Genetic and environmental influences on calf birth weight of Butana cattle breed in Sudan

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SUMMARY

This study was conducted to estimate the effect of some genetic and environmental factors on calf birth weight of Butana cattle breed. The study included 1839 records of 562 Butana cows at Atbara Livestock Research Station covering the period from 1949 to 1999. The analysis of variance revealed that sire, parity number and sex of calf influence significantly ($P<0.05$) calf birth weight, while year season of calving did not ($P>0.05$).
The least squares mean for calf birth weight was found to be 25.26±0.305 kg with a coefficient of variation of 13.26%. Also the result showed that the calf birth weight had a heritability of moderate magnitude (0.20±0.15). The genetic correlations of birth weight with lactation milk yield, lactation length, dry period, calving interval and age at first calving were -0.21±0.22, 0.42±0.22, 0.41±0.25, 0.08±0.26 and 0.22±0.27 respectively. The phenotypic and environmental correlations with all traits studied were small and negative.

INTRODUCTION

The Government of the Sudan, soon after independence established a number of livestock research stations in various parts of the country to study and improve the productivity of native breeds. One of these, Atbara Livestock Research Station, was established at Shendi city in 1943 and then moved to Atbara in 1949. The primary goals of the station were to produce milk and milk products and to improve through selective breeding the Butana cattle breed.

Estimation of genetic and environmental influences on animal performance is essential for improving breeding programmes. Calf birth weight is an economically important trait that is mostly influenced by additive and non additive gene actions of the calf and the dam. Hafez and Dyer (1969) reported that birth weight determines the future performance of individuals engaged in a prevailing environment.
The objective of this paper was to study the effects of various genetic and non-genetic factors influencing calf birth weight in a herd of Butana cattle breed at Atbara Livestock Research Station.

MATERIALS AND METHODS

Atbara Livestock Research Station is situated in the River Nile State in Northern Sudan. It is located at 17' 42º N latitude and 33' 58º E longitude and at an altitude of approximately 345 meters above sea level with an average annual precipitation of 70 mm. The atmospheric temperature in this area varies from a maximum of 47.7 ºC in April to a minimum of 4.5 ºC in January.

The data used in this study were obtained from Atbara Livestock Research Station records. They included 1894 records of 562 Butana cows covering the period from 1949 to 1999. The data were further classified into five periods according to the year of calving and the year of birth of the cow. Each period extended for ten years.

Mixed model least-squares and maximum likelihood analysis was performed for each trait to compute the least squares means, standard errors and coefficients of variation using Harvey's computer programme (1990).

The following statistical model was applied to analyses calf birth weight:

$$Y_{ijkl} = \mu + R_i + C_j + S_k + X_l + E_{ijkl}$$

Where

Y_{ijkl} = the $_{ijkl}$th observation of calf birth weight.

μ = the overall mean.

R_i = effect of i^{th} parity number (I = 1-5).

C_j = effect of j^{th} year-season of cow's birth (j = 1-15).

S_k = effect of k^{th} sire of cow (k = 1-21).

X_l = effect of 1^{th} sex of calf (1 = 1-2).

E_{ijkl} = effect of 1^{th} residual error.

The heritability was estimated by paternal half-sib variance analysis. Heritability, genetic, phenotypic and environmental correlations were calculated using the procedure by Becker (1975). Differences between means were tested using Duncan's Multiple Range Test (DMRT).

RESULTS

The mean squares from the analysis of variance for calf birth weight are laid out in Table **1**. The results revealed that the sire of cow significantly ($P<0.05$) affected the calf birth weight and that both parity number and sex of calf had a highly significant ($P<0.001$) influence on birth weight. However, year-season of calving had an insignificant ($P>0.05$) effect on birth weight.

Table 1. Analysis of variance for calf birth weight.

Source	d.f	Calf birth weight M.S
Sire	21	17.842 *
Year-season effect	14	15.058 n.s
Parity number	4	458.224 ***
Sex	1	409.201 ***
Remainder	1798	10.957

d.f = *degree of freedom.*
M.S = *mean squares.*
* = *significant at 0.05.*
*** = *significant at 0.001.*
n.s = *not significant.*

The least squares means and standard errors for calf birth weights are laid out in Table **2**. This analysis shows that the overall mean ± S.E. of birth weight was 25.26±0.305 kg with a coefficient of variation of 13.26%. The results also showed an increased birth weight to reach a maximum birth weight in the fourth parity (26.14±0.36 kg) before decreasing in the fifth parity.

The results showed that the calf birth weight in the first lactation (23.35±0.34 kg) was significantly ($P<0.05$) lower than the birth weight in other parities. Also the results indicated that calf birth weight in the third lactation was significantly ($P<0.05$) higher than birth weight in first and second parity, while it was not significantly different ($P>0.05$) from calf birth weight in the fourth and fifth parity cows. In addition, the results showed that the birth weight of a male calf (25.70±0.31 kg) was higher than the birth weight of a female calf (24.78±0.32 kg).

Moreover, the calf birth weight was found to have a heritability of moderate magnitude (0.20±0.15); (Table **2).** Table **3** shows the genetic, phenotypic and environmental correlations between birth weight and some reproductive and productive traits. The genetic correlations of birth weight with lactation milk yield and lactation length were both moderate and were lower negative (-0.21±0.22 and -0.42±0.22 respectively). The genetic correlations of birth weight with dry period and age at calving were moderate and positive (0.41±0.25 and 0.22±0.27 respectively). Estimates of phenotypic correlations ranging between -0.10 to -0.01. The environmental correlations ranged from -0.14 to -0.02.

Table 2. Least squares means, standard errors and heritability estimate of calf birth weight

Items		n = (1839)	Birth weight L.S.M ± S.E (kg)
Overall mean			25.26±0.305
Coefficient of variation			13.26%
Parities			
First parity		435	23.35±0.34[c]
Second parity		434	25.05±0.33[b]
Third parity		379	25.93±0.34[a]
Fourth parity		319	26.14±0.36[a]
Fifth parity		272	25.81±0.37[a]
Year-season of calving			
Winter	1949-1958	36	25.54±0.97
Dry summer		33	23.70±1.17
Wet summer		35	24.57±1.15
Winter	1959-1968	131	25.15±0.48
Dry summer		197	25.44±0.46
Wet summer		85	25.71±0.54
Winter	1969-1978	221	24.65±0.44
Dry summer		256	25.38±0.43
Wet summer		154	25.40±0.45
Winter	1979-1988	192	25.85±0.51
Dry summer		168	25.57±0.52
Wet summer		119	25.56±0.56
Winter	1989-1999	89	25.12±0.71
Dry summer		65	24.94±0.75
Wet summer		58	26.27±0.84
Sex			
Male		923	25.73±0.31
Female		916	24.78±0.32
Heritability estimate			0.20±0.15

L.S.M = least squares means S.E. = standard error
n = total number of observations
Means without a common superscript differ significantly (P<0.05)
(Winter = November – February, Dry summer = March – June & Wet summer = July – October).

Table 3. Genetic, phenotypic and environmental correlations between Birth weight and some reproductive and productive traits

Calf birth weight	Lactation milk yield	Lactation length	Dry period	Calving interval	Age at first calving
Genetic correlation	-0.21 ±0.22	-0.42 ±0.22	0.41 ±0.25	0.08 ±0.26	0.22 ±0.27
Phenotypic correlation	-0.05	-0.08	-0.01	-0.10	-0.01
Environmental correlation	-0.02	-0.02	-0.08	-0.14	-0.11

DISCUSSION

One of the major problems hindering efforts to improve and conserve local genetic resources is the lack of information on various production and reproduction traits. Characterization of the Butana breed is an important first step towards the conservation of this well adapted breed. As mentioned before calf birth weight may partially determine the future performance of individuals engaged in a prevailing environment. Also it is an economically important production trait. The mean calf birth weight in the present study was found to be 25.26±0.305 kg and this was very close to the estimates of Khallafalla, (1977) and El-Habeeb (1991), but higher than that given by Saeed *et al*., (1987) for indigenous Kenana dairy cattle in the Sudan.

The birth weight was significantly ($P<0.001$) affected by parity number. These findings are in agreement with those reported by Khallafalla (1977) and Abdel-Aziz *et al*., (1991[a]) and (1991[b]) for indigenous and crossbred cattle in the Sudan. The increase in Butana birth weight up to the fourth parity found in this study is well supported by the findings of Saeed *et al*., (1987) and Abdel-Aziz *et al*., (1991[b]) for Kenana cattle. Hafez and Dyer (1969) reported that the criteria through which parity attained its effect clustered around the continuous dam growth through her first few pregnancies, and that in general birth weight is related to maternal development. Therefore this may be the reason of variation among parities in the present study.

On the other hand, the decrease in birth weight in the fifth delivery revealed in the present study was very close to that reported by Abdel-Aziz *et al*., (1991[a]) who also reported a decrease in birth weight after fourth parity. This may be due to the excessive internal fat deposition in aged dams, which might prevent full expansion of the pregnant uterus.

The year-season of calving insignificantly ($P>0.05$) affected birth weight. This result was similar to that obtained by Khallafalla (1977) who reported an insignificant effect of season of calving on birth weight. However, Saeed *et al*., (1987) showed that the month of birth had no significant effect on birth weight, in contrast with year groups which had a significant effect. Abdel-Aziz *et al*., (1991[a] and 1991[b]) reported that year season interactions had a highly significant effect on birth weight among Kenana and crossbred cows in the Sudan. This discrepancy in different studies can be attributed to differences in

ecological and managerial components, which exert their effects on dam physiology and feed intake.

The present investigation indicated that the sire had a significant ($P<0.05$) influence on birth weight. This result is consistent with those reported by Saeed *et al.*, (1987) and Abassa (1984) for Kenana and White Fulani cattle, respectively. The variation may be attributed to differences in the genetic constitution of sires. This is not surprising since birth weight has a heritability of moderate magnitude.

The analysis of variance showed that the sex of calf exerts a significant ($P<0.001$) effect on birth weight. Male calves were heavier than female calves at birth. This result is in agreement with those results obtained by Saeed *et al.*, (1987) Abdel-Aziz *et al.*, (1991^{b}). the difference in birth weight reflects of different sex hormones.

The results showed that the heritability estimate of calf birth weight was medium and in agreement with those estimates obtained by El-Habeeb (1991). However, it is lower than that reported by Khallafalla (1977) for indigenous dairy cattle in the Sudan. Also it is similar to those results obtained by Mwandotto (1986) and Sow *et al.*, (1988) for Kenyian Sahiwal and Senegalese White Fulani cattle, respectively. The genetic correlations of calf birth weight with lactation milk yield and lactation length were moderate and negative.

Those between calf birth weight and dry period, calving interval and age at first calving were positive. These indicate that improvement of calf birth weights will have a positive impact on rate of maturity and calving interval but will not necessarily improve lactation yield.

Phenotypic and environment correlations were very small and negative.

The results of this work and those reported by other researcher (El-Amin 1969, El-Habeeb 1991, Musa *et al.*, 2005) conclude that the Butana breed ranks among the best tropical breed and that there is good potential for future improvement.

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التأثير الجيني والبيئي علي وزن الميلاد لعجول أبقار البطانة في السودان

لطفي محمد أحمد موسي[1] ، محمد خير عبدالله أحمد[1] وكمال عبدالوهاب جبارة الله[2]
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ملخص البحث:

إجريت هذه الدراسة لتقدير بعض العوامل الجينية والبيئية علي وزن الميلاد لعجول البطانة . شملت هذه الدراسة عدد 1839 سجل بعدد 562 بقرة بطانة بمحطة بحوث تربية الحيوان عطبره وذلك في الفترة ما بين 1949 إلي 1999م .
ومن التحليل التباييني لهذه الدراسة أظهرت بأن الذكور عند الولادات وجنسية المولود لهم تأثير معنوي ($P<0.05$) علي وزن الميلاد بينما الموسم الشتوي ليس له تأثير معنوي .
متوسط مجموع وزن ميلاد العجول وجد يساوي 0,305±25,26 كجم مع تباين التكافيء ب 13.26% وأيضآ أوضحت نتائج الدراسة بأن العامل الوراثي لوزن الميلاد . العلاقة الجينية لوزن الميلاد مع إنتاج الحليب ، طول موسم الحليب ، فترة الجفاف ، الفترة بين الولادتين والعمر عند الولادة الأولي هي (0.21-)±0.22 ، 0.42±0.22 ، 0.41±0.25 ، 0.08±0.26 ، 0.22±0.27 بالتتابع .
العلاقة بين المظهر والبيئة مع كل الصفات المدروسة هي بسيطة وسالبة .