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The effect of an herb mixture supplement on the performance of milking sheep during the summer feeding period

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An experiment was conducted on 66 milking ewes of the Koluda prolific dairy sheep breed, housed indoors, during summer feeding based on alfalfa forage. The aim of the study was to determine the effect of our own herb mixture supplement added to concentrate feed (in the amount of 10 or 20 g/sheep/day) for milking sheep on consumption of feed and nutrients, as well as body weight, body condition, milk yield, chemical composition of the milk and condition of the udder. The addition of herbs to the concentrate feed increased its content of biologically active substances (ethereal oils and flavonoids) in proportion to the amount of herbs added. The use of the herb supplement had no effect on the body weight or body condition of the sheep. The addition of herbs in the amount of 20 g/sheep/day improved udder health, evaluated on the basis of the electrical resistance of the milk. The use of herbs increased lactation persistence and daily milk yield, which translated to greater milk production. Milk yield from sheep fed with supplements of 10 and 20 g of herbs was greater than in the control, by 8.2% and 16.4%, respectively. No effect of the herb mixture was noted on the content of the basic chemical components of the milk, other than a reduction in the content of milk fat in the case of the 20 g herb supplement.

KEY WORDS: sheep / dairy production / herbs / summer feeding

In order to meet the expectations of today's consumers, many studies have been undertaken to increase animal productivity and to improve the health-promoting quality of animal products using natural feed additives, including herbs. Herbs are defined as wild or cultivated plants with prophylactic or medicinal properties [2]. The stimulatory, prophylactic or medicinal properties of plants are determined by their content of biologically active substances, which in turn is conditioned by harvesting at the optimal stage of growth, the conditions and location where they are acquired, and proper drying and storage of the plants [11]. Production waste from the herbal industry can be used as feed additives provided that they have retained an adequate level of active

substances. The development of phytochemistry (the chemistry of natural substances of vegetable origin) has enabled the identification of nutrients and biologically active substances present in herbal materials. Thus far about 30,000 secondary metabolites have been identified. According to Różański [13], the most commonly occurring groups of these substances are tannins, saponins, ethereal oils, flavonoids, glycosides, alkaloids, mucilage and pectins.

Ethereal oils are usually volatile liquid substances composed mainly of terpenes and having a characteristic odour. They exhibit a variety of properties, including antibacterial and disinfectant activity [3, 17]. Some ethereal oils stimulate intestinal peristalsis and have cholagogic and carminative effects. Many plants containing ethereal oils improve the flavour of animal feeds, e.g. caraway, fennel, anise, marjoram and thyme. However, in determining the composition of herbal mixtures for sheep we should take into account the taste preferences of these animals. Herbs with a high content of ethereal oils may not be accepted by sheep, particularly those with well-established dietary habits [14].

Herbs containing flavonoids (e.g. chamomile, Saint John's wort, garlic, fenugreek or marigold) are regarded as natural antioxidants. They also relax intestinal smooth muscle and bile ducts and exhibit anti-inflammatory activity. These and other biologically active plant substances often exhibit beneficial synergistic and multi-faceted effects in animals. Knowledge of the effects of biologically active substances contained in medicinal plants makes it possible to determine the proportions of individual herbs to be used in mixtures in order to achieve the intended purpose and to enhance their beneficial effects. This may be particularly important in the case of animals housed indoors, where the vegetable-based feeds used originate in herb-poor field monocultures.

The available literature contains relatively few studies on the effect of herbs in diets for sheep on their milk performance. Hutton et al. [4] showed a positive effect of the use of fresh herbs (chicory and English plantain) and red and white clover forage in the diet of ewes suckling lambs. Sheep whose diet included these plants produced more milk on the 7th, 14th and 21st days of lactation (by 20.0%, 32.1% and 33.3%, respectively) than sheep that only grazed in a pasture dominated by perennial ryegrass, and their lambs attained a higher body weight at 22 and 66 days of age (by 11.5% and 17.8%). Kraszewski et al. [10] showed a beneficial effect of the use of herbs added to feed in the amount of 1% and 2% (chamomile, yarrow, common nettle, common agrimony, English plantain, Saint John's wort, and hairy lady's mantle) on the milk performance of Black-and-White cows, i.e. an increase in milk yield during lactation by 12.3% and 24.4%, respectively ($P \leq 0.05$). Herbs were also found to increase milk production in cows in studies by Waghorn and Clark [16] and Chapman et al. [1].

The available literature, mainly concerning cattle, indicates that the milk performance of ruminants may be improved by using herbs as natural dietary supplements. Similar effects may be expected in sheep used for dairy purposes, particularly when they are housed indoors, during the winter or summer, and do not graze in natural pastures.

The objective of the study was to determine the effect of adding a herbal mixture to concentrate feed for milking ewes in summer feeding conditions (in the amount of 1.5% or 3.0%) on consumption of the feed ration, body weight and body condition, milk yield, udder health, and the proximate chemical composition of the milk.

Material and methods

The study was carried out at the National Research Institute of Animal Production, Koluda Wielka Experimental Station. The material for the study consisted of ewes of the Koluda prolific dairy sheep breed, aged 2 to 8 years, milked commercially for a three-month period after weaning lambs at the age of 8-9 weeks.

The experiment was conducted on 66 ewes during the period from June to August in summer feeding conditions (alfalfa forage, grass hay and a concentrate feed mixture). The ewes were housed indoors in a pen on deep litter. Sheep were assigned to three feeding groups which were analogous in terms of date of lambing, body weight, number of lambs reared, and daily weight gain in the litter.

Feeding was in accordance with IZ PIB-INRA [5] norms for milking ewes with a body weight of 70 kg and milk yield of 0.6 kg/day. Throughout the experiment the same ration of bulk feed and concentrate mixture was used in all groups (Tab. 1), but in the experimental groups (II and III) the wheat bran in the concentrate feed was partially replaced with an herb mixture: group II – 10 g/sheep/day; group III – 20 g/sheep/day. Concentrate feed was given to the sheep daily and they received bulk feed 6 times a week: 110% of the feed ration from Monday to Friday and 150% of the ration on Saturday (they did not receive bulk feed on Sunday).

In the study we used our own mixture of 9 herbs, which was meant to benefit the animals by improving their digestion and metabolism (fennel, caraway, coriander, fenugreek, and peppermint—total share of the mixture 55%), by acting as galactogogues (fennel, coriander and fenugreek—total share 35%) and through bacteriostatic and anti-inflammatory activity (common nettle, peppermint, English marigold, chamomile and milk thistle—55%). At the Institute of Natural Fibres and Medicinal Plants in Poznań the content of ethereal oils and flavonoids was determined in the herb mixture and in the concentrate feed mixtures used in the diet of the experimental sheep, according to the procedures used at the Institute.

The amount of feed supplied was recorded daily, and the amount of uneaten food twice a week (on Monday and Thursday). Every two weeks feed samples were collected for laboratory testing. Observations of body weight and evaluation of the body condition of the sheep (on a 5-point scale) [12] were carried out at the beginning and end of the experiment.

Individual monitoring of the amount of milk produced was carried out by means of control milking. For each control milking the sheep were milked mechanically twice, in the morning from 5^{00} to 7^{00} and in the evening from 17^{00} to 19^{00}. Control milking was conducted six times at 14-day intervals. Sheep which produced less than 100 g of milk in the morning and evening milking combined were eliminated from milking and considered dry.

Table 1
Quantity and nutritive value of feeds used during the milking period

Specification	Group I	Group II	Group III
Concentrate feed (kg/head/day) containing:	0.65	0.65	0.65
crushed barley	0.46	0.46	0.46
wheat bran	0.18	0.17	0.16
herb mixture	0.00	0.01	0.02
premix	0.01	0.01	0.01
Alfalfa forage (kg/head/day)	6.40	6.40	6.40
Grass hay (kg/head/day)	0.24	0.24	0.24
Nutritive value of ration			
JPM	1.67	1.67	1.67
BTJN (g)	221	221	221
BTJE (g)	186	186	186

JPM – feed unit for lactation
BTJN – protein digested in the intestine when rumen fermentable nitrogen is limiting
BTJE – protein digested in the intestine when rumen fermentable energy is limiting

For each group of ewes lactation persistence was calculated as the ratio of the number of ewes that were milked for the entire period of the experiment to the number of ewes at the start of the experiment, expressed as a percentage.

The data obtained during control milking were used to calculate milk yield for individual ewes by Fleischmann's method [8], according to the following formula:

$$Wmd = w_1 \times d_1 + \sum_{i=1}^{6} (w_1 + w_{i+1}) : 2 \times d_i + w_6 \times d_6$$

where:

Wmd – milk yield during milking period
w_1 – amount of milk obtained from first control milking (morning + evening)
d_1 – number of days from start of milking to first control milking
w_i – amount of milk from *i*th control milking (morning + evening)
w_{i+1} – amount of milk obtained from the milking following milking w_i
d_i – number of days between successive milkings (w_i and w_{i+1}),
w_6 – amount of milk obtained in final control milking (morning + evening)
d_6 – number of days from final control milking to end of milking

Evaluation of udder health included measurements of the electrical resistance (conductivity) of milk collected separately from each half of the udder of individual sheep, using

an electronic mastitis detector by Dramiński. The electrical conductivity of the milk was measured when the sheep were selected for the experiment and then at monthly intervals at the time of control milking. If reduced electrical resistance was noted (under 300 units) from at least one half of the udder, the ewe was eliminated from milking with suspected mastitis.

The proximate composition of the milk was determined, including dry matter, protein, fat, and lactose. Three series of analyses were performed on milk samples from 20 ewes in each group, from morning control milking in the first, second and third month of the experiment. The analyses were performed in a MilcoScan apparatus in the laboratory of the District Dairy Cooperative in Inowrocław (3 groups x 3 control milkings x 20 samples = 180 samples).

The results were analysed statistically in the STATISTICA 6 PL software package, using one-way analysis of variance (ANOVA). Statistical differences between groups were verified by Duncan's test.

Results and discussion

During the experiment 100% of the concentrate mixture was eaten in all groups, while 97-98% of the green alfalfa forage was consumed, at a similar level in all groups (Tab. 2). The sheep in the experimental groups were characterized by better intake of grass hay (by 4.2 pp) than the control. This translated directly to slightly higher nutritional value of the feed consumed and somewhat higher consumption of nutrients by the sheep in the experimental groups. The proportion of herb mixture in the concentrate feed (group II vs group III) did not differentiate daily consumption of feed and nutrients by the sheep.

The total intake of concentrate feed containing the herbal additive indicates that the herbs used in the mixture and their proportion in the concentrate feed suited the taste preferences of the sheep despite the high percentage (55%) of herbs rich in ethereal oils, considered to be less acceptable to sheep. Simitzis et al. [14] found that adult sheep did not tolerate oil supplements in the diet very well (particularly mint and oregano). Ewes devoted less time to meals and feed consumption fell in comparison to the period preceding the experiment. The results of our own study conducted during winter feeding did not confirm these observations [6], as greater intake of both haylage and grass hay was observed in the groups of ewes fed on concentrate feed with the same mixture of herbs, as compared to the control.

Proportionally greater content of active substances was noted in the concentrate feed mixtures containing herb supplements (groups II and III) than in the control mixture: by 47.0% and 117.6%, respectively, for ethereal oils and by 145.4% and 327.3% for flavonoids (Tab. 3).

In the experiment the increase in the content of active substances with respect to the control was at a similar level as in our experiment conducted in winter feeding conditions [6]. Ethereal oils, including monoterpenes, have a multi-faceted beneficial effect on the body [15]; they stimulate the digestive system, regulate metabolic processes, and exhibit antibacterial, antiviral, antifungal, tonic and anticarcinogenic effects.

Table 2
Daily consumption of feeds and their nutritive value

Specification	Group I		Group II		Group III	
	kg	% of ration	kg	% of ration	kg	% of ration
Daily consumption of feeds (kg/head):						
concentrate feed	0.65	100.0	0.65	100.0	0.65	100.0
alfalfa forage	6.18	96.6	6.26	97.8	6.27	98.0
grass hay	0.20	83.3	0.21	87.5	0.21	87.5
Nutritive value of consumed feeds*						
JPM	1.62		1.64		1.64	
BTJN (g)	214		216		217	
BTJE (g)	180		182		182	
Daily consumption of components* (g)						
dry matter	2008		2031		2033	
protein	237		238		232	
fat	92		94		94	
fibre	500		502		505	

*Per day and per sheep
JPM – feed unit for lactation
BTJN – protein digested in the intestine when rumen fermentable nitrogen is limiting
BTJE – protein digested in the intestine when rumen fermentable energy is limiting

Table 3
Content of bioactive substances in the herb mixture and concentrate mixtures

Specification	Herb mixture	Concentrate mixture		
		MK	MD1	MD2
Ethereal oils (ml/kg)	11.59	0.17	0.25	0.37
Flavonoids (% of dry matter)	0.459	0.011	0.027	0.047

MK – control mixture without herbs
MD1 – experimental mixture with 1.5% herbs
MD2 – experimental mixture with 3.0% herbs

The sheep did not differ significantly between groups in body weight or body condition score at the beginning or at the end of the experiment (Tab. 4). However, fairly characteristic differences were observed for changes in both body weight and body condition score

in the control and experimental groups over the course of the experiment. The mean body weight was similar at the start of the experiment and then decreased in all groups during the experiment. The sheep of the Koluda prolific dairy sheep breed on which the experiment was conducted attained relatively low body conditions scores, particularly at the start of the experiment, with an average score of 1.74. After the completion of the experiment the sheep from all the groups attained considerably higher body condition scores, and in both groups whose diet included the herb supplement the improvement was greater than in the control, by 32.2% and 27.1%.

Table 4
Body weight and condition of the ewes during the experiment

Specification		Group			SEM
		I	II	III	
Number of ewes	n	22	22	22	
Body mass (kg)					
start of experiment	$\bar{x}$	70.45	69.20	70.34	1.261
	V%	13.3	14.9	16.3	
end of experiment	$\bar{x}$	69.29	66.91	68.04	1.114
	V%	11.4	13.8	15.0	
Body condition (1-5 pt)					
start of experiment	$\bar{x}$	1.77	1.64	1.80	0.065
	V%	25.7	31.5	34.0	
end of experiment	$\bar{x}$	2.25	2.16	2.39	0.072
	V%	26.3	27.1	24.1	

In summer feeding conditions, as in the case of winter feeding [6], the herb supplement was not found to affect the body weight of the milking ewes. The decrease in body weight observed in the Koluda sheep during the experiment may suggest that the feeding level was too low with respect to the nutritional needs resulting from the level of milk production. A study by Korman et al. [9] found an increase in the body weight of Koluda sheep during the milking period, but with a feeding level about 10% higher. No effect of the herb supplement on the body condition of the sheep was observed, but the final body condition scores were on average about 30% higher than at the start of the experiment. The generally low body condition scores of Koluda sheep are due to the large contribution of the East Friesian sheep breed to their genotype (37%), which is linked to a dry and bony body constitution [7]. The improvement in the body condition of the sheep while their body weight decreased during the milking period is difficult to interpret, but may be due to the use of a largely subjective point scale to evaluate body condition.

Table 5
Milk production characteristics

Specification		Group			SEM
		I	II	III	
Number of sheep	n	22	22	22	
Lactation persistence	%	87.8	93.7	98.1	
Milking period (days)	$\bar{x}$	79.8	85.3	89.3	1.862
	V%	25.3	22.1	21.3	
Daily milk yield (kg/ewe)	$\bar{x}$	0.418	0.423	0.435	0.018
	V%	39.1	29.1	34.3	
Milk production in milking period* (kg/ewe)	$\bar{x}$	33.36	36.08	38.84	1.617
	V%	39.1	29.1	34.3	

*Estimated on the basis of control milking according to the Fleischmann method

Ewes from the experimental groups (II and III) were characterized by greater lactation persistence than the control (I), by 5.9 and 10.3 pp, respectively (Tab. 5). No statistically confirmed differences were noted for performance parameters of the milk of the ewes in the groups compared. However, characteristic tendencies were observed in these traits, depending on the size of the herb supplement in the feed ration. In groups II and III the milking period was longer than in group I (by 5.5 and 9.5 days, i.e. by 6.9% and 11.9%), while at the same time the daily milk yield was somewhat higher (by 1.2% and 4.1%, respectively). In total, over the entire milking period this translated to greater milk yield in groups II and III than in group I (by 8.2% and 16.4%, respectively; NS). These differences were not confirmed statistically, probably due to the high variation within groups (coefficient of variation 21-39%).

In summer feeding conditions, as in the case of winter feeding [6], there was no statistically confirmed effect of adding herbs to concentrate feed on the milk performance parameters analysed. However, a tendency indicating a beneficial effect of herbs on the lactation persistence of the sheep was observed, which was more pronounced in the case of the larger portion of the supplement (20 g/sheep/day). In the sheep whose diet included herbs there was also a tendency towards increased daily milk production, and thus an increase in market milk production throughout the experiment. It should be noted, however, that the herb supplement had a markedly more favourable effect on milk production during winter feeding [6] than during summer feeding, particularly in the case of the larger portion of the supplement. During winter feeding milk production by ewes fed with a supplement of 10 g of herbs was 4.8% higher, and 12.2% higher in the case of the 20 g additive, whereas during the summer feeding period a pronounced increase was obtained only in the case of the larger portion of herbs (4.1%).

The lactation curves of the groups of sheep (Fig.) show that at the start of milking (day 64 of lactation) daily milk production was relatively high and was similar in all groups

(on average 0.852 kg/sheep). After 14 days a sharp decrease in milk yield was noted in all groups (by 32.2%), after which the lactations curves gradually declined and overlapped. After 122 days of lactation the decrease in yield in group I was more pronounced, so that at the final control milking (day 136 of lactation) milk yield in the experimental groups was higher than in the control, on average by 18.3% (NS).

The shape of the lactation curves of the ewes in the feeding groups indicate that the diet supplemented with herbs had a beneficial effect on the level of milk performance primarily in the final milking period. Similar relationships were noted in our study conducted during the winter feeding period [6]. As a result of the more gradual drop in the lactation curves of the experimental groups in comparison with the control, in total more milk was obtained from the ewes receiving the herb supplement over the entire milking period. The relatively low milk production of the Koluda ewes during the summer feeding period was largely due to the sharp decrease in milk performance in the first two weeks of milking, which was the result of fluctuations in the quality of the green forage, the main feed component during this period.

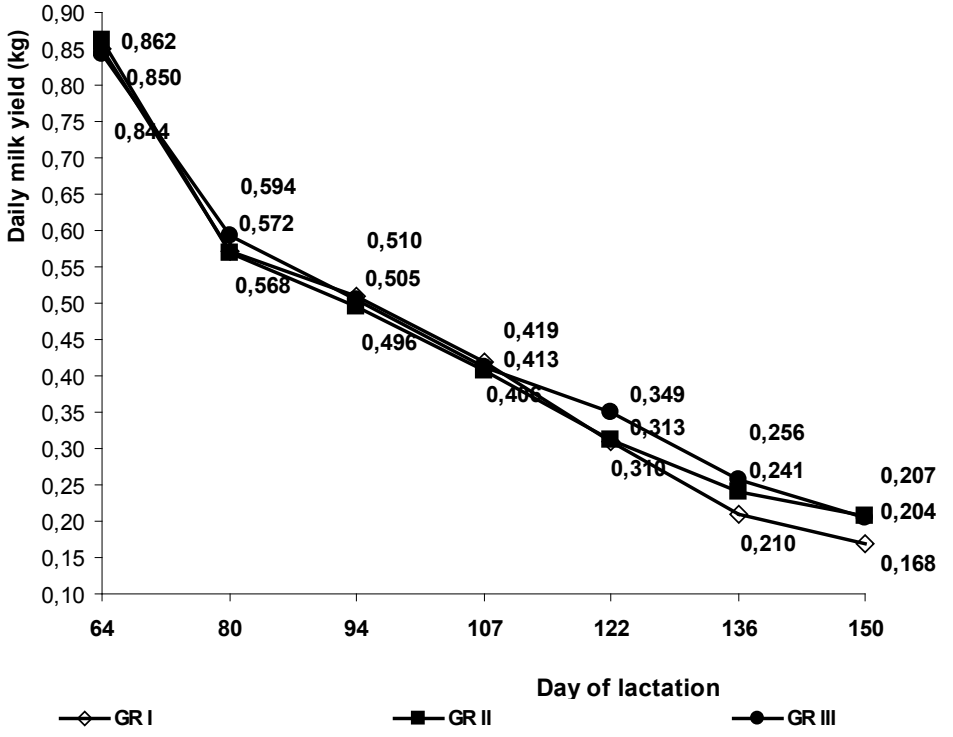

Fig. Mean daily milk production during milking period (kg/ewe)

The electrical conductivity of the milk of the ewes in the groups (Tab. 6) showed a clear tendency towards beneficially higher values in the groups receiving the herb supplement. On average for all months of milking and for milk from both halves of the udder, the differences between groups II and III and group I were 3.3% and 8.1%, respectively. Thus we can speak of a clear improvement in udder health, expressed as increased electrical resistance, only in the case of the larger herb supplement. A similar tendency was noted during winter feeding [6]. It should be noted, however, that the milk obtained in the summer generally had higher electrical resistance (by 11.9%), which indicates better udder health in the sheep milked in the summer than in the winter.

Table 6

Electrical conductance of milk (unit of electrical resistance – j.o.e.)

Specification			Group			SEM
			I	II	III	
First month of milking						
udder half:	left	$\bar{x}$	458.6	440.9	460.5	11.116
		V%	24.0	18.5	17.2	
	right	$\bar{x}$	433.2	471.4	483.2	8.015
		V%	13.8	16.4	83.2	
Second month of milking						
udder half:	left	$\bar{x}$	456.2	472.7	489.5	10.108
		V%	16.6	15.9	18.1	
	right	$\bar{x}$	460.9	472.3	479.5	12.251
		V%	22.8	17.4	22.1	
Third month of milking						
udder half:	left	$\bar{x}$	435.0[a]	468.0	505.3[a]	12.615
		V%	13.7	9.3	30.2	
	right	$\bar{x}$	448.5	455.0	491.3	11.086
		V%	12.1	12.0	26.3	

aa – means differ significantly at $P \leq 0.05$

The milk of the ewes from the control and group II did not differ significantly in terms of the content of basic chemical components (Tab. 7). The milk of the ewes from group III, in comparison with groups I and II, contained less fat, by 8.4% ($P \leq 0.05$) and 9.4% ($P \leq 0.01$), respectively, which translated to lower content of dry matter, by 3.9% and 3.5% ($P \leq 0.05$), respectively. This meant that the milk of the group III sheep had the highest, most favourable protein-to-fat ratio, and the 9.6% difference in comparison to group II was significant at $P \leq 0.01$. These differences were due to the relationship between the concentration of these two components in the milk of the ewes in groups II and III, and were probably accidental.

Table 7
Basic chemical composition of milk and production of milk components

Specification		Group			SEM
		I	II	III	
Number of ewes	n	20	20	20	
Content in 100 g of milk (g)					
dry matter	$\bar{x}$	17.98^{a}	17.91^{b}	17.28^{ab}	0.124
	V%	6.3	5.4	4.6	
protein	$\bar{x}$	6.28	6.16	6.08	0.071
	V%	10.7	8.4	8.6	
fat	$\bar{x}$	6.53^{a}	6.60^{A}	5.98^{Aa}	0.092
	V%	10.1	11.0	12.2	
lactose	$\bar{x}$	4.50	4.55	4.55	0.034
	V%	8.6	3.9	4.3	
Protein/fat ratio	$\bar{x}$	0.980	0.938^{A}	1.028^{A}	0.013
	V%	15.1	17.8	18.9	
Production of milk components* (kg/ewe)					
dry matter	$\bar{x}$	6.83	6.91	6.83	0.278
	V%	37.4	30.1	32.5	
protein	$\bar{x}$	2.37	2.37	2.37	0.091
	V%	36.6	29.3	28.9	
fat	$\bar{x}$	2.46	2.55	2.38	0.104
	V%	36.7	32.4	35.5	
lactose	$\bar{x}$	1.75	1.76	1.81	0.078
	V%	41.7	30.4	36.3	

*Estimated on the basis of control milking results and the chemical composition of milk
Means differing significantly: AA at P≤0.01; aa, bb at P≤0.05

No statistically significant or more characteristic differences were noted between groups in the production of basic milk components.

The results obtained for the content of basic chemical components of the milk of individual ewes and their production during the entire experiment indicate no clear effect of the use of the herb supplement on this group of parameters. This is also confirmed in a study by Jarzynowska [6] conducted on sheep in winter feeding conditions. In the summer experiment the significant decrease in fat content observed in the milk of the ewes fed the larger herb supplement was probably accidental, as it was not confirmed in our study conducted in winter feeding conditions [6] or in the available literature.

In conclusion, the use of herb mixtures in the summer diet of milking sheep, in the amount of 10 and 20 g/sheep/day, increased the content of biologically active substances

(ethereal oils and flavonoids) in the feed ration in proportion to the size of the herb supplement, and also suited the taste preferences of the sheep. Tendencies were noted for a longer milking period, increased milk yield and improved udder health in the case of the 20 g herb supplement. The use of herbs in the diet had essentially no effect on the content of the basic chemical components of the milk.

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