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ESTIMATION OF GENETIC PARAMETERS FOR MILK TRAITS OF FLECKVIEH RECORDS NOT SUBJECTED TO CULLING

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SUMMARY

Records of 305-day Fleckvieh lactation for yields of milk (MY), fat (FY), protein (PY), fat-plus-protein (FPY) and carrier (CY) were examined and estimates of genetic, phenotypic and environmental variations and covariations were obtained for the first three lactations as well as for combined all lactations. A total of 26874 records representing 10466 cows sired by 650 bulls extracted from 50788 records were used.

Means and standard deviations of milk traits increased with advancing of parity. Greater increase in yield traits was found from first to second lactation than from second to third lactation. Coefficients of variation (CV) for milk traits ranged from 12.9% to 17.2% in the first lactation, from 11.4% to 17.8% in the second lactation and from 14.3% to 15.5% in the third lactation. Estimates of CV% for FY was higher than that for PY.

The sire of the cow affected significantly (P<0.001) all milk traits of the first three lactations. For all milk traits, the sire variance component (σ^2_s) expressed as percentage (V%) decreased with advance of lactation from 6.7- 7.8% in the first lactation to 5.4-6.1% in the third lactation. The percentages of variance component attributable to the sire for all milk traits were moderate and ranged from 5.4% to 7.8%. Moderate sire heritabilities (h^2_s) concurred with moderate estimates of sire variance components for yield traits. Estimates of h^2_s ranged from 0.27 to 0.31 in the first lactation, from 0.25 or 0.27 in the second lactation and from 0.22 to 0.24 in the third lactation. Heritability of the first lactation was high and decreased with advance of lactation. In each lactation, heritability estimates were lower for PY than that for FY, whereas both MY and CY were in close agreement.

The cow within sire contributed significantly (P<0.001) to variation of all milk traits. The percentage of variance component attributable to cow within sire for milk traits were high and ranged from 27.4% to 43.3%. Repeatability estimates for all milk traits were fairly moderate or slightly high ranging from 0.33 to 0.49.

Genetic correlations (r_G) in the first three lactations between yield traits were positive and high, ranging from 0.87 to 1.0. Phenotypic correlations (r_P) of milk traits were also positive and high ranging from 0.83 to 1.00. The same trend was also observed for environmental correlations (r_E). Estimates of r_P and r_E were higher than those corresponding estimates of r_G in the second and third lactations for yield traits. FPY had the highest correlations with all yield traits excluding CY which reached unity with MY.

Keywords: Fleckvich, genetic parameters, milk traits, culling

INTRODUCTION

Heifer yield is a good indicator of lifetime performance (Hoque and Hodges, 1980), but neglecting information of later lactations will lead to possible changes in the ranking of sires over lactations. In Austria, Essl (1982 & 1984) concluded that selection of Fleckvieh, Braunvieh and Pinzgauer AI bulls should be based on records of the third lactation of their daughters. In addition, selection of bull dams should take place on the earliest lactation after the record of the third lactation is completed. In practice, assessing the value of later records for both sire and cow evaluation requires, in the first instance, knowledge of the genetic parameters concerned, i.e. heritabilities and genetic correlations. Meyer (1984) reported that first lactation yield is not only an efficient selection criterion for lifetime production since the performance in all lactations is determined more or less by the same genes, but including later lactations will improve the precision of sire evaluation only to a limited extent. Also, including later lactations will create more ties between sires, i.e. daughters of a sire will be compared with daughters of other sires which had no records in the 1st lactation, and consequently increase the accuracy of evaluation.

The objective of present study was to estimate the sire and error variances and covariances for milk traits (milk, fat, protein, fat-plus-protein and carrier yield) of Fleckvieh records.

MATERIALS AND METHODS

Data

Data on performance of 305-day lactation of Fleckvieh cattle were obtained from Official Test Federation of Austrian Cattle Breeders (ZAR) in lower Austria. Detailed descriptions of these data have been presented previously by Hartmann et al. (1992). Records were begun between 1977 and 1982. A total of 26874 lactation records representing 650 sires were used. All normal records of less than 305 day milk length along with those reaching 305 day were included.

Heifers were inseminated when they reached an average of 320 Kg body weight, while cows were inseminated during the 1st heat period after 60 days post-partum. AI technique was used, avoiding half-sib, full-sib and sire-daughter matings.

Milk traits of 305-day lactation included yields of milk (MY), fat (FY), protein (PY), fat-plus-protin (FPY) and carrier (CY= MY -(FY+PY)). The data set comprised only cows that have information on their first lactation and subsequent later ones. However, those cows having information of later lactations with no first lactation information were eliminated. To avoid bias due to differences among sires in the average values of herd, each record was expressed as a deviation from the average of the herd which belong to it, i.e. herd effect was eliminated. Consequently, any herd that contains only one record didn't contribute to the present study. Also, if the cow was changed from a herd to another, her records were eliminated. Each sire was represented in at least two different herds.

Statistical Models

Data of the first three lactations were analysed for each lactation separately. Herd-adjusted data of each lactation was analyzed separately using the least-square maximum likelihood mean weighted (LSMLMW) computer program of Harvey (1990). The model adopted was:

$$Y_{iklmn} = \mu + S_i + YS_k + A_l + D_m + e_{iklmn} \quad \text{(model 1)}$$

where: Y_{iklmn}= 2X-305 milk record expressed as a deviation from the herd average, μ= the overall mean, S_i= the random effect of ith sire, YS_k= the fixed effect of kth year-season combination (K=16), A_l= the fixed effect of lth age at calving (subclasses classified monthly from <24 month to 61 month), D_m= the fixed effect of mth days open (subclasses starting from <45 days as a first class and intervals of 30 days thereafter) and e_{iklmn}= the random error (0, σ^2_e). Estimates of variance and covariance components were calculated using LSMLMW program (Harvey, 1990) depending on method 3 of Henderson for such estimation (Henderson, 1984). Paternal half-sib analysis of variance was utilized to obtain estimates of h^2_s for each lactation as: $h^2_s = 4\sigma^2_s/(\sigma^2_s+\sigma^2_e)$. Estimates of genetic ($r_G$) and phenotypic ($r_P$) correlations between any two milk traits were also calculated. The respective standard errors of the genetic correlations were approximated according to Harvey (1990) as described by the formula of Swiger et al. (1964).

Data of all lactations were analysed using the following mixed model:

$$Y_{ijklmn} = \mu + S_i + C_{ij} + Y_{Sk} + A_l + D_m + e_{ijklmn} \quad \text{(model 2)}$$

where all terms as in model (1) except C_{ij}= the random effect of jth cow nested within the random effect of ith sire and A_l= the fixed effect of age at calving (in terms of three-month interval starting from <24 month, till 77 month). Heritabilities across all lactations (h^2_s) were calculated as: $h^2_s = 4\sigma^2_s/(\sigma^2_s + \sigma^2_c + \sigma^2_e)$. Repeatability estimates (t) for milk traits were calculated across all lactations as: $t = (\sigma^2_s + \sigma^2_{c:s})/(\sigma^2_s + \sigma^2_{c:s} + \sigma^2_e)$.

Standard errors of h^2 and t estimates were computed according to Harvey (1990).

RESULTS AND DISCUSSION

Means and variations

Means, phenotypic standard deviations (SD), coefficients of variation (CV%) and determination (R2) of yields of milk (MY), fat (FY), protein (PY), fat-plus-protein (FPY) and carrier (CY) in the first three lactations and across all lactations are given in Table 1. As expected, means and phenotypic standard deviations of milk traits increased with advancing parity. Greater increase in yield traits was found from first to second lactation than from second to third lactation. The present estimates generally fall within the range of those estimates obtained from Fleckvieh cattle in most Austrian studies (e.g. Soliman et al., 1990; Soliman and Khalil, 1993). Results given in Table 1 indicate that estimates of standard deviation for each trait tend to increase with the increase of the mean of the trait in each lactation (a scale effect).

For the first three lactations and all lactations, estimates of CV for yield traits ranged from 11.0% to 17.8% (Table 1). Similarly, the Austrian studies (e.g. Soliman and Khalil, 1989; Soliman et al., 1990; Soliman and Khalil, 1993) reported higher variation for yield traits. The CV% for FY was higher than that for PY, which was in agreement with findings of many other studies (e.g. Soliman and Khalil, 1989; Soliman et al., 1990; Ashmawy and Khalil, 1990; Soliman and Khalil, 1993). Meyer (1985) concluded that high CV indicate that there was short-term environmental variation affecting dairy performance. In Australian cattle, the high CV could be explained by misidentification of some sires in Australian milk recording system (Meyer, 1985) which may have a reduction effect on the variance between sires. The latter author added that the high CV clearly demonstrates a substantially higher residual variance in this population (21% in Australian cattle vs 14% in British cattle). Sire variance components and heritability estimates in each lactation.

The sire of the cow affected significantly (P<0.001) all milk traits of the first three lactations (Table 2). Most of the studies evidenced this trend (e.g. Berger et al., 1981; White et al., 1981; Soliman and Khalil, 1989; Soliman et al., 1990; Ashmawy and Khalil 1990; Soliman and Khalil; 1993).

Table 1. Means, standard deviations (SD), percentages of variation (CV%) and coefficients of deter-mination (R^2) of milk traits in the first three lactations and across all lactations of Fleckvieh records

Trait	Mean	SD	CV%	R^2 of model
First lactation				
MY	3803	608.4	14.8	0.523
FY	155	25.9	15.6	0.518
PY	155	21.5	12.9	0.519
FPY	279	45.2	15.0	0.520
CY	3486	554.9	14.8	0.523
Second lactation				
MY	4351	719.6	15.2	0.527
FY	191	31.1	16.1	0.523
PY	172	23.6	11.4	0.524
FPY	324	53.5	15.2	0.525
CY	3981	652.4	15.1	0.527
Third lactation				
MY	4731	729.6	14.3	0.523
FY	194	32.2	15.6	0.519
PY	154	23.6	14.3	0.520
FPY	350	54.4	14.5	0.520
CY	4381	679.5	14.4	0.523
All lactations				
MY	4254	783.5	11.0	0.663
FY	174	33.9	12.1	0.651
PY	168	28.7	11.5	0.669
FPY	314	58.67	11.5	0.661
CY	3949	729.3	10.8	0.590

Estimates (σ^2) and percentages (V%) of variance component due to sire and remainder and heritability estimates (h^2_s) for milk traits in the first three lactations are presented in Table 3. Sire variance component (σ^2_s) expressed as percentage (V%) decreased from the first to the third lactation, while the residual variance component (σ^2_e) takes the reverse direction (Table 3), i.e. with advance of lactation the sire genetic variance decreases along with an increase in the nongenetic variance. The same trend was reported by many other workers (e.g. Tong et al., 1979; Karras and Schlote, 1982; Pape et al., 1983; Romberg et al., 1983; Meyer 1984; Soliman et al., 1990; Soliman and Khalil, 1993). In contrast, Meyer (1985) on Australian cattle, found that both sire and residual components increased proportionally by about 20% from the first to the second lactation for MY and FY. This suggests a scale effect associated with the increase of production from the first to the second lactation. However, Boldman and Freeman (1990) reported that the sire variance component is increased with increasing production level.

Table 2. F-ratios of least-squares ANOVA for milk traits in the first three lactations of Fleckvieh records

Source of variation	df	MY	FY	PY	FPY	CY
First lactation						
Sire	646	2.3***	2.4***	2.2***	2.4***	2.3***
Year-season	13	17.8***	11.7***	19.7***	16.3***	17.9***
Age at calving	14	11.6***	11.6***	11.7***	12.8***	11.8***
Days open	5	104.6***	81.9***	61.5***	78.7***	103.8***
Remainder df	10207					
Remainder mean square		314912	578	401	1749	359277
Second lactation						
Sire	646	2.1***	2.1***	2.2***	2.2***	2.1***
Year-season	11	22.8***	16.9***	20.5***	19.0***	22.7***
Age at calving	16	16.8***	16.3***	15.2***	16.6***	17.0***
Days open	5	98.8***	84.0***	92.4***	92.1***	99.2***
Remainder df	10202					
Remainder mean square		439366	831	472	2429	502333
Third lactation						
Sire	397	1.8***	1.7***	1.7***	1.7***	1.8***
Year-season	7	16.7***	13.7***	12.2***	13.4***	16.8***
Age at calving	12	5.2***	4.4***	4.4***	4.5***	5.2***
Days open	5	43.2***	35.1***	42.7***	40.4***	42.9***
Remainder df	4685					
Remainder mean square		459523	913	486	2588	398452

***= P<0.001.

The percentages of variance component attributable to the sire for all milk traits were moderate and ranged from 5.4% to 7.8% (Table 3). This range was lower than that of 11.1% to 13.6% reported by Soliman and Khalil (1989) on Braunvieh cattle and also lower than that of

7.5% to 10.7% reported by Soliman et al. (1990) on Pinzgauer cattle. However, the moderate variance component due to sire suggests that there is a considerable opportunity for selection in this population (McDowell et al., 1976; Aboubakar et al., 1987).

Table 3. Estimates of variance component due to sire (σ^2_s) and remainder (σ^2_e), and sire heritability estimates (h^2) for milk traits in the first three lactations of Fleckveih records

	Sire		Remainder			
Trait	σ^2_s	V%	σ^2_e	V%	h^2	SE
First lactation						
MY	24310	7.2	314913	92.8	0.29	.027
FY	49	7.8	578	92.2	0.31	.028
PY	29	6.7	401	93.3	0.27	.026
FPY	147	7.8	1750	92.2	0.31	.028
CY	27953	7.2	359278	92.8	0.29	.027
Second lactation						
MY	29100	6.2	439366	93.8	0.25	.025
FY	59	6.6	831	93.4	0.26	.026
PY	34	6.7	473	93.3	0.27	.026
FPY	179	6.9	2429	93.1	0.27	.026
CY	33391	6.2	502334	93.8	0.25	.025
Third lactation						
MY	29412	6.0	459524	94.0	0.24	.037
FY	52	5.4	914	94.6	0.22	.036
PY	28	5.5	487	94.5	0.22	.036
FPY	153	5.6	2588	94.4	0.22	.036
CY	25801	6.1	398453	93.9	0.24	.037

Moderate sire heritabilities concurring with moderate sire variance component estimates were obtained (Table 3). However, heritability estimates of yield traits agreed with those previously published (Soliman and Khalil, 1993); most estimates ranged between 0.2 to 0.3. The present estimates were larger than those reported by Meyer (1985) (0.1-0.2) on Australian cattle, while they were lower than those estimates reported in Austrian studies (e.g. Soliman and Khalil 1989; Soliman et al., 1990). The lower estimates reported by Meyer (1985) could therefore, in part, be attributable to the comparatively low level of production in Australia. Boldman and Freeman (1990) reported that estimates of each variance component (genetic, permanent and