J. of Animal and Poultry Production, Mansoura Univ., Vol 11 (10): 383-388, 2020

Journal of Animal and Poultry Production

Journal homepage: www.japp.mans.edu.eg
Available online at: www.jappmu.journals.ekb.eg

Estimation of Genetic and Non-Genetic Factors Influencing Growth Traits Performance of Egyptian Buffalo

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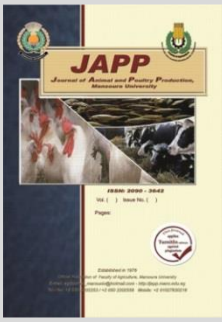

ABSTRACT

The current study aimed to estimate genetic parameters for body weight traits and daily weight gains of Egyptian buffalo. Impacts of sex, season and year of calving as fixed effects on these criteria are also included in the study. The present study was carried out on buffalo herd maintained at Mostorod Station of Animal Aroduction, Faculty of Agriculture, Al-Azhar University of Egypt. Records of 91 calves (39 males and 52 females) produced from 3 Sires and 91 Dams were used for the study.These calves were born between 2010 and 2015. Parameters of the body weights and average daily weight gain were done for each calf. The effects of sex (male and female), year (2010 to 2015) and the calving seasons (summer and winter) were estimated for the previous parameters. The overall means for birth (BW), weaning(WW)and yearling weights(YW)were 33.26, 93.85 and 208.47 kg, respectively. Male calves had higher significant body weights at WW and YW than female calves. Season of calving had no significant effect on the body weights at different ages. Calving year had significant effect on BW, WW and YW. Heritability estimates (h^2) were recorded as moderate for BW (0.22) and WW (0.20), and high for YW (0.73).Conclusions: Heritability estimate levels recorded in this study were ranged from medium to high; this means that Egyptian buffalo possesses potential for growth and therefore the possibility to improving growth performance in this herd can be achieved through an organized breeding selection program with appropriate systems linked to nutrition and management.

Keywords: Egyptian Buffalo, Heritability, body weight traits.

INTRODUCTION

Egyptian Buffalo is one of the main sources for meat and milk production in Egypt, since they contribute more than 70% and 47% of annual milk and meat production, respectively (Salam and El-Shibiny 2001; Abou-Bakr *et al.*, 2009; Khattab , 2017). Therefore, Egyptian buffalo population has been increased from 3.250.000 to 4.100.000 heads during the period from 1993 to 2017 (Khattab, 2017) to compensate the increasing consumer demand. Buffalo meat is a promising market, as consumers are preferred because of its excellent nutritional properties and palatability, so gaining popularity in many parts of the world (Giordano *et al.*, 2010; Giuffrida-Mendoza *et al.*, 2015; Huerta-Leidenz *et al.*, 2016). Even though Egyptian buffalo production has made an important contribution to economic growth successfully and meets the rapidly increasing demand for milk and meat nutritional needs, inadequate focus has not been paid, but progress towards change is far from desirable. However, little efforts have been made to improve the genetic potentiality of Egyptian buffalo for meat and milk production. Estimating the genetic parameters for different growth traits and their relationships helps in planning an effective breeding program to achieve genetic improvement in Egyptian buffaloes (Karima *et al.*, 2010). Phenotype at early age is an expression of genetic pattern, and accordingly superior individuals can be selected on basis of their early performance (Akhtar *et al.*, 2012).

Therefore, birth weight as a measure of the expected value of the calf is justified as one of the first measures that can be obtained, in addition to being easier to recording with a reasonable degree of accuracy (Johanson *and Berger*, 2003). Buffalo growth around 12 months of age is directed to the muscles and away from obesity and there is a strong phenotypic and genetic correlation between yearling weight and other body weights (Karima *et al.*, 2010). The success of the breeding program depends to large extent on the understanding and knowledge of the relationship between genetics, phenotypic and the impact of environmental (Massey and Benyshek, 1982). Over and above, heritability estimates and the genetic correlation among body weight traits at early ages are essential for deciding the criteria for selection and predicting the genetic gain expected (Chopra and Charya, 1971). The current study aimed to estimate the heritability for birth, weaning and yearling body weight traits of Egyptian buffalo. As well as, study targeted the impacts of sex, season and year of calving as fixed effects on these criteria, birth. Body weight gains at different growth stages are also included in the study.

MATERIALS AND METHODS

Animal records and parameters*;*

The present study was carried out on buffalo herd maintained at Mostorod Station of Animal Production, Faculty of agriculture, Al-Azhar University of Egypt. Records of 91 Egyptian buffalo calves (39 males and 52

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DOI: 10.21608/jappmu.2020.123613

females) produced from 3 Sires and 91 Dams were used for the study. These calves were born between 2010 and 2015 and reared under semi-intensive system of management. Parameters of the body weights at birth (BW); weaning (WW) and 12 months (YW) of age were done for each calf. As well as, the average daily gain during different growth stages from birth to weaning (ADG_{0-3}), weaning to yearling (ADG_{3-12}) and from birth to yearling (ADG_{0-12}) were recorded. The effects of sex, year and the calving seasons were estimated for the previous parameters.

Statistical analysis

Collected data were statistically analyzed by least squares methods using SAS (SAS, 2008). Significance differences among sub-class means were tested by Duncan's multiple range tests (Duncan 1955).

Models used for analysis

$$Y_{ijkl} = \mu + G_i + S_j + R_k + e_{ijkl}$$

Where:

- **Y_{ijk} Observation on the l[th] individual of the i[th] sex born in the j[th] and k[th] season and year of calving, respectively.**
- **μ Overall mean when equal subclass numbers exist.**
- **G_i Fixed effect of i[th] sex (i = 1, 2).**
- **S_l Fixed effect of j[th] season (j = 1, 2).**
- **R_k Fixed effect of k[th] year (k = 1, 2, 3, 4, 5 and 6).**
- **e_{ijkl} Random error particular to the ijkl[th] observation assumed to be independently and normally distributed with mean zero and variance of δ^2e**

Variance, covariance components were obtained by Restricted Maximum Likelihood Method (MLM), using the program MTDFREML (Multiple Trait Derivative-Free Restricted Maximum Likelihood) by Boldman *et al* (1995).

To estimate heritability for the traits studied.

The animal model used was as follows:

$$y = Xb + Z_a a + e$$

Where:

- **y = Vector of trait study (weight or gain) ;**
- **X = Incidence matrix for fixed effects;**
- **b = Vector of overall mean and fixed effects;**
- **Z_a = Incidence matrix for random effects;**
- **a = Vector of direct genetic effects ;**
- **e = Vector of random errors normally and independently distributed with mean zero and variance δ^2e .**

RESULTS AND DISCUSSION

Body weights at different ages:

Influence of calving sex:

The overall least squares means± SE for BW, WW and YW were 33.26 ± 0.82, 93.85 ± 1.88 and 208.47 ± 5.04 kg, respectively (Table, 1). Although male calves at birth had no significant differences than females (33.61 ± 0.94 vs 32.91 ± 0.71 kg) while, male calves had higher significant ($P \leq 0.01$) weights at WW (98.57 ± 2.14 vs 89.13 ± 1.62 kg) and YW (219.70 ± 5.75 vs 197.24 ± 4.35 kg) than female calves (Table, 1).

In the current study, the overall means of BW, WW and YW were 33.26, 93.85 and 208.47 kg, respectively.

These results are quite coincided with other findings of various buffalo breeds, where birth weights ranged 26-36 kg (Due *et al*., 1993; Jogi and Lakhani, 1996; Thiruvenkadan *et al*., 2009; Karima *et al*., 2010 and Khattab *et al*., 2019). The current estimates are higher than those recorded for Nagpuri and Murtah buffalo calves, where birth weights ranged between 23 and 26 kg (Nawale *et al*., 1997). Moreover, Akhtar *et al*., 2012 and Thiruvenkadan *et al*., 2009 recorded weaning and yearling weights ranged between (50 and 66) and between (130 and 146) kg, respectively. These apparent variations may be resulting from differences in the management and lack of genetic improvement. Although birth weight may be appropriate criteria in a primary section of growth, the effects of mother is powerful and should not be ignored. Parity had highly significant ($P \leq 0.01$) effect on body weights at all stages, where body weight observed in second and later parities were significantly heavier than those born in first parity (Thiruvenkadan *et al*. 2009)., However, growth traits are usually influenced by various factors (genetic and non-genetic). Male calves in this study had non-significant heavier body weight at birth than female calves. Whatever the case, the influence of calves' sex was found to be highly significant at weaning and yearling weights, where male had heavier weight than female calves for both stages.

Table 1. Least square means <u>+</u> standard errors (LSM<u>+</u>SE) for Birth, Weaning and Yearling body weights.

Items	No	BW(kg) LSM ±SE	WW(kg) LSM ±SE	YW(kg) LSM ±SE
Overall means	91	33.263 ± 0.828	93.851 ± 1.878	208.470 ± 5.042
Sex of calves		NS	**	**
Male	39	33.612 ± 0.942[a]	98.574 ± 2.137	219.698 ± 5.735
Female	52	32.914± 0.714[a]	89.129 ± 1.620	197.243 ±4.349
Season		NS	NS	NS
Summer	50	32.778 ± 0.722	91.959 ± 1.637	206.553 ±4.392
Winter	41	33.748 ±0.937	95.744 ±2.124	210.388 ±5.700
Year		**	**	*
2010	3	29.167 ± 2.697	86.615 ± 6.103	219.811 ± 16.37
2011	9	34.615 ± 1.634	107.305 ± 3.706	225.496 ±9.945
2012	12	32.967± 1.323	95.483± 2.999	205.330±8.048
2013	19	35.606 ± 1.041	94.019± 2.359	191.406±6.332
2014	23	35.464 ± 0.948	91.776 ±2.149	196.976 ±5.767
2015	25	31.761 ± 0.919	87.912 ± 2.083	211.806 ±5.592

BW = Birth weight; WW = Weaning weight; YW= Yearling weight; NS = non-significant * = $P \leq 0.05$ and ** = $P \leq 0.01$.

These results are in agreement with other studies of different buffalo breeds (Due *et al.,* 1993; Thiruvenkadan *et al*., 2009; Sorathiya *et al*. 2009; Pandya *et al*. 2015 and Khattab, 2019). Furthermore, Fooda (2005) indicated significant sex effects on weights at 6 and 9 months, but not at birth. Contrary, Kumaravel *et al*., (2004) suggested that, birth weight was highly significantly affected by calf sex. Furthermore, Thevarnanoharan *et al*., (2001) and

Pandya *et al*., (2015) indicated calving sex had no significant effect on the body weight at 3, 6 and 12 months. Whatever the case, the differences in birth weights between sex may attributed to male-female differences at the genetic level, in the sex chromosomes which have already induced sex-specific organ development expressed by the differences in the production of gonadal sex hormones (Daniel and James, 2018), and thus differences in the rate of growth and development of the skeletal growth during the pre and post-natal period (Attallah, 1988).

Influence of calving season:

Season of calving had no significant effect on the body weights at different ages (Table, 1). However, there was slightly increase in the weights of calves born during winter compared with those born during summer season. The body weights at birth, weaning and yearling were 32.78 ± 0.72, 91.96 ± 1.64 and 206.55 ± 4.39 kg respectively for summer season, and it were 33.7 ± 0.93, 95.74 ± 2.12 and 210.39 ± 5.70 kg for winter season.

Season of calving had no significant effect on body weights recorded at different ages. However, there was slightly increasing weights for calves born during winter season compared with those born during summer. Existing results are in line with various authors, where season of calving had no effects on the body weights at birth (Thevamanoharan *et al*., 2001; Fouda, 2005; and Khattab *et al*., 2019) and 12 months of age (Fooda 2005 and Pandya *et al*., 2015). Furthermore, season of birth had no significant effects on the body weight at different ages (Yadav *et al*., 2001). Contrary, the previous study on Egyptian buffalo showed that the effect of season on calves' body weights was significant at birth (Mahdy *et al*., 1999) and weaning (Alim 1991). Similarly, Kumaravel *et al*., (2004) and Pandya *et al*., (2015) observed significant ($P \leq 0.05$) effect of season of birth on body weight at different ages.

Influence of calving year:

As showed in (Table, 1), calving year had highly significant ($P \leq 0.01$) effect on BW and WW but was significant ($P \leq 0.05$) for YW. The highest BW 35.61 ± 1.04, 35.46 ± 0.95 and 34.61 ± 1.63 kg were recorded for years 2013, 2014 and 2011, respectively, whereas the lowest BW (29.17 ± 2.70 kg) was recorded for year 2010. The highest and lowest WW (107.30 ± 3.71 vs 86.61 ± 6.10 kg) were recorded for years 2011 and 2010 respectively. The highest and lowest YW (225.50 ± 9.95 vs 191.41 ± 6.33 kg) were observed at years 2011 and 2013, respectively. Year of calving had significant effect on body weights at birth, weaning and yearling weight. Similar results were reported for previous study in Egyptian buffalo calves (Fooda, 2005 ; Khattab *et al*., 2019), among Murrah buffalo (Due *et al*., 1993) and among swamp buffaloes (Thevamanoharan *et al*. 2001). However, the presence of variation in calves' body weights with different ages during different years reflects the level of management efficiency and availability of good quality fodder in an adequate quantity, as well as the presence of environmental effects such as temperature and humidity and phenotypic trend, In addition, Mahdy *et al*. (1999) and Ashmawy and Manal El- Bramony (2017) working another sets of Egyptian buffaloes concluded that the differences in BW and WW among different year of birth can be due to differences in management and agro climatic conditions.

Average daily gain at different growth periods;

Influence of calving sex:

The overall least squares means ± SE for average daily gain from Birth to weaning (*ADG_{0-3}*), weaning to yearling (ADG_{3-12}) and birth to yearling (ADG_{0-12}) were 0.61 ± 0.01, 0.43 ± 0.02 and 0.48 ± 0.01 kg, respectively (Table, 2). Sex of calf had highly significant ($P \leq 0.01$) effect on average daily gain from Birth to weaning (ADG_{0-3}) and from birth to yearling (ADG_{0-12}). However, the effect of sex was less significant ($P \leq 0.05$) during the period from weaning to yearling (ADG_{3-12}). Male calves had significantly gains in the daily weights during stages ADG_{0-3} (0.65 ± 0.02 vs 0.56 ± 0.01 kg), ADG_{3-12} (0.46 ± 0.02 vs 0.41 ± 0.02 kg) and ADG0-12 (0.51 ± 0.02 kg vs 0.45 ± 0.01 kg) than female calves (Table, 2).

Table 2. Least squares means ± standard errors (LSM+SE) for daily weights at different ages (kg).

Items	No	ADG0-3(kg) LSM ±SE	ADG3-12(kg) LSM ±SE	ADG0-12(kg) LSM ±SE
Overall means	91	0.605 ± 0.0156	0.432 ± 0.018	0.479 ± 0.013
Sex of calves		**	*	**
Male	39	0.649 ± 0.0178	0.457 ± 0.021	0.509 ± 0.015
Female	52	0.562 ± 0.0135	0.408 ± 0.016	0.450 ± 0.011
Season		NS	NS	NS
Summer	50	0.591 ± 0.013	0.432 ±0.016	0.476 ±0.011
Winter	41	0.619 ± 0.017	0.432 ± 0.021	0.484± 0.015
Year		**	*	*
2010	3	0.574 ± 0.050	0.502 ± 0.062	0.522 ± 0.044
2011	9	0.726 ±0.030	0.446 ± 0.037	0.523 ± 0.026
2012	12	0.625 ± 0.025	0.414 ± 0.030	0.472 ± 0.021
2013	19	0.584 ± 0.019	0.367 ± 0.024	0.426 ± 0.017
2014	23	0.563 ± 0.017	0.396 ± 0.021	0.442 ± 0.015
2015	25	0.561 ± 0.017	0.467 ± 0.021	0.493 ± 0.015

ADG0-3 = daily weight gain from Birth to weaning; ADG3-12 = from weaning weight to yearling; ADG0-12 = Birth to yearling weight; NS = non-significant; * = $P \leq 0.05$ and ** = $P \leq 0.01$

The average daily weight gain during different stages of the current study were found to be within range of different buffalo breeds (Chantalakhana *et al*., 1984; Jogi and Lakhani, 1996; Nawale *et al*., 1997; Thevamanoharan *et al*., 2001). Male calves had significantly higher average daily gain than females for different periods. These results are consistent with Jogi and Lakhani, (1996), Nawale *et al*., (1997) and Zahid *et al*., (2016). This indicates male grew faster than female during pre-weaning growth period and first year of age. However, results of other researchers showed that, differences in the daily weight gain between male and female calves were non-significant during pre-weaning period (Fooda 2005) and post weaning to 12 months of age (Thevamanoharan *et al*. 2001 and Fooda 2005).

Influence of calving season

Season of calving had no significant effects on the average daily gains during different growth stage. However, there was slightly increase in the weight gains for calves born during winter than those born during summer. Daily weight gains for stages ADG_{0-3}, ADG_{3-12} and ADG_{0-12} were 0.59 ± 0.01, 0.43 ± 0.02 and 0.48 ± 0.01 kg, for summer season, respectively, whereas during winter season were 0.62 ± 0.02, 0.43 ± 0.02 and 0.48 ± 0.02 kg, respectively (table2).

Season of calving had no significant effects on daily weights gain during various growth stages. However, there was slightly increase in the gain for calves born during winter compared to those born during summer season. Similarly, the average daily gain for three to six months was highest in Nili - Ravi Buffalo calves were born in the spring season, while the calves born during the dry hot season were the lowest. (Akhtar *et al*. 2012).

Influence of calving year

The year of calving had a very important impact ($P\leq0.01$) on average daily gains during (ADG0-3) and less significant ($P\leq0.05$) during (ADG3-12) and (ADG0-12) (Table, 2). During (ADG0-3), the highest and lowest daily weight gains were 0.77 ± 0.03 and 0.56 ± 0.02 kg observed for calves born in 2011 and 2015, respectively (Table, 2). On the other side, during (ADG_{3-12}), the highest and lowest daily gains were 0.50 ± 0.06 and 0.37 ± 0.02 kg for calves born in years 2010 and 2013, respectively, whereas during (ADG_{0-12}) were 0.52 ± 0.03 and 0.43 ± 0.02 kg for years 2011 and 2013, respectively (Table, 2). Year of calving had highly significant effect on daily weight gains during different stages of growth (Akhtar *et al*. 2012). Similarly, Fooda (2005) and Thevarnanoharan *et al*. (2001) found great fluctuation in the daily weight gains during pre and post weaning stages of calves born during different years.

This variation mainly reflects efficiency levels of feeding and management of the herd during different years.

Heritability estimates and variance components:

Direct heritability and variance components which were estimates for body weight recorded at different ages are presented in (Table, 3). Heritability estimates (h^2) were recorded as moderate for BW (0.22) and WW (0.20), and high for YW (0.73). The genetic variance (δ^2g) recorded for BW, WW and YW were 5.066, 37.404 and 486.733, respectively.

Table 3. Estimates of Heritability (h^2) and variance components for birth, weaning and yearling weights

Traits	h^2	δ^2p	δ^2g	δ^2e
BW	0.22	23.3370	5.06579	18.2712
WW	0.20	186.106	37.4044	148.701
YW	0.73	669.340	486.733	182.606

δ^2p = phenotypic variance, δ^2g= genetic variance, δ^2e = environmental variance

Estimated heritability between varies traits for body weight in this study were found to be moderately for birth and weaning weights, and highly for yearling weight. According to moderate direct h^2 estimates for BW and WW indicated that the genetic improvement of birth and weaning weight can be achieved through selection breeding programs as well as better managerial practices. In addition, Khattab *et al*. (2009) with Friesian calves concluded that pre weaning growth and weaning weight could be used to select for weights at later ages. Likewise similar findings of correlations between varies traits for body weight and heredity were moderately to highly positive in Surti (Pandya *et al*., 2015) ; Murrah buffaloes (Salces *et al*., 2006; Jay *et al*., 2015) and Egyptian buffaloes (Khattab *et al*., 2019). Furthermore, Atil *et al*., (2005) showed that highly positive correlation between yearling weight at the ends of growth curve and genetics specify that this weight may be genetically modified by sel ection.In this investigation, the heritability estimate for birt h weightwas higher than that reported by others for Egyptia n buffaloes (Alim 1991; Mahdy *et al*. 1999; Mourad and Khattab 2009), and lower than that recorded for swamp Indian [Thevamanoharan *et al*. 2000 and 2001) and Thailand buffaloes (Chakarvarty and Rathi 1989; Tien and Tripathi 1990). The variations for the estimates of heritability in this study and other reported could be due to difference between breeds and herds. Anyway, low estimated heritability indicates that Improvement by selection is not a realistic path to advance, but improvement in management and environmental condit ions will result in higher weights (Thiruvenkadan *et al*., 2009).

It has to be taken into consideration that highly positive correlation between phenotypic and genetic It means that the choice of one traitwould have a positive e ffect on the other traits (Akhtar *et al*. 2012). In addition, Ashmawy and Manal El- Barmony (2017) with another set of Egyptian buffaloes concluded that selection to improve weight at weaning is expected to have a positive response in age at calving.

CONCLUSIONS

On the basis heritability estimates levels which recorded in this study and ranged medium to high, the possibility of improving growth performance in this herd can be achieved through organized selection program.

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العوامل الوراثية وغير الوراثية التي تؤثر على صفات النمو في الجاموس المصري

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هدفت هذه الدراسة إلى تقدير المعالم الوراثية لصفات وزن الجسم وكذلك معدلات النمو اليومية للجاموس المصري في مراحل النمو المختلفة (الولادة والفطام والعمر السنوي). كما تم تضمين تأثيرات الجنس وموسم وسنة الولادة كتأثيرات بيئية على الصفات محل الدراسة . أجريت هذه الدراسة على قطيع الجاموس في محطة مسطرد للإنتاج الحيواني التابعة لكلية الزراعة جامعة الأزهر بالقاهرة, وقد تم إستخدام سجلات 91 سجل للجاموس المصري (39 ذكر و 52 أنثى) تم إنتاجها من عدد 3 أباء و 91 أم. وُلدت هذه العجول خلال أعوام 2010 وحتي 2015. وقد تم تقدير المعالم الوراثية لأوزان الجسم عند الولادة ثم الفطام وكذلك عمر 12 شهر لكل عجل, كما تم تسجيل متوسط معدلات النمو اليومي خلال مراحل النمو المختلفة من الولادة حتى الفطام ومن الفطام حتى عمر العام ومن الولادة إلى عمر العام. كما تم تقدير تأثير الجنس (ذكر وأنثى) وكذلك سنة الولادة (2010 - 2015) وموسم الولادة (الصيف والشتاء) للصفات السابقة. أظهرت النتائج أن متوسط وزن الميلاد 33,26 كجم والفطام 93,85 كجم و 208,47 كجم عند عمر سنة. كما أوضحت الدراسة أن الجنس له تأثير معنوي حيث كان للعجول الذكور وزن فطام 98,57 كجم أكبر مقابل 89,13 كجم للإناث وكذلك عند عمر سنة كان وزن الذكور 219,70 كجم أكبر من الإناث التي بلغت 197,24 كجم بينما لم يكن لموسم الولادة تأثير معنوي على أوزان الجسم في مختلف الأعمار. كما اوضحت النتائج ان لسنة الولادة تأثير معنوي على جميع الأوزان في جميع المراحل . وقد ظهرت تقديرات المكافئ الوراثي (h2) على أنها معتدلة لوزن الميلاد (0,22) والفطام (0,20) ومرتفعة لوزن الجسم عند عمر سنة (0,73). الإستنتاجات: تراوحت مستويات تقدير المكافئ الوراثي المسجلة في هذه الدراسة من متوسطة إلى عالية. وهذا يعني أن الجاموس المصري يمتلك إمكانات للنمو، وبالتالي فإن إمكانية تحسين أداء النمو في هذا القطيع يمكن تحقيقها من خلال برنامج تربية وإنتخاب منظم مع أنظمة مناسبة مرتبطة بالتغذية والإدارة.