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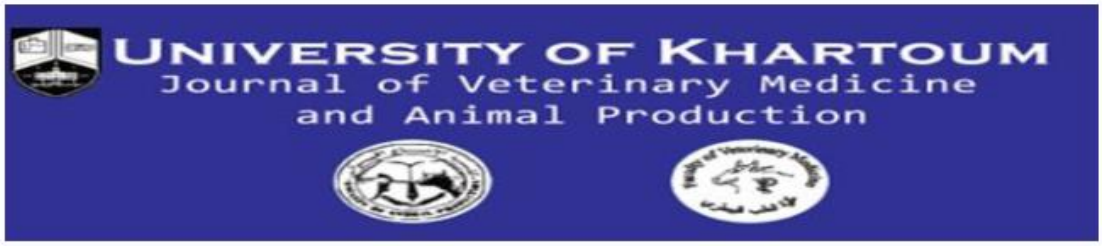

Analysis of the Productive and Reproductive Traits of Butana and Erashy Cows reared under households' management system in Eastern Sudan

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Abstract

The study was performed to assess the productive and reproductive performances of Butana and Erashy indigenous cows raised in semi-arid regions under households' management system in Eastern Sudan. Data on (N = 477), Butana (n = 278) and Erashy (n = 199) cows were used. Field survey and structured questionnaire were used to collect data from (N = 115) households. Productive traits considered were, daily milk yield (DMY), lactation milk yield (LMY), lactation length (LL), tri-mister lactation milk yield (beginning, middle and end) (TLMY)while, reproductive traits included age at sexual maturity (ASM), age at first calving (AFC), calving interval (CI) and services per conception (SPC). General Linear Model (GLM) procedures, Univariate analysis of variance with various in-dependent effects (in-put variables) and observations on productive and reproductive traits as dependent effects (out-put variables) from the studied animals were described by the analytical mathematical linear model. The overall mean DMY, LMY, ASM, AFC, CI, and SPC were estimated to be 10.32 ± 0.16 liters, 1498.40 ± 28.65 liters, 6.75 ± 0.05 months, 3.17 ± 0.06 liters, 6.80 ± 0.11 liters, 45.05 ± 0.01 months, 49.16 ± 0.07 months, 18.18 ± 0.10 and 1.35 ± 0.01 respectively. Cattle ecotype highly significant ($p < 0.001$) affects daily milk yield (DMY), lactation milk yield (LMY), lactation length (LL), (beginning and middle) tri-mister lactation milk yield (TLMY), age at sexual maturity (ASM), age at first calving (AFC), calving interval (CI) and services per conception (SPC).Parity number significantly ($p < 0.05$) affects daily milk yield (DMY), lactation milk yield (LMY) and age at sexual maturity (ASM) and not significantly ($p > 0.05$) affects lactation length (LL), end tri-mister lactation milk yield (ETLMY), age at first calving (AFC), calving interval (CI) and services per conception (SPC).Improving production system, management factors as well as reproductive efficiency is required for optimal reproduction and lactation performance for Butana and Erashy cattle ecotype under their production conditions. From the estimates of variables, productive and reproductive traits have a good potential for selection in this study.

Key words: Performance, Semi-arid regions, Butana, Erashy Cows, Sudan.

المستخلص

أجريت هذه الدرّاسة لتقييم أداء أبقار البطانة والأيرشاي الحلية تحت نظام إدارة الأسر في شرق السودان. أستحدمت بيانات لعشيرة بحجم (ن = 477) تمثل (ن = 278) أبقار البطانة و (ن = 199) للأيرشاي. أستخدم المسح الميداني

والإستبانة المفصلة والمعداة جيداً لجمع البيانان من عدد (ن = 115) لأسر مربي الأنواع. شملت الدراسة الصفات الإنتاجية للإنتاج اليومي للحيب، إنتاج الحليب الموسمي، طول موسم الحليب، الحليب خلال المراحل الثلاث للمنحنى الإنتاجي (البداية، المتوسط والنهاية)، إضافة إلى الصفات التناسلية كالعمر عند النضج الجنسي، العمر عند الولادة الأولى، طول فترة الحمل وعدد التلقيحات لكل حمل. إستخدم النموذج الرياضي الخطي العام و تحليل التباين الأحادي لعدد من المتغيرات الثابته والمشاهدات للصفات الإنتاجية والتناسلية كمتغيرات تابعة. بلغت المتوسطات العامة المقدرة لكل من إنتاج الحليب اليومي، إنتاج الحليب الموسمي خلال الثلاث مراحل من منحنى الحليب، طول موسم الحليب وعدد التلحقات لكل حمل 10.32 ± 0.16 لترات، 1498.40 ± 25.65 لترات، 6.75 ± 0.05 شهراً 3.17 ± 0.06 لترات، 6.80 ± 0.11 لترات، 45.05 ± 0.01 شهراً، 49.16 ± 0.07 شهراً، 18.18 ± 0.18 و 1.35 ± 0.01 على التوالي. أظهر نوع البقار تأثير معنوياً عالياً بإحتمالية ($p < 0.001$) على إنتاج الحليب اليومي، إنتاج الحليب الموسمي، طول موسم الحليب ومراحل المنحنى (البداية، المتوسة والنهاية)، إنتاج الحليب الكلي، العمر عند النضج الجنسي، العمر عند الولادة الأولى، فترة الحمل وعدد التلقيحات لكل حمل. لرقم الولادة تأثير معنوي ($p < 0.05$) على إنتاج الحليب اليومي والموسمي، العمر عند النضج الجنسي هذا بالإضافة إلى التأثير غير المعنوي بإحتمالية ($p < 0.05$) على طول موسم الحليب والمرحلة النهائية من منحنى إنتاج الحليب، العمر عند الولادة الأولى، طول فترة الحمل وعدد التلقيحات لكل حمل. تحسين نظام الإنتاج والعوامل الإدارية إضافة إلى الكفاءة الإنتاجية مطلوبة للأداء التناسلي وإنتاج الحليب المتوسط لكل من أبقار البطانة والأيرشاي تحت ظروف الإنتاج المحلي لبيئات هذه الأبقار. من التّقديرات للمتغيرات في هذه الدّراسة تبيّن أن هنالك مؤشرات جيدة للإنتخاب للصفات الإنتاجية والتّناسلية.

الكلمات المفتاحية: الأداء، المناطق شبه الجافة، البطانة، الأيرشاي، السودان.

Introduction

Cattle, especially indigenous ecotypes, because of their natural selection against harsh environments and adaptation to regional conditions play an important role in the livelihood of considerable of small-households in the Sudan from socio-economic point of view. The study of indigenous ecotypes is important for conservation of genetic resources in livestock. Thus, integrated attempts in term of management and genetic improvement to enhance production are of crucial importance (Mohmmadabadi and Sattaymokhtari, 2013). Economical and biological efficiency of cattle production enterprises generally, improves by increasing productivity and reproductive performance of cows. In order to increase productive and reproductive performance, it is important to improve the genetic potential of animals (Musa *et al*., 2018). Knowledge of the performance estimates among various productive and reproductive quantitative traits can help to improve the production potential in the future breeding program in indigenous stock through selection. In Sudan, cattle play a vital role in supporting the livelihood of large number of population (Musa *et al*., 2015). The country's cattle population is estimated at 29.840.000 heads (MARF, 2012); the majority of which are indigenous ecotypes, maintained under households' management type of system. It's provided households community with milk, meat, manure, drought power and cash income, and plays significant role in social and cultural values of the communities (Musa *et. al*., 2015).

However, the conservation and survival of these indigenous ecotypes genetic resources are endangered by indiscriminate crossing with a tendency between small households to owned few high-yielding breeds and other associated factors. The trend of loss of indigenous adapted ecotypes will have long term negative implication, and in overall instances, will reduce productivity rather than ensure it.

Therefore, this study aimed to assess the productive and reproductive performance of Butana and Erashy indigenous cows raised in semi-arid regions under households management system in Eastern Sudan.

Material and methods:

Study area:

The animals included in the present study were located at Eastern Sudan. This area is inhibited by different tribes who raise these indigenous cattle ecotypes. Typical arid and semi-arid zones with highly rainfall that seasonal occurring between

July and October (260 mm in the southeast to less than 100 mm in the northwest). Maximum temperatures ranged from 42°C in May to 34°C in August and minimum temperatures ranged from 25°C in May to 16°C in January – February. The vegetation was dense and significant areas were covered with semi-evergreen woodland (IFAD, 2003).

Statistical layout, design and sampling technique:

A total of five areas were purposively selected basing on location and pure cattle population density. In each area, five households were randomly selected and interviewed from one visit with structured questionnaire and four cows from each were used to obtain data on the productive and reproductive performance of the indigenous cattle with (5 * 5 * 4) layout. The questionnaire was developed in accordance with the aims of the study and designed in a simple manner so as to get accurate information from households. The questionnaire focused mainly on productive and reproductive performance. Details of the specifications considered for evaluation of productive and reproductive traits of Erashy indigenous cattle ecotype are presented in Table1. The observations were collected according to the guidelines of FAO (FAO, 2012).

Study animals' management:

All the animals were managed under field condition base system. The animals were led out to graze freely on the natural pastures during the day and return to pens and in the evening they are fed while they were milked on concentrate (local material) which was supplemented with whole grain and dry grass forage in all herds. The amount of concentrate offered depended on the volume of milk from each cow. Fresh water was given on an ad lib. basis. Cows were hand milked once a day at all herd.

General statistical and calculation procedures:

There are some specific scientific statistical procedures and methods to obtain field conditions based-system level data. The model applied for productive and reproductive traits included the fixed effects (explanatory variables) of cow ecotype and parity or lactation number. From the collected data, the following response variables of interest were derived, daily milk yield (DMY), lactation milk yield (LMY) was total milk yield (liter) and lactation length (LL) as the number of months from the beginning of lactation across middle up to the last, age at first calving (AFC) as the number of months from birth date to first calving, calving interval (CI) was interval in days between two consecutive calving, services per conception (SPC) as the number of services the cow required until conceived. Observations on productive and reproductive traits as response variables from the studied animals were described by the following details of the analytical mathematical linear model:

$Y_{ij} = \mu + p_i + l_j + e_{ij}$

Where:

Y_{ij} = the ijth observation of one response variable which is considered for analysis,

μ = the overall mean common to all observations,

p_i= the fixed effect of the ith cow ecotype (i = Butana and Erashy),

l_j= the fixed effect of the jth lactation no (for j = 1, 2, 3, 4 and 5 of lactations), and

e_{ij} = random residual error term associated to Y observations and assumed to be normally distributed with zero mean and variance $\sigma 2e$.

Analysis started with Univariate analysis of variance using General Linear Model (GLM) procedures. All data collected in this study were summarized, coded and subjected to various statistical analysis tools using Statistical Packages for the Social Sciences (IBM® SPSS®) release 25.0 (2017) software. Least square means and significant means for all response variables were separated using Duncan's Multiple Range Test (DMRT) at ($p < 0.05$). The simple and linear phenotypic correlations among various productive and reproductive traits were also calculated.

Table 1: Numbers of animals used in each ecotype:

Traits	Butana	Erashy	Total
Daily milk yield	278	199	477
Lactation milk yield	278	199	477
Lactation length	278	199	477
Age at first calving	278	199	477
Calving interval	278	199	477
Cervices per conception	278	199	477

Results and discussion

Productive performance:

The productivity of indigenous cattle largely depends on their reproductive performance, poor reproductive performance resultant on poor productive efficiency. Poor reproductive efficiency is caused by failure of the cow to; become pregnant, maintain of pregnancy; calf losses.

Cattle ecotype was highly significant ($p < 0.001$) source of variation for all productive and reproductive performances (Tables 2, 3 and 4). The effect of parity number was significant ($p < 0.05$) on daily milk yield (DMY), lactation milk yield (LMY) (Table 2) and had no significant effects ($p > 0.05$) on lactation length (LL). Daily milk yield was measured through the tri-misters (beginning, middle and last) during lactation period; ecotype had highly significant effects ($p < 0.001$) on lactation milk yield tri-misters.

The estimated overall mean of total milk production in this study was found to be 1498.40 ± 28.65 litters/ lactation. This finding was lower than that reported by Musa et al. (2005), who reported that the total lactation production of Sudanese Butana cattle ecotype in Atbara livestock Research Station was166.57 ± 108.00 litters. Also these results were higher than those reported by Musa *et al*. (2006), (538.26 and 598.73 Kilogram per lactation, respectively for Butana and Kenana cattle ecotypes). The lactation length in the present study is in close agreement with the previous findings of Musa *et al*. (2006) who reported that the lactation length was (6.73) months. However, the estimated overall mean of lactation length in the present study is shorter than that reported by Mekonnen *et al*. (2012), in a study of Horro cattle breed of Ethiopia they found an overall mean lactation length of 9.59 ± 0.21 months. The estimated overall mean reported daily milk yield during the beginning stage of lactation in this study for all studied cattle ecotypes was similar to that reported by Musa *et al*. (2006) for Butana and Kenana cattle ecotypes, while the estimated daily milk yield during the middle lactation was higher than that reported by Musa *et al*. (2006) for the studied cattle ecotypes. The results showed that the estimated daily milk yield during the end of lactation was lower than that reported by Musa *et al*. (2006). The results of Univariate variance of variance reveled that there was highly significant ($p < 0.001$) differences between the studied cattle ecotypes in the scored daily milk yield during the three trimesters of milk production. Parity number significantly ($p < 0.05$) affect daily milk yield during beginning and middle lactation, while not significantly affected the last period of lactation (Table 3). Means daily milk yield increased from parity one to third. There were slightly differences between parities, however, after parity three a decline trend was observed.

Table 2: Least square means (LSM) and standard error (SE) of daily milk yield (DMY) Lactation length (LL) and lactation milk yield (LMY) for the effect of ecotype and parity.

Source	N	Daily milk yield (liters)	Lactation Milk yield (liters)	Lactation length (months)
μ	477	10.32 ± 0.16	1498.40 ± 28.65	6.75 ± 0.05
Ecotype		**	**	*
Butana	278	11.68 ± 0.21[a]	1664.05 ± 36.56[a]	6.63 ±0.07[b]
Erashy	199	08.95 ± 0.24[b]	1332.74 ± 43.23[b]	6.88 ± 0.08[a]
Parity		*	*	N. S.
1st	90	09.95 ± 0.36[b]	1459.99 ± 63.41[ab]	6.77 ± 0.12
2nd	133	10.45 ± 0.29[ab]	1513.56 ± 52.00[ab]	6.75 ± 0.10
3rd	160	10.99 ± 0.26a	1612.70 ± 47.83[a]	6.84 ± 0.09
4th	94	09.85 ± 0.35[b]	1407.33 ± 62.27[b]	6.66 ± 0.11

Within response variable group means followed by the same superscript letter do not significantly differ (P < 0.05), ** = Significant (P < 0.001), N.S = Not significant, N = Total number of observations, and μ = the overall mean.

Table 3: Least square means (LSM) and standard error (SE) of three trimesters lactation milk yield (Liters) for the effect of ecotype and parity.

Source	N	Beginning	Middle	Last
μ	477	3.17 ± 0.06	6.80 ±0.11	1.04 ± 0.02
Ecotype		***	***	***
Butana	278	3.76 ± 0.08[a]	7.52 ± 0.14[a]	1.20 ± 0.03[a]
Erashy	199	2.57 ± 0.10[b]	6.08 ± 0.17[b]	0.88 ± 0.03[b]
Parity		*	*	N. S.
1st	90	3.10 ± 0.14[ab]	6.53 ± 0.25[b]	1.01 ± 0.04
2nd	133	3.32 ± 0.12[ab]	6.77 ± 0.20[b]	1.05 ± 0.04
3rd	160	3.33 ± 0.11[a]	7.31 ± 0.19[a]	1.09 ± 0.03
4th	94	2.91 ± 0.14[b]	6.60 ± 0.24[b]	0.99 ± 0.04

Within response variable group means followed by the same superscript letter do not significantly differ (P < 0.05), *** = Significant (P < 0.001), N.S = Not significant, N = Total number of observations, and μ = the overall mean.

Reproductive performance:

Age at sexual maturity ASM is the age at which the breeding heifers reach for the sexual maturity and accepting mating for the initial period the mean of45.04 ± 0.01 and 45.06 ± 0.01 months was reported for Butana and Erashy cows respectively with the overall as 45.05 ± 0.01were indicated in Table 4. There was highly significant (p < 0.001) differences between the studied ecotypes in (ASM), lower age was reported for Butana ecotype. However, the obtained results in this study were higher than that reported by Tegegne (2009) for Borana cattle of 26.16 ± 4.32 months in Ethiopia and similar to that reported by Garoma (2014) for Kereyu cows of 45.00 ± 0.6 months.

The overall mean age at first calving in the present study was found to be 49.22 ± 0.13 months and was younger than that reported by Musa *et al*. (2006) who reported a mean age of 52.20 and 50.76 months for Sudanese Butana and Kenana cows, respectively. The overall mean age at first calving in the present study was also younger than that 58.08 ± 0.07 months which reported for Horro cattle breed in Ethiopia (Mekonnen *et a*l. 2012). The overall mean calving interval estimated in this study is similar to the finding of Musa *et al*. (2006) of 17.01 ± 0.39 months for Sudanese Kenana cattle ecotypes and shorter than that reported by Mekonnen *et al*. (2012) of 21.08 ± 0.30 months for Horro cattle breed of Ethiopia.

Service pre conception (SPC) was significantly ($p< 0.001$) affected by ecotype, while parity number had no significant ($p> 0.05$) effect. It shows that how many services are required for a successful conception of breeding animals and it is calculated by dividing the number of conceptions with the number of inseminations Habib et al. (2010). The overall mean SPC was estimated to be 1.35 ± 0.01. The estimated overall mean SPC was higher than that repotted by Minale *et al* (2011) of 1.28 ± 0.06 for Fogera cattle in Ethiopia, but service per conception is lower than that reported by Tewodros (2008) of 1.54 ± 0.69 for dairy cows in North Gondar in Ethiopia. Gebrekidan *et al*. (2014b) illustrated that, number of services per conception is influenced by availability of feed and high environmental temperature.

Table 4: Least square means (LSM) and standard error (SE) for age at sexual maturity (ASM), age at first calving (AFC), calving interval (CI) and Services per conception (SPC) classified by different sources of variations

Source	N	ASM (months)	AFC (months)	CI (days)	SPC
μ	477	45.05 ± 0.01	49.16 ± 0.07	18.18 ± 0.10	1.35 ± 0.01
Ecotype		***	***	***	***
Butana	278	45.04 ± 0.01[b]	48.24 ± 0.07	19.70 ± 0.13[a]	1.40 ± 0.02[a]
Erashy	199	45.06 ± 0.01[a]	50.08 ± 0.01	16.66 ± 0.15[b]	1.31 ± 0.01[b]
Parity		N. S.	N. S.	N. S.	N. S.
1st	90	45.05 ± 0.02	49.30 ± 0.15	18.24 ± 0.22	1.36 ± 0.02
2nd	133	45.05 ± 0.01	48.89 ± 0.12	18.51 ± 0.18	1.35 ± 0.01
3rd	160	45.04 ± 0.01	49.23 ± 0.11	18.07 ± 0.17	1.37 ± 0.01
4th	94	45.06 ± 0.01	49.26 ± 0.15	17.90 ± 0.22	1.35 ± 0.02

Within response variable group means followed by the same superscript letter do not significantly differ ($P < 0.05$), *** = Significant ($P < 0.001$), N.S = Not significant, N = Total number of observations, and μ = the overall mean.

Phenotypic correlations:

The correlation is one of the most common and most useful statistics that describes the degree of relationship between two variables. Phenotypic correlation measuring the strength of relationship between one to other performance Hilmia (2008). The phenotypic correlations among different productive and reproductive traits are presented in Table 5. The correlations were found to be positive, moderate and very highly significant ($p< 0.01$) between lactation milk yield (0.58) and lactation length. Similarly, positive but weak and non-significant ($p> 0.05$) phenotypic correlations were observed between lactation milk yield and calving interval (0.06), between age at sexual maturity and age at first calving (0.03).

Negative moderate and highly significant ($p> 0.01$) correlation were found between age at first calving and calving interval (-0.51), age at first calving and services per conception (-0.43), and calving interval and services per conception (-0.50).

Table 5 Estimates of phenotypic correlations among various productive and reproductive traits

Traits	LMY	LL	ASM	AFC	CI
LL	0.58**				
ASM	- 0.12**	-0.04			
AFC	-0.10*	-0.13**	0.03		
CI	0.06	-0.16**	-0.04	-0.51**	
SPCs	0.25**	-0.10*	-0.15**	-0.43**	-0.50**

** Correlation is significant at the level (0.01) and * correlation is significant at the level (0.05).

Similarly, negative but weak and highly significant (p> 0.01) correlations were observed between lactation milk yield and age at sexual maturity (-0.12), lactation length and age at first calving (-0.13), lactation length and calving interval-0.16), also between age at sexual maturity and services per conception (-0.15). The results also revealed negative, weak and significant (p< 0.05) correlations were found between lactation milk yield and age at first calving (-0.10) and lactation length and calving interval (-0.10). Negative, weak and non-significant (p> 0.05) correlation were observed between lactation length and age at sexual maturity (-0.04) and age at sexual maturity and calving interval (-0.04). The obtained results in the present study are closely in agreement with the findings that reported by Ahmed and Sivarajasingam (2002).

Conclusions

The following conclusions are made,

- Results obtained indicated that cattle ecotype had highly significant (p< 0.001) effect on all productive and reproductive studied traits.
- The effect of parity number was significant (p < 0.05) on DMY, LMY, TLMY, BDMY, MDMY and ASM but no significant effect on LDMY, LL, AFC, CI and SPC.
- The households' management system is vital where it help to maintain the variation in performance between ecotypes suggested that it is the key entry point for further improvement for productive and reproductive performance of the indigenous cattle ecotypes.
- The presence of performance variation between the indigenous cows in the studied ecotypes indicates the presences of wide range scope for improvement through selection.
- Estimated correlation coefficients information may be requiring the assessment of metric-traits productive and reproductive variables as indicators to assist in selection programs.

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