Egyptian J. Anim. Prod. (2021) 58(2):57-61

GENETIC PARAMETERS FOR SOME REPRODUCTIVE TRAITS IN EGYPTIAN BUFFALOES

A.A.H. Helmy[1] and R.A.M. Somida[2]

1- Animal Production Research Institute, Agricultural Research Centre, Dokki, Giza, Egypt, 2- Animal Production Department, Faculty of Agriculture, Fayoum University, 63514 Fayoum, Egypt,

**** Correspondence Email: ram04@fayoum.edu.eg***

Received: 10/3/2021 Accepted: 27/3/2021

SUMMARY

The traits of the study were: age at first calving (AFC), gestation length (GL), days open (DO), and calving interval (CI). The records were collated from three buffalo experimental herds (El-Nattaf El-Gadid, El-Nattaf El-Kadim and El-Gimeza) that belonging to Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Egypt. A total of 19,445 records for 1534 buffalo cows calved from 1991 to 2018 were analyzed. A moderate estimate of repeatability was obtained for GL and CI of 0.38 and 0.15, respectively. While the repeatability estimation was slightly lower at 0.13 for DO. That can be explained by the high obtained values of random permanent effect variance of 73, 955, 1119 for GL, DO and CI, respectively. For all studied traits heritability estimates (h^2) were very low as it ranged from 0.0001 to 0.01, this could be due to the small estimated additive effect of 2.0, 0.01and 11.0 for GL, DO and CI, respectively. Except for AFC, h^2 was slightly higher at 0.13. Estimated genetic (rg) and phenotypic (rp) correlation among all traits were in the same trend being positive and varied from low to high (0.04 to 0.99). The highest correlation value either genetic or phenotypic was between CI and DO. While the lowest rg and rp values were between GL and DO.

Keywords: Egyptian Buffalo, reproduction traits, heritability, repeatability, correlation

INTRODUCTION

The Egyptian buffalo serves as an economically important source of milk and meat. One of the major problems limiting the full utilization of this animal is its low reproductive efficiency. This can be due to late puberty onset, long post-natal service period, and consequently long calving interval (Khalil *et al*., 1991). Poor fertility performance increases production cost through higher culling rates, longer calving intervals, less milk, fewer calves per cow per year, and, finally, decreased profit (Bagnato and Oltenacu, 1994). Recently, breeding programs of dairy animals paid more attention to improve the functional and reproductive traits of dairy cows because disregarding fertility resulted in a reduced economic profit of a farm (Komlosi *et al*. 2010). Knowledge of genetic and phenotypic parameters such as heritability, repeatability, and phenotypic correlation is necessary for planning efficient breeding programs of animal husbandry. Heritability estimates allows animal breeders to determine whether selection, or better management practices, or both can improve a particular trait. While, repeatability explains how a productive trait or measured parameter, keeps a stable level in the future following measurements (Cilek and Sahin, 2009). Reproductive traits such as age at first calving, gestation length, days open and calving interval are known for their relatively low heritabilities. Previous studies reported a positive correlation among them (Khalil *et al*.,1991, Gupta *et al.*, 2015, and Abo-Gamil *et al*., 2017) indicating that these traits can be compiened in an index, also indirect selection can play an important role in their improvement and this can be possible by using information from traits with higher heritability and genetic correlations with reproductive traits. Hence, the aim of the current study was to estimate genetic parameters of the some reproductive traits in the Egyptian buffalos.

MATERIALS AND METHODS

Dataset:

The traits used in the study were age at first calving (AFC), gestation length (GL), days open (DO), and calving interval (CI). The records were collated from three buffalo experimental herds (El-Nattaf El-Gadid, El-Nattaf El-Kadim and El-Gimeza) that belonging to Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture and Land Reclamation, Egypt. A total of 19,445 records for 1534 buffalo cows calved from 1991 to 2018 were analyzed (Table 1).

Table 1. Description of data set for Egyptian buffaloes

Item	Number
Number of animals in the pedigree	1534
Number of sires with progeny	98
Number of sires with progeny and records	52
Mean number of progeny records per sire	104.3
Number of dams with progeny	1341
Number of dams with progeny and records	1053

Statistical analyses:

We evaluated the systematic environmental effects on reproductive performance using a linear model fitting these effects as fixed effects. These fixed effects included the effects of season of calving (n=4 seasons), year of calving (n=28 years), sex of calf (male and female), herd (3 herds), and parity (14 parities). The linear model was fitted as follows:

$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + P_m + e_{ijklmn}$

Where:

Y_{ijklmn}: the phenotypic record of a given reproductive trait on Animal n; μ: the overall mean; A_i: the fixed effect of i^{th} season of calving; B_j: the fixed effect of j^{th} year of calving; C_k: the fixed effect of k^{th} sex; D_l: the fixed effect of l^{th} herd; P_m: the fixed effect of m^{th} parity and e_{ijklmn}: random residual assumed to be independent normally distributed $(0,\sigma^2e)$. The significant fixed effects were used to form contemporary groups (CG) for each trait, which were included in genetic parameters analyses.

Variance components, heritability, repeatability, and breeding values were estimated using two models using VCE6 software (**Groeneveld** *et al.*, 2010). The first model was a univariate animal model fitting for all records available on all parities allowing to estimate heritability and repeatability for reproductive traits. The model was described in a matrix notation as follows:

$y = X\beta + Z1a + Z2pe + e$

y is a vector of observations, β: a vector of fixed effects with an incidence matrix ***X***, ***a***: a vector of random animal effects with incidence matrix ***Z1***, ***pe***: a vector of random permanent environmental effects with incidence matrix ***Z2***, and ***e***: a vector of random residual effects with mean equals zero and variance $\sigma^2 e$. The vector of additive (animal) effects ***(a)*** was assumed to be $N\sim(0,\ A\ \sigma^2 a)$, where ***A*** is the numerator relationship matrix among animals in the pedigree file and $\sigma^2 a$ is direct genetic variance. The vector of random permanent environmental effects ***(pe)*** was assumed to be $N\sim(0,\ Ic\ \sigma^2 pe)$, where ***Ic*** is the identity matrix of order equal to the number of buffalo cows, and $\sigma^2 pe$ is permanent environmental effects variance. The vector of residual (environmental) effects ***(e)*** was assumed to be $N\sim(0,\ In\ \sigma^2 e)$, where ***In*** is the identity matrix of order equal to the number of records, and $\sigma^2 e$ is the environmental variance. Heritability estimates (h^2) was estimated as the ratio of genetic variation that is due to additive genetic variance to total phenotypic variance ($h^2 = \sigma^2 a / \sigma^2 p$). Repeatability was estimated as ratio of additive genetic variance plus permanent environmental effects variance to total phenotypic variance ($R = (\sigma^2 a + \sigma^2 pe) / \sigma^2 p$).

The second model was a bivariate animal model to estimate genetic correlations between reproductive traits as follows:

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} x_1 & 0 \\ 0 & x_2 \end{bmatrix}\begin{bmatrix} b_1 \\ b_2 \end{bmatrix} + \begin{bmatrix} z_1 & 0 \\ 0 & z_2 \end{bmatrix}\begin{bmatrix} a_1 \\ a_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix}$$

Where y_i = vector of observations, b_i = vector of fixed effects, a_i = vector of random animal effects for the ith trait, e_i = vector of random residual effects for the i^{th} trait, and X_i and Z_i are incidence matrices relating records of the ith trait to the fixed and the random animal effects, respectively.

It is assumed that:

$$\text{var}\begin{bmatrix} a_1 \\ a_2 \\ e_1 \\ e_2 \end{bmatrix} = \begin{bmatrix} g_{11}A & g_{12}A & 0 & 0 \\ g_{21}A & g_{22}A & 0 & 0 \\ 0 & 0 & r_{11} & r_{12} \\ 0 & 0 & r_{21} & r_{22} \end{bmatrix}$$

Where g_{11} is the genetic variance for trait 1, g_{22} is the genetic variance for trait 2, $g_{12} = g_{21}$ is the genetic covariance between both traits, r_{11} is the residual variance for trait 1, r_{22} is the residual variance for trait 2, $r_{12} = r_{21}$ is the residual covariance between both traits.

RESULTS AND DISCUSSIONS:

All studied traits, except gestation length, were significantly affected by year of calving, season of calving and parity. Similar trend was reported by Afifi, *et al*. (1992) and Aziz, *et al.* (2001)

Simple statistics; means, standard deviations (SD), minimum (Min.), maximum (Max.), and coefficient of variance (CV %) for different reproductive studied traits are presented in Table2. Buffalo cows with AFC ranged from 784 to 1926 days a GL Ranged from 295 to 341 days, a DO ranged from 65 to 265 days, and a CI ranged from 322 to 611 days were used for further analyses .The overall means for AFC, GL, DO and CI were 1355, 317.95, 165.20, and 466. 44 days, respectively. AFC mean considerably varied from 1128 to 1620 days as reported in the literature by Barros *et al.* (2016) working on Murrah buffalo and Hussain*et al.* (2006) for Nili-Ravi buffaloes. The present mean of GL is higher than that reported by Abdel-Hamid and Fattah (2016) of 295.07 days for Egyptian buffaloes. In contrast, lower than estimated by Ryan *et al*. (2007) of 340 days on African buffalo. Means reported herein for DO and CI fall within the ranges of those obtained for the Egyptian buffaloes as ranged from 120.8 to 250.9 days and from 428 to 539.9 days, respectively (El-Naser, 2020 and Afifi, *et al*., 1992). This study reflected variation coefficients ranged from 6.98 % to 19.67% except for DO had a higher C.V % of 57.67%, that indicating a large variation among individual buffaloes which can be a good opportunity for this trait to be improved.

Table 2. Means, standard deviations (SD), minimum (Min.), maximum (Max.), and coefficient of variation (CV%) for the reproduction traits of Egyptian buffalo

Traits	N	Mean	SD	Min	Max	C.V%
Age at First Calving (AFC; days)	1534	1355	205	784	1926	15.13
Gestation length (GL; days)	8212	317.95	22.19	295	341	6.98
Days Open (DO; days)	6500	165.20	95.27	65	265	57.67
Calving Interval (CI; days)	6500	466.44	91.77	322	611	19.67

Variance components, direct heritability, and repeatability estimates for different studied traits are shown in Table 3. A moderate estimate of repeatability was obtained for GL and CI of 0.38 and 0.15, respectively. While the repeatability value was slightly lower at 0.13 for DO. This can be explained by the high obtained values of random permanent effect variance of 73, 955, 1119 for GL, DO and CI, respectively and indicating that information of the first parity is inadequate for predicting the later parities performance, these results are within the range reported in the literature as ranged from 0.05 to 0.24 for CI and from 0.03 to 0.17 for DO (Afifi*et al*., 1992 and Metry *et al.*,1994), While the present repeatability estimate of GL was lower than that reported by Mourad (1997). For all studied traits heritability estimates were very low as ranged from 0.0001 to 0.01, this could be due to the small estimated additive effect of 2.0, 0.01 and 11.0 for GL, DO, and CI, respectively reflecting that these traits are affected by a larger extent of environmental factors. Except for AFC, h2 was slightly higher at 0.13. This may arise from that AFC depends on puberty reaching and can be influenced by a lesser degree of management practices. The obtained results in this study fall within the range of those reported by other investigators as ranged from 0.11 to 0.45 for AFC (El-Bramony, 2011, and El-Naser, 2020), from zero to 0.06 for GL on different buffalo breeds (Khalil *et al*., 1991 and Thevamanoharan *et al*., 2002), from zero to 0.18 for DO (Metry *et al.*,1994 and Abo-Gamil *et al*., 2017) and from zero to 0.17 for CI (Cockrill, 1974 and Abo-Gamil *et al*., 2017).

Table 3. Variance components, heritability, and repeatability estimates for reproductive traits of Egyptian buffaloes

Traits	σ^2a	σ^2pe	σ^2e	σ^2p	h^2a (SE)	R
AFC	0.036	-	0.270	0.307	0.12 (0.04)	-
GL	2.0	73	124	199	0.01 (0.02)	0.38 (0.01)
DO	0.01	955	6329	7285	0.0001 (0.01)	0.13 (0.01)
CI	11	1119	6285	7416	0.002 (0.02)	0.15 (0.01)

σ^2a : direct genetic variance; σ2pe : random permanent effect variance; σ^2e : residual variance; σ^2p =phenotypic variance; h^2a : direct heritability; R : repeatability. AFC: Age at First Calving (days); GL: Gestation Length (days); DO: Days Open (days);and CI: Calving Interval (days).

Genetic and phenotypic correlations among studied traits are given in Table 4. Estimated genetic and phenotypic correlation among all traits were in the same trend being positive and varied from low to high (0.04 to 0.99). The highest correlation value either genetic or phenotypic was between CI and DO this may be attributed to the fact that days open can be defined as the interval from calving to the next successful service, short calving intervals have resulted from short days open (Cameons,1976). While the lowest rg and rp values were between GL and DO. Genetic correlations can arise in several ways, they can be caused by pleiotropic gene effect, linkage, pleiotropic occurs when one locus affects multiple traits (Falconerand Mackay, 1996). The current results are similar to that reported by Shalaby*et al.* (2016) in Egyptian buffaloes as rg between DO and CI was positive and high of 0.99. On the contrary, a higher result was obtained by Abo-Gamil*et al*. (2017) being 1.00. Reported rg values between AFC and all of CI, DO and GL were positive and lower than those obtained in the current study being (0.19, 0.24, and 0.14), respectively in different buffalo breeds (Khalil *et al*.,1991, Gupta*et al.*, 2015 and El-Naser,2020). Also, Khalil *et al*.(1991) reported rg values between GL and CI ranged from zero to 0.34 in different lactations. The obtained rp values in this study fall within the range of those reported by other investigators as ranged from 0.04 to 0.16 between AFC and GL and from 0.09 to 0.18 between CI and GL in different lactations (Khalil*et al*.,1991). On the other hand,the reported rp values were lower than those of this study ranging from 0.08 to 0.57 between AFC and CI in different lactations and being 0.09 between AFC and DO (Khalil *et al*.,1991 and Abo-Gamil*et al*., 2017) .

Table 4. Genetic (above diagonal) and phenotypic (below diagonal) correlations among reproductive traits of Egyptian buffaloes and their standard errors (SE)

	AFC	GL	DO	CI
AFC		0.15 (0.31)	0.37 (0.07)	0.38 (0.07)
GL	0.05 (0.02)		0.04 (0.39)	0.05 (0.12)
DO	0.59 (0.08)	0.04 (0.02)		0.99 (0.21)
CI	0.59 (0.08)	0.14 (0.02)	0.99 (0.01)	

AFC :Age at first calving ,GL :gestation length ,DO :days open, and CI :calving interval

CONCLUSION

According to the results of this study, environmental conditions such as managerial practices and proper feeding regimes are needed to be enhanced on the farm. The low estimates for heritabilities of reproductive traits and positive genetic correlation among them indicating that direct selection may not be effective to improve these traits, but they can be improved through indirect selection or by involving them in a selection index. It is shown that it is important to set up a plan to the improvement of genetic and environmental conditions at the same time to improve the Egyptian buffalo reproductive traits.

REFERENCES

Abdel-Hamid, S.E. and A.F.A. Fattah, 2016. Some productive performance of Egyptian dairy buffaloes in relation to the reproductive status. Alexandria Journal of Veterinary Sciences, 50, 135-139.

Abo-Gamil, Z.H.S., K.M. El-Bayomi, M.E.S. Abo-Salem, S. Ramadan, S.A. Darwish, E.A. Sallam, and E.A. Manaa, 2017. Estimation of Genetic and Phenotypic Parameters for some Productive and Reproductive Traits in Egyptian Buffaloes.Benha Journal of Applied Sciences, 2 ,53-59.

Afifi, E. A., M.H. Khalil, L.H. Bedeir and S.M. Zeidan, 1992. Genetic analysis of reproductive traits in Egyptian buffaloes. Egyptian Journal of Animal Production, 29, 139-154.

Aziz, M. A., Schoeman, S. J., Jordaan, G. F., El-Chafie, O. M., and Mahdy, A. T. 2001. Genetic and phenotypic variation of some reproductive traits in Egyptian buffalo. South African Journal of Animal Science, 31, 195-199.

Bagnato, A.and Oltenacu, P.A., 1994. Phenotypic evaluation of fertility traits and their association with milk production of Italian Friesian cattle. Journal of Dairy Science,77:874–882.

Barros, C. D. C., Aspilcueta-Borquis, R. R., Fraga, A. B. and Tonhati, H. 2016. Genetic parameter estimates for production and reproduction traits in dairy buffaloes, Revista Caatinga, 29:216-221.

Cameons, J. K. 1976. The buffalo in Malaysia. Min. Agric., Malaysia Bulletin.No,145.Kuala Lumpur.

Cilek S. and Sahin E. 2009. Estimation of some genetic parameters heritability and repeatability for milk yield in the Anatolian population of Holstein cows. Archiva Zootechnica12: 57-64.

Cockrill, W.R., 1974.The Husbandry and Health of the Domestic Buffalo. Études Rurales, 60:123-123.

El-Bramony, M.M., 2011. Genetic and phenotypic parameters of milk yield and reproductive performance in the first three lactations of Egyptian buffalo. Egyptian Journal of Animal Production, 48:1-10.

El-Naser, I.A., 2020. Direct and maternal genetic trends for some productive and reproductive traits in Egyptian buffaloes. Jurnal Ilmu Ternak dan Veteriner, 25: 1-10.

Falconer, D.S. and Mackay, T.F.C 1996.Introduction to Quantitative Genetics. 4th Ed., Longman Group, Essex, England.

Groeneveld, E., Kovac, M. and Mielenz, N. 2010. VCE User'sGuide and Reference ManualVersion 6.0. Institute of Farm Animal Genetics press, Neustadt

Gupta, J.P., Sachdeva, G.K., Gandhi, R., and Chakravarty, A. 2015. Developing multiple-trait prediction models using growth and production traits in Murrah buffalo. Buffalo Bulletin. 34: 347–355.

Hussain, Z., ,Javed, K., Hussainn, S.M.I. and Kiyani, G.S. 2006. Reproductive performance of Nili-Ravi buffaloes in Azad Kashmir.Journal of Animal and Plant Sciences, 16: 15-19.

Khalil, M. H., Mourad, K. A., Mohamed, M. M. and Owen, J.B. 1991. Genetic and phenotypic evaluation for reproductive performance of Egyptian buffaloes. Animal Science, 52:75-82.

Komlosi I., Wolfova, M., Wolf J., Farkas B., Szendrei Z.and Beri B. 2010. Economic weights of production and functional traits for Holstein-Friesian cattle in Hungary. Journal of Animal Breeding and Genetics, 127: 143–153.

Metry, G. H., Wilk, J. C., McDowell, R. E., and EI Rigalaty, H. A., 1994. Factors affecting the performance ofEgyptian buffaloes. Annals of Agricultural Science, Moshtohor, 32 :827-841.

Mourad, K.A., 1997. Buffaloes in Egypt.Buffalo Bulletin. 16: 81–86.

Ryan, S.J., C.U. Knechtel and W.M. Getz, 2007. Ecological cues, gestation length, and birth timing in African buffalo Syncerus caffer. Behavioral Ecology, 18: 635-644.

Shalaby N., E. Oudah and Y, El-Sharkawy, 2016. Comparison between some productive and reproductive traits and genetic parameters in the first three lactations in Egyptian buffaloes.

Journal of Animal and Poultry Production, Mansoura University, 7: 113–119.

Thevamanoharan, K., W. Vandepitte, G. Mohiuddin and K. Javed, 2002. Animal model heritability estimates for various production and reproduction traits of Nili-Ravi buffaloes. Pakistan Journal of Agricultural Sciences, 39: 50-55.

المقاييس الوراثية لبعض الصفات التناسلية في الجاموس المصري

عزة أحمد حسن حلمي[١] و رشا عبدالحميد محمود صميده[٢]

١-معهد بحوث الإنتاج الحيواني، وزارة الزراعة، مصر، ٢- قسم الإنتاج الحيواني، كلية الزراعة، جامعة الفيوم

تم تجميع البيانات التناسلية للعمرعند أول ولادة (AFC) وطول فترة الحمل (GL) والفترة المفتوحة (DO) والفترة بين ولادتين (CI) من سجلات ثلاث قطعان لمحطات تجارب : النطاف الجديد والنطاف القديم والجميزة و التابعة لمعهد بحوث الإنتاج الحيواني ، مركز البحوث الزراعية ، وزارة الزراعة وإستصلاح الأراضي بمصر . تم تجميع و تحليل عدد 19445 سجلاً عن 1534 جاموسة ولدت خلال الفترة من 1991 إلى 2018 , كانت قيم معامل التكرار لطول فترة الحمل و الفترة بين ولادتين GL , CI هى 0.38 ,0.15، على التوالي . بينما بلغت قيمة معامل التكرار أقل قليلاً من (0.13) للفترة المفتوحة DO و يمكن تفسير ذلك من خلال القيم العالية التي تم الحصول عليها لتباين التأثير العشوائي الدائم البالغ (73 ، 955 ، 1119) لطول فترة الحمل و الفترة المفتوحة و الفترة بين ولادتين GL ، CI , DO على التوالي . كانت قيم العمق الوراثى لجميع الصفات المدروسة منخفضة جدًا حيث تراوحت من (0.0001 إلى 0.01) وقد يكون هذا بسبب التأثير التجميعى المقدر والبالغ (2.0 ,0.01 , 11.0) لطول فترة الحمل والفترة المفتوحة و الفترة بين ولادتين GL , DO , CI على التوالي و ذلك باستثناء العمر عند اول ولادة AFC و الذى كان أعلى قليلاً من (0.13) . كان الارتباط الوراثي والمظهري المقدر بين جميع الصفات في نفس الاتجاه موجبًا ومتباين من منخفض إلى مرتفع (0.04 إلى 0.99) , كانت أعلى قيمة ارتباط سواء وراثى أو مظهرى بين الفترة بين ولادتين و الفترة المفتوحة CI , DO بينما كانت أدنى قيم للإرتباط الوراثى و المظهرى rg و rp بين طول فترة الحمل و الفترة المفتوحة GL وDO .