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TEST-DAY MILK, FAT AND PROTEIN YIELDS AS SELECTION CRITERIA IN EGYPTIAN BUFFALO

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SUMMARY

Test-day records collected at monthly intervals from lactating buffalo cows calving between 1999 and 2010 raised at four experimental stations belonging to the Animal Production Research Institute (APRI), Egypt were used in this study. A total of 7926 test-day milk, fat and protein yields were analyzed to estimate genetic parameters and promote early selection criteria for lactation yields based on test-day yields through breeding scheme. The variance components were computed using restricted maximum likelihood (REML) algorithm, fitting a repeatability animal model. The fixed effects included a herd-year of calving, herd-test-date and age at calving and days in milk at first test-date as a covariate. Analysis of covariance showed significant effects of all fixed factors on studied traits except both season of calving and the interaction between herd-year of calving and season of calving.

The mean (standard deviation) lactation yields of milk, fat, and protein were 1420 (579), 94 (41) and 53 (22) kg, respectively.

Heritability estimates for lactation milk, fat, and protein yields using multivarite repeatability model were 0.137, 0.096, and 0.122, respectively. Estimates of heritability for indivadual test-day milk, fat, and protein yields fitting bivariate repeatability model ranged from 0.035 to 0.152, 0.020 to 0.106, and 0.063 to 0.127, respectively.

Clearly, estimates of heritability for test-day yields tended to increase gradually with test-day advanced up to the seventh test-day along the trajectory of the lactation and then estimates were decreased sharply to the end of the lactation.

Genetic and phenotypic correlations among lactation yields were high (0.944 to 1.000). Genetic correlations between lactation and test-day yields (milk, fat, and protein) were moderate to high ranged from 0.668 to 1.000, 0.584 to 1.000 and 0.528 to 1.000, respectivley. Corresponding phenotypic estimates varied from 0.559 to 0.735, from 0.527 to 0.693, and from 0.511 to 0.700.

Estimates of the expected correlated genetic gain for all lactation yields along DIM tended to be increased gradually up to the seventh test-day and then was declined sharply to end of the trajectory of the lactation. Consequently, direct selection of test-day yields from five to seventh can considered to promote substantial expected correlated genetic gain to improve milk yield and quality through breeding scheme of this population.

Keywords: Buffalo cows, test-day yields, genetic correlations, expected correlated genetic gain, breeding scheme

INTRODUCTION

In Egypt, buffalo is mainly reared for milk production. Buffalo milk is usually consumed fresh according to the demand of the Egyptian domestic market. This is ranging between 55 and 80%. Moreover, buffalo males between 2-24 months of age are considered important as a source of red meat. Buffalo contributes about 56% of the national milk production, in addition to about 42.6% of the total red meat produced in Egypt. Therefore, genetic improvement of products (milk and meat) is essential. According to the Egyptian Government report in 2014 (central for public mobilization and statistics, CAPMAS), its population counts around 4,000,000 animals.

Through last decades, there had been more interest in modeling individual test-day (TD) records for routine genetic evaluation in dairy cattle instead of using traditional aggregating records for economically important traits. Meyer *et al*. (1989) stated that individual test-day records for interest yield considering individual test-days, usually in monthly intervals (repeated measurements) along the trajectory of the lactation. Yields for completed 305-d lactation are commonly standardized to a period of 10 months. Some general aspects of TD models are a step towards a more biological view for individual variation of the lactation curve (Schaefer and Dekkers, 1994 and Jamrozik and Schaefer, 1997). TD models are more precise adjustment for temporary environmental relevant to each TD (Meyer *et al*., 1989 and Ptak and Schaeffer, 1993). This allows evaluation based on a limited number of TD records during lactation (incomplete lactation) to 305-d yields with the requirement that the cow had milked for a minimum number of days (90-d) and avoids the use of extension factors assuming that there is no variability in change of individual pattern of lactation curve among dairy animals (Jamrozik and Schaefer, 1997). Compared with the traditional models for aggregated lactation yields, TD models are more accurate with increasing the volume of data (Jensen, 2001).

Moreover, Meyer *et al*. (1989) and Ptak and Schaeffer (1993) suggested that animal model with repeated records along the trajectory of the lactation included covariables to describe the pattern shape of the lactation curve and fitting herd-test date as a fixed effect of reduced residual variation more than herd-year-season of calving effect. In dairy cattle, heritability estimates for TD records were slightly lower than those obtained for lactation records (Meyer *et al*., 1989). Moreover, applying random regression models heritability estimates for TD yields have been higher than for lactation yields (Jamrozik and Schaeffer, 1997 and Jensen, 2001) for dairy cattle and El-Bramony *et al*. (2004) for Egyptian buffalo in experimental population.

In dairy cattle breeding schemes, reducing the generation interval has been identified as a main tool to increase genetic progress (Nicholas and Smith. 1983). Therefore, the use of individual TD records rather than aggregating records could be early predictors of genetic of merit to decrease the generation interval which result in increasing the amount of genetic gain (Abdel-Aziz *et al*., 1973; Murthy *et al*., 1986; Mathew and George, 1989 and Meyer *et al*., 1989).

On the basis of these advantages, this study presents an analysis of lactation and individual TD records of the first seven lactations to:

1) estimate variance components for both lactation and test-day traits (milk, fat, and protein).
2) estimate expected direct response for lactation yields and expected correlated response between test-day and lactation yields, separately, for each studied trait.
3) promote early selection criteria for lactation yields based on TD yields through breeding scheme in the expermental buffalo population.

MATERIALS AND METHODS

Data originated from buffalo cows experimental herds of Mehallet Mousa, Kafr El-Sheik Governorate, belonging to the Animal Production Research Institute (APRI), Ministry of Agriculture and Land Reclamation, during 1999 to 2010.

Management of the experrimental herds:

Buffalo cows were kept under semi-open sheds. The ration was offered twice daily and clean water was available all the time. Amounts of rations given to the animals were determined according to animal body weight and level of milk production, and mineral salt was offered regularly. As a rule, buffalo heifers were attempted for service for the first time when they reached 24 mo or 330 kg.

Buffalo cows usually were served when seen in oestrus two months after calving, and they tend to calve in the winter season. Buffalo cows were naturally mated in a group-mating system; bulls were used for 3 breeding years. Rectal palpation to check pregnancy was performed 60 days after the last service. Milking was practiced twice a day at 7:00 am and 7:00 pm throughout the lactation period. Buffalo cows were to be dried two-mo before their expected calving dates. Drugs against diseases and parasites were applied twice a year. Abnormal records affected by diseases and abortion or by missing dates of birth, calving and dry off or sex codes of calves were excluded. The annual herd replacement rate is 15-20% as possible. Age at first calving averaged for this population 1129±4.2 days while the average interval between first successive calvings is 441±14 days. The average length of pergnancy was 322±10 days (Mourad *et al*.,1991; Mourad and Mohamed, 1995 and El-Bramony *et al*., 2004).

Description of the data set:

Test day (TD) records for milk yield, fat, and protein percentages were measured following an alternative am-pm monthly recording scheme. Fat and protein percentages were measured by the automated method of infrared absorption spectrophotometry (Milk-o-Scan; Foss Electric, Hillerφd, Denmark) at the Dairy Services Unit, Animal Production Research Institute, Sakha, Kafr El-Sheikh Governorate. Test-day fat and protein yields per lactation were calculated by the product of test-day fat and protein percentages and test-day milk yield. There are various methods to calculate the cumulative yields using individual test-day records (ICAR, 2008). According to the test interval method as described by Fleischmann's method (Barillet, 1985), the average milk yield measured between two consecutive test-date were multiplied by number of days interval, and the results for all intervals were accumulated to obtained lactation yields.

TD records from the first seven lactations between 5 and 285 days in milk (DIM) were considered in the statistical analysis. In addition, the first TD included test days between 5 and 15 DIM and all the subsequent tests were of 30-d interval up to 285 DIM. Buffalo cows had at least 5 TD records/lactation. TD data after 285 days was discarded as well from data file because it had few number of observations. TD records/ lactation were classified according to days in milk into ten test-days (TD1 to TD10). Data file were classified according to the month of calving into two seasons: hot (April through September) and mild for the rest of months. A data file with 7926 test-day yields from 1326 lactations of 810 lactating buffalo cows calving between 1999 and 2010 were used in this study (Table 1).

Traits definition:

The present study included lactation yields and test-day yields for all studied traits, in kilograms: lactation milk yield (LMY), lactation fat yield (LFY), lactation protein yield (LPY).Test-day yields for milk (DMY), fat (DFY), and protein (DPY) were included.

Table 1. Structure of the data set

Item	Value
TD records, no.	7926
Lactations with buffalo cow, no.	1326
Buffalo cow, no.	810
Sires, no.	139
Dams, no.	616
Herds, no.	4
Lactation /buffalo cow, no.	1-7
TD records/lactation, mean	5.98
Years of birth of buffalo cow	1989 to 2006
Years of calving of buffalo cow	1999 to 2010

Statistical analysis:

The (co)variance components for lactation yields and test-day milk, fat, and protein yields were estimated by restricted maximum likelihood (REML) algorithm (Groeneveld and García Cortés, 1998) using the software VCE 4.0, fitting a repeatability animal model and incorporating all available pedigree information. All known relationships among individuals were considered in the animal model.

The fixed effects included herd-year of calving, herd-test-date and age at calving and days in milk at first test-date as a covariate. Additive genetic, permanent environmental and residual for each studied traits with the corrsponding covariance matrix between them were considered as random effects.

The following multivarite repeatability animal model, in matrix notation, was employed to analyze lactation yields for milk, fat, and protein:

$Y= X\beta + Z\alpha + Wp + e$ (1)

Where:

Y is the a vector of observations of response lactation yields;

β is the vector of fixed effect of herd-year of calving and age at calving as a covariate;

α is the vector of random animal additive genetic effect, normally and independently distributed (0, $I\sigma^2_a$);

p is the vector of random permanent environmental effect of the buffalo cow;

X, Z and W are incidence matrices for fixed and random effects and

e is the vector of nonobservable random residual effect, normally and independently distributed (0, $I\sigma^2_e$).

The assumed bivarite repeatability animal model, in matrix notation were used to analyze test-day yields with lactation yields for all studied traits, separately, for each trait:

$Y= X\beta + Z\alpha + Wp + e$ (2)

Where:

Y is the a vector of observations of response test-day yields and lactation yields for all studied traits;

β is the vector of fixed effects of herd-year of calving, herd-test-day and age at calving and days in milk at first TD as a covariate and

X, Z, W and e are defined as in model (1).

Expected direct response to selection for lactation yields and correlated response for lactation yield with direct selection for test-day yields were calculated by Falconar and Mackay (1996), for all studied traits as:

$R_X= i\, h^2\, \sigma_p$ and $CR_Y = i\, h_X\, h_Y\, r_{Gx\,GY}\, \sigma_{pY}$ (3)

Where: R_X is the direct response in selection for X trait; h^2 is the heritability estimate of X trait; σ_p is the standard deviation of the phenotypic values; CR_Y is the correlated response in Y trait; i is the selection intensity assuming to be one for comparison only; h_X and h_Y are the square roots of heritability estimates of the two traits X and Y; $r_{Gx\ GY}$ is the genetic correlation between two traits and σ_{pY} is the standard deviation of phenotypic value of trait Y.

RESULTS AND DISCUSSION

Table (2) presents the descriptive statistics of data editing for the studied traits. The overall mean (standard deviation, SD) lactation yields of milk, fat, and protein among 1326 lactations were 1420 (579), 94(41) and 53(22) kg. These means are in the lower range of the values in the literature reviewed by (Rosati and Van Fleck, 2002; Barros *et al*., 2013; Flores *et al*., 2013and Malhado *et al*., 2013) working on other populations of buffaloes. Therefore, much attention should be paid for improving managerial practices in the current expermental population.

Preliminary analysis of covariance using PROC GLM; SAS (2002) showed a significant effect (P<0.01) of herd-year of calving, herd-test-day and age at calving and days in milk at first test-date as a covariate on the studied traits. On the other hand, season of calving and the interaction between herd-year of calving and season of calving had no significant effect (p>0.05) on these traits. Similar results were obtained by Ashmawy (1990), Mourad *et al*. (1991), Mourad and Mohamed (1995) and El-Bramony *et al*. (2004) working on the same population and (Cerón-Muñoz *et al*., 2002; Tonhati *et al*., 2008; Barros *et al*., 2013 and Malhado *et al*., 2013) on other populations of buffalo.

Actual lactation curve pattern:

Among 1326 lactations, the change of pattern in actual lactation curve for test-day yields over DIM had similar trends (Table 2). Test-day yields increased till third TD (peak phase) followed by a gradual decline until the end of lactation at the tenth TD. The rate of decline was observed from TD1 to TD3 (10.95%), while a rate of decline (1.53%) after peak phase was noticed between TD3 and TD4 for DMY. Corresponding values for DFY were (12.30%) and (1.08%) and (10.68%) and (1.61%), for DPY, respectively.

The pattern of change in the test-day yields over DIM among lactations observed in this study was in agreement with those reported by Catillo *et al*. (2002); Cerón-Muñoz *et al*. (2002) and Tonhati *et al*. (2008) for other populations of buffalo. Moreover, this trend obtained in the current study is close with that reported by El-Bramony *et al*. (2004 & 2016) for this population working on anthor data.

Genetic parameters for lactation yields:
Estimates of variance components and genetic parameters were obtained from multivariate analyses including lactation yields are given in Table 3. Overall, heritability estimates are similar and comparable to literature values for lactation yields among lactations. As reported in other studies, values of heritability for lactation yields ranged between 0.03 to 0.28 (Mourad and Mohamed, 1995; Rosati and Van Fleck, 2002; Tonhati *et al*., 2008; Barros *et al*., 2013; Flores *et al*., 2013; Malhado *et al*., 2013 and EL-Bramony, 2015) on different populations of buffalo. Low heritability estimates obtained for lactation yields are close to that reviewed by Rosati and Van Fleck (2002) working on Italian river buffalo.

Table 2. Number of observations (N), mean, standard deviations (SD), minimum (Mini.), and maximum (Maxi.), for lactation yields (in bold) and test-day yields in kg at selected days in milk (TD1 to TD10)

		Yield											
		Milk				Fat				Protein			
Test-day	N	Mean (kg)	SD (kg)	Mini. (kg)	Maxi. (kg)	Mean (kg)	SD (kg)	Mini. (kg)	Maxi. (kg)	Mean (kg)	SD (kg)	Mini. (kg)	Maxi. (kg)
	1326	**1420**	**579**	**467**	**3983**	**94**	**41**	**30**	**342**	**53**	**22**	**20**	**188**
1	659	7.67	2.88	2.0	17.0	0.496	0.216	0.11	1.37	0.281	0.112	0.06	0.70
2	997	8.45	3.31	2.0	18.0	0.553	0.243	0.09	1.47	0.309	0.123	0.06	0.80
3	1002	8.51	3.25	2.0	18.0	0.557	0.239	0.10	1.47	0.311	0.120	0.07	0.79
4	1062	8.38	3.06	2.0	18.0	0.551	0.226	0.10	1.49	0.306	0.116	0.07	0.75
5	1146	7.73	3.02	2.0	18.0	0.515	0.218	0.11	1.30	0.285	0.117	0.05	0.83
6	1012	6.93	2.86	2.0	16.0	0.466	0.211	0.08	1.18	0.257	0.110	0.04	0.65
7	757	6.35	2.82	2.0	15.8	0.428	0.211	0.08	1.47	0.240	0.110	0.05	0.85
8	528	5.91	2.71	2.0	15.7	0.409	0.207	0.08	1.35	0.222	0.102	0.05	0.60
9	425	5.52	2.54	2.0	13.9	0.394	0.194	0.09	1.13	0.210	0.095	0.05	0.55
10	338	5.16	2.58	2.0	14.3	0.371	0.187	0.09	0.97	0.203	0.103	0.06	0.55

Buffalo cows evaluation and selection are important in breeding scheme, this will provide of breeders to rank their animals (Ashmawy, 1990). Repeatability estimates for lactation yield traits in current study are within the range as in the literature which ranged from 0.29 to 0.52 as stated by Ashmawy (1990), Mourad and Mohamed (1995), Tonhati *et al*. (2008), Malhado *et al*. (2013) and EL-Bramony (2015) for different populations of buffalo. The higher estimates of repeatability could be a result of estimates of permanent environmental variance tended to increase with advanced lactation order (Table 3). Proportions of permanent environmental variance as proportions of total variance vary from 0.328 to 0.423% for lactation yields.

On the basis of the first lactation of each buffalo cow would lead to an accurate prediction of future performance and would afford an opportunity for a faster return of sires to service if their evaluation can be made early (Abubakar *et al*., 1986).

Correlations among lactation yields:
Genetic and phenotypic correlation coefficients among lactation yields were high ranging from 0.995 to 1.000 and from 0.944 and 0.959, respectively and are given in Table 3.

Large and positive estimates for genetic correlation coefficients frequently reported in the literature for other populations of buffalo. As indicated by Jairath *et al.* (1994), the same genes involved in controlling same traits (pleiotropy), cause high genetic correlations between milk yield traits. Moreover, they indicated that selection for any of these traits would result in a correlated positive response in the others. These results suggest the possibility of using these traits as selection criteria to improve milk yield compared with single-trait selection for milk yield (Van Fleck, 1978).

Genetic parameters for test-day yields:
Estimates of variance components and genetic parametes for test-day yields at selected days in milk (TD1 to TD10) obtained from bivariate analysis, with lactation yields separately, for each trait are shown in Table (4).

Table 3. Estimates of additive genetic (σ^2_a), permanent enviormental (σ^2_{pe}) and residual (σ^2_e) variances (kg^2) and estimates of heritability (h^2), repeatability (t), genetic correlation coefficient (r_g) and their standard errors in brackets and phenotypic correlation coefficient (r_p) for lactation yields

	Lactation yield		
Parameter	Milk	Fat	Protein
σ^2_a	37964.1	1892.9	954.2
σ^2_{pe}	117425.8	7023.6	2560.7
σ^2_e	122360.4	10872.3	4300.3
h^2	0.137	0.096	0.122
	(0.025)	(0.026)	(0.038)
t	0.559	0.451	0.450
	(0.016)	(0.019)	(0.017)
r_g (M , F) = 1.000	r_g (M , P) = 0.997		r_g (F, P) = 0.995
(0.132)	(0.142)		(0.140)
r_p(M , F) = 0.954	r_p (M , P) = 0.959		r_p (F, P) = 0.944

Table 4. Estimates of additive genetic (σ^2_a), permanent enviormental (σ^2_{pe}) and residual (σ^2_e) variances (kg^2) and estimates of heritability (h^2), repeatability (t) and genetic correlation coefficients (r_g) and phenotypic correlation coefficients (r_p) at selected days in milk (TD1 to TD10) by bivariate analysis with lactation yields, separately, for each trait sorted by test-day yields: (a): milk; (b): fat and (c): protein.

(a)

Milk yield

	Test-day									
Parameters	1	2	3	4	5	6	7	8	9	10
σ^2_a	0.439	0.350	0.367	0.471	0.770	0.824	0.930	0.217	0.025	0.025
σ^2_{pe}	2.158	2.463	2.280	2.678	2.560	2.080	1.973	2.008	2.004	2.009
σ^2_e	4.262	4.023	4.040	3.713	3.820	4.162	3.229	3.508	3.560	3.570
r_g	0.668	0.691	0.988	0.873	0.993	1.000	1.000	1.000	0.886	0.885
r_p	0.559	0.665	0.691	0.735	0.718	0.703	0.726	0.680	0.604	0.690
h^2	0.064	0.051	0.055	0.100	0.108	0.117	0.152	0.038	0.036	0.035
t	0.379	0.411	0.396	0.477	0.466	0.411	0.473	0.388	0.383	0.383

(b)

Fat yield

	Test-day									
Parameters	1	2	3	4	5	6	7	8	9	10
σ^2_a	0.0021	0.0011	0.0012	0.0033	0.0032	0.0040	0.0050	0.0011	0.0010	0.0010
σ^2_{pe}	0.0231	0.0221	0.0222	0.0263	0.0241	0.0220	0.0201	0.0200	0.0222	0.0211
σ^2_e	0.0301	0.0281	0.0292	0.0297	0.0280	0.0250	0.0220	0.0244	0.0261	0.0280
r_g	0.712	0.584	0.918	0.805	0.989	1.000	1.000	0.857	0.895	0.836
r_p	0.527	0.626	0.633	0.677	0.656	0.626	0.659	0.643	0.578	0.693
h^2	0.038	0.021	0.023	0.056	0.058	0.078	0.106	0.024	0.020	0.020
t	0.456	0.452	0.445	0.499	0.494	0.510	0.533	0.464	0.471	0.441

(c)

Protein yield

	Test-day									
Parameters	1	2	3	4	5	6	7	8	9	10
σ^2_a	0.0010	0.0011	0.0013	0.0014	0.0015	0.0016	0.0018	0.0011	0.0010	0.0010
σ^2_{pe}	0.0060	0.0051	0.0071	0.0070	0.0072	0.0061	0.0061	0.0051	0.0061	0.0070
σ^2_e	0.0070	0.0066	0.0083	0.0072	0.0071	0.0062	0.0063	0.0053	0.0070	0.0080
r_g	0.528	0.655	0.988	0.872	0.999	0.984	1.000	1.000	0.876	0.811
r_p	0.511	0.612	0.645	0.699	0.658	0.660	0.700	0.643	0.557	0.680
h^2	0.071	0.086	0.078	0.090	0.095	0.115	0.127	0.096	0.071	0.063
t	0.500	0.484	0.503	0.538	0.551	0.554	0.556	0.539	0.504	0.500

The total variance of a test-day yield is the sum of additive genetic, permanent environmental, and residual variance. The pattern of change in total variance across DIM tended to increase toward the mid lactation, followed by a gradual decrease until the end of the lactation for DMY (Figure 1). Estimates of additive genetic variance increased reaching maximum at the TD7 and then estimates were decreased sharply to the end of the trajectory (Table 4 and Figure 1). Moreover, a flat trend was obtained for the permanent environmental variance, slightly increasing toward mid lactation. While the pattern of residual variance was not constant along DIM of the lactation.

Clearly, estimates of all variances for DFY and DPY formed different pattern along DIM of the lactation. As shown in (Table 4 and Figure 1) variances had low estimates, which are in accordance with similar estimates reported for Friesian cows by Swalve (1995).

Estimates of total variance were not constant thoughout the lactation. Moreover, The pattern of additive genetic variance tended to increase gradually untill the TD7 and then estimates tended to decrease sharply toward the end of the trajectory. The similarity in pattern of the lactation along DIM for permanent environmental and residual variances in the current is in agreement with the result reported by Swalve (1995).

In general, the estimates of permanent environmental and residual variance were higher as proportions of total variance along DIM of the trajectory of the lactation. These finding led to lower estimates of heritability, while values of repeatability showed opposite trend.

Proportions of permanent environmental variance varied between 0.294 and 0.377%, 0.418 and 0.450%, and 0.398 and 0.456%, while residual variance as proportions of total variance ranged from 0.523 to 0.621% and 0.467 to 0.559% and 0.444 and 0.559, for DMY, DFY and DPY, respectively.

Clearly the estimates of heritability showed the same pattern at selected DIM for the all test-day yields. For milk, fat, and protein there was tendency toward moderate estimates in mid lactation. Then all yields were decreased sharply from TD7 to the end of the lactation (Table 4, Figure 2). This pattern is accordance with many other similar investigation. Hurtado-Lugo *et al.* (2006), concluded that estimates of heritability ranged from 0.01 to 0.20, with moderate value in the fifth test-day for milk yield. As reported in other study working on Murrah buffalo, Tonhati *et al*. (2008) obtained lower heritability estimates after the sixth month of lactation. Flores *et al*. (2013), stated that daily heritability estimates along DIM were low averged 0.15, 0.08, and 0.09 for DMY, DFY, and DPY, respectively. In dairy cattle, heritability estimates for TD records were slightly lower than those obtained for lactation records (Meyer *et al.,* 1989). Estimates of heritability obtained in the present study are low despite the fact that the Egyptian buffalo has not gone through intense genetic selection that could result in eroding the additive genetic variance. As indicated by Meyer *et al*. (1989), monthly alternative recording schemes contributed in increasing residual variation than composite monthly recording scheme which results in the lower estimates of heritability. They added these low estimates were not only causing comparative small variances between sires but also had considerably more short-term environmental variation affecting dairy animals.

A corresponding trend was stated, by Jensen *et al*. (2001) and EL-Bramony *et al*. (2004). They reported that the residual and permanent enviornmental variances generally increased with parity, which causes decrease in estimates of heritability.

Table 4 presents repeatability values for test-day yields (milk, fat, and protein) over DIM of the lactations. Estimates ranged from 0.379 to 0.477, from 0.441 to 0.533, and 0.484 to 0.556, respectivley. The range is comparable with that (0.48 to 0.52) reported by Ashmawy (1990), Mourad and Mohamed (1995), EL-Bramony, (2015) of the same population for lactation milk yield. Estimates of test-day repeatability for milk yield were reported 0.24 to 0.39 (Tonhati *et al*., 2008) for Murrah buffalo.

In conclusion, estimates of heritability and repeatability for lactation and test-day yields showed that much attention should be paid for improving managerial practices and performing selection scheme for this experimental buffalo population through breeding schemes.

Correlations between test-day and lactation yields:

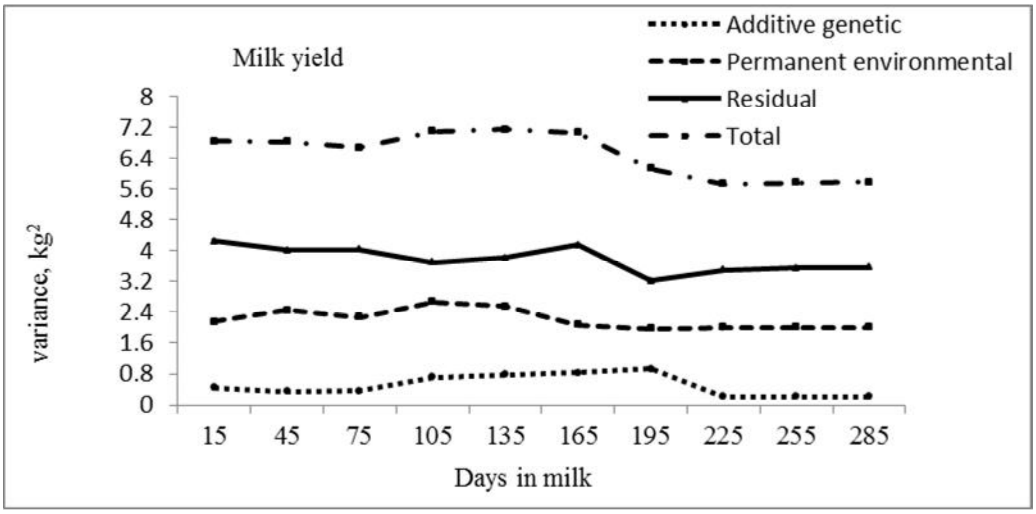
Estimates of genetic and phenotypic correlation coefficients between test-day (TD1 to TD10) and lactation yields, seperatly, for each trait are given in Table 4. The estimates of genetic correlations across DIM increased with DIM advanced up to TD8 for both DMY and DPY while, till TD7 for DFY and all were decreased gradually toward the end of the lactation. The estimates were moderate to high varying from 0.668 to 1.000, 0.584 to 1.000 and 0.528 to 1.000 for DMY, DFY, and DPY, respectivley. Corresponding estimates of phenotypic correlations were of medium size, varying from 0.559 to 0.735, 0.527 to 0.693, and 0.511 to 0.700, respectivley. As previously montioned, the high genetic association between test-day and lactation yields in the current study was due to the fact that the same genes involved in controlling same traits (pleiotropy), which cause high genetic correlations between studied yield traits as indicated by Jairath *et al.* (1994). Similar pattern of genetic correlations over DIM were previously reported by Tonhati *et al*. (2008) for other population of buffalo.

Expected genetic responses for studied traits:

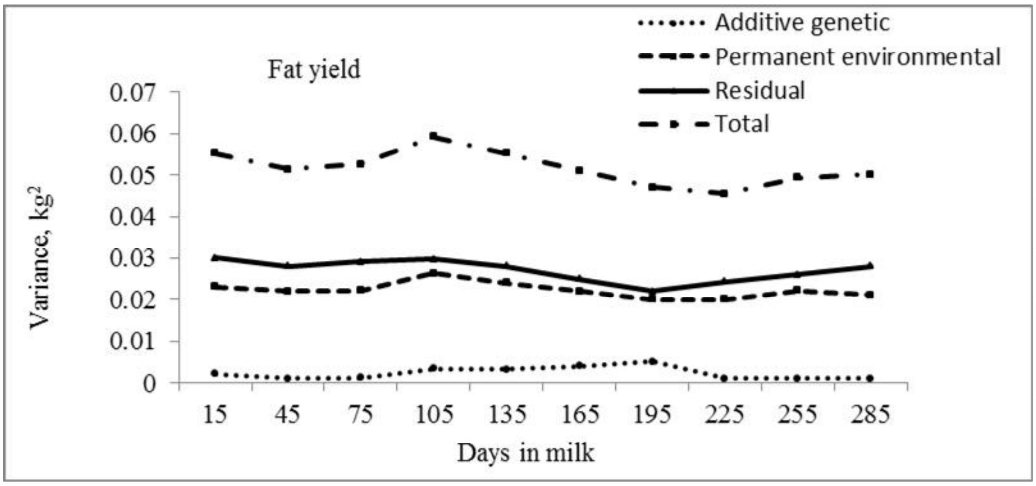
The adoption of partial yields as criteria of selection may contribute in reducing the generation interval which results in increasing the amount of genetic gain and early selection.

Estimates of expected genetic gain to direct selection for lactation yields and expected correlated response for lactation yields with direct selection for test-days at selected days in milk (TD1 to TD10) and responses per generation expressed as precentages considered, are tabulated in Table 5. The expected direct genetic gain through direct selection for lactation yields were 79.3 kg (5.6%) for LMY, 3.4 kg (4.2%) for LFY, and 2.7 kg (5.1%) for LPY as shown in Table (5).

(a)



(b)



(c)

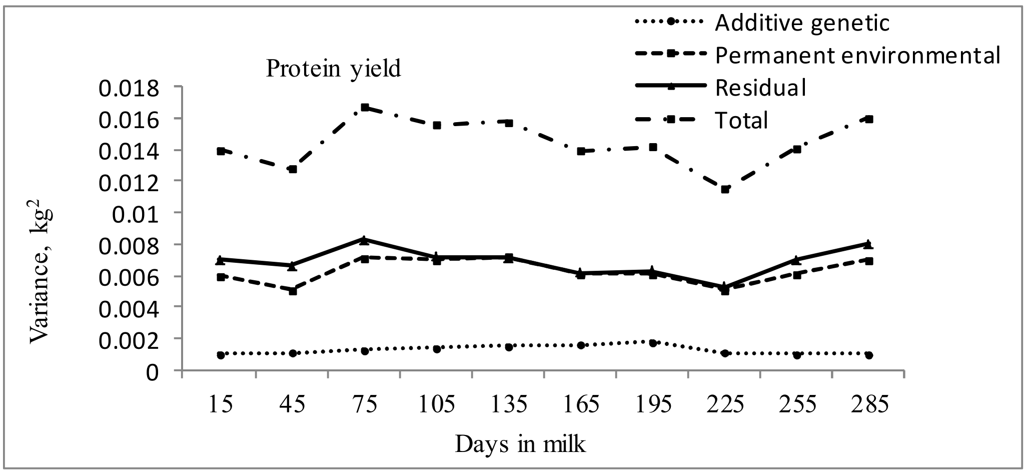


Figure 1: Changes of additive genetic, permanent environmental, residual and total variances at selected days in milk sorted by test-day yields: (a): milk; (b): fat and (c): protein in Egyptian buffalo

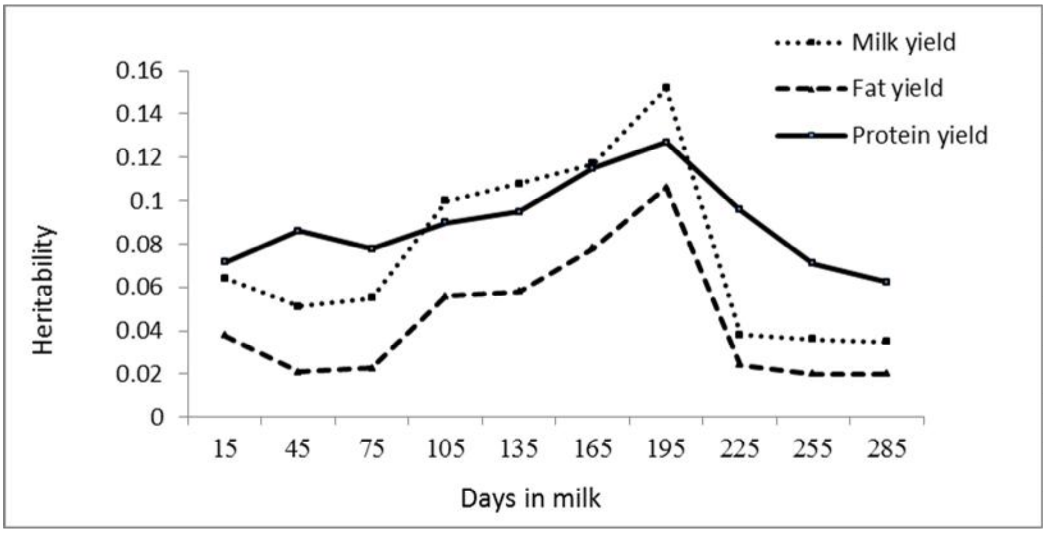


Figure 2: Changes of heritability estimates at selected days in milk for milk, fat and protein yields in Egyptian buffalo

Table 5. Expected direct response to selection of lactation yields (milk, fat, and protein in bold) and expected correlated response for lactation yields with direct selection for test-day milk, fat, and protein yields in kg at selected days in milk (TD1 to TD10) and responses per generation expressed as precentages of overall mean in brackets

Test-day	Expected genetic response in lactation yields (kg):		
	Milk	Fat	Protein
	79.3 (5.6)	**3.4 (4.2)**	**2.7 (5.1)**
1	36.2 (2.6)	1.8 (1.9)	1.1 (2.0)
2	33.4 (2.4)	1.1 (1.1)	1.5 (2.8)
3	49.7 (3.5)	1.8 (1.9)	2.1 (4.0)
4	59.2 (4.2)	2.4 (2.6)	2.0 (3.8)
5	69.9 (4.9)	3.0 (3.2)	2.4 (4.5)
6	73.3 (5.2)	3.6 (3.8)	2.6 (4.8)
7	83.6 (5.9)	4.1 (4.4)	2.7 (5.2)
8	41.8 (2.9)	1.7 (1.8)	2.4 (4.5)
9	36.0 (2.5)	1.6 (1.7)	1.8 (3.4)
10	35.5 (2.5)	1.5 (1.6)	1.6 (3.0)

Selection intensity equals 1.0 just (for comparison), for selection single trait separately, on female side, no selection on male side.

The estimates of expected correlated genetic gain for lactation milk yield, when direct selection is made on the basis of test-day milk yield at selected DIM (TD1 to TD10) ranging between 33.4 (2.4%) to 83.6 kg (5.9%) as presented in Table 5. On the other hand, (Table 5) the corresponding values of the expected correlated genetic gain in lactation fat yield when selection made on test-day fat yield along DIM varied between 1.1 (1.1%) to 4.1 kg (4.4%). Similarly for lactation protein yield, the corresponding values of expected correlated genetic gain ranged from 1.1 (2.0%) to 2.7 kg (5.2.%) (Table 5) when selection based on test-day protein yield across DIM.

Considering the estimates of heritabilty for lactation and test-day yields and genetic correlation coefficients among those yields, the estimates of the expected correlated genetic gain in lactation yields along DIM tended to increase gradually up to the TD7 and then declined sharply to the end of the trajectory of the lactation at TD10 as shown in Table (5). Consequently, direct selection of test-days from five to seventh can be considered to early promote substantial expected correlated genetic gain in studied lactation yields to improve milk yield and quality through breeding scheme of this population. These findings are in close agreement with these reported by Tonhati *et al*. (2008) working on Murrah buffalo. They stated that the first six months of lactation, could be adopted as a selection criteron to increase total milk yield. As indicted by El-Bramony (2009), the first six test-days had best predication of monthly records for the first three lactation, working on another data of the same population.

In earlier study (Khan and Johar, 1989) concluded that the highest correlated response obtained in LMY when selection was made on the basis of the first 150-d followed by180-d in first lactation of Murrah buffalo. Morover, Tailor and Banerjee (1998) found that the highest correlated gain in 305-d LMY was 39 kg (4.0%) of fourth month yield in Surti buffalo. Moreover, Van Fleck (1978) suggested the possibility of using yield traits (milk, fat, and protein) as selection criteria to improve milk yield compared with single-trait selection for milk yield.

CONCLUSION

Compared with the traditional models for aggregated lactation yields, TD models are more accurate when with the volume of data to be analyzed is much larger. Despite the volume of test-day records per lactation are limited, especially number of test-day records along day in milk from TD7 to TD10 of all studied lactations. This is due to that the most dairy animals making early dry off. The change of pattern in actual yields was less in average with those reviewed in the literature of other populations of buffalo.

Estimates of heritability and repeatability for lactation and test-day yields showed that much attention should be paid for improving managerial practices and performing selection scheme for this experimental buffalo population through breeding programs.

The genetic correlations between test-day and lactation yields indicated that a large proportion of additive genetic variance is common to both, these traits. Consequently, direct selection of test-days from five to seventh can be considered to promote substantial expected correlated genetic gain to improve milk yield and quality for this expermental buffalo population through breeding schemes.

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إنتاج اللبن والدهن والبروتين اليومي كمقياس إنتخاب فى الجاموس المصري

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جُمعت السجلات اليومية على فترات شهرية من إمهات جاموس حلاب خلال الفترة من ١٩٩٩ حتى ٢٠١٠ للأربعة مزارع تجريبية تابعة لمعهد بحوث الإنتاج الحيواني- مصر. حللت ٧٩٢٦ سجل يومي لإنتاج اللبن، والدهن، والبروتين لتقدير المعايير الوراثية وتأسيس مقياس انتخاب مبكراً وفقاً لسجلات الإنتاج اليومى ضمن برنامج تربية. قدرت مكونات التباين باستخدام نموذج الحيوان المتكرر- لوغاريثم (REML). إشتمل النموذج الإحصائي على التأثيرات الثابتة "القطيع- سنة الولادة ، والقطيع- ويوم الإختبار" وصححت البيانات لتأثير العمرعند الولادة وأيام الحليب عند الإختبار الأول. أظهرت النتائج تأثيراً معنوياً لكل العوامل الثابتة على جميع الصفات تحت الدراسة بإستثناء كل من "موسم الولادة والتداخل بين موسم الولادة وسنة الولادة.

كانت تقديرات المتوسط (الإنحراف المعيارى) للإنتاج الموسمى للبن، والدهن، والبروتين/كجم ١٤٢٠(٥٧٩)، و٩٤ (٤١)، و٥٣(٢٢) كجم على التوالى. بلغت تقديرات المكافئ الوراثى للإنتاج الموسمى (اللبن، والدهن، والبروتين) بإستخدام نموذج الحيوان المتكرر المتعدد الصفات ٠.١٣٧ ، و ٠.٠٩٦، و٠.١٢٢ على الترتيب. تراوحت تقديرات المكافئ الوراثى للإنتاج اليومي بإستخدام نموذج الحيوان لأكثر من صفة من ٠.٠٣٥ إلى ٠.١٥٢، و ٠.٠٢٠ إلى ٠.١٠٦ ، و٠.٠٦٣ إلى ٠.١٢٧ على الترتيب. إتجهت تقديرات المكافئ الوراثى للإنتاج اليومي للزيادة تدريجياً مع تقدم السجلات اليومية حتى السجل السابع على طول مسار منحنى الحليب ، ثم اتجهت للتناقص نحو نهاية المنحنى. كانت تقديرات الإرتباط الوراثي والإرتبط المظهرى بين الإنتاج الموسمي عالية وتراوحت من (٠.٩٤٤ إلى١.٠٠٠). وكانت تقديرات الإرتباط الوراثي بين الإنتاج الموسمي واليومي متوسطة إلى عالية لإنتاج (اللبن، والدهن، والبروتين) من ٠.٦٦٨ إلي١.٠٠٠ ، و٠.٥٨٤ إلي١.٠٠٠، و٠.٥٢٨ إلي١.٠٠٠ على الترتيب. بينما تراوحت التقديرات المقابلة للإرتبط المظهرى من ٠.٥٥٩ إلى ٠.٧٣٥ و ٠.٥٢٧ إلى ٠.٠٦٩٣ و٠.٥١١ إلى ٠.٧٠٠ على الترتيب. اتجهت تقديرات الإستجابة الوراثية المتوقعة لكل صفات الإنتاج الموسمى للزيادة عبر أيام الحليب حتى السجل اليومى السابع ثم انخفضت بوضوح نحو نهاية مسار منحنى الحليب. بناء على ذلك إمكانية استخدام السجلات اليومية للإنتاج من الخامس الى السابع كمقياس إنتخاب وراثى يتوقع يؤدى ذلك لتحسين إنتاج اللبن كماً ونوعاً ضمن برنامج تربية لهذه العشيرة.