Dimassi et al. (2006) in goat milk of Dahlem Cashmere breed raised in Germany. It is close to protein values found by Johanson et al. (2015) - 2.93%, 3.20% and 3.39% in Swedish White breed with low, medium and high levels of a_{s1}-casein and close to those obtained by Zullo et al. (2005) for milk fat (4.62%-5.23%) in several herds of Cilentana goats with different pigmentation, raised in the Salerno region. Damian et al., (2008) reported a milk fat content of Saanen and Anglo-Nubian breeds of 3.59% and 4.65%, respectively, which is lower than our results, and Šlyžius et al. (2017) found values for milk fat in Anglo-Nubian goats in Lithuania - 5.20%, which coincides with our results for BWD x AN - 5.19%.

The data on dry matter, milk fat and protein obtained in the present study in all three groups of goats are lower than those of Raynal-Ljutovac et al. (2008), respectively 14.8%, 5.63% and 4.09% and higher than those found by Abbas et al. (2014) for Saanen goat breed in Nigeria - 12.15%, 3.41% and 3.07%.

The variation in the casein values between the three milks was insignificant and was due to the breed and the lactation phase, as the highest results were found in BWD x AN - 2.20%, which coincides with that obtained by Imran et al. (2008) - 2.18% casein in goat's milk tested in Pakistan, and the lowest values were reported in BWD breed - 2.03%. Compared to our results, Peychevski et al. (1986) also found a low casein content (2.08-2.32%) in goat's milk processed into white brined cheese, but

with a significantly lower non-casein protein content (0.65-0.68%), similar to the studies of Albenzio et al. (2006) for the aggregate milk from four goat herds during the spring season - 0.35-0.60% (2.5-2.9% casein).

The amount of non-casein protein varied in a relatively narrow range from 0.87% in BWD to 1.18% in BWD x AN.

Lactose had the lowest results in milk from BWD x AN - 4.25%, and the highest in BWD x TG - 4.51%, which is close to those indicated by Tudisco et al. (2014) - 4.57-4.65% lactose in the milk of goats raised fon pastures and stables in Italy.

Variations in calcium values between groups are minimal and coincide for BWD with those found by Park et al. (2007) - 0.134% calcium in goat's milk, but lower than those obtained by Rawya and Ahmed (2014) - 0.200% in Damascus goats in Cyprus.

As the milk density changes depending on the content of milk fat and dry matter, the lower content of dry matter in the milk of BWD breed, determines the lower density of this milk (28.2ºG) compared to that of BWD x TG (29.0ºG), as the differences are statistically insignificant ($p>0.05$) and coincide with the results obtained by Odzhakova, (2002) for milk density of local goats - 28.6ºG and crossings - 29.1ºG raised in the Middle Rhodope Mountain.

There were no significant differences between the groups in terms of active and titratable acidity, in contrast to the data from some studies abroad - pH 6.36 ÷ 6.82 (Helmut & Fiechter, 2012) and 5.69 ÷ 6.92 (Dračková et al., 2008) and 11.5 ÷ 20.5°T (Dračková et al., 2008).

Mihailova et al. (2000) indicate values for titratable acidity in BWD - 15.8ºT and for local goats - 15.6ºT, which is close to the one obtained in the present study for BWD breed - 15ºT.

Imran et al. (2008) found identical to our results active acidity - 6.59 in goat milk in Pakistan.

Bhosale et al. (2009) found lower data on active acidity from 6.23 to 6.49 in the milk of first to fourth lactation goats in India

Iancu (2010) reported pH values from 6.25 to 6.38 in first to seventh lactation goats in Sibiu (Romania), which confirms our claim that the differences in the values of these indicators are probably due to nutrition, climatic conditions, individual characteristics and health condition of the animals, the specificity of the area, etc.

One of the most important indicators in cheese-making, on which the structure, yield and quality of the cheese largely depends, is the curdling capacity of the milk and the syneresis of the obtained rennet coagulum (Peychevski, 1983).

Coagulation and the conditions of syneresis determine the final characteristics of the cheese, due to their impact on the moisture and protein content. The dry matter content, the composition of the whey and the characteristics of the final product are determined mainly by the control of the syneresis process and the separation of the whey applied during processing into cheese (Garćia et al., 2014).

The milk used has a very good curdling capacity of 283 s for BWD x AN, 285 s for BWD x TG and 294 s for BWD.

Mihailova et al. (2000) found the curdling capacity of goat's milk of BWD breed - 266.4 s, for crossings - 291 s and for domestic goats - 239.2 s. Peychevski et al. (1986) found a much faster curdling of milk from Saanen goats (53.3 ÷ 57 s), probably due to the influence of higher titratable acidity in their study - 17.7 and 18.7°T (Gorbatova, 1984) or the content of $\alpha s1$-casein and the higher degree of dispersion of casein micelles (Vegarud et al., 1999).

In contrast to the present results and those of Peychevski et al. (1986), Clark & Sherbon, (2000) found significantly slower curdling of milk from 6 breeds of goats and some of their crossings - between 346 s and 964 s, 531 s for that of Nubian and 829 s of Toggenburg breed.

According to Regulation (EC) No 853/2004 laying down specific hygiene rules for food of animal origin, raw goat's milk must contain no more than 1,500,000 total number of micro-organisms/ml (TNMO/ml), while the number of somatic cells in goat's and sheep's milk has not set a limiting upper threshold (Jimenez-Granado et al., 2014).

The total number of microorganisms in the milk processed into white brined cheese varied from 6.27 x 105 cfu/ml (BWD x TG) to 8.40 x 105 cfu/ml (BWD).

Carusillo et al. (2014) examined 536 samples of raw goat's milk and found that in 85.1% of

the samples OTNMO was below 1,500,000/ml, as most of them (80.2%) contained TNMO below 500,000/ml.

Cupáková et al. (2012) found an average monthly total number of microorganisms in the order of 4.53-5.21 log cfu/ml, with the highest peak in July.

In the absence of mastitis, the number of somatic cells in goat's milk can vary from 270 x 10^3 to 2000 x 10^3 cfu/ml (Jiménez-Granado et al., 2014).

Processed milk from BWD and BWD x TG contained significantly less TNSC - 1.90 and 1.67 x 10^5 pcs/ml, respectively, compared to that of BWD x AN - 2.13 x 10^5 cfu/ml.

The speed and amount of whey released from the milk coagulation is an important technological indicator. The studied goat's milk had a well-defined syneresis (Figure 1).

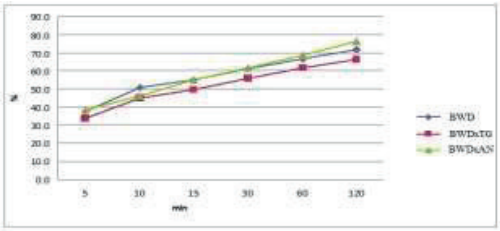

Figure 1. Syneresis of rennet coagulum of goat's milk used for cheese production

At the fifth minute, 37.7% whey was released for BWD, 33.7% for BWD x TG and 38.3% for BWD x AN, after the first hour - 66.7% for BWD, 61.7% for BWD x TG, 68.7% for BWD x AN, and after the 2nd hour - 71.7% for BWD, 66.3%, for BWD x TG and 76.5% for BWD x AN.

The milk of BWD x AN had the best syneresis, and the lowest was that of BWD x TG, which is close to the one obtained by Mihaylova et al. (2000) for the amount of whey released - 71% in local goats, 70% in the milk of BWD breed and 66% in the milk of crossings.

Brine cheeses are the most important type of this product for the Eastern Mediterranean and Balkan countries. These types of cheese can be very similar, but also quite different in terms of technological process, composition, physicochemical and organoleptic properties.

The cheese quality varies depending on the physicochemical composition of the goat's milk and the technology used (Litopoulou-Tzanetaki & Tzanetakis, 1992; Barac et al., 2016; Sulejmani & Hayaloglu, 2018).

The relatively lowest water content was registered in the 24th hour of production from BWD milk (53.34%), while the highest was found in milk of BWD x AN (58.40%) (Table 2).

Table 2. Cheese composition at the 24th hour of production

(n = 6)

Indicators	Groups		
	BWD	BWD x TG	BWD x AN
	x ± Sx	x ± Sx	x ± Sx
Water content, %	53.34±0.730	57.10±2.612	58.40±0.910
Protein, %	15.16±0.186a*	12.54±0.871b**	12.76±0.601b**
Fat, %	24.0±0.829	19.32±0.585	20.64±0.690
Milk fat in dry matter (MFDM)	51.41±1.029	48.86±0.227	49.60±0.792
Salt, %	2.46±0.087	2.44±0.090	2.40±0.080
Titrable acidity, °T	146.67±3.333	139.33±7.024	144.34±4.410
Water in non-fat residue (WNFR), %	70.18±0.317	72.83±1.020	72.97±0.616
Salt in water phase (SWP), %	4.60±0.100	4.30±0.246	4.11±0.177

Note: a - BWD; b - BWD/BWDxTG; *P≤0,05; **P≤0,01

The data for this indicator from the present study are close to those of Barac et al. (2016) for fresh white brined cheese made from goat milk pasteurized at 90°C/10 min (53.29%) and Kondyli et al. (2016) - 54.56%, for goat's milk cheese on the 2nd day of production. Our results are slightly lower than those of Litopoulou-Tzanetaki & Tzanetakis (1992) for white brined cheese made from raw goat's milk (58.0 and 59.4%, respectively, on the 15th and 75th day of production). Sulejmani & Hayaloglu (2018) found a significantly higher water content in

fresh (1st day of production) white brined cheese made from raw (67.4%) and pasteurized at 80°C/2 min goat's milk (67%).

The highest protein and fat content in the cheese at the 24th hour is the highest in the BWD breed - 15.16% and 24.0%, respectively, and the lowest in the BWD x TG - 12.54% and 19.32%, which is higher than that found by Zeng et al. (2007) - 15.9% fat and 11.8% protein for soft cheese (at 24 hours) from mixed milk of Alpine and Nubian goats in the USA.

Soryal et al. (2005) reported values of 12.57% and 12.84% protein in soft milk cheese of Alpine and Nubian goats in the United States and fat, respectively - 15.78% and 15.54% for the same breeds, and Albenzio et al. (2006) found results of 15.4% to 19.4% protein in Cachioricota cheese after one week of maturation from milk of 4 herds of Garganica goats in Italy.

The fat content values in the dry matter in the white brined cheese at the 24th hour from 48.86% at – BWD x TG to 51.41% at BWD are lower than those of Barac et al. (2016) - 57.18% and significantly higher than the data in the studies of Sulejmani & Hayaloglu, (2018) for white brined cheese produced from raw (43.36%) and pasteurized (37.86%) milk.

Cheese ripening process depends on the conditions of the microenvironment in which the lactic acid bacteria develop and the rennet enzyme acts. The microenvironment in the cheese is determined by the content of water, salt and pH. Important for the correct ripening and quality of the cheese are not the absolute, but the relative values of these indicators - water in fat-free residue (WFR) and the salt content in the aqueous phase (SWP) (Upreti & Metzger, 2007).

The water content in the fat-free residue affects the course of biochemical and microbiological processes, and the ability to produce a product with a characteristic taste and aroma (Rearce & Gilles, 1979). Salt content in the aqueous phase and pH at the time of salting also have a great and decisive influence on the normal course of microbiological processes and the durability of the cheese (Lawrence et al., 1987).

The water content in the fat-free residue of cheese at the 24th hour varied in a relatively narrow range - 70.18 ÷ 72.97%, respectively in BWD and BWD x AN. These data are very close to the water content found by Kondyli et al. (2016) in the fat-free residue in goat cheese on the second day of production - 72.88%.

The lowest salt values in goat's white brined cheese were found in BWD x AN - 2.40%, and the highest in BWD - 2.46%. While in the studies of Sulejmani & Hayaloglu (2018) this indicator in fresh cheese is in the range of 2.02 ÷ 2.73%, the data of Barac et al. (2016) for the salt content in goat white brined cheese for the period 10th ÷ 50th day of production are significantly lower - 1.85-2.10%.

The salt content in the aqueous phase in goat cheese at the 24th hour in our study ranged from 4.11 to 4.60%. For goat white brined cheese on the 2nd day of production Kondyli et al. (2016) found 1.47% salt and 2.69% salt in the aqueous phase.

The goat's milk cheese had the highest titratable acidity in BWD breed - 146.67ºT, and the lowest in BWD x TG - 139.33ºT, which is less than the titratable acidity established by Jeleva (2005) - 156.9ºT for white brined cheese of buffalo milk at 24 hours. On the third day of the production of traditional white brined cow's milk cheese with a leaven consisting only of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* or supplement to them of *Lactobacillus paracasei* subsp. *paracasei* (L. casei), Dabevska-Kostoska et al. (2015) found an even lower titratable acidity - 107.8 ÷ 141.1°T (0.97 ÷ 1.27% lactic acid).

The research data of Mallatou et al. (1994) showed that fresh goat Feta cheese had an average water content of 58.5%, 75.6% water in the fat-free residue and a titratable acidity of 144.4°T (1.3% lactic acid).

The cheese composition on the 45th day of production is presented in Table 3.

Compared to the cheese at the 24th hour of production, the water content of the mature white brined cheese from the individual batches decreased slightly and reached values of 52.60%, 54.74% and 55.11%, as the values for BWD breed were by 0.74%, for BWD x TG by 2.36%, and for BWD x AN by 3.29% lower.

Table 3. Cheese composition on the 45th day of production

Indicators	Groups		
	BWD	BWD x TG	BWD x AN
	x ± Sx	**x ± Sx**	**x ± Sx**
Water content, %	52.60±0.865a*	54.74±0.538	55.11±0.595b*
Protein, %	14.60±0.857a*	11.97±0.708	11.95±0.617b*
Fat, %	27.71±1.325	25.05±1.153	25.08±1.183
Milk fat in dry matter, % (MFDM)	58.42±1.924	55.32±2.186	55.84±1.939
Salt, %	2.67±0.064	2.63±0.055	2.77±0.095
Titrable acidity, °T	223.33±14.530a*	243.33±20.078c*	230.0±101b*
Water in non-fat residue, % (WNFR)	72.77±0.643	73.06±0.871	73.58±0.498
Salt in water phase, % (SAP)	5.09±0.185	4.88±0.116	5.03±0.230

Note: a - p<0.05; a-BWD; b - BWD/BWD x AN; c - BWD/TG; *P≤0.05.

Its content was significantly higher in the present study than those found by Peychevski et al. (1986) for mature white brined cheese from the milk of Saanen goats - 49.10 ÷ 50.03%, probably due to the higher acidity of the processed milk and the accelerated syneresis of the cheese mass during the technological process (Gorbatova, 1984).

Unlike the present result, Peychevski et al. (1986) and Kondyli et al. (2016) found an increase in the water content of mature white brined cheese (60th day) from goat's milk by 0.91%, compared to fresh (2nd day of production). The same tendency to increase the water content from 55.83 to 61.84% was found by Miloradovic et al. (2017) for goat white brined cheese, produced by the traditional technology - heat treatment of milk at 65°C/30 min, as in the study of Kondyli et al. (2016). More significant increases in water content in mature goat's white brined cheese - 47.0 to 54.4% and 53.29 to 57.05% were obtained in other studies (Dabevska-Kostoska et al., 2015).

These results from the studies of Dabevska-Kostoska et al. (2015), Kondyli et al. (2016) and Miloradovic et al. (2017) are probably due to the long initial ripening at high temperature - respectively 16-18°C for 15-20 days and 13-15°C for 40 days, which affects the course of biochemical processes in the cheese.

The cited results are in contradiction with our data and those of Balabanova (2015), who found a decrease in the water content in cow's and buffalo's white brined cheese, ripening at 15°C - by 8.3% and 13.4%, respectively.

The highest protein was found in BWD breed - 14.60% and the lowest in BWD x AN - 11.95%, as its values decreased compared to the 24th hour - by 0.56% in BWD, 0.57% in BWD x TG and 0.81% in BWD x AN.

Data from the study by Kondyli et al. (2016) showed a more significant decrease (by 1.44%) in the protein content of mature goat white brined cheese on day 60. Similar results were obtained for white brined Feta cheese (Mallatou et al., 1994) and from goat's milk.

Barać et al. (2016) prove that the protein content in white brined goat's milk cheese decreases during ripening, which coincides with that found in our studies and is due to the fact that ripening takes place in salted brine and the decrease in protein values is due to the diffusion of weakly bound or partially hydrolysed proteins in the cheese.

The highest milk fat values were found in BWD - 27.71%, and the lowest in BWD x TG - 25.05%, which is identical to that indicated by Popović-Vranješ et al. (2016) - 25.3% fat in hard cheese produced in Serbia and less than that obtained by Poveda et al. (2008) - 34.75% and 37% in hard goat cheese from different geographical regions.

There is a relationship between the casein and milk fat content of processed milk and the composition and yield of the cheese. At the same fat content, the increase of casein amount raises the efficiency of using the dry matter in processed milk increases. This reduces the milk fat of the dry matter in the cheese while maintaining the standard requirements. The standardization of milk allows the production of a standard product in terms of milk fat in dry matter and water content (Chomakov & Peychevski, 1974; Peychevski et al., 1986).

The highest milk fat content in the dry matter was registered in the cheese from BWD milk - 58.42%, and the lowest in BWD x TG breed -

55.32%, which is higher than that obtained by Popović-Vranješ et al. (2016) - 42.6% - 51% in mature cheese produced in Serbia.

Peycheski et al. (1986) also obtained a lower content of milk fat in the dry matter (44.20-44.76%) of white brined cheese than the milk of Saanen goats (K/M 0.709-0.738). We attribute this to the much lower ratio in the goat's milk processed by us (0.413 ÷ 0.430 - Table 1).

During ripening, the water in the fat-free residue in the white brined cheese in all three batches studied by us varied in a relatively narrow range and increased slightly from 70.18 to 72.77% (BWD), 72.83 to 73.06% (BWD x TG) and from 72.97 to 73.58 % (BWD x AN). Our results are close to those found by Kondyli et al. (2016) - 72.88 ÷ 74.48%, in contrast to the research of Miloradovic et al. (2017), whose data show a significant increase in WFR in the maturation process - from 67.52% to 74.92%.

The results of the research of Peychevski et al. (1986) show a significantly lower content of WFR in mature goat white brined cheese - 63.35 ÷ 64.03%.

Chen et al. (2010) investigated the technological qualities of Alpine goat milk with different number of somatic cells in the production of semi-soft Colby cheese and also found a low water content in the fat-free residue in the cheese - 63.55 ÷ 64.19%.

The salt amount varies within narrow limits between the individual batches of cheese. Compared to white brined cheese, at the 24th hour of production, the salt content of mature cheese from BWD milk was 0.21%, at BWD x TG by 0.19%, and at BWD x AN by 0.37% more on the 45th day of maturation.

Dabevska-Kostoska et al. (2015) found an almost double increase (from 2.55 to 5.14%) in the salt content of goat white brined cheese on day 40, and Kondyli et al. (2016) - significantly lower values (1.47-3.05% on the 60th day).

The salt content in the aqueous phase in the cheese at the 24th hour and the mature cheese from the three groups in our study varied in a relatively narrow range - from 4.11-4.60 to 4.88-5.09%. The results of Kondyli et al. (2016) are close to the above - from 2.69 to 5.50%, in contrast to the data of Dabevska-Kostoska et al. (2015), which vary in a significantly longer range - from 4.79% to 9.01%. The salt content in mature white brined cheese from the milk of Saanen goats is relatively high in the research of Peychevski et al. (1986) (7.94-7.95%).

The titratable acidity during ripening increased in the milk cheese of all three groups of animals and is close to that found by Gerchev et al. (2004) - 221.5ºT for white brined cheese from milk of goats of different breed and age composition, raised in the region of the Central Balkan Mountain. These and our results are lower than the established titratable acidity in mature Saanen goat cheese in the studies of Peychevski et al., (1986) - 274.4 ÷ 284.4°T. In contrast to the above data, Dabevska-Kostoska et al. (2015) found significantly lower titratable acidity in goat white brined cheese on the 40th day - 147.8°T. The titratable acidity of Feta cheese from goat's milk on the 60th day of production is even lower - 111.1°T (Mallatou et al., 1994).

CONCLUSIONS

1. Goat's milk processed into white brined cheese from the studied goat breeds, such as Bulgarian White Dairy and its crossings with Toggenburg and Anglo-Nubian raised in one herd under the same production conditions is characterized by the lowest content of dry matter (13.03%), milk fat (4.91%), dry fat-free residue (8.32%), protein (2.97%), casein (2.03%), calcium (0.139%) and density (28.2 ºG), in Bulgarian White Dairy breed compared to its crossings.

2. The hygiene indicators were within acceptable limits and comply with Regulation (EC) No 853/2004.

3. The slowest curdling (294 s) was observed in milk from BWD, and the fastest in milk from BWD x AN (283 s), with the best syneresis observed.

4. The lowest water content at the 24th hour of production was observed in the milk cheese of Bulgarian White Dairy breed (53.34%), as the highest protein and milk fat values (15.16%, 24.0%) were observed in the batch produced from the milk of the same breed.

.In the mature white brined cheese on the 45th day of production, the water and protein content decreased in all three batches compared

to the 24-hour cheese, while the values for milk fat, fat content in the dry matter, water in the fat-free residue and salt in the aqueous phase increased.

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