Factors affecting goat milk yield and its composition

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ABSTRACT: The aim of the paper was to prove the accuracy of various statistical models of variance analysis for estimation of systematic factors that influence milk yield and fat and protein content in dairy goats. Data on daily milk production recorded by methods AT, AC or A4 for the population of Czech White Shorthaired Goats over 1992–2002 was used for calculations. A total of 78 736 test day from 6 234 goats were analysed. Average daily milk production was 3.09 kg with 3.72% of fat and 2.84% of protein. Variability of examined traits was significantly influenced by effects of herd-year or herd-test day, litter size, parity, season of kidding, stage of lactation and the combined effect parity-year-season of kidding. The variants of model equations in which complex effects of herd-year were replaced by effects of herd-test day showed higher values of reliability for the three traits analysed.

Keywords: Czech White Shorthaired Goat; fat; protein; lactation curve; test day

The main goal of dairy goat production is to improve traits related with milk performance. It is possible to apply stronger selection in goats than in dairy cows due to higher fertility and shorter generation interval. Nevertheless, the lack of suitable Genetic Evaluation System (GES) is a serious obstacle for more intensive genetic progress in dairy goats. In the Czech Republic, the dairy goat population consists of a high percent of small herds (< 10 animals) that ranged from about 77% in 1992 to 30% in 2001 (CMA, 2002). In addition, the artificial insemination is not used either for tests of bucks in different herds or for maximal utilization of the best bucks in the population.

The main goal of this paper is to prove the suitability of various statistical models of variance analysis for estimation of systematic factors that influence milk yield and its composition in dairy goats. This analysis is needful for the construction of optimal model equations for breeding value estimation (BVE) in the conditions of the Czech Republic. A similar topic was analysed by Večeřová and Křížek (1993a), Milerski and Mareš (2001), Ciappesoni *et al.* (2002a). Margetín (1999) recommended to include the combined effect of herd × year × season, effects of lactation number, litter size, linear regression on interval from birth to first control and length of lactation period and random additive genetic and fixed environmental effects of goat into the model equation for BVE in dairy goats in the Slovak Republic. Bagnicka and Lukaszewicz (1999) compared several models of the BLUP Animal Model in the Polish population of dairy goats. Various authors (Iloeje *et al.*, 1981; Boichard *et al.*, 1989; Analla *et al.*, 1996; Brežnik *et al.*, 1997; Ciappesoni *et al.*, 2002b) presented estimated genetic and phenotypic parameters in dairy goats.

BVE for milk production traits in dairy goats was presented by Analla *et al.* (1995), Sullivan (2000), Wiggans *et al.* (2000), Clément *et al.* (2002) and others. The methods of BVE for dairy goats used in different countries were reviewed by Montaldo and Manfredi (2002). Brežnik *et al.* (1997), Sullivan (2000) or Ciappesoni *et al.* (2002b) reported the use of test-

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day Animal Model for BVE in dairy goats. Milerski *et al.* (1999) found considerable differences in the evaluation of individual animals between the system of evaluation of dairy goats presently used in the Czech Republic and BVE done by BLUP Animal Model.

MATERIAL AND METHODS

Data from the official milk recording of the Czech White Shorthaired breed of goats provided by the Sheep and Goat Breeders Association (SCHOK) was used as the basic material for our calculations. The analysed data were recorded in the period from 1992 to 2002. Daily milk production was recorded by methods AT, AC or A4 (ICAR, 2001). Although the analysed data were recorded in production operations, several fixed effects were included in the model. The most marked effects will be chosen using the ordinary Least Squares Method and the procedure GLM (SAS, 1996).

Several checks of performance records were carried out in order to exclude logical inconsistencies and biological improbabilities: (a) Age at first kidding had to be at least 275 days. (b) Difference between lactation number and period (in years) from birth to the 31/12/*n* (*n* = production year): 0.5–2 years. (c) Test-day records included for year *n* had to be between the dates 1st October *n*-1 and the 31st March *n*+1. (d) Kidding date had to be between the dates 1st October *n*-1 and the 30th September *n*. Other used criteria are shown in Table 1. Poor quality data were excluded from the followings computations. The original performance record database included 87 736 test-day records. The number of data considerably diminished after the introduction of the above-mentioned criteria, a total of 78 736 records of daily milk production, 77 536 records of fat percentage and 78 269 records of protein percentage in milk from 6 234 goats were finally analysed.

Table 1. Criteria to exclude logical inconsistencies and biological improbabilities

Criteria	Min.	Max.
Milk (kg)	0.3	9.0
Fat (%)	1.5	9.0
Protein (%)	1.0	8.0
DIM (days)	10	365
Age at 31/12/*n** (years)	0.5	15

*n = production year

The effects of herd, test day, number and stage of lactation, production year, kidding season and litter size were tested using the followings five models:

Model 1: $y_{ino} = htd_i + e_{ino}$

Model 2: $y_{ijklmno} = hy_i + lr_j + S_k + kid_l + lst_m + e_{ijklmno}$

Model 3: $y_{ijklmno} = htd_i + lr_j + S_k + kid_l + lst_m + e_{ijklmno}$

Model 4: $y_{ijklno} = htd_i + kid_k + a_{lj} + b_{lj} \times DIM_{jno} + c_{lj} \times DIM^2_{jno} + d_{lj} \,.\, DIM^3_{jno} + e_{ijklno}$

Model 5: $y_{ijklno} = htd_i + kid_k + a_{lj} \times p_{0\,jno} + b_{lj} \times p_{1jno} + c_{lj} \times p_{2\,jno} + d_{lj} \times p_{3\,jno} + e_{ijklno}$

where: $y_{ijklmno}$, y_{ijklno}, y_{ino} = *o*-th test day observation of milk yield (kg), fat or protein content (%) of goat *n*

hy_i = combined fixed effect of herd-year *i* (2 511 levels)

htd_i = combined fixed effect of herd-test-date *i* (17 204 levels)

lr_j = fixed effect of lactation number (4 levels: 1st, 2nd, 3rd and later lactations)

s_k = fixed effect of season of kidding (5 levels: from December to January, February, March, April and from May to November)

kid_l, kid_k = fixed effect of litter size (1, 2 and 3 and more kids)

lst_j = fixed effect of lactation stage (15 levels: intervals of 20 days from 0 to 300 DIM)

a, b, c, d_{lj} = fixed regression coefficients of *l*-th lactation curve effect in *j*-th lys

lys_j = time-independent combined fixed effect of lactation-year-season of kidding *j* (206 levels)

DIM = Days In Milk

p_0, p_1, p_2, $p_{3\,jno}$ = terms of the third degree Legendre polynomial with four coefficients with $p_0 = 1$, $p_1 = z$, $p_2 = 0.5\,(3z^2 - 1)$, $p_3 = 0.5\,(5z^3 - 3z)$, $z = [2(DIM\text{-}10)/290] - 1$

e_{ijklm} = random residual

RESULTS AND DISCUSSION

Means and standard deviations for examined traits: milk yield (MY), protein percent (PP) and fat percent (FP) are given in Table 2. The daily average of milk production was 3.09 kg. Brežnik *et*

Table 2. Descriptive statistics of production parameters

Trait	Valid *n*	Mean	SD	Min.	Max.
Milk (kg/day)	78 736	3.09	1.30	0.30	9.00
Fat (%)	77 536	3.72	0.99	1.50	8.99
Protein (%)	78 269	2.84	0.47	1.00	7.96

al. (1997) reported the average of milk production 1.98 kg per test-day in dairy goats in Slovenia. In the Czech Republic, Večeřová and Křížek (1993a) found higher average milk production of 1 180 kg during 285 days of lactation (on average 4.14 kg/day) in a set of dairy goats, on the contrary Milerski and Mareš (2001) and Ciappesoni *et al.* (2002a) observed lower average milk yield of 2.58 and 2.93 kg/day for the white and the brown Czech breeds, respectively. The observed averages for fat and protein contents are comparable to results obtained by other authors (Večeřová and Křížek, 1993a; Brežnik *et al.*, 1997; Milerski and Mareš, 2001; Ciappesoni *et al.*, 2002a). At an international level the obtained averages are comparable with France, where the average production of the Alpine breed was 753 kg of milk in a lactation of 277 days and 3.58% and 3.14% of fat and protein respectively (Institut de l'Elevage and France Contrôle Laitier, 2000). Contrariwise, Analla *et al.* (1996) found higher percentages of milk fat (5.4%) and milk proteins (3.5%) in Murciano-Granadina goats in Spain, whilst the milk production per lactation was 334 kg on average for that population.

In Tables 3 to 5, the results of analysis of variance for each production parameter according to five different models are presented. As the comparison of determination coefficients (R^2) and residual standard deviations between the five models shows, the variants of model equations in which complex effects of *hy* were replaced by effects of *htd* (models 1 and 3–5) resulted in markedly higher values of R^2 for the three traits analysed, such results are in agreement with Milerski and Mareš (2001). Models 4 and 5 with non-linear (polynomial) regression explained a slightly higher part of variance than the models with the stage of lactation included into equations as a class effect (models 2 and 3). The determination coefficients reached by model 1 for the three traits were markedly higher than the R^2 of model 2 and only slightly lower than the R^2 of model 3, which means that a higher part of variation is explained by the herd-test-date effect. There were not any dif-

Table 3. Analysis of variance of milk yield

Model		1	2	3	4	5
R^2		0.788793	0.599904	0.805108	0.814048	0.814048
Res. standard dev. (kg)		0.674729	0.833970	0.648006	0.637298	0.637298
Degrees of freedom		17 204	2 519	17 121	17 947	17 947
F-test – levels of statistical significance of the effect	hy_i		< 0.0001			
	htd_i	< 0.0001		< 0.0001	< 0.0001	< 0.0001
	lr_j		< 0.0001	< 0.0001		
	s_k		< 0.0001	< 0.0001		
	kid_l		< 0.0001	< 0.0001	< 0.0001	< 0.0001
	lst_m		< 0.0001	< 0.0001		
	a_{lj} (= lys_j)				< 0.0001	
	$b_{lj} \times DIM_{jno}$				0.1692	
	$c_{lj} \times DIM^2_{jno}$				0.1464	
	$d_{lj} \times DIM^3_{jno}$				0.2884	
	$a_{lj} \times p_{0\,jno}$ (= lys_j)					< 0.0001
	$b_{lj} \times p_{1\,jno}$					< 0.0001
	$c_{lj} \times p_{2\,jno}$					0.0090
	$d_{lj} \times p_{3\,jno}$					0.2884

Table 4. Analysis of variance of fat content

Model		1	2	3	4	5
R^2		0.588411	0.273732	0.590790	0.601733	0.601733
Res. standard dev. (%)		0.720598	0.859389	0.719176	0.714441	0.714441
Degrees of freedom		17 136	2 513	17 053	17 879	17 879
F-test – levels of statistical significance of the effect	hy_i		< 0.0001			
	htd_i	< 0.0001		< 0.0001	< 0.0001	< 0.0001
	lr_j		0.5065	0.0191		
	s_k		< 0.0001	< 0.0001		
	kid_{l-}		0.0392	0.0023	0.0030	0.0030
	lst_m		< 0.0001	< 0.0001		
	a_{lj} (= lys_j)				< 0.0001	
	$b_{lj} \times DIM_{jno}$				< 0.0001	
	$c_{lj} \times DIM^2_{jno}$				< 0.0001	
	$d_{lj} \times DIM^3_{jno}$				< 0.0001	
	$a_{lj} \times p_{0\,jno}$ (= lys_j)					< 0.0001
	$b_{lj} \times p_{1\,jno}$					< 0.0001
	$c_{lj} \times p_{2\,jno}$					< 0.0001
	$d_{lj} \times p_{3\,jno}$					< 0.0001

Table 5. Analysis of variance of protein content

Model		1	2	3	4	5
R^2		0.624491	0.339384	0.626551	0.638255	0.638255
Res. standard dev. (%)		0.329531	0.391914	0.328055	0.325096	0.325096
Degrees of freedom		17 111	2 514	17 028	17 854	17 854
F-test – levels of statistical significance of the effect	hy_i		< 0.0001			
	htd_i	< 0.0001		< 0.0001	< 0.0001	< 0.0001
	lr_j		0.0637	0.5024		
	s_k		< 0.0001	0.0006		
	kid_l		< 0.0001	0.0001	0.0006	0.0006
	lst_m		< 0.0001	< 0.0001		
	a_{lj-} (= lys_j)				< 0.0001	
	$b_{lj} \times DIM_{jno}$				< 0.0001	
	$c_{lj} \cdot DIM^2_{jno}$				< 0.0001	
	$d_{lj} \cdot DIM^3_{jno}$				< 0.0001	
	$a_{lj} \times p_{0\,jno}$ (= lys_j)					< 0.0001
	$b_{lj} \times p_{1\,jno}$					< 0.0001
	$c_{lj} \times p_{2\,jno}$					< 0.0001
	$d_{lj} \times p_{3\,jno}$					< 0.0001

ferences between the R^2 of models 4 and 5. Minimal differences (only in regression parameters for MY) between models 4 and 5 were observed.

Tables 6 to 8 show Least Squares Means (LSM) by effects according to model 3. Different letters (superscript) indicate statistical differences between the LSM of each level. In accordance with Milerski and Mareš (2001), the effects of *herd-year (hy)* and *herd-test-date (htd)* significant influenced the three traits examined according to the five models.

In agreement with some authors (Zeng and Escobar, 1995; Browning *et al.*, 1995; Pacheco *et al.*, 1998; Antunac *et al.*, 1998; Fernández, 2000; Antunac *et al.*, 2001; Milerski and Mareš, 2001; Ciappesoni *et al.*, 2002a), all the models found the *lactation number (lr)* effect as a variation source of milk yield while the first-lactation goats had the significantly lowest milk production per day. The milk yield increased progressively with the parity until the 3rd lactation (Table 6). A slightly lower yield in the 4th and further lactations was obtained. The differences between MY were as follows: 11.7%; 15% and –1.5% between 1st and 2nd, 2nd and 3rd and 3rd and 4th and further lactations, respectively. Křížek *et al.* (1992) mentioned differences of 15, 11 and 3–5% between parities. Margetín (1999) recommended the following correction coefficients for milk production of goats on different lactations: 1st lactation

Table 6. Effect of lactation number on milk yield and composition (model 3)

Lactation number	LSM		
	milk yield (kg/day)	fat content (%)	protein content (%)
1	2.91^{a****}	3.52^{a}	2.83^{a}
2	3.25^{b****}	3.54^{b*}	2.83^{a}
3	3.42^{c****}	3.54^{a,b}	2.82^{a}
4 and more	3.37^{d****}	3.55^{b**}	2.82^{a}

a, b, c, d: LSMs rows with no common superscripts differ (****P < 0.0001; **P < 0.01; *P < 0.05)

Table 7. Effect of season of kidding on milk yield and composition (model 3)

Season of kidding	Months	Milk yield (kg/day)					Fat content (%)					Protein content (%)				
		LSM	2	3	4	5	LSM	2	3	4	5	LSM	2	3	4	5
1	Dec–Jan	2.668	n.s.	*	**	***	3.70	**	****	****	****	2.87	n.s.	*	**	***
2	February	2.699		***	***	****	3.74		***	***	****	2.88		***	***	****
3	March	2.733			*	***	3.78			n.s.	****	2.89			*	***
4	April	2.729				*	3.80				***	2.91				*
5	May–Nov	2.673					3.89					2.93				

Significance: ****P < 0.0001; ***P < 0.001; **P < 0.01; *P < 0.05; n.s. not significant

Table 8. Effect of litter size on milk yield and composition (model 3)

Litter size	LSM		
	milk yield (kg/day)	fat content (%)	protein content (%)
1	3.49^{a****}	3.83^{a**}	2.85^{a}
2	3.59^{b****}	3.83^{a***}	2.84^{b****}
3 and more	3.71^{c****}	3.80^{b}	2.84^{b*}

a, b, c: LSMs rows with no common superscripts differ (****P < 0.0001; ***P < 0.001; **P < 0.01; *P < 0.05)

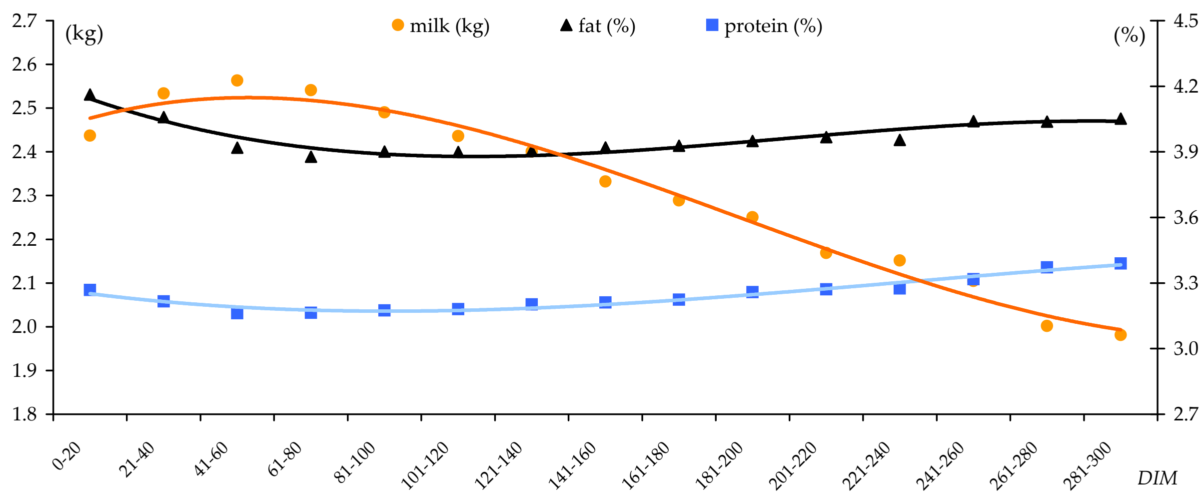
1.40; 2nd lactation 1.12; 3rd and further lactations 1.00. The correction coefficients estimated according to model 3 were: 1st lactation 1.18; 2nd lactation 1.05; 3rd and further lactations 1.00.

In addition, statistically significant differences in the fat contents depending on *lr* levels were observed with model 3. First-lactation goats had a significantly lower fat content than goats in 2nd and 4th and further lactations. Contrariwise, Večeřová and Křížek (1993b) found a decreasing trend of milk fat content by the lactation number. In accordance with Zeng and Escobar (1995) the influence of *lr* on protein content was not observed.

Statistically significant differences caused by the season of kidding *(s)* in the three traits were found with model 2 and 3. Similar results were found by other authors (Pedauye, 1989; Gipson and Grossman, 1990; Pacheco *et al.*, 1998). The effect of the season of kidding on milk yield and composition (according to model 3) is shown in Table 7. The most of the kidding took place in February and March, 32.6 and 38.2%, respectively. Goats kidding in March and April had the highest milk yields. Probably, the lower milk yields of the goats kidding in the first two seasons (December–January and February) were caused by the poor quality feed and the change of the winter to the summer ration when they reached the lactation peak (between 40–80 days in milk). A significant increasing trend of the FP and PP with later season of kidding was observed.

The effect of litter size (*kid*) was significant in all the models for the three traits. The highest value of daily milk production was found in goats with three and more kids. This fact is in agreement with the results presented by some authors (Gipson and Grossman, 1990; Večeřová and Křížek, 1993b; Browning *et al.*, 1995; Milerski and Mareš, 2001; Ciappesoni *et al.*, 2002a), who reported a lower milk production in goats with single litters (Table 8). Nevertheless, Fernández (2000) and Večeřová and Křížek (1993b) did not find the litter size as a source of milk production variation. In agreement with Milerski and Mareš (2001) the highest protein contents were observed in goats with single litters and lower fat contents in does with three and more kids.

In concordance with other authors (Voutsinas *et al.*, 1990; Haenlein, 1996; Zeng *et al.*, 1997), the effect of *lactation stage* (lst) was observed as a source of variation for the three traits in both models (2 and 3). Figure 1 shows the average lactation curves of MY, FP and PP and their respective 3rd degree polynomial trend lines. All three traits showed statistically significant differences throughout lactation. In agreement with Křížek *et al.* (1992), the milk yield increased from the 40th to 80th day in milk (*DIM*). After this peak, the milk production descended pro-



3rd order polynomial trend lines

x = lactation stage

Milk	$y = 0.0005x^3 - 0.0136x^2 + 0.0717x + 2.4182$	$R^2 = 0.983$
Fat	$y = -0.0005x^3 + 0.0171x^2 - 0.1487x + 4.2748$	$R^2 = 0.8994$
Protein	$y = -0.0002x^3 + 0.007x^2 - 0.056x + 3.3007$	$R^2 = 0.9586$

Figure 1. Lactation curves of milk yield and fat and protein content (model 3)

gressively until the end of the lactation, the average diminution was about –2.2% per period of 20 days. Such a low decrease of the lactation (correction) curve was probably caused by strong seasonality of kidding in goats in the Czech Republic. Does measured within one test day were usually in the same stage of lactation so a large part of variability caused by the days in milk effect could also be explained by the effect of test day. Křížek *et al.* (1992) mentioned a reduction of milk yield from 8 to 15% per month. The production peak between the 20th and 30th day reported by Haenlein (1996) would not correspond to the conditions in the Czech Republic. In accordance with Haenlein (1996), the milk components (FP and PP) showed an inverse trend in comparison with MY. The lowest values were reached between 40 and 80 *DIM*.

The lactation-year-season (*lys*) effect was found as a source of variation in the three traits for all the models.

In both models (4 and 5) the effects of *regression parameters for lactation curves* for FP and PP were highly statistically significant ($P < 0.0001$). In the case of milk yield, according to model 4 the effects of regression parameters were not statistically significant. On the contrary, model 5 found it as a source of variation with the exception of the third degree element. For this reason, despite the fact that determination coefficients of both models were equal, the Legendre polynomial (model 5) appears to describe better the variation of milk performance through the lactation than the 3rd degree polynomial (model 4).

Based on the comparison of determination coefficients and residual standard deviations of the five models studied, models 4 and 5 were chosen for the estimation of genetic and phenotypic parameters of dairy goats.

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REFERENCES

Analla M., Jiménez-Gamero I., Munozserrano A., Seradilla J.M., Falagán A. (1996): Estimation of genetic parameters for milk yield and fat and protein contents of milk from Murciano-Granadina goats. J. Dairy Sci., *79*, 1895–1898.

Analla M., Muñoz-Serrano A., Serradilla J.M. (1995): Dairy goat breeding systems in the South of Spain. In: Gabiña D. (ed.): Strategies for Sheep and Goat Breeding. Proceedings of the Meeting of the joint FAO/CIHEAM Network on Sheep and Goats, Subnetwork on Animal Resources, Sidi-Thabet, Tunisia, 26–28 March 1995. Cahiers Options Méditerranéennes, *11*, 143–154.

Antunac N., Kaps M., Havranek J.L., Samaržija D. (1998): Effects of breed and parity on some dairy traits of Alpine and Saanen goats in Croatia. In: Proceedings International Symposium on the Milking of Small Ruminants, Athens, Greece. EAAP Publication, No. 95, 460–462.

Antunac N., Samarzija D., Havranek J.L., Pavic V., Mioc B. (2001): Effects of stage and number of lactation on the chemical composition of goat milk. Czech J. Anim. Sci., *46*, 548–553.

Bagnicka E., Lukaszewicz M. (1999): Genetic and environmental variation of dairy traits in a Polish population of goats. Animal Science Papers and Reports, Polish Academy of Sciences, *17*, 59–65.

Boichard D., Bouloc N., Ricordeau G., Piacere A., Barrilet F. (1989): Genetic parameters for first lactation dairy traits in the Alpine and Saanen goat breeds. Genet. Sel. Evol., *2*, 205–215.

Brežnik S., Kovač M., Kompan D., Malovrh Š. (1997): Genetic and environmental parameters of test day for milk yield, fat, protein and lactose content of dairy goats. In: Proc. 48th Annual Meeting of the EAAP, Vienna, 1997.

Browning R. Jr., Leite-Browning M.L., Sahlu T. (1995): Factors affecting standardized milk and fat yields in Alpine goats. Small Ruminant Res., *18*, 173–178.

Ciappesoni C.G., Milerski M., Přibyl J. (2002a): Parámetros productivos de cabras de la raza checa marrón de pelo corto. In: XXVII Jornadas Científicas y VI Jornadas Internacionales SEOC, 19–21 de septiembre Valencia (España), 819–825.

Ciappesoni C.G., Milerski M., Gabrielová H. (2002b): Estimation of breeding values in dairy goats with test day model (in Czech). In: Sborník přednášek z 5. mezinárodní konference a setkání chovatelů (SCHOK), 15.–16. listopadu 2002, Seč, Czech Republic, 93–96.

Clément V., Boichard D., Piacère A., Barbat A., Manfredi E. (2002): Genetic evaluation of french goats for dairy and type traits. In: Proc. 7th World Congress on Genetics Applied to Livestock Production, Montpellier, France, 2002, CD-Rom Comm. No. 01–46.

CMA (Czech Ministry of Agriculture) (2002): Situační a výhledová zpráva – ovce a kozy [online]. Ministerstvo zemědělství ČR, 2002, [cited 2002-10-16]. Available from: http://www.mze.cz/

Fernández G. (2000): Parámetros productivos de cabras Pardo Alpinas y sus cruzas, bajo régimen de pastoreo. Producción Latina, *XXV*, 541–544.

Gipson T.A., Grossman M. (1990): Lactation curves in dairy goats: a review. Small Ruminant Res., *3*, 383.

Haenlein G.F.W. (1996): Composition of goat milk and factors affecting it. In: Goat Management [online]. University of Delaware [cited 2002-12-16]. Available from: <http://ag.udel.edu/extension/information/goatmgt/gm-list.htm>

ICAR (International Committee for Animal Recording) (2001): ICAR rules, standards and guidelines for milk recording in goats. In: International Agreement of Recording Practices [online] ICAR, updated in May 2001, [cited 2002-10-1]. Available from: http://www.icar.org/

Iloeje M.U., Van Vleck L.D., Wiggans G.R. (1981): Components of variance for milk and fat yields in Dairy goats. J. Dairy Sci., *64,* 2290–2293.

Institut De L'elevage – France Contrôle Laitier (2000): Résultats de contrôle laitier des espèces bovines et caprines. Paris, France. 78 pp.

Křížek J., Mátlová V., Skřivánek M., Šafaříková H., Šimák P., Škarda J., Večeřová D. (1992): Chov koz. Farm, Praha.

Margetín M. (1999): Systém zvyšovania efektívnosti chovu kôz využitím racionálnych metód selekcie a plemenitby. Výskumný ústav živočíšnej výroby, Nitra, 16 s.

Milerski M., Mareš V. (2001): Analysis of systematic factors affecting milk production in dairy goat. Acta Univ. Agric. et Silvic. Mendel. Brun (Brno), *1*, 43–50.

Milerski M., Šafus P., Mareš V. (1999): Porovnání různých metod hodnocení dojivosti koz. In: Význam chovu ovcí a koz v předvstupním období do EU, 19.–20. 11. 1999, Seč, Česká republika, 87–90.

Montaldo H., Manfredi E. (2002): Organisation of selection programmes for dairy goats. In: Proc. 7th World Congress on Genetics Applied to Livestock Production, Montpellier, France, 2002, CD-Rom Comm. No. 01–35.

Pacheco F., Monteiro A., Lopes Z., Barros M. (1998): Contrôle latièr caprin dans la région du Minho (Portugal). In: Proceedings International Symposium on the Milking of Small Ruminants, Athens, Greece, EAAP Publication No. 95, 460–462.

Pedauye J. (1989): Lactation curve and milk composition in Murciano-Granadina goats breed. Anales de Veterinaria, *5*, 3.

SAS Insititute Inc. (1996): SAS/STAT User's Guide, Version 6.12. Fourth Edition, Vol. 2, SAS Institute, Inc., Cary, NC.

Sullivan B.P. (2000): Genetic Evaluations of Canadian Dairy Goats [online]. In: Proc. 7th International Conference on Goats. Poitiers, France, May 20, 2000, [cited 2002-10-16]. Available from: http://www.ccsi.ca/goats/7icg/cdn-text.htm

Večeřová D., Křížek J. (1993a): Výběr modelů pro odhad plemenné hodnoty koz na podkladě mléčné užitkovosti. Živoč. Výr., *38,* 9–20.

Večeřová D., Křížek J. (1993b): Analýza variance mléčné užitkovosti koz bílého krátkosrstého plemene. Živoč. Výr., *38*, 961–967.

Voutsinas L., Pappas C., Katsiari M. (1990): The composition of Alpine goats milk during lactation in Greece. J. Dairy Res., 57, 41–51.

Wiggans G.R., Hubbard S.M., Wright J.R. (2000): Genetic evaluation of dairy goats for yield and type. In: 7th International Conference on Goats, Tours, France, May 20, 2000.

Zeng S.S., Escobar E.N. (1995): Effect of parity and milk production on somatic cell count, standard plate count, and composition of goat milk. Small Ruminamt. Res., *17*, 269–274.

Zeng S.S., Escobar E.N., Popham T. (1997): Daily variations in somatic cell count, composition, and production of Alpine goat milk. Small Ruminant. Res., *26*, 253–260.

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ABSTRAKT

Analýza faktorů ovlivňujících produkci mléka koz a její složení

Cílem práce bylo porovnat vhodnost použití různých statistických modelů analýzy proměnlivosti pro odhad systematických faktorů ovlivňujících produkci mléka, obsah tuku a obsah bílkovin u dojných koz. Pro analýzy byly použity záznamy z kontroly užitkovosti pomocí metod AT, AC i A4 u populace českých bílých krátkosrstých koz z let 1992–2002. Do souboru bylo zařazeno celkem 78 736 záznamů kontrolních měření u 6 234 koz. Průměrný denní nádoj mléka byl 3,09 kg s tučností 3,72 % a obsahem bílkovin 2,84 %. Proměnlivost analyzovaných užitkových vlastností byla průkazně ovlivněna efekty stáda a roku nebo kontrolního dne, četností vrhu, stáří kozy, období kozlení, fází laktace nebo sdruženým efektem věku kozy, roku a období kozlení. Varianty modelové rovnice, u kterých byl sdružený efekt stáda a roku nahrazen modelovou rovnicí s efektem stáda a kontrolního měření se vyznačovaly vyšším podílem vysvětlené proměnlivosti.

Klíčová slova: česká bílá krátkosrstá koza; mléčný tuk; laktační křivka; mléčné bílkoviny; kontrolní den

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