ELECTROLYTE AND ERYTHROCYTE PROFILE DURING PREGNANCY AND EARLY LACTATION IN CROSSBRED HEIFERS*

Shibu .K. Jacob[1*], Philomina, P.T.[2] and Ramnath.V.[3]

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ABSTRACT

The serum concentration of macroelements such as sodium and potassium as well as red blood cell associated traits like total red blood cell count, haemoglobin content, volume of packed red cells and erythrocyte indices were determined in crossbred heifers. The screening of macrominerals and RBC traits were undertaken in heifers before and after conception at regular intervals as well as during the 1st month of lactation. The serum concentration of sodium increased while potassium fluctuated as pregnancy advanced. The total RBC count reached the lowest value by 9th month of gestation. This reduction was compensated by the increase in MCV. The haemoglobin content and VPRC exhibited a declining trend throughout the period of gestation.

INTRODUCTION

Electrolytes have multifaceted functions in animal's body including maintenance of plasma osmolarity and volume, acid-base balance, nerve impulse propagation and as cofactors for various enzymes and thus play a vital role in maintaining homeostasis within the body. Alterations in the haematological, biochemical and electrolyte profile occur in the body, in and around parturition and during peak lactation. High producing dairy cattle are always on the verge of risk due to the high turnover of fluids, minerals and organic matter in the body during pre and post-partum periods thereby, disturbing the homeostasis which eventually lead to abnormal clinical situations as reported by Blood and Radostits (1989). Hence the study was undertaken to monitor major electrolytes especially sodium and potassium in serum and red blood cell profile along with erythrocyte indices during pregnancy and early lactation in crossbred heifers.

MATERIALS AND METHODS

Twenty healthy cross-bred sexually mature heifers maintained under identical managemental conditions in a single herd at Kerala Agricultural University, Cattle Breeding Farm, Thumburmuzhi were selected for the study. Animals were fed individually as per standard recommendations and water was provided *ad libitum*.

Blood was collected from all the twenty animals by jugular vein puncture as soon as they attained required adult weight and it was considered as the control group.

Selected animals were then inseminated during estrous and pregnancy confirmed by rectal palpation method, after three months of insemination. Of the 20 animals inseminated, 11 got conceived which formed the experimental group.

Blood was then collected at monthly intervals from 3rd to 9th month of pregnancy (7 times) as well as on 1st month of lactation from the experimental group. The health status of the experimental animals was regularly monitored throughout the period of experiment.

Three ml of whole blood was collected in clean, dry, labeled vials using ethylene diamine tetra-acetic acid (EDTA) at a concentration of 1-2 mg per mL of blood as the anticoagulant for the estimation of red blood cell parameters like total RBC count, haemoglobin content (Hb), volume of packed red cells (VPRC) and derived units like mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC).

[1]MVSc. Scholar, Veterinary Surgeon, Mobile Farm Aid Unit, Ayravon, Pathanamthita, * Corresponding Author
Mobile:- 9447112160; e-mail:- jkshibu@yahoo.com

[2]Professor and Head, Department of Veterinary Physiology, COVAS, Mannuthy, Thrissur

[3]Associate Professor, Department of Veterinary Physiology, COVAS, Pookode, Wayanad

Simultaneously 10mL of whole blood was collected in labelled test tubes for serum separation. After centrifugation, clear serum was transferred in clean, dry labelled vials and stored at -20^{0}C. The concentration of serum sodium and potassium were estimated using flame photometer as per the method of Oser (1976).

The data obtained during pregnancy and early lactation were compared using paired 't' test and statistically analyzed for significance with controls (Snedecor and Cochran, 1994). Variations between months of pregnancy and early lactation were also analysed.

RESULT

The serum concentration of sodium and potassium of non-pregnant (control), pregnant (from 3rd month of pregnancy to the term) and early lactating (1st month of lactation) cross-bred heifers are shown in table 1.

Table 1. The serum concentration of sodium and potassium before and after conception and in early lactation in cross-bred heifers (n=11)

Period / month of pregnancy	Sodium (mEq/L)	Potassium (mEq/L)
Non-pregnant (control)	$188.07^{a} \pm 13.23$	$5.43^{a} \pm 0.34$
3	$158.73^{b} \pm 10.61$	$4.98^{b} \pm 0.39$
4	$167.54^{abc} \pm 8.77$	$4.45^{bc} \pm 0.36$
5	$165.21^{abcd} \pm 8.77$	$4.98^{bcd} \pm 0.44$
6	$179.80^{abcde} \pm 8.50$	$4.10^{cde} \pm 0.31$
7	$199.99^{af} \pm 4.69$	$4.35^{bcdef} \pm 0.19$
8	$196.83^{aefg} \pm 6.76$	$4.82^{bcdfg} \pm 0.18$
9	$216.74^{afgh} \pm 8.23$	$5.66^{abdh} \pm 0.27$
1st month of lactation	$215.94^{afgh} \pm 8.28$	$5.45^{abdgh} \pm 0.30$

Values bearing similar superscripts in the column did not differ significantly ($p<0.01$)

A great deal of fluctuations in the serum sodium levels of cross bred heifers were observed during the period of study. A significant reduction ($p<0.01$) in the serum sodium concentration from the basal value of 188.07 ± 13.23 mEq/L was noticed during the 3rd month of pregnancy. From the 4th month onwards the serum sodium level increased and reached a peak 216.74 ± 8.23 mEq/L nearing the term. The serum sodium level recorded during 1st month of lactation was slightly lower than the term value and was found to be 215.94 ± 8.28 mEq/L. The serum sodium levels observed during 7th ,8th , 9th month of pregnancy and 1st month of lactation were significantly higher ($p<0.01$) when compared to the value obtained during 3rd month of pregnancy.

The serum potassium concentration during 3rd (4.98 ± 0.39 mEq/L) and 4th month of pregnancy (4.45 ± 0.36 mEq/L) were significantly lower than the control levels (5.43 ± 0.34 mEq/L). The potassium level reached the lowest value of 4.10 ± 0.31mEq/L by the 6th month of pregnancy. The potassium level increased from 7th month and during 9th month it reached the highest value of 5.66 ± 0.27 mEq/L. During the 1st month of lactation, serum potassium level dropped to 5.45 ± 0.30 mEq/L which was almost equal to the preconception level.

The red blood cell traits such as total red blood cell count, haemoglobin (Hb) content and volume of packed red cells of non-pregnant (control), pregnant (from 3rd month of pregnancy to the term) and early lactating (1st month of lactation) cross-bred heifers are shown in table 2.

The erythrocyte count during 3rd month of pregnancy was significantly lower than the control levels and the value started to decline gradually and reached to the lowest value of $5.48 \pm 0.24 \times 10^6$ /µL during the ninth month of pregnancy. During 1st month of lactation erythrocyte count was significantly lower than the control as well as pregnancy period.

From the 6th month of pregnancy, the Hb content was significantly lower ($p<0.01$) than the control level and the lowest value was obtained in the 9th month of pregnancy (8.23 ± 0.18g%). However, during the 1st month of lactation the Hb content further dropped to 8.18 ± 0.35g%.

In the present study, it was found that during 3rd month of pregnancy VPRC was significantly lower ($p<0.01$) than the control levels. By the 6th month of

Table.2 Red Blood cell traits before and after conception and in early lactation in crossbred heifers (n=11)

Period / month of pregnancy	Total Red blood cell count (millions/µL)	Haemoglobin (g%)	Volume of packed red cells (%)
Non pregnant (control)	$6.40^{a} \pm 0.38$	$10.09^{a} \pm 0.46$	$32.27^{a} \pm 1.03$
3	$5.80^{b} \pm 0.16$	$9.96^{a} \pm 0.60$	$30.46^{b} \pm 0.81$
4	$5.86^{b} \pm 0.25$	$9.98^{a} \pm 0.63$	$32.18^{a} \pm 1.43$
5	$5.69^{b} \pm 0.22$	$10.17^{a} \pm 0.36$	$30.36^{b} \pm 0.58$
6	$5.64^{b} \pm 0.20$	$8.64^{b} \pm 0.26$	$28.91^{b} \pm 0.53$
7	$5.85^{b} \pm 0.26$	$8.77^{b} \pm 0.23$	$30.55^{a} \pm 0.78$
8	$5.63^{b} \pm 0.29$	$8.96^{b} \pm 0.34$	$30.64^{a} \pm 0.72$
9	$5.48^{b} \pm 0.24$	$8.23^{b} \pm 0.18$	$29.27^{b} \pm 0.94$
1st month of lactation	$5.22^{c} \pm 0.23$	$8.18^{b} \pm 0.35$	$28.82^{b} \pm 1.05$

Values bearing similar superscripts in the column did not differ significantly($p<0.01$)

Table.3 Erythrocyte indices before and after conception and in early lactation in crossbred heifers (n=11)

Period / month of pregnancy (MCV) (fl)	Mean corpuscular volume	Mean corpuscular haemoglobin (MCH) (pg)	Mean corpuscular haemoglobin concentration (MCHC) (g%)
Non pregnant (control)	$51.92^{a} \pm 3.26$	$16.33^{a} \pm 1.16$	$31.72^{a} \pm 2.03$
3	$52.79^{a} \pm 1.81$	$17.29^{a} \pm 1.12$	$32.97^{a} \pm 2.34$
4	$55.92^{a} \pm 3.40$	$17.06^{a} \pm 0.88$	$31.72^{a} \pm 2.58$
5	$54.43^{a} \pm 3.00$	$18.07^{a} \pm 0.93$	$33.67^{a} \pm 1.50$
6	$51.85^{a} \pm 1.96$	$15.58^{a} \pm 0.95$	$29.98^{a} \pm 1.14$
7	$52.72^{a} \pm 1.30$	$15.25^{a} \pm 0.78$	$28.89^{a} \pm 1.01$
8	$55.65^{a} \pm 2.84$	$16.34^{a} \pm 1.18$	$29.29^{a} \pm 1.10$
9	$54.13^{a} \pm 2.45$	$15.22^{a} \pm 0.70$	$28.38^{a} \pm 1.05$
1st month of lactation	$55.95^{b} \pm 2.59$	$15.89^{a} \pm 0.90$	$28.85^{a} \pm 1.80$

Values bearing similar superscripts in the column did not differ significantly($p<0.01$)

pregnancy the lowest value of 28.91± 0.53% was obtained, which later increased to 36.64 ± 0.72% by 8th month. During the 1st month of lactation, VPRC value further declined to 28.82 ± 1.05%.

The erythrocyte indices of non-pregnant (control), pregnant (from 3rd month of pregnancy to the term) and early lactating (1st month of lactation) cross-bred heifers are shown in table 3.

Mean corpuscular volume (MCV) varied throughout the various stages of study. The MCV value during 3rd month of pregnancy was 52.79 ± 1.81 fl whereas that of control was 51.92 ± 3.26fl. The MCV during 9th month of pregnancy was 54.13 ± 2.45 fl, which later increased to 55.95 ± 2.59 fl by 1st month of lactation.

Mean corpuscular haemoglobin (MCH) during 3rd month of pregnancy was 17.29 ± 1.12 pg, whereas that of control was 16.33 ± 1.16 pg. Variations were observed in the MCH levels throughout the period of study which attained a value of 15.22 ± 0.70 pg during 9th month of pregnancy and 15.89 ± 0.90 pg during the 1st month of lactation.

The Mean corpuscular haemoglobin concentration (MCHC) level during 3rd month of

pregnancy and control were 32.97 ± 2.34 g% and 31.72 ± 2.03 g% respectively. The MCHC value showed variation throughout the period of study which reached to the lowest value of 28.38 ± 1.05 g% during 9th month of pregnancy.

DISCUSSION

Physiological conditions like pregnancy, parturition and lactation impose tremendous stress for the animal and animal must maintain homeostasis for survival.

In the present study, it was observed that serum sodium concentration at the 3rd month of pregnancy was lower than controls and then by 6th month of pregnancy even though showed an increasing tendency, the values were lower than the preconception levels, which agree with recordings of Singh *et al.* (1999) who observed lower sodium values in pregnant yaks from 3rd to 6th month when compared with normal cycling ones. Sikka (1992) reported that requirements of sodium and potassium were considerably increased during pregnancy period. However , in the present study an increasing trend was noticed from the 3rd to 9th month of gestation with peak value at the 9th month of pregnancy, which was in close agreement with the findings of Deshpande *et al.* (1998). A gradual significant increase in the serum sodium level in crossbred cows during advancing stages of gestation may be due to an increasing demand of this mineral for the growing fetus. The serum sodium concentration decreased during 1st month of lactation than the advanced month of pregnancy, which was in consonance with an earlier report of Underwood (1981) who concluded that decrease in sodium level was most likely to occur during lactation due to the drainage of sodium in milk. Rowlands *et al*. (1975) and Deshpande *et al*. (1998) observed that serum sodium level was lowered from the day of parturition to the first two months of lactation. Similarly Murtuza *et al*. (1979) also reported that serum sodium levels in early lactating cows were lower than the late pregnant cows.

In the present study, serum potassium level, showed gradual declining tendency from 3rd to 6th month of pregnancy. This observation was in agreement with the observation of Krajnicakova *et al.* (1994), who found that potassium level decreased significantly from the day of insemination in ewes. It was earlier mentioned that serum sodium level was lower than pre-conception values during three to six months of pregnancy and the levels of the potassium and sodium decrease in the first few months of pregnancy might be due to an increased permeation of electrolytes into the uterine environment. Serum potassium level reached the highest value during 9th month of pregnancy, whereas during 1st month of lactation, it declined. These observations were in close agreement of Belyea *et al.* (1975) who concluded that plasma potassium increased in late pregnancy period and then declined during early lactation. The decrease in plasma potassium during early lactation is due to an increased transfer of this cation into milk. Sen *et al*. (1989) observed that the serum potassium levels declined significantly from the day of parturition till 21st day of lactation in crossbred cows.

In the present study, it was recorded that the total red blood cell count fluctuated insignificantly between the different months of pregnancy and reached the lowest value during the 9th month of pregnancy. It was also observed that this insignificant reduction in erythrocyte count was being compensated by an increase in MCV values. In contrast to this observation Prabhakaran *et al*. (1997) reported an increased erythrocyte count, whereas Johnson *et al*. (1990) did not observe any significant difference in erythrocyte count of pregnant and non-pregnant cows. In the present investigation it was also found that the erythrocyte count further decreased during 1st month of lactation and it is in agreement with the report of Gupta *et al*. (1995) who found that total erythrocyte count was slightly lower in the postpartum period which might be due to the continuous lactational stress.

In the present study the haemoglobin content varied to a greater extent between months of pregnancy and reached a lower value during 6th month and the least at 9th month of pregnancy and it continued to decline further during the 1st month of lactation. This observation was closely in consonance with the findings of Stilinovic *et al*. (1992), who reported that Hb content had a tendency to decrease till 75 days after parturition. This observation made in the present study also agree

with the findings of Klinkon and Nemec (1998), who recorded lower values during four days after parturition than at parturition. Lower values for Hb content and erythrocyte count during 1st month of lactation than at 9th month of pregnancy may be due to the continuous stress of lactation.

The decreasing trend of volume of packed red cells (VPRC) as pregnancy advanced was in agreement with the observations of Wang Qung Lan *et al*. (1998), who reported that in dairy cows, VPRC decreased from three months before calving and reached the lowest value on the day before parturition. The declining trend of VPRC during first month of lactation was also in agreement with the findings of Prabhakar *et al*. (1999).

In the present study, the mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were not significantly different when compared to controls. This observation was in full agreement with the findings of Klinkon and Nemec (1998) who reported that the MCV, MCH and MCHC values were not significantly affected by pregnancy. However, insignificant lower values for MCV, MCH and MCHC observed during ninth month of pregnancy and first month of lactation were positively correlated with the erythrocyte count, haemoglobin concentration and VPRC observed during the corresponding period.

Monitoring of electrolytes and red blood cell values would help in the maintenance and improvement of productive health of farm animals through effective management.

REFERENCES

Belyea,R.L , Coppock, C.E and Lake,C. B.(1975). Effects of silage diets on health, reproduction and blood metabolites of dairy cattle. *J. Dairy Sci*. **58**: 1336-1346

Blood, D.C. and Radostits,O.M.(1989) "*Veterinary Medicine. A textbook of disease of cattle, sheep, pigs , goats and horses*". 7th edn. (Asian). ELBS, Great Britain.

Deshpande, S. M, Mantri, A.M, Talvelkar, B.A and Deshmukh ,B.T.(1998). Studies on macroelements during gestation and early postpartum period in

Gupta,G.C, Pachauri, S.P and Rajora, V.S. (1995). Haematological profile in peri-parturient cattle and buffaloes. *Indian J. Anim. Sci.* **65(11)** 1225- 1227

Johnson, S.K , Johnson, A.R, Keefer, C.L. and Silcox, R.W. (1990). Blood constituents during the estrous cycle and early pregnancy in dairy cows. *Theriogenology*. **34(4)**: 701-707

Klinkon, M. and Nemec, M. (1998). Erythrocyte count in Friesian dairy cows at parturient period. *Veterinarske Novice* **24(2)** 47-50.

Krajnicakova, M, Bekeova, E., Maracek, I and Hendrichovsky, V. (1994). Sodium and potassium concentrations and their relationships to ovarian harmones in ewes during oetrus synchronization and pregnancy. *Veterinarni medicina*. **39 (9)** : 541- 550

Murtuza, Md., Pandey, M.D and Rawat, J.S. (1979). Concentration of certain minerals in the serum of Hariyana cattle under various physiological states. *Indian Vet. J*.**56**: 95-99

Oser, B.L. (1976)." *Hawk's physiological chemistry*". Tata McGraw-Hill publishing Co.Ltd., NewDelhi. 1141p

Prabhakar, S, Nanda, A.S and Ghuman, S.P.S. (1999). Sequential changes in some blood indices during peripartal period in buffaloes. *Indian Vet. J.* **76**: 1067- 1070p

Prabhakaran,V, Chithravel, V., Kokilaprabhakaran.S. and Ravindranath, T.K (1997). Haemogram of pregnant Jersey heifers. Indian J. Anim. Hlth. **36(2)** 185-186

Rowlands,G.J., Manston, R., Rita,M. Pocock and Sally,M. Dew. (1975). Relationships between stage of lactation and pregnancy and blood composition in a herd of dairy cows and the influences of seasonal changes in management on these relationships. *J. Dairy Res*. **42**: 349- 362

Singh,M, Nigam,J.M, Mohinder Singh and Sharma, K.B. (1999). Blood plasma biochemical profile of pregnant and non-pregnant yaks in comparison with reported values in cattle. *Indian Vet. J*. **76**: 568-570

Snedecor,G.W and Cochran,W.G. (1994). Statistical methods. 8th edn., Iowa state university press, Ames, Iowa.

Stilinovic,Z, Lovrinov, D and Kronja, M. (1992). Haemoglobin concentrations in the blood of dairy cows during pregnancy and lactation. *Veterinarski Arhiv*. **62(6)**: 363-371

Underwood, E.J. (1981). "*The mineral nutrition of livestock*". Commonwealth agriculture Bureau, London.

Wang Qung Lan, Guo KeJun., Jiao Shuxian., Cheng DeMing and Wan Shaoyue (1998). Changes in the main haemorheological values in dairy cows during the perinatal period. *Chinese J.Vet. sci.* **18(6)** : 574-576