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Expected Genetic Gain for Selection of Preweaning Growth Traits in Egyptian Buffaloes

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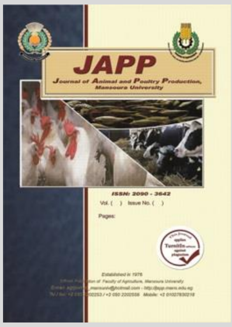

ABSTRACT

Data on 1946 buffalo calves born between 2000 and 2016 at Mahallet Mousa farms belonging to Animal Production Research Institute, were utilized in this study. Genetic parameters of birth weight (BW), preweaning daily gain (PWDG) and weaning weight (WW) were estimated using MTDFREML. The different selection indices for previous traits were constructed by Matlab program. Means of BW, PDWG and WW were 37.40 kg, 493.53 g and 90.37 kg, respectively. The heritability estimates for above-mentioned traits were 0.24, 0.26 and 0.29, respectively. The genetic correlations among the mentioned growth traits were ranged from 0.18 to 0.79. Corresponding phenotypic correlations among same traits were ranged from 0.13 to 0.48. The expected genetic gains for direct selection of BW, PWDG and WW were varied between 0.23 -1.18 kg, 10.80 – 23.74 g and 0.50 - 3.06 kg, respectively. Comparison among selection indices indicated that the highest expected genetic gains for PWDG (8.73 g) and WW (3.50 kg) were obtained from the index I_4 included (PDWG and WW). Moreover, the accuracy of this index was closest to the highest index of accuracy. Thus, selection based on index I_4 could be improve the response of aggregate genotype for preweaning growth traits of Egyptian buffalo calves.

Keywords: Preweaning growth traits, direct selection, selection index, buffalo calves.

INTRODUCTION

The Egyptian buffalo is considered the most important agricultural animal in small holders. Therefore, it plays an important role in the agricultural income in Egypt. The number of buffaloes in Egypt is about 3.4 million head (FAO, 2017). Oudah and El-Awady (2006) reported that genetic improvement in preweaning growth traits of Friesian calves could be achieved using multiple traits selection indices. Baker (1974) included that selection index revealed greater genetic improvement of several traits. The essential goal of the selection index was to maximize economic response of multiple-trait selection (Hazel, 1943 and Hazel *et al*., 1994). Šafus *et al.* (2006) found that direct effects are the highest important for daily gain up to weaning in bulls of beef cattle. Faid-Allah (2014) found that using multi-source information for construct selection indices could be promote genetic improvement for preweaning body weights in Friesian heifers. Low heritability estimate of birth weight in Egyptian buffaloes may be due to the little direct genetic selection has been effected (Mourad and Khattab, 2009). Abu El-Naser (2019) clarified that select of female buffalo calves based on their birth weight was better than relying on their successive body weights. The aims of the present study were to determine the direct and correlated responses to selection for birth weight (BW), preweaning daily gain (PWDG) and weaning weight (WW) of Egyptian buffaloes and construct selection indices for these studied traits.

MATERIALS AND METHODS

Data:

Data on 1946 buffalo calves (994 females and 952 males) progeny of 122 sires were born at the Mahallet Mousa farms belonging to Animal Production Research Institute, through the period from 2000 to 2016. The studied traits were birth weight (BW, kg), preweaning daily gain (PWDG, g) and weaning weight (WW, kg).

Herd management:

The calves after birth were suckling colostrum during the first three days of their life. And after that it is housed individually in calf bed during suckling period (15th weeks of age). Calves were artificially suckling using natural milk to weaning. In addition to providing fodder for calf at third week of their age and berseem hay or Egyptian clover (*Trifolium alexandrinum*). Water and mineral mixture were available freely to calf at all times of the day.

Statistical analysis:

Variance components and genetic parameters were estimated by REML using MTDFREML program (Boldman *et al*., 1995). The assumed model was:

$$Y = Xb + Za + e$$

Where: Y= a vector of observations (BW, PWDG and WW), b= a vector of fixed effects (month of birth, farm, parity of dam and sex of calf), a = a vector of direct genetic effects, e = a vector of the residual effects. X and Z are incidence matrices relating records to fixed and genetic effects, respectively.

Estimation of direct and correlated responses:

Predicted genetic change for direct selection and correlated responses per generation were calculated according to Falconer and Mackay (1996), at selection intensity (i=1) based on the following equations.

$$DR = i * h^2 * \sigma_p \text{ and } C_{RY} = i * h_x * h_y * r_g * \sigma_{py}$$

Where:

DR= direct selection, C_{RY}= correlated response to selection, h^2= the heritability of x trait, σ_p= the phenotypic standard deviation of traits, $h_x = \sqrt{h^2 x}$, $h_y = \sqrt{h^2 y}$, r_g= the genetic correlation between the two traits, σ_{py}= the standard deviation of phenotypic value of trait y and i= selection intensity (i=1).

Selection index construction:

Selection index construction depended on selection index theory delineated by (Hazel, 1943). The selection indices included combinations of BW, PWDG and WW

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were constructed using Matlab program (Matlab, 2002). The index value was computed by the following equation:

$$\mathbf{I= b_1p_1+ b_2p_2+\ldots\ldots\ldots+ b_np_n} = \sum_{i=1}^{n} b_i\, p_i$$

Where:

P_i= phenotypic values of traits and b_i = partial regression coefficients.

The general index was calculated by solving the following equations:

$$\mathbf{Pb = Ga \quad to\ give \quad b = P^{-1}Ga}$$

Where: P= is the phenotypic variance-covariance matrix,
G= is the genetic variance-covariance matrix,
b= is a vector of partial regression coefficients to be used in the index,
a= is a vector of relative economic values of the traits, and
P^{-1}= is the inverse of phenotypic variance-covariance matrix.

Values of b and P were used to estimated index variance as following σ^2_I= $\underline{b}'\ \underline{P}\ \underline{b}$ = $\underline{b}'\ \underline{G}\ \underline{a}$ where b´ is the transpose of (b) vector of partial regression coefficients. While, σ^2_H= a´Ga, where σ^2_H= aggregate genotypic variance, and a´ is the transpose of economic value column vector. Estimated accuracy of the index (R_{IH}) from the correlation between σ^2_H and the index variance (σ^2_I) and compare all different indexes based on R_{IH} achievement best into an index and was determined the relative efficiency (RE) for each index depended on R_{IH} relative to the original index (I_1). The expected genetic gain (ΔG) per generation was estimated by the equation of Tabler and Touchberry (1959) as shown ΔG= σ_I*$_i$*B_{YI} where i is the selection intensity (i=1) and B_{YI} is the regression of each trait on the index. B_{YI} = $\underline{b}'c_i/\underline{b}'$Pb where c_i is the i $\underline{th}$ column of G matrix.

The relative economic values:

The economic values of studied traits were calculated on the basis of the change in the difference between input and output for per unit change in these traits according to the prices of 2016. The difference between expenses and revenues as final actual net profit of the studied traits was used to estimate the economic values as illustrated by Oudah and El-Awady (2006). Thus, the relative economic values for BW, PWDG and WW were 1, 0.007 and 0.84, respectively. Nevertheless, the efficiency of an index is not very susceptible to change of the economic weights (Vandepitte and Hazel, 1977).

RESULTS AND DISCUSSION

Means:

The overall means of WB, PWDG and WW were 37.40 kg, 493.53 g, 90.37 kg, respectively (Table 1). The present means of BW and WW were close to those obtained in Egyptian buffaloes by El-Awady *et al.* (2005), Mourad and Khattab (2009), Awad and Afify (2014) and Abu El-Naser (2019) being 33, 34.17, 36.30 and 36.56 kg, respectively for BW and being 87, 91.15, 91.31 and 96.95 kg, respectively for WW. Variation between means of BW and WW obtained in the present study and those obtained in other studies on Egyptian buffaloes may be due to differences in management, number of records and environmental conditions.

Table 1. Means, standard deviation (SD) and coefficient of variation (CV) for traits under study.

Items	Mean	SD	CV%
BW, kg	37.40	4.90	13.17
PWDG, g	493.53	91.30	18.50
WW, kg	90.37	10.54	11.67

BW= birth weight, PWDG= preweaning daily gain and WW= weaning weight

Genetic parameters:

The heritability (h^2) estimates for BW, PWDG and WW of buffalo calves were 0.24, 0.26 and 0.29, respectively (Table 2). These estimates were moderate and comparable to those (0.24, 0.28 and 0.28, respectively) reported by Oudah and El-Awady (2006) for the same traits in Friesian calves. Abu El-Naser (2019) found h^2 estimates were 0.31 and 0.22 for BW and WW, respectively of Egyptian buffaloes. In addition, the current estimates of h^2 for BW and WW were higher than those (0.046 and 0.257, respectively) reported by Mourad and Khattab (2009). Moderate h^2 estimates for BW, PWDG and WW indicated that these traits could be improved through individual selection as well as better management system.

Table 2. Heritability on the diagonal, genetic correlations above and phenotypic correlations below diagonal for studied traits.

Items	BW	PWDG	WW
BW	0.24	0.47	0.18
PWDG	0.13	0.26	0.79
WW	0.48	0.24	0.29

In general genetic correlations (r_g) among studied traits were positive and ranged from 0.18 to 0.79. Likewise, phenotypic correlations (r_p) among studied traits were positive and ranged from 0.13 to 0.48 in table (2). The present results reflected that genetic improvement of any traits will positively affect the other traits. El-Awady *et al.* (2005) and Mourad and Khattab (2009) indicated that the r_g between BW and WW of Egyptian buffaloes were 0.41 and 0.62, respectively. Abu El-Naser (2019) clarified that the r_g and r_p between BW and WW of Egyptian buffaloes were 0.15 and 0.45, respectively. Shemeis *et al.* (2006) declared that the r_g and r_p among birth weight, average daily gain during the period separating birth from weaning and weaning weight of Holstein heifers were ranged from (0.34 to 0.93) and (0.7 to 0.92), respectively. Akhtar *et al.* (2012) clarified that the r_g and r_p between BW and WW of Nili Ravi buffalo heifers were 0.81 and 0.41, respectively.

Direct and correlated responses to selection:

The direct selection responses for BW, PWDG and WW of buffalo calves were 1.18 kg, 23.74 g and 3.06 kg, respectively with intensity equal 1.00 per generation. Direct selection for BW led to genetic improve of 10.80 g and 0.50 kg for PWDG and WW, respectively. Likewise, direct selection for PWDG led to genetic improve of 0.58 kg, and 2.29 kg for BW and WW, respectively. While direct selection for WW led to genetic improve of 0.23 kg, 19.83 g for BW and PWDG, respectively (Table 3). These results indicated that more genetic improvement for preweaning growth traits of Egyptian buffalo calves could be achieved when direct selection based on weaning weight. El-Awady (2009) and El-Awady *et al.* (2014) appreciated the direct selection and correlated responses for productive traits in Egyptian buffaloes.

Table 3. Expected direct and correlated responses to selection for preweaning growth traits of Egyptian buffalo calves per generation.

Items	BW, kg	PWDG, g	WW, kg
BW, kg	1.18	10.80	0.50
PWDG, g	0.58	23.74	2.29
WW, kg	0.23	19.83	3.06

Selection indices:

The original selection index (I_1) which incorporating BW, PWGD and WW was the best index (R_{IH}= 0.61 and RE%=100). Following by index I_4 which included PWDG and WW (R_{IH}=0.60 and RE% =98.36). Contrariwise the minimum of R_{IH} was observed in index I_3 which included BW and PWDG (R_{IH} =48 and RE%= 78.69) illustrated in Table (4). The current estimates of R_{IH} and RE% are similar to those estimated by Oudah and El-Awady (2006) for BW, WW and PWDG in Friesian calves. The highest expected genetic change per generation for BW was obtained by index I_2 being 0.99 kg. As well as, the highest expected genetic gains for PWDG and WW were achieved by index I_4 being 8.73 g and 3.50 kg, respectively. Contrarily, the lowest expected gain was obtained by index I_2 for WW (2.40 kg), index I_4 for BW (0.65 kg) and the index I_3 for PWDG (6.45 g). Mourad and Khattab (2009) indicated that the expected genetic gain per generation was ranged from 0.32 to 0.73 kg for BW and from 1.85 to 3.10 kg for WW of Egyptian buffaloes.

Table 4. Expected genetic change (ΔG) per generation of selection indices of studied traits, accuracy (R_{IH}) and relative efficiency (RE %).

Items	Traits						R_{IH}	RE%
	BW kg		PWDG g		WW kg			
	b	ΔG	b	ΔG	b	ΔG		
I_1	0.015	0.97	0.080	8.49	0.179	3.21	0.61	100
I_2	0.324	0.99	0.099	7.09	-	2.40	0.57	93.44
I_3	0.160	0.76	-	6.45	0.231	2.54	0.48	78.69
I_4	-	0.65	0.089	8.73	0.220	3.50	0.60	98.36

CONCLUSION

Moderate heritability estimates for preweaning growth traits of buffalo calves indicated that the genetic improvement of these traits could be achieved using selection. Additionally, the current results indicated that the highest genetic gain for PWDG and WW was obtained when the selection index (I_4) included these traits was used. Thus, could be increased growth preweaning without increasing birth weight through index I_4 in Egyptian buffaloes.

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العائد الوراثي المتوقع من الانتخاب لصفات النمو قبل الفطام فى الجاموس المصرى

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البيانات المستخدمة فى الدراسة لعدد ١٩٤٦من عجول (الذكور والاناث) الجاموس المولودة خلال الفترة من٢٠٠٠ الى ٢٠١٦ بمزارع محلة موسى التابعة لمعهد بحوث الإنتاج الحيواني. قدرت المعايير الوراثية لوزن الميلاد ومعدل الزيادة اليومية قبل الفطام ووزن الفطام باستخدام برنامج MTDFREML وتم بناء الأدلة الانتخابية المختلفة للصفات السابقة باستخدام برنامج Matlab . وكانت المتوسطات المقدرة لوزن الميلاد ومعدل الزيادة اليومية قبل الفطام ووزن الفطام ٣٧,٤٠ كجم , ٤٩٣,٥٣ جم , ٩٠,٣٧ كجم على التوالى. وكانت تقديرات المكافئ الوراثي للصفات سالفة الذكر هى ٠,٢٤ ,٠,٢٦ ,٠,٢٩ على التوالي. وتراوحت معاملات الارتباطات الوراثية بين الصفات السابقة بين ٠,١٨ الى ٠,٧٩. بينما تراوحت معاملات الارتباطات المظهرية بين ٠,١٣ الى ٠,٤٨ لنفس الصفات. تراوحت قيم العائد الوراثي المتوقع من الانتخاب المباشر لوزن الميلاد ومعدل الزيادة اليومية قبل الفطام ووزن الفطام بين ٠,٢٣ - ١,١٨كجم و ١٠,٨٠ – ٢٣,٧٤جم و ٠,٥٠ – ٣,٠٦كجم على التوالي. بالمقارنة بين الأدلة الانتخابية المختلفة وجد أن أعلى عائد وراثي متوقع لمعدل الزيادة اليومية قبل الفطام (٨,٧٣جم) ووزن الفطام (٣,٥ كجم) تحقق ذلك باستخدام الدليل رقم ٤ المتضمن معدل الزيادة اليومية قبل الفطام ووزن الفطام. علاوة على ذلك كانت دقة هذا الدليل أقرب ما يكون إلى أعلى دليل فى الدقة .وبذلك فان استخدام الدليل الانتخابى رقم ٤ يمكن أن يؤدي الى تحسين الاستجابة الوراثية لصفات النمو قبل الفطام فى عجول الجاموس المصري.