ACTA UNIVERSITATIS AGRICULTURAE ET SILVICULTURAE MENDELIANAE BRUNENSIS

Volume LXI 11 Number 1, 2013

http://dx.doi.org/10.11118/actaun201361010093

EFFECT OF DIFFERENT CROSSBREEDS OF LACAUNE AND EAST FRIESIAN BREEDS ON MILK YIELD AND BASIC MILK PARAMETERS

Leona Konečná, Jan Kuchtík, Šárka Králíčková, Michaela Pokorná, Květoslava Šustová, Radek Filipčík, Táňa Lužová

Received: January 14, 2013

Abstract

KONEČNÁ LEONA, KUCHTÍK JAN, KRÁLÍČKOVÁ ŠÁRKA, POKORNÁ MICHAELA, ŠUSTOVÁ KVĚTOSLAVA, FILIPČÍK RADEK, LUŽOVÁ TÁŇA: *Effect of different crossbreeds of Lacaune and East Friesian breeds on milk yield and basic milk parameters.* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 1, pp. 93–98

The aim of the study was to evaluate the effect of different crossbreeds (CB) of Lacaune (LC) and East Friesian (EF) breeds (LC 50 EF 50, LC 75 EF 25 and LC 87.5 EF 12.5) on daily milk yield (DMY) and basic milk composition (contents of total solids (TS), fat (F), protein (P), casein (C) and lactose (L) for the whole lactation. The evaluation of the interactions between CB and parity (PA) and between CB and litter size (LS) on above mentioned indicators was also an integral part of this study. The study was carried out on the organic farm in Valašská Bystřice. The factor of CB had a significant effect only on DMY and contents of P and C for the whole lactation whilst the higher proportion of LC breed in genotype, the higher DMY and the lower P and C contents. The CB x PA had a significant effect on all indicators except for the lactose content when in all CB the DMY increased with the increase of the lactation number. On the other hand, in all CB the contents of TS, F, P and C were relatively very variable depending on the parity. Lastly, as for the interaction between CB and LS, the ewes with twins produced significantly more milk compared to ewes with singles and these ewes had also significantly higher contents of P and C and not significantly higher contents of TS and F.

organic sheep milk, Lacaune, East Friesian, milk yield, milk composition

The sheep milk, due to its specific composition, is generally above all processed into cheese. In some countries the sheep milk is also processed into yogurt, butter or ghee.

In the Czech Republic (CR) the sheep dairy production is ranked among a minority production compared to other animal production. However, last ten years can be considered as the period of the gradual renewal of this production in CR, whilst presently there is reared more than 1 500 milking ewes (Králíčková *et al.*, 2012). During above mentioned period was also recorded the growth of Czech domestic consumer demand for sheep cheese which is an important aspect from the point of view of marketing. In the CR the main product from the sheep milk is also cheese, whilst the whey is above all processed into so called "žinčica".

East Friesian (EF) sheep originating from East Friesia in Northern Germany is ranked among one of the most important dairy sheep breed in the world. Lacaune (LC) breed is also ranked among most important dairy sheep breed, however this breed originated from France and its milk is there above all used for making a cheese called Roquefort. Both above mentioned breeds are already several years reared in CR either as purebreds, or as a sire breed crossed with domestic dairy breeds in order to improve the milk yield and quality of milk. However, EF sheep are rather sensitive to unfavourable climatic conditions (low temperatures, long-term rainfall etc.). On the other hand the LC sheep can adapt relatively well to these conditions. Taking into account the above stated facts on some czech farms in sub-mountainous and mountainous regions have started to cross EF ewes or ewes EF crossbreds with domestic breeds (Improved Wallachian breed, Šumavka breed) with LC sires in order to improve resistance of sheep against unfavourable climatic conditions and even also, to some measure, improved milk quality.

Cheese yield and its resulting quality depend on quality of milk as a raw material for its production, especially the content of basic milk components is crucial. The milk quality is influenced by a number of factors including breed, parity and litter size (Nudda *et al.*, 2003 and Oravcová *et al.*, 2007). The effect of crossing between LC and EF on milk yield and basic composition of milk was the topic of the studies which were carried out by Thomas *et al.* (2000) and Thomas *et al.* (2004). From these studies above all resulted that in the ewes crossbreds of LC x EF was found out the slight decrease in milk production. However, on the other hand, an increase of fat and protein contents have been also found. By the way, from these surveys the small effect of crossing on lamb growth also follows.

From the most of studies results that the parity and litter size had a significant effect on milk yield whilst in general milk yield increases with both increase of lactation number and increase of litter size. By contrast, there are relatively a lot contradictory reports on the effect of parity and litter size on the composition of milk.

The aim of the study was to evaluate the effect of different CB of LC and EF breeds on daily milk yield (DMY) and basic milk composition (contents of total solids, fat, protein, casein and lactose) for the whole lactation. The evaluation of the interactions between CB and parity (PA) and between CB and litter size (LS) on above mentioned indicators was also an integral part of this study.

MATERIAL AND METHODS

The study was carried out on the organic farm in Valašská Bystřice during two subsequent years. The farm is situated at an altitude of 500–600 m above the sea level with an average annual temperature of 7.6 °C. Three different groups of crossbreeds of Lacaune (LC) and East Friesian sheep (EF) were involved in the experiment. The number of ewes by crossbreed (CB), by crossbreed and parity (CB x PA) and by crossbreed and litter size (CB x LS) which were involved in the experiment are presented in Tab. I.

During both years of the experiment the lambing occurred in the period from the end of January to the end of March and the weaning of lambs was carried out at the end of April. After the weaning all sheep began to be machine milked twice a day. From the birth till the end of April the daily feed ration of ewes consisted of meadow hay *(ad libitum)*, haylage (0.5 kg/ewe), organic oat (0.3kg/ewe) and mineral lick MIKRO Mg Super *(ad libitum)*. Since the 1st of May till the end of experiment the daily feed ration of ewes consisted of grazing on permanent pasture *(ad libitum)*, organic oat (0.05 kg/ewe) and mineral lick MIKRO Mg Super *(ad libitum)*. During the experiment, all ewes have been reared in one flock under identical conditions without any discernible differences in nutrition or management.

Milk records and samplings for each sheep have been carried out five times in the period from May to September. They were carried out during the morning and evening milking (6 a.m., 6 p.m.), whereas, sampling was done only in the morning. After sampling the individual milk samples were cooled to 5–8 °C and transported in a thermo-box to a specialized milk laboratory at Mendel University in Brno. As part of the laboratory analysis, the following determinations of milk composition were carried out: total solids (TS), fat (F), total protein (TP), casein (C) and lactose (L) contents. The evaluation of daily milk yield (DMY) was also an integral part of this study. Milk yield was determined from the whole day with an accuracy of 0.1 l. TS content (in %) was determined gravimetrically; by over drying at 102 °C to constant weight (Czech technical Standard ISO No. 6731, 1998). F content (in %) was determined by Gerber's acidobutyrometric method (Czech Technical Standard ISO No. 2446, 2001). TP and C contents (in %) were determined using

I: *Numbers of ewes by CB, by CB x PA and by CB x LS*

Number of ewes by CB	
CB	n
LC 50 EF 50	70
LC 75 EF 25	48
LC 87.5 EF 12.5	57
Number of ewes by CB x PA	
CB x PA	n
LC 50 EF 50 x PA 1	4
LC 50 EF 50 x PA 2	13
LC 50 EF 50 x PA 3	24
LC 50 EF 50 x PA 4	29
LC 75 EF 25 x PA 1	14
LC 75 EF 25 x PA 2	10
LC 75 EF 25 x PA 3	11
LC 75 EF 25 x PA 4	13
LC 87.5 EF 12.5 x PA 1	18
LC 87.5 EF 12.5 x PA 2	14
LC 87.5 EF 12.5 x PA 3	11
LC 87.5 EF 12.5 x PA 4	14
Number of ewes by CB x LS	
CB x LS	n
LC 50 EF 50 x LS 1	24
LC 50 EF 50 x LS 2	46
LC 75 EF 25 x LS 1	28
LC 75 EF 25 x LS 2	20
LC 87.5 EF 12.5 x LS 1	33
LC 87.5 EF 12.5 x LS 2	24

a PRO-MILK apparatus (manufactured by the Danish Co. Foss Electric; Czech Technical Standard No. 570530, 1974). L content (in %) was determined polarimetrically (Czech Technical Standard No. 570530, 1974).

A statistical analysis was carried out using the mathematical-statistical package STATISTICA version 9.0. The following mathematical model was used:

$$Y_{ijkl} = \mu + CB_i + CB \times PA_j + CB \times LS_k + e_{ijkl},$$

where Y_{ijkl} is the experimental observation, μ the general mean, CB_i the fixed effect of $_i$the crossbreed (i =1, 2 and 3), CB × PA_j the fixed effect of $_j$the interaction between crossbreed and parity (j = 1…12), CB × LS_k the fixed effect of $_k$the interaction between crossbreed and litter size (k = 1…6) and e_{ijkl} is random residual error. The HSD test was used to determination the statistically significant difference. The differences were considered significant if $P \leq 0.05$.

RESULTS AND DISCUSSION

The factor of CB had a significant effect only on daily milk yield and contents of protein and casein for the whole lactation (Tab. II). On the other hand, in our study there was not found any significant effect of this factor on contents of total solids, fat and lactose which is not in line with the results published by Mioc *et al.* (2009), Thomas *et al. (2004)* and Abd Allah *et al.* (2011). From the Tab. II also follows that the higher proportion of LC breed in genotype, the higher daily milk yield, nevertheless this trend was in the beginning of this experiment to a certain measure expected. However, on the other hand from our study also follows that the higher proportion of LC, the lower protein and casein content while this trend is in agreement with the data published by Thomas *et al.* (2000) and can be explained by negative correlation between milk yield and contents of protein and casein.

As for contents of TS and F these were relatively very balanced in all crossbreeds. In contrast the contents of lactose were in crossbreeds of LC 50 EF 50 and LC 75 EF 25 comparable, but in crossbreeds with the highest proportion of LC breed in genotype was found, even when not significant, the lowest content of this milk component (4.73 % and 4.74 % vs 4.35 %). Nevertheless this trend can be also in some measure explained by negative correlation between milk yield and lactose content.

The interaction between crossbreed and parity had a significant effect on all indicators except for the lactose content (Tab. III) when in all crossbreeds the DMY was rising with the increase of the lactation number. The same trends were also reported by Maria and Gabiňa (1993) and Ploumi *et al. (1998)* whilst from the most of studies also result that the highest milk yields are found from the third to the fifth lactation. On the other hand in studies which were carried out by Christodoulou *et al.* (1997) and Sevi *et al.* (2000) have not been recorded the effect of parity on DMY.

The contents of TS and F in all crossbreds depending on parity were relatively variable, but the highest contents of both these milk components were found in LC 50 EF 50 and LC 75 EF 25 on the fourth lactation. On the other hand for example Sevi *et al.* (2000) and Nudda *et al.* (2003) found out the continuously rising trend of fat content as the number of lactation advanced when in both above mentioned studies the highest contents of F were found in the fourth lactation. By contrast Novotná *el al.* (2009) reported the highest contents of TS and F already on the second lactation.

As for P and C contents, only in crossbreds with the lowest proportion of LC in genotype both these contents tended to increase with parity. The same tendency was reported by Fuertes *et al.* (1998), Sevi *et al.* (2000) and Mioc *et al.* (2009). This trend can be also explained by the increases of the body weight and the development of the udder granular tissue. Nevertheless contrary to expectation in both other crossbreds the contents of P and C were relatively very variable. As for lactose contents depending on the parity, these were a priori very well balanced, but in LC 75 EF 25 and LC 87.5 EF 12.5 crossbreeds were found slight increase of their contents with advanced lactation. In contrast Mioc *et al.* (2009) published opposite trend, whilst Novotná *et al.* (2009) reported the highest L content on the third lactation and the lowest on the second lactation. In conclusion to Tab. III, it is possible to state that the highest contents of TS, F, P and C have been found in crossbreeds with lowest proportion of LC in genotype on fourth lactation.

From the most studies result that purebred or crossbreed ewes with twins produced more milk compared to ewes with singles. This trend has also been confirmed in our study (Tab. IV). By contrast, there are relatively a lot of contradictory reports on the effect of the litter size on milk composition. In our study this factor significantly affected only the contents of P and C whilst in all crossbreds the highest contents of both these milk components have been found in ewes with twins. The same trend has also been reported by Snowder and Glimp (1990), however, in their study this effect has not been significant. In our study the ewes crossbreeds with twins had also not significantly higher contents of TS and F. On the contrary, in all crossbreds with twins the lowest contents of lactose has been found which is also in line with the results published by Snowder and Glimp (1990).

CONCLUSIONS

The factor of CB had a significant effect only on DMY and contents of protein and casein for the whole lactation whilst the higher the proportion of LC breed in genotype, the higher daily milk yield and the lower protein and casein contents.

II: Effect of crossbreed on daily milk yield (l) and contents of total solids (%), fat (%), protein (%), casein (%) and lactose (%)

	Daily milk yield (l)			Total solids (%)			Fat (%)			Protein (%)			Casein (%)			Lactose (%)		
	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.
			*			NS			NS			*			*			NS
LC50EF50	0.77	0.015	a	18.60	0.083		7.14	0.070		6.00	0.032	a	4.47	0.031	a	4.73	0.013	
LC75EF25	0.79	0.018	ab	18.67	0.097		7.14	0.081		5.96	0.039	ab	4.42	0.036	ab	4.74	0.018	
LC87.5EF12.5	0.83	0.018	b	18.62	0.093		7.15	0.078		5.88	0.034	b	4.35	0.029	b	4.35	0.015	

*,a,b = P ≤ 0.05; NS: statistically not-significant

III: Effect of interaction between crossbreed and parity on daily milk yield (l) and contents of total solids (%), protein (%), casein (%) and lactose (%)

	Daily milk yield (l)			Total solids (%)			Fat (%)			Protein (%)			Casein (%)			Lactose (%)		
	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign	L.S.M.	S.E.M.	Sign	L.S.M.	S.E.M.	Sign	L.S.M.	S.E.M.	Sign	L.S.M.	S.E.M.	Sign
			**			**			**			**			**			NS
LC50EF50xPA1	0.48	0.043	AD	17.69	0.278	AC	6.5	0.287	AB	5.68	0.116	AB	4.20	0.118	AB	4.75	0.075	
LC50EF50xPA2	0.66	0.027	AF	18.34	0.194	AC	6.94	0.175	AB	5.95	0.063	AB	4.37	0.068	AB	4.71	0.025	
LC50EF50xPA3	0.79	0.022	BEF	18.24	0.116	A	6.79	0.093	A	5.98	0.053	AB	4.41	0.051	AB	4.71	0.023	
LC50EF50xPA4	0.85	0.026	BC	19.25	0.133	B	7.61	0.110	B	6.08	0.054	A	4.60	0.050	A	4.75	0.022	
LC75EF25xPA1	0.72	0.032	BDF	18.62	0.205	AB	7.14	0.169	AB	5.90	0.087	AB	4.39	0.083	AB	4.70	0.036	
LC75EF25XPA2	0.70	0.030	BDF	18.30	0.176	AB	6.98	0.167	AB	5.85	0.076	AB	4.29	0.073	AB	4.68	0.031	
LC75EF25xPA3	0.83	0.038	BF	18.44	0.184	AB	6.84	0.146	AB	6.05	0.073	AB	4.41	0.057	AB	4.78	0.041	
LC75EF25xPA4	0.88	0.035	CE	19.19	0.177	BC	7.50	0.150	AB	6.04	0.065	AB	4.54	0.061	AB	4.80	0.030	
LC87.5EF12.5xPA1	0.76	0.028	BF	18.38	0.157	AC	6.99	0.134	A	5.76	0.062	B	4.23	0.050	B	4.76	0.031	
LC87.5EF12.5xPA2	0.80	0.037	BF	18.84	0.187	AB	7.32	0.165	AB	6.03	0.069	AB	4.46	0.061	AB	4.68	0.026	
LC87.5EF12.5xPA3	0.81	0.037	BF	18.56	0.222	AB	6.98	0.175	AB	5.93	0.078	AB	4.43	0.068	AB	4.82	0.032	
LC87.5EF12.5xPA4	0.97	0.039	C	18.76	0.189	AB	7.34	0.159	AB	5.85	0.055	AB	4.35	0.055	AB	4.83	0.027	

**,A,B,C,D,E,F = P ≤ 0.01; NS: statistically not-significant

IV: Effect of interaction between crossbreed and litter size on daily milk yield (l) and contents of total solids (%), protein (%), casein (%) and lactose (%)

	Daily milk yield (l)			Total solids (%)			Fat (%)			Protein (%)			Casein (%)			Lactose (%)		
	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.	L.S.M.	S.E.M.	Sign.
			**			NS			NS			**			**			NS
LC50EF50xLS1	0.75	0.023	A	18.43	0.137		7.01	0.120		5.89	0.052	AB	4.36	0.051	AB	4.76	0.024	
LC50EF50xLS2	0.79	0.020	AB	18.75	0.104		7.21	0.085		6.06	0.040	A	4.53	0.038	A	4.71	0.016	
LC75EF25xLS1	0.77	0.023	A	18.60	0.132		7.09	0.115		5.92	0.051	AB	4.37	0.049	AB	4.75	0.023	
LC75EF25xLS2	0.80	0.030	AB	18.76	0.142		7.21	0.123		6.02	0.059	AB	4.48	0.051	AB	4.73	0.027	
LC87.5EF12.5xLS1	0.80	0.022	AB	18.55	0.118		7.12	0.101		5.82	0.045	B	4.30	0.039	B	4.75	0.022	
LC87.5EF12.5xLS2	0.88	0.030	B	18.71	0.148		7.20	0.125		5.96	0.051	AB	4.42	0.043	AB	4.80	0.020	

**,A,B = P ≤ 0.01; NS: statistically not-significant

The interaction between crossbreed and parity had a significant effect on all indicators except for the lactose content whilst in all crossbreeds the daily milk yield was rising with the increase of the lactation number. On the other hand, in all crossbreeds the contents of total solids, fat, protein and casein were relatively very variable depending on the parity. Lastly, as for the interaction between crossbreed and litter size, the ewes with twins produced significantly more milk compared to ewes with singles and these ewes had also significantly higher contents of protein and casein and not significantly higher contents of total solids and fat.

SUMMARY

East Friesian (EF) sheep are rather sensitive to unfavourable climatic conditions. On the other hand the Lacaune (LC) sheep can adapt relatively well to these conditions. Taking into account the above stated facts on some czech farms in sub-mountainous and mountainous regions have started to cross EF ewes or ewes EF crossbreds with domestic breeds with LC sires in order to improve resistance of sheep against unfavourable climatic conditions and even also, to some measure, improved milk composition. The aim of the study was to evaluate the effect of different crossbreeds (CB) of LC and EF breeds (LC 50 EF 50, LC 75 EF 25 and LC 87.5 EF 12.5) on daily milk yield (DMY) and basic composition of milk (contents of total solids (TS), fat (F), protein (P), casein (C) and lactose (L) for the whole lactation. The evaluation of the interactions between CB and parity (PA) and between CB and litter size (LS) on above mentioned indicators was also an integral part of this study. The study was carried out on the organic farm in Valašská Bystřice. The factor of CB had a significant effect only on DMY and contents of P and C for the whole lactation whilst the higher the proportion of LC breed in genotype, the higher DMY and the lower P and C contents. The CB x PA had a significant effect on all indicators except for the L content whilst in all CB the DMY was rising with the increase of the lactation number. On the other hand, in all CB the contents of TS, F, P and C were relatively very variable depending on the parity. Lastly, as for the interaction between CB and LS, the ewes with twins produced significantly more milk compared to ewes with singles and these ewes had also significantly higher contents of P and C and not significantly higher contents of TS and F.

Acknowledgement

This study was supported by projects No. QH91271 and NAZV KUS QJ1230044 which were financed by the Ministry of Agriculture of the Czech Republic.

REFERENCES

ABD ALLAH, M., ABASS, S. F., ALLAM, F. M., 2011: Factors affecting the milk yield and composition of Rahmani and Chios sheep. *International Journal of Livestock Production*, Vol. 2 (3), 24–30.

Czech Technical Standard No. 570530, 1974: Methods for testing of milk and milk products. Czech Standards Institute, Prague, 108 pp.

Czech Technical Standard ISO No. 6731, 1998: Milk, cream and evaporated milk–Determination of total solids content (Reference method). Czech Standards Institute, Prague, 8 pp.

Czech Technical Standard ISO No. 2446, 2001: Milk–Determination of fat content (Routine method). Czech Standards Institute, Prague, 16 pp.

FUERTES, J. A., GONZALO, C., CARRIEDO, J. A., SAN PRIMITIVO, F., 1998: Parameters of Test day milk yield and milk components for dairy ewes. *Journal of Dairy Science*, 81: 1300–1307.

CHRISTODOULOU, B., PLOUMI, K., GIOUZELYANNIS, A., VAINAS, E., KATANOS, I., 1997: Performance analysis of the Florina (Pelagonia) sheep for milk production. *Živočišná výroba*, 42: 241–246.

KRÁLÍČKOVÁ, Š., POKORNÁ, M., KUCHTÍK, J., FILIPČÍK, R., 2012: Effect of parity and stage of lactation on milk yield, composition and quality of organic sheep milk. *Acta univ. agric. et silvic. Mendel. Brunen.*, 60, 1, 71–78.

MARÍA, G., GABIÑA, D., 1993: Non-genetic effects on milk production of Latxa ewes. *Small Ruminant Research*, 12: 61–67.

MIOC, B., PRPIC, Z., ANTUNAC, N., ANTUNOVIC, Z., SAMARŽIJA, D., VNUCEC, I., PAVIC, V., 2009: Milk yield and quality of Cres sheep and their crosses with Awassi and East Friesian sheep. *Mljekarstvo*, 59, 3: 217–224.

NOVOTNÁ, L., KUCHTÍK, J., ŠUSTOVÁ, K., ZAPLETAL, D., FILIPČÍK, R., 2009. Effects of the lactation stage and parity on milk yield, composition and properties of organic sheep milk. *Journal of Applied Animal Research*, 36 (1): 71–76.

NUDDA, A., FELIGINI, M., BATTACONE, G., MACCIOTTA, N. P. P., PULINA G., 2003: Effects of lactation stage, parity, β-lactoglobulin genotype and milk SCC on whey protein composition in Sarda dairy ewes. *Italian Journal of Animal Science*, 2: 29–39.

ORAVCOVÁ, M., MARGETÍN, M., PEŠKOVIČOVÁ, D., DAŇO, J., MILERSKI, M., HETÉNYI, L., POLÁK, P., 2007: Factors affecting ewe's milk fat and protein content and relationships between milk yield and milk components. *Czech Journal of Animal Science*, 52: 189–198.

PLOUMI, K., BELIBASAKI, S., TRIANTAPHYLLIDIS, G., 1998: Some factors affecting daily milk yield and composition in a flock of Chios ewes. *Small Ruminant Research*, 28: 89–92.

SEVI, A., TAIBI, L., ALBENZIO, M., MUSCIO, A., ANNICHIARICO, G., 2000: Effect of parity on milk yield, composition, somatic cell count, renneting parameters and bacteria counts of Comisana ewes. *Small Ruminant Research*, 37: 99–107.

SNOWDER, G. D., GLIMP, H. A., 1990: 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.

THOMAS, D. L., BERGER, Y. M., MC KUSICK, B. C., GOTTFREDSON, R. G., 2000: Comparison of East Friesian-crossbred and Lacaune-crossbred ewe lambs for dairy sheep production. In: *Proceedings of the 6th Great Lakes Dairy Sheep Symposium*. Guelph, Ontario, Canada, 10–16.

THOMAS, D. L., BERGER, Y. M., GOTTFREDSON, R. G., TAYLOR, T. A., 2004: Comparison of East Friesian and Lacaune breeds for dairy sheep production in North America. In: *Proceedings of the 10th Great Lakes Dairy Sheep Symposium*. Hudson, Wisconsin, USA: The Dairy Sheep Association of North America, 115–123.

Address

Ing. Leona Konečná, prof. Dr. Ing. Jan Kuchtík, Ing. Šárka Králíčková, Ing. Michaela Pokorná, Ing. Radek Filipčík, Ph.D., Department of Animal Breeding, doc. Ing. Květoslava Šustová, Ph.D., Ing Táňa Lužová, Ph.D., Department of Food Technology, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic, e-mail: konecna@mendelu.cz