Phenotypic and Genotypic Trends for Some Economic Traits in Egyptian Buffaloes

Amina, I.S. Ahmad[1], Shaima, M. El – Komey[1], Set El- habiab, S.Awad[2] and A. S. Khattab[1].

[1]Animal Production Department, Faculty of Agriculture, Tanta university Egypt and[2] Animal production Research Institute , Ministry of Agriculture, Dokki, Cairo, Egypt.
Email : Adelkhattab@yahoo.com

Abstract

A total of 2763 lactation records of Egyptian buffaloes, sired by 147 bulls, were collected from Mahalla Mousa Farm, Kafer El sheihk Government. Traits studied are milk production (MP), lactation length (LL) and age of heifers at calving (AHC). Effects of period and month of calving, lactation order and heifers at calving were studied as main effects , beside bull, buffaloes within bulls and errors were studied as random effects.. Also, Animal mode was used to estimate genotypic parameter, transmitting ability, phenotypic and genotypic trends for above traits studied. Least squares analysis of variance (Table 2) show a significant effects of year of calving and month of calving and lactation order on MP, LL and AHC. Linear and quadratic regression coefficients of MP and LL on AHC had also a significant effect. Sires and buffaloes within sires had a significant effect on MP, LL and AHC. Estimates of (h^2) were 0.28, 0.20 and 0.10, for MP, LL and AHC respectively. Genotypic correlations between MP and each of LL and AHC were 0.76 and -0.36, respectively. Genotypic correlation between MP and AHC was -0.30. Phenotypic correlation between MP and both of LL and AHC were 0.80 and -0.90, respectively and phenotypic correlation between LL and AHC was -0.40.

Predicted transmitting ability from buffaloes ranged from -774 to 933 kg for MP from – 60 to 101 d for LL and from – 4 to 8 mo., for AHC. Predicted sire transmitting ability for MP ranged from – 408 to 535 kg, for LL ranged from -27 to 29 d and for AHC ranged from -2 to 5 mo., Expected dam transmitting ability ranged from -388 to 365 kg for MP, from – 30 to 23 d for LL from - 2 to 2 mo., for AHC. Annual phenotypic and genetic trend for milk production calving was positive and significant. While, annual genotypic change for lactation length and age of heifers at calving were negative and significant.

Key words: Phenotypic , Genotypic, Trends, Egyptian buffaloes

1. INTRODUCTION

Milk production obtained from buffaloes are controlled by many non genetic effects (i.e., season or month of calving, year of calving, lactation number and age of heifers at calving) and genetic effects. Adjust records for non genetic factors are necessary to obtain the best estimates of genetic parameters and genetic changes. Estimates of heritability of milk traits was vary from 0.12 to 0.41 (**Khattab and Mourad, 1992;Khattab *et al*., 2003&2010; El- Arian *et al*., 2012 and Ibrahim**

et al.,2012), for lactation period from 0.04 to 0.31 (**Khattab *et al*., 2003&2010; El- Arian *et al*., 2012 and Ibrahim *et al*.2012)** and for age of heifers at calving heritability estimates near zero **(Khattab *et al*., 2003).**

Khattab and Mourad (1992) and El- Arian et al. (2012) working on Egyptian buffaloes, estimated phenotypic and genetic trends for milk traits by using sire and animal model, respectively.

The objectives of the study are to (1) estimate non-genotypic factors affecting milk production, lactation length and age of heifers at calving (2) estimate phenotypic and genotypic parameters (3) estimate predicted transmitting ability from buffaloes, sires and dams by using multi trait animal model and (4) estimate phenotypic and genotypic changes for above traits studied of Egyptian buffaloes herd kept at Mahalla Mousa Station.

Material and Methods

Source of Data

A total of 2763 lactations records of 357 Egyptian buffaloes sired by 147 bulls were used for the present study. Data were collected on the herd of the Mahalla Mousa Farm during the period from 1995 to 2015. bulls having less than 5 daughters were omitted. Artificial insemination (AI) was used starting from 2009 to 2015. Bulls were chosen for breeding purposes at 2-4 years of age.

Buffaloes were fed on (***Trifolium alexandrinum***) during winter seasons, while for summer seasons animals were fed on concentrate ration and rice straw. Buffaloes producing more than 12 kg milk per day and that are pregnant in the last two months of pregnancy were supplements with extra concentrate ration. Buffaloes were hand milked twice a day. Traits studied are milk production (MP), lactation length (LL, d) and age of Heifers at calving (AHC)). Table 1 shows the description of data.

Table 1. Description of data.

Observations	Numbers
Total number of records	2763
Total number of bulls	147
Total number of buffaloes	357
Total number of dams	183
No. of equations	2198
No. of rounds	569

Analysis

For milk production and lactation length, the main effects of month of calving, year of calving and lactation number and age of heifers at calving as regression and random effects of bulls, buffaloes within bulls and errors were studied. While for age of heifers at calving, the main effects of month and year of calving and bulls, buffaloes within bulls and errors are random effects.

Genotypic parameters

Heritability, genetic and phenotypic correlation are estimated by using multi trait animal model **(Boldman et al. 1995). T**he main effects of month and year of calving and lactation number, age of heifers at calving as regression and random effects of animals, uncorrelated random effects and errors were studied.

Phenotypic and genotypic trend

The annual phenotypic changes for milk traits studied are estimated by using the linear regression of milk traits studied (MP, LL and AHC) on year of calving. Trends in transmitting abilities of sires for different traits studied were estimated from the regression estimates of sire breeding values on each year of calving as described by **(Khattab and Mourad, 1992).**

Results and Discussion

Means of traits

Overall means, standard deviation (SD) and coefficient of variability (CV %) for milk production (MP), lactation length (LL) and age of heifers at calving (AHC) are presented in Table 2.

Table 2. Overall means, stander deviation (SD), coefficient of variability for milk yield production (MP), lactation length (LL) and age of heifers at calving (AHC).

Traits	N	Mean	SD	CV%
MP, kg	2763	1649	697	42.30
LL, d	2763	197	690	33.82
AHC, mo.,	2763	37.53	6.45	17.18

Coefficient of variability for MY, LL and AHC were 42.30 %, 33.82 % and 17.18 %, respectively (Table 2). These estimates are higher than that reported by **El- Arian *et al*.(2012)** (31.6 %) and **Khattab *et al*. (2003)**, 37.4% for TMY, respectively. The value of CV % of LL was higher than those of **El- Arian *et al*. (2012)** for Indian buffaloes (21.5 %). The value of CV % for AHC was less than that found by **Khattab *et al*. (2003)** (17.18 %) for Egyptian buffaloes. The increase value of CV % for MP and LL (Table 2), indicate a great variation for milk traits.

Non Genetic Effects

Table 3 show a highly significant effect of non genetic factors affecting on milk traits studied. Significant effect of month or season of calving and year of calving on milk yield, lactation length and age of heifers at calving are stated by **Ashmawy (1991), Afzal et al. (2007), El- Arian *et al*. (2012) and Abu El- Naser (2014)**. **El- Arian *et al*. (2012)** analysis 3321 lactation records of Egyptian buffaloes, reported that the significant effect of season and period of study on productive traits may be due to changes in milk production from year to year, change in age of animals, different climatic, management and phenotypic trend.

Lactation number had a highly significant effect on MP, LL and AHC (Table 3). The present results are agree with those results found by **Ashmawy (1991) and Abu El- Naser (2014)**. Also, **Afzal *et al*. (2007) and LiviaVidu et al. (2013)**,found a significant effect of lactation order on milk yield and lactation length. The significant effects of lactation number on MY, LL and AHC may be due to the increase of body weight, body size and udder system.

Linear and quadratic regression coefficients of MY and LL on AHC are highly significant and being 79.04 kg/mo., and -0.98 kg/mo.,^{2}, respectively for MY and 6.62 d/mo. and -0.079 d/mo.,^{2}, respectively for LL ($P < 0.01$, Table 3) Considering age at first calving in the model as a second degree polynomial to describe its effect on total negative regression coefficients. As age at first calving increased milk production and lactation length increased and then decreased after that. Table 3. showed that the maximum milk production and lactation length are attainable at 35 and 30 mo., respectively using the regression prediction equation**. Arian *et al.* (2012), Ibrahim *et al*. (2012) and Sharma *et al*. (2016)** arrived to the same results.

Table 3. F- Values for non genetic factors affecting on milk production (MP), lactation length (LL) and age of heifers at calving (AHC).

S.O.V.	d. f	F- Values		
		TMY	LP	AFC
Between Sires	146	3.93**	3.29**	606**
Between buffalos : Sires	258	2.90**	2.07**	338.80**
Between Month of calving	11	6.19 **	5.89**	0.53**
Between year of calving	25	11.15**	7.73**	1.97**
Between parity	12	20.60**	10.43**	
Regressions				
Age at first calving, L	1	23.58**	17.95**	
Age at first calving, Q	1	24.49**	17.16**	
Reminder , M.S.	2308	284226	3373	0.56

****<0.010**

<u>Random Effect</u>

Table 3 show that bulls and buffaloes: bulls had a highly significant effect on MY, LL and AH. The present results indicate the possibility of increase of milk traits through sire and buffaloes selection. **Ashmawy (1991), Khattab and Mourad(1992 and Ibrahim *et al*. (2012)** stated a significant effect of random factors

Mixed Model Equations (MME)

Number of equations (MME) and number of rounds are 2198 and 569, respectively. The higher number of mixed model equations and number of iterations may be due to use three traits in the analysis and considering also genotypic covariance and errors covariance among these traits.

Genotypic parameters

Heritability (h^2) estimates, genetic and phenotypic correlation between traits studied traits are found in Table 4.

Table 4. Heritability estimates (h^2) with standard errors (on diagonal), genotypic Correlations (r_g) below diagonal and phenotypic correlations (r_p) among traits studied.

Variables	Milk production	lactation length	Age of heifers at calving
Milk production	0.28±0.01	0.80 ±0.05	-0.90±0.09
Lactation length	0.70 ±0.20	0.20 ±0.02	- 0.40±0.10
Age of heifers at calving	-0.36±0.09	- 0.30±0.09	0.10±0.01

Estimates of h^2 for MP, LL and AHC are 0.28, 0.20 and 0.10, respectively (Table 4). The moderate h^2 estimates for MP and LP concluded that milk traits from Egyptian buffaloes could be increased by selection of sires and improved management. Also, including uncorrelated random effects in the model could be the reason for decreasing estimates of heritability from animal model Lower h^2 estimate for AHC concluded that AHC is affected by environmental factors. Estimates of heritability of AHC are higher than those found by many authors. **Khattab and Mourad (1992)**, Khattab et al. (2010) and El- Arian et al. (2012) and ranged from 0.17 to 0.0.21 for milk production, from 0.13 to 0.16 for lactation period.

On other hands higher **Tonhati et al. (2000)** on Murrah buffaloes in Brazil, reported that h^2 estimates fort milk yield and age at first calving were 0.38 and 0.20, respectively. **Khattab et al.(2003**) stated that h^2 estimates for milk yield, lactation length and age at first calving were 0.43, 0.14 and 0.25, respectively. **Ibrahim *et al.* (2012)** reported that h^2 estimates for milk yield and lactation length were 0.41 and 0.31, respectively.

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Genetic correlations between traits studied are presented in Table 4. Estimate of genotypic correlation between MP and LL was (0.76). **Khattab and Mourad, (1992) ,Khattab et al. (2003) ,El-Basuini (2010) and El- Arian et al.,(2012)** found that the genotypic correlation between milk yield and lactation period ranged from 0.62 to 0.80. The present results, indicating that buffaloes giving higher milk production will also having longer lactation length.

Estimates of genetic correlation between MY and AHC was negative (-0.36). These results show that selection against higher age at first calving. Milk production from buffaloes will increase. Similarly, the genotypic correlation between LL and AHC was negative (-0.30). These results leads to suggest that selection for higher productively would be correlated with longer LL and younger AHC.

The present results suggested that a decrease of AHC is an aim of breeders, decrease the cost of breeding heifers, short the generation number and increase the number of calves per cow. On the other hand, **Tonhati et al. (2000)** working on Murrah buffaloes in Brazil, reported that the genotypic correlations between age at first calving and each of milk yield and lactation period were 0.63 and 0.33, respectively

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Phenotypic correlation between MY and LL was 0.80 (Table 4) .**Khattab and Mourad,(1992);Khattab et al., (2003), El- Basuini (2010) and El- Arian et al., 2012)** found that the phenotypic correlations between milk yield and lactation length ranged from 0.61 to 0.80.

Phenotypic correlation between AHC and each of MP and LL were negative and being -0.90 and -0.40, respectively (Table 4). Therefore the younger heifers produce more milk and longer lactation period rather than older heifers. Therefore, the reduction age at first calving is a desirable goal of dairymen.

<u>Predicted breeding values</u>

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Table 5 show the minimum, maximum, range and accuracy of predicted transmitting ability from buffalo, sires and dams.

The expected transmitting ability showed large differences between buffaloes for MP, LL and AHC. The BTA different from -774 to 933 kg for MP, from – 60 to 101 d for LL and from – 4 to 8 mo., for AHC. The present results indicate the high genotypic improvement in milk traits studied.. The high accuracy of predicting breeding values by using multi – trait animal model which ranged from 0.21 to 0.97 are similar to those obtained by **El- Basuini (2010)**(0.21 to 1.00). The same author found that the buffaloes transmitting ability ranged from -373 to 404 kg for total milk yield and from -30 to 36 d for lactation period.

The present estimates of predicted BTA from buffaloes are higher than the results obtained by **Khattab et al. (2003)** from -263 to 376 kg for milk yield and from -52 to 79 for period of lactation and from -1.8 to 6.30 for age of heifers at calving.

The present results in Table 5. Show the importance of buffaloes, therefore, selection the top BTA for milk traits will be increased milk production in the next generation.

Table 5. Minimum, maximum and range of predicted buffaloes transmitting ability (BTA), sire transmitting ability (STA) and dam transmitting ability (DTS) and it is accuracy (rit) for traits studied.

		Traits		
		Milk production, kg	Lactation length, d	Age of heifers at calving, mo.,
BTA	Min.,	-774	-60	- 4
	Max.	933	101	8
	Range	1707	161	12
	Rit.	0.26 to 0.97	0.21 to 0.95	0.40 to 95
STA	Min.,	-408	-37	-2
	Max.	535	29	5
	Range	943	66	7
	Rit.	0.26 to 0.86	0.21 to 0.83	0.20 to 0.83
DTS	Min.,	388	-30	-2
	Max.	- 365	51	2
	Range	753	81	4
	Rit.	0.26 to 0.74	0.21 to 0.73	0.20 to 0.71

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Table 5. show that the range of predicted sire transmitting ability (STA) for different traits studied. Small and large STA for MP were -408 and 535 kg, respectively, for LL were -27 and 29 d, respectively and for AHC were -2 and 5, mo., respectively with the range being 943 kg, 66 d and 7 mo., respectively. The present results conclude that there are large differences among sires for MP, LL and AHC. **Khattab and Mourad (1992)** reported that estimates of sire transmitting ability between -147 to 154 kg for milk yield and from -20 to 31 d for lactation length. They suggested that large differences among sires in productive traits. Also,, **Khattab et al. (2003)** stated that sire transmitting ability ranged from -211 to 407 kg , -26 to 33 d and -2.0 and 5.0 mo., for total milk yield, lactation period and age at first calving, respectively.**El- Basuini (2010)** found that the sire transmitting ability ranged from -299 to 455 kg for milk production and from 0-22 to 42 d for period of lactation**. El- Arian et al. (2012)** stated that the ranges of sire transmitting ability were 1418 kg and 13.27 d for milk yield and lactation period, respectively. The same authors also concluded that positive breeding values for milk yield are also positive values for lactation period. Therefore, selection of these sires with improve the environmental factors will improve milk yield.

Minimum, maximum, range and accuracy of predicted dam transmitting ability (DTA) are presented in Table 5. Minimum and maximum of DTA were -388 to 365 kg for MP, from - 30 to 51 d for LL and from - 2 to 2., mo., for AHC with the range being 753 kg, 81 d and 4 mo., respectively. **Khattab et al. (2003)** found that the ranges of dam breeding values were 259 kg, 77 d and 7.5 mo., for milk yield, lactation period of lactation and age of heifers at calving, respectively. **El- Basuini (2010)** with another set of Egyptian buffaloes, stated that the ranges of predicted dam transmitting ability were 941 kg, 94 d for TMY and LP, respectively.

The accuracy of predicted dam breeding values ranged from 0.20 to 0.74 and less than those estimated from buffalos and sires (Table 5).

The present results indicated that the high accuracy of buffaloes and sires transmitting ability, indicated that it is necessary to depend on sire for estimating breeding and also accuracy of predicting breeding values of dams indicated that dams are less important than sires and buffaloes for estimating breeding values. In addition, the present results indicated that predicting breeding values of buffaloes, sires and dams giving positive values for MP are also in most cases positive values for LL and negative values for AHC. The present results also show that selection of the top buffaloes, bulls and dams for positive transmitting ability will increase productive and reproductive traits.

Phenotypic and genotypic trends

Annual Phenotypic trends for MP, LL and AHC are presented in Table 6.computed as the regression coefficients of the traits values on the year of calving, Annual phenotypic trend for MP and AHC were positive, significantly and being 9.07 ±2.2 kg/year and 0.30 ±0.02 mo., /year, while annual phenotypic trend for LP was negative, not significantly and being – 0.55 ±0.21 (Table 6). **Khattab and Mourad, (1992) and El Arian et al., (2012** reported that the phenotypic trends ranged from -11.70 to 74.20 kg for milk yield and from -5.7 to 18.84 d for lactation period.

Table 6. Estimates of phenotypic change (b± S.E.) and probability for milk production (MP), lactation length (LL) and age of heifers at calving (AHC).

Traits	b± S.E.	P
MY, kg	9.07±2.2	0.0001
LL, d	-0.55 ±0.21	0.086
AHC, mo.,	0.30±0.02	0.0001

Positive phenotypic change for milk production (Table 6) indicated that phenotypic improvement in milk yield was achieved during the period of the study. Differences in milk production from year to year could be due to the different of feeding system, climatic and management. The observed negative phenotypic trend for LL and positive phenotypic trend for AHC was unexpected because the same data indicated high positive phenotypic correlation between TMY and LP (0.80, Table 6) and negative phenotypic correlation between TMY and AFC

(- 0.90, Table 4). **Khattab and Mourad (1992)** found that phenotypic trend for LP was – 5.7 d/year.

Average genotypic change for MP, LL and AH in different year of calving are estimates of annual genotypic trend for these traits are presented in (Tables 7 and 8). In most cases, the average genotypic trend for milk production are positive and ranged from -21.1 to 57.4 Kg (Table 7) and the regression on the sire breeding values on time was positive and significant (1.43 kg/year). These results indicated that the sires used in the later years were superior genotypic worth to those used in the earlier years. On other words, sires used in previous years were better than in recent years. Also, this may be due to use proven sires and used artificial insemination from the best bulls. **Tonhati et al. (2000) and El- Arian et al. (2012)** estimated average genetic **change** for milk production and ranged from 1.57 to 57.81 kg.

On the other hand **Khattab an Mourad (1992)** working on the same herd using sire model and estimated annual genotypic trend by regressing sire transmitting ability for each year on year of calving, they reported no specific genotypic trends were observed in milk yield. The regression on the sire breeding values on time was not significant and indicated a decrease of – 1.60 kg for total milk yield. These results indicated that the sires used in the later years were of inferior genotypic worth to those used in the earlier years.

Table 7. Average genotypic changes for milk production (MP), lactation period (LL) and age of heifers at calving (AHC)

Year of calving	Annual genotypic trend		
	MP, kg	LL ,d	AHC, mo.,
1995	16.5	-1.7	1.3
1996	-2.9	-3.9	1.1
1997	31.7	-0.4	1.1
1998	-21.1	-4.1	1.0
1999	-6.1	-3.4	1.0
2000	4.4	-1.9	1.0
2001	4.6	-1.9	0.8
2002	-0.2	-2.3	0.8
2003	10.8	-2.9	0.9
2004	9.1	-3.0	0.9
2005	17.3	-3.1	0.9
2006	38.1	-1.6	1.0
2007	1.0	-3.7	0.8
2008	26.5	-1.3	0.9
2009	23.6	-0.9	0.5
2010	40.6	3.2	0.4
2011	14.5	2.0	0.4

2012	- 5.8	3.2	0.4
2013	-19.9	2.1	0.4
2014	-20.5	2.8	0.4
2015	57.4	1.6	0.4

Table 8. Estimates of genotypic change (b± S.E.) and probability (P) for different traits studied.

Traits	b± S.E.	P
Milk production, kg	1.43±0.05	0.0001
Lactation length, d	-0.03±0.003	0.0001
Age of heifers at calving, mo.,	-0.05±0.004	0.0001

Annual genotypic trend for LL and AHC were negative, significant and being -0.03 d/year and -0.05 mo., /year. These results may be due to plan of selection of sires for increase milk yield and decrease each of lactation length and age of heifers at calving and this is a goal of dairymen. **Khattab and Mourad (1992)** using sire model and estimated annual genotypic trend by regressing sire transmitting ability for each year on year of calving, reported no specific genotypic trends were observed in lactation period . The regression on the sire breeding values on time was not significant and indicated a decrease of – 0.40 d for lactation period. These results indicated that the sires used in the later years were of inferior genotypic worth to those used in the earlier years. **Tonhati et al.(2000)** came to the same results on Murrah buffaloes.

The present results concluded that selection for lower age of heifers at first calving will increase milk production.

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