ONLINE JOURNAL OF ANIMAL AND FEED RESEARCH

An International Peer-Reviewed Journal which Publishes in Electronic Format

Volume 6, Issue 4, July 2016

Online J. Anim. Feed Res., 6 (4): July 25, 2016

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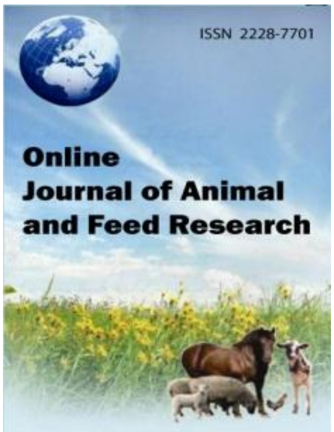

ISSN: 2228-7701

Frequency: Bimonthly

Current Issue: 2016, Vol: 6, Issue: 4 (July)

Publisher: SCIENCELINE

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Online Journal of Animal and Feed Research

Volume 6, Issue 4: 83-89; July 30, 2016 ISSN 2228-7701

EFFECTS OF EXOGENOUS RECOMBINANT BOVINE SOMATOTROPIN (RBST) ON HEMATOLOGICAL INDICES OF KUNDHI BUFFALO MALE CALVES

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ABSTRACT: The aim of present research was assessment of the rbST effects on hematological indices and also its optimum safe dose in kundhi buffalo male calves for beef production. The calves were divided into three groups, with or without rbST treatment. The rbST administered intramuscularly during fortnight, for eleven weeks with an interval of two weeks. Then blood samples were collected at the end of eleven weeks for analysis. In comparison with group A and B, red blood cells count, hemoglobin, mean corpuscular hemoglobin concentration, platelets count and mean corpuscular volume indices were significantly (P<0.05) higher. There was no significant effect on mean corpuscular hemoglobin, erythrocyte sedimentation rate and packed cell volume. The white blood cells in rbST treated groups (P<0.05) increased, and this increase was attributed due to increase in neutrophil number. However, there was non-significant effect of rbST on eosinophils, basophils, monocytes and lymphocytes between all groups. It was concluded from outcomes that rbST produced dose dependent effect on hematological values in kundi buffaloe calves and no adversely higher values were observed that determine polycethemia or leukocytosis. It is therefore suggested that rbST can be used at the dose rate of 1mg/kg b.w. as growth promoter in Kundhi buffaloe calves.

ORIGINAL ARTICLE
pii: S222877011600011-6
Received 22 Jun. 2016
Accepted 10 Jul. 2016

Keywords: rbST, Hematology, Hematological, Polycethemia, Leukocytosis, Kundhi Buffalo, Calves.

INTRODUCTION

In the developed countries such as USA, hormones are used as growth promoters for improving the efficiency of feed conversion thereby weight gain in beef animals as well as for milk production in dairy animals (Marounek et al., 2007). Somatotropin is a homeorhetic hormone secreted from the pituitary gland play major role in nutrient partitioning in the animal body, and employed as a growth promoter and also for milk production (Capper, 2010).

Now a days, instead of somatotropin genetically engineered synthetic recombinant bovine somatotropic hormone (rbST) used as a feed supplement or via injection, for production of milk yield in livestock animals and as growth promoter in beef animals (Collier and Bauman, 2014). Previously research suggested that rbST increased the milk production in various species cows (Eppard, 1997), goat and sheep (Baldi, 1999) and in buffalo (Moallem et al., 2000; Jorge et al., 2002; Gulay et al. 2004; Mishra and Shukla, 2004). In Pakistan, rbST is also used via injection or supplemented in the feed. In increasingly vulnerable environment, the rbST is regularly practiced in commercial dairy animals particularly in buffalo for augmentation of milk production. For that reason, it is important to monitoring the effect of rbST on health status of the animals. The blood hematological indices are important indicators of the health status of the animals.

The documented studies about effect of rbST on hematological profile in different species such as in cow (Dilbar et al., 2014), small ruminants (Azza et al., 2010), sheep (Sallam et al., 2005; El-Din et al., 2009) and in Nilli ravi buffalo (Jabbar, 2004; Jabbar et al., 2010; Khaliq and Rahman, 2010). The kundhi buffalo is a local breed of sindh province in Pakistan. Although there are some reports on lactating buffalo especially on kundhi breed. But very few researches so far has been carried on fattening buffalo calves of kundhi breed to see the effect of rbST on hematological profiles. The current study evaluated the effect of rbST with different dosage regimes in fattening kundhi buffalo male calves to monitoring the health status. The main objective was assessment of rbST regarding

To cite this paper: Khuhro AP, Soomro SA, Kaka NA, Khuhro RP, Siyal FA, Bhutto ZA, Arain MA, Saeed M, Soomro RN and Brohi SA. 2016. Effects of exogenous recombinant bovine somatotropin (rbST) on hematological indices of Kundhi buffalo male calves. *Online J. Anim. Feed Res.*, 6 (4): 83-89.
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its dose selection during the therapy, whether low or high doses could be used safely devoid of any side effect on the health status such as hematological indices.

MATERIAL AND METHODS

Experimental animals

A total of eighteen healthy Kundi buffalo male calves, 6 months of age, with average body weight of 60kg were selected for current study. The experiment was conducted at Livestock Experimental Station, Sindh Agriculture University, Tandojam Pakistan. The calves were housed in pens with free access to water and provided sufficient housing space and open space for exercise. The calves were fed twice a day add libitum with access to a total mixed ration. Animals were divided into three groups (A, B and C). Each group consisted of six animals. Before commencement of the study, the calves were allowed for at least three weeks of acclimatization period. During adaptation period the calves were ear tagged, drenched and vaccinated against some common infectious diseases.

Feeding management

An economical fattening ration (concentrate mixture) consisted of crushed maize and wheat bran as major energy ingredients were formulated (Table-1) according to previously described method (Sharma et al., 1995). The chemical composition and nutritive values of feed ingredients such as Fats, Crude Protein, TDN, Crude Fiber and Ash of the ration was determined as per standard methods described by AOAC (2000).

Table 1 - Formulation and chemical composition of experimental fattening ration (% on dry matter (DM) basis).

INGREDIENTS	Quantity (Kg)	DM	CP	TDN	CF	Ca	P
Dry roughages							
Wheat Straw	20	18	0.468	8.64	7.4	0.04	0.01
Green roughages							
Berseem (*Trifolium alexandrinum*)	40	7.2	1.152	4.608	1.61	0.26	0.02
Concentrates							
Maize Crushed	3	2.7	0.297	2.241	0.05	—	0.02
Wheat Bran	4	3.56	0.57	2.492	0.32	0.01	0.04
Rice Polish	10	9	1.08	7.29	0.29	0.02	0.12
Cotton Seed Cake	16	14.4	5.04	11.38	1.44	0.02	0.14
Moong Kutta	5	4.65	0.93	3.627	0.24	0.01	0.04
Di-Calcium Phosphate	0.25	0.25	—	—	—	0.09	—
Molasses	2	1.56	0.062	1.139	—	0.02	—
Salt	0.25	0.25	—	—	—	0.09	—
Total	100.5	61.66	9.599	41.417	11.43	0.57	0.41
Chemical composition			16	68	18.5	1.05	0.6

Treatment period

After 3 weeks of adaptation period, the treatment of rbST and fattening ration was started. All the calves in three groups were fed experimental ration. The group A served as control without treatment while B and C experimental groups. The rbST was administered intramuscularly to animals at dose rate of 0.5 and 1.0 mg/kg body weight (BW), respectively for group B and C, fortnightly for eleven weeks of period with interval of two weeks.

Collection of blood samples and complete blood count (CBC)

The blood samples from the calves collected weekly, (at last day of week) for the period of eleven weeks. The samples drawn in chilled EDTA vacutainers (BDH, Germany) and were brought to the Department of Veterinary Physiology and Biochemistry, Sindh Agriculture University tandojam, Pakistan for comprehensive examination. All the CBC parameters were done manually. All parameters were performed according to the standard hematological procedures as previously described (Sharma, 2005). Red blood cells (RBC's) and white blood cells (WBC's) or leukocytes quantified via haemocytometer method, platelets or thrombocytes through chamber counting system, neurtrophils, eosoniphils, basophils, lymphocytes and monocytes through differential leukocytes count (DLC),

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packed cell volume (PCV) measured via microhaematocrit method, erythrocyte sedimentation rate (ESR) via Westergren's procedure, hemoglobin (Hb) level was by acid-hematin, mean corpuscular volume (MCV) by PCV/RBC'sx10 formula, mean corpuscular hemoglobin concentration (MCHC) through Hb/PCVx100 equation and mean corpuscular hemoglobin (MCH) through Hb/RBC'sx10 formula.

Statistical analysis

The data was shown as means ± S.E.M., and analyzed in student edition statistical software via one-tailed ANOVA. Least significant difference LSD was applied to indicate significant difference between and within the means of control and rbST treated groups. The significance level was set at $P<0.05$.

RESULTS

Red blood cells (RBC) count and hemoglobin (Hb) level

The mean values of RBCs count and hemoglobin level treated with rbST for the period of eleven weeks depicted in Figure 1. The overall mean RBC concentration increased (P<0.05) in calves of group C as compared to other groups (A and B). No difference was observed between A and B or between B and C. The increased RBCs count was observed within normal limits in group C. Concurrently, with increased RBCs count, the overall mean hemoglobin level also increased (P<0.05) in calves of group C treated with rbST at dosage of 1.0 mg/kg BW in contrast to remaining groups. Similarly, no difference was noticed between A and B or B and C groups, and increased hemoglobin in groups C was within the limits.

Mean corpuscular hemoglobin concentration (MCHC)

The effect of rbST treatment on MCHC for eleven weeks showed in Figure 1. In comparison with groups A (control) and B, the indices of MCHC raised (P<0.05) in group C animals received rbST with dose of 1.0 mg/kg BW There was no significant effect of rbST between groups A and B or B and C. Moreover, the increase in MCHC concentration in C group was within normal values.

MCH, ESR and PCV

In comparison with control, no significance difference was observed for mean values of MCH, ESR and PCV values in buffalo calves fed fattening ration between and within the groups (A, B and C) as mentioned in Figure 1.

White blood cells (WBCs) count

The mean values of WBCs of animals treated through rbST for period of eleven weeks publicized in Figure 2. The rbST treatments produced pronounce effect on WBCs count. In comparison with control (group A), dose dependent significant effect of rbST was observed in B and C groups. The raised indices of WBCs were higher in group C than B. The increased in total WBC count were within normal limits.

Platelets count

The overall mean showed significant effect of rbST in groups B and C as compared to A in dose dependent manner as shown in Figure 2. The increase in platelets count was higher in calves of group C (rbST 1.0 mg/kg BW) as compared to that of group B (rbST 0.5 mg/kg BW). The increase in platelets count was within limits such as no thrombocytosis was seen in buffalo calves treated with rbST.

Mean corpuscular volume (MCV)

The effect of rbST MCV is depicted in Figure 2. The overall mean values showed that the MCV values increased in rbST treated calves groups (B and C) in contrast to non-treated group (A) in dose dependent fashion. The increased indices of MCV observed to be higher in group C than B group animals.

Differential leukocytes count (DLC)

Mean values of different WBCs observing through DLC mentioned in Figure 3. DLC analysis showed that rbST treatment produced significant effect on nutrophils counts. The overall mean values showed that the number of neutrophils increased in rbST treated groups as compared to control group. The increase in neutrophils was within normal ranges and no sign for neutrophilia was observed in calves treated with rbST. There was no significant effect of rbST on esionophils, basophils, lymphocytes and monocytes between and within the groups.

To cite this paper: Khuhro AP, Soomro SA, Kaka NA, Khuhro RP, Siyal FA, Bhutto ZA, Arain MA, Saeed M, Soomro RN and Brohi SA. 2016. Effects of exogenous recombinant bovine somatotropin (rbST) on hematological indices of Kundhi buffalo male calves. *Online J. Anim. Feed Res.*, 6 (4): 83-89.
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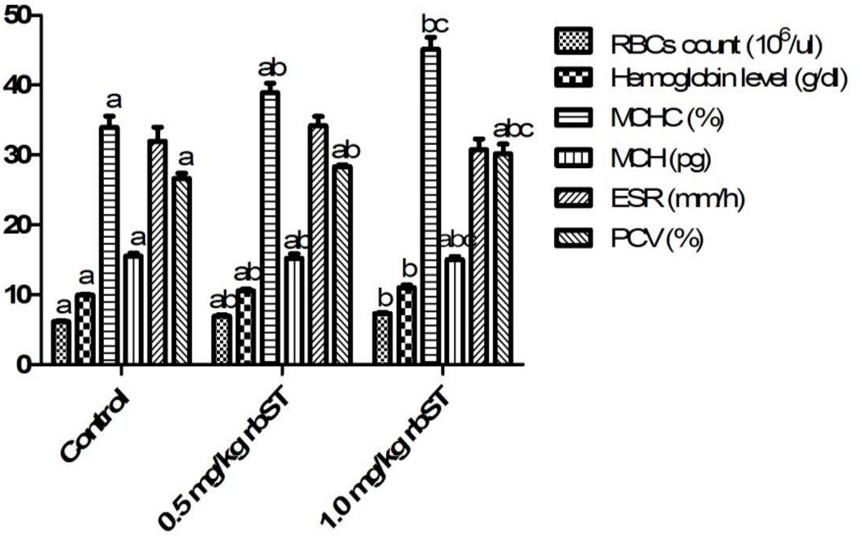

Figure 1 - Mean RBCs count, hemoglobin level, MCHC, MCH, ESR and PCV of Kundhi buffalo calves fed fattening ration during treatment period of 11 weeks with rbST. Significant difference level (P<0.05) with different superscripts.

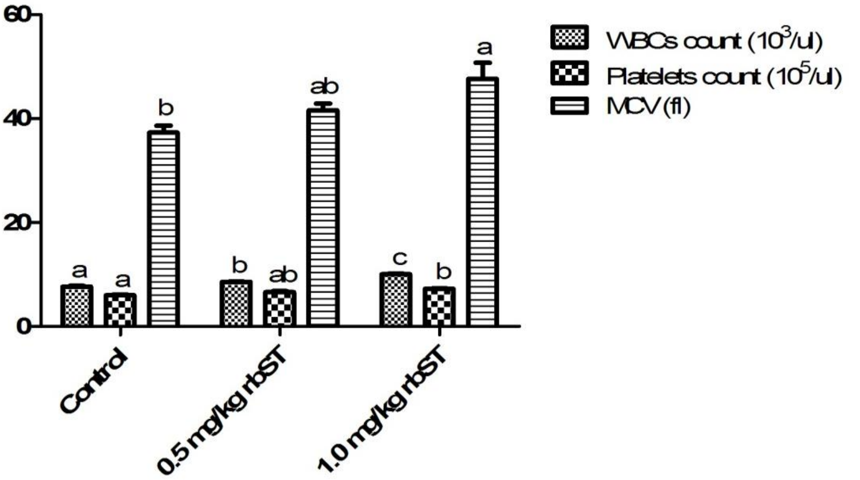

Figure 2 - Mean WBCs count, platelets count and MCV of Kundhi buffalo calves fed fattening ration during treatment period of 11 weeks with rbST. Significant difference level (P<0.05) with different superscripts.

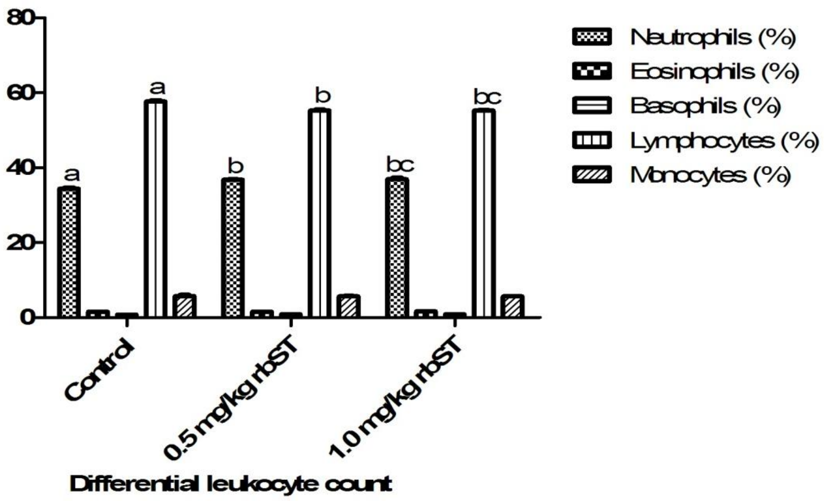

Figure 3 - Mean differential leukocytes or WBCs (neutrophils, eosinophils, basophils, lymphocytes and monocytes) of Kundhi buffalo calves fed fattening ration during treatment period of 11 weeks with rbST. Significant difference level (P<0.05) with different superscripts.

DISCUSSION

Recombinant bovine somatotropin (rbST) is a synthetic hormone which has widely been studied in lactating animals for milk production (Azza et al., 2010; Chaiyabutr et al., 2011) and as growth promoter in young animals. But its effects on hematological indices have not been much studied particularly in fattening kundhi buffalo calves. The RBC count was significantly increased in rbST treated calves as compared to control in dose dependent fashion. Nasser et al. (2007) found non-significant increased indices of RBC in goats when medicated 50 mg rbST one time each week for the period of eight weeks. Though, Eppard et al. (1997) investigated significant decrease value of RBC in lactating cows following rbST treatment. Other studies in cow and buffalo publicized not significantly alteration in RBC values when treated with rbST (Azza et al., 2010; Khaliq and Rahman, 2010). Nour-El-Din et al. (2009) and Dilbar et al. (2014) did not observe any change in RBC count in lambs' and bull after treatment with rbST. The discrepancies in the effect of rbST treatment on RBC count suggest that, effect depend on species, physiological status of the animal, dose and duration of the treatment. Concurrently with increase in RBC count, the rbST also increased the hemoglobin level and MCHC of kundhi buffalo calves. However, somewhat declined in hemoglobin level was observed in contrast with control, when induced with 100 mg rbST for eight weeks once daily (Nasser et al., 2007). But, Nour-El-Din et al. (2009) mentioned raised level of Hb in lambs induced with 100 mg of rbST every week like compared to non-treated animals. But, Dilber et al. (2014) observed no effect on Hb and MCHC in rbST treated bulls with 500 mg dose every week for the period of ten weeks. The rbST treatment increased the body weight (Gavidia, 2001) and stimulation of erythropoiesis during growth is necessary to ensure proportionality between erythrocyte and body masses (Kurtz, 1988). So possibly in present study, RBC and its related indices also increased with proportionate with body mass during growth process. The rbST might have direct effect on hemopoietic stem cells. The rbST-induced erythropoiesis may be mediated by insulin-like growth factor (IGF-I). As IGF-I concentration increased in rbST treated animals (Schernhammer, 2006) and stimulate the erythropoiesis either directly or indirectly through release of erythropoietin (Kurtz, 1988). The rbST produced no effect on the MCH between the groups might be species difference and difference in the protocol of the experiment. The ESR values were not different between the groups, which coincide with preceding report (Dilbar, 2014). While Khaliq and Rahman (Khaliq and Rahman, 2010) noticed decrease indices of ESR in lactating buffaloes treated with rbST when injected 500 mg two times with an interval of sixteen days. No significant effect was observed on PCV percentage in rbST treated calves which conincide with previous study (Chaiyabutr, 2011). Khaliq and Rahman (2010) noticed decrease indices of PCV in rbST treated buffaloes. Alike outcomes were acquired in ovine (Sallam et al. 2005), caprine (Nasser, 2007) and bovine (Dilbar et al., 2014).

In our study no effect was observed probably due to low dose of rbST and many other factors such as species, age, sex and physiological conditions. The platelets count also increased in the present study was within normal ranges. However, increasing trends in platelets count had also been observed in lactating cows treated with rbST (Chaiyabutr et al., 2011; Burton et al., 1992). In our study MCV values increased which coincide with Burton et al. (1992) report. The increase in MCV might have been resulted from overall increase in blood cells. The total leukocyte count was raised in rbST medicated buffalo calves. The differential leukocytes count analysis further confirmed that increased WBC was mainly accompanied due to an increase in neutrophils. In current study, lymphocyte count also increased which is accordingly with previous report (Khaliq and Rahman, 2010). The previous studies also proved that leucoctosis is actually because of neutrophilia (Azza et al., 2010; Chaiyabutr et al., 2011; Burton et al., 1992; Hoeben et al., 1999), but Khaliq and Rahman (2010) noticed decrease in neutrophils in Nilli-ravi buffalo. The exact motive for higher indices of WBC count in rbST medicated animal still not clear, possibly neutrophil is the part of innate immunity probably rbST stimulate this immunity.

CONCLUSION

It was concluded from outcomes that rbST produced dose dependent effect on hematology in kundi buffaloe calves and no adversely higher values were observed that determine polycethemia or leukocytosis. It is therefore suggested that rbST can be used at the dose rate of 1mg/kg b.w. as growth promoter in Kundhi buffaloe calves. It is recommended that further toxicological studies conducted in the future about effect of different doses of rbST on various body systems of diverse species of livestock. The outcomes of toxicological studies in the future give guidance to the veterinary practitioner regarding dose management during therapy.

Acknowledgements

We are highly thankful to department of livestock management, Sindh Agriculture University, Pakistan, to providing animals for experiment. We are also thankful to teachers and technicians of department of physiology and biochemistry for proper guidance, support and help.

Competing interests

The authors declare that they have no competing interests exist.

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Online Journal of Animal and Feed Research

Volume 6, Issue 4: 90-95; July 30, 2016 ISSN 2228-7701

ESTIMATION OF GENETIC PARAMETERS FOR REPRODUCTIVE TRAITS OF FOGERA AND HOLSTEIN FRIESIAN CROSSBRED CATTLE AT METEKEL RANCH, AMHARA REGION, ETHIOPIA

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ABSTRACT: The study was carried out at Metekel ranch, Amhara region, Ethiopia, with the objective of estimating genetic parameters for reproductive traits of Fogera and Holstein Friesian crossbreed cattle. The data used in the study included pedigree records and reproductive performance records of animals born from 1990 to 2012.The parameters were estimated by using Variance Component Estimation (VCE 6.0) software. Four models were used Viz. Model1: $Y= X_b+Z_1a + e$; Model2:$Y=X_b+Z_1a+Z_3c + e$; Model3: $Y=Xb+Z_1a+Z_2m+ e$; cov a,m=0 and Model4: $Y= X_b + Z_1a + Z_2m+ Z_3c + e$; cov a, m=0.Traits like Gestation Length (GL), Calving Interval (CI) and Days Open(DO) were estimated using model2 and 4 which fit permanent environmental effect due to repeated records per cow. Whereas, age at first service (AFS) and age at first calving (AFC) were estimated using model 1, 3, and 4. Estimates of direct heritability of the studied traits ranged from 0.01±0.05 for DO to 0.26±0.21 for AFS, besides high error variance was observed. The phenotypic correlations between traits ranged: 0.33 to 0.99 between CI and DO and GL and DO respectively. And genetic correlations ranged from -1.0 to 1.0 between GL and CI between CI and DO respectively. The result in this study indicates there were low heritability estimates high environmental variances which imply selection based on phenotypic performance of animals was unlikely to bring genetic progress in the studied herd because of the low estimate of heritability of the trait. Besides, The result showed there was moderate to high correlation that indicated selection for one trait will affect the correlated traits. Thus, selection method, in addition to individual records, should incorporate pedigree and progeny information in the form of an index to get optimum genetic progress in the studied population. In addition, selection for any particular trait(s) must be carried out with caution as it could have an adverse effect due to correlated response on the correlated traits.

Keywords: Correlation, Crossbred, Economic traits, Fogera and Holstein Friesian, Genetic parameter, Heritability, Metekel ranch, Reproductive trait

Abbreviations: AFC=age at first calving, AFS= Age at first service CI= calving interval=DO Days Open GL= Gestation Length

ORIGINAL ARTICLE
pii: S222877011600012-6
Received 22 Jun. 2016
Accepted 20 Jul. 2016

INTRODUCTION

The total cattle population of Ethiopia is estimated to be 53.39 million. Out of this population, about 98.95% are local breeds while hybrids and exotic breeds account only for about 0.94% and 0.11%, respectively (CSA, 2013). From the total milk production in Ethiopia 81.2% came from cattle, whereas; 6.3%, 7.9% and 4.6% come from camels, goats and ewes, respectively (CSA, 2008). Of the total milk produced from cattle 97% of the milk is produced by the indigenous stock and the remaining 3% from improved crosses and pure grade (exotic) cattle. The dairy production in Ethiopia is based largely on indigenous breeds of cattle and breed improvement and development programs, have been directed mainly on crossbreeding activities through research stations, government stock multiplication centers and private farms (MOARD, 2007).

Economically important traits in animals are affected by both genetic and environmental factors. The genetic factors are due to a random sample of genes received from the two parental gametes whereas the environmental factors include influences of climate, nutrition, health and management (Bourdon, 1999). Genetic analysis of animal genetic resources most often aims at separating genetic and environmental effects (Falconer and Mackay, 1996). Genetic parameter estimates are needed for implementation of breeding programs and assessment of progress of ongoing programs where accuracy of their estimation is of paramount importance (Wasike, 2006). The

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genetic and phenotypic parameters in quantitative genetics include heritability, genetic and phenotypic correlations and repeatability, which play a vital role in the formulation of any suitable breeding plan for genetic improvement program (Aynalem, 2006).

The reliability of phenotype depends upon the heritability of the trait. Heritability is critically important for selection of polygenic traits. When selection is made for trait(s), heritability decides how much genetic improvement is expected in the trait(s) while genetic correlation between traits selected and other correlated trait (s) decides how much response to selection can be expected for traits not selected in addition to the response for the selected traits (Rao and Bhatia, 2002). The response to selection is the combined result of direct selection for each trait and indirect selection caused by the genetic correlation between the traits (Bourdon, 1999).

Crossbreeding allows us to use hybrid vigor which affects the heritability of the traits. Though crossbreeding in Ethiopia had been initiated in the early 1950s, the formal breed improvement research was started in early 1970's at Bako, Melka Werer, Adami Tulu and Holleta Agricultural Research Centers. Metekel ranch was established in 1986 for the purpose of Fogera cattle conservation and improvement program. Under the improvement program Fogera x Holstein Friesian crosses have been produced. With the view to evaluate performance of these crossbreds, growth and reproduction traits have been recorded and being recorded since the establishment of the ranch. Hence, the present study was intended to contribute its part in filling the gaps. Thus, this study was initiated with the following objective:

- Estimating genetic parameters of reproductive traits of Fogera and Holstein Friesian crossbred cattle population.

MATERIALS AND METHODS

Description of the study Area

Metekel Cattle Breeding and Improvement Ranch is found in the Guangua district of Awi zone in Amhara National Regional State, and is situated about 505 km North-west of Addis Abeba, 200 km from Bahir Dar town on the road to Guba. Its altitude ranges from 1500-1680 m.a.s.l. The annual mean relative humidity is 61.7% and it reaches high from June to October (76.7- 83.8%). The ranch receives an average annual rainfall of 1730.0 mm; average temperature ranges from 13.7 to 29.5^{0}C. The area has three rainy seasons; long rainy season (June-October), short rainy season (March-May) and dry season (November-February). The ranch has three types of soils viz. Red, brownish red (Latosols) and dark brown. The vegetation is mostly composed of perennial and annual grasses and a few scattered trees.

Herd management

The Ranch has been engaged in maintenance of Fogera cattle population outside their adapted environment (*ex-situ conservation*). The cattle herded based on breed and age. During the day time animals graze on natural pasture and were provided with hay in addition to grazing during dry season. Crossbred female calves above three months of age and sick animals were supplemented with Desmodium (*Desmodium triflorum*), Rohodus (*Chloris gayana*) and Elephant grass (*Pennisetum purpureum*) both in wet and dry seasons through cut and carry system. The main source of water was a year-round river. Tap-water has been provided to lactating Fogera cows, crossbred stock and sick animals. Health management practice includes the prevention and control scheme. The prevention scheme focused on vaccination against anthrax, blackleg and pasturollosis once in every 6 to 8 months and once per year for CBPP. Whereas, control measure focused on internal and external parasites. De-worming was conducted twice a year, at the start and end of the rainy seasons.

Breeding program

The breeding program has two components: selection and crossbreeding. The establishment of the pure breed unit was meant for the improvement of the Fogera breed and for providing heifers for cross- breeding to exotic dairy sires (by Artificial insemination). In the selection program of pure breed unit, the tradition was Fogera bulls were allowed to run together with Fogera cows. The selection activity undertaken at Metekel ranch had never been based on quantitative traits; instead the visual appraisal had been used. But recently they have been trying to study and include background of the animal during selection. According to the breeding plan of the ranch, heifers available for mating for the first time should attain a minimum body weight of 250 kg. If the heifer didn't attain the minimum body weight its mating time will be extended. At around three to six months of pregnancy, the F1 heifers were sold to farmers for milk production (Melaku et al., 2011). Very recently the ranch has started to distribute non pregnant F1 heifers to minimize rearing costs.

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Study design, source and nature of the data

A retrospective type of study was carried out to evaluate the reproductive performances of Fogera X Holstein Friesian crossbred cattle in the ranch. At the ranch, records of individual animals were kept on individual animal cards. Therefore, in this study, a 23 year old farm records (i.e. All records of animals born and cows that calved between 1990 and 2012 were included). The main problem encountered was the challenge of the pedigree record screening procedure. Therefore, consistency checks were performed on identification of animals and their pedigrees.

Data management and Data analyzed

Records with irregularity in pedigree information and dates were discarded. The animals that have abnormal calving, i.e., abortion and stillbirths were not included in the analysis. After clearing the data for consistency of pedigree information a final data set comprising of 526, 44, 105, 92 and 52 records of AFS, AFC, CI, GL and DO respectively, were used for analysis.

Statistical analysis

The genetic parameters estimated were heritability and correlation. They were estimated using variance component estimation (VCE) procedure which is a software program package to estimate dispersion parameters under a general linear model for quantitative genetic analysis of continuous traits, fitting a linear mixed model for estimation of covariance components. The resulting genetic parameters were obtained by restricted maximum likelihood. It is assumed that traits analyzed were continuous and had a multivariate normal distribution.

The variance components and heritability were estimated by Uni-variate, bi-variate and multivariate animal model using four models which fitted direct additive, dam's (maternal) additive genetic and permanent environmental effect as a random effect and the fixed effects. Parameter for GL, CI and DO were estimated using model 2 and 4 which fit permanent environmental effect due to repeated records per cow. On the other hand AFS and AFC were estimated using model 1, 3, and 4. The Likelihood ratio tests were conducted to determine the most suitable model.

The model equations used for the analysis of reproductive traits (viz. AFS, AFC, GL, CI and DO) were:

Model1 $Y= Xb + Z_1a + e$;

Model2 $Y= Xb + Z_1a + Z_3c + e$;

Model3 $Y= Xb + Z_1a + Z_2m + e$ ($cov_{a, m} = 0$);

Model4 $Y= Xb + Z_1a + Z_2m + Z_3c + e$ ($cov_{a, m} = 0$)

Where, Y = vector of records; b = vector of fixed effects; X = incidence matrix of fixed effects a = vector of direct additive genetic effect; m = vector of maternal additive genetic effect; c = vector of permanent environmental effect; and Z_1, Z_2 and Z_3= incidence matrix for direct additive genetic effect, maternal additive genetic effect and permanent environmental effects respectively; e = vector of random errors.

Correlations (genetic and phenotypic) among the different traits were estimated from bi-variate analysis by using different models. Comparison of the different models was made by using the log-likelihood ratio tests to determine the best model.

RESULTS AND DISCUSSIONS

Heritability and correlation estimates for reproductive traits

The result of heritability estimation for reproductive traits is summarized in Table 1. Except AFS and AFC, the other traits (GL, CI and DO) are repeated per cow and permanent environmental effect must be fitted in the model. Therefore, estimates were not possible from model 1 and 3 for these traits. Hence, based on the Likelihood ratio tests the best model for all repeated reproductive traits was Model 2 which includes the permanent environmental effect.

Table 1 Heritability (diagonal), phenotypic correlations (above diagonal) and genetic correlations (below diagonal) from five traits

Parameters	AFS	AFC	CI	GL	DO
AFS	0.26±0.214	0.85463	–	–	–
AFC	1.00	0.15±0.23	–	–	–
CI	–	–	0.05±0.09	-0.21969	0.99657
GL	–	–	-1.00	0.079±0.131	-0.32678
DO	–	–	1.00	-0.4662	0.010±0.05

AFC=age at first calving, AFS= Age at first service CI= calving interval=DO Days Open GL= Gestation Length

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Age at first service (AFS): The heritability estimate of AFS was 0.26 which was lower than 0.42±0.05 (Yosef, 2006) for Holstein breeds, 0.61±0.15 (Aynalem, 2006) for Ethiopian Boran X Friesian and 0.316 ± 0.074 (Deb et al., 2008)for Bangladesh Cattle Breed-1. Moderate heritability of present study implied that AFS may be shortened in subsequent generations following the selection of breeding animals based on their individual performances.

Age at first calving (AFC): The heritability of direct genetic effect for AFC was 0.15. It was comparable with those reported by Yosef (2006) of 0.16 ± 0.06 for Jersey breed; 0.19±0.00 by Hadi et al. (2011) for Iranian Holstein; 0.21 ± 0.03 by Oyama et al. (2002) for Wagyu cattle. However, it was lower than 0.404 ± 0.069 (Deb et al., 2008), 0.53±0.116 (Gebeyehu, 2014) for Holstein; 0.61±0.15 (Aynalem, 2006) for Boran x Holstein; 0.39 ± 0.28 (Gaikward and Narayankedkar, 2000) for Gir X Holstein Friesian and Gir X Jersey cattle; 0.406±0.23 (Choudhary et al., 2003) for Sahiwal cattle. The current result was higher than the finding of Ilatsia et al. (2007) (0.04) for Sahiwal; Wasike (2006) (0.04) and Wasike et al. (2009) (0.04 ± 0.06) for Kenyan Boran.

Calving interval (CI): The estimated value was 0.05 and it was comparable with 0.05±0.02 reported by Ojango and Pollot (2002) from Kenya; 0.04±0.00 by Hadi et al. (2011) for Iranian Holstein; 0.08±0.05 by Yosef (2006) for Holstein breed and 0.08 ± 0.03 by Demeke et al. (2004). However, the result was lower than Gogoi et al. (1992) 0.25 for Jersey x Sindhi crossbreds; Rahumathulla et al. (1993) also estimated 0.37 for Jersey x Tharparker cattle in India and Islam et al. (2004) 0.38±0.05 for Local zebu x Frisian.

Days open (DO): The direct heritability for DO was 0.01 which is comparable to 0.01 ± 0.03 reported by Almaz (2012) and 0.224±0.082 Mohamed (2004). But lower than 0.041 Mhamdi et al. (2010). Although the estimated value of the current study was low, it was within the range of estimates reported in the literature for tropical cattle (Lobo et al., 2000 and Cammack et al., 2009).

Gestation length (GL): The estimated direct heritability (0.08) for GL was lower than 0.26±0.57 0.14±0.28, 0.25±0.45 for Sahiwal x Friesian, Sahiwal x Pabna, Friesian x Pabna respectively (Das et al., 2003). From multivariate analysis, the permanent environmental effect for the trait was found to be higher than direct genetic effect. This shows the presence of maternal genetic effect (permanent environmental effect) on GL. Similar pattern was observed by Almaz (2012).

Correlations

Since livestock are usually bred for multiple rather than single traits to bring about production efficiency in their lifetime, there is always bound to be a relationship between traits. This relationship can be shown through the correlation of trait values positively or negatively on the individual of a population Falconer (1989).

As indicated in table 1 there was a positive phenotypic correlation between Age at first service (AFS) and Age at first calving (AFC) (0.85). In addition, the strong positive phenotypic correlation was observed between Calving interval and Days open (0.99). However, negative correlations were observed between CI and GL. Consistently, low phenotypic correlations among reproductive traits were reported by Oyama et al. (2004); 0·00 for GL and CI and -0·03 for DO and GL. Except between DO and GL which showed moderate negative genetic correlation (-0.4662) strong genetic correlations were observed among reproductive traits in the current study, which ranged from strong positive 1.00 between AFS and AFC, between CI and DO to strong negative -1.00 between CI and GL (Table 1). The strong negative correlation showed that as calving interval increase the dam gets more time to build her body which could help for better fertility and fast growth of the fetus, as a result, the gestation length became short.

Due to the strong genetic relationship between these traits, selection of one of them could have high effect on the other through correlated responses. Similarly strong positive genetic correlation reported by Oyama et al. (2004) and Goyache et al. (2005) between DO and CI. The same authors (Oyama et al., 2004 and Goyache et al., 2005) reported a negative genetic correlation between GL and DO similar to the present study.

CONCLUSIONS

The low direct heritability estimate for reproductive traits in this study indicates that there is low additive genetic variance in the study population. It indicates that the observed phenotypic variation is largely attributable to environmental effect. In other words the low heritability estimates indicate low genetic control of the expression of the traits. This is indicative of the fact that selection based on phenotypic performance of animals could not be effective in the population studied or the population has low response to selection. Therefore, one may decide on for a long-term strategy of achieving change in these traits firstly through improvement of the production environment and then by gene transfer through crossbreeding.

Based on the result of the present study the recommendations are as follows

- Accuracy of genetic parameter estimation is dependent on the availability and quality of records on animal's pedigree and performance. Thus the record keeping of the ranch should be improved and a standard record keeping practice on reproductive traits should be established.

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- The selection method of the ranch especially for heifers since the ranch gets semen from National Artificial Insemination Center (NAIC) based on the physical appearance of the animals need to be updated and must be based on the phenotypic and genetic evaluation result rather than on the basis of qualitative traits.

Acknowledgements

This study was funded by the Ministry of education (Arba Minch University). I (corresponding author) would like to thank Metekel ranch and Dr. Getinet Mekuriaw (PhD, Assistant professor) for their help.

Competing interests

The authors confirm and declare that they have no competing interests exist.

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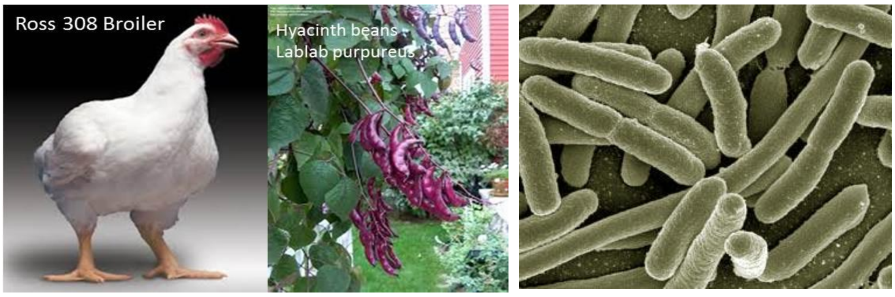

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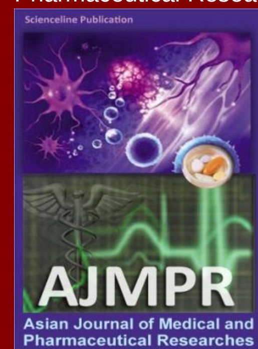

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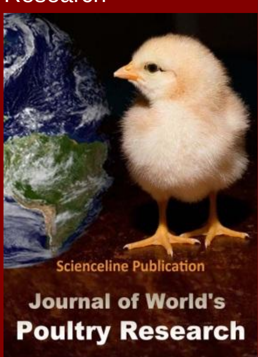

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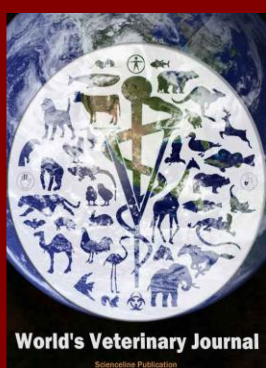

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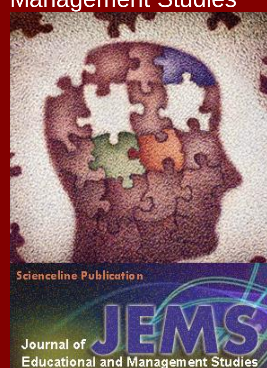

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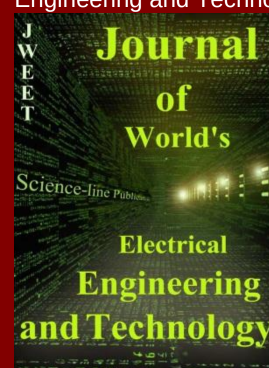

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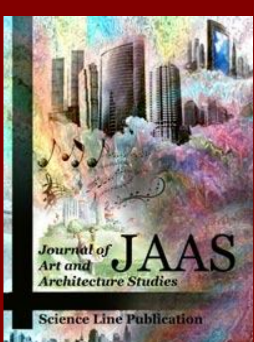

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