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Influence of separation from lambs and litter size on milk yield and milk composition in Kołuda ewes*

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The research was carried out on 38 Kołuda ewes. Two trial milkings were done in June 2013 – the first in the 9th week of lactation, in the final suckling period, and the second in the 11th week of lactation, 14 days after weaning of lambs was complete. Thirty-eight ewes were chosen and randomly assigned to two groups, each consisting of 6 ewes rearing single lambs, 10 with twins and 3 with triplets. Before the first trial milking (I) the ewes were separated from their lambs for 12 hours. Half of the ewes were milked in the presence of lambs (group A) and the other half in the absence of lambs (group B). Samples of milk from the same ewes were taken during the commercial milking period, 2 weeks after the lambs had been weaned (second trial milking – I). There were no differences in milk yield or milk composition between ewes milked in the presence and absence of lambs. Milk of ewes milked 12h after separation from lambs had lower content of total solids (15.05 vs. 16.48 g/100 g, P≤0.01), protein (4.82 vs. 5.18 g/100 g, P≤0.01) and fat (4.84 vs. 6.05 g/100 g, P≤0.01) but higher content of lactose (5.02 vs. 4.78 g/100 g, P≤0.01) compared to milk from the same ewes 2 weeks after the lambs were weaned. The research showed a tendency in ewes rearing twins milked following separation from lambs to produce more milk, with higher content of total solids and fat but lower lactose content, in comparison to ewes rearing single lambs. Milk of ewes rearing triplet lambs did not differ from that of ewes rearing single and twin lambs, with one exception – milk of ewes rearing triplets had lower lactose content than the milk of ewes with single lambs.

KEY WORDS: sheep / milking system / milk composition

A mixed system of suckling only during the day and machine milking once daily in the morning for the first 30 days of lactation in ewes is common in many countries [13, 23, 25]. The disadvantage is that such milk is low in fat content [10, 21, 23].

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Many authors have reported low fat content in milk after isolation or weaning of calves [5, 9, 20]. Dymnicki et al. [7] reported that milk of cows milked mechanically after 12--hour isolation of calves was characterized by very low fat content (0.55-0.87%). There were no differences in protein and lactose content compared to the standard composition of cow's milk. Hoberg et al. [17] observed the same with goats.

McKusick et al. [22] consider one or all of the following mechanisms to be responsible for low fat content in the milk of suckled ewes obtained by machine milking: 1) milk ejection during machine milking does not occur, 2) milk fat synthesis is inhibited and 3) fat transfer from the alveoli to the cistern between milkings does not occur. The authors believe that only the cisternal milk fraction is available during machine milking of ewes in a mixed system. According to Combellas and Tesorero [5], more than 80% of milk is stored in cow udder alveoli and transferred to the cistern by a neurohormonal reflex initiated by contact of the calf's mouth with the udder. Costa and Reinemann [6] show that the percentage of alveolar milk ranges from 30% to 50% in sheep.

In ewes, McKusick et al. [22] determined that in cisternal milk the concentration of fat, but not protein, was lower than in alveolar milk (4.49% vs. 7.92%). Suckled ewes do not release all of their milk during machine milking. Thus the low fat percentage can be partly attributed to the fact that only some of the milk is stored in the cistern. Levy [19] observed a decrease of about 90% in fatty acid synthesis in rats within 24 hours after separation from their pups. The synthesis of fatty acids was restored when the pups were returned to the mother for suckling. Bencini and Pulina [2], in a literature review, describe the factors affecting the quality of sheep milk in Australia and New Zealand. Many papers have presented results showing that the milk yield of ewes with twin and triplet lambs is higher than in ewes with single lambs. Alexander and Davies [1] reported that two independent sets of data, obtained by two different methods of measuring milk production, show that milk yield is greatly influenced by the number of lambs suckled but not by the number of lambs born. There are few reports on the effect of the number of lambs reared or born on milk quality.

The literature shows [2, 13, 14, 19, 21, 25] that ewes' milk yield and synthesis of its components may be inhibited by the rearing and milking system due to stress and some hormonal changes. In the case of ewes milked during nursing without lambs present, it can be sustained by means of some visual and acoustic stimuli. The main aim of this study was to prove this hypothesis. Additionally, the influence of litter size on milk yield and milk composition was investigated.

Material and methods

The research was done on 38 Kołuda Sheep ewes, aged from 2 to 7 years. The Kołuda Sheep was created by crossing ewes of three Polish native breeds (Polish Merino, Polish Lowland-Wielkopolska Sheep and Polish Longwool-Kamieniec Sheep) with rams of prolific breeds (Romanov and Finn) and a dairy breed (East Friesian).

Two trial milkings were done in June 2013; the first (I) in the 9th week of lactation, in the final period of suckling, and the second (II) in the 11th week of lactation, 14 days after the lambs were completely weaned, in the initial period of the milking.

The ewes were fed in one group, in accordance with their requirements, according to IZ feeding standards for ewes during lactation. Their diet consisted of alfalfa roughage – 4 kg, field-grass hay – 0.5 kg and concentrate – 0.5 kg. Thirty-eight ewes were chosen and randomly assigned to two groups (A and B), each consisting of 6 ewes rearing single lambs, 10 with twins and 3 with triplets. The body weights of the ewes were between 50-60 kg and their body condition score (BCS) ranged from 1.5 to 2.5 on a 5-point scale.

The sheep were milked mechanically in a separate location outside the sheep-shed. Before the first trial milking the ewes were separated from their lambs in the sheep shed for 12 hours during the evening (5:00 p.m.). Half of the ewes were milked in the presence of lambs (group A – visual and vocal contact with lambs during milking) and the other half in the absence of lambs (group B – without visual and vocal contact with lambs during milking). Samples of milk from the same ewes were taken during the commercial milking period in the 11th week of lactation and 12 hours after the last milking. Both milkings were done mechanically at 5.00 a.m. The milking machine was set to provide 90 pulsations per minute. The amount of milk for each ewe was measured in kg (accuracy to 0.000 kg).

The milk samples were analysed at the laboratory of the Institute of Genetics and Animal Breeding in Jastrzębiec (MilkoScan™ FT2, Foss-Denmark). The milk composition was analysed for total solids, protein, fat, lactose and casein.

The traits presented in Tables 1 and 2 were analysed using Student's t-test for independent samples. The traits presented in Tables 3 and 4 were analysed using one-way variance analysis by ANOVA [28]. Because there were no statistically significant differences in any of the traits analysed between groups milked in the 9th week of lactation in the presence or absence of lambs (Table 1), the data were treated as one group in the further analyses. The 3 models used for analysis included the following factors: milking technique (in the presence or absence of progeny), time of milking (following separation from lambs and 2 weeks after weaning) and litter size (singles, twins and triplets).

Results and discussion

The results presented in Table 1 show that are no clear differences in milk yield and composition between ewes milked in the presence (B) and absence (A) of lambs. Combellas and Tesorero [5] presented the results of a study carried out to evaluate the cow-calf relationship during milking and reported lower milk yield (–19.6%) in cows milked without the presence of the calf compared to cows stimulated by the calf. Fat content was lower as well: 1.2% vs. 2.4-2.7%. No data have been found to confirm these results in ewes.

Table 2 presents data on milk yield and milk components in ewes milked 12 hours after separation from lambs (I) and 2 weeks after weaning was complete (II). There were no differences in milk yield and casein content between I and II. However, the milk of ewes milked 12 h after separation from lambs (I) in the 9th week of lactation had lower content of total solids (15.05 vs. 16.48 g/100 g, $P \leq 0.01$), protein (4.82 vs. 5.18 g/100 g, $P \leq 0.01$) and fat (4.84 vs. 6.05 g/100 g, $P \leq 0.01$), but higher content of lactose (5.02 vs.

Table 1

Yield and composition of milk from ewes milked in the 9th week of lactation 12 hours after separation from lambs in the absence (A) or presence (B) of lambs

Trait	Statistical parameter	Milking		SEM
		A – without lambs	B – with lambs	
Number of ewes	n	19	19	
Milk yield (kg)	x	0.348	0.333	0.022
	v%	44.6	34.4	
Total solids (g/100 g)	x	14.79	15.30	0.223
	v%	8.9	9.3	
Protein (g/100 g)	x	4.69$^{\alpha}$	4.95$^{\alpha}$	0.069
	v%	9.5	7.9	
Casein (g/100 g)	x	3.84$^{\alpha}$	4.05$^{\alpha}$	0.055
	v%	9.3	7.1	
Fat (g/100 g)	x	4.66$^{\alpha}$	5.02$^{\alpha}$	0.194
	v%	23.4	25.8	
Lactose (g/100 g)	x	5.07	4.98	0.036
	v%	3.9	4.8	
Protein-to-fat ratio	x	1.050	1.045	0.039
	v%	21.1	25.0	

x – mean for the item
v% – coefficient of variation
Means within rows differ significantly: αα at P≤0.10

4.78 g/100 g, P≤0.01) and protein-to-fat ratio (1.047 vs. 0.923, P≤0.05) than the milk of the same ewes milked 2 weeks after the lambs had been weaned (II). Borys and Dymnicki [3] reported similar results, but the differences in protein and fat content were much greater – 15.8 and 38.3%, respectively. McKusick et al. [23] and Fuertes et al. [10] observed a similar reduction in fat content after progeny separation in suckling ewes, as did Fröberg et al. [9] for suckling cows. There were no differences in protein and lactose content compared to the standard composition of sheep's and cow's milk.

Hammadi et al. [16] showed that composition of goats' milk was close to normal after separation from kids for 8-24 hours and oxytocin injection before milking. Similar results were obtained by Dymnicki et al. [8] for cows milked 12 hours after separation from calves. Milk obtained with injection of oxytocin contained approximately 3.2% fat, while milk obtained without an oxytocin injection contained only 0.5-0.9% fat.

In the present study, very high variation was observed in milk yield (v% = 39.5 and 41.3) and fat content (v% = 24.7 and 26.9). Fluctuations between milk yields were 0.168-0.558 kg for the group milked 12 hours after separation from lambs and 0.132-0.785 kg for the group milked 2 weeks after weaning. Fluctuations for fat content were 2.69-7.64 g/100 g and 3.05-10.00 g/100 g, respectively.

Table 2

Yield and composition of milk from ewes milked in the 9th week of lactation, 12 hours after separation from lambs (I) and in the 11th week of lactation, 2 weeks after weaning (II)

Trait	Statistical parameter	Milking		SEM
		I – 12 h after separation from lambs	II – 2 weeks after weaning	
Number of ewes	n	38	37	
Milk yield (kg)	x	0.340	0.313	0.015
	v%	39.5	41.3	
Total solids (g/100 g)	x	15.05^{A}	16.48^{A}	0.207
	v%	9.1	11.5	
Protein (g/100 g)	x	4.82^{A}	5.18^{A}	0.064
	v%	8.8	11.9	
Casein (g/100 g)	x	3.94	4.08	0.046
	v%	8.6	10.8	
Fat (g/100 g)	x	4.84^{A}	6.05^{A}	0.178
	v%	24.7	26.9	
Lactose (g/100 g)	x	5.02^{A}	4.78^{A}	0.036
	v%	4.4	7.2	
Protein-to-fat ratio	x	1.047^{a}	0.923^{a}	0.031
	v%	22.8	31.4	

x – mean for the item
v% – coefficient of variation
Means within rows differ significantly: AA at P≤0.01, aa at P≤0.05

Table 3 presents the results for milk yield and its composition depending on litter size. Ewes rearing twins and milked after separation from lambs have a clear tendency (P≤0.10) towards higher milk yield (41.4%), total solids (7.5%) and fat content (24.9%) than ewes rearing single lambs, but a lower protein-to-fat ratio (17.3%). Many authors [2, 14, 15, 26, 27] have reported that sheep with twin lambs produce more milk than those with a single lamb, and ewes rearing triplets produce more milk than those rearing twins. Burton [4] shows that ewes rearing 3 lambs produce more milk than those rearing 2 lambs. The author suggests that these ewes are more efficient at conversion of feed to milk production. There are a few papers on the effect of the number of lambs on milk composition, but the results are conflicting. Gardner and Hogue [11] validated our results that ewes rearing single lambs had a lower concentration of fat in their milk than ewes rearing twins. The same authors in another paper [12] reported that ewes rearing twins produced milk with a higher fat and protein concentration than those rearing single lambs. Similar results were obtained by Serra et al. [26]. Gonzalo et al. [14] reported that ewes that had given birth to twins had higher milk yield (by 4.4%) than ewes with singles. However, fat and protein content fell by 1.7% and 0.8% in ewes with twins. Higaki et al. [18] reported that colostrum fat and protein content in the milk of ewes carrying triplets are higher than in ewes with twins.

Table 3
Milk yield and composition depending on litter size – milking in the 9th week of lactation 12 hours after separation from lambs

Trait	Statistical parameter	Litter size			SEM
		1	2	3	
Number of ewes	n	12	20	6	
Milk yield (kg)	x	0.273$^{\alpha}$	0.386$^{\alpha}$	0.324	0.022
	v%	32.1	38.0	39.4	
Total solids (g/100 g)	x	14.35$^{\alpha}$	15.43$^{\alpha}$	15.17	0.223
	v%	6.0	9.7	9.6	
Protein (g/100 g)	x	4.67	4.84	5.06	0.069
	v%	6.3	9.7	8.5	
Casein (g/100 g)	x	3.88	3.94	4.07	0.055
	v%	6.3	10.0	7.7	
Fat (g/100 g)	x	4.18$^{\alpha}$	5.22$^{\alpha}$	4.89	0.194
	v%	21.4	23.7	24.0	
Lactose (g/100 g)	x	5.16$^{A\alpha}$	4.99$^{\alpha}$	4.89^{A}	0.036
	v%	4.1	3.7	5.4	
Protein-to-fat ratio	x	1.165$^{\alpha}$	0.964$^{\alpha}$	1.090	0.039
	v%	22.8	18.4	26.7	

x – mean for the item
v% – coefficient of variation
Means within rows differ significantly: AA at P≤0.01, αα at P≤0.10

Yilmaz et al. [30] and Ważna et al. [29] obtained no statistically significant differences in milk yield between the above-mentioned groups of ewes, and Mroczkowski et. al. [24] found no statistically significant differences in milk yield or in the content of its main components – protein, fat and lactose.

The present study showed that milking of ewes with and without the presence of lambs had no impact on the chemical composition of their milk. There was no difference between the milk yield of ewes milked 12 hours after separation (9th week of lactation during suckling) and the milk yield of ewes milked 2 weeks after weaning (commercial milking – 11th week of lactation). The milk of ewes obtained in the 9th week of lactation, just 12h after separation, had lower content of total solids, which was a consequence of its lower fat and protein content. This could potentially be a disadvantage of such milk in cheese production.

The research showed a tendency in ewes rearing twins milked following separation from lambs to produce more milk, with higher content of total solids and fat but lower

Table 4

Milk yield and composition depending on litter size – milking in the 11th week of lactation 2 weeks after weaning

Trait	Statistical parameter	Litter size			SEM
		1	2	3	
Number of ewes	n	12	20	5	
Milk yield (kg)	x	0.315	0.303	0.351	0.021
	v%	59.0	32.5	24.1	
Total solids (g/100 g)	x	15.79	16.75	17.05	0.312
	v%	10.7	12.7	5.8	
Protein (g/100 g)	x	4.90	5.31	5.37	0.101
	v%	10.7	12.4	9.1	
Casein (g/100 g)	x	3.89	4.15	4.27	0.073
	v%	9.5	11.4	8.6	
Fat (g/100 g)	x	5.55	6.25	6.42	0.268
	v%	28.7	28.9	8.7	
Lactose (g/100 g)	x	4.88	4.71	4.80	0.056
	v%	6.5	8.0	4.7	
Protein-to-fat ratio	x	0.975	0.913	0.837	0.048
	v%	39.2	29.0	3.6	

x – mean for the item;
v% – coefficient of variation

lactose content, in comparison to ewes rearing single lambs. Milk of ewes rearing triplet lambs did not differ from that of ewes rearing single and twin lambs, with one exception – the milk of ewes rearing triplets had lower lactose content than the milk of ewes with single lambs.

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