11

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Genetic Analysis of Lactation Traits in Egyptian Buffaloes

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MILK production records for an Egyptian buffalo herd were collected in the period from 1970 to 1985. Data on 2739 lactation records including 696 buffalo cows (Paternal half-sisters) representing 67 sires were used to estimate the genetic and phenotypic variations and covariations of lactation period (LP) and yield of milk recorded on 90 days (90DY), 180 days (180DY), 305 days (305DY) and total lactation (TY). Averages of 90DY, 180 DY, 305DY, TY and LP were 601, 999, 1361, 1558 kg and 288 days, respectively. Parity effects were highly significant (P < 0.001) for all milk yield traits. All productive tratis increased with parity order till reaching the peak and declined thereafter, except TY and LP increased linearly as order of lactation advanced. Season of calving affected (P<0.01 or P<0.001) all productive traits except 90DY and 180DY. Summer calvers had the highest production of 90DY, 180DY and 305DY, but spring - calvers had the highest TY and LP. Year of calving constituted highly significant (P<0.001) source of variation for all productive triats studied. All milk yield triats decreased in quadratic form as age at calving advanced except TY which decreased linearly. Most lactation traits increased linearly (P<0.001) as days open increases . Days open correction factors for 180 DY, 305DY and TY decreased with the increase of the open period and the curve for 180DY was nearly similar to the curves of 305DY and TY. For all lactations, sire of the cow affected significantly (P<0.05 or P<0.001) all productive traits studied while for first lactation there was a significant sire effects (P<0.05) for 90DY. However, cow within sire affected significantly (P<0.001) productive traits in all lactations. Repeatability estimates were moderate and ranged from 0.295 to 0.407 for all lactation traits studied. Heritability estimates for all productive traits in the first and across all lactations were low and ranged between 0.006 to 0.109 . Genetic, phenotypic and environmental correlations between lactation traits were positive and high.

Key Words : Buffalo, Cenetic parameters, Lactation traits.

In developing countries and in Egypt in particular, animal production is mainly in hands of numerous small farmers. In such situation, buffaloes serve as an economically important source of milk and meat. Buffalo's milk accounts for 70% of the total milk produced in Egypt and it is characterized by high butterfat content when compared to cow's milk. Also, buffalo males are considered as an important source of veal production at about two months of age. Buffalo is, therefore, considered the main dairy animal in Egypt. Numbers of Egyptian buffaloes and their production of milk and meat represented by FAO report (1990) for Egypt compared to those of the world indicate that the contribution of the Egyptian buffaloes in milk and meat in the world is relatively considerable, *i.e.* about 5 and 14% of the world buffalo's milk and meat, respectively.

Few studies on Egyptian buffaloes (Abdel-Aziz and Hamed, 1979; Mourad *et al*, 1986) estimated different sets of age corrctions for 305-day and / or total milk yield, but no account was taken for days open. Also, information on the genetic aspects of some productive traits in Egyptian buffaloes is scarce. Without knowledge for the genetic of this species, effective improvement cannot be achieved . Therefore, the main objectives of this study were : (1) to investigate some non- genetic factors affecting productive performance of the Egyptian buffaloes, (2) to derive sets of correction factors of milk yield for days open, and (3) to estimate the genetic and phenotypic parameters of some economic traits in this type of buffaloes.

Material and Methods

This work was carried out using the productive records of the Egyptian buffalo herd raised at Mehallet Mousa Experimental Farm, Animal Production Research Institute, Ministry of Agriculture, Egypt. This farm is located in the northern part of Nile Delta in Kafer El-Sheikh Governorate.

Management and feeding

Animals were kept under a regular system of feeding and management adopted by the Animal Production Research Institute, Ministry of Agricultutre. During winter and spring months (from December to May), animals were kept on Egyptian colver (*Trifolium alexandrinum*) field all time (day and night) to graze *ad libitum*. Heavy milk buffalo cows and those in the last two months of pregnancy were supplemented with dry concentrate mixture proportional to their weight and production. During summer and autumn months from June to the end of November, animals were housed in open sheds for protection from direct solar radiation and fed on a dry concentrate mixture (according to their weight and production) in addition to hay of Egyptian clover and rice or wheat straw.

Animals in lactation were hand milked twice daily (once in the morning and the other in the afternoon). For two months before the next expected calving dates, buffalo cows, if did not go dry, were dried by milking them once a day, then once every two days until complete drying.

Breeding plan and data

Bulls were assigned to mate the famales naturally at random. Artificial insemination was only practised when there was a probability for veneral disease infection. Buffalo-heifers were served for the first time when they reached 24 months or 330 kg, while buffalo-cows (calvers) were usually served two months postpartum. Pregnancy was detected by rectal palpation 60 days after the last service. Buffaloes that failed to conceive were rebred in the next heat period. Buffalo-bulls were chosen for breeding purposes at 2-3 years of age. They were evaluated before being used for body conformation and for semen characteristics. Each bull was used for breeding for a period of about 3-7 years.

Data on 2946 lactation records of 430 buffalo cows sired by 51 bulls were collected over a period of 16 years started by 1970. Lactation traits studied were first 90-day (90DY), 180-day (180DY), 305-day (305DY) and total milk yield (TY) and length of lactation period (LP). The 90-day milk yield was considered as initial milk yield.

Statistical analysis

Data were analysed using Harvey's (1990) mixed model computer program. Data of 1*st* lactation were analysed by fitting the effects of year and season of calving, year x season interaction (as fixed effects) and sire of cow (as random effect) along with age of cow and days open (as covariates). Data across all lactations were analysed fitting the effects of year, season, parity, days open and year x season interaction (as fixed effects) and sire and cow within sire (as random effects) along with age of cow (as a covariate).

When one set of linear and quadratic regression on age of cow at calving was fitted to the mixed model, the prediction equation for adjusted productive traits (*i.e.* milk traits) was estimated according to Harvey (1990) as :

$$Y = \mu + b_L (AC - X\mu) + b_Q (AC - X\mu)^2$$

where Y = the predicted value of milk trait : μ = overall mean of milk trait, adjusted for effects in the model; b_L & b_Q= the estimates of partial linear and quadratic regression coefficients of milk trait on age of cow, respectively; AC= age of cow; and $X\mu$= usually equal to mean of age.

Days open correction factors for 180DY, 305DY and TY were constructed by smoothing the curve representing the relationship between least- squares means of milk yield with classes of days open using polynomial regression analysis of third degree. In case of nonsignificant partial cubic regression coefficient, the polynomial regression of the *2nd* degree was used and if the quadratic term was not significant the relationships between days open and lactation traits were examined for linearity. The prediction equations of adjusted - lactation traits were estimated as :

$$Y = \mu + b_L (X - X\mu) + b_Q (X - X\mu)^2 + bc (X- X\mu)^3$$

where Y= the predicted value of a trait, μ= overall least-square mean of a given lactation trait (adjusted for effects in the model), b_L, b_Q and b_C = estimates of partial linear, quadratic and cubic regression coefficients of a given lactation trait on days open , X= days open, and $X\mu$= usually equal to mean of days open. The multiplicative days open correction factors for 180DY, 305DY and TY were computed on the basis of modal class (the most frequent class) as : $C_i = \mu_m / \mu_i$, where C_i = the multiplicative days open correction factor, μ_m= the least-square mean of a given milk yield at modal class and μ_i = the predicted average of milk at each class of days open.

Estimation of genetic parameters

By equating mean squares of random effects to their expectations, estimates of variance components, *i.e.* sire ($\sigma^2 s$), cow within sire ($\sigma^2 C : S$) and remainder ($\sigma^2 e$) were obtained. Henderson method 3 was utilized to estimate the genetic and phenotypic variance and covariance components for the different traits. Paternal half-sib heritability ($h^2 s$) for different traits in the first lactation were calculated as four times the ratio of $\sigma^2 s$ to the sum of $\sigma^2 s$ and $\sigma^2 e$, *i.e.* $h^2 s=4\sigma^2 s/ \sigma^2 s + \sigma^2 e$. Heritability across all lactations were estimated by the paternal half-sib method as : $h^2 s= 4\sigma^2 s/ \sigma^2 s + \sigma^2 c : s+ \sigma^2 e$. Repeatability or intraclass correlation (t) estimated as : $t= \sigma^2 s+\sigma^2 c: s / \sigma^2 s+\sigma^2 c: s +\sigma^2 e$ where $\sigma^2 s+ \sigma^2 c : s$ estimates the sum of genetic and permanent environmental variances among cows, and $\sigma^2 e$ estimates the temporary environmental effects associated with each lactation. Genetic, phenotypic and environmental correlation coefficients between any two traits were estimated by the formulae outlined by Harvey (1990). Approximate standard errors for heritability, repeatability and genetic correlation estimates were computed by the LSMLMW program of Harvey (1990).

Results and Discussion

Means and variation of uncorrected records

Means , standard deviations (SD) and coefficients of variation (CV) for initial 90-day (90DY), 180-day (180DY), 305-day (305DY) and total (TY) milk yields and days of lactation length (LP)- in *1st* lactation and across all lactations are presented in Table 1. Means reported here for 305DY and for TY fall within the range of most estimates obtained for Egyptian buffaloes (*e.g.* Rashad, 1989; Ashmawy, 1991) and Murrah buffaloes (*e.g.* Johari and Bhat, 1979) . Mean of 90DY is close to those obtained by other Egyptian investigators (Farrag *et al,* 1982; Salem, 1983; the estimates were 570.8 and 653.0 kg, respectively). Also, the mean of 180DY (Table 1) is in the neighbourhood of the means estimated by Farrag *et al* (1982) and Mourad (1984) for Egyptian buffaloes. Estimates of CV given in Table 1 showed that variation in most yield traits (*i.e.* 180DY, 305DY and TY) were relatively high compared with that of 90DY or LP. Poor managerial procedures of such buffalo herd may have lead to such high variation. Sharma and Basu (1985) reported similar results.

TABLE 1. Actual means $^{+}$, standard deviations (s.d.) and coefficients of variations (CV) for productive traits in Egyptian buffaloes.

	First lactation			All lactations		
Trait	Mean	s.d.	CV%	Mean	s.d.	CV%
90DY (kg)	441	120	25.8	601	176	20.2
180DY	731	370	47.5	999	476	36.6
305DY	1037	562	49.4	1361	684	36.7
TY	1249	370	43.0	1558	662	28.9
LP (days)	295	120	30.7	288	98	23.0

$^{+}$Number of lactation records used was 2739.

Year of calving

Estimates of individual year effects are too numerous to be reported here. There was an increase (P<0.05) in milk yield traits and LP with advancing of year of calving. It is clear that year effects represent primarily managerial rather than genetic changes, since the effect of sire (*i.e.* contribution of sire) was accounted for in the models of statistical analyses. Such improvement in managerial and feeding systems occurred with advance of year of calving.

Season of calving

Least-squares means given in Table 2 show that no definite trend for the effect of season of calving on milk traits was observed. F-ratios given in Table 3 indicated that season of calving was more effective on yields of milk at late stage of lactation (P<0.001) than at early lactation (P>0.05). This is close to what found by Mourad (1984), Khattab *et al*, (1985) and Mohamed (1986).

Summer calvers recorded, in general, the highest milk production compared to the other seasons, while spring calvers recorded the longest LP and TY (Table 2). These findings are in quite agreement with those of other Egyptian studies (*e.g.* Mourad, 1984; Mostageer *et al*, 1981; Mohamed, 1986; Kotby *et al*, 1988; Rashad, 1989). Results of the present study could be explained on the basis that cows calved in summer will be in lactation during subsequent autumn and winter where high quality green fodder were available in enough quantities and weather become milder (Mourad, 1984; Rashad, 1989). Also, photoperiodicity, level of nutrition and exercise appear to be the main factors responsible for seasonal variation in productive performance of Egyptian buffaloes.

Parity

Least-squares means presented in Table 2 show that milk yield traits increased in curvilinear manner as parity advanced. LP increased linearily ($p < 0.001$) as parity advanced up to the *7th*. Among the successive parities, the first had the lowest ($p < 0.01$) means of yield traits and LP. A similar trend was observed by most Egyptian investigators (*e.g.* Mourad, 1984 ; Mohamed , 1986; Rashad, 1989 ; Ashmawy, 1991) and by other non-Egyptian ones (Jawarker and Johar , 1975; Basu and Ghai, 1978). The relatively high values of F-ratios given in Table 3 indicate that parity was one of the most important non-genetic factors influencing ($p < 0.001$) yield traits and LP of the Egyptian buffaloes. Most of the Egyptian studies (*e.g.* Mourad, 1984 ; Kotby *et al*, 1988; Rashad, 1989 ; Ashmawy, 1991) showed that parity effects were of some importance in influencing yields and length of lactation in Egyptian buffaloes.

TABLE 2. Least squres means and standard errors of parity and season of calving affecting milk production traits.

Independent variable	No	90 DY (kg)		180DY (kg)		305DY (kg)		TY (kg)		LP (days)	
		Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
Parity											
1st	599	554	42	911	123	1218	170	1326	155	226	22
2nd	621	634	25	1090	72	1470	102	1627	94	268	13
3rd	509	640	16	1047	42	1409	63	1656	61	279	8
4th	362	637	16	1051	42	1401	62	1655	61	285	8
5th	251	648	22	1034	60	1352	86	1632	80	289	11
6th	176	594	28	945	81	1233	113	1546	104	298	15
≥7th	221	601	36	964	105	1285	145	1630	133	316	20
Season of calving											
Autumn	825	609	15	998	39	1284	59	1512	57	273	8
Winter	939	623	15	972	39	1279	59	1538	57	278	8
Spring	638	602	16	1008	40	1374	60	1624	58	287	8
Summer	337	627	17	1046	45	1416	66	1652	63	282	9

Age at calving

Cow age in months, treated as a covariate, had significant quadratic effect on most milk traits studied (Table 3). The significant effect of age at calving on most milk traits in buffaloes was reported by many investigators for Egyptian buffaloes (*e.g.* Ragab *et al*, 1973; Mourad 1984 ; Rashad 1989), for Indian buffaloes (*e.g.* Umrikar and Dehpande , 1985). F-ratios for different traits showed that the linear effect of age at calving did not account for as much variation in yield traits as it did for LP (Table 3).

TABLE 3. Least squares analysis of variance of factors affecting milk production traits across all lactations.

Source of variation	d. f	F- ratios				
		90DY	180DY	305DY	TY	LP
Sire	166	1.76***	1.32*	1.36*	1.36*	1.35*
Cow/ sire	629	2.52***	2.66***	3.24***	3.88***	3.28***
Year of calving	15	5.29***	2.56***	3.29***	3.71***	10.90***
Season of calving	3	2.40ns	1.44ns	4.06**	4.98***	2.10ns
Parity	6	12.61***	7.89***	9.36***	11.44***	6.26***
Year X season	45	2.88***	1.66**	1.77***	2.07***	1.38*
Days open:	11	0.80ns	1.47ns	7.51***	20.44***	45.79***
Regression on age at calving						
Linear	1	0.49ns	0.05ns	0.50ns	0.12ns	8.34**
Quadratic	1	26.23***	9.40***	9.36**	9.10**	0.65ns
Remainder df	1961					
Remainder mean squares		14778	134378	249485	202727	4325
R^2 of model		0.63	0.55	0.56	0.58	0.62

ns = non- significant; * = p<0.05; **= p< 0.01; *** = p < 0.001 .

TABLE 4. Partial linear and quadratic regression coefficients (b) and tests of significance and prediction equations of lactation yield (kg) and length days of 1st lactation on age of the cow (months).

Trait	Linear (unit / month)		Quadratic (unit / month)^2		Prediction equation +
	b	s.e.	b	s.e.	
90DY	0.36	1.23	-0.022	0.125	90DY = 431 + 0.36 (AFC- 38.1) - 0.022 (AFC- 38.1)^2
180DY	-2.97	3.76	0.595	0.384	180DY = 680 - 2.97 (AFC- 38.1) + 0.595 (AFC- 38.1)^2
305DY	-2.86	5.54	0.890	0.566	305DY = 97 - 2.86 (AFC- 38.1) + 0.890 (AFC- 38.1)^2
TY	-8.12*	5.81	1.191	0.593	TY = 1205 - 8.12 (AFC- 38.1) + 1.191 (AFC- 38.1)^2
LP	-1.44**	0.98	0.272	0.100	LP = 285 - 1.44 (AFC- 38.1) + 0.272 (AFC- 38.1)^2

+ AFC = observed age at first calving ; * = P < 0.05;** = p <0.01.

Most estimates of partial regression coefficients (b's) given in Table 4 lead to the conclusion that milk traits studied decreased in curvilinear manner as age of cow advanced. Other Egyptian studies have shown a curvilinear trend for age-of-cow effects on productive performance of buffaloes (*e.g.* Ragab *et al*, 1973 ; El-Tawil *et al*, 1976 ; Mourad 1984). Accordingly, curvilinear relationships for age of cow could be fitted on the data of milk traits of Egyptian buffaloes. From partial linear and quadratic regression coefficients presented in Table 4 , prediction equations for the first lactation milk traits of Egyptian buffaloes (adjusted for other effects in the model) were calculated . Therefore, early prediction (in first lactation) based on the regression of each yield and LP on age of cow at first calving could be obtained and plotted to indicate the changes that would be expected in such traits with advance of age of cow .

Days open

Days open affected ($p < 0.001$) 305DY, TY and LP (Table 3) . Significant effect of days open on milk production of buffaloes was reported by many investigators (e.g Ashmawy, 1991). The magnitude of days open effects , as judged by the size of the F-ratio (Table 3), were much larger for 305DY and TY than in 90 and 180 days in milk. This trend could be attributed to the competition between milk production of buffalo cow and the nutrition of her foetus especially with the beginning of the *6th* month of pregnancy . It could be explained on the basis that milk secretion hormones decrease with advance of stage of gestation.

The estimates of partial regression coefficients of different traits on days open are presented in Table 5. For each additional day open, 305DY and TY increased significantly ($P< 0.001$) by 1.258 and 1.914 kg /day, respectively. For Egyptian buffaloes, Ashmawy (1991) found that estimates of partial linear and quadratic regression coefficients on days open were 2.76 kg/day and -0.0003 kg/day^2 for TY and -1.72 kg/day and 0.001 kg/day ^{2}for 305DY. Lundstrom *et al* (1982) reported that the delaying of days open may be caused by several factors, *e.g.* the operator's decision(poor oestrus detection, missing of oestrus) and culling policy. Accordingly, The operators were to inseminate their high yielding cows later than moderate or low-producing cows. This could automatically produce antagonistic relation between milk traits and days open.

TABLE 5. Partial regression coefficients (b) and their standard errors of polynomial regression analysis of third degree for production traits on days open.

Trait	Linear (unit / day)		Quadratic (unit / day^2)		Cubic (unit / day^3)	
	b	s.e.	b	s.s.	b	s.e.
90DY	-0.043 ns	0.034	-0.0003 ns	0.0004	0.000007 ns	0.000004
180DY	0.390***	0.105	-0.0003ns	0.0011	0.000008 ns	0.000012
305DY	1.258***	0.143	-0.0022 ns	0.0014	0.000013 ns	0.000016
TY	1.914***	0.129	0.0001 ns	0.0013	0.000022 ns	0.000015
LP	0.415***	0.019	0.0005**	0.0002	0.000004 ns	0.000002

ns = non-significant , **= p<0.01; ***= p< 0.001.

As expected, 180, 305DY and TY increased linearly (P< 0.001) with the increase of days open (Table 5). It was observed that the means for 305DY were similar to the means of TY. The quantity of 305DY, for instance, increased by only 507 kg, from monthly classes of < 30 (1*st* class) to >360 days (last class), *i.e.* over about 11 months of lactation. Consequently, 90 days open period was desirable for economic production in Egyptian buffaloes. Ashmawy (1991) concluded that reduction of days open in buffaloes is a desirable goal of dairymen. In practice, the farmers will inseminate their low performance cows as early as possible .

Days open correction factors

The modal value (more frequent class) of 61-90 days open is observed in the present study. Schaeffer and Henderson (1972) reported that correction factors for days open could be computed to any desirable base. Correction factors for days open across all lactations are presented in Table 6. These factors indicated that DO correction factors based on polynomial regression analysis of third degree for lactation traits studied decreased with the increase of the open period . Correction factors of the present study showed also that the curves for 180DY were nearly similar to the curves of 305DY and TY.

TABLE 6. Days-open correction factors (CF) for lactation traits in Egyptian buffaloes.

Days - open class	N	180Dy	305Dy	TY
≤ 30	34	1.041	1.087	1.127
31-60	232	1.029	1.051	1.079
61-90	286	1.016	1.018	1.034
91-120	280	1.004	0.972	0.992
121-150	275	0.993	0.958	0.954
151-180	254	0.981	0.931	0.919
181-210	215	0.969	0.905	0.903
211-240	172	0.958	0.880	0.856
241-270	189	0.948	0.869	0.828
271-300	179	0.937	0.835	0.801
301-330	274	0.926	0.814	0.776
≥331	249	0.917	0.794	0.753

Year X season interaction

The effect of interaction between year and season of calving was significant in all traits (Table 3). Such significant interaction and its biological importance is open to question in respect to lactation traits in buffaloes .

Variance components estimates

Effects of sires on lactation traits in the first lactation and across all lactations are given in Table 7 . Results obtained in the present study for all lactations show that the sire of the cow affected significantly ($P < 0.05$ or $P < 0.001$) all lactation traits studied (Table 7). Findings of the first lactation indicate that there was a significant sire effect ($P < 0.05$) for 90DY, while other traits were not affected. Afifi and Barrada (1973) and Cady *et al* (1983) have concluded that sire effects on milk yield traits of buffaloes were significant . Also, a significant cow effect ($P < 0.001$) on lactation traits was observed (Table 7) . Similar findings were reported by Cady *et al* (1983) for initial and 305DY of the Nili-Ravi buffaloes.

The percentage of variance attributable to the sire and cow within-sire components for all milk traits of all lactations are given in Table 7. Slight differences in sire component of variance were observed between the different traits , expect 90DY. The sire contribution ranged from 0.4 to 4.1% in first lactation and 0.9 to 2.9% in all lactations. These estimates for milk traits are lower than those estimates reported on the Egyptian buffaloes (Afifi and Barrada, 1973) and on Nili-Ravi buffaloes (Cady *et al*, 1983). The proportion of variance attributable to cow-within sire for lactation traits ranged from 27.9 to 42.6%. Most of these findings are similar to those obtained on Nili-Ravi buffaloes by Cady *et al* (1983). The present and reviewed studies, therefore, indicate that through sire and cow selection for milk traits, a genetic improvement of such traits is possible.

Repeatability estimates

Repeatability estimates (t) for different milk traits were moderate and ranged from 0.309 to 0.441, all with standard errors of values around 0.02 (Table 8). Similar estimates were obtained by many investigators (*e.g.* Mohamed, 1986 with Egyptian buffaloes; Jawarkar and Johari, 1975 with Murrah buffaloes ; Cady *et al*, 1983 with other Indian buffaloes). Accordingly, moderate estimates of repeatability for milk traits obtained in the present and reviewed studies lead to the conclusion that culling of buffalo cows for productive traits based on a single production record, as commonly practiced by buffalo breeders, would be efficient from the genetic standpoint and consequently assessment of several records are not required before selection of cows for such traits.

Heritability estimates

Estimates of heritability based on paternal half-sib for productive traits in first and across all lactations ranged from 0.015 to 0.166 and were generally lower than those reported on Egyptian, Indian and Murrah buffaloes (Table 8). The relatively low estimates for productive traits obtained in the present study could be due to that some sires were slightly different in age or may be due to some sires were partially confounded with year or season of calving (in a few cases, a sire was used in just one year and season) and consequently, some upward bias in the remainder component of

TABLE 7. Variance component estimates (σ^2) and proportions of variation (V%) due to random effects for lactation yields and length in Egyptian buffaloes.

Trait	First lactation						All lactations								
	Sire			Remainder			Sire			Cow within sire			Remainder		
	d.f	σ^2_s	V%	d.f	σ^2_s	V%	d.f	σ^2_s	V%	d.f	σ^2_s	V%	d.f	σ^2_s	V%
90DY	59	562	4.1*	480	12989	95.9	66	620	2.9***	629	5968	27.9***	1961	14778	69.2
180DY	59	533	0.4ns	480	120751	99.6	66	1855	0.9*	629	59495	30.4***	1961	13438	68.7
305DY	59	5006	1.9ns	480	262419	98.1	66	4759	1.2*	629	149111	36.9***	1961	249485	61.9
TY	59	1091	0.4ns	480	288614	99.6	66	4336	1.2*	629	153484	42.6***	1961	202728	56.2
LP	59	67	0.8ns	480	8220	99.2	66	78	1.1*	629	2639	37.5***	1961	4326	61.4

ns= nonsignificant, * = $P < 0.05$; *** = $P < 0.001$.

variance *i.e.* downward bias in sire component of variance) was obtained . Another reason for such low estimates of heritability may be selection, based on culling policies , which was commonly applied in this herd of Egyptian buffaloes. However, the low magnitude of heritability estimates for milk production traits of Egyptian buffaloes suggest that a small additive genetic variation in these traits was detected and consequently the non-genetic factors (*i.e.* managerial practices) are playing the major source of contribution in such variation. This is confirmed by other non -Egyptian studies for Murrah and Indian buffaloes (Gurung and Johar, 1982 ; Singh *et al*, 1984).

TABLE 8 . Estimates of repeatability (t) and heritability (h2) of milk production traits in Egyptian buffaloes.

Trait	Repeatability		Heritability ewstimates			
			First lactation		All lactations	
	t	s.e.	h^2	s.e.	h^2	s.e.
90DY	0.309	0.024	0.166	0.112	0.116	0.042
180 DY	0.314	0.024	0.018	0.092	0.038	0.028
305DY	0.381	0.024	0.075	0.100	0.047	0.030
TY	0.441	0.025	0.015	0.092	0.048	0.030
LP	0.386	0.024	0.032	0.094	0.045	0.029

Estimates of heritability for milk yield traits in the first and across all lactations were low in magnitudes (Table 8). These estimates are within the range of those reported by some Egyptian workers (*e.g.* Mourad , 1984 ; Mohamed , 1986) . Higher estimates were reported by Patro and Bhat (1979) and Kornel and Patro (1988) in Indian buffaloes. The estimates of heritability for LP were also low (Table 8) and consequently one can conclude that the major part of the variation in this trait is of non-genetic origin.This is expected and most estimates reported in the literature (*e.g.* Jawarkar and Johar, 1975 ; Johari and Bhat , 1979 ; Patro and Bhat, 1979;Mourad 1984; Sharma and Basu, 1985) confirmed these results.

Correlations

Genetic (r_G), phenotypic (r_p) and environmental (r_E) correlations among lactation traits are presented in Table 9. Most estimates of r_G were similar to the corresponding estimates of r_p and r_E in directions and were slightly higher in magnitudes. The high r_p 's obtained here for Egyptian buffaloes gave, in practice, a considerable advantage in management and culling policy for such type of dairy animal.

TABLE 9. Estimates of genetic correlation and their standard errors (below diagonal) and phenotypic and environmental correlations (above diagonal)⁺ for lactation traits.

Trait	90 DY	180DY	305DY	TY	LP
90 DY		0.65(0.64)	0.61(0.60)	0.64(0.65)	0.33(0.33)
180DY	0.961±0.156		0.95(0.94)	0.76(0.76)	0.62(0.62)
305DY	0.791±0.158	0.973±0.036		0.88(0.88)	0.75(0.74)
TY	0.650±0.174	0.765±0.180	0.902±0.080		0.84(0.83)
LP	0.417±0.249	0.749±0.223	0.894±0.122	0.992±0.059	

+ Environmental correlations are given in prentheses adjacent to the phenotypic correlations.

Estimates of r_G and r_p among yield traits (90DY, 180DY, 305DY and TY) are positive and high ranging from 0.610 to 0.973. High estimates of r_G or r_p among yield traits were also observed by Mourad (1984). These mainly part-whole genetic and phenotypic associations indicate that milk yield in 90-day of lactation could be good indicators for production in total lactation. Consequently, early selection for high yield of milk at 90 days of lactation will be associated with an improvement in the corresponding traits of 180DY, 305DY and TY.

Positive and high estimates of r_G and r_p between milk yield and LP were generally obtained; estimates ranging from 0.33 to 0.992 (Table 9). This means that selection against short LP is also expected to be guided against low milk production. It also indicate that there was a positive genetic and phenotypic dependency of milk yield on LP.

Estimates of $r_E$amongst lactation traits were positive and generally high (Table 9) . These estimates emphasize the large environmental influences the buffalo cow has on her lactation and therefore an improvement in the environment (*i.e.* management, feeding , housing ...etc) affecting LP would be associated by an improvement in environment affecting the other yield traits (90DY, 180DY, 305DY and TY). This indicates also that better environmental and managerial conditions will optimize LP and consequently more yield obtained.

Conclusion Productive efficiencies in Egyptian buffaloes are poor and that is probably due to managerial factors mainly nutrition (green fodder availability) and climatological factors together with the fact that no effective selection programme was carried out. This poor performance is one of the limiting factors for the effective use of high genetic potential of this species as a dairy animal in Egypt.

Owing to moderate repeatabilities for lactation traits obtained here, a single production record should be considered when evaluating buffalo cow records for selection or culling purposes.

Low genetic variation due to sires (*i.e.* low heritability for most lactation traits) obtained here suggest that there is little scope for improving the lactation performance of Egyptian buffalo through direct selection.

High estimates of genetic and phenotypic correlation in the present study offer the possibility to select for yield traits at early ages, *i.e.* at 90 days of lactation. The positive and high correlation between lactation length and milk yield is desirable to combine them into an index with a view to improve lactation efficiency of Egyptian buffaloes.

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التحليل الوراثى لصفات الادرار فى الجاموس المصرى

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أجريت هذه الدراسة على سجلات اللبن لاحدى قطعان الجاموس المصرى خلال الفترة من سنة ١٩٧٠ حتى ١٩٨٥. أستخدمت بيانات ٢٩٤٦ سجل ادرار لعدد ٤٣٠ جاموسة (مجموعات أنصاف أشقة) بنات ٥١ طلوقة وذلك لتقدير التباين الوراثى والمظهرى لبعض الصفات الإنتاجية . إشتملت الصفات الأنتاجية على طول فترة الإدرار ومحصول اللبن عند ٩٠، ١٨٠، ٣٠٥ يوما من الإدرار وإجمالى إدرار الموسم ، تتلخص النتائج المتحصل عليها فيما يلى :

١- كان متوسط انتاج اللبن خلال ٩٠ يوما ، ١٨٠ يوما ، ٣٠٥ يوما من الإدرار والإدرار الكلى هو ٦٠١ ، ٩٩٩ ، ١٣٦١ ، ١٥٥٨ كيلو جرام على التوالى وكان متوسط طول فترة الإدرار ٢٨٨ يوما .

٢- كان لترتيب موسم الإدرار تأثيرا معنويا (عند مستوى ٠.٠١) على جميع الصفات الإنتاجية المدروسه - حدث زياده مستمره فى بعض الصفات الإنتاجية مع تقدم موسم الإدرار الى أن وصلت الى أعلى مستوى من الإدرار ثم انخفضت مرة أخرى . هذا فيما عدا انتاج اللبن الكلى وطول فترة الادرار حيث حدث بها زياده مستمره فى صوره خطيه مع تقدم موسم الإدرار .

٣- ظهر لفصل السنه تأثيراً معنويا (عند مستوى ٠.٠١) على جميع الصفات الإنتاجية المدروسه فيما عدا انتاج اللبن خلال ٩٠ يوما الأولى من الإدرار. أعطت ولادات فصل الصيف اعلى انتاج من اللبن خلال ٩٠ يوما ، ١٨٠ يوما، ٣٠٥ يوما من الإدرار بينما اعطت ولادات فصل الربيع اعلى قيمة من انتاج اللبن الكلى واطول فتره للإدرار.

٤- ظهر لسنة الولاده تأثيرا معنويا (عند مستوى ٠.٠١) على جميع الصفات الإنتاجية المدروسة .

٥-كان لعمرالجاموسه عند الولاده تأثيراً معنويا (عند مستوى ٠.٠٥ أو ٠.٠١) على كل الصفات الإنتاجية المدروسه حيث لوحظ تناقص انتاج اللبن بصوره خطيه انحنائية وذلك بتقدم عمر الجاموسه .

٦- تزايدت معظم صفات الإدرار زياده خطيه (مستوى معنويه ٠.٠٠١) بزيادة طول فترة الأيام المفتوحة . تم إشتقاق معاملات تصحيح لطول فترة الأيام المفتوحة لتصحيح سجلات انتاج اللبن للجاموس المصرى . تناقصت معاملات التصحيح لسجلات اللبن مع زيادة فترة الأيام المفتوحه وكان منحنى معاملات تصحيح ١٨٠ يوما من الإدرار يشابه تقريبا منحنيات معاملات التصحيح لانتاج ٣٠٥ يوما من الادرار وللإدرار الكلى .

٧- كان هناك تأثيرا واضحا للطلوقه (أباء الجاموس) على جميع الصفات الإنتاجية وذلك بالنسبة لمواسم الإدرار مجتمعه بينما كان التأثير معنويا فقط على انتاج اللبن خلال ٣٠٥ يوما من الإدرار ولطول فتره الإدرار للموسم الأول. كذلك كان للبقره

تاثيراً معنويا واضحا (على مستوى ۰.۰۱) على جميع الصفات الإنتاجيه المدروسه .

٨- كانت قيم المعامل التكرارى لصفات محصول إدرار اللبن ولطول فترة الإدرار متوسطه القيمه حيث تراوحت القيم من ۰.۲۹٥ إلى ۰.٤٠٧ مما يقودنا الى الإعتماد على سجل انتاجى واحد لانتخاب اناث الجاموس المصرى .

٩- كان المكافئ الوراثى منخفض لجميع صفات الإدرار سواء فى الموسم الأول أو لكل مواسم الإدرار حيث تراوحت القيم بين ۰.۰۰٦ الى ۰.۱۰۹ .

١٠- كانت الإرتباطات الوراثيه والمظهريه والبيئيه بين صفات الإدرار موجبه وعاليه القيمه .