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GENETIC ASSESSMENT AND TRENDS FOR MILK PRODUCTION TRAITS IN A HERD OF EGYPTIAN BUFFALOES *(Bubalus bubalis)*

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SUMMARY

*This study investigates genetic, non-genetic factors, estimate genetic parameters and genetic trends for milk production and milk constituent's traits of Egyptian-buffaloes. The data obtained from an experimental farm in the Nile-Delta, Kafr-ElShikh governorate, owned by APRI (Animal Production Research Institute), Egypt. Data consists of 3417 records of Egyptian-buffaloes, 72 sires and 1129 dams. The means ±Std for Total milk yield [TMY], and Somatic Cell Count [SCC] were 1905.52±416.17 kg, 191.85±74.88 *10-3 cells/ml., respectively. The means for milk constituents include yields of Fat [FY], Protein [PY], Lactose [LY], Total Solids [TSY], Solid Non-Fat [SNFY] were 64.93±19.42, 53.40±6.40, 48.58±4.64, 157.24±12.52, and 95.75±11.32 g/kg milk, respectively. Sire, dam within sire, and non-genetic factors had significant effects for studied traits. Heritability estimates were 0.25, 0.41, 0.22, 0.30, 0.20, 0.25, and0.10 for TMY, FY, PY, LY, TSY, SNFY, and SCC, respectively. The means of EBVs for TMY, FY, PY, LY, and TSY were -10.23±24.06, -0.039±1.28, -0.058±0.24, 0.181±0.44, and0.122±0.98, respectively. The genetic trends for TMY, FY, PY, TSY, and SNFY were 8.154 kg/year (R^2=0.6893), 1.070 kg/year (R^2=0.8386) and0.058/year (R^2=0.9351), 0.177/year (R^2=0.8475), 1.899/year (R^2=0.9109), and -2.063/year (R^2=0.7799), respectively. Moderate heritability and positive genetic and phenotypic correlation coefficients for studied traits indicated the possibility of improving them using selection indices.*

Keywords: Egyptian buffaloes, Milk Production, Heritability, Breeding value, somatic cell count

INTRODUCTION

Egyptian buffaloes *(Bubalus bubalis)* are considered the main dairy animal species from a socio-economic perspective in Egypt. Buffalo cows produced milk with high content of fat, protein and total solids compared with European dairy cattle (*Bos taurus*) and Zebu cattle (*Bos taurus indicus).* The dairy industry is constantly evolving, and one of the key factors driving its progress is the genetic improvement of milk traits in dairy cattle. Genetic trend refers to the alteration in the average genetic value of a population as time elapses. It is an essential indicator of the genetic progress in a specific trait. Monitoring genetic trends for economic traits plays a vital role in enhancing milk production, milk quality, and overall herd performance(Borghese, 2005).

Egypt, being an agricultural nation, heavily relies on livestock as a crucial element of its agricultural sector. The production of livestock alone contributes approximately 24.5% to the overall gross domestic products of the agricultural industry in Egypt(Goma and Phillips, 2021).

The buffalo is a species that produces milk and is also a significant source of meat in Egypt. In Egypt, buffaloes contribute 44% and 39% of the milk and red meat supplied to the local market, respectively (Abdel-Salam and Fahim, 2018).Egyptian buffaloes exhibit a remarkable tolerance and robustness in tropical and subtropical climates, especially when compared to their hybridization with the Italian breed (Nasr, 2017)

Partitioning the total phenotypic variance of the animal economic traits into a genetic and non-genetic component is the most important factor in determining the real progress that can be achieved (Abou-Bakr, 2009). Especially in the current status with very limited information that available for genomic evaluation of milk production and other traits in Egyptian buffalo (El-Halawany *et al*., 2017). The heritability estimates of milk production traits were moderate, suggesting that they could be enhanced through direct mass selection (Malhado *et al*., 2013). SCC could be used as an indirect selection criterion for mastitis incidence, as it is widely done in dairy cattle. Breeding values of an individual represented the best criteria for identifying selected animals (Abdel-Salam *et al*., 2009). In the recent past, the best linear unbiased prediction (BLUP) procedure has been widely used as a standard method of sire evaluation (Faid-Allah, 2018).The genetic capacity of dairy cows plays a crucial role in the economic aspect, and the enhancement of this capacity is evaluated through the genetic trend (Kunaka and Makuza, 2005).It is imperative to consistently assess the genetic, phenotypic parameters and trends in dairy cattle to ascertain the desirability of these parameters and trends for each specific trait (Amimo *et al*., 2007).

The purpose of this study was to estimate the genetic, non-genetic factors, genetic parameters and genetic trends for milk production and constituent's traits of Egyptian-buffaloes.

MATERIALS AND METHODS

This study was carried out following the guidelines set by Menoufia University for the ethical treatment of animals used in scientific research. The Institutional Animal Care and Use Committee (IACUC), has approved this study with Ref., №., (MUFAG/F/AP/6/23).

Data:

The data was obtained from an experimental farm placed in Delta of the Nile, governorate of Kafr El-Shikh, owned by APRI, Egypt. Records of Egyptian buffalo-cows kept at three experimental farms (Mehallt Mosa, El-Nattf El-Gadid and El-Nattf El-Kadym) were collected from 3417 records of Egyptian buffalo-cows, 72 sire and 1129 dam that represented the period from 2000 to 2007.

Management and feeding system:

Animals were housed in partially open sheds. Lactating buffalo-cows were milked either manually or using a machine twice a day, at 7 a.m. and 4 p.m., throughout the entire lactation period. The quantity of milk produced was recorded daily. The buffalo-cows were maintained under the same feeding system on the farm. From December to May, the animals grazed on Egyptian clover along with a mixture of concentrate and rice straw. From June to November, the animals were fed a combination of concentrate, rice straw, and a limited amount of clover hay and/or silage. The animals' feeding regimen was determined based on their live body weight, milk production, and pregnancy status. The concentrate feed mixture was provided twice daily before milking, while rice straw was offered once daily at 9 a.m. In the summer, clover hay or silage was offered at 11 a.m. The animals were allowed to drink water from water troughs three times a day. The buffalo-cows were artificially inseminated, and the pregnancy was confirmed through rectal palpation 35 days after AI.

Studied traits:

Different traits that were examined included the milk production traits as total milk yield (TMY, kg), somatic cell count (SCC, $*10^{-3}$cells/ml); and milk constituents traits included yields (g/kg milk) of total solids (TSY), solid non-fat (SNFY), fat (FY), protein (PY), and lactose (LY).

Statistical analysis:

The data were organized and subjected to statistical analysis using SAS computer program (SAS, 2002). The following linear mixed model with main effects was used to analyze studied traits:

$Y_{ijklmno} = \mu + S_i + D_{j(Si)} + M_k + Y_l + P_m + F_n + e_{ijklmno}$

Where: $Y_{ijklmno}$ = observation;μ = overall mean; S_i = the random effect of the i^th^ sire; D_j = the random effect of the j^th^ dam within sire; M_k = the fixed effect of the k^th^ season of calving , k=1:4;Y_l = the fixed effect of the l^th^ year of calving , l=2000:2007;P_m = the fixed effect of the m^th^ parity, m = 1: ≥6;F_n = the fixed effect of the n^th^ farm, n=1:3; and $e_{ijklmno}$ = the random errors, NID $(0,\sigma^2 e)$.

Genetic parameters:

Genetic parameters and the expected breeding values (EBV) were conducted by derivative-free-REML with a simplex algorithm via MTDFREML (Multiple-Trait Derivative-Free Restricted Max. Likelihood)(Boldman *et al*., 1995). Model in matrices notation was as follow:

Y = Xb + Za + e

Where: Y= observations vector (observed traits); b= fixed effects vector (season, year, parity, and farm); a= random animal additive genetic direct effects vector; X, Z=Known incidence matrices relating observations to the respective traits and e= residual effects vector $(0, I\sigma_e^2)$

The genetic trend for traits was estimated via the regression coefficient of mean annual animal EBVs to animal year of calving using SAS computer program (SAS, 2002).

RESULTS AND DISCUSSION

Statistical Description:

As shown in Table 1, the mean ±Std (CV, %) of TMY was 1905.52 ±416.17 (21.84) kg. It is higher than the means of many investigations done in Egyptian buffaloes as follow;1429, 1649, 1546.5,and 1420 as recorded bymany authors (Mohamed *et al*., 2010,Khattab *et al*., 2017, El-Naser, 2020, and El-Bramony *et al*., 2017). In addition, it is lower than that detected by others as follow; 2070 kg, and 10551 kg as documented by (El-Awady *et al*., 2016b and Abdel–Baray *et al*., 2017), respectively. The mean ±Std (CV, %) of lactation period (LP) was 254.15 ±23.83 (9.37).

Table 1. The means ±Std and Coefficient of variation of milk production and milk constituent's traits in Egyptian buffalo

Traits	Mean ±Std	CV (%)
Milk Production Traits		
TMY, kg	1905.52 ±416.17	21.84
Milk Constituents Traits		
FY, g/kg milk	64.93±19.42	29.91
PY, g/kg milk	53.40±6.40	11.98
LY, g/kg milk	48.58±4.64	9.56
TSY, g/kg milk	157.24±12.52	7.96
SNFY, g/kg milk	95.75±11.32	11.82
Udder Health Trait		
SCC, *10^{-3} cells/ml milk	191.85±74.88	39.03

Std= Standard deviation, CV= Coefficient of variation

The mean ±Std (CV,%) of FY was 64.93 ±19.42 (29.91) as indicated in Table 1, it is higher than 94.5, 164.4, 94.9 and 92 kg as recorded by (El-Bramony, 2015, El-Arian *et al*., 2012, El-Bramony *et al*., 2010b, and El-Bramony *et al*., 2010a), respectively.

Table 1 presents the mean ±Std (CV,%) of PY which was 53.40 ±6.40 (11.98), it is higher than 59, 89.5, 53.6 and 59 kg as documented by (El-Bramony, 2015, El-Arian *et al*., 2012, El-Bramony *et al*., 2010b, and El-Bramony *et al*., 2010a), respectively.

Table 1 present the mean ±Std (CV,%) of LY which was 48.58 ±4.64 kg (9.56), it is lower than 128.2 (El-Arian *et al*., 2012). In addition, Mean of TSY and SNFY were 157.24 ±12.52 (7.96%) and 95.75 ±11.32 (11.82%) kg, they are lower than 336 and 185.5 kg, respectively (Chitra *et al*., 2018).

Table 1 manifests the mean ±Std (CV,%) of SCC which estimated 191.85 ±74.88 *10^{-3}cells/ml milk (39.03), it is within range of 168232 and 204000.85 cells/ml milk as recorded by (El Awady *et al*., 2016, and El-Arian *et al*., 2012), respectively.

Genetic and non-geneticfactors:

The sire and dam (P≤0.05), have a significant impact on all the traits examined as shown in Table 2;these results are in concur with El-Arian *et al*., (2001); Khattab *et al*., (2003); Abdel-Salam *et al*., (2009); Khattab *et al*., (2017), and Fooda *et al*., (2010) who reported that bulls had a highly substantial effect on milk yield and lactation length.

Table 2. Genetic and non-genetic effects on studied traits

Factors	Yield, Kg						SCC
	TMY	F	P	L	TS	SNF	
Sire	**	**	**	**	**	**	**
Dam	**	*	*	*	*	**	*
Parity	**	0.033 *	0.013 *	0.011 *	Ns	0.010 *	0.018 **
Year	**	**	**	**	**	**	Ns
Season	**	ns	ns	Ns	0.025 *	0.028 *	Ns
Farm	**	***	ns	**	**	**	**

TMY= Total Milk yield; FY= Fat yield; PY= Protein yield; LY= Lactose yield; TSY = Total Solid yield; SNFY = Solid not fat yield; SCC =Somatic Cell Count.
* Significant differences (P ≤0.05); ** Highly significant differences (P ≤0.01).

The parity had a highly significant effect on TMY, LP, SCC, FY, PY, LY, and SNFY but had no a significant effect on TSY; these results are in accordance with Hussain *et al*. (2006), and Ramadan, (2018). Moreover, the year of calving had a significant effect on TMY, LP, PY, LY, FY, PY, LY, TSY, and SNFY; while had no significant impact on SCC; these results are similar to those reported by Hussain *et al*. (2006), Hammoud *et al*., (2009).It is noteworthy that the season of calving had a highly significant effect on TMY, LP, SCC, TSY, and SNFY, but had non-significant effects on FY, PY, and LY; which is similar to data reported by Ramadan, (2018).

The farm as a fixed effect had a significant effect on TMY, LP, SCC, FY, LY, TSY, and SNFY, while farm effect had no significant impact on PY as shown in Table 2. This result is in agreement with that demonstrated by Abdel-Salam *et al*., (2009); Fooda *et al*., (2010) and El-Bramony *et al*., (2010b). The effects of year-season of calving, herd, and parity on TMY in Egyptian buffalo-cows were all highly significant (P>0.001) (Mohamed *et al*., 2010).

Heritability estimates(h^2):

The potential for genetic improvement through selection is influenced by the heritability estimate of a trait. Thus, a high heritability of traits serves as a crucial indicator for the response to selection. Estimating the heritability of traits is a vital genetic parameter that is necessary for animal breeding programs.

Table 3, displays heritability estimates for milk production and milk constituents. Heritability estimates for TMY, FY, PY, LY, TSY, SNFY, and SCC were 0.25, 0.22, 0.30, 0.20, 0.25, and0.10, respectively; as shown in Table 2.In Egyptian buffalo, Lower to moderate estimates for TMY were0.25, 0.18, 0.159,and0.16 as recorded by Mohamed *et al.* (2010),El-Bramony *et al.* (2010b), El-Bramony, (2015) and El-Bramony *et al.* (2010a), respectively. On the contrary, higher heritability estimates for TMY were 0.34 and 0.34 as recorded by El Awady *et al.* (2016a), and El-Awady *et al.* (2016b), respectively. The present estimate for SCC is lower than each of 0.23 and0.27 that recorded by El Awady *et al.* (2016a),and El-Bramony *et al.* (2010a), respectively. The present estimate for FY is higher than 0.12, 0.16, and 0.113 which documented by El-Bramony *et al.* (2010a), El-Bramony *et al.* (2010b), El-Bramony, (2015), respectively. The present estimate for PY is higher than 0.15, 0.13, and 0.145 as recorded by , El-Bramony, (2015), respectively.

Genetic (r_g) and phenotypic (rp) correlations:

Genetic correlation is a description of the relation between the additive deviation caused by genes in two traits. In addition, phenotypic correlation may define as the association between two characters that can directly be observed on the same individual.

Table 3, reveals the values of genetic (r_g) and phenotypic correlations (r_P) among milk production traits. The phenotypic correlation coefficients are the noted relationship between the phenotypic performances of different traits while the genetic correlation is a degree of association between genes responsible for the additive variance of different traits. If the genetic correlation between the two traits is high, the selection for one trait would result in an improvement /deterioration for the other trait as a correlated response.

The rg's between TMY, and SCC was positive and ranged 0.112-0.546 as shown in Table 3. The rg's among TMY, FY, PY, LY, TSY, SNFY were positive and ranged between 0.310 to 0.545.

In Egyptian buffalo, rg among MY traits were highly positive, as estimated between MY and FY(0.997 ±0.131), MY and PY(0.986 ±0.142), and FY and PY(0.993 ±0.140)(El-Bramony, 2015), and recorded 0.87 between TMY and 305-MY (Abo-Gamil *et al*., 2017). In addition, it was estimated 0.98 between MY and FY, 0.99 between MY and PY, 0.99 between FY and PY(El-Bramony *et al*., 2010a).Moreover, it was recorded 0.18 ±0.09, 0.30 ±0.10, and 0.37 ±0.09 between TMY, and each of FY, PY, and LY, respectively(El-Bramony *et al*., 2010a). The negative rg between SCC and milk traits ranged from -0.66 to -0.18 (El-Arian *et al*., 2012). Moreover, rg was estimated 1 and0.997 among TMY and each of FY and PY, respectively; and 0.995 between PY and FY(El-Bramony *et al*., 2017). Negative rg were noted between TMY and SCC -(0.11 ±0.03).

Moreover, negative rg between SCC each of MY, FY, and PY were - 0.27, - 0.26, and – 0.28, respectively; between MY and each of FY and PY were 0.99 and 0.99, respectively and between FY and PY was 0.98 (El-Bramony *et al*., 2010b).

The rp's between TMY, and SCC were positive and ranged 0.201 to 0.501 as shown in Table 3. The rp's among TMY, MY, FY, PY, LY, TSY, and SNFY were positive and ranged 0.318 to 0.449.

Table 3. Heritability (diagonal), genetic(below) and phenotypic (above) correlation coefficients for studied traits

Traits	TMY	FY	PY	LY	TSY	SNFY	SCC
TMY	**0.25±.02**	0.319**	0.318**	0.302**	0.434**	0.349**	0.201*
FY	0.313	**0.41±.02**	0.234*	0.286**	0.747**	-0.129*	-0.074
PY	0.409	-0.230	**0.22±.01**	-0.109	0.092	0.271	-0.027
LY	0.309	-0.286	0.112	**0.30±.02**	0.084	0.325**	-0.117
TSY	0.521	0.747	0.397	0.084	**0.20±.01**	-0.012	-0.024
SNFY	0.455	-0.129	0.478	0.325	0.412	**0.25±.01**	-0.018
SCC	0.112	-0.073	-0.025	-0.118	-0.022	-0.018	**0.10±.01**

TMY= Total Milk yield; FY= Fat yield; PY= Protein yield; LY= Lactose yield; TSY = Total Solid yield; SNFY = Solid not fat yield; SCC =Somatic Cell Count.

* Significant differences (P ≤0.05); ** Highly significant differences (P ≤0.01).

In Egyptian buffalo, high positive rp was estimated to be 0.94, 0.89 and 0.85between MY and FY, MY and PY, and FY and PY, respectively(El-Bramony *et al*., 2010a);and rp among TMY and each of FY and PY were ranged from 0.944 to 1 (El-Bramony *et al*., 2010b); and between MY and FY was 0.956 and between PY and FY was 0.947 (El-Bramony, 2015).In addition, rp was estimated to be 0.77 between TMY and 305-MY (Abo-Gamil *et al*., 2017). Therp between TMY, and each of FY, PY, and LY were positive and being 0.64, 0.63 and0.53, respectively. Moreover, negative rp between SCC and milk traits which ranged from -0.01 to- 0.20 (El-Arian *et al*., 2012). Additionally, the rp between TMY and SCCwas0 -0.13;Also, SCC had very weak and negative rp with both MY (-0.02) andPY (-0.03) and almost no correlation with FY (0.01) (El-Bramony *et al*., 2017). However it was estimated 0.96 and 0.96 between MY and (FY and PY) were, respectively; and0.95 between FY and PY(El-Bramony *et al*., 2017).

Expected breeding value (EBV)and genetic trend:

Statistical models and data analysis techniques have made it possible to estimate genetic trends with greater precision. Large-scale data collection, such as milk recording systems and national databases, provide a wealth of information for genetic evaluation programs(Brito *et al*., 2020).The genetic trend in milk traits is determined by the selection pressure placed on these traits during breeding(Brito *et al*., 2021). Genetic improvement in milk traits has led to substantial increases in milk production over the years. The positive genetic trend for milk constituents led to enhancing milk quality. Selecting cows with higher milk fat and protein content led breeders to improve the nutritional value of milk. This has a direct impact on the production of dairy products such as cheese, butter, and yogurt(Oltenacu and Broom, 2010).

The means of EBV for FY, PY, LY and TSY were -0.039 ±1.28, 0.058 ±0.24, 0.181 ±0.44 and0.122±0.98 as shown in Table 4.

The results presented in Table 4 shows mean of EBV for TMY which was averaged -10.23 ±24.06 kg, it is lower than 760, 819 kg as recorded by Ramadan (2018),and Khattab *et al*., (2010), respectively.

The EBV of TMY in Egyptian buffalo cows was estimated to be -774:933, 430:330 and - 869:844 kg as documented by Khattab *et al*., (2017). The additive genetic effects for the 442 animals ranged from +235.76 to -246.60 kg. So, the animal with the highest additive genetic effect produced 235.76 kg more milk than the population average (Yazgan and Soysal, 2023).

Table 4. Breeding values estimates (EBV) for studied traits

Traits	Mean	Std	Min	Max
EBV-TMY	-10.23	24.06	-59.41	9.99
EBV-FY	-0.039	1.28	-1.99	1.56
EBV-PY	-0.058	0.24	-0.46	0.19
EBV-TSY	0.181	0.44	-0.33	0.75
EBV-SNFY	0.122	0.98	-1.38	1.22

TMY= Total Milk yield; FY= Fat yield; PY= Protein yield; LY= Lactose yield; TSY = Total Solid yield; SNFY = Solid not fat yield.

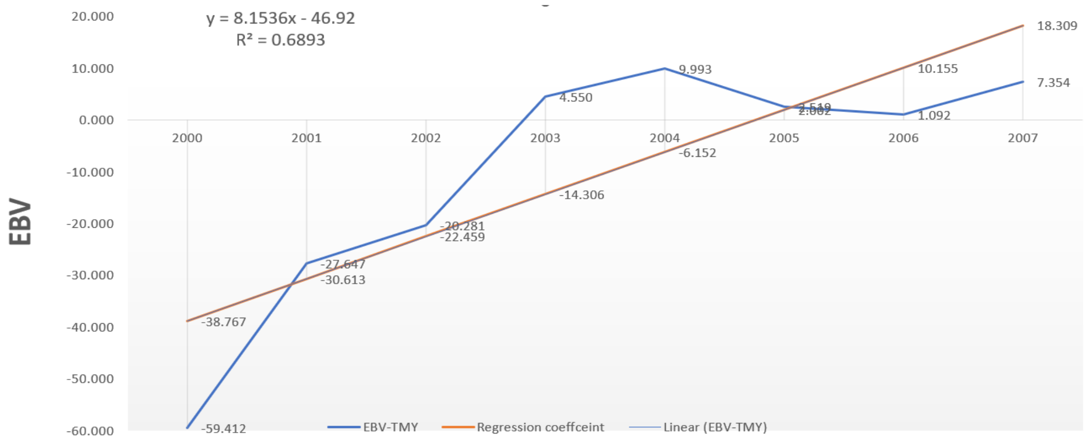
The data presented in Table 5 and Figures 1:5 reveal a positive genetic trend for each of TMY, FY, PY, LY, TSY, and SNFY. The genetic trend for TMY was of 8.154 kg/year (R^2=0.6893), and 0.058 /year (R^2=0.9351) for FY, 0.177 /year (R^2=0.8475) for PY, 1.899 /year (R^2=0.9109) for TSY, -2.063/year (R^2= 0.7799) for SNFY Similar results as a positive genetic trend for milk traits were noted in Egyptian buffalo by Mohamed *et al*., (2010), EL-Hedainy *et al*. (2020) and in Nili- Ravi buffalo by (Ahmad, 2007). In Egyptian buffalo, genetic trend for TMY was +12.55kg/ year of calving and the regression coefficient was +67 kg / year of calving (Mohamed *et al*., 2010).

Table 5. Estimates of EBV and regression coefficients per year of calving for studied traits

Year of calving	Total Milk Yield		Fat Yield	
	EBV-TMY	Reg. coef.	EBV-FY	Reg. coef.
2000	-59.412	-38.767	-1.994	-1.813
2001	-27.647	-30.613	-1.706	-1.306
2002	-20.281	-22.459	-0.508	-0.799
2003	4.550	-14.306	-0.068	-0.293
2004	9.993	-6.152	0.770	0.214
2005	2.519	2.002	0.684	0.721
2006	1.092	10.155	0.948	1.228
2007	7.354	18.309	1.560	1.734

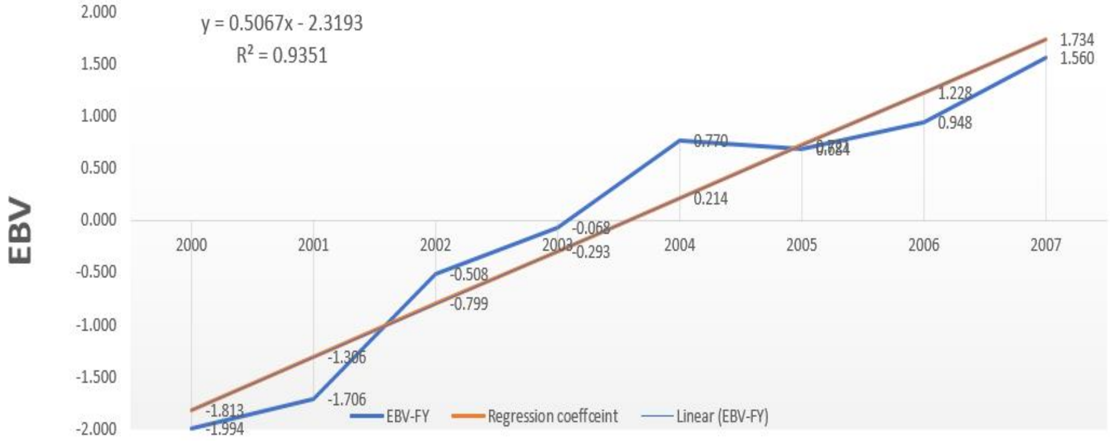
Table 5. Cont.

Year of calving	Protein Yield		Total Solid Yield		Solid not-Fat Yield	
	EBV-PY	Reg. coef.	EBV-TSY	Reg. coef.	EBV-SNFY	Reg. coef.
2000	-0.458	-0.372	-0.240	-0.416	-1.382	-1.110
2001	-0.356	-0.282	-0.325	-0.246	-1.137	-0.758
2002	-0.060	-0.192	-0.301	-0.075	-0.356	-0.406
2003	0.002	-0.102	0.131	0.096	0.365	-0.054
2004	-0.078	-0.013	0.368	0.267	1.218	0.298
2005	0.148	0.077	0.347	0.437	0.577	0.651
2006	0.186	0.167	0.714	0.608	0.637	1.003
2007	0.156	0.257	0.755	0.779	1.056	1.355



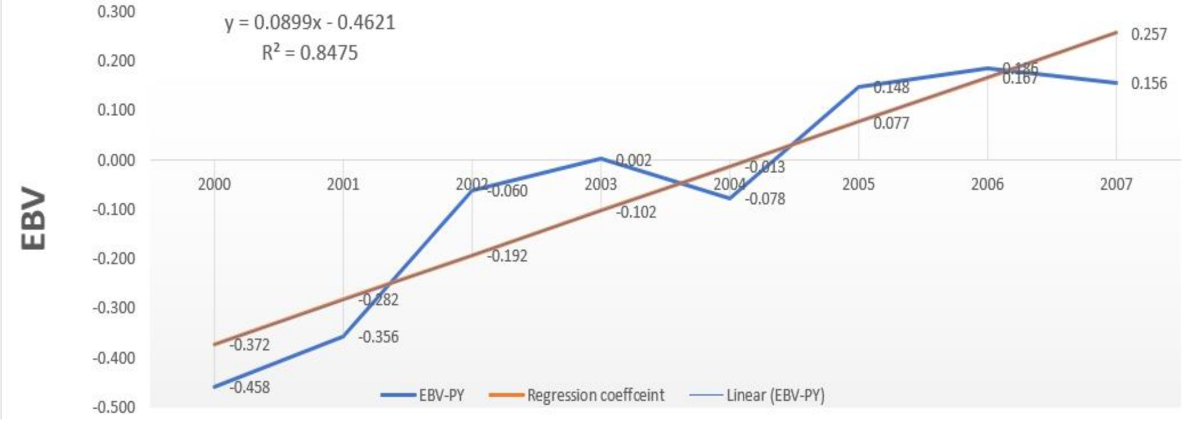
Year of calving

Figure 1: Genetic trend for total Milk yield In Egyptian Buffalo.



Year of calving

Figure 2: Genetic trend for fat yield In Egyptian Buffalo.



Year of calving

Figure 3: Genetic trend for protein yield In Egyptian Buffalo.

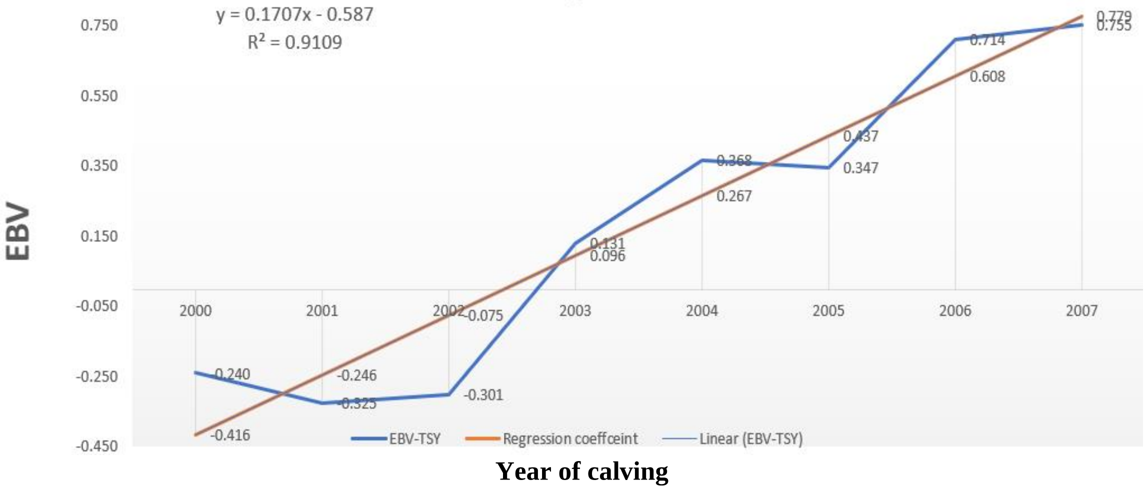


Figure 4: Genetic trend for Total Solid yield In Egyptian Buffalo.

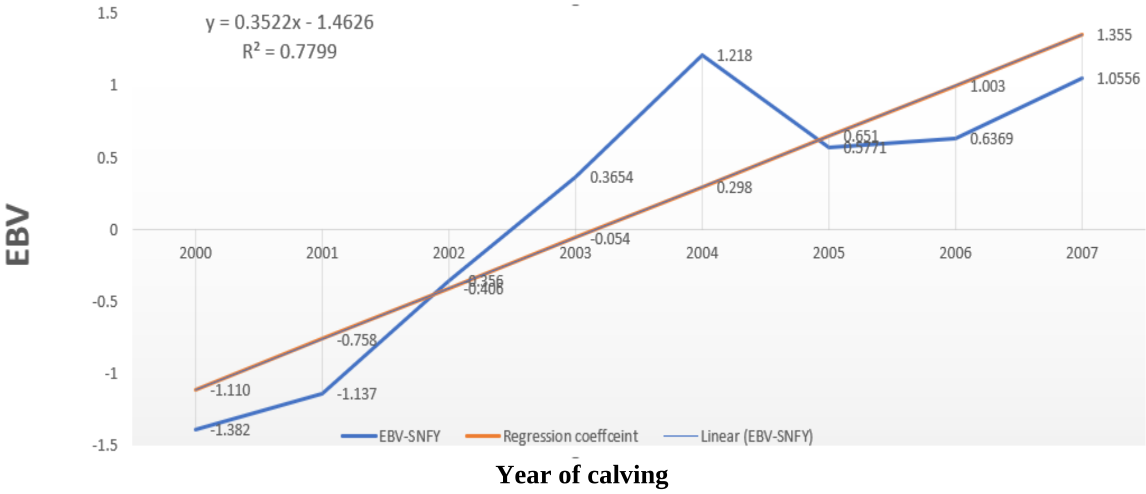


Figure 5: Genetic trend for solid not-fat yield In Egyptian Buffalo.

CONCLUSION

The present investigation evaluated genetic parameters and association of milk constituents and milk production traits in Egyptian herds of dairy buffalo cows which suggested the potential use of milk production and constituents' traits in genetic selection. Improved milk constituents may also be attained via indirect selection for udder health traits. Moderate estimates of heritability and positive genetic correlation among certain studied traits suggested that genetic improvement would be achieved via selection breeding program Further research focused in genetic parameters of buffalo milk traits is required in order to improve profitability of Egyptian buffalo.

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التقييم الوراثي والاتجاهات الوراثية لصفات إنتاج اللبن في قطيع من الجاموس المصري *(Bubalus bubalis)*

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هذه الدراسة إهتمت بتقييم تأثير العوامل الوراثية وغير الوراثية وتقدير المقاييس الوراثية والاتجاهات الوراثية لصفات إنتاج اللبن ومكونات اللبن للجاموس المصري. تم الحصول على البيانات من مزرعة تجريبية في دلتا النيل بمحافظة كفر الشيخ، تابعة لمعهد البحوث الإنتاج الحيواني في مصر. تم جمع البيانات من ٣٤١٧ سجلًا للجاموس، ناتج عن ٧٢ أبًا و١١٢٩ أمًا خلال الفترة من عام ٢٠٠٠ الى ٢٠٠٧.وكانت قيم المتوسطات لإجمالي إنتاج اللبن[TMY] ، وعدد الخلايا الجسدية[SCC] هي١٩٠٥,٥٢±٤١٦,١٧ كجم، ٢١٨٤,٧٦±٥٦٢,٨٦، ٢٥٤,١٥±٢٣,٨٣يومًا، ١٩١,٨٥±٧٤,٨٨ × ١٠^٣ خلية/مل، على التوالي. وكانت قيم المتوسطات محصول (جم/كجم لبن) الدهن[FY] والبروتين[PY] واللاكتوز [LY]والمواد الصلبة الكلية[TSY] والمادة الصلبة غير الدهنية[SNFY] هي ٦٤,٩٣±١٩,٤٢، ٥٣,٤٠±٦,٤٠، ٤٨,٥٨±٤,٦٤، ١٥٧,٢٤±١٢,٥٢، و٩٥,٧٥±١١,٣٢ جم/كجم لبن، على التوالي. كان للأب والأم تأثيرات معنوية على الصفات المدروسة، والعوامل غير الوراثية شملت موسم اللبن وسنة الولادة وموسم الولادة والمزرعة لها تأثيرات معنوية على معظم الصفات المدروسة. كانت قيم المكافئ الوراثي ٠,٢٥ و٠,٤١و٠,٢٢و٠,٣٠و٠,٢٠و٠,٢٥و٠,١٠ لـTMY، FY، PY، LY، TSY، SNFY، SCC على التوالي. متوسطات لتقديرات القيم التربوية لصفاتTMY، FY، PY، LY، TSY كانت -١٠,٢٣±٢٤,٠٦ كجم، -٠,٠٣٩±١,٢٨، ٠,٠٥٨ ±٠,٢٤، ٠,١٨١ ±٠,٤٤، و٠,١٢٢±٠,٩٨ على التوالي. كانت الاتجاهات الوراثية للصفات TMY، FY، PY، TSYوSNFY تساوى٨,١٥٤كجم/سنة($R^2=0.69$) و-٠,٠٥٨/سنة ($R^2=0.94$)، -٠,١٧٧سنة($R^2=0.85$)، ١,٨٩٩/سنة($R^2=0.91$)، -٢,٠٦٣ /سنة($R^2=0.78$)، على التوالي.تشير قيم المكافئ الوراثي ومعاملات الارتباط الوراثي والمظهريالموجبة للصفات تحت الدراسة إلى إمكانية تحسينها باستخدام الأدلة الانتخابية.