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GENETIC PARAMETERS AND SELECTION RESPONSES OF 305-DAY AND CUMULATIVE MILK YIELD TRAITS UNDER CUMULATIVE MONTHLY RECORDING SYSTEMS IN DAIRY CATTLE

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ABSTRACT

Lactation records used in the present study were of Fleckvieh cows, calveing in two successive years (1990 and 1991), from the official Federation of Austrian Cattle Breeders (ZAR). Normal 305-day milk yield (305-day MYT) records and calculated cumulative milk yield traits (CMYT) of each of three periods were used. First cumulative 31-120 day ($CMRS_1$), 2^{th} cumulative 61–150 day ($CMRS_2$) and 3^{th} cumulative 31–150 day ($CMRS_3$) represent the milk records of 1^{th} lactation only. Monthly test-day records were computed and used for genetic evaluation. Available data consisted of 19000, 27158 and 18999 lactation records of daughters sired by 1424, 1748 and 1424 for $CMRS_1$, $CMRS_2$ and $CMRS_3$, respectively. Yields of 305-day and calculated cumulative milk – (MY & CMY), fat – (FY & CFY), protein – (PY & CPY), fat – plus – protein – (FPY & CFPY) and protein/fat ratio – (PY/FY & CPY/FY%) were studied in $CMRS_1$ to $CMRS_3$.

Estimates of heritability (h^2) for CMYT under different CMRS ranged from 0.32 to 0.43, while for 305-day MYT h^2 ranged from 0.48 to 0.59. However, estimates of coefficients of additive genetic variation (CAGV%) for CMYT under different CMRS ranged from 6.2 to 7.5%, while for 305-day MYT CAGV% ranged from 6.2 to 7.7%. Generally, the highest estimates of h^2 and CAGV% on CMYT were found under $CMRS_2$. However, the estimates of h^2 for cumulative fat yield (CFY) and percentage of protein yield/fat yield – (CPOF%) under CMRS were higher than those for all studied CMYT. Estimates of genetic correlation (r_G), phenotypic correlation (r_P) and environmental correlation (r_E) between 305-day MYT and CMYT under different CMRS were generally positive, varying from moderate to high.

Selection for CMYT under the $CMRS_2$ had the highest correlated response in relation to 305-day MYT. Therefore, these results suggest that, attempts to increase CMYT by selection would increase 305-day MYT nearly as much as direct selection.
Keywords: Fleckvieh, cumulative milk recording system, genetic parameters, selection response, 305-day milk yield traits, cumulative milk yield traits.

INTRODUCTION

Dairy animal breeders base used to selection on 305-day lactations. Changing the system of genetic evaluations to part-lactation yields create greater economic advantage. Early selection of sires based on part-lactation yields helps in reducing generation interval consequently, increasing genetic gain for milk yield in dairy cattle. Part-lactation has been reported to be highly correlated with the complete lactation (Kumer *et al.*, 1992 & Zahed *et al.*, 1997).

Recording of milk yields is essential for genetic improvement in dairy cattle. However, in most of developing countries there is no systematic recording, due to lack of breed associations, breeding programs and a national institution responsible for sustaining recording system. The financial constraints are due to the poor income from their animals. The small farmers are not willing and are not able to pay for the recording of their animals. The technical constraints situation are lack of national animal identification and incentives especially for small farmers (Nigm, 2000). Therefore, subsidies and economic incentives are needed to promote record keeping. On the other hand, under increasing pressure to reduce cost, numerous milk-testing schemes have been developed in many countries. One of the most widely used attempts is using the monthly recording system as individually single test day or cumulative for milk yield traits (CMYT) for evaluation purposes. The evaluation of whole time milk yield of cows in a lactation is time consuming and laborious. In the same time, the use of cumulative records has been recommended to animal breeders because of high positive correlations between cumulative and whole lactation performance (Wilmink, 1987). Thus, it is possible to achieve more rapid progress per unit time due to direct selection of desired CMYT.

The present study aimed to: 1) estimate the genetic, phenotypic and environmental parameters, 2) evaluate direct and correlated response per generation due to selection for 305-day MYT based on CMYT under cumulative monthly recording systems.

MATERIALS AND METHODS

Data of milk yield traits of Austrian Fleckvieh cattle, collected by the Official Federation of Austrian Cattle Breeders (ZAR) in lower Austria was used in the present study. Records of cows calving in two successive years from January 1990 to September 1991 were used. Heifers and cows were artificially inseminated (AI) when heifers reached an average of 320 kg body weight and after the first observed heat in cows. Full-sib and sire-daughter matings were avoided. Details of the breeding policy and management for Austria Fleckvieh cattle were described by Hofinger *et al.* (1997).

Table (1) shows the single monthly test-day (TD) milk yield traits sample used for computlly monthly and cumulative milk yield traits to three periods of cumulative milk traits: 1st cumulative 31 – 120 day ($CMRS_1$), 2nd cumulative 61 – 150 day ($CMRS_2$) and 3rd cumulative 31 – 150 day ($CMRS_3$).

As shown in Table (2) distribution of sires and total number of records 3 periods ($CMRS_1$, $CMRS_2$ and $CMRS_3$) were computed from the 1st lactations records only.

Studied traits were 305-day milk yield traits [milk yield (MY), fat yield (FY), protein yield (PY), fat-plus-protein yield (FPY) and protein/fat yield percentage (PY/FY%)]. The same milk yield traits computed as cumulative [milk yield (CMY), fat yield (CFY), protein yield (CPY), fat-plus-protein yield (CFPY) and percentage-protein/fat (CPOF%)] in the examined four periods.

Data were analyzed separately using the Least Squares Maximum Likelihood Mean Weighted (LSMLMW) computer program of Harvey (1990). The linear mixed model included the random effect of sire, the fixed effects of calving year-season (CYS), age at first calving (AFC), days open (DO) and the period from the first monthly test day to next calving date (TFTNC) as partial linear and quadratic regression coefficients.

Table (1): Equations used to calculate cumulative and 305-day milk yield traits (CMYT & 305-day MYT).

Recording system	Method of computation
Y ($CMRS_1$)	$[(\sum_{i=1}^{3} TD_i \times 30.5)]$ where: i = 1, 2 and 3, 1 = TD_2, 2 = TD_3 and 3 = TD_4
Y ($CMRS_2$)	$[(\sum_{i=1}^{3} TD_i \times 30.5)]$ where: i = 1, 2 and 3, 1 = TD_3, 2 = TD_4 and 3 = TD_5
Y ($CMRS_3$)	$[(\sum_{i=1}^{4} TD_i \times 30.5)]$ where: i = 1,2,3 and 4,1 = TD_2, 2 = TD_3, 3=TD_4 and 4=TD_5
Y (305-day)	$[(\sum_{i=1}^{10} TD_i \times 30.5)]$ where: i = 2, ... and 10 month of lactation (ML)

Where TD = monthly test-day milk yield.

Table (2): Distribution of sires and total number of records

Period	No. of sires	Total No. of records
$CMRS_1$ (31-120-day)	1424	19000
$CMRS_2$ (60-150-day)	1748	27158
$CMRS_3$ (31-150-day)	1424	18999

Estimates of sire and remainder components of variance and covariance were computed according to Henderson method III (1953) using LSMLMW (Harvey, 1990). Estimates of paternal half-sibs heritability (h^2), were calculated as, $h^2_s = 4\ \sigma^2_s/(\sigma^2_s + \sigma^2_e)$, where: σ^2_s and σ^2_e are sire and remainder components of variance, respectively. Genetic (r_G), phenotypic (r_P) and environmental (r_E) correlations were estimated. Approximate standard errors (SE) for h^2 and r_G estimates are obtained according to Harvey (1990) and described by Swiger *et al.* (1964). Coefficients of additive genetic (CAGV%) and phenotypic (CPV%) variations were calculated according to Oltenacu *et al.* (1991).

Selection based on single trait for CMYT under different CMRS were estimated according to Falconer (1981) using the following equations; $R_x = i.\ h^2_x.\ \sigma p_x$ and $CR_y = i,\ h_x.\ h_y.\ r_g.\ \sigma p_y$, where: R_x = the changes expected from direct response due to selection of trait x, i = the intensity of selection of trait x, h^2_x = the heritability of trait x, σp_x = phenotypic standard deviation of trait x, while CR_y = the changes expected correlated response to selection of trait y, h_x and h_y are the square roots of respective h^2 estimates, r_G = the genetic correlation between x and y traits and σp_y = the phenotypic standard deviation of trait y. The expected genetic changes per generation were calculated on cow side, where the selection intensity (i) for a trait was set to be 1.0 for the purpose of comparisons.

RESULTS AND DISCUSSION

Sire of the cow had highly significant ($P < 0.001$) effect on all examined 305-day and cumulative milk yield traits (305-day MYT and CMYT) under different cumulative milk recording systems (CMRS) as shown in Table 3. These results are in agreement with (Zahed *et al.*, 1997; El-Sayed, 1998;

Genena, 1998; Mostafa et al., 1999 and Farghaly and Schleppi, 2002). Consequently, sires selection would lead to genetic improvement of milk yield traits.

Estimation of variance components (V%) due to sire (σ^2_s) and remainder (σ^2_e) of 305-day MYT and CMYT under different CMRS are presented in Table 3. Estimates of V% attributed to sire (σ^2s) effect on 305-day MYT and CMYT were moderate in CMRS and it ranged from 12.1 to 14.7% and 7.2 to 10.7%, respectively. Generally the range of V% due to (σ^2_s) effect on CMYT (7.2 to 10.7%) under different CMRS were lower than that (6.0 to 12.9%) recorded by Soliman *et al.*, (1990) and higher than that (0.7 to 6.7%) obtained by Soliman and Khalil (1993) and Zahed *et al.* (1997). While in the case of $CMRS_1$, $CMRS_2$ and $CMRS_3$ the range were from 12.1 to 14.2% and 7.2 to 9.4%: from 13.0 to 14.7% and 9.4 to 10.7% and from 12.1 to 14.3% and 8.6 to 10.5%, respectively Table 3. It could be noticed that the highest estimates value of V% due to sire (σ^2_s) effect on 305-day MYT and CMYT were in the $CMRS_2$ (from 13.0 to 14.7% and 9.4 to 10.7%) when compared to the other different CMRS (e.g. $CMRS_1$ & $CMRS_3$).

Estimates of V% due to sire for 305-day and cumulative fat yield (305-day FY and CFY) under different examined CMRS showed higher values than 305-day MYT and CMYT, Table 3. Also, the values of V% due to (σ^2_s) of 305-day and cumulative fat-plus-protein yield (305-day FPY and CFPY) were higher than each of 305-day MY, PY and CMY, CPY traits, Table 3.

Moreover, in the case of 305-day protein/fat as percentage ratio (305-day POF%) the V% due to sire were 14.2, 14.6 and 14.3% under $CMRS_1$, $CMRS_2$ and $CMRS_3$, respectively. While for cumulative protein/fat as percentage ratio (CPOF%) were 9.2, 10.3 and 10.5% under $CMRS_1$ up to $CMRS_3$, respectively (Table 3). The obtained results indicated that moderate V% due to (σ^2_s), suggested that there is an opportunity for selection in this population. Moreover, the size of V% of σ^2_s plays an important role for genetic improvement of production traits.

Estimates of heritability (h^2) for 305-day MYT and CMYT under different CMRS are given in Table 3. Estimates of h^2 for 305-day MYT ranged from 0.48 to 0.57 under both $CMRS_1$ and $CMRS_3$ and from 0.52 to 0.59 under $CMRS_2$. Also, estimates of h^2 for CMYT ranged from 0.32 to 0.36; from 0.37 to 0.43 and from 0.35 to 0.41 under $CMRS_1$ up to $CMRS_3$, respectively. Generally, the highest h^2 estimates of 305-day MYT and CMYT under different CMRS were obtained with the $CMRS_2$, while the lowest h^2 were under both $CMRS_1$ and $CMRS_3$ in 305-day MYT and under $CMRS_1$ in CMYT. Estimates of h^2 in the present study for CMYT under CMRS were higher than those obtained by Zahed *et al.* (1997) and Soliman *et al.* (1990). Moreover, estimates of h^2 for CMYT (0.32 to 0.36) under $CMRS_1$ were nearly similar to Wilmink (1987), being 0.31 to 0.37 however, the range of h^2 for CMYT (0.37 to 0.43) under $CMRS_2$ were higher than Wilmink (1987). On the other side, the estimates of h^2 for both 305-day POF% and CPOF% were 0.57 and 0.37; 0.58 and 0.41 and 0.57 and 0.42, respectively, under different CMRS.

The coefficients of additive genetic and phenotypic variation (CAGV% & CPV%) for 305-day MYT and CMYT under different CMRS are presented in Table 3. Estimates of CAGV% and CPV% for 305-day MYT ranged from 6.2 to 7.4% and 17.6 to 19.6% under both $CMRS_1$ and $CMRS_3$ and from 6.6 to 7.7% and 10.2 to 20.2% under $CMRS_2$, respectively. Also, the estimate of CAGV% and CPV% for CMYT under $CMRS_1$ up to $CMRS_3$ were ranged from 6.2 to 7.4% and 22.8 to 24.0%; from 6.6 to 7.5% and 21.4 to 22.9% and from 6.3 to 7.1% and 21.1 to 22.2%, respectively.

Table 3: Estimates of mean squares (M.S), percentage of variance (V%) of sire (σ^2_s) and remainder (σ^2_e), heritability (h^2 ± S.E.), coefficients of additive (CAGV%) and phenotypic (CPV%) variance for 305-day (MYT) and calculated cumulative milk yield traits under different cumulative monthly recording systems (CMRS).

Trait	M.S	(σ^2_s)	V%	(σ^2_e)	V%	(h^2)	S.E	CAGV %	PV%
				$CMRS_1$ (31 – 120 days)					
Recorded 305-day milk traits (MYT):									
MY (Kg)	2.8***	71406	12.2	513064	87.8	0.49	0.03	6.2	17.6
FY (Kg)	3.2***	177	14.2	1073	85.8	0.57	0.03	7.4	19.6
PY (Kg)	2.8***	84	12.1	612	87.9	0.48	0.03	6.4	18.5
FPY (Kg)	3.0***	484	13.4	3139	86.6	0.53	0.03	6.8	18.6
POF%	3.2***	0.0006	14.2	0.004	85.8	0.57	0.03	--	--
Calculated cumulative milk traits (CMYT):									
CMY (Kg)	2.2***	4260	8.1	48614	91.9	0.32	0.02	6.5	22.8
CFY (Kg)	2.3***	11	9.4	106	90.6	0.36	0.02	7.4	24.0
CPY (Kg)	2.1***	5	7.2	64	92.8	0.32	0.02	6.2	23.1
CFPY(Kg)	2.3***	30	8.6	319	91.4	0.35	0.02	6.8	23.1
CPOF%	2.3***	0.0006	9.2	0.006	90.8	0.37	0.002	--	--
				$CMRS_2$ (60 - 150 days)					
Recorded 305-day milk traits (MYT):									
MY (kg)	3.3***	79552	13.1	529349	86.9	0.52	0.02	6.6	18.2
FY (kg)	3.6***	191	14.7	1112	85.3	0.59	0.02	7.7	20.2
PY (kg)	3.3***	94	13.0	631	87.0	0.52	0.02	6.8	19.0
FPY (kg)	3.5***	530	14.0	3252	86.0	0.56	0.02	7.2	10.2
POF%	3.6***	0.0007	14.6	0.004	85.4	0.58	0.02	--	--
Calculated cumulative milk traits (CMYT):									
CMY (kg)	2.6***	5325	9.4	51270	90.6	0.38	0.02	6.6	21.4
CFY (kg)	2.8***	13	10.7	108	89.3	0.43	0.02	7.5	22.9
CPY (kg)	2.6***	7	9.6	66	90.4	0.37	0.02	6.8	21.9
CFPY(kg)	2.7***	37	10.2	326	89.8	0.41	0.02	7.0	21.9
CPOF%	2.8***	0.0007	10.3	0.006	89.7	0.41	0.02	--	--
				$CMRS_3$ (31 – 150 days)					
Recorded 305-day milk traits (MYT):									
MY (kg)	2.8***	71409	12.2	51309	87.8	0.49	0.03	6.2	17.6
FY (kg)	3.2***	177	14.2	1073	85.8	0.57	0.03	7.4	19.6
PY (kg)	2.8***	84	12.1	612	87.9	0.48	0.03	6.4	18.5
FPY (kg)	3.0***	484	13.4	3139	86.6	0.53	0.03	6.8	18.6
POF%	3.2***	0.0006	14.3	0.004	85.7	0.57	0.03	--	--
Calculated cumulative milk traits (CMYT):									
CMY (kg)	2.3***	8076	8.9	82173	91.1	0.36	0.02	6.3	21.1
CFY (kg)	2.5***	20	10.3	175	89.7	0.41	0.02	7.1	22.2
CPY (kg)	2.3***	10	8.6	106	91.4	0.35	0.02	6.3	21.5
CFPY(kg)	2.4***	56	9.6	529	90.4	0.39	0.02	6.6	21.4
CPOF%	2.6***	0.0006	10.5	0.005	89.5	0.42	0.02	--	--

*** Significant at ($P < 0.001$).

The obtained results (Table 3) indicated that the highest CAGV% of 305-day MYT was under $CMRS_2$, while the lowest was under $CMRS_1$ and $CMRS_3$. However, for CMYT the highest CAGV% was under $CMRS_2$ when compared to the other CMRS. The highest CPV% for both 305-day MYT and CMYT were found under both of $CMRS_1$ and $CMRS_3$ while the lowest CPV% were under $CMRS_2$.

The moderate V%, h^2 and CAGV% for CMYT and CPOF% under different CMRS (especially under $CMRS_2$), indicate that selection on incomplete records could be an acceptable alternative to select cows on complete records (305-day lactation). Consequently, improvement may occur through early selection for these traits instead of adding information from the complete records.

Estimation of genetic (r_G), phenotypic (r_P) and environmental (r_E) correlations between 305-day MYT and CMYT under different CMRS are given in Table 4. The estimates of r_G, r_P and r_E between 305-day MYT and CMYT under different CMRS were generally positively varied from moderate to high and ranged from 0.79 to 0.94; from 0.74 to 0.84; from 0.71 to 0.80 as well as from 0.84 to 0.97; from 0.78 to 0.88; from 0.73 to 0.83 and from 0.82 to 0.96; from 0.79 to 0.89 and from 0.77 to 0.87 for r_G, r_P and r_E, respectively. In general, the present results indicated that, estimates between 305-day MYT and CMYT under $CMRS_1$ were lower than those with CMYT under other different CMRS (e.g. $CMRS_2$ and $CMRS_3$). Moreover, the highest r_G (0.84 to 0.97) and r_P (0.78 to 0.88) estimates were found between 305-day MYT and CMYT under $CMRS_2$. While the highest r_E estimates (0.77 to 0.87) were under $CMRS_3$. Also, these results indicate that the records of CMYT may be used to predict 305-day MYT with high precision and could safely guide for further improvement. These values were generally nearly similar to that obtained by Soliman and Khalil, 1993; Soliman and Hamed, 1994 and Zahed *et al.*, 1997. However, the correlation between CFY and either 305-day FY or PY or FPY showed higher correlation values r_G (0.86 to 0.97) relative to other traits. Therefore, it could be mainly used as a good indicator for each of 305-day FY; PY and FPY traits.

The r_G estimates between 305-day MYT and CPOF% and between CMYT and POF% under $CMRS_1$ up to $CMRS_3$ were in general negative and varied from low to moderate with a range from -0.09 to -0.46 and from -0.13 to -0.51, respectively. Regarding the r_P estimates it was generally typical, it varied in magnitude and signs with a range from -0.25 to 0.09 and from -0.26 to 0.07, respectively. This value is lower than the range of -0.27 to 0.30 obtained by Soliman and Khalil (1993). Also, the r_E estimate varied from low to moderate with a range from -0.06 to 0.23 between 305-day MYT and CPOF% and from -0.04 to 0.27 between CMYT and POF% under $CMRS_1$ up to $CMRS_3$, except 305-day FY with CPOF% and CFY with POF%. In general the results showed a positive, high to moderate r_G, r_P and r_E estimates between POF% and CPOF%, which ranged from 0.92 to 0.94, from 0.70 to 0.77 and from 0.53 to 0.63, respectively. In most cases, r_P and r_E estimates were similar to the corresponding r_G estimates in direction but were lower in magnitude. They were positive and high in agreement with results of Soliman and Khalil (1993).

Table 4: Estimates of genetic (r_G ± S.E), phenotypic (r_P) and environmental (r_E) correlation coefficients between 305-day and calculated cumulative milk yield traits (305-day MYT & CMYT) under different cumulative monthly recording systems (CMRS).

Correlated traits	CMRS$_1$ (31 – 120 days)				CMRS$_2$ (61 – 150 days)				CMRS$_3$ (31 – 150 days)			
	r_G	S.E	r_P	r_E	r_G	S.E	r_P	r_E	r_G	S.E	r_P	R_E
MY & CMY	0.90	0.01	0.83	0.80	0.96	0.004	0.88	0.83	0.92	0.01	0.88	0.87
MY & CFY	0.79	0.02	0.75	0.73	0.84	0.01	0.79	0.75	0.82	0.02	0.79	0.78
MY & CPY	0.85	0.01	0.79	0.77	0.90	0.01	0.83	0.80	0.87	0.01	0.84	0.83
MY & CFPY	0.83	0.02	0.78	0.77	0.88	0.01	0.83	0.79	0.86	0.01	0.83	0.82
MY & CPOF%	-0.10	0.04	-0.03	0.13	-0.11	0.04	0.02	0.13	-0.13	0.04	0.03	0.15
FY & CMY	0.81	0.02	0.74	0.72	0.86	0.01	0.78	0.74	0.83	0.01	0.78	0.77
FY & CFY	0.94	0.01	0.83	0.76	0.97	0.004	0.87	0.79	0.96	0.01	0.88	0.82
FY & CPY	0.86	0.01	0.76	0.72	0.90	0.01	0.79	0.73	0.88	0.01	0.80	0.77
FY & CFPY	0.93	0.01	0.81	0.76	0.96	0.004	0.86	0.79	0.95	0.01	0.86	0.82
FY & CPOF%	-0.45	0.04	-0.22	-0.04	-0.44	0.03	-0.24	-0.06	-0.46	0.04	-0.25	-0.05
PY & CMY	0.86	0.01	0.79	0.76	0.91	0.01	0.83	0.79	0.87	0.01	0.84	0.82
PY & CFY	0.86	0.01	0.77	0.71	0.90	0.01	0.81	0.74	0.88	0.01	0.82	0.77
PY & CPY	0.93	0.01	0.84	0.79	0.97	0.09	0.88	0.83	0.95	0.01	0.89	0.85
PY & CFPY	0.91	0.01	0.82	0.77	0.94	0.01	0.86	0.80	0.93	0.01	0.87	0.83
PY & CPOF%	-0.09	0.04	0.08	0.20	-0.09	0.04	0.07	0.21	-0.10	0.04	0.09	0.23
FPY & CMY	0.85	0.01	0.78	0.76	0.90	0.01	0.82	0.79	0.87	0.01	0.83	0.82
FPY & CFY	0.93	0.01	0.82	0.76	0.96	0.004	0.87	0.79	0.93	0.01	0.87	0.82
FPY & CPY	0.91	0.01	0.81	0.77	0.95	0.01	0.85	0.80	0.93	0.01	0.86	0.83
FPY & CFPY	0.94	0.01	0.84	0.78	0.97	0.004	0.88	0.82	0.96	0.01	0.89	0.85
FPY & CPOF%	-0.31	0.04	-0.10	0.07	-0.30	0.03	-0.11	0.07	-0.32	0.04	-0.11	0.08
POF% & CMY	-0.20	0.04	-0.01	0.15	-0.15	0.04	0.004	0.15	-0.20	0.04	0.001	0.17
POF% & CFY	-0.49	0.04	-0.23	-0.02	-0.48	0.03	-0.26	-0.04	-0.51	0.04	-0.25	-0.02
POF% & CPY	-0.16	0.04	0.06	0.23	-0.13	0.04	0.07	0.25	-0.16	0.04	0.07	0.27
POF% & CFPY	-0.36	0.04	-0.11	0.10	-0.34	0.03	-0.12	0.10	-0.37	0.04	-0.11	0.11
POF% & CPOF%	0.92	0.01	0.70	0.53	0.93	0.01	0.75	0.59	0.94	0.01	0.77	0.63

Estimates of changes expressed as % of the overall means of trait, were expected by direct-response (R_x) and indirect correlated response due to selection (CR_y) per generation from single-trait selection on cows (females), for 305-day MYT based on CMYT under different CMRS and are summarized in Table 5. The selection intensity was set to be 1.0; to compare the expected changes for correlated response (CR_y) from CMYT under different periods of CMRS. Table (5) and Fig. (1) showed that selection for the CMYT under CMRS$_2$ had the highest estimates of changes. In general the CR_y for 305-day MYT was high. This is due to the high h^2 estimate of the former trait and the high r_G estimates between 305-day MYT and each CMYT under different CMRS.

The obtained results using CMRS$_2$ showed that the expected response of selection for CMY trait, in the next generation was 333; 14.7; 10.9 and 25.5 kg for 305-day MY, FY, PY and FPY traits, respectively. This represented per generation 7.8; 8.2; 7.7 and 8.0%, respectively. However, selection for CFY trait in relation to selection for CMY trait under CMRS$_2$ lead to small changes per generation -0.6; 1.7; 0.4 and 1.1% for 305-day MY, FY, PY and FPY traits, respectively. In the same time the selection for the CPY trait resulted in -0.6; 0.3; 0.4 and 0.3% for 305-day MY, FY, PY and FPY traits, respectively. In addition, the selection for CFPY trait was accompanied by -0.4; 1.3; 0.5 and 0.9% compared to selection for CMY trait as shown in Table 5.

Table 5: Estimates of expected direct and correlated response (CR) per generation from single trait selection for recorded 305-day milk traits using calculated cumulative milk traits under cumulative monthly recording systems (CMRS).

Selection	CR	MY	FY	PY	FPY	POF %	MY	FY	PY	FPY	POF %	MY	FY	PY	FPY	POF %
CMYT	$CMRS_1$ (31 – 120 days)						$CMRS_2$ (61- 150 days)					$CMRS_3$ (31- 150 days)				
CMY	a*	273	12.2	8.9	21.1	-0.01	333	14.7	10.9	25.5	-0.01	295	13.3	9.5	22.9	-0.01
	b**	6.3	6.8	6.2	6.5	-1.10	7.8	8.2	7.7	8.0	-0.88	6.8	7.4	6.7	7.1	-1.10
CFY	a	254	15.1	9.4	24.5	-0.02	310	17.6	11.5	29.0	-0.02	281	16.4	10.3	26.7	-0.03
	b	5.9	8.4	6.6	7.6	-2.8	7.2	9.9	8.1	9.1	-3.00	6.5	9.1	7.2	8.3	-3.10
CPY	a	257	13.0	9.6	22.6	-0.01	308	15.2	11.5	26.6	-0.01	276	13.9	10.2	24.1	-0.01
	b	5.9	7.2	6.7	7.0	-0.85	7.2	8.5	8.1	8.3	-0.75	6.4	7.7	7.1	7.5	-0.89
CFPY	a	263	14.7	9.8	24.4	-0.02	317	17.0	11.7	28.6	-0.02	287	15.8	10.6	26.3	-0.02
	b	6.1	8.2	6.9	7.5	-2.00	7.4	9.5	8.2	8.9	-2.10	6.6	8.8	7.4	8.1	-2.20
CPOF %	a	-32.6	-7.3	-1.0	-8.3	0.04	-39.6	-7.8	-1.1	-8.8	0.05	-45.1	-8.0	-1.2	-9.1	0.05
	b	-0.75	-4.1	-7.0	-2.6	5.30	-0.92	-4.4	-0.79	-2.8	5.70	-1.0	-4.4	0.83	-2.8	5.80
MYT																
MY	a	375	16.4	12.0	28.2	-0.01	406	17.6	13.2	30.5	-0.01	375	16.4	12.0	28.2	-0.01
	b	8.6	9.1	8.4	8.7	-1.10	9.4	9.8	9.3	9.5	-0.96	8.6	9.1	8.4	8.7	-1.10
FY	a		20.2	12.7	32.8	-0.03		21.3	13.7	35.0	-0.03		20.2	12.7	32.8	-0.03
	b		11.2	8.9	10.1	-3.70		11.9	9.7	10.9	-3.60		11.2	8.9	10.0	-3.70
PY	a			12.7	29.4	-0.01			14.0	32.2	-0.01			12.7	29.4	-0.01
	b			8.9	9.1	-0.85			9.9	10.1	-0.76			8.9	9.1	-0.85
FPY	a				31.9	-0.02				34.4	-0.02				31.9	-0.02
	b				9.9	-2.50				10.8	-2.40				9.9	-2.50

a* = response in actual units of measurement (kg), except ratios.
b = response (a) per generation expressed as a percentage of the overall mean of trait.**

Generally, using any of CMYT as a criterion of selection would result in an increase in other 305-day MYT (e.g. Soliman *et al.*, 1990 and Soliman and Khalil, 1993).Thus, under $CMRS_2$ using CMYT (CMY, CFY, CPY and CFPY traits), as criterion of correlated response per generation resulted loss in POF% by 0.01; -0.02; -0.01 and -0.02, respectively due to the small negative value of genetic correlation (-0.09 to -0.46) between CMYT and POF% trait. However, in the case of selection for the CPOF% trait under $CMRS_2$ less correlated response of -39.6; -7.8; -1.1 and -8.8 kg for 305-day MY, FY, PY and FPY traits, respectively was found in the next generation. This represented -0.9; -4.4; -0.8 and -2.8%, respectively. The POF%, also showed little correlated response as 0.045 kg and 5.7% of the same trait. These results are due to the small value of r_G between each of CPOF% and 305-day MYT under different CMRS.

The results suggested that, selection using CMYT may lead near estimates of increase by 305-day MYT as direct selection. Such procedure would lead to a decrease in generation interval and consequently would increasie genetic gain per year. On the other side, little reduction in the expected genetic response per generation as present of milk yield traits was expected when selection for CMYT (especially CPY and CFPY) under $CMRS_2$.

CONCLUISION

The results indicate moderate sire variance (V%) for CMYT, which may lead to selection opportunity for genetic improvement of the studied traits. In the same trend, the values of moderate h^2 and CAGV% for CMYT and CPOF% under different CMRS (especially under $CMRS_2$) showed that selection on incomplete records could be an acceptable alternative to select cows on their complete records. Values of r_G and r_P in the case of using different CMYT could be used to predict 305-day MYT with high precision and safe further evaluations. Additionally, the values of genetic correlation between 305-day MYT and CMYT reflect the existence of non-additive genetic component as well as common environmental source of variation among those traits.

The attempts to increase CMYT by selection might increase 305-day MYT nearly as much as direct selection, in spite of the observed little reduction in the expected genetic response changes per generation (%) if selection for CMYT (especially CPY and CFPY) under $CMRS_2$ was used instead of 305-day MYT.

Therefore, the present results lead to conclude that, using single trait selection for both CMYT and CPOF% under $CMRS_2$ systems, could be utilized satisfactorily for genetic improvement as same as 305-day MY.

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المعالم الوراثية والاستجابة للانتخاب لصفات اللبن فى ٣٠٥ يوم وصفات اللبن التراكمية باستخدام أنظمة التسجيل الشهرية التراكمية فى ماشية اللبن.

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أجريت الدراسة على سجلات الإدرار لأبقار الفلاك فى، وذلك لفترة عامين متتاليين من سنة ١٩٩٠ إلى ١٩٩١م. تم الحصول على السجلات من الاتحاد الفيدرالى النمساوى الرسمى لمربى الماشية (ZAR). استخدمت ثلاث فترات لتقدير صفات إنتاج اللبن التراكمية المقدرة والمسجلة فى ٣٠٥ يوم وهى الأولى من ٣١ – ١٢٠ يوم ($CMRS_1$)، الثانية من ٦١ – ١٥٠ يوم ($CMRS_2$)، والثالثة من ٣١ – ١٥٠ يوم ($CMRS_3$) خلال موسم الإدرار الأول. تم تقدير صفات إنتاج اللبن التراكمية باستخدام التسجيل ليوم الاختبار الشهرى الفردى واستخدمت القيم الناتجة للتقييم الوراثى. كان عدد السجلات المستخدمة ١٩٠٠٠ و٢٧١٥٨ و١٨٩٩٩ سجلا لبنات ١٤٢٤ و١٧٤٨ و١٤٢٤ طلوقة تحت أنظمة التسجيل $CMRS_3$, $CMRS_2$, $CMRS_1$ على التوالى خلال الموسم الأول فقط، شملت الصفات المدروسة: صفات ناتج اللبن التراكمى و٣٠٥ يوم وهى: محصول اللبن، الدهن، البروتين، إنتاج الدهن والبروتين معا ونسبة إنتاج البروتين/إنتاج الدهن كنسبة مئوية، تحت أنظمة التسجيل المختلفة.

تراوحت قيم العمق الوراثى لصفات إنتاج اللبن التراكمى والإنتاج فى ٣٠٥-يوم من ٠,٣٢ – ٠,٤٣ ومن ٠,٤٨ – ٠,٥٩ على التوالى، بينما تراوحت قيم معامل التباين الوراثى التجمعى من ٦,٢ – ٧,٥% ومن ٦,٢ – ٧ر٧% على التوالى تحت أنظمة التسجيل المختلفة، كانت أعلى قيم العمق الوراثى والتباين الوراثى التجمعى لصفات إنتاج اللبن التراكمى باستخدام النظام الثانى ($CMRS_2$) مقارنة بأنظمة التسجيل الأخرى، بينما كانت قيم العمق الوراثى لصفتى إنتاج الدهن التراكمى وإنتاج البروتين إلى إنتاج الدهن التراكمى كنسبة مئوية أعلى من باقى الصفات، كانت قيم معاملات الارتباطات الوراثية والمظهرية والبيئية بين صفات إنتاج اللبن التراكمى المقدرة والمسجلة فى ٣٠٥ يوم باستخدام أنظمة التسجيل المختلفة موجبة متباينة فى القيمة من المتوسطة – العالية. كانت أعلى قيم الاستجابة المرتبطة للتحسين الوراثى المتوقع غير المباشر لصفات إنتاج اللبن فى ٣٠٥ يوم وكنسبة مئوية للجيل باستخدام الانتخاب الفردى لصفات إنتاج اللبن التراكمى باستخدام نظام التسجيل ($CMRS_2$) مقارنة بأنظمة التسجيل الأخرى. تشير النتائج السابقة إلى أنه يمكن إجراء التحسين الوراثى المبكر لصفات إنتاج اللبن فى ٣٠٥ يوم باستخدام صفات إنتاج اللبن التراكمى تحت نظام ($CMRS_2$) خلال الفترة من ٦١ – ١٥٠ يوم حيث حقق هذا النظام أعلى عائد وراثى.