Available online at www.easletters.com

Entomology and Applied Science Letters

ISSN No: 2349-2864

Entomology and Applied Science Letters, 2016, 3, 3:27-33

Determination of metabolic profiles at pre partum and postpartum stages in fresian x bunaji and bunaji cows

Ibe C. C.[1], Uchechukwu N. V. S.[2] and Rekwot P. I.[3]

[1]*Department of Theriogenology and Production, Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria*
[2]*Department of Surgery and Theriogenology, College of Veterinary Medicine, Michael Okpara University, Umudike*
[3]*Ruminant Reproduction Research Unit, National Animal Production Research Institute, Zaria*

ABSTRACT

A study of the metabolic profile reflecting metabolic energy status prior to artificial insemination, during the different trimesters of pregnancy and at postpartum period (PP), in Friesian x Bunaji (FR x BJ) and Bunaji (BJ) cows, placed on the same feeding regimen was conducted. Twenty eight cows comprising of 11 FR x BJ and 17 BJ were observed for normal cyclicity. Only 8 cows (4 FR x BJ and 4 BJ) that showed normal cyclicity were used for the study. They where synchronized using a single intramuscular injection of 25 mg of $PGF_{2\alpha}$ and inseminated using Friesian semen. Blood samples were obtained every morning before feeding during pre–insemination, pregnancy and PP at 30 days interval. The samples obtained were processed for serum and assayed for metabolites and electrolytes. The pre–insemination (control) values (range) for metabolic parameters for both breeds were glucose (GL) (2.17 ± 0.44 – 2.29 ± 0.32 mMol/L), triglyceri des (TRG) (0.61 ± 0.07 – 0.74 ± 0.08 mMol/L), chole sterol (CHL) (4.85 ± 0.77 – 5.15 ± 0.58 mMol/L), urea (UR) (7.41 ± 0.97 – 10.46 ± 2.68 mMol/L), creatinine (C RT) (188.68 ± 15.32 – 135.13 ± 23.05 mMol/L), sodium (Na^+) (152.38 ± 7.43 – 152.75 ± 5.53 mMol/L), potassium (K^+) (4.30 ± 0.29 – 4.31 ± 0.29 mMol/L) chloride (Cl^-) (103.38 ± 5.16 – 106.25 ± 3.69 mMol/L), bicarbona te (HCO_3^{2-}) (17.23 ± 2.72 – 23.00 ± 2.49 mMol/L), total protein (TP) (55.19 ± 5.16 – 59.54 ± 6.05 g/l) and albumin (ALB) (27.69 ± 3.10 – 29.02 ± 5.27 g/l). There was increa se in GL, TRG, CHL, HCO_3^{2-}, Ca^{2+}, TP, and ALB levels in the two breeds, with onset of pregnancy when compared to the control, but CRT, UR, Na^+, K^+, and Cl^- levels decreased with onset of pregnancy. There were no significant differences ($P > 0.05$) in the levels of GL, UR, CHL, Na^+, K^+, HCO_3^{2-}, Ca^{2+}, TP and ALB between the two breeds, throughout the reproductive stages. However, significant differences were obtained in other metabolic parameters between the breeds at different reproductive stages. This research has provided a baseline data on metabolic parameters of FR x BJ and BJ cows prior to insemination, during the different trimesters of pregnancy and at postpartum period, which are considered valuable in future clinical and experimental applications.

Keywords: Bunaji, Fresian x Bunaji, metabolic profile.

INTRODUCTION

Blood metabolites reflect the nutritional status as well as the physiological condition of an animal. Physiological changes occur in cows at the peripartum period. Such changes occur in the metabolism of several tissues and organs, such as the placenta, udder, liver, adipose tissue, muscle tissue and gastrointestinal tract of high-yielding dairy ruminants and other mammals during pregnancy and lactation [1, 2]. The essence of these changes is to distribute the nutrients throughout the maternal body and finally to supply glucose and amino acids to the growing foetus, or acetate, propionate and butyrate to the mammary gland, during its growth and function [1]. Profiles of blood metabolites have been used widely to identify problem herds and to indicate dietary causes of disease or low production. It is important, therefore, to monitor nutritional and physiological status rapidly and precisely, since the cows are prone to peripartum metabolic disorders and reproductive diseases [3, 2].

The transition period (which overlaps the periparturient period) defined as 3 weeks prepartum to 3 weeks postpartum, is critical for a cow's health. It is marked by metabolic, hormonal, and immunological changes that have an impact on the incidence of infectious and metabolic diseases [4]. This affects subsequent performance and productivity. Therefore, the availability of a blood metabolic profile in the Friesian x Bunaji and Bunaji cows during the transition period will help clinicians in drawing inferences of the incidence of metabolic diseases in these breeds.

MATERIALS AND METHODS

Study Location

This study was conducted at the Dairy Research Programme, National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika. Shika is located about 20 km along the Zaria - Sokoto road in Giwa Local Government Area of Kaduna State, Nigeria. It is geographically located between latitude 11^{o} 12'N and longitude 7^{o} 33'E at an altitude of 640 M above sea level [5]. It has three distinct climatic seasons; the cold dry season (November - February), the hot dry season (March - May) and the wet season (June - October) [6]. The total annual rainfall ranges from 617 to 1365 mm with and most of the rains fall between July and September [7]. The mean annual minimum and maximum temperature in Shika are 17.7 ^{o}C and 31.5 ^{o}C, respectively, and the relative humidity is 28.8 % during the cold dry and 67.6 % during the wet season [8].

Experimental Animals and Management

Twenty eight cows of 5 to 6 years of age, comprising of 11 Friesian x Bunaji and 17 Bunaji were observed for normal cyclicity. Only 8 cows (4 Friesian x Bunaji and 4 Bunaji) that showed normal cyclicity were used for the study. They where synchronized using a single intramuscular injection of 25 mg of $PGF_{2\alpha}$ as the dinoprosttromethamine (Lutalyse®, Pharmacia and Upjohn Company LLC, Division of Pfizer Inc. New York). All synchronized cows were inseminated using Friesian semen. The cows were kept in a pen and released every morning into paddocks to graze. The cows grazed on woolly finger grass (*Digitarias mutsii*), signal grass (*Brachiaria decumbens*), gamba grass (*Andropogongayanus*), golden bristle grass (*Setarias phacelata*) and thatch grass (*Hyparrheniarufa*). Grazing was supplemented with whole cotton seed (39.66 %), maize (35.31 %) maize offal (22.02 %), bone meal (2.00 %) and salt (1.00 %) while water was provided *ad libitum*. The animals were preconditioned for two weeks before commencement of the experiment. During this period, they were screened for endoparasites by the analysis of their faecal and blood samples. The animals were clinically healthy before they were utilized for the study. The cows prior to insemination were used as the control to compare the effect of pregnancy at different trimesters, on metabolic profiles (self pairing).

Experimental Sampling

The study was carried out in 3 phases: prior to insemination, during the 3 trimesters of pregnancy and 2 months postpartum. Jugular venous blood samples were collected from dams using 20 ml syringe and 18 Gauge 1½ inch sterile needle. Blood samples were collected at 30 days interval in the last two months prior to insemination, and the mean value was obtained for the control. Thereafter, venous blood samples were collected at 30 days interval during the different trimesters (first, second and third) and during the first 2 months postpartum. The blood samples were used for the analysis of metabolic profile.

Evaluation of Metabolic Profile

Jugular blood samples were obtained early in the morning at 30 days interval. Ten ml of blood was collected from each animal using the 20 ml syringe and 18 G needle. The blood was poured immediately into ice packed serum bottles (MEUS sri PIOVE DI-ITALY) for metabolic profile determination. The blood samples were transferred to the Department of Chemical Pathology of Ahmadu Bello University Teaching Hospital, Shika for analysis.

The serum samples for the determination of blood metabolites were centrifuged at 2343 x g for 10 minutes and the samples obtained were aliquoted into test tubes and analyzed immediately. The samples were analysed for glucose, triglycerides, cholesterol, creatinine, blood urea nitrogen, total protein and albumin using the Express plus analyser (Bayer Diagnostic, Norwood, Massachusetts). Samples for serum calcium were analysed using a calcium analyser (Randox laboratories Ltd. Antrim, UK) which employs the colorimetric method. Sodium and potassium ions were analysed using Corning 410 analyser (Sherwood, UK) which employs the flame photometric method while chloride and bicarbonate ions were analysed using the conventional titrimetric method.

Statistical Analysis

Data was expressed as mean ± SEM (standard error of mean) and presented in tables. The mean values of blood metabolites and electrolytes in the different trimesters of pregnancy and at postpartum were subjected to one-way analysis of variance (ANOVA), followed by Turkey's post hoc test using Statistical Package for Social Science (SPSS) version 21 to determine significant differences. Also, student's t-test was used to compare between Friesian x Bunaji and Bunaji cows the mean values of the corresponding parameters under consideration. Values of $P < 0.05$ were considered significant.

RESULTS AND DISCUSSION

Serum metabolites

The serum metabolite values observed in the Friesian x Bunaji and Bunaji cows at the different reproductive stages are shown in tables 1 and 2. The significant increase in values of serum glucose concentration observed during the third trimester and postpartum periods (when lactation must have set in) in the two breeds agrees with the report by [9] in dairy cows and by [10] in ewes. [11], however, conversely recorded a decrease in plasma glucose concentrations in the first 12-16 days of lactation in dairy cows. Based on their findings, [12] and [13] reported that increased glucose flow to the mammary gland leads to a fall in serum glucose at the onset of lactation, causing a negative energy balance in the lactating dam. This, nonetheless, has been greatly prevented by adequate dry mater intake especially during the third trimester and early lactation [14]. The concentrate feeding employed for animals in the present study was probably adequate to prevent a negative energy balance during pregnancy and lactation, as indicated by their serum glucose level. The significantly lower values of serum glucose concentration in the Friesian x Bunaji than Bunaji cows at postpartum observed in this study indicates that the Friesian x Bunaji is more prone to negative energy balance than the Bunaji cows, as it produces more milk and thus takes up more serum glucose than the Bunaji cows. Thus, there is a need to place the Friesian x Bunaji breeds on more concentrate than the pure Bunaji cows especially during pregnancy and the postpartum period.

The higher mean values of blood glucose level recorded in this study may have provided more co-factors and induced the expression and activity of the enzymes involved in milk fat synthesis [15]. This agrees with the report of [16] and [17] which concluded that increase in milk production during lactation is attributed to increased serum glucose concentration at late pregnancy and postpartum.

The increased serum triglycerides at early lactation in both the Friesian x Bunaji and Bunaji cows observed in the present study has been reported in ewes by [10]. The increase in serum triglyceride concentration during late pregnancy observed in this study is necessary to maintain positive energy balance. This increase is under the influence of growth hormone and insulin, which play direct role in adipose tissue metabolism during pregnancy [18]. According to [19], the diminished responsiveness of adipose tissue to insulin during late pregnancy and the increased responsiveness of adipose tissue to growth hormones during the same period, predispose the ruminant to increased mobilisation of fat deposited during gestation, resulting in increased blood concentration of triglycerides (as is the case in this study), which are used as alternative fuel source for the dam and for milk synthesis.

The decrease in serum cholesterol level at the third trimester and lactation periods in both breeds observed in the present study is similar to the report of [20] but contrary to the report of [10]. A significant decrease in serum cholesterol during late pregnancy and early lactation maybe indicative of an impaired liver [19], as the majority of serum cholesterol is derived from hepatic biosynthesis, and fat accumulation in the hepatocytes at parturition can impair normal liver function in cows [21].

The significant rise in the value of serum urea concentration at postpartum in both breeds agrees with [22] who reported that serum urea level was higher in lactating cows, compared to non-lactating cows. Similarly, reports from [23] showed that serum urea concentration was higher during lactation and the last trimester of pregnancy in sheep. Conversely, Brozostowski *et al*. [24] observed an increase in urea level during early pregnancy, while there was a decrease below the reference levels in late pregnancy. The drop in urea during gestation is probably associated with the use of urea for protein synthesis on the rumino-hepatic pathway as a compensation for the low protein uptake prior to pregnancy [25] while the elevated value at postpartum is consistent with the significant drop in total protein at postpartum as urea level increases during protein catabolism [26].

The significant drop in serum creatinine level at postpartum in both the Friesian x Bunaji and Bunaji has been reported in Holstein x Friesian cows by [20]. The significant drop in serum creatinine level in this study indicates the absence of maternal tissue (muscle) breakdown for milk production as suggested in small ruminants by [28]. This also implies that although the maternal protein supply declined during this period, as indicated by a drop in total protein, the decline was not devastating to induce maternal tissue catabolism as alternative protein source.

Table 1: Mean SEM values of blood metabolites during the reproductive stages in Friesian x Bunaji and Bunaji cows

Reproductive Stages and Level of Metabolites (Mean ± SEM)						
Parameter (mMol/L)	Breed	Prior to insemination	First trimester	Second trimester	Third trimester	Post partum
Glucose	FR x BJ	2.17 ± 0.44	3.10 ± 0.38	2.89 ± 0.32	3.60 ± 0.30 ^{a}	4.91 ± 0.57 ^{b*}
	BJ	2.29 ± 0.32	3.50 ± 0.39	2.83 ± 0.33	3.83 ± 0.49 ^{a}	5.48 ± 0.54 ^{b*}
Triglyceride	FR x BJ	0.74 ± 0.08 ^{a}	0.91 ± 0.06 ^{a,b}	0.93 ± 0.06 ^{a,b}	1.58 ± 0.26 ^{b,c}	1.86 ± 0.32 ^{c*}
	BJ	0.61 ± 0.07 ^{a}	0.93 ± 0.08 ^{a}	1.02 ± 0.06 ^{a}	1.45 ± 0.12 ^{b}	2.69 ± 0.16 ^{c*}
Cholesterol	FR x BJ	5.15 ± 0.58	6.17 ± 0.63 ^{a}	5.29 ± 0.46	4.12 ± 0.46 ^{b}	4.78 ± 0.33
	BJ	4.85 ± 0.77	7.08 ± 0.73 ^{a}	5.92 ± 0.83	3.72 ± 0.34 ^{b}	4.95 ± 0.41
Urea	FR x BJ	10.46 ± 2.68 ^{a}	3.73 ± 0.40	4.63 ± 0.78	4.75 ± 0.51	9.50 ± 5.08
	BJ	7.41 ± 0.97 ^{a}	2.86 ± 0.20 ^{b,c}	4.92 ± 0.64	6.08 ± 0.67 ^{a,,c}	4.13 ± 0.52 ^{b,d}
Creatinine	FR x BJ	188.63 ± 15.32 ^{a}	97.08 ± 12.07 ^{b}	89.50 ± 11.06 ^{c}	90.25 ± 4.63 ^{d*}	77.36 ± 12.95^{e}
	BJ	135.13 ± 23.05 ^{a}	94.00 ± 9.76	96.25 ± 5.78	113.00 ± 9.65 ^{a*}	54. 38 ± 10.13^{b}

Means ±SEM in column for metabolite with asterisks are significantly different (p < 0.05)

[a,b,,c,d,e] *Means ±SEM in rows for each metabolite with different letter superscripts are significantly different (p < 0.05)*

SEM - Standard error of means; FR x BJ - Friesian x Bunaji; BJ – Bunaji

In the Friesian x Bunaji, there was no significant difference (P > 0.05) in the value of total protein across the reproductive stages. Conversely, in the Bunaji cows, the total protein was significantly (P < 0.05) lower at postpartum, compared to the values prior to insemination and during pregnancy.

The difference in value of albumin between the Friesian x Bunaji and Bunaji cows during each reproductive stage was not significant (P > 0.05). The serum albumin concentration at third trimester was significantly (P < 0.05) higher than the value at postpartum in both the Friesian x Bunaji (36.67 ± 7.61 g/l vs 18.50 ± 2.20 g/l) and Bunaji (28.25 ± 4.32 g/l vs 17.25 ± 2.30 g/l) cows.

The drop in serum total protein soon after parturition in both breeds suggests that while maternal protein supply via dry matter intake was adequate for foetal muscle growth during pregnancy, there was more demand for gluconeogenesis and milk protein synthesis to maintain milk production during lactation [29], hence the increased uptake and subsequent drop in value at the peak of lactation. Fox *et al*. [30] suggested that current models underestimate actual gestational protein requirement throughout late gestation. This potential discrepancy would result in depletion of protein reserves to support gestation rather than early lactation.

In the present study, the decreased level of serum albumin in both breeds as pregnancy advanced into the third trimester as well as at postpartum has earlier been reported by [24]. Conversely, [11] recorded that plasma albumin concentrations increased slightly, but significantly, during lactation period in dairy cows. The dairy cows used by [11] were fed with rations of high protein content. It has been established that albumin requirement increases during late pregnancy and lactation as maternal serum protein concentrations decrease with advancement in pregnancy, due to an increased foetal growth, especially the utilization of amino acids from the maternal circulation for protein synthesis in the foetal muscles [31] and for the development of maternal mammary glands [32]. Therefore, there is a need to improve on protein nutrient availability for the dam.

Table 2: Mean ± SEM values of total protein and serum albumins during the reproductive stages in Friesian x Bunaji and Bunaji cows

Reproductive Stages and TP/ALB levels (Mean ± SEM)						
Parameter (g/l)	Breed	Prior to Insemination	First Trimester	Second Trimester	Third Trimester	Postpartum
Total Protein	FR x BJ	59.54 ± 6.05	58.33 ± 5.75	62.42 ± 2.12	56.33 ± 3.70	45.00 ± 4.45
	BJ	55.19 ± 5.16^{a}	58.92 ± 6.06^{a}	63.92 ± 3.69^{a}	56.83 ± 4.20^{a}	34.75 ± 2.74^{b}
Albumins	FR x BJ	29.02 ± 6.48	31.50 ± 4.84	37.00 ± 1.97	36.67 ± 7.61^{a}	18.50 ± 2.20^{b}
	BJ	27.69 ± 3.10	29.00 ± 4.29	35.92 ± 2.50	28.25 ± 4.32^{a}	17.25 ± 2.30^{b}

Means ±SEM of TP/ALB within column of each reproductive stage are not significantly different (P > 0.05)

[a, b] *Means ±SEM in rows with different letter superscripts are significantly different (P < 0.05)*

SEM - Standard error of means; FR x BJ – Friesian x Bunaji; BJ - Bunaji; TP: Total protein; ALB: Albumin

Serum Electrolytes

The mean values of sodium, potassium, chloride, bicarbonate and calcium ions of the Friesian x Bunaji and Bunaji cows are shown (Table 3).

In each of the two breeds, there was a continuous decrease in sodium ion from the period prior to insemination to the second trimester, followed by an increase in the value up to postpartum. The difference in the value of sodium ion of the Friesian x Bunaji and Bunaji cows at each reproductive stage was not significant (P > 0.05). In the Friesian x Bunaji, the value of sodium ion prior to insemination was significantly (P < 0.05) higher than the value during pregnancy, while the difference in the value prior to insemination and the value at postpartum was not significant ($P > 0.05$). In the Bunaji cows, the value of sodium ion prior to insemination was significantly ($P < 0.05$) higher than the value during the stages of pregnancy and at postpartum.

In both the Friesian x Bunaji and Bunaji cows, there was a decrease in the value of potassium ion from the period prior to insemination to the first trimester. Thereafter, there was an increase in the value throughout pregnancy, followed by a decrease in the value at postpartum. The difference in value of potassium ion of the Friesian x Bunaji and Bunaji cows at each reproductive stage was not significant ($P > 0.05$). Comparison across the reproductive stages revealed that there was no significant difference ($P > 0.05$) in the value of potassium ion in the Friesian x Bunaji. However, in the Bunaji cows, the value of potassium ion at postpartum was significantly ($P < 0.05$) lower than the value obtained prior to insemination (2.51 ± 0.24 mMol/L vs 4.31 ± 0.29 mMol/L) and during pregnancy. Also, in the Bunaji cows, the potassium ion at the first trimester was significantly ($P < 0.05$) lower than the value at the third trimester (4.15 ± 0.23 mMol/L vs 5.52 ± 0.47 mMol/L).

The value of chloride ion in the Bunaji cows at the third trimester was significantly ($P < 0.05$) higher than the value in the Friesian x Bunaji (104.92 ± 1.71 mMol/L vs 100.17 ± 1.42 mMol/L). In each of the two breeds, there was no significant ($P > 0.05$) difference in the values of chloride ion across the different reproductive stages.

The result of sodium, potassium and chloride ion concentrations in the Friesian x Bunaji cows in the present study agrees with the findings of [33] who reported that there was no significant difference in the third trimester of pregnancy and postpartum values of serum electrolytes in cattle herds in Zaria. Earlier studies [34] reported a decrease in sodium and potassium ions at parturition in Baladi goats and speculated that the decrease was due to the cations being lost in the colostrum. The present result suggests that the homeostasis of the electrolytes at parturition was maintained in the Friesian x Bunaji despite their increased demand in colostrum production. Similar result was obtained for sodium and chloride ions in the Bunaji cows. The significant decrease in potassium ion postpartum in the Bunaji cows could be due to an increased uptake of the ion for colostrum, relative to the feed intake of the ion.

According to [35], sodium ion concentrations would be assumed to follow urea concentrations with respect to the body recycling nitrogen. The present result is in agreement with the assumption of [35] as the concentrations of both urea and sodium ions decreased with the onset of pregnancy and increased at postpartum in both breeds.

The value of bicarbonate ion in both the Friesian x Bunaji and Bunaji cows increased at the onset of pregnancy. This was followed by a fall in value at the second trimester, with a final postpartum value of 23.50 ± 2.68 mMol/L and 25.13 ± 1.86 mMol/L in the Friesian x Bunaji and Bunaji cows, respectively. There was no significant difference ($P > 0.05$) in the value of bicarbonate ion of the Friesian x Bunaji and Bunaji cows during each reproductive stage. In the Friesian x Bunaji, bicarbonate ion at the first trimester was significantly ($P < 0.05$) higher than the value obtained prior to insemination (25.42 ± 0.92 mMol/L vs 17.23 ± 2.72 mMol/L).

The non-significant difference in mean values of bicarbonate ion prior to insemination and postpartum in the two breeds used in the present study contradicts the result of Ate[36] who reported that the prepartum (third trimester) value of bicarbonate ions was significantly higher than the postpartum value in a settled cattle herd.The findings, however, from the present study might be attributed to the adequacy of bicarbonate salts in the grazing forage of the animals.

In each of the two breeds, there was an increase in the blood calcium level from prior to insemination to the second trimester. Thereafter, there was a drop in the value by the third trimester in both the Friesian x Bunaji and Bunaji cows. The difference in calcium ion of the Friesian x Bunaji and Bunaji cows at each reproductive stage was not significant ($P > 0.05$). Comparison across the reproductive stages revealed that in the Friesian x Bunaji, calcium level in the second trimester was significantly ($P < 0.05$) higher than the value at postpartum (3.40 ± 0.32 mMol/L vs 2.04 ± 0.17 mMol/L). In the Bunaji cows, there was no significant difference ($P > 0.05$) in the blood calcium level across all the reproductive stages.

The significant drop in serum calcium concentration in Friesian x Bunaji at third trimester indicated an increased uptake of calcium for foetal bone growth [37]. The continuous decline of serum calcium at postpartum lactation in the Friesian x Bunaji is an adaptation required to meet the high demand for milk production associated with the breed, relative to the local Bunaji [38], since an especially large loss of calcium to milk occurs during lactation [4]. Thus, as both breeds were exposed to the same dietary level of calcium, more calcium was mobilised for milk synthesis in the high milk producing Friesian x Bunaji.

Table 3: Mean SEM values of serum electrolytes and minerals during the reproductive stages in Friesian x Bunaji and Bunaji cows

Reproductive Stages and Level of Metabolites (Mean ± SEM)						
	Breed	Prior to insemination	First trimester	Second trimester	Third trimester	Post partum
Sodium	FR x BJ	152.38± 7.43^{a}	137.17±1.77^{b}	122.17±4.93^{b}	123.75±2.68^{b}	134.50±2.80
	BJ	152.75 ±5.53^{a}	134.17±1.62^{b}	117.67±5.36^{b}	124.83±2.65^{b}	135.00±2.36^{b}
Potassium	FR x BJ	4.3±0.029	3.85±0.18	4.22±0.25$^{a, b}$	6.64±0.61	3.23±0.33
	BJ	4.31±0.29$^{a, b}$	4.15±0.23^{a}	4.77±0.36	5.52±0.47^{b}	2.51±0.24^{c}
Chloride	FR x BJ	103.38 ± 5.16	101.17±2.26	102.33±2.58	100.17±1.42*	107.13±1.92
	BJ	106 ± 3.69	100.83±2.12	103.58±2.14	104.92±1.71*	107.13±1.04
Bicarbonate	FR x BJ	17.23 ± 2.72^{a}	25.42±0.92^{b}	22.92±1.35	21.10±2.10	23.50±2.68
	BJ	23.00±2.49	24.83±1.59	20.58±1.35	22.33±1.39	25.13±1.86
Calcium	FR x BJ	2.47±0.14	2.83±0.12	3.40±0.11^{a}	2.72±0.30	2.04±0.17^{b}
	BJ	2.38±0.34	3.14±0.26	3.77±0.34	2.98±0.36	3.20±0.76

**Means ±SEM within column for electrolyte with asterisks are significantly different ($p < 0.05$)*

^{a,b,c} Means ±SEM in rows for each electrolyte and mineral with different letter superscripts are significantly different ($p < 0.05$)

SEM - Standard error of means; FR x BJ - Friesian x Bunaji; BJ - Bunaji

CONCLUSION

Serum metabolites (glucose, triglycerides, cholesterol, urea, and creatinine) and electrolytes (sodium, potassium, calcium) of both Friesian x Bunaji and Bunaji cows were modified by pregnancy in varied ways. The significant drop in calcium levels at the third trimester suggested the higher demand for foetal growth and probably enhanced lactogenesis at this stage. Also, the significant drop in cholesterol levels at advanced stage of pregnancy in both breeds may suggest a tendency towards the development of fatty liver.

Total proteins and albumins were also significantly changed during the course of pregnancy and postpartum period. The current findings regarding the metabolic profile prior to insemination, during the different trimesters of pregnancy and at postpartum have expanded the knowledge for the diagnosis and prognosis of reproductive and metabolic diseases in Friesian x Bunaji and Bunaji cows in the study area.

REFERENCES

[1] K.L. Ingvartsen, J.B. Andersen, *Journal of Dairy Science*,**2000**, 83: 1573-1597.
[2] D.C. Piao, T. Wang, J.S. Lee, R.S.A.Vega, S.K. Kang, J.C. Yun, H.G. Lee, *J. AnimSciBiotechnol.* **2015**, 6(1), 9.
[3] E. Balıkcı, A. Yıldız, F. Gürdoğan, *Small Ruminant Research*, **2007**, 67, 247-251.
[4] M.C. Loiselle, C. Ster, B.G. Talbot, X. Zhao, G.F. Wagner, Y.R. Boisclair, P. Lacasse, *Journal of Dairy Science*, **2008**, 92, 1900-1912.
[5] G.N. Akpa, J.O. Ifut, F. Mohammed, *J Anim Prod*, **2002**, 29, 264-270.
[6] F.O. Abeke, A.A. Sekoni, O.O. Oni, I.A. Adeyinka, B.I. Nwagu, *Journal of Tropical Agriculture, Food, Environment and Extension*, **2008**, 7, 223-228.
[7] O.O. Oni, B.Y. Abubakar, S.O. Ogundipe, *Nig J Anim Prod*, 1991,18, 66-69.
[8] P.I. Rekwot, D. Ogwu, E.O. Oyedipe, *AnimReprodSci*, **2000**, 63, 1-11.
[9] R. Djoković, H. Šamanc, J. Bojkovski, N. Fratrić, *LucrariStiinłificeMedicinaVeterinara*, **2010**, 43: 34-40.
[10]M. Karapehlivan, E. Atakisi, O. Atakisi, R. Yucayurt, S.M. Pancarci, *Small Ruminant Research*, **2007**, 73, 267-271.
[11]A. Busato, D. Faissler, U. Küpfer, J. W. Blum, *J Vet Med*,**2002**, 49:455-460.
[12]M.D. Reist, D. Erdin, K. von Euw, H.Tschuemperlin, Y. Leuenberger, M. Chilliard, C. Hammon, C. Morel, Y. Philipona, N.K. Zbinden, J.W. Blum, *Journal of Dairy Science*, **2002**, 85, 3314-3327.
[13]T.R. Overton, M.R.Waldron, *Journal of Dairy Science*, **2004**, 87, 105-119.
[14] National Research Council. Nutrient requirement of dairy cattle, 7th ed., National Academy of Science, Washington, DC, **2001**.
[15] T. Komatsu, F. Itoh, S. Kushibiki, K. Hodate, *Journal of Animal Science*, **2005**, 83, 557-564.
[16]M.M.A.El-Sherif, F. Assad, *Small Ruminant Research*, **2001**, 40, 269-277.
[17] T.R. Regnault, H.V. Oddy, C. Nancarrow, N. Sriskandarajah, R.J. Scaramuzzi, *Reprod Biol Endocrinol*, **2004**, 2, 64.
[18]K.L. Ingvartsen, *Anim Feed Sci Tech*, **2006**, 126: 175-213.
[19] D.E. Grum, J. K. Drackley, J. H. Clark, *Journal of Dairy Science*, **2002**, 85, 3026-3034.
[20] G. Piccione, G. Caola, C. Giannetto, F. Grasso, S. Calanni Runzo, A. Zumbo, P. Pennisi, *Animal Science Papers and Reports*, **2009**, 27, 321-330.
[21] H.M. Dann, N.B. Litherland, J.P. Underwood, M. Bionaz, A. D'Angelo, J.W. McFadden, J.K. Drackley, *Journal of Dairy Science*, **2006**, 89, 3563-3577.

[22] F.H.D. Gonzalez, J.A.R.D. Rocha, *Arq. Faculty Veterinaria da Federal University of Rio Grande doSul*, **1998**, 26, 52-64.
[23] Z. Antunovic, D. Sencic, M. Speranda, B. Liker, *Small Ruminant Research*, **2002**, 45, 39-44.
[24] H. Brozostowski, S. Milewski, A. Wasilewska, Z. Tanski, *Archivum Veterinarium Polonicum*, **1996**, 35, 53-62.
[25] B. Yokus, D.U. Cakir, Z. Kanay, T. Gulten, E. Uysal, *J Vet Med*, 2006, 53, 271-276.
[26] W. Bruce, M. D. Nugent, **2005**, 23: 629-648.
[27] G. Piccione, V. Messina, S. Marafioti, S. Casella, C. Giannetto, C. F. Fazio, *Veterinarija ir Zootechnika*, **2012**, 58, 59-64.
[28] N.Roubies, N. Panouis, A. Fytianou, P.D. Katsoulos, N. Giadinis, H. Karatzias, *J Vet Med*, **2006**, 53, 277-281.
[29] M. Mohri, K. Sharifi, S. Eidi, *Research in Veterinary Science*, **2007**, 83, 30-39.
[30] D.G. Fox, C.J. Sniffen, J.D. O'Connor, J.B. Russell, P.J. Van Soest, *J Anim Sci*, **1992**, 70, 3578-3596.
[31]Jainudeen, M.R. and Hafez, E.S.E. Gestation, prenatal physiology and parturition. *In*: Reproduction in Farm Animals, Lea and Febiger Press, Philadelphia, **1994**, pp 247-283.
[32] Everts, H. Nitrogen intake and metabolism during pregnancy and lactation. *In*: The Lactating Sow, Wageningen University Press, The Netherlands, **1994**, pp. 201-219.
[33] I.U. Ate, Ph.D Thesis. *Ahmadu Bello University*, (Zaria, Nigeria, **2005**).
[34] M.E. Azab, H.A. Abdel-Maksoud, *Small Ruminant Research*, **1999**, 34, 77-85.
[35] Kaneko, J.J, Harvey, J.W. and Bruss, M.L. Clinical Biochemistry of Domestic Animals, 5th ed. Academic Press, San Diego, California, **1997**, pp 409-471.
[36] I.U. Ate, P.I. Rekwot, A.J. Nok, L.B. Tekdek, *African J Biomed Res*, **2009**, 12 (2), 25 - 30.
[37] F.A. Martz, A.T. Belo, M.F.Weiss, R.L. Belyea, J.P. Goff, *Journal of Dairy Science*, **1990**, 73, 1288-1295.
[38] J.A. Adeneye, *Nig J Anim Prod*, **1989**, 16,8-15.