Egyptian J. Anim. Prod.(1993) 30(1):21-37.

Estimation of Genetic Parameters for Single and Composite Milk Traits in Fleckvieh Cattle and Their Uses in Programmes of Early Selection

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SUMMARY

Data on 58767 Austrian Fleckvieh lactation records representing 985 AI sires were used to estimate the change of genetic parameters of 100- and 305-day lactation milk traits with the advance of parity up to the fourth one. Milk traits were yields of milk, fat and protein as single traits and yield of fat-plus-protein and protein to fat ratio as composite traits. In most cases, sire of cow, cow-within-sire, year, season of calving, year X season interaction and both days open and age at calving (as linear and quadratic covariates) had pronounced effects ($P<0.001$) on all milk traits. Heritabilities for all traits decreased with advance of lactation number. The estimates of 100-day lactation in the first four lactations ranged from 0.08 to 0.27 for milk yield, 0.0 to 0.22 for fat yield, 0.08 to 0.21 for protein yield, 0.03 to 0.23 for fat-plus- protein and 0.06 to 0.09 for protein to fat ratio, while the corresponding estimates for 305-day lactation were 0.09 to 0.31; 0.09 to 0.32; 0.13 to 0.27; 0.11 to 0.31 and 0.11 to 0.15. Repeatabilities for yield traits in 100-day lactation were 0.41 for milk yield, around 0.30 for yields of fat, protein and fat-plus-protein and 0.14 for protein to fat ratio, while the corresponding estimates in 305-day lactation were 0.47, 0.40 and 0.23 in the same order. High and positive genetic, phenotypic and environmental correlations among yield traits were obtained among/ and within 100- and 305-day lactation. Fat-plus-protein yield had the highest correlations with all yield traits; the estimates were almost constant across all lactations especially for the relationship among this trait and both fat and protein yields. No consistent trend in sign or magnitude was observed for the relationship between protein to fat ratio with all traits studied;

Issued by Egyptian Society of Animal Production.

most estimates between this trait and protein yield was high and positive.

Keywords: Dairy Cattle, Single and Composite Milk Traits, Genetic Parameters, Early Selection

INTRODUCTION

Most recent studies of genetic parameters in dairy cattle have suggested that records of the first lactation is more important than any later lactation for evaluating the breeding value of the dairy animal. However, with emphasis on selection based on first lactation yield, interest has concentrated the effect of this on later lactations. These investigations generally indicated that the first lactation is more highly heritable than later lactations (e.g. Soliman et al, 1990). Assuming the genetic parameters are the same for all lactations, where they are in fact different, they would decrease the genetic improvement by introducing errors in the selection of dairy animals. In this respect, there has been growing interest in sire evaluations for all lactation records of daughters to provide more accurate sire proofs as well as cow evaluations (e.g. Henderson, 1975; Slanger et al, 1976; Hintz et al, 1978; Essl, 1982&1984). 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 third lactation record of the cow is completed. This research was carried out with the objective (1) to estimate genetic parameters of some 100- and 305-day milk traits of the first four lactations in Fleckvieh cattle with special emphasis on the composite traits of fat-plus-protein yield and protein to fat ratio, and (2) to investigate the possibility of early selection for 305-day milk traits on the basis of 100-day lactation traits.

MATERIAL AND METHODS

Data

Lactation records of 58767 Fleckvieh cows of Official Test Federation of Austrian Cattle Breeders (ZAR) in Lower Austria were collected. All records were 305-day, but all normal records of less than 305 days in length were included. Data were available on 19215, 19105, 12468 and 7979 daughters representing 933, 985, 812 and 652 sires in the 1st, 2nd, 3rd and 4th lactations, respectively. The data were restricted further to daughters produced by AI so that differences in culling practices between herds would not appear as differences between bulls. Each sire must have daughters in at least two herds and each herd must have at least two sires to be included in the data. Thus for each daughter, all lactation records used in the analysis were made in the same herd. All AI services were made using deep-frozen semen with the restriction of avoiding half-sib, full-sib and sire-daughter matings. A more complete description of the breeding policy and management followed were given by Hartmann et al. (1992). Milk traits of 100-day lactation were yields of milk (100M), fat (100F), protein (100P), fat-plus-protein (100FP) and protein to fat ratio (100PFR), while the corresponding traits for 305-day lactation were 305M, 305F, 305P, 305FP and 305PFR, respectively. All traits were expressed as a deviation from the herd average and therefore, the herd effect was eliminated.

Statistical models

Data for each parity was analyzed separately using the LSMLMW computer program of Harvey (1990). The following mixed model was adopted to analyse data of all milk trait stated above:

$$Y_{ijkl} = \mu + S_i + A_j + Y_k + (AY)_{jk} + b_L(X1_{ijkl} - X1_\mu) + bQ(X1_{ijkl} - X1_\mu)^2 + b_L(X2_{ijkl} - X2_\mu) + b_Q(X2_{ijkl} - X2_\mu)^2 + e_{ijkl} \quad ...... (1)$$

where Y_{ijkl} = performance of the observation ijkl expressed as deviation from the herd average; u= the overall mean, S_i= random effect of the ith sire; A_j= fixed effect of the jth season of calving; Y_k= fixed effect of the kth year of calving; $(AY)_{jk}$= effect of the interaction between season and year of calving; b_L= linear regression coefficient of Y on X; b_Q= quadratic regression coefficient of Y on X; $X1_{ijkl}$= age at calving of the lth cow; $X1_\mu$ =average age at calving in month; $X2_{ijkl}$= days open of the lth cow ; $X2_\mu$=average days open, and e_{ijkl}= a random error (0, $\sigma^2 e$).

Data of all lactations were analyzed by adopting the model:

$$Y_{ijklmn} = \mu + S_i + C_{ij} + A_k + Y_l + P_m + (AY)_{kl} + (AP)_{km} + b_L(X1_{ijklmn} - X1_\mu) + b_Q(X1_{ijklmn} - X1_\mu)^2 + bL(X2_{ijklmn} - X2_\mu) + bQ(X2_{ijklmn} - X2_\mu)^2 + e_{ijklmn} \quad ...(2)$$

Where all terms are explained in the previous model, except C_{ij}= random effect of jth cow nested within a random effect of ith sire, and Pm= fixed effect of mth parity and $(AP)_{km}$= effect of the interaction between season of calving and parity.

Estimates of sires ($\sigma^2 S$) in the first model, cows-within sire ($\sigma^2_{C:S}$) in the second model and remainder ($\sigma^2 e$) components of variance and covariance were computed according to method 3 of Henderson. Paternal half-sib analysis of variance and covariance was utilized to obtain the estimates of heritability and correlations. Heritability (h^2) estimates were calculated for each separate parity as: $h^2 = 4\sigma^2_S/(\sigma^2_S + \sigma^2 e)$. Repeatability (t) estimates were calculated as: $t = (\sigma^2_S + \sigma^2_{C:S})/(\sigma^2_S + \sigma^2_{C:S} + \sigma^2 e)$. Standard errors for h^2 and repeatability estimates were computed according to Harvey (1990). Estimates of genetic (r_G)

(with standard errors), phenotypic (r_p) and environmental (r_E) correlations were obtained by computing techniques described by Harvey's program (1990). The weighted averages of heritability or genetic correlation and their standard errors across all parities were calculated according to Dempfle (1975) using Weighted Least Squares.

RESULTS AND DISCUSSION

Means and variation

Means and coefficients of variations (CV%) for 100- and 305-day milk traits of the first four parities are given in Table 1. The results show that yield traits increased up to the fourth lactation, while the variations (CV%) showed an obvious opposite trend for all traits studied. The estimates of CV for composite traits were about twice as large as those for protein to fat ratio. The pattern of the increase of yield traits with parity showed a much greater rise from first to second lactation than with any other two lactations. The protein to fat ratio in 100- and 305-day lactation (0.80 to 0.82) exceeded the value (0.78) reported by Hardie et al. (1978). A lower fat percent and higher protein percent accounted for this difference.

TABLE 1. Mean and their standard deviations (SD) and coefficient of variation (CV%)+ for 100- and 305-day single and composite milk traits of the first four lactations in Fleckvieh cattle.

Traits	1st lactation			2nd lactation			3rd lactation			4th lactation		
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
100MY (kg)	1554	239	14.5	1866	286	14.5	2032	287	13.6	2083	287	13.4
100FY (Kg)	61	11	16.4	74	11	14.5	80	11	12.8	81	10	12.4
100PY (Kg)	49	8	15.8	59	9	14.9	63	9	14.0	65	9	13.8
100FPY (Kg)	110	18	15.2	133	19	13.8	144	18	12.3	146	18	12.1
100PFR (%)	79	9	10.4	82	8	9.6	80	8	9.4	80	8	9.6
305MY (Kg)	3790	629	17.5	4316	717	15.4	4657	718	14.5	4787	706	14.0
305FY (Kg)	154	26	16.0	178	31	16.4	192	32	15.7	197	32	15.5
305PY (Kg)	124	22	15.9	143	24	15.7	152	24	14.6	155	24	14.4
305FPY (Kg)	278	46	15.3	321	54	15.5	345	54	14.8	353	54	14.5
305PFR (%)	80	7	8.1	83	7	7.4	80	6	7.0	80	6	7.2
No. of records	19215			19105			12468			7979		

+Coefficient of variation computed as the residual standard deviation divided by overall least-squares mean of a given trait.

Estimation of non-genetic effects

The effects of year and season of calving on all traits in the first four parities (Table 2) were significant (P<0.001). The effects of interaction between year and season of calving on most traits were

TABLE 2. F-ratios of least-squares analysis of variance of 100- and 305-day single and composite milk traits of the first four lactations of Fleckvieh cows.

Source of var.	d.f	100M	100F	100P	100FP	100FFR	305M	305F	305P	305FP	305PFR
First lactation											
Sire	932	2.4	2.1	2.1	2.2	1.5	2.7	2.7	2.5	2.7	1.8
Year of calving(Y)	4	14.1	5.2	164.7	33.0	342.8	22.2	21.4	169.1	39.9	601.1
Season of calving(S)	3	30.2	17.4	155.2	51.3	232.0	37.7	24.0	262.5	94.3	515.6
Y x S	12	1.6^{ns}	2.5	44.4	8.7	99.0	1.3^{ns}	2.0	47.7	9.6	163.3
Regressions											
Age linear	1	193.1	196.6	163.5	203.0	5.1	155.4	168.2	160.6	177.7	0.4^{ns}
Age quadratic	1	2.9^{ns}	7.2	3.2^{ns}	6.1	2.2^{ns}	0.1^{ns}	0.9^{ns}	0.2^{ns}	0.5^{ns}	2.0^{ns}
Days open linear	1	52.5	47.3	19.6	37.7	20.4	721.6	551.4	684.8	657.0	18.2
Days open quadratic	1	0.9^{ns}	0.7^{ns}	5.5	2.5^{ns}	2.1^{ns}	135.4	95.2	211.4	151.6	52.3
Remainder mean sq.	18259	50746.6	100.3	59.1	278.6	67.5	332016.7	605.3	386.8	1817.3	41.7
Second lactation											
Sire	984	1.7	1.4	1.6	1.5	1.3	1.8	2.0	1.9	2.0	1.6
Year of calving(Y)	4	22.8	9.3	152.4	43.7	320.6	31.2	25.6	141.3	44.2	512.6
Season of calving(S)	3	31.0	9.9	113.3	39.3	205.8	33.8	22.3	201.2	76.2	541.0
Y x S	12	1.7^{ns}	3.1	43.4	12.8	97.9	1.0^{ns}	1.3^{ns}	41.5	9.7	152.7
Regression											
Age linear	1	285.3	305.0	252.0	320.6	4.4	338.7	304.4	259.1	304.0	16.0
Age quadratic	1	0.0^{ns}	1.0	0.2	0.6^{ns}	0.0^{ns}	0.1^{ns}	0.2	0.1^{ns}	0.1^{ns}	0.7^{ns}
Days open linear	1	118.7	93.4	91.4	106.0	0.5^{ns}	728.0	606.1	769.8	721.6	10.1
Days open quadratic	1	5.8	5.5	53.1	24.1	38.7	85.1	66.3	246.4	139.8	126.6
Remainder mean sq.	18097	73480.1	115.7	78.4	339.0	61.2	443221.3	846.5	505.0	2487.9	37.8
Third lactation											
Sire	811	1.4	1.2	1.3	1.3	1.1	1.5	1.5	1.6	1.5	1.4
Year of calving(Y)	4	17.7	7.7	54.9	20.2	92.6	21.5	15.9	50.8	21.9	157.1
Season of calving(S)	3	7.4	3.8	48.0	18.7	65.8	22.1	14.5	79.3	34.8	136.8
Y x S	12	0.4^{ns}	1.9	13.5	4.4	27.4	1.0^{ns}	1.5^{ns}	13.2	3.7	46.1
Regressions											
Age linear	1	104.3	91.1	57.8	86.9	4.0	98.2	80.3	69.4	79.8	7.6
Age quadratic	1	6.0	3.1	6.6	5.4	1.3^{ns}	4.5	3.6^{ns}	5.2	4.4	0.1^{ns}
Days open linear	1	92.3	79.6	68.1	85.3	0.2^{ns}	419.6	342.0	419.5	396.7	1.1^{ns}
Days open quadratic	1	7.6	13.6	22.6	19.9	3.5^{ns}	37.5	31.0	65.5	46.8	18.6
Remainder mean sq.	11633	76423.1	105.1	77.5	316.0	56.4	453943.2	914.9	494.1	2598.8	31.5
Fourth lactation											
Sire	652	1.2	1.0^{ns}	1.2	1.1	1.2	1.3	1.3	1.4	1.3	1.4
Year of calving(Y)	3	10.5	2.2^{ns}	12.1	24.8	20.2	12.9	7.2	10.9	7.4	26.8
Season of calving(S)	3	22.6	12.0	34.9	22.5	28.9	38.6	34.7	45.6	41.0	10.0
Y x S	9	1.3^{ns}	1.0^{ns}	2.5	1.5^{ns}	3.7	1.2^{ns}	1.2^{ns}	1.1^{ns}	1.1^{ns}	2.1
Regressions											
Age linear	1	56.2	52.1	22.6	41.9	9.2	70.1	67.2	42.4	59.7	21.2
Age quadratic	1	1.0^{ns}	0.1	1.5^{ns}	0.3^{ns}	4.3	1.2	0.4^{ns}	1.1^{ns}	0.0^{ns}	7.8
days open linear	1	51.5	36.7	32.9	41.1	0.0^{ns}	257.6	165.1	223.9	201.7	1.6^{ns}
days open quadratic	1	11.2	14.6	12.5	16.0	0.0^{ns}	38.9	23.7	39.3	31.8	2.2^{ns}
Remainder mean sq.	7307	78176.4	100.5	80.0	311.5	56.8	450985.5	936.5	501.1	2631.5	33.3

^{ns} non-significant, other F-ratios are significant at $P<0.05$, $P<0.01$ or $P<0.001$.

significant ($P<0.001$) in the first three parities, except on 100M, 305M and 305F where it was not significant (Table 2). Adjustment for interaction between year and season of calving, therefore, seems necessary if sire evaluation in yield traits other than milk and fat yields is to be recommend in such kind of data. Across all parities, significant partial linear regression coefficients ($P<0.001$) of yield traits on age at calving were observed (Table 2), except 100PFR ($P>0.05$). It can be concluded that adjustments for age effects are necessary to get more accurate sire evaluation for yield traits.

Days open affected ($P<0.001$) all yield traits of 100- and 305-day lactation across all parities (Table 2). In general, milk traits studied in both 100- and 305-day lactation increased linearly with the increase of days open. Blau and Scholz (1982) reported that the delaying of days open may be caused by several factors, e.g. the farmer's decision and selection policy. Accordingly, the farmers were to inseminate high-yielding cows later than moderate or low-producing cows. This could automatically produce a negative relation between yield traits and days open (Distl et al. 1985). From an economic point of view, farmers, therefore would inseminate their low-performance cows as early as possible. In this respect, an open period of 60 days is recommended as optimum days open for attaining maximum production (Soliman et al, 1989). The same trend was observed earlier by Soliman and Khalil (1989).

Heritability estimates

Estimates of heritability (h^2) for 100- and 305-day milk traits in the first four lactations are shown in Table 3. Estimates of h^2 for 305-day milk traits in the first four lactations ranged from 0.09 to 0.31 for 305M, 0.09 to 0.32 for 305F, 0.13 to 0.27 for 305P, 0.11 to 0.31 for 305FP, and 0.11 to 0.15 for 305PFR, while the corresponding estimates in 100-day lactation ranged from 0.08 and 0.27, 0.0 and 0.22, 0.08 and 0.21, 0.03 and 0.23 and 0.06 and 0.09, respectively. Heritabilities for yield traits expressed as weighted average of the estimated values of the first four lactations ranged from 0.11 to 0.18 and from 0.18 to 0.19 for 100-and 305-day lactation, respectively, while the respective estimates of protein to fat ratio were 0.06 and 0.13. It seems that h^2 of fat-plus-protein yield in all lactations followed the same trends as fat yield and protein yield. The h^2 estimated for protein exceeded those values reported in literature (e.g. Alps and Averdunk, 1984; Neimann-Sorensen et al, 1987). There was a quite large variation in h^2 estimates between parities in yield traits than in protein to fat ratio. h^2 estimates of yield traits of single and composite traits were about twice as high as protein to fat ratio (Table 3). However, estimates of h^2 for protein to fat ratio are lower than those previously reported by different studies (e.g. Gaunt, 1973; Hardie et al., 1977; White et al, 1981).

TABLE 3. Proportions of variance+ (%) due to sire and cow effects and heritability (h^2) and repeatability (t)++ for 100- and 305-day single and composite milk traits in the first four lactations of Fleckvieh cows.

Traits	100-day lactation			305-day lactation		
	t	VS%	h^2	t	VS%	h^2
Milk yield	0.41			0.47		
1st lactation		6.7	0.27		7.7	0.31
2nd lactation		3.8	0.15		4.3	0.17
3rd lactation		2.8	0.11		3.3	0.13
4th lactation		1.9	0.08		2.2	0.09
Weighted average			0.18			0.18
Fat yield	0.29			0.43		
1st lactation		5.4	0.22		8.0	0.32
2nd lactation		2.1	0.09		4.8	0.19
3rd lactation		1.3	0.05		3.4	0.13
4th lactation		0.0	0.01		2.4	0.09
Weighted average			0.11			0.18
Protein yield	0.31			0.40		
1st lactation		5.3	0.21		6.8	0.27
2nd lactation		3.0	0.12		2.6	0.18
3rd lactation		2.2	0.09		3.6	0.14
4th lactation		2.0	0.08		3.2	0.13
Weighted average			0.13			0.18
Fat-proten-yield	0.32			0.43		
1st lactation		5.7	0.23		7.8	0.31
2nd lactation		2.6	0.11		4.9	0.20
3rd lactation		2.0	0.08		3.5	0.14
4th lactation		0.8	0.03		2.7	0.11
Weighted average			0.12			0.19
Protein to fat ratio	0.14			0.23		
1st lactation		2.3	0.09		3.9	0.15
2nd lactation		1.5	0.06		2.8	0.12
3rd lactation		0.7	0.03		2.8	0.11
4th lactation		1.4	0.06		2.9	0.12
Weighted average			0.06			0.13

+ Sire (VS%) and cow-within-sire (VC%) effect were significant (P<0.001) for most traits in the different lactations.

++ Standard errors of heritabilities ranged from 0.00 to 0.025 and that of repeatabilities were 0.01.

The first lactation had higher h^2's than those of the second and subsequent lactations. In general, h^2's for the 2nd and 3rd lactations seem to be of similar magnitude and had lower estimates than that for the 1st lactation. This is in agreement with other studies (e.g. Karras and Schlote, 1982; Pape et al., 1983; Romberg et al., 1983; Alps and Averdunk, 1984; Soliman, 1984; Swalve and Van Vleck, 1986; Reinhardt et al., 1987; Soliman et al., 1990). The reported and present results were mainly due to that a fairly large increase in the non-additive genetic variance and decrease in the genetic variance from the 1st to subsequent lactations. One reason might be that the true difference in genetic variance between the first and the second lactations is larger than that between any other two lactations. Possible explanations for the decline of h^2 with the advance of parity, especially from the first parity to the second, may be as follow:

a) If all genes have equal effects, the first lactation is controlled by more pairs of genes than the second lactation or if the same number of genes control both lactations, they have larger effects on the first lactation.

b) The presence of genetic maternal effect that gradually decreases in importance in succeeding lactation could be cause the estimate of h^2 of first lactations to be larger.

c) The presence of constant genetic effects and an increase in the environmental effects in the second lactation will lead to lower estimates of heritability of the second lactation. Other environmental factors, such as variation in length of dry period, calving interval, age of cow at calving and mastitis which could not be fully accounted for by the model, would logically seem to add to the variation of second and later lactations.

d) The effect of selection on first lactation. One indication of this is that all cows with first records did not have a second record and this selection would be expected to reduce the variance of second records.

e) In some situations, several sires were used in a single herd and a few in just one year and season. For such a case, the herd and age effects (i.e. some of the genetic contributions from the sire) might have also been removed.

f) Different sets of genes with lesser additive effect are called upon to operate in subsequent lactations.

Repeatability estimates

Estimates of repeatability (t) for yield traits ranged from 0.29 to 0.41 for 100-day lactation and from 0.40 to 0.47 for 305-day lactation (Table 3). The corresponding estimates of PFR were 0.14 and

0.23, respectively. The standard errors of the estimates are around 0.01 (Table 3). Among yield traits, milk yields are slightly more repeatable than other traits. Repeatability estimates for 100M and 305M were of similar magnitudes (0.41 vs 0.47), but those of other traits of 305-day lactation were higher than those obtained by 100-day lactation. Estimates of repeatability obtained in this study for yield traits are within the range of those reported by other workers (e.g. Gaunt 1973) but lower than those by Soliman and Khalil (1989). Moderately high estimates of repeatability obtained here for 305-day lactation yield traits indicate that records beyond the first lactation actually add little new information about the producing ability of a cow. Accordingly, culling policies of cows for yield traits based on single record, would be efficient from a genetic standpoint and consequently, assessment of several records are not required before selecting cows for these yield traits.

Repeatability estimates are higher than their corresponding heritabilities of the different lactations and also higher than the h2 estimates as a weighted average of all lactations (Table 3). The estimates for milk traits were approxi mately twice as large as the corresponding weighted average of h2 estimates. This is because relationship between consecutive lactations generally increases as the cows get older (i.e. repeatability of consecutive records of the same cow tends to increase), while the h2 estimates tends to decrease with the advance of parity (e.g. Soliman, 1984; Neimann-Sorensen et al., 1987; Soliman and Khalil, 1989; Soliman et al., 1990). Selection based on culling policies, which was commonly applied by dairy cattle breeders in the 2nd and succeeding lactations, may be responsible for such decreasing in additive genetic variance.

Correlations

Estimates of genetic (r_G), phenotypic (r_P) and environmental (r_E) correlations between yield traits are presented in Table 4. In general, correlations between yield traits (r_G, r_P and r_E) are strongly positive and most of estimates were similar in magnitudes. Estimates of correlations between 100-day yield traits ranged from 0.92 to 0.99, 0.83 to 0.99, 0.76 to 1.00 and 0.62 to 1.00 in the first, second, third and fourth parities, respectively, while the corresponding ranges in 305-day lactation were 0.91 to 0.99, 0.87 to 0.99, 0.81 to 0.99 and 0.77 to 0.98. However, estimates of r_G, r_P and r_E obtained here fall within the range reported in literature (e.g. Blau and Scholz, 1982; Karras and Schlote, 1982; Pape et al., 1983; Alps et al, 1984; Simianer and Papst, 1984; Soliman, 1984; Dommerholt and Wilmink, 1986; Neimann-Sorensen et al., 1987; Soliman and Khalil, 1989; Soliman et al., 1990). High estimates of environmental correlations among milk traits are of interest for herd management purposes Such environmental associations among yield traits are relatively important within a given herd.

TABLE 4. Estimates of genetic (rG)[+] with standard errors, phenotypic (r_P) and environmental (r_E) correlations (x 100) among and between 100-day and 305-day lactation single and composite milk traits of Fleckvieh cattle

Traits		1st lactation			2nd lactation			3rd lactation			4th lactation		
		r_G	r_P	r_E	r_G	r_P	r_E	r_G	r_P	r_E	r_G	r_P	r_E
100M	:100F	92	85	82	85	80	80	88	76	75	a	75	a
	:100P	93	83	80	83	84	84	76	84	85	62	84	86
	:100FP	94	89	87	86	87	87	82	85	86	76	85	86
	:100PFR	-12	-08	07	21	05	03	27	16	16	62	21	18
	:305M	92	87	85	81	83	83	77	82	83	79	83	83
	:305F	84	79	77	57	72	75	48	71	74	36	71	74
	:305P	88	75	71	62	71	73	53	72	75	46	72	75
	:305FP	88	80	77	60	74	77	51	74	77	42	74	77
	:305PFR	-13	-09	08	05	-08	-10	06	-10	12	28	-08	-12
100F	:100P	93	78	75	90	77	75	98	74	72	a	73	a
	:100FP	99	96	95	97	95	95	100	94	94	a	94	a
	:100PFR	-32	-37	-38	08	-33	-36	63	-30	-33	a	-25	a
	:305M	86	73	69	78	67	66	71	63	63	a	62	a
	:305F	92	83	81	81	76	76	73	73	74	a	72	a
	:305P	88	69	63	78	63	62	77	61	60	a	61	a
	:305FP	92	80	76	81	73	73	76	70	70	a	69	a
	:305PFR	-36	-30	-29	-21	-34	-36	-03	-39	-43	a	-35	a
100P	:100FP	98	93	91	97	93	92	98	92	91	107	92	92
	:100PFR	07	27	31	51	33	32	71	40	39	121	46	42
	:305M	88	70	65	78	70	69	65	70	70	64	70	70
	:305F	87	70	64	73	68	67	66	68	68	56	68	69
	:305P	94	84	81	86	81	81	81	79	80	85	81	81
	:305FP	91	79	75	81	76	76	74	75	75	71	76	76
	:305PFR	-03	24	29	22	18	17	28	13	09	73	15	09
100FP	:100PFR	-16	-10	-09	01	-11	-13	68	03	00	139	09	04
	:305M	88	76	72	80	72	72	68	70	71	79	71	71
	:305F	92	82	79	79	77	77	70	76	77	69	75	76
	:305P	92	80	76	84	76	75	80	75	74	96	75	75
	:305FP	93	84	81	82	79	79	76	77	78	84	78	78
	:305PFR	-22	-07	-04	01	-11	-13	-13	-17	-20	74	-12	-18
100PFR	:305M	-08	-09	-09	21	04	02	27	12	12	55	16	14
	:305F	-25	-25	-27	07	-13	-16	24	-04	-06	48	01	-02
	:305P	03	17	21	41	25	23	65	28	27	87	34	30
	:305FP	-13	-07	-06	21	04	04	42	10	08	68	16	12
	:305PFR	89	84	83	88	79	78	104	71	71	91	70	69
305M	:305F	91	90	90	87	89	90	83	88	89	77	87	89
	:305P	95	88	85	88	89	89	81	91	92	77	90	91
	:305FP	94	93	92	89	92	93	84	92	93	80	91	93
	:305PFR	-14	-08	-06	-12	-09	-08	-14	11	10	13	-10	-12
305F	:305P	95	86	82	94	87	86	93	89	88	88	87	87
	:305FP	99	97	96	99	98	97	99	98	98	98	98	98
	:305PFR	-39	-29	-27	-34	-34	-34	-32	-39	-40	-05	-38	-42
305P	:305FP	98	96	95	98	96	95	98	96	96	97	96	96
	:305PFR	08	22	30	01	14	17	05	06	06	42	10	06
305FP	:305PFR	26	07	02	20	14	12	16	21	21	18	18	23

[+] Standard error of rG ranged from 0.001 to 0.015.

[a] Negative estimates of sire variance components set to zero.

The highest estimates of r_G among milk traits were obtained in the first parity. Estimates of correlation show that r_P and r_E were higher than the corresponding estimates of r_G in the second and subsequent lactations for the relationship between 100M and other yield traits in 305-day lactation. These results indicate that such relationships are influenced by additional environmental factors in lactations after the first one.

Fat and protein yields in 100- and 305-day lactation were highly positively correlated with fat-plus-protein (FP) yields and higher than the corresponding estimates between milk yield and FP yields (estimates ranging from 0.97 to 1.00 vs 0.80 to 0.94). Most estimates of r_P and r_E were almost similar to the corresponding estimates of r_G in directions and magnitudes. Results given in Table 4 indicate that the estimates of r_G, r_P and r_E of fat or protein yields with FP were consistent across all lactations. These mainly part/whole genetic relationships indicate that fat or protein yields could be used as a good indicators for FP across lactations. Consequently, selection for high fat or protein yields will be associated with genetic improvement in FP across all lactations. Composite traits were also strongly related with other yield traits in/ and among 100- and 305-day lactation, especially in the first lactation. The correlations (r_G) between FP and both fat and protein yield were 0.92 and 0.91, resp., while the corresponding estimate with milk yield was 0.88.

Genetic relationship between 100-day yield traits and the corresponding traits in 305-day lactation were essentially positive and high especially in the first parity where the estimates were positive ranging between 0.84 and 0.94 (Table 4). The highest estimates were observed between 100FP and all yield traits of 305-day lactation. The estimated values in the other parities are still high and ranging from 0.70 to 0.85 except the correlation between milk yield and other yield traits where r_G's were lower ranging between 0.36 to 0.62. These results gave an evidence that selection for yield traits in 100-day lactation, especially of composite trait in the first parity, leads to an improvement in all yield traits of 305-day lactation.

In most cases, PFR had a variable sign in r_G, r_P and r_E and is lowly correlated with all yield traits in/ and among 100-and 305-day lactation (Table 4). The highest negative estimates were observed between fat yield and PFR, while protein yield had a positive r_G with PFR. These estimates increased with the advance of lactation. The estimates of r_G between 100P and both 100PFR and 305PFR were higher than those estimates of 305P and 305PFR. Consequently, selection for high yield of protein at 100-day lactation will be associated with genetic improvement in 100PFR and 305PFR. Selection for fat yield in 100- and 305-day leads to a reduction in both 100PFR and 305PFR.

GENERAL DISCUSSION AND CONCLUSIONS

Heritabilities decreased as parity increased and increased with length of time included in measuring the yield. First lactation had the highest heritability estimates and gives more accurate estimate of breeding value of a cow than subsequent lactations (Swalve and Van Vleck, 1986; Soliman et al, 1990). Using the first lactation seems adequate for proving sires, but the information in the second and third records would help considerably in estimating the breeding value of cows. The practical consequence of the present study as well as reviewed ones is that, though the first lactation progeny test may be used for an initial decision as to whether a bull should be brought into general AI service, the final decision must await some assessment of mature lactations. A further consequence of these results, important in making decisions between individual cows, is that the weighted average of h^2 of the first four lactations is lower than that of first lactation. However, several studies have been shown that sires can be ranked on the daughter's first lactation records with little loss in accuracy and no apparent harmful effects on longevity or future production of the daughters, especially because the correlations between first and later lactations were positive and high. If cows are culled solely on their merit as individuals, then it would be expected that a bull whose daughters had a high mean yield would have a relatively high proportion surviving to the next lactation and, in consequence, the selection differential applied to them as a selected group would be less than average. Intensive selection has been applied to PFR, and as a consequence the sire variance components for PFR in the second lactation up to the 4th were slightly different than that of the first lactation. Therefore, the h^2 estimates of PFR in the second and subsequent lactations were almost constant.

Generally, the high genetic correlations between 100- and 305-day yield traits in Fleckvieh cattle, especially correlations including fat-plus-protein, suggest that if selection is for 100-day lactation performance a correlated response in 305-day lactation performance will be nearly as great as if selection were directly for 305-day lactation performance. The greatest gain would come from direct selection for yields of protein and protein-plus-fat. The figures given here for the genetic correlations between different traits of 100-and 305-day lactation indicating that there is a general agreement between the ranking of sires on 100- and 305-day lactation. Consequently, these correlations are sufficiently high that an initial decision can be made on the basis of 100-day lactation of the first lactation progeny test as to whether a bull should be brought back into general AI service. The final decision as to usage of a bull for breeding, or perhaps even for continued use in cow breeding, should be at least based on the first 305-day lactation.

How, therefore, should we select our dairy animals. If different genes are affecting milk traits in the different lactations, then surely our aim should be to maximize the improvement in a herd with the present age composition. We should then evaluate a bull by knowing his progeny test for all ages of daughters and weighting this according to the usual age distribution found. We can assume that roughly one-quarter of the population are heifers. Then in the evaluation of a bull with a reasonable number of daughters, both heifers and mature cows, we should give three times as much weight to his mature progeny test as to the heifer progeny test. In some recording systems, it is rather difficult to get a progeny test based on mature animals but not difficult to decide whether the increase of bull's daughters with age is greater or less than average. Under these conditions a simple rule would be to add to the bull's heifers progeny test three-quarters of the deviation from average of his daughter's increase in age from heifers to maturity. The choice of bulls on the basis of a progeny test was previously discussed, assuming that this test was based on sufficient daughters to guarantee a high correlation between observed and true values. On the other hand, the h^2 of the separate lactations becomes important. This could be used to calculate a selection index maximizing the correlation between the index and the breeding value of the animal for heifer lactation plus three times mature lactation (Dommerholt and Wilmink, 1986). All records are then considered as deviations from the herd average of animals of the same age without any age correction.

The relative weighting factor given to the first lactation may decline a little as the number of later lactations available increases but this effect is not large. The most sensitive parameter determining this coefficient is the relative h^2 of the first lactation compared to that of later ones. For PFR the decline in h^2 in later lactations is not so great, so that selection can adequately be made on the basis of first lactation information only. If information is available on other lactations then weighted average would seem to be the most satisfactory method (Dempfle, 1975). The PFR could be increased, but it will be a slow process and at the expense of selection pressure for milk yield. Increases in the proportion of protein to fat would be expected to accrue from a decline in fat percent, with essentially no change in protein percent.

In Europe, the breeding goal is affected by the quota system. In recent years (Neimann-Sorensen et al, 1987; Soliman and Khalil, 1989) payment prices for protein became much higher than the prices for fat. In addition the present European Countries (EC) quota system (based on milk and fat) leads from an economic viewpoint to greater emphasis on the selection for yields of protein and fat-plus-protein and protein to fat ratio. Also, such system leads to a reduction in cow numbers of the herd. Moreover, it has a little or negative value for carrier (the milk without the fat and protein) and positively influences the values for contents in milk especially protein. On top of this the market interest in protein increases as opposed to fat. The above mentioned aspects calls for adaptation of the selection strategies and to set up several studies to investigate the necessity of an update of adequate selection indices. As suggested previously, selection for protein-plus-fat yield would be worthy of consideration

ACKNOWLEDGEMENTS

The authors are grateful to professor E.S.E. Galal, Department of Animal Production, Faculty of Agriculture, Ain Shams University, Cairo, Egypt for helpful comments and for reading the manuscript. We gratefully acknowledge the Official Federation of Austrian Cattle Breeders (ZAR) for supplying the data.

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تقدير المقاييس الوراثية لصفات اللبن الفردية والمركبه فى ماشية الفلاك فى واستخداماتها فى برامج الإنتخاب المبكر ·

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استخدمت بيانات ٥٨٧٦٧ سجل إدرار لماشية الفلاك فى النمساوية والتى تمثل ٩٨٥ طلوقة لتقدير معدل التغير فى المقاييس الوراثية لصفات اللبن عند ١٠٠ ، ٣٠٥ يوما من الإدرار وذلك بتقدم موسم الإدرار من الموسم الاول حتى الرابع · اشتملت الدراسة على صفات محصول اللبن والدهن والبروتين كصفات فردية وصفات محصول الدهن زائد البروتين ونسبة محصول البروتين لمحصول الدهن كصفات مركبة ·

تلخصت النتائج المتحصل عليها فيما يلى :-

– كان لتأثير كل من آباء الأبقار ، الأبقار داخل الآباء ، سنة وموسم الولادة ، تفاعل سنة وموسم الولادة ، فترة الايام المفتوحة ، وعمر البقرة تاثيرا واضحا على معظم الصفات المدروسة ·

– تناقصت قيم المكافى الوراثى لكل الصفات مع تقدم موسم الإدرار ، تراوحت القيم فى المواسم الأربعة بين ٠,٠٨ الى ٠,٢٧ لصفة محصول اللبن ، بين صفر الى ٠,٢٢ لصفة محصول الدهن ، بين ٠,٠٨ الى ٠,٢١ لصفة محصول البروتين ، بين ٠,٠٣ الى ٠,٢٣ لصفة محصول الدهن زائد البروتين وبين ٠,٠٦ الى ٠,٠٩ لصفة نسبة محصول البروتين لمحصول الدهن وذلك لصفات الإدرار عند ١٠٠ يوما فى حين تراوحت القيم المناظرة لصفات الإدرار عند ٣٠٥ يوما بين ٠,٠٩ الى ٠,٣١ ، ٠,٠٩ الى ٠,٣٢ ، ٠,١٣ الى ٠,٢٧ ، ٠,١١ الى ٠,٣١ ، ٠,١١ الى ٠,١٥ على التوالى ·

– كانت قيم المعامل التكرارى لصفات الإدرار عند ١٠٠ يوم هى ٠,٤١ لمحصول اللبن ، حوالى ٠,٣ لمحصول الدهن او البروتين او محصول الدهن زائد البروتين ، ٠,١٤ لنسبة محصول البروتين لمحصول الدهن فى حين كانت القيم المناظرة عند ٣٠٥ يوم من الإدرار هى ٠,٤٧ ، ٠,٤ ، ٠,٢٣ بنفس الترتيب ·

– كانت الإرتباطات الوراثية والمظهرية والبيئية موجبة وعالية القيمه بين صفات المحصول داخل ١٠٠ او ٣٠٥ يوم من الإدرار وكذلك بين صفات ١٠٠ يوم وصفات ٣٠٥ يوم من الإدرار · كذلك وجد ان هناك إرتباط قوى بين محصول الدهن زائد البروتين وكل صفات المحصول الاخرى حيث كانت معظم القيم ثابتة طوال مواسم الإدرار المختلفة خاصة تلك العلاقة القوية بين تلك الصفة وكل من صفات محصول الدهن والبروتين · على الجانب الآخر لم يظهر هناك اتجاة محدد وثابت فى الإشارة أو القيمة للعلاقة بين صفة محصول الدهن زائد البروتين وكل صفات المحصول المدروسه وذلك باستثناء العلاقة بين صفة محصول الدهن زائد البروتين وصفة محصول البروتين حيث كانت معظم القيم موجبة وعالية القيمة ·

– أوصت الدراسة بأنه عمليا يمكن تحقيق أقصى إنتاجية للأبقار وذلك بالإنتخاب المبكر لصفات محصول البروتين كصفة فردية ومحصول الدهن زائد البروتين وصفة نسبة محصول البروتين لمحصول الدهن كصفات مركبة ·