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Conference paper

GENETIC PARAMETERS WITH TEST-DAY MODEL IN SLOVENIAN DAIRY SHEEP

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Summary

Validation of multiple-trait animal test-day model and the estimation of (co)variance components in Slovenian dairy sheep were performed. For the period 1994-2002, 41145 test-day, records of 3317 ewes (2081 Bovec, 525 Improved Bovec and 717 Istrian pramenka) were used. The model contained breed only in joint analysis across breeds. Days in milk, parity and litter size were treated as covariates. Random part of the model consisted of common flock environment within test month as flock-year-month, permanent environment as ewe within parity and additive genetic effect. Heritabilities for all breeds together were 0.25 for daily milk yield, 0.14 for fat (FC) and 0.12 for protein content (PC). New estimates of (co)variance components are proposed for regular genetic evaluations in Slovenian dairy sheep. In addition, there are indications for specific lactation curves within flock as well as animal-suggesting random regression models for further research.

Keywords: dairy sheep, genetic parameters, test-day model

Introduction

Grassland represents two thirds of agricultural land in Slovenia. Most of meadows and pastures are in the hilly and Karst regions, where cultivation is difficult. Therefore, these regions are abandoned and more and more overgrown with shrubs or forest. Sheep breeding is becoming important to prevent the overgrowth of agricultural land.

Currently, the dairy sheep represent 25 % of recorded sheep population in Slovenia (Komprej et al., 2003). An accurate prediction of breeding values is needed for the efficient selection of breeding animals. In the last ten years, the

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prediction of breeding values for milk traits with test-day model has been introduced (Ptak and Schaeffer, 1993). The use of test-day model has the advantage of modelling records at their origin. The accuracy of breeding values by this approach is higher due to a larger number of records per animal. There is also no need to wait to the end of lactation. Due to mating season of sheep before the end of lactation, this method shortens generation interval and thus, increases genetic progress at the same intensity of selection. In sheep, test-day model was used by Barillet and Boichard (1994), Baro et al. (1994), El-Saied et al. (1998), Brežnik (1999), Serrano et al. (2001), Volanis et al. (2002), Oravcova et al. (2002) and some others. Kominakis et al. (2001) and Horstick and Distl (2002) have already used random regression model.

The genetic analysis of Andonov (1994) in goats was the first application of test-day model in Slovenia Brežnik (1999) applied test-day model for (co)variance components estimation in sheep. Since then, the number of test-day records in sheep has increased substantially. Therefore, the aim of our study was to validate the model and estimate the (co)variance components with multiple-trait animal test-day model for daily milk yield (DMY), fat (FC) and protein content (PC) for dairy sheep in Slovenia.

Material

Data for three Slovenian dairy sheep breeds, Bovec (BO), Improved Bovec (IB) and Istrian pramenka (IP), were obtained from Slovenian selection program for small ruminants. ICAR regulations (method A4) are used in milk recording. For the period 1994-2002, 41145 test-day records of 3317 ewes (2081 B, 525 IB and 717 IP) were included. Only records with known daily milk yield, fat and protein content were used. Pedigree file contained 3743 (2369 BO, 729 IB and 799 IP) animals of both sexes. The 2169 (57.95 %) animals had at least one ancestor known and the rest of them (1574) had both unknown.

Among all three breeds, the Bovec sheep had the highest average daily milk yield (1089 g, Table 1). Lower average daily milk yield in Improved Bovec sheep could appear due to smaller number of records at the beginning of lactation and unexperienced breeders with a new genotype. In fact, the native Bovec sheep was improved with the East Friesian sheep and additional cause could also be a sensitivity of East Friesian breed to our climate. In contrast to daily milk yield, the Istrian pramenka had the highest fat content (7.23 % vs. 6.57 % for BO and 6.25 % for IB) as well as the highest protein content in milk (5.65 % vs. 5.53 % for BO and 5.35 % for IB).

Table 1. - BASIC STATISTICS BY BREED

Breed	N	Mean	SD	Min	Max
Bovec (BO)					
Daily milk yield (g)	27727	1089	742	50	5720
Fat content (%)		6.57	1.60	1.51	17.31
Protein content (%)		5.53	1.14	2.64	12.85
Days in milk		110	51.7	5	305
Improved Bovec (IB)					
Daily milk yield (g)	6693	996	608	58	5760
Fat content (%)		6.25	1.34	1.84	12.82
Protein content (%)		5.35	0.89	2.52	10.21
Days in milk		137	56.0	6	292
Istrian pramenka (IP)					
Daily milk yield (g)	6725	708	402	50	3360
Fat content (%)		7.23	1.62	1.79	15.16
Protein content (%)		5.65	0.90	2.64	12.38
Days in milk		124	52.5	5	301

Methods

Genetic evaluation was performed for all breeds together as well as for each breed separately. Daily milk yield, fat and protein contents were modelled with test-day model (1). The model contained effect of breed (B) only in joint analysis across breeds. Days in milk (x), parity (z), and litter size (w) were treated as covariates. Days in milk (DIM) were limited from 5 to 305 days and modelled with modified Ali-Schaeffer's lactation curve (Ali and Schaeffer, 1987). Instead of 305, a constant 150 was used because lactation usually ends earlier than in cows. Parities eight and higher were considered as one group. The same was done with the litter size of three lambs and more. Simple quadratic and linear regressions were used for parity and litter size, respectively. Random part of the model contained the effect of common flock environment within test month as flock-year-month (f), permanent environment as ewe within parity (p) and additive genetic effect (a). Usual assumptions were applied to covariance structure. Effects and levels for all random effects and residual were assumed to be unrelated except relationship provided by pedigree for additive genetic effect.

$$y_{ijklm} = \mu + B_i + \sum_{n=1}^{4} b_{ni}x_n + b_5(z_{ijklm} - \bar{z}) + b_6(z_{ijklm} - \bar{z})^2 + b_7(w_{ijklm} - \bar{w}) + f_j + a_{il} + p_{ikl} + e_{ijklm} \quad (1)$$

$$x_1 = x_{ijklm}/c, \quad x_2 = (x_{ijklm}/c)^2, \quad x_3 = \ln(c/x_{ijklm}), \quad x_4 = (\ln(c/x_{ijklm}))^2, \quad c = 150 \quad (2)$$

Development and validation of the model as well as the basic statistics were done by SAS (SAS, 2001). (Co)variance components were estimated by VCE-5 (Kovač and Groneveld, 2002) by multiple-trait animal model.

Results and discussion

Fixed effects

The fixed part of the model explained from 41.54 % for FC to 54.50 % for DMY variation in test-day records. The effect of DIM nested within breed accounted for the majority of explained variation: from 38.01 % for FC to 47.77 % for DMY. High values can be explained with the coincidence of DIM and season (month) of production. Due to the same reason, we also encountered problems by fitting the fixed effect of season in the model. Therefore and also because of small flocks, the season was modelled with random effect as a common flock environment within test month.

Stage of lactation was modelled with modified Ali-Schaeffer's lactation curve, which was not reasonable in the previous study of Breznik (1999), due to a small amount of records at the beginning of lactation. Instead, Breznik (1999) used a simple quadratic regression to sufficiently describe the declining phase of lactation. Shape of the lactation curve for DMY (Figure 1) was as expected; an increase to the peak, which was reached after the first month of lactation, and a decrease after the peak. However, there was no decrease at the beginning of lactation for: FC and PC (Figure 2 and 3), as it can be observed in cows. Only an increase after lambing was noticed.

Figure 1. - LACTATION CURVES FOR DAILY MILK YIELD WITHIN BREEDS

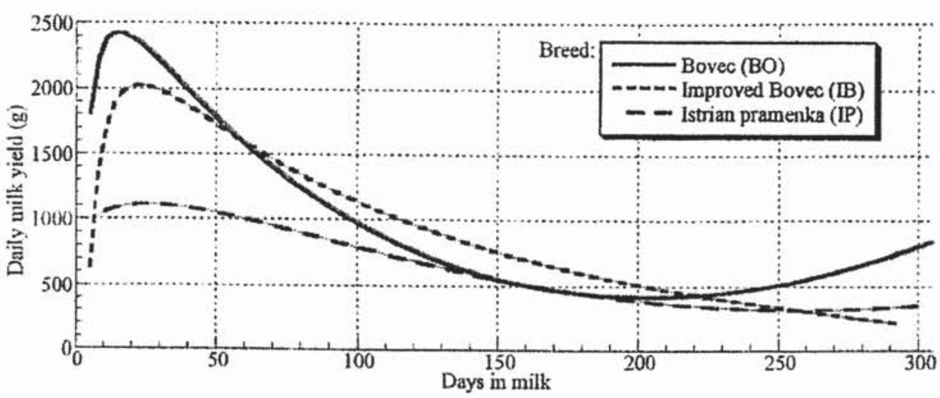


Figure 2. - LACTATION CURVES FOR FAT CONTENT WITHIN BREEDS

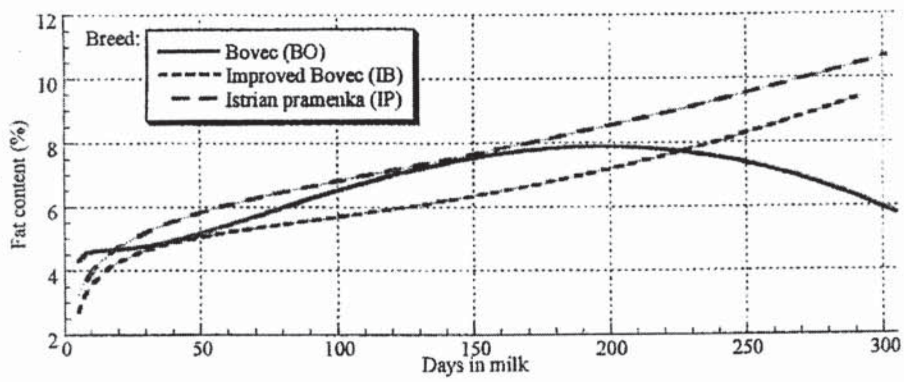
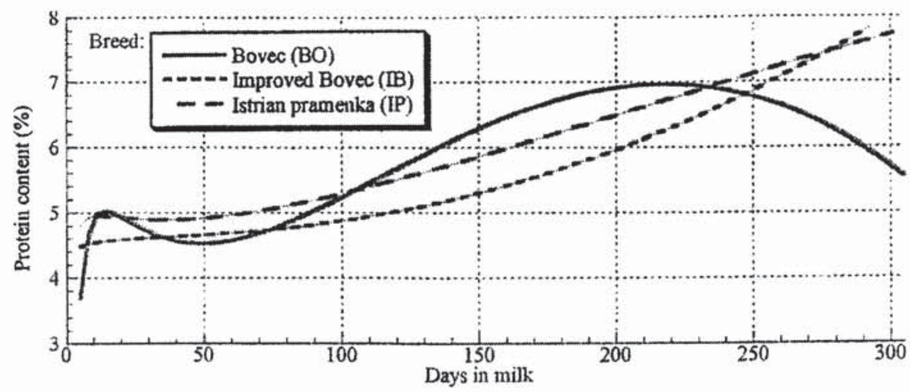


Figure 3. - LACTATION CURVES FOR PROTEIN CONTENT WITHIN BREEDS



The lactation curves for all three traits differed significantly among breeds (p=0.0001). BO and IB breeds had higher DMY and lower FC and PC compared to IP. After approximately 150 days in milk, all three lactation curves for breed BO changed the shape: an increase for DMY and a decrease for FC and PC. This was not in agreement with the common knowledge about the shape of lactation curve in ruminants. The unusual shape for DMY was mainly a consequence of one large flock with 5743 records, high DMY (1504 g on average), lower FC and PC and longer lactations (180 days on average). DMY increased to fourth lactation (1122 g) and decreased slowly after, while FC decreased to third lactation (6.57 %) and increased after. With increased litter size DMY increased linearly, while FC and PC decreased.

Random effects

Common flock environment within test month explained 25% of phenotypic variation in DMY for all breeds (Table 2). Estimates for BO and IP breeds were similar, while the estimate for IB was higher. In FC and PC, common flock environment within test month for all breeds explained higher proportion of phenotypic variation: 0.46 and 0.61, respectively. Low values for permanent environment were obtained for DMY (0.12 to 0.17). Estimates for FC and PC were even lower, from 0.01 to 0.04.

Table 2. - ESTIMATES WITH STANDARD ERRORS FOR VARIANCE PROPORTIONS AND PHENOTYPIC VARIANCE

Effect*	Trait	All breeds	Bovec (BO)	Improved Bovec (IB)	Istrian pramenka (IP)
f^2	DMY	0.25±0.007	0.25±0.008	0.41±0.009	0.23±0.010
	FC	0.46±0.006	0.46±0.009	0.42±0.01	0.50±0.020
	PC	0.61±0.007	0.60±0.008	0.59±0.01	0.58±0.020
p^2	DMY	0.15±0.003	0.14±0.004	0.12±0.007	0.17±0.009
	FC	0.02±0.001	0.01±0.002	0.04±0.004	0.03±0.004
	PC	.0.01*0.0009	0.01±0.001	0.01±0.002	0.02±0.003
h^2	DMY	0.25±0.006	0.26±0.007	0.21±0.010	0.26±0.010
	FC	0.14±0.003	0.13±0.005	0.17±0.010	0.11±0.007
	PC	0.12±0.003	0.13±0.004	0.15±0.007	0.12±0.007
V_P	DMY(g^2)	202547	223396	247535	115057
	FC ($\%^2$)	1.772	1.832	1.279	1.974
	PC ($\%^2$)	0.852	0.910	0.585	0.706

*c2 - common flock within test-month; p2 - permanent environment; h2 - heritability; Vp - phenotypic variance

Heritability estimate for DMY for all breeds was 0.25. BO and IB breed had similar estimate (0.26), while estimate for IB breed was lower (0.21). Heritabilities for FC and PC from our data were around 0.13 and were similar among breeds. In IB breed, the heritability for FC was higher (0.17). These estimates were slightly higher than those from previous study on Slovenian data by Brežnik (1999), who reported 0.20 for DMY, 0.11 for FC and 0.10 for PC. The averages of heritabilitiy estimates from Barillet and Boichard (1994), Baro et al. (1994), El-Saied et al. (1998), Serrano et al. (2001) and Volanis et al. (2002) were 0.28 for DMY, 0.33 for FC and 0.31 for PC. Higher estimates than in our study could be caused by fitting herd test-day or herd year-season effect as fixed and such reducing phenotypic variance. On the other hand, Oravcova et al. (2002) reported lower heritabilities with random flock year-month interaction for two breeds: 0.10 and 0.19 for DMY, 0.06 and 0.12 for FC and 0.07 and 0.14 for PC.

Conclusions

The heritability estimates for DMY, FC and PC were slightly higher than those from previous study on Slovenian data. Average estimates from literature are higher, mostly due to different models. New estimates of (co)varianee components are proposed for regular genetic evaluations in Slovenian dairy sheep. In addition, there are indications for specific lactation curves within flock as well as animal suggesting random regression models for further research.

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GENETIČKI PARAMETRI S MODELOM DNEVNOG TESTA U SLOVENSKE MLIJEČNE OVCE

Sažetak

Ispitivana je opravdanost modela dan testiranja životinja mnogostrukih osobina i obavljena procjena komponenata (ko)varijance u slovenske mliječne ovce. Za razdoblje 1994-2002. upotrijebljeno je 41145 zapisa dana testiranja 3317 ovaca (2081 pasmine Bovec, 525 Poboljšani Bovec i 717 istarske Pramenke). Model je sadržavao pasminu samo u zajedničkoj analizi kroz pasmine. Dani laktacije, paritet i veličina legla tretirani su kao kovarijance. Slučajno izabran dio modela sastojao se od zajedničke okoline stada u mjesecu testiranja kao stado - godina - mjesec, stalne okoline kao pariteta ovce unutar pariteta i dodatnog genetičkog djelovanja. Nasljednosti za sve pasmine zajedno bile su 0,25 za dnevni prinos mlijeka, 0,14 za masnoću (FO) i 0,12 za sadržaj bjelančevina (PC). Predlaže se nova procjena komponenata (ko)varijance za redovito genetičko procjenjivanje slovenske mliječne ovce. Osim toga, postoje indikacije za specifične krivulje laktacije unutar stada kao i životinja pa se predlažu slučajni modeli regresije za dalje istraživanje.

Ključne riječi: mliječna ovca, genetički parametri, model dnevni test

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