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ORIGINAL ARTICLE

Milkability of improved Valachian, Tsigai and their crosses with Lacaune and East Friesian

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Milkability is defined as the ability of an animal to give a regular, complete, and rapid milk secretion by the mammary gland in response to a proper milking technique. Indicators of milk production and milkability of ewes were determined in 359-370 ewes of 9 genotypes. For each ewe, the milk flow was recorded during the individual control measurements. The amount of milked milk was measured in individual time intervals after the attachment of milking cups to teats on udder of the ewe (10 indicators). We processed the obtained data using the REML methodology, with the MIXED procedure of the SAS statistical package. All indicators characterizing milk production and milkability of ewes were statistically significantly influenced by the genotype and the control year factors (P<0.001). The order and stage of lactation were also significant factors in some cases. The machine milk yield of the monitored population of ewes was 318.26 ml on average. The total milk yield was 436.58 ml and the machine stripping ratio was 27.73% on average, ranging from 0 to 95%. The highest machine stripping ratio was determined in the Lacaune breed (37.69%), which had the highest total milk yield (524.69 ml) and one of the highest machine milk yield (332.70 ml). Compared to purebred Tsigai ewes and ewes of the improved Valachian breed, crossbreeds with dairy breeds had better milk production and, in some indicators, also better milkability.

Keywords: Dairy sheep, Machine milking, Milkability, Systematic effects.

Introduction

The machine milking of Improved Valachian and Tsigai in Slovakia already started during 1960s. Introduction of milking machines required information related to the milkability of ewes and search for the best milking parameters. Therefore many experiments were carried out concerning milkability of the mentioned breeds in Slovakia between 1960s and 1980s (Mikuš, 1973), in cooperation with France (Labussiere, 1988). However, machine technology had not spread to farms in a larger scale since that time in Slovakia.

Genetic improvement of the milkability is the main tool to improve cheese production, and consequently the income of the producers.

Milk, a product that is consumed by newborns to develop and grow, is one of the most important products of livestock. It is the main source of nutrition in feeding a human and animal offspring. Increasing demand for cheese made from processed ewe milk indicates that dairy sheep are becoming an interesting economic alternative for farmers. Farms with high-producing dairy sheep usually milk large flocks automatically (by machine milking) and conduct milking twice-daily throughout lactation period. As a result, more than half of total daily labor on dairy sheep farms is spent on milking (Marnet McKusick, 2001), and therefore milking is one of the main reasons that deterres people from dairy sheep production.

Milking characteristics and udder morphology are important factors determining milkability in dairy ewes. Machine milking benefits are maximal milk yield with better hygienic properties than hand-milked milk, and easier stripping.

Milk flow kinetics is related to milk production (Mioč, et al., 2009; Kremer, et al., 2015; Kremer and Roses, 2016; Turkyilmaz, et al., 2018; Salamon, et al., 2019; Panayotov, et al., 2018; Pourlis, 2020; Prpic, et al., 2020; Sevov, et al., 2018; Vrdoljak, et al., 2020;

Palii, et al., 2020) especially in non-well genetically selected breeds (Mačuhová, et al., 2020). It can indicate the occurrence of milk ejection reflex, which is crucial for complete milk extraction and thus for milk production. Milk within the udder of dairy ruminants can be divided into two fractions: the cisternal fraction, which has already been transferred from the alveoli to the cistern during the intermilking interval. It is immediately obtainable without prior milk ejection, and the alveolar fraction, which can be induced from the udder only if milk ejection occurs during machine milking (Tančin Bruckmaier, 2001). Wide range of differences between dairy species exists with respect to the proportion of total milk that can be stored within the cistern. Improving milkability is a major issue to considere in breeding dairy species. Milking is the most time-consuming task in dairy farming. The constant increase in average flock size and its productivity has been contributing to the extention of milking time. In Slovakia, Lacaune ewes are selected for milk production traits, because of somatic cell count and udder morphology. On the one hand, selection of udder morphology aims to improve milking ability indirectly. Direct assessment of milk flow can be assessed with automatic milking jars (Marie-Etancelin, et al., 2006).

Milk production and milk flow profiles are important parameters to be recorded and evaluated, as being informative for milking management.

Monitoring the milkability of animals allows to improve efficiency of milking procedures and reduce farm production costs. It is knotweed that udder traits like depth, udder attachment or teat placement are correlated with milk production, machine milking extraction or mastitis incidence.

The aim of the presented work was to determine the milk production and milkability of ewes in the breed Improved Valachian (ZV), Tsigai (C), Lacaune (LC) and their crossbreeds with 25, 50 and 75% genetic share of specialized dairy breeds Lacaune and East Frisian. At the same time, we analyzed genetic and non-genetic factors which influence selected indicators qualifying the milkability of ewes during the milking period under machine milking conditions.

Materials and Methods

The breed Improved Valachian originated from a coarse wool Valachian breed in Slovakia, where intensive cross-breeding programme started in 1950. To improve wool, meat and milk production the crossing with wide range of breeds (Leicester, Lincoln, Texel, Cheviot, Kent and East Friesian sheep) was attempted. The Improved Valachian was recognized as an independent dual purpose breed (wool-meat and meat-milk, respectively) in 1982. Tsigai and Improved Valachian are very similar in production potential. At present Tsigai and Improved Valachian are crossed with the purpose to improve their milk production, milkability and prolificacy with dairy breeds as Lacaune and East Friesian. We included biological material from the Center of Animal Production Research Nitra-Institute of Sheep and Goat Breeding Trenčianska Teplá in our experiments. In this farming, during the milking period, under machine milking conditions, we determined the milk production and milkability of ewes of various breeding groups over a period of 7 years. The kinetics of milk ejection was monitored during the milking period. The animals were bred and managed within one dairy flock.

The ewes were milked twice a day during lactation period, in each of the monitored years. Machine milking was performed in a row milking parlor 1 × 24 stalls, with a sliding fixing device (vacuum 38 kPa; number of pulses 140-160/min^{-1}; pulsation ratio 1:1). The included ewes represented purebred individuals of the Valachian, Tsigai and Lacaune breeds. In addition to the purebred ewes of the breeds Improved Valachian, Tsigai and Lacaune, the experiment also included ewes-crossbreeds with different genetic proportions of improved breeds Lacaune and East Frisian. The crosses created on the basis of the Improved Valachian breed and on the basis of the Tsigai breed, were divided into six genotypic groups, with 25%, 50% and 75% genetic share of.Lacaune and East Friesian diary breeds (IV × SDB 25%, IV × SDB 50%, IV × SDB 75%, T × SDB 25%, T × SDB 50%, T × SDB 75%). We compared the functional and morphological properties of the udder of selected ewes of 9 genotypes (3 purebred breeds, 6 genotype groups of hybrids). Most crosses created on the basis of a breed of Tsigai or the Improved Valachian formed two-breed crossbreeds with 25%, 50 and 75% genetic share of the Lacaune breed. Three-breed crossbreeds with 25, 50 and 75% genetic share of both Lacaune and East Frisian dairy breeds represented a significantly smaller part of the evaluated population (17 ewes, i.e., about 5% of the evaluated population). In the experimental ewes of all 9 genotypes, ewes were presented in the first, second, third and subsequent lactations in each of the monitored years. Most measurements were taken in May and July. Experimental measurements were always performed in the evening, and then in the morning milking. During the milking period, at least 2, in some years up to 4 milk control measurements were performed. Some ewes were included in the experiment within two or even more years, which shows that we performed up to 8 control measurements of milk on some ewes. The specific number of observations of the selected indicators, depending on genotype, order and stage of lactation, are given in the relevant Table 2-5.

During the individual control measurements, the milk flow was recorded for each ewe, at individual time intervals after the attachment of the teat cups to the udder of the ewe. Certified milk meters standardly used by Breeding Services, š. p. Bratislava for the control of sheep milk yield, were applied, with the measurement accuracy ± 10 ml. In this case, we recorded the amount of milked milk at 10 second intervals until the milk flow stopped and the amount of milk remained at the same level for at least 20 seconds. If the milk flow was not detectable for 20 seconds using our specific meters, the timekeeper instructed the milker to start the machine stripping. All ewes were machine stripped for another 60 seconds. If the milk flow was noticeable for more than 60 seconds, then machine milking continued and a new machine stripping was done only from the moment when no milk flow was recorded in the previous 20 seconds. The sheep were machine stripped again at the instruction of the timekeeper until the milk flow stopped. We also recorded the amount of milk drawn at 10-second intervals during each machine stripping. Based on the individual recording of the milk release of each ewe in 10 seconds, or at second intervals we evaluated:

- Milk yield in 10 s (MY10s)

- Milk yield in 30 s (MY30s)
- Milk yield in 60 s (MY60s)
- MY30s/MMY (%)
- MY60s/MMY (%)
- Machine milk yield (MMY) (ml)
- Machine stripping (MS) (ml)
- Total milk yield (ml)
- MS/TMY (%)
- Milking time (s)

The machine milk yield represented the amount of milk drawn after the milking set was put on (without prior udder stimulation) until the milk flow was completed within 20 seconds time interval. Machine stripping represents the amount of milk drawn from the beginning of machine stripping to the withdrawal of the milking set.

Data were processed by REML methodology using a MIXED procedure from the SAS statistical package. The following statistical model with fixed and random effects was applied:

$yijklm=\mu+Yi+LSj+GENk+Pl+an_m+a*DIM_{ijklm}+e_{ijklm}$

where:

yijklm=is an observed trait (see above for details); Yi=year (fixed effect with 4 to 7 levels); LSj=lactation stage, fixed effect with 4 levels (from 40th to 99th lactation day, from 100th to 129th lactation day, from 130th to 159th lactation day and from 160th to 210th lactation day); GENk=genotype (breed group; fixed effect with 9 levels; see above for detail characterization); P1=parity (fixed effect with 3 levels; first, second, third and further parity); an_m=animal (random effect); DIM_{ijklm}=days in milk (covariate; 40 to 210 days in milk); e_{ijklm}= is the random error.

The differences were statistically significant at P<0.05, or less.

Results and Discussion

As can be seen from the Table 1, we observed a large variability in the evaluated population for all indicators characterizing milk production and milk yield of ewes. For the whole monitored population of ewes, the machine stripping was on average 118.69 ml and the total milk yield 436.58 ml with a relatively large range (30 to 1339 ml), Table 1. The average total mild yield at the level (436.58 ml) is not high, if we consider the fact that in the monitored population there were also high-producing purebred ewes of the Lacaune breed. In the case of selection of sheep for milk production obtained by machine milking, the machine stripping ratio should be reduced, which significantly affects labour productivity and the udder health of machine-milked ewes. For the whole monitored population of ewes, the machine stripping reached on average 318.26 ml, while the range was relatively large (10 to 1200 ml). The machine stripping ratio in the monitored population of ewes was relatively high (27.73%), ranging from 0 to 95% (Table 1). When evaluating the milk flow rate, we found that in some ewes, the amount of milk yield in 10, 30 or 60 seconds at the level of 400, 650 or 1200 ml and vice versa, some ewes did not run milk at all during this time. In the best ewes, the ratio of milk yield in 30, or 60 seconds of the total milk yield was up to 100%.

Table 1. Basic variational-statistical characteristics of selected indicators characterizing milk production and milkability of ewes.

Indicators	n*2	$\bar{x}$	s	v	min.	max.
Milk yield in 10 s (MY10s) (ml)	1029	90.13	76.45	84.82	0	400
Milk yield in 30 s (MY30s) (ml)	1218	220.40	100.78	45.73	0	650
Milk yield in 60 s (MY60s) (ml)	1159	307.15	154.09	50.17	0	1200
Machine milk yield (MMY) (ml)	1218	318.26	166.90	52.44	10	1200
Milking time (s)	1218	62.67	16.10	25.69	15	160
Total milk yield (ml)	1218	436.58	197.11	45.15	30	1339
Machine stripping (ml)	1218	118.69	91.85	77.39	0	775
Machine stripping ratio MS/TMY (%)	1218	27.73	15.53	56.00	0	95
Milk yield ratio in 30s MY30s/MMY (%)	1218	53.83	18.35	34.09	0	100
Milk yield ratio in 60s MY60s/MMY (%)	1159	69.35	17.01	24.52	0	100

*[2]n-number of observations; $\bar{x}$ - mean value; s-standard deviation; v-variation coefficient

Our results (Table 2) show that the genotype factor has a statistically significant effect on all monitored production factors: the amount of milk yield in 10 seconds, the amount of milk yield in 30 seconds, the amount of milk yield in 60 seconds, machine milk yield, milking time, total milk yield, machine stripping, machine stripping ratio, milk yield ratio in 30 seconds and milk yield ratio in 60 seconds (P<0.001). The influence of the factors like lactation sequence, lactation stage and the day of lactation were not so highly statistically significant. On the contrary, the accompanying variable "year" had a statistically highly significant effect on all indicators we surveyed (P<0.001).

Table 2. Analysis of covariance of indicators of milk production and milkability of ewes.

Source of variance	(df)	Trait: MY10s		MY30S		MY60S		MMY		MT	
		F value	P>F	F hodnota	P>F	F hodnota	P>F	F hodnota	P>F	F hodnota	P>F
Year	5	97.04	<0.0001	36.68	<0.0001	24.82	<0.0001	22.58	<0.0001	32.69	<0.0001
Lactation stage	3	0.60	0.6147	2.25	0.0808	8.88	<0.0001	10.11	<0.0001	0.37	0.7749
Genotype	8	4.01	0.0001	3.61	0.0004	9.45	<0.0001	12.92	<0.0001	7.11	<0.0001
Parity	2	1.95	0.1434	3.15	0.0043	5.33	0.0050	4.86	0.0080	0.52	0.5947
Days in milk	1	0.41	0.5231	9.76	0.0018	21.87	<0.0001	38.46	<0.0001	9.10	0.0026

Source of variance	(df)	Trait: TMY		MS		MS/TMY		MY30s/MMY		MY30s/MMY	
		F value	P>F	F value	P>F	F value	P>F	F value	P>F	F value	P>F
Year	6	32.10	<0.0001	8.71	<0.0001	6.64	<0.0001	8.65	<0.0001	4.97	<0.0001
Lactation stage	3	14.52	<0.0001	1.93	0.1235	0.80	0.4960	3.88	0.0090	1.68	0.1688
Genotype	8	29.30	<0.0001	21.58	<0.0001	8.54	<0.0001	15.69	<0.0001	9.59	<0.0001
Parity	2	0.60	0.5469	8.10	0.0003	9.37	<0.0001	2.74	0.0652	10.15	<0.0001
Days in milk	1	48.69	<0.0001	1.52	0.2175	0.25	0.6163	0.30	0.5848	0.00	0.9582

+++ P<0,001; ++P<0,01; +P<0,05

Table 3 shows that the most milk yield in 10 seconds was found in C × DOJ crosses (25% DOJ) (109.87 ± 22.724 ml) and, conversely, the least milk yield in the first 10 seconds was found in purebred Lacaune ewes (53.61 ± 5.294 ml). Mačuhová, et al. (2007) found in 80 ewes of the breeds Improved Valachian, Tsigai, Lacaune and their crossbreeds that 28% of the ewes iniciated milk during the first 10 seconds of machine milking. Regarding the amount of milk yield in 30 seconds as an indicator, we found the most milk yield for this indicator in crosses ZV × DOJ (25% DOJ) at the level of 249.87 ± 15.448 ml and vice versa, the lowest average value for this indicator was found in purebred Tsigai ewes (176.42 ± 8.411 ml).

For the indicator of the amount of milk yield in 60 seconds, we found the highest average value in crosses ZV × DOJ (25% DOJ) (341.35 ± 21.052 ml) and vice versa, in purebred ewes of the breed Improved Valachian we found the lowest average value for this indicator (277.46 ± 12.666 mL). The indicators evaluated by us: the amount of milk yield in 10, 30 and 60 seconds well characterize the milk release rate of milked ewes. In practice, the more milk is yield in 60 seconds, the more advantageous it is for the breeder (more sheep will be milked per unit of time). As expected, we found the highest average machine milk yield in purebred ewes of the Lacaune breed (332.70 ± 12.312 ml) and conversely, the lowest average machine milk yield in the monitored population was found in purebred ewes of the Tsigai breed (207.60 ± 12.004 ml).

Table 3. Influence of genotype on individual indicators characterizing milk production and milkability of ewes-I.

Source of variance		MY10s*1		MY30S*2		MY60S*3		MMY*2		MT*2	
		LSM	± SE	LSM	± SE	LSM	± SE	LSM	± SE	LSM	± SE
Genotype											
Improved Valachian (100)	**186*1 218*2 200*3**	**88.79**	**5.584**	**200.93**	**9.116**	**277.46**	**12.666**	**274.35**	**13.001**	**57.65**	**1.268**
ZV × SDB (25%) (125)	49 68 67	88.15	10.994	249.87	15.448	341.35	21.052	354.97	22.115	63.47	2.161
ZV × SDB (50%) (150)	69 93 91	84.53	8.791	221.87	12.955	324.24	17.666	343.16	18.529	63.05	1.813
ZV × SDB (75%) (175)	79 82 82	72.65	8.560	220.56	13.720	337.87	18.663	366.49	19.617	67.31	1.926
Tsigai (200)	**244 268 244**	**80.52**	**5.027**	**176.42**	**8.411**	**209.21**	**11.766**	**207.60**	**12.004**	**55.12**	**1.171**
C × SDB (25%) (225)	10 18 15	109.87	22.724	226.64	31.429	331.59	43.245	314.55	44.573	56.79	4.281
C × SDB (50%) (250)	135 169 164	89.11	6.422	226.42	9.989	307.06	13.571	327.16	14.226	62.48	1.379
C × SDB (75%) (275)	35 47 47	85.27	13.014	212.24	20.324	305.18	27.383	337.05	28.778	66.43	2.746
Lacaune (300)	**222 255 249**	**53.61**	**5.294**	**216.59**	**8.642**	**315.18**	**11.773**	**332.70**	**12.312**	**62.88**	**1.194**
Significant differences		100:300+++; 125:300+; 150:300++; 175:300+; 200:300+++; 225:300+; 250:300+++; 275:300+;		100:125++;100:200+; 125:200+++; 175:200++; 200:250,300+++;		100:125,175++; 100:150,300+; 100:200+++; 125:200+++; 150:200+++; 175:200+++; 200:250,300+++; 200:225,275++;		100:125,150,250++; 100:175,200,300+++; 100:275+; 125:200+++; 150:200+++; 175:200+++; 200:225+; 200:250,275,300++;		100:125,150,250+; 100:175+++; 100:275,300++; 125:200+++; 150:200+++; 175:200+++; 175:225,250,300+; 200:250,275,300+++;225:275+;	

+++ P<0,001; ++P<0,01; +P<0,05; ns-non significant; *1, *2, *3-number of measurements depending on the indicator.

Table 4 shows that, as expected, we found the largest average total milk yield in purebred Lacaune ewes (524.69 ± 13.571 ml) and, conversely, the lowest average value in this indicator was found in purebred Tsigai ewes at (278.53 ± 13.208 ml). The highest average machine stripping was again found in purebred ewes of the Lacaune breed (194.51 ± 7.875 ml) and, conversely, the lowest average value in this indicator was found in purebred ewes of the Tsigai breed (73.39 ± 7.656 ml). The highest average machine stripping was found in purebred ewes of the Lacaune breed, up to (37.69 ± 1.357%) and vice versa, the lowest average machine stripping ratio was found in crossbreeds ZV × DOJ (25% DOJ) at the level (23.09 ± 2.442%).

Table 4. Influence of genotype on individual indicators characterizing milk production and milkability of ewes–II.

Source of Variance	n	TMY^{*1}		MS^{*1}		MS/TMY^{*1}		MY30s/MMY ^{*1}		MY60s/MMY^{*2}	
		LSM ± SE		**LSM ± SE**		**LSM ± SE**		**LSM ± SE**		**LSM ± SE**	
Genotype											
IV (100)	**218^{*1} 200^{*2}**	**349.61**	**14.314**	**76.81**	**8.298**	**24.06**	**1.435**	**58.92**	**1.669**	**75.21**	**1.607**
IV x SDB (25%) (125)	68 67	446.98	24.258	91.68	14.022	23.09	2.442	55.06	2.833	72.80	2.671
IV x SDB (50%) (150)	93 91	460.40	20.343	119.88	11.772	27.79	2.046	50.27	2.375	68.89	2.241
IV x SDB (75%) (175)	82 82	495.08	21.544	130.00	12.478	27.96	2.166	46.03	2.514	65.31	2.367
T (200)	**268 244**	**278.53**	**13.208**	**73.39**	**7.656**	**27.41**	**1.324**	**64.03**	**1.540**	**71.87**	**1.492**
T x SDB (25%) (225)	18 15	429.11	49.353	115.94	28.721	27.97	4.906	52.93	5.741	73.01	5.480
T x SDB (50%) (250)	169 164	435.95	15.685	110.82	9.104	26.71	1.568	54.45	1.828	69.79	1.720
T x SDB (75%) (275)	47 47	496.30	31.915	159.43	18.507	32.48	3.165	45.59	3.710	63.25	3.464
LC (300)	**255 249**	**524.69**	**13.571**	**194.51**	**7.875**	**37.69**	**1.357**	**42.93**	**1.582**	**58.93**	**1.492**
Significant differences		100:125,150,175,200,250,275,300+++; 125:200+++; 125:300++; 150:200+++; 150:300++; 175:200+++;175: 250+; 200:225++; 200:250,275,300+++; 250:300+++;		100:150,250++; 100:175,275,300+++; 125:175+; 125:275++;125:300+++;150:200,300+++;175:200,300+++; 200:250++;200:275,300+++;225:300++;250: 275+;250:300++;		100:275+;100:300+++; 125:275+; 125:300+++; 150:300+++;175:300+++;200:300+++;225:300+; 250:300+++;		100:150,275++; 100:175,300+++;100:200+;125:175,275+; 100:200++;100:300+++;150:200+++; 150:300+; 175:200+++; 175:250++; 200:250,275,300+++;250:275+;250:300+++;		100:150,250+; 100:175,300+++;100:275++; 125:175,275+; 125:300+++;150:300+++;175:200,300+; 200:275+;200:300+++;225:300+;250:300+++;	

+++ P<0,001; ++P<0,01; +P<0,05; ns – non significant; *1, *2, number of measurements depending on the indicator.

In the indicator of the milk yield ratio in 30 seconds, we found the highest average value in purebred ewes of the Tsigai breed (64.03 ± 1.540%) and vice versa, the lowest in purebred ewes of the Lacaune breed (42.95 ± 1.582%). In the indicator of the milk yield ratio in 60 seconds, we found the highest average value in purebred ewes of the Improved Valachian breed, namely (75.21 ±

1.607%) and vice versa, the lowest average value was found in purebred ewes of the Lacaune breed (58.93 ± 1.492%). Another factor considered to affect milk production and the milkability of ewes is the "lactation order" factor.

Table 5 shows that the factor "lactation order" had a statistically highly significant effect (P<0.001) on the indicators of the machine stripping, the machine stripping ratio and the milk yield ratio in 60 seconds. We found a statistically significant effect (P<0.01) in the indicators of the milk yield in 30 and 60 seconds and machine mild yield. The influence of the lactation order on the indicators of the milk yield in 10 seconds and the time of machine milk yield was not statistically significant.

Table 5. The influence of the order and stage of lactation on the indicators characterizing milk production and milkability of ewes.

Source of variation		Trait									
		MY10S*1		**MY30S*2**		**MY60S*3**		**MMY*2**		**MT*2**	
		LSM ± SE		**LSM ± SE**		**LSM ± SE**		**LSM ± SE**		**LSM ± SE**	
Parity											
1. (1)	370*1 434*2 425*3	87.87	4.302	226.25	6.167	323.04	8.546	335.41	8.893	61.76	0.892
2. (2)	317 348 321	80.76	4.444	214.71	6.862	300.69	9.608	310.88	10.046	61.12	1.039
3. (3)	342 436 413	79.86	4.804	209.55	7.122	292.64	9.914	306.39	10.335	62.18	1.046
Significant differences		ns		1:3+;		1:2+; 1:3++;		1:2,3++;		ns	
Lactation stage											
40-99 day (1)	184 261 251	91.21	9.183	225.46	12.489	330.04	18.088	334.05	19.063	61.94	2.151
100-129 day (2)	324 366 357	86.16	5.191	223.27	7.204	302.46	10.110	305.74	10.660	61.29	1.136
130-159 day (3)	289 335 316	81.05	5.106	205.36	7.755	277.06	11.250	293.79	11.545	61.28	1.244
160-210 day (4)	232 256 235	72.92	8.347	213.26	12.071	312.28	17.846	336.64	18.417	62.25	2.078
Significant differences		ns		ns		1:3+; 3:4++;		1:2+; 3:4+++;		ns	

Source of variation		Trait									
		TMY *1		MS*1		MS/TMY*1		MY30s/MMY *1		MY60s/MMY *2	
		LSM ± SE		LSM ± SE		LSM ± SE		LSM ± SE		LSM ± SE	
Parity											
1. (1)	434*1 425*2	440.33	9.684	226.25	6.167	323.04	8.546	335.41	8.893	61.76	0.892
2. (2)	348 321	429.85	10.774	214.71	6.862	300.69	9.608	310.88	10.046	61.12	1.039

3+ (3)	436 413	435.36	11.182	209.55	7.122	292.64	9.914	306.39	10.335	62.18	1.046
Significant differences		ns		1:2+;1:3+++;2:3+;		1:2+;1:3+++;2:3+;		1:3+;		1:2++; 1:3+++; 2:3+;	
Lactation stage											
40-99 day (1)	261 251	462.81	19.609	132.18	10.874	26.65	2.157	48.54	2.352	70.21	2.333
100-129 day (2)	366 357	420.67	11.311	117.44	6.412	27.03	1.193	53.18	1.340	70.71	1.294
130-159 day (3)	335 316	405.87	12.176	112.46	6.872	29.25	1.295	53.90	1.450	67.34	1.443
160-210 day (4)	256 235	451.38	18.952	114.57	10.514	30.48	2.084	53.37	2.273	67.07	2.302
Significant differences		1:2++; 1:3+;3:4+++;		ns		ns		1:2++;		ns	

+++ P<0,001; ++P<0,01; +P<0,05; ns-non significant; *1, *2, *3 number of measurements depending on the indicator.

The differences between the ewes on the 1st to 3rd lactation were statistically insignificant for the indicators of the milk yield in 10 seconds and the time of machine milk yield, except for the indicators of the milk yield in 30 and 60 seconds and machine milk yield (P<0.01). The best ejection of milk in the first 10, 30 and 60 seconds and the highest average machine milk yield had ewes on the 1st lactation. Total milk yield was not statistically significantly affected by the "lactation order" factor. The ewes in the first lactation had the largest total milk yield, and the milk yield ratio in 30 and 60 seconds. On the contrary, the machine stripping ratio gradually increased, reaching the highest average value (30.77 ± 1.148%) in ewes on the 3rd lactation. The influence of the factor "lactation stage" on individual indicators of milk production and milkability of ewes was statistically highly evident in the indicators of total milk yield (P<0.001) and the milk yield ratio in 30 seconds (P<0.01) and vice versa, inconclusive for machine stripping, the machine stripping ratio, the time of machine milk yield, the milk yield in 10 and 30 seconds and the milk yield ratio in 60 seconds.

In dairy ewes, 25% of the total milk yield for the entire lactation is produced during the first month (Folman, et al., 1966; Ricordeau, et al., 1962). This is primarily due to the fact that milk production is increasing from parturition to about 24 days of lactation when the peak milk production is attained. To complicate matters, ruminants have the highest probability of mastitis during the first 45 days post-partum (Hamann, 2000). Generally, milk yield and length of lactation in sheep vary across breeds (i.e., dairy and nondairy breeds). The East Friesian breed is widely reported as the highest milk producer with around 3100 g/day (at peak lactation) and 500-700 kg total milk yield and having the longest lactation length (around 240 days) compared with non-dairy breeds (90-150 days) (Green, et al., 2016). Boyazoglu (1991) reviewed the results of experiments that evaluated the East Friesian in countries of the Mediterranean region. In all countries, the pure East Friesian was found to be unacceptable due to high incidence of respiratory disease and poor adaptability to high environmental temperatures. Only in Israel was a cross of the East Friesian with the local Awassi breed found to result in a more productive animal than the local breed (Gootwine and Goot, 1996). East Friesian ewes also have been reported to have some undesirable milking characteristics relative to the Lacaune. Bruckmaier, et al. (1997) reported that East Friesian ewes had a greater proportion of the udder cistern located below the exit into the teat channel, delayed oxytocin release and milk iniciation, slower milk flow rates during milking, and longer milking times compared to Lacaune ewes.

According to Menzies, et al., 2013, the total milk production in sheep is dependent on the shape of the lactation curve, which deals with the time and height of peak milk production (maximum daily milk yield during lactation) and the length of lactation. However, the length of lactation and peak milk production are influenced by breed, photoperiod (daylight length), nutrition, multiplicity of lactacion (first or second time lactation), stress and pain at milking, milking frequency and presence of IMIs (Pollott and Gootwine, 2004). Some studies have demonstrated that milk production is associated with liter size i.e., in twin- and triplet- bearing ewes, thereby production is about 20 litres milk per lactation and 1% increase in lactation persistency than in single-bearing ewes. This was recorded in some Assaf dairy breed in Israel where the animals were kept under intensive management system and surprisingly, the lambs were weaned at birth (and reared artificially) on the premise of accurate measurement of the ewes' milk production (Pollott and Gootwine, 2004). Similar effect is possible in non-dairy breeds, but some differences may occur because they produce lower quantity of milk (averagely 47-103 litres) compared to the dairy breeds which produce about 234-354 litres of milk per lactation (Shrestha, et al., 2008). Nieto, et al. (2018) reported a 30% reduction in milk yield of merino ewes bearing single lambs compared to the twin-bearing ewes, and there was no effect of production in the dams suckling ewe lambs or ram lambs. This impact of milk production was further explained where there was a consistently higher milk production in twin-bearing ewes than the singlebearing ones, and with a 33% and 28% decline from days 28 and 56 for the single and twinbearing ewes respectively. While the sharp decline from day 56 to 70 (57% for the singles and 42% for the twins) was associated with lambs' decreasing dependence on milk. However, the milk yield between parturition and day 28 was not given in the study, this may be in order not to compromise the growth and development of the lambs, hence the ewes were milked near their peak lactation period (Bencini, et al., 1992; Bencini and Purvis, 1990). In addition, multiparous ewes have higher peak milk production and lactation persistency than the primiparous ewes. It was further observed in some studies (Bencini and Pulina, 1997; Paten, et al., 2017; Snowder and Glimp, 1991) that heavier ewes (multiparous ewes) produced more milk than their lighter counterparts i.e. primiparous ewes. This may be because the multiparous ewes are usually older and more matured than the primiparous which are still undergoing physiological development.

Conclusion

Based on our results, we propose to use the indicators of the machine milk yield and the machine yield ratio, in the selection of sheep for better milkability. Optionally also some others. In accordance with the trend in all sheep-developed countries, we propose to include them in the routine performance control and later in the genetic evaluation of dairy sheep in Slovakia.

Conflict of Interest

The authors have no conflict of interest about this research results and publication of this article.

References

Bencini, R., Purvis, I. (1990). The yield and composition of milk from Merino sheep. In: Proceedings of the Australian Society of Animal Production, 18:144-147.

Bencini, R., Hartmann, P., Lightfoot, R. (1992). Comparative dairy potential of Awassi x Merino and Merino ewes. In Proceedings of the Australian Association of Animal Breeding and Genetics, 10:114-117.

Bencini, R., Pulina, G. (1997). The quality of sheep milk: a review. Australian Journal of Experimental Agriculture, 37:485-504.

Boyazoglu, J.G. (1991). Milk breeds of sheep and milk recording, breeding and selection schemes in milk breeds. In: Maijala, K. (Ed.). Genetic Resources of Pig, Sheep and Goat, Elsevier Science Publishers B.V, Amsterdam, 13:243-255.

Bruckmaier, R.M., Paul, G., Mayer, H., Schams, D. (1997). Machine milking of Ostfriesian and Lacaune dairy sheep: udder anatomy, milk ejection and milking characteristics. Journal of Dairy Research, 64:163-172.

Folman, Y., Volcani, R., Eyal, E. (1966). Mother-offspring relationships in Awassi sheep. I: The effect of different suckling regimes and time of weaning on the lactation curve and milk yield in dairy flocks. The Journal of Agricultural Science, 67:359-368.

Gootwine, E., Goot, H. (1996). Lamb and milk production of Awassi and East-Friesian sheep and their crosses under Mediterranean environment. Small Ruminant Research, 20:255-260.

Green, W., Grant, C., Whattford, L., Genever, L. (2016). Understanding mastitis in sheep. Beef and Lamb, pp:1-16.

Hamann, J. (2000). Teat tissue resistance mechanisms with special regard to machine milking. In: A. Zecconi (Ed.) Proceeding IDF Symptoms Immunology Rum Mamm Gland, Stresa, Italy, pp:102-111.

Kremer, R., Giordano, J.P., Roses, L., Rista, L. (2015). Production of Milchschaf sheep in a grazing dairy system. Veterinaria (Montevideo), 51:12-23.

Kremer, R., Rosés, L. (2016). Production and composition of milk of Milchschaf (East Friesian) sheep, milked 1 vs 2 times a day. Veterinaria (Montevideo), 52:128-134.

Labussiere, J. (1988). Review of physiological and anatomical factors influencing the milking ability of ewes and the organization of milking. Livestock Production Science, 18:253-274.

Mačuhová, L., Uhrincať, M., Marnet, P.G., Margetín, M., Mihina, Š., Mačuhová, J., Tančin, V. (2007). Response of ewes to machine milking: evaluation of the milk flow curves. Slovak Journal of Animal Sciences, 40:89-96.

Mačuhová, L., Tančin, V., Mačuhová, J. (2020). The effect of milking frequency on milk yield and milk composition in ewes. Czech Journal of Animal Science, 65:41-50.

Marnet, P.G., McKusick, B.C. (2001). Regulation of milk ejection and milkability in small ruminants. Livestock Production Science, 70:125-133.

Marie-Etancelin, C., Manfredi, E., Aurel, M.R., Pailler, F., Arhainx, J., Ricard, E., Lagriffoul, E., Guillouet, P., Bibé, B., Barillet, F. (2006). Genetic analysis of milking ability in Lacaune dairy ewes. Genetics Selection Evolution, 38(2): 183-200.

Menzies, P.I., Jansen, J., Fitzpatrick, C., Foran, M., Wilman, P., Taylor, V. (2013). A guide to udder health for dairy sheep: to assist producers, veterinarians, extension and dairy support personnel in the production of quality sheep milk. University of Guelph.

Mikuš, M. (1973). Spúšťanie mlieka pri strojovom dojení oviec počas laktácie. Živočíšna výroba, 18:469-475.

Mioc, B., Prpic, Z., Antunac, N., Antunovic, Z., Samarzija, D., Vnucec, I., Pavic, V. (2009). Milk yield and quality of Cres sheep and their crosses with Awassi and East Friesian sheep. Mljekarstvo, 59:217-224.

Nieto, C.A.R., Ferguson, M.B., Macleay, C.A., Briegel, J.R., Wood, D.A., Martin, G.B., Bencini, R., Thompson, A.N. (2018). Milk production and composition, and progeny performance in young ewes with high merit for rapid growth and muscle and fat accumulation. Animal, 12:2292-2299.

Panayotov, D., Sevov, S., Georgiev, D. (2018). Milk yield and morphological characteristics of the udder of sheep from the breed Lacaune in Bulgaria. Bulgarian Journal of Agricultural Science, 24:95-100.

Paten, A,, Pain, S., Peterson, S., Lopez-Villalobos, N., Kenyon, P., Blair, H. (2017). Effect of dam weight and pregnancy nutrition on average lactation performance of ewe offspring over 5 years. Animal, 11(6), 1027-1035.
Palii, AP., Shkromada, O.I., Todorov, N.I., Grebenik, N.P., Lazorenko, A.B., Bondarenko, I.V., Boyko, Y.A., Brit, O.V., Osipenko, T.L., Halay, O.Yu., Paliy, A.P. (2020). Effect of linear traits in dairy cows on herd disposal. Ukrainian Journal of Ecology, 10:88-94.
Pollott, G.E., Gootwine, E. (2004). Reproductive performance and milk production of Assaf sheep in an intensive management system. Journal of Dairy Science, 87:3690 3703.
Pourlis, A. (2020). Ovine mammary morphology and associations with milk production, milkability and animal selection. Small Ruminant Research, 184:106009.
Prpic, Z., Vnucec, I., Benic, M., Konjacic, M., Ugarkovic, N.K., Mioc, B. (2020). Udder shape and milk yield of different sheep breeds. Journal of Central European Agriculture, 21:197-206.
Ricordeau, G., Denamur, R., Petrequin, P. (1962). Production laitière des brebis Préalpes du Sud pendant les phases d'allaitement, de sevrage et de traite. Annales de Zootechnie, 11:5-38.
Salamon, D., Furdic, P., Tesija, T., Dzidic, A. (2019). Genetic parameters for the external udder morphology in commercial farms of Istrian sheep from Croatia. Journal of Central European Agriculture, 20:68-73.
Sevov, S., Georgiev, D., Panayotov, D. (2018). Milk yield and morphological characteristics of the udder of sheep from the breed Lacaune in Bulgaria. Bulgarian Journal of Agricultural Science, 24:95-100.
Shrestha, J., Boylan, W., Rempel, W. (2008). Evaluation of sheep genetic resources in North America: Milk production and composition of purebred, crossbred and synthetic populations. Canadian journal of Animal Science, 88(4), 569-576.
Snowde, G.D., & Glimp, H.A. (1991). Influence of breed, number of suckling lambs, and stage of lactation on ewe milk production and lamb growth under range conditions. Journal of Animal Science, 69(3), 923-930.
Tančin, V., Bruckmaier, R.M. (2001). Factors affecting milk ejection and removal during milking and suckling of dairy cows. Veterinarni Medicina-Czech, 46:108-118.
Turkyilmaz, D., Ozyurek, S., Esenbuga, N., Yaprak, M. (2018). Correlation between various udder measurements and milk components in Morkaraman, Tuj and Awassi sheep. Pakistan Journal of Zoology, 50:1921-1927.
Vrdoljak, J., Prpic, Z., Samarzija, D., Vnucec, I., Konjacic, M., Ugarkovic, N.K. (2020). Udder morphology, milk production and udder health in small ruminants. Mljekarstvo, 70:75-84.

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