Scientific Annals of Polish Society of Animal Production - Vol. 14 (2018), No 2, 37-48

The influence of the addition of herbs to the summer diet of sheep on the yield of bundz rennet cheese and its nutritional value

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The study was carried out on samples of raw sheep milk and bundz rennet cheese produced from it. The milk was obtained from ewes of the Koluda prolific dairy breed, from June to August. The sheep were housed indoors and fed with alfalfa green forage and a mixture of concentrate feeds. Three groups were formed for the experiment: group I – control, fed without the addition of herbs to the concentrate feed, and groups II and III, in which an herb mixture was added to the concentrate feed in the amount of 10 and 20 g/sheep/day, respectively. Six experimental batches of bundz rennet cheese were made from the sheep milk, and the effect of the addition of herbs to the sheep diet on the chemical composition of the raw milk, the cheese yield, and its nutritional value was analysed. The results showed that the use of the herbal supplement in the feed of the Koluda prolific dairy sheep in summer had no effect on the chemical composition of the raw milk, and thus its value for processing, expressed as the yield of bundz rennet cheese. Moreover, there was no statistically confirmed influence of the experimental factor on the chemical composition of the cheese. Only a tendency towards lower fat content was noted in the group III cheese in comparison with groups I and II (by 6.5% and 8.0% respectively), which resulted in an improved protein-to-fat ratio (by 7.3% and 9.0% respectively) and lower energy value (by 3.6% and 5.2% respectively). We also noted a tendency towards higher mineral content (ash) in the cheese from groups II and III as compared to group I, by 8.7% and 13.0%, respectively However, these differences were not confirmed statistically, probably due to high intra-group variation in this feature (V% in groups I, II and III: 19.7, 33.7 and 46.1, respectively).

KEY WORDS: herbs / sheep / sheep cheese / nutritional value

Functional food, i.e. food with health-promoting constituents with proven beneficial effects on one or more functions of the body in addition to nourishment, becomes particularly important in times of increased incidence of diet-related diseases [9, 19]. Contemporary,

informed consumers therefore search for products that are not only tasty and safe, but also natural and beneficial to their health [14, 23, 30]. Surveys indicate that consumers believe food quality can be improved by returning to traditional methods of animal husbandry, natural feeding, and traditional methods of food production, without interference in the form of additives such as vitamins or minerals [1, 29]. Survey results indicate acceptance for measures taken to reduce the content of constituents with a negative effect on health, e.g. cholesterol and fat [29, 32]. New trends in consumer behaviour are manifested in the growing interest in traditional, regional food, with guaranteed quality [1]. In a study by Żakowska-Biemans and Kuc [33], as many as 78% of survey respondents declared interest in purchasing such food, the vast majority considering it to be 'healthy', 'less processed' and 'tasty'. The best-known and most commonly purchased sheep products included cheeses (72% of respondents), including oscypek, feta, bryndza and bundz. Consumers value the authenticity of this category of products, owing to their original formulas and the natural origin of the ingredients. Sheep milk, besides its unquestionable health-promoting properties, also has high nutritional value [2]. Research on the content of individual milk constituents has shown that sheep's milk has much higher content of dry matter, and thus of protein and fat, than cow or goat milk [7]. Hence it is an excellent raw material for cheese production and is distinguished by greater cheese yield (the amount of cheese in kg obtained from 100 kg of milk) than cow or goat milk.

Research suggests that traditional and regional food can become an important segment of the market, meeting the expectations of consumers interested in high quality food and unique taste qualities. To meet the expectations of consumers, research was undertaken in which herbs were added to the diet of sheep as a natural factor stimulating their production and health and thereby improving the quality of their milk and the cheese produced from it. For this purpose, varied levels of an herbal mixture were added to the diet of sheep housed indoors and fed preserved bulky feed derived from monoculture crops.

Material and methods

The research was carried out at the National Research Institute of Animal Production, Experimental Station in Kołuda Wielka. The experimental material consisted of 66 ewes of the Koluda prolific dairy breed (aged 2 to 8 years), milked commercially from June to August, after the lambs had been weaned at the age of 8-9 weeks. The ewes were housed indoors and fed alfalfa greens, hay and a mixture of concentrate feeds. The nutrition level was established according to INRA-88 standards for milking sheep, based on the requirements of a ewe with a body weight of 70 kg producing on average 0.6 kg of milk. Three feeding groups were created in the experiment: group I (control) was fed bulky feed and compound concentrate feed without herbs, while groups II and III received the same feed as group I, but with a herb supplement added to the concentrate feed in the amount of 10 and 20 g/head/day, respectively. The herb mixture used in the experiment was composed of 9 herbs (common nettle *Urtica dioica*, fennel *Foeniculum capillaceum*, caraway *Carum*

carvi, coriander *Coriandrum sativum*, fenugreek *Trigonella foenumgracum*, peppermint *Mentha piperita*, English marigold *Calendula officinalis*, chamomile *Matricaria chamomilla*, and milk thistle *Silybum marianum*). It was intended to benefit the animals mainly by improving their digestion and metabolism, by acting as galactogogues, and by exerting bacteriostatic and anti-inflammatory effects, thereby improving the quality of the milk and the cheese produced from it.

Six experimental batches of bundz rennet cheese were made from the sheep milk (at two-week intervals). The cheeses were made from 10 kg of milk from each group, using the vat method, at the Kołuda Wielka Experimental Station processing plant associated with the farm. Before processing, the milk was collected and stored for 2 days at 4°C. The milk was pasteurized at 75°C for half an hour, after which it was cooled to 34°C and treated with calf rennet in the amount of 0.15 ml/kg of milk. The curd was sliced and then placed in cheese moulds lined with cheesecloth. The cheese mass was subjected to 10 kg of pressure per mould (i.e. 2.5 kg/kg of cheese) for 12 hours. The cheese blocks were weighed 12 hours after being removed from the cheese moulds. The cheese yield was calculated as the ratio of the weight of the cheese to the weight of the milk it was made from, expressed as a percentage. The proximate chemical composition of samples of bulk milk and bundz was determined. For milk, the content of dry matter, non-fat dry matter, protein, fat and lactose were determined with a MilcoScan apparatus in the laboratory of the regional dairy cooperative (OSM) in Inowrocław. For the cheese, dry matter (oven-dry method), protein (Kjeldahl method), fat (Soxhlet method), and ash (combustion method) were analysed in the laboratory of the Kołuda Wielka Experimental Station. Based on the chemical composition, the basic nutritional parameters of the cheese were calculated, i.e. the protein-to-fat ratio and gross calorific value, using physiological gross energy factors according to Rubner [28].

The results of the experiment were analysed statistically by one-way analysis of variance (ANOVA) using the STATISTICA 6 PL package, where the experimental factor was the addition of herbs in the three groups. Statistical differences between groups were verified by Duncan's test. Coefficients of variation (V%) were calculated to assess variation between groups.

Results and discussion

There were no statistically confirmed differences between feeding groups in the content of dry matter, non-fat dry matter, fat, protein or lactose in the milk or in the content of these constituents in its dry matter (Table 1). Only in the milk of the group III sheep was there a tendency for lower dry matter content, due to the lower content of protein and fat (by 4% and 5% respectively), in comparison to the other groups. The composition of the milk did not undergo pronounced changes during the research and was similar in the groups in analogous periods of lactation (Fig. 1). Only in the final stage of the study was there a slight increase in the fat content and thus the dry matter content of the milk, probably due to declining milk production, which is negatively correlated with protein and fat content.

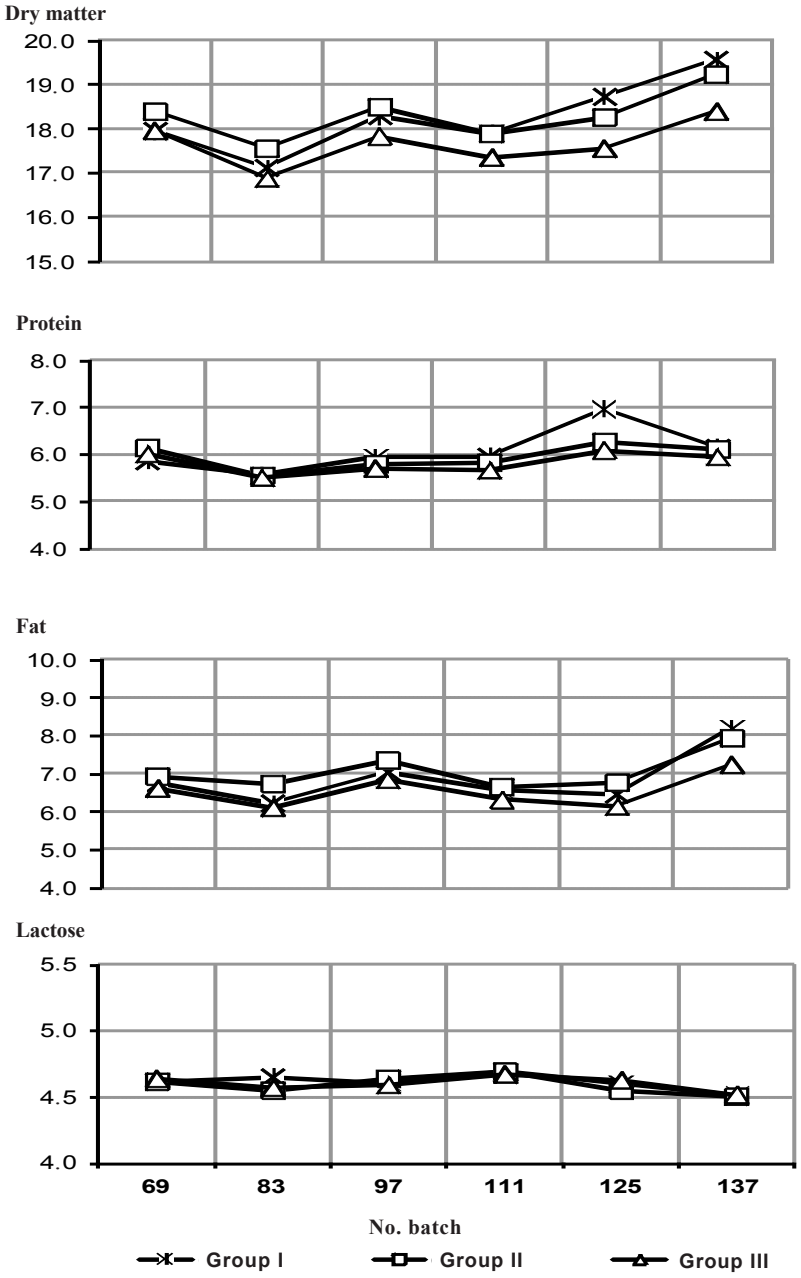

Fig. 1. Chemical composition of raw milk for cheese-making in the period from 69 to 137 days of lactation

Table 1
Chemical composition of raw milk used to make cheese

Item		Group			SEM
		I	II	III	
Number of experimental batches	n	6	6	6	
Content of chemical constituents in milk (g/100 g):					
dry matter	$\bar{x}$	18.26	18.30	17.66	0.162
	V%	4.6	3.1	3.0	
non-fat solids	$\bar{x}$	11.39	11.24	11.12	0.079
	V%	4.1	2.3	2.2	
protein	$\bar{x}$	6.07	5.94	5.82	0.080
	V%	7.9	4.5	4.0	
fat	$\bar{x}$	6.87	7.06	6.54	0.134
	V%	10.3	6.9	6.8	
lactose	$\bar{x}$	4.61	4.59	4.60	0.014
	V%	1.2	1.5	1.2	
Protein-to-fat ratio	$\bar{x}$	0.891	0.843	0.892	0.018
	V%	12.1	7.2	6.9	
Content of chemical constituents in milk dry matter (%)					
protein	$\bar{x}$	33.27	32.49	32.95	0.334
	V%	6.1	3.6	3.0	
fat	$\bar{x}$	37.58	38.55	37.00	0.459
	V%	6.7	4.2	4.3	
lactose	$\bar{x}$	25.33	25.11	26.09	0.269
	V%	5.5	3.9	3.5	

In studies conducted on Polish Mountain and Olkuska sheep during pasture grazing, there was an upward trend in the fat content of the milk during lactation and protein content at the end of lactation [17, 22]. Similarly as in our own research, Lacerda et al. [21] reported no influence of the experimental factor (in the form of oregano added to the feed of Holstein cows and zebu) on the chemical composition of milk. On the other hand, Kraszewski et al. [20] noted an increase in fat, protein and lactose content in the milk of cows fed with a 2% herb supplement. In our study, the lack of effect of the herb supplement on the chemical composition of milk, with a simultaneous increase in milk production [6] (by 8.2% in group II and 16.4% in III, compared to the control), negatively correlated with the protein and fat content in the milk, indicates that there was no deterioration in the technological parameters of the milk (cheese yield). A similar milk composition as in our research was demonstrated by Korman et al. [18] in Koluda sheep housed indoors in winter and summer feeding conditions, by Gerchev and Mihaylov [8] in the sheep of local Balkan breeds grazed in mountainous areas, and by Bonczar et al. [5] in Polish Mountain sheep grazed in the vicinity of Nowy Targ. The milk of the Koluda sheep in our research

contained slightly less dry matter, fat and lactose, and a similar amount of protein as the milk of Polish Merino ewes (19.2%, 7.7%, 5.1% and, 5.9%, respectively) [24]. Similarly, Molik et al. [22] reported a slightly higher content of dry matter (18.9% and 18.2%, respectively) and fat (7.5% and 7.1%, respectively) and similar protein content (5.9%) in the milk of pasture-grazed Polish Mountain and Olkuska sheep in comparison to our results. Konieczny [17], on the other hand, in the milk of Polish Mountain sheep kept in the pasture in organic farming conditions, showed higher content of fat (9.0%) and lactose (6.2%), and lower content of protein (4.1%). As a result, this milk had a much less favourable protein-to-fat ratio of only 0.46. Pakulski and Dulewicz [25], in a study on the composition of the milk of Polish Merino (MP, winter season) and East Friesian sheep (FR, summer season), found much lower protein content (4.5% and 3.7%, respectively). Thus, the dry matter of the milk contained less protein (MP – 23.5%, FR – 23.2%), and more fat (MP – 45.0%, FR – 39.2%). The raw milk used in the production of bundz in our study contained slightly less protein and significantly less fat than the milk of Polish Mountain sheep of the Coloured variety and Podhale Zackel sheep, grazed in the Podhale region [15]. The differences shown in the chemical composition of the milk resulted in part from the different genotypes of the sheep as well as from different housing and feeding systems. In light of the above, it can be concluded that the milk obtained from the ewes, irrespective of the use of the herb supplement, had high protein content and therefore good production potential.

Due to the fairly similar chemical composition of the milk in each of the feeding groups, there were no statistically confirmed differences in the yield of bundz cheese (Fig. 2). A high positive correlation between milk protein and fat content and cheese yield was demonstrated by Sevi et al. [31] and Bojanić-Rašović et al. [4]. The influence of the concentration of chemical constituents in raw milk (sheep and sheep + cow) on cheese yield in the production of semi-hard and soft cheese is also confirmed by other studies [3, 10, 11, 12, 13]. However, studies by Pakulski and Dulewicz [25] and Jarzynowska [10] showed that in addition to the influence of the chemical composition of milk on cheese yield, the production technology has a significant impact as well. Jarzynowska [10] obtained more cheese by the acid-rennet method (curd cheese) than by the rennet method (bundz) and more cheese from sheep milk than from sheep + cow milk. Pakulski and Dulewicz [25] reported greater yield in the production of bundz as compared to oscypek and semi-hard ripened cheese, and in the processing of Polish Merino milk as compared to the milk of East Friesian sheep. It should be noted that these authors found much lower yield of bundz than in our research, i.e. 26.3% from the milk of Merinos and only 23.2% from East Friesian sheep milk. Lower yield of bundz was also obtained by Kawęcka and Paraponiak [16] from the milk of Mountain sheep and the Bergschaf and Weisses Alpenschaf breeds (22.0%, 23.2% and 23.5%, respectively) and by Pakulski et al. [27] from the milk of East Friesian sheep and crosses of these breeds (25.8% and 24.7%, respectively), while the yield of cheese made from the milk of coloured Merino sheep was similar, at 29.2%. Comparison of the results of our research with the literature data cited above shows that the milk of Koluda prolific dairy sheep had high technological value for the production of bundz. The diffe-

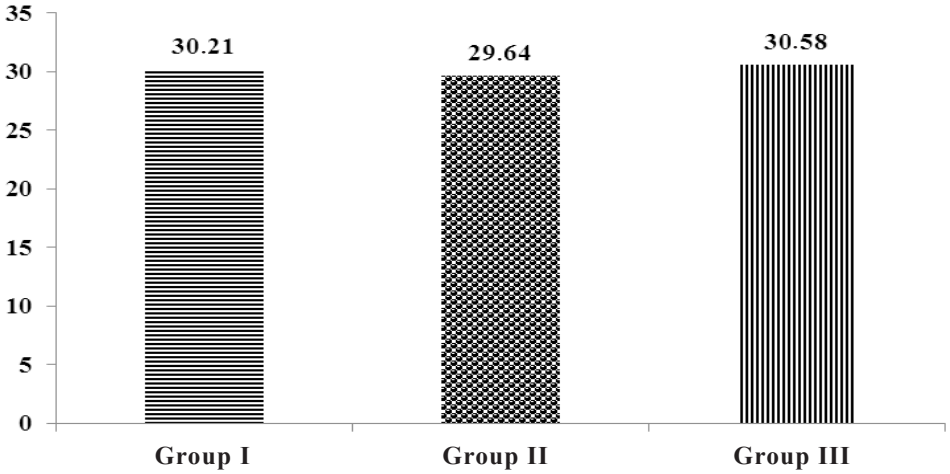

Fig. 2. Yield of bundz rennet cheese (kg/100 kg milk)

rences in cheese yield may have resulted from the nature of micro-production, in which it is difficult to maintain standard cheese production parameters. More important, however, could be differences in the concentration of the constituents of the raw milk used, obtained from sheep of different breeds and in different feeding conditions.

No statistically confirmed differences were found in the content of dry matter, protein, fat and ash in bundz made from the milk of sheep from different feeding groups (Table 2). This translated into a similar nutritional value of this cheese, expressed as the protein-to--fat ratio and the energy value. Only a tendency towards lower fat content was noted in the cheese from group III in comparison to groups I and II (by 6.5% and 8.0%, respectively), which resulted in an improved protein-to-fat ratio (by 7.3% and 9.0%, respectively) and a lower energy value (by 3.6% and 5.2%, respectively). There was also a tendency for higher content of minerals (ash) in the cheese from groups II and III in comparison with group I, by 8.7% and 13.0%, respectively. However, these differences were not confirmed statistically, probably due to high intra-group variation in this feature (V% 19.7, 33.7 and 46.1 in groups I, II and III, respectively). Changes in the content of the main chemical constituents of bundz obtained from successive experimental batches of cheese indicate, on the one hand, substantial fluctuations in dry matter, protein, fat and ash content (in the initial period of the research), and on the other hand a lack of more characteristic differences in the curves for the content of these constituents depending on the experimental factor (Figure 3). These fluctuations may have been caused by the fact that the cheese was produced in laboratory conditions, in which there is no standardization of production processes, and resulted in part from the processing of the cheese curd.

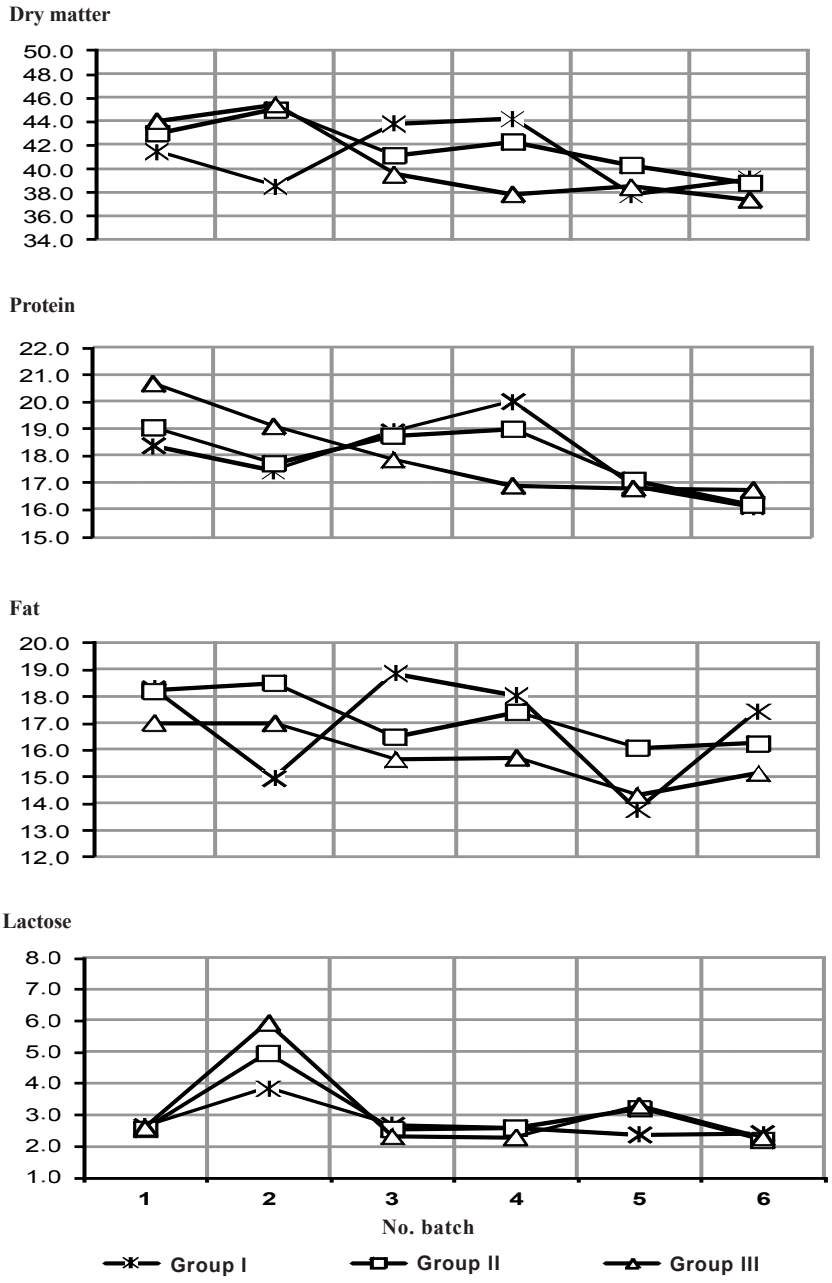

Fig. 3. Chemical composition of cheese produced in each experimental batch

Table 2
Chemical composition and nutritional value of bundz cheese

Item		Group			SEM
		I	II	III	
Number of cheese batches	n	6	6	6	
Content of chemical constituents (g/100 g):					
dry matter	$\bar{x}$	40.84	41.77	40.45	0.640
	V%	6.8	5.2	8.4	
non-fat solids	$\bar{x}$	23.94	24.60	24.65	0.420
	V%	6.4	5.2	10.3	
protein	$\bar{x}$	17.95	17.96	18.01	0.311
	V%	7.9	6.5	8.8	
fat	$\bar{x}$	16.90	17.17	15.80	0.354
	V%	12.1	6.1	6.7	
ash	$\bar{x}$	2.76	3.00	3.12	0.238
	V%	19.7	33.7	46.1	
Protein-to-fat ratio	$\bar{x}$	1.062	1.046	1.140	0.020
	V%	10.7	6.2	4.4	
Caloric value (kcal/100 g)	$\bar{x}$	237	241	228	3.857
	V%	8.9	4.7	6.7	

The bundz produced in our study contained more protein and less fat, and thus had a better protein-to-fat ratio than bundz obtained by Pakulski and Dulewicz [25]: 15.0%, 21.2% and 0.707, respectively. Similarly, in research by Pakulski et al. [27], the bundz obtained from the milk of Coloured Merino and East Friesian sheep contained more fat (18.5% and 20.8%, respectively) and less protein (15.2% and 16.0%, respectively) and had a less favourable protein-to-fat ratio (0.822 and 0.770, respectively). Bonczar et al. [5], studying the composition of bundz obtained from the milk of Mountain sheep grazing on pastures, showed a higher content of protein and fat (about 21%), with a similar protein-to-fat ratio as in our research (1,009). The differences found in the composition of bundz made in our study with respect to the cited works of other authors result to a greater extent from differences in production technology than from the composition of the milk used. This thesis is confirmed by research showing a similar composition of cheeses produced by the same method from sheep milk and sheep + cow milk, differing in the concentrations of chemical constituents, e.g. bundz [5] or semi-hard ripened cheeses [11, 12]. Pakulski and Pakulska [26] demonstrated the effect of production technology on the composition of cheese by producing various kinds of cheese from the milk of Polish Merino sheep in winter. They found that cheese that was scalded and then smoked contained the least fat (10.3%), while ripened cheese contained the most (23.3%). The lowest protein content was found in brined cheese (12.6%) and the highest in cheese that was scalded and then smoked (22.6%). Farm-based cheese production and especially microproduction in laboratory conditions do not guarantee fully standardized production technology. This explains the unequal composi-

tion of cheeses obtained in successive batches. There were no characteristic changes in the composition of the cheese during the study period depending on the experimental factor.

To sum up, the use of the herbal supplement in the diet of ewes of the Koluda prolific dairy breed in the summer did not affect the chemical composition of the raw milk used to make cheese, and thus had no effect on its technological value, expressed as the yield of bundz rennet cheese. The experimental factor also had no statistically confirmed influence on the chemical composition of the bundz produced. Only a tendency towards lower fat content in the group III cheese was noted in comparison with groups I and II (by 6.5% and 8.0%, respectively), which resulted in an improved protein-to-fat ratio (by 7.3% and 9.0%, respectively) and lower energy value (by 3.6% and 5.2% respectively). There was also a tendency for higher content of minerals (ash) in the cheese from groups II and III compared to group I, by 8.7% and 13.0%, respectively. However, these differences were not confirmed statistically, probably due to high intra-group variability in this feature (V% 19.7, 33.7 and 46.1 in groups I, II and III, respectively).

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