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Serum electrolyte values of cows during third trimester of pregnancy and early lactation in settled cattle herds in Zaria, Northern Nigeria

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ABSTRACT: Some serum electrolyte values of 170 cows in eight settled cattle herds in Zaria, Northern Nigeria during the third trimester of pregnancy and first two weeks of lactation were determined. The cows were sampled once weekly during the third trimester of pregnancy and early lactation (first two weeks) periods for two consecutive weeks respectively. The total (overall) mean prepartum and postpartum serum electrolyte values did not differ significantly (P>0.05) except for bicarbonate, where its prepartum values were significantly (P<0.01) higher than the postpartum values. Generally, most of the serum electrolyte values were within normal range as reported in the literature while some were slightly but not significantly lower than the lowest values of the range. At the herd level, there were significant differences (p<0.05) between the prepartum and postpartum values of serum sodium, phosphorus and bicarbonate and lack of significant difference (p>0.05) for all other serum electrolytes in some herds while no significant difference (p>0.05) was found between the prepartum and postpartum serum electrolyte values in the other herds. These prepartum and postpartum serum electrolyte values were not associated with obvious clinical disease. These values may therefore represent reference values that are compatible with normal health in indigenous and crossbred cows during the period under study in the area.
Key words: Serum, electrolyte, prepartum, postpartum, cows, Nigeria.

INTRODUCTION

The health and metabolism of farm animals have been assessed by measuring serum biochemical parameters (Friendship and Henry, 1992). In human medicine, clinical biochemical analyses have been used extensively in large-scale health investigations (Hewett, 1974). Measurement of these parameters provide a practical diagnostic tool for evaluating pathological conditions in live animals or for monitoring the health status of animals (Verheyen *et al*., 2007). There is a good correlation between the serological abnormalities of herd blood parameters and the existence of clinical problems within the herds (Blowey, 1992). The fertility of farm animals has also been found to be significantly inversely related to levels of serum biochemical parameters such as serum inorganic phosphorus, serum potassium, serum total protein and serum urea - nitrogen (Hewett, 1974).

The productivity of indigenous cattle is low as a result of poor genetic base of the livestock, poor management practices, harsh environmental conditions, nutritional inadequacies, and diseases (Agyemang *et al*., 1991). In order to improve the productivity of indigenous cattle, crossbreeding programmes have been embarked upon, and of course there have been

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changing feeding and management practices. The crossbred cows may have different serum electrolyte profile from indigenous ones, and changed management and feeding practices are known to affect serum biochemical parameters (Verheyen *et al*., 2007). Increased productivity of animals especially the dairy cattle have been reported to be associated with increased production diseases and fertility problems (Hewett, 1974). This fertility problem has been found to be significantly inversely related to serum electrolytes such as serum inorganic phosphorus, serum potassium, serum total protein and serum urea - nitrogen (Hewett, 1974).

Measuring serum electrolyte levels of animals therefore, can provide an indication of fertility disorders in indigenous and crossbred cattle in Nigeria. Although several reports exist on serum electrolytes of cattle especially cows during pregnancy and lactation in the literature (Golden and Allcroft, 1932; Peters and Van Slyke, 1932; Wilson and Hart, 1932; Allcroft and Golden, 1934; Wadaran *et al*., 1939; Hibbs, 1950; Blosser *et al*., 1951; Blum *et al*., 1974; Belyea *et al*., 1975; Wilson *et al*., 1977; Lumsden *et al*., 1980; McAdam and O'dell, 1982), most of these reports are rather old. There is scarce data on serum biochemical parameters including electrolytes of indigenous cattle in Nigeria (Oduye and Fasanmi, 1971; Akerejola *et al.*, 1980; Gbodi *et al.*, 1989). Morever, the serum electrolyte profile of the crossbred animals may be different from those of the indigenous cattle as several factors such as herd, age, stage of lactation, feeding, season, gestation and sampling method (Hewett, 1974), and season ((Akerejola *et al.*, 1980; Gbodi *et al.*, 1989) and diet (Wilson *et al*., 1972), stage of gestation and lactation (Tewes *et al*., 1979; Reese *et al*., 1984; Verheyen *et al*., 2007), breed (Groth *et al*., 1986), disease (Odink *et al*., 1990), presence of haemolysis (Dorner *et al*., 1983) and parity (Verheyen *et al*., 2007) do influence blood parameters. Furthermore, the serum electrolyte levels of cows during the different stages of their reproductive life such as late pregnancy and early lactation period have not been investigated thoroughly in Nigeria. These stages of the reproductive life especially in high producing animals have been associated with occurrence of metabolic diseases (Hewett, 1974). Establishing normal reference values for serum electrolytes in indigenous and crossbred cows therefore will present a good diagnostic tool for metabolic diseases.

This research was therefore carried out to determine the normal serum electrolyte values of apparently healthy indigenous and crossbred cows during the third trimester of pregnancy as well as in the first week of lactation. It was also carried out to detect serum electrolyte values in cows that may be associated with clinical disease during these periods.

MATERIALS AND METHODS

Description of study location: This work was carried out in Zaria, Northern Nigeria, from January 2001 to February 2005. Zaria is located at latitude 11^{o} 08'', at an altitude of 686 metres above sea level, and lies within the Guinea savanna zone; and has three distinct seasons including harmattan (November to February), hot (March to May) and rainy (June to October) (Ayo *et al.,* 1998).

Description of study herds and animals: The study involved eight (8) settled cattle herds in Zaria and its environs (within the radius of 50 kilometers). The herds were selected based on the owners' consent and willingness to participate in the study. The herd size, structure and management practices were studied in detail using the combination of a designed questionnaire and interview with the owners as well as physical observations. The herd sizes ranged from 14 to 315 (average 79). The herds consisted of cows, heifers, mature bulls, young bulls and calves, all herded together except in herd I where the calves were separated from their dams and housed in calf pens. Herds III, V, VII and VIII had Bunaji breed; I, and IV and VI, had Bunaji and Bunaji x Friesian breeds; and II had Bunaji and N'dama breeds. In herd I, the cows were subdivided into pregnant and open (dry or non pregnant) herds and kept separately. In addition, sheep and goats were also kept in herds II and IV; only goats in herd VI, and only sheep in herd VII.

One hundred and seventy (170) adult female cattle (cows and heifers) in their third trimester of pregnancy were used for the study. They were identified by rectal palpation and/or breeding records; and adequately identified by ear tags or as identified by the owner. Pregnant females joined the study only when their pregnancy entered the third trimester. Postpartum cows in the respective herds without reproductive disorders constituted the control group.

Herd management practices: The management practices used for the study herds are summarized as follow: herds I, and II were institutional herds (herds belonging to Ahmadu Bello University, Zaria) while the rest were private herds. The cows in all the herds were grazed on pasture during the rainy season but the cows in herds I and II were also provided with liberal concentrate supplementation; Herds I, III, and IV were dairy/beef herds while II, V, VI and VII were beef, and herd VIII, beef/feedlot. Housing were essentially open sheds for all herds except for herds I and IV, where in addition, calf pens were available for calves. Only herd I had regular sanitation of housing and the rest were occasionally cleaned. Breeding was by natural means except for herd I where AI was practised. Cows in herds I, III, and IV were hand - milked while those in the rest of the herds were not milked. Herds I and II had adequate restraint facilities and record keeping while the others either had fairly adequate (III, V) or none at all (IV, VI, VII, and VIII).

Experimental design: The selected herds were visited from January 2001 to February 2005. One blood sample (25 ml) was collected from each prepartum animal via jugular vein using 18G needle mounted on a 20 ml syringe, usually between 8.00 and 11.00 hours once per week for two consecutive weeks. Out of this, 5 ml were put in a tube containing EDTA (1 mg of anticoagulant/1ml of blood) for parasitic studies while the other two parts of 10 ml each were dispensed into two separate test tubes without anticoagulants for processing for serum with centrifugation at 1875g for 10 minutes, and the serum stored at – 20^{o}C until used. Similarly, blood was collected from postpartum cows in their first and second weeks of lactation and processed as described above. A minimum of four blood samples were collected from each animal (two prior to and two following parturition). All the prepartum samples from each animal were subsequently pooled together as were the postpartum samples to get the prepartum and postpartum mean values of the electrolyte.

Serum electrolyte analyses

Calcium, phosphorus, sodium and potassium levels were determined by flame photometry method (Corning 400R; S/400/3888 Essex UK) (Chessbourough, 1991). Serum chloride was determined by mercuric nitrate titrametric method of Schales and Schales, (1941). The determination of serum urea was by diacetylmonoxime method of Natelson and March using thiomicarbarbazide (Chessbourough, 1991). Bicarbonate was determined using titrametric method (Chessbourough, 1991).

Data analyses: The t - test was used to compare the overall and herd prepartum and postpartum serum electrolyte means to test for statistical significant difference at 5% level of significance.

RESULTS

Total and herd serum electrolyte values in cows during third trimester of pregnancy and early lactation

The mean total prepartum (p1) and postpartum (p2) serum electrolyte values (calcium, phosphorus, sodium, chloride, potassium, bicarbonate and urea) of cows are shown in Table 1. No significant differences (p>0.05) were found between the prepartum and postpartum serum electrolyte values, except for the concentrations of bicarbonates where the prepartum value was significantly (P<0.01) higher than the postpartum values.

Table 1: Mean total serum electrolyte values of third trimester - pregnant and postpartum cows in settled cattle herds in Zaria

Parameter	Status	Mean (±S.D) electrolyte value n=176 (in mmol/l)
Calcium	p1	2.16±0.33[a]
	p2	2.15±0.22[a]
Phosphorus	p1	1.14±3.00[a]
	p2	1.19±0.29[a]
Sodium	p1	130.43±25.69[a]
	p2	135.63±8.99[a]
Chloride	p1	91.39±10.95[a]
	p2	93.15±7.0[a]
Potassium	p1	4.00±1.12[a]
	p2	4.02±0.74[a]
Bicarbonate	p1	28.07±3.31[a]
	p2	26.85±1.42[b]
Urea	p1	2.77±0.18[a]
	p2	2.63±1.47[a]

a, b superscripts where similar means for p1 and p2indicates no statistical difference (p>0.05) and where different indicates statistical difference (p<0.05). T – test of analysis. n – Total number of animals. ±S.D – standard deviation

Table 2: Mean herd serum prepartum and postpartum parameters of cows in settled cattle herds in Zaria

Parameter	Status	Mean (± standard deviation) /Herd values (mmol/l)							
		I n= 81	II n= 41	III n= 14	IV n= 8	V n= 5	VI n= 8	VII n= 5	VIII n= 8
Calcium	P1	2.10±0.24 [a]	2.18±0.19 [a]	2.18±0.19 [a]	1.80±01.04 [a]	1.16±0.31 [a]	2.21±2.72 [a]	2.25±0.21 [a]	2.21±0.21 [a]
	P2	2.1 [a] 1±0.22 [a]	2.12±0.26 [a]	2.12±0.17 [a]	2.39±0.26 [a]	1.19±0.21 [a]	2.25±2.77 [a]	2. 21±0.81 [a]	2.11±0.19 [a]
Phosphorus	P1	1.15±0.21 [a]	1.30±0.34 [a]	1.07±0.15 [a]	0.83±0.64 [a]	2.08±0.32 [a]	1.30±0.27 [a]	1.13±0.22 [a]	1.00±0.12 [a]
	P2	1.26±0.26 [a]	1.23±0.36 [a]	1.03±0.18 [a]	1.07±0.23 [a]	2.19±0.13 [a]	1.30±0.26 [a]	1.23±0.26 [a]	1.16±0.34 [a]
Chloride	P1	135.46±4.03 [a]	109.73±48.00 [a]	134.58±5.29 [a]	134.40±4.33 [a]	142.60±9.93 [a]	125.65±2.45 [a]	134.09±12.06 [a]	138.66±10.85 [a]
	P2	137.07±10.64 [a]	135.53±6.89 [a]	132.86±10.46 [a]	138.33±13.82 [a]	136.33±7.47 [a]	125.66±2.51 [a]	142.00±14.49 [a]	135.60±2.96 [a]
Sodium	P1	96.73±1.33 [a]	88.73±17.38 [a]	94.08±3.82 [a]	90.00±4.00 [a]	98.00±6.46 [a]	87.88±5.99 [a]	85.14±10.22 [a]	93.16±8.35 [a]
	P2	98.07±7.88 [b]	92.17±5.54	91.73±9.73 [a]	90.00±10.33 [a]	97.00±7.36 [a]	88.66±6.11 [a]	88.00±5.88 [a]	94.60±3.43 [a]
Potassium	P1	4.12±0.61 [a]	3.12±1.40 [a]	3.93±0.71 [a]	3.70±0.27 [a]	5.54±1.17 [a]	3.84±0.95 [a]	4.05±0.62 [a]	4.10±0.83 [a]
	P2	3.74±0.78 [b]	4.10±0.70 [a]	3.74±0.65 [a]	4.01±0.70 [a]	4.20±0.78 [a]	3.86±0.98 [a]	4.14±1.11 [a]	4.42±0.72 [a]
Bicarbonate	P1	29.53±2.03 [a]	29.68±4.84 [a]	26.41±1.44 [a]	25.60±1.14 [a]	27.80±0.63 [a]	25.01±0.90 [a]	27.42±3.77 [a]	27.50±0.83 [a]
	P2	27.46±1.76 [a]	27.25±1.29 [b]	26.53±1.30 [a]	26.83±1.47 [a]	25.83±1.26 [a]	25.00±1.00 [a]	26.80±1.09 [a]	26.80±0.44 [a]
Urea	P1	3.56±1.61 [a]	3.60±1.42 [a]	1.91±1.08 [a]	0.80±0.44 [a]	3.35±1.13 [a]	2.99±4.29 [a]	2.19±2.11 [a]	2.58±1.59 [a]
	P2	3.11±1.21 [a]	3.07±1.07 [a]	1.33±0.88 [a]	2.00±1.14 [a]	2.45±1.28 [a]	3.00±4.33 [a]	2.60±2.16 [a]	2.90±0.96 [a]

a, b superscripts for p1, p2 for each parameter in each herd where different indicates significant difference ($p<0.05$) and where similar indicates no significant difference ($p>0.05$). – Prepartum values were lost.

At the herd level (Table 2), the values of serum sodium and potassium of postpartum cows were significantly ($P<0.05$) higher than the prepartum values respectively in herd II, while the values of serum bicarbonate of prepartum cows were significantly (($P<0.01$) higher than postpartum values in herds II and V respectively. The values of other serum electrolytes of prepartum and postpartum cows in the herds did not differ significantly ($p>0.05$).

DISCUSSION

The mean total concentrations of serum electrolyte parameters of cows in their third trimester of pregnancy and during the first week of lactation obtained in this study were from apparently healthy cows in settled cattle herds. These values were generally within the normal range reported for indigenous cattle in Nigeria (Wosu, 2002) except for chloride and phosphorus whose mean values were slightly below the lowest values of the range. This study showed a general lack of significant differences in the mean serum electrolyte values of third trimester pregnant and early lactating cows except for bicarbonates. This result agrees with the results of other workers (Sellers and Roepke, 1951; Belyea *et al*., 1975) for serum inorganic phosphorus, sodium and chloride that these electrolyte values remain fairly constant, but in contrast with others (Golden and Allcroft, 1932; Wilson and Hart, 1932; Allcroft and Golden, 1934; Wadaran *et al*., 1939; Hibbs, 1950; Blum *et al*., 1974; Belyea *et al*., 1975; Wilson *et al*., 1977) who reported differences for prepartum and postpartum calcium, magnesium and potassium levels respectively. Serum calcium has been reported to show a tendency to decrease shortly after calving (Golden and Allcroft, 1932; Wilson and Hart, 1932; Allcroft and Golden, 1934; Wadaran *et al*., 1939; Hibbs, 1950; Blum *et al*., 1974; Belyea *et al*., 1975; Wilson *et al*., 1977) while plasma potassium levels increase in late prepartum and decrease in early postpartum (Belyea *et al*., 1975). Although there was a significant difference in the prepartum and postpartum bicarbonate concentrations, both values were within the limited range (24 – 28 meq/l) maintained by bicarbonates during pregnancy and lactation (MacAdam and O'dell, 1982). The significance of the increased value of bicarbonate postpartum is not very obvious

At the herd level, the means of most of the serum electrolyte parameters of prepartum and postpartum cows in most of the herds also fell within the range reported (Wosu, 2002) and did not differ significantly. There was however differences in the prepartum and postpartum levels of some of the electrolytes, thus indicating the role of herd as a factor affecting electrolyte values (Hewett, 1974). The low levels of chloride and phosphorus in herd I and IV could not be attributed to a particular factor. Studies by Peters and Van Slyke (1932) and Blosser *et al*. (1951) did not show herd differences in chloride levels. However, incorrect feeding regime has been reported to be associated with low levels of chloride and phosphorus (Hewett, 1974). The low serum levels of sodium, potassium, chloride, phosphorus and urea in herds II, III, and VI may be associated with the occasional supply of salt licks to the animals in addition to the possibility of inadequate levels of these parameters in the feed. Low blood phosphorus levels are commonly found in grazing cattle (Parker and Blowey, 1976), and therefore dietary supplement may be essential. One calf in herd VIII with the low level of phosphorus suffered a musculoskeletal problem (inability to stand on the legs) which could be attributed to this phosphorus deficiency. The low level of serum urea observed in herd IV where animals were given high concentrates cannot be readily explained.

The serum electrolyte values obtained for cows in this study were not associated with clinical disease. Therefore, these values may represent baseline data considered compatible with normal health during third trimester of pregnancy and early lactation.

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