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Heritability, Genetic and Phenotypic Correlations of Milk Production and Reproduction Traits of Ethiopian Boran Cattle with Different Levels of Holstein Friesian Inheritance

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Abstract: Data on the Ethiopian Boran and their crosses with Holstein Friesian cows collected over a period of 23 years (1990 to 2012) at Holeta Agricultural Research Center (HARC) were used to determine heritability, genetic and phenotypic correlations of the milk production and reproduction traits of Ethiopian Boran cattle with different levels of Holstein Friesian inheritance. Multivariate and univariate analysis was employed to estimate heritability and bi-variant analysis was used for estimating genetic and phenotypic correlations. The heritability values of daily milk yield, lactation length, total lactation milk yield, calving interval, days open and age at first calving were 0.430±0.036, 0.325±0.038, 0.476±0.035, 0.122±0.0337, 0.119±0.0335 and 0.333±0.027, respectively in Ethiopian Boran. The corresponding estimate values were 0.519±0.022, 0.272±0.028, 0.570±0.021, 0.162±0.0314, 0.167±0.0317 and 0.387±0.070, respectively in crosses. Genetic correlations were in the range of 0.997 (calving interval and days open) and 0.261(total lactation milk yield and calving interval) in Ethiopian Boran as well as 0.998 (calving interval and days open) and 0.589 (daily milk yield and lactation length) in crosses. The phenotypic correlations were also located in the range of 0.998 (calving interval and days open) and -0.0057(total lactation milk yield and calving interval) in Ethiopian Boran and 0.998 (calving interval and days open) and 0.154 (daily milk yield and lactation length) in crosses. The high heritability in this study may warrant designing selection to improve the Ethiopian Boran and their crosses for milk production and reproduction traits. However heritability estimate of this work for calving interval and days open was higher than other estimate values. This indicated that there is also a room of selection for these traits beside to management improvement.

Key words: Phenotype · Correlation · Heritability · Milk · Production · Reproduction · Traits

INTRODUCTION

Ethiopia believed to have the leading livestock population in Africa. In the country, there were 53.99 million cattle [1]. Out the total population in the country, 98.95% were local breeds. Hybrid and exotic breeds accounted for about 0.94 percent and 0.11 percent, respectively. The average lactation period per cow is estimated to be about six months and average milk yield per cow per day is about 1.32 liters in the sedentary areas of the country [1]. Livestock directly contributes to the livelihoods of more than 70% of Ethiopians [2]. It accounts for 15-17% of national GDP and 35-49% of agricultural GDP.

The national per capita consumption of milk and milk products is about 20 liters per person per year. This is extremely low from the recommended amount of the world health organization (WHO), which is 180 liters. In order to meet the demand of the growing population of Ethiopia, milk production has to be improved through introducing genetic improvement and management intervention options.

Even though few studies have been done on dairy herd of Holeta agricultural research center that assessed cross breeding effects on production and reproduction traits, there is a need to include recent data for timely recommendations. In this study, f_2 particularly f_3 genetic groups have been also included which were not studied

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by other researchers. Moreover, there is no strategy to maintain the improvement in milk production obtained after 50% crosses. Thus, this study is essential to assess contributions of individual breed additive effects, individual heterotic effects and individual recombination effects for milk production and reproduction traits of Ethiopian Boran cattle with different levels of Holstein Friesian inheritance.

MATERIALS AND METHODS

Description of the Study Area: This study was conducted at Holeta Agricultural Research Center (HARC) of the Ethiopian Institute of Agricultural Research (EIAR) that is located 35 km west of Addis Ababa (38.5°E longitude and 9.8°N latitude) in the high lands of Ethiopia at an elevation of 2400 m above sea level. The minimum and maximum daily temperature of the area is ranging from 5 to 10°C and 18.7 to 24.0°C, respectively. The periods of heavy rainfall may occur during rainy season and the area receives an average rainfall of 1200mm.There are three main seasons in the year; long rainy season from June to September, dry season lasts from October to February followed by short rainy season having light rain from March to May. The principal soil type is vertisol.

Study Animals and Management: Ethiopian Boran and different genetic grades level of their crossbreeds with Holstein Friesian were used in this study. Regular conditions of feeding and management practices were adopted for all animals during the entire experimental periods. Natural grazing, hay and concentrate supplement constitute the major feed supply. There is no biased management option based on the genetic groups or level of milk production [3]. The animals were grazed on natural pasture for about 8 hours during daytime. At night all animals were kept in their barn and supplemented with natural pasture hay. Concentrate composed of 30% wheat bran, 32% wheat middling and 37% noug cake (*Guizotia abyssinica*) and 1% salt. Lactating cows were provided with approximately 3 to 4 kg of concentrates at each milking. Pregnant cows and heifers were kept into maternity pens at night during the last two months of gestation and supplemented with 2 kg of concentrate; no other animal received any regular concentrate supplement. Clean and fresh drinking water was always available in free access. Newborn calves were allowed to suckle their dam freely soon after birth until 24 hours in order to ensure them colostrum feeding. Then they were separated from the dam and bucket feeding was followed till weaning age. Each calf was provided with a fixed amount of 260kg of whole milk during the pre-weaning period.

Calves were kept in-doors until the age of six months and were offered concentrate and hay starting two weeks after birth. They were allowed approximately 1kg of concentrate per day and hay ad-libitum until weaning age (in average 3 months). In addition vaccination against Rinderpest, Foot and Mouth disease, Anthrax, Pasteurolsis, Blackleg and Contagious Bovine Pleuropneumonia were given to the animals. They are also drenched and sprayed for internal and external parasites at regular intervals. Specific treatments are given whenever any disease occurs.

Artificial insemination with semen produced from locally recruited bulls or imported semen from National Artificial Insemination Centre has been practiced.

Data Collection: The following data that were collected from 1990 to 2012 related to milk production and reproductive performance of the indigenous and crossbreed cows were considered for the study.

- Identification number of each cow
- Parity, breed group, sire of cow, dame of cow.
- Disposal date

Milk Production Traits:

- Daily milk yield (liter)
- Total lactation milk yield (liter)
- Lactation length (day)

Reproduction Traits:

- Calving interval (day)
- Days open (day)
- Age at first calving (day)

Statistical Analysis: Daily milk yield (liters), total lactation milk yield (liter), lactation length (days), calving interval (days), da ys open (days) and age at first calving (days) were analyzed using General Linear Model (GLM) procedure of SAS [14] Multivariate and univariate analysis was employed to estimate heritability and bi-variant analysis was used for estimating genetic and phenotypic correlations. Genetic parameters (heritability, genetic and phenotypic correlations) were estimated using PEST software (version 4.2) and

VCE software (version 6). Based on number of observations, heritability of milk production traits (daily milk yield, lactation length and total lactation milk yield), reproduction traits (calving interval and days open) and age at first calving were estimated by tri-variate, bi-variate and uni-variate analysis respectively. Three data sets (Ethiopian Boran, crosses and combined) were used for this analysis.

- $\delta^2_p = \delta^2_A + \delta^2_E$
- $h^2 = \delta^2_A / \delta^2_p$

Correlations (genetic and phenotypic) among the different traits were estimated by bi-variate analysis.

RESULTS AND DISSCUSIONS

Genetic Correlations: The genetic correlations were found to be 0.797, 0.958 and 0.923 between daily milk yield-lactation length, daily milk yield-total lactation milk yield and lactation length-total lactation milk yield respectively in the Ethiopian Boran. The corresponding values were 0.589, 0.956 and 0.795 in the Ethiopian Boran and Holstein Friesian crossbred cows respectively (Table, 1).

Other researchers reported strong genetic correlations between milk traits: 0.79±0.15 in Friesian and Sahiwal cows [4], 0.98 in Sahiwal, Holstein Friesian X Sahiwal and Jersey X Sahiwal [5], 0.71 in Friesian-Bunaji crosses [6] and 0.93 in crossbred dairy cattle in Brazil [7] between lactation length and lactation milk yield. Deb *et al*. [8] reported genetic correlation estimates of 0.797 and 0.797 between lactation milk yield X daily milk yield and lactation milk yield X lactation length respectively in Bangladesh native cattle breed-1. Aynalem Haile [9] reported very high genetic correlations; 0.55±0.12 and 0.97±0.14 for lactation length and lactation milk yield, 0.78±0.12 and 0.43±0.14 for lactation length and daily milk yield and 0.99±0.05 and 0.94±0.05 for lactation milk yield and daily milk yield in Ethiopian Boran and Holstein Friesian crossbred cows, respectively.

Moderate estimate value of 0.32 for annualized milk production and lactation length was reported by Sendros Demeke *et al*. [10] in Boran, Holstein Friesian, Boran X Holstein Friesian and Boran X Jersey. Low estimate value of 0.16 for lactation length and lactation milk yield was reported in Sahiwal cattle [11].

The strong and positive genetic correlation was found between calving interval and days open. The genetic correlation estimates were 0.997±0.0009 and 0.998±0.0004 in Ethiopian Boran and Ethiopian Boran and Holstein Friesian crossbred cows respectively. The present estimate disagreed with Toghiani [12] who reported a weak and positive genetic correlation value of 0.111 between calving interval and days open.

Table 1: Genotypic correlations in some milk production and reproduction traits

Traits	Ethiopian Boran	Crosses
DMY-LL	0.797±0.057	0.589±0.060
DMY-TLMY	0.958±0.012	0.956±0.009
LL-TLMY	0.923±0.024	0.795±0.031
CI-DO	0.997±0.0009	0.998±0.00004
LL-CI	0.417±0.099	0.805±0.064
TLMY-CI	0.261±0.097	0.593±0.064

DMY-LL: daily milk yield with lactation length, DMY-TLMY; daily milk yield with total lactation milk yield, LL-TLMY: lactation length with total lactation milk yield, CI-DO: calving interval with days open, LL-CI: lactation length with calving interval, TLMY-CI: total lactation milk yield with calving interval

Table 2: Phenotypic correlations in some milk production and reproduction traits

Traits	Ethiopian Boran	Crosses
DMY-LL	0.385	0.154
DMY-TLMY	0.862	0.819
LL-TLMY	0.755	0.662
CI-DO	0.998	0.998
LL-CI	0.13	0.55
TLMY-CI	-0.0057	0.22

DMY-LL: daily milk yield with lactation length, DMY-TLMY; daily milk yield with total lactation milk yield, LL-TLMY: lactation length with total lactation milk yield, CI-DO: calving interval with days open, LL-CI: lactation length with calving interval, TLMY-CI: total lactation milk yield with calving interval

The genetic correlation estimates between selected milk production and reproduction traits were found to be 0.417±0.099 and 0.261±0.097 for calving interval with lactation length and total lactation milk respectively in Ethiopian Boran. The corresponding estimate values for Ethiopian Boran and Holstein Friesian crosses were 0.805±0.064 and 0.593±0.064 respectively. The present estimates were comparable with Deb *et al.* [8] who found genetic correlation value of 0.399 and 0.56 calving interval with lactation length and lactation milk yield respectively in Bangladesh cattle breed-1[U2]. Malau-Aduli *et al*. [6] reported the lower genetic correlation estimate value of 0.10 and 0.06 for calving interval with lactation length and lactation milk yield respectively in Friesian-Bunaji crossbreds. The present estimates disagreed with Aynalem Haile [9] who reported that negative estimate value of -0.99±0.03 for calving interval with lactation length and agreed with estimate value of 0.27±1.36 calving interval with lactation milk yield in Ethiopian Boran; the

author also reported the genotypic correlation estimate values of 0.82±0.42 for calving interval with lactation length which is in agreement with the present work in Ethiopian Boran and Holstein Friesian crosses.

Phenotypic Correlations: The phenotypic correlations of Ethiopian Boran among the milk traits were 0.39, 0.86 and 0.76 between daily milk yield and lactation length, daily milk yield and total lactation milk yield and lactation length and total lactation milk yield respectively. The phenotypic correlations of crosses were found to be 0.15, 0.82 and 0.66 between daily milk yield and lactation length, daily milk yield and total lactation milk yield and lactation length and total lactation milk yield respectively. A strong phenotypic correlation of 0.78 between total lactation milk yield and lactation length was reported by Malau-Aduli *et al*. [6]. Ahmed *et al.* [5] found phenotypic correlation of 0.78 using bivariate analysis and 0.99 using multivariate (tetravariate) analysis between lactation milk yield and milk yield per day of calving. Vercesi Filho *et al.* [7] and Shubha Lakshmi *et al.* [4] reported phenotypic correlation of 0.85 and 0.66 between lactation length and lactation milk yield respectively. The study by Eid *et al.* [13] revealed that total lactation milk yield had positive phenotypic correlations with daily milk yield and lactation length and reported an estimate of 0.480 and 0.362 between lactation length and total lactation milk yield and lactation length and daily milk yield respectively.

Aynalem Haile [9] reported phenotypic correlation of 0.39±0.03 between daily milk yield and lactation length, 0.57±0.03 between daily milk yield and total lactation milk yield and 0.31±0.07 between lactation length and total lactation milk yield for Ethiopian Boran and the corresponding values were 0.14±0.03, 0.13±0.03 and 0.28±0.03 respectively for Ethiopian Boran and Holstein Friesian crossbred dairy cows.

Ethiopian Boran and Holstein Friesian crosses had the same phenotypic correlation estimate of 0.998 for calving interval and days open. The phenotypic correlations was obtained 0.13 and -0.0057 for calving interval and lactation and calving interval and length and total lactation milk yield in Ethiopian Boran respectively. The corresponding values for crosses were 0.55 and 0.22 respectively. The present estimate of phenotypic correlations among milk production and reproduction traits is comparable with the value of 0.19 and 0.13 lactation length-calving interval and lactation milk yield-calving interval respectively Malau-Aduli *et al*., [6]. Ahmed *et al.* [5] reported phenotypic correlations between lactation length-calving interval and lactation milk yield-calving interval of 0.25 and 0.28 respectively. Aynalem Haile [9] found that negative phenotypic correlation value of -0.99±0.03 between calving interval and lactation length and positive phenotypic correlation of 0.27±1.36 between calving interval-lactation milk yield in Boran cows. The author reported phenotypic correlation of 0.82±0.42 and 0.06±22 between calving interval-lactation length and calving interval-lactation, milk yield respectively in Ethiopian Boran and Holstein Friesian crossbred cows.

CONCLUSION

The high heritability estimates for milk production and reproduction traits observed in the study may warrant designing of selection to improve the Ethiopian Boran and their crosses. Besides, heritability estimates for calving interval and days open were higher than other parameter heritability estimate values. This indicated that there is also a room of selection for these traits beside to management improvement. However, the improvement for low heritable reproduction traits could be through nutrition and reproductive management. High genotypic and phenotypic correlations were recorded between daily milk yield-total lactation milk yield, lactation length-total lactation milk yield and calving interval-days open in Ethiopian Boran and crosses. Thus, these highly and positively correlated traits are taken as a good opportunity for the breeder in way that the selection of one trait would result in an improvement of the other trait.

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