



## Variation in Mineral Composition of Raw Milk of Cow and Sheep Breeds from Kano and Jigawa States, Nigeria, with Season

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### ABSTRACT

The study evaluates the effects of seasons on mineral compositions of the raw milk of cow and sheep breeds. The study was conducted at Fulani settlements within Kano and Jigawa states, Nigeria. Raw milk samples were analysed for mineral elements using Atomic Absorption Spectrophotometer (AAS) and Flame Emission Spectrophotometer (FES). The results of the present analyses showed that K had the highest concentration, while Mn had the lowest in all the breeds during rainy season (RS) and dry season (DS). K, Na, and Mn were highest in cow breeds for the RS and DS, while Ca, P, Mg and Zn were highest in sheep breeds during the RS and DS. Among the cow breeds Ca, P, Fe, Mn and Cu were highest in the raw milk of Red Bororo cow (RBC) for both RS and DS, K, Na and Zn were highest in the raw milk of White Fulani cow (WFC) during the RS and DS, while Mg was highest in the raw milk of Sokoto Gudali cow (SGC) during the RS and DS. For sheep breeds Ca, Mg and Zn were highest in the raw milk of Uda sheep (US) during the RS and DS, K, P, Na and Mn were highest in the raw milk of (BS) during the RS and DS, while Fe and Cu were highest in the raw milk of (YS) during the RS and DS. Generally K, P, Na and Mn were high in the raw milk of cow breeds during Rainy season (RS), while Ca, Fe, Mg, Zn and Cu were high during RS in the raw milk of sheep breeds. Some of the nutritional elements concentrations were below the Institute of Medicine (IOM) standard requirements for human consumption. There is a need for improvement of the local breeds in the nutritional elements to meet the standard requirements.

**Keywords:** raw milk, breeds, mineral composition

### INTRODUCTION

In Nigeria, milk production from local breeds of cow and sheep represents an important component of the agribusiness sector with great economic, nutritional, and social implications. In Nigeria, cattle is the primary source of milk, providing more than 90% of the total animal domestic milk output (Walshe *et al.*, 1991) with the white Fulani or 'Bunaji' breed recognized as the principal producer, while sheep and goat produced the remaining (Adeneye, 1989). However, poor nutrition (Adegbola, 2002) and low reproductive performance (Olaloku, 1999) have been highlighted as some of the major factors affecting milk production from these indigenous breeds. Milk as a food of outstanding interest is designed by nature to be a complete food for every young mammal (Allan, 1991).

Milk is a food of particular interest, both in terms of its nutritional value and its effect on health. Its high calcium content is the main argument put forward in milk promotion campaigns for maintaining the privileged position of milk in the daily diet (Hozyasz, Słowik 2013). According to Ramesh (2006), the major

components of milk are water (87.40%), milk solid (12.60%), solid-not-fat (9.00%), fat (3.60%), protein (3.40%), milk sugar or lactose (4.90%) and ash or minerals (0.70%). Studies have shown that these nutrients are distributed in milk in appropriate dietary requirements (American Academy of Pediatrics, 1993).

Variations in the contents can be related to animal breeds, season/weather condition during milking locality, stage of lactation, age and size of cow, environmental and dietary composition (Smith *et al.*, 2000) herd management (Frank, 1988) and as a result of human handling, the mineral composition may vary (Zurera-Cusano *et al.*, 1994). Milk contains 20 nutritionally essential minerals grouped into macro- and micro minerals that are involved in several physiological processes. The mineral composition of milk is not constant but varies with milk accumulation, stage of lactation, nutritional status, genetic variance, season, animal species, soil contamination, health status and the milk yield of an individual animal (Gaucheron, 2005; Cashman, 2006; Gallego *et al.*, 2006; van Hulzen *et al.*, 2009). Milk is produced in urban and rural areas mostly in non-organized way

and usually supplied to the consumers in raw form (Ahmed *et al.*, 2004). Milking is usually done in the morning and after the household and calf requirements are met, the excess are taken to the traditional market as fresh or sour milk, cheese, ghee and butter for human consumption. Milk processing is significantly affected by the proportion of milk components. It has been shown that the quality of milk intended for consumption and processing varies subject to cattle and sheep breeds (Barlowska *et al.*, 2011). Nevertheless, the chemical composition of milk, including the content of macro- and microelements, is not constant. It depends on a variety of environmental, genetic, seasons and physiological factors (Danków, Pikul 2011). Hence there is a need to assess the local breeds of dairy cow and sheep breeds during wet and dry seasons in Nigeria to ascertain the best nutritionally enriched milk. This study therefore assessed the effects of season on nutritional elements composition of raw milk from traditionally managed local cow and sheep breeds raised among Fulani herdsman within Kano and Jigawa States, Nigeria.

## MATERIALS AND METHODS

### Herd Management:

All the cow and sheep breeds used for this study were owned by pastoralists of the same herd and were reared semi intensively in a temporary settlement in the study area. The animals are herded to the fields in the morning after milking to graze natural forages and crop residues. They are returned in the evening and kept during the night in the open field, near the homestead. Supplementary food was uncommon. Routine grazing was carried out twice daily (morning and evening) they were fed on natural pasture comprising mainly guinea grass and other forages. The animals were between the ages of 3-4 years.

## RESULTS AND DISCUSSIONS

**Table 1 Elemental composition of raw milk of cow breeds during RS and DS (mg/L).**

	RBC		SGC		WFC	
	RS	DS	RS	DS	RS	DS
Ca	416.94±5.80 <sup>a</sup>	361.77±2.51 <sup>b</sup>	368.56±4.60 <sup>a</sup>	338.45±1.24 <sup>b</sup>	398.57±3.78 <sup>a</sup>	350.87±1.23 <sup>b</sup>
K	1040.8±4.92 <sup>a</sup>	901.20±4.99 <sup>b</sup>	910.04±9.58 <sup>a</sup>	867.24±4.80 <sup>b</sup>	1180.5±5.66 <sup>a</sup>	1050.9±8.66 <sup>b</sup>
P	592.87±5.97 <sup>a</sup>	567.45±8.33 <sup>b</sup>	388.12±5.23 <sup>a</sup>	350.11±5.81 <sup>b</sup>	437.05±5.62 <sup>a</sup>	409.23±5.50 <sup>b</sup>
Na	350.60±4.06 <sup>a</sup>	317.23±4.37 <sup>b</sup>	410.57±6.17 <sup>a</sup>	380.11±8.78 <sup>b</sup>	545.09±5.34 <sup>a</sup>	402.17±4.87 <sup>b</sup>
Fe	8.26±0.05 <sup>a</sup>	7.28±0.10 <sup>a</sup>	7.09±0.05 <sup>a</sup>	6.12±0.06 <sup>a</sup>	7.29±0.02 <sup>a</sup>	6.79±0.05 <sup>a</sup>
Mg	80.57±0.22 <sup>a</sup>	78.34±0.35 <sup>b</sup>	90.64±0.50 <sup>a</sup>	80.11±0.11 <sup>b</sup>	94.47±0.54 <sup>a</sup>	80.22±0.47 <sup>b</sup>
Mn	0.07±0.01 <sup>a</sup>	0.06±0.01 <sup>a</sup>	0.06±0.01 <sup>a</sup>	0.04±0.01 <sup>a</sup>	0.05±0.01 <sup>a</sup>	0.03±0.01 <sup>a</sup>
Zn	21.20±0.55 <sup>a</sup>	18.23±0.53 <sup>b</sup>	29.57±0.33 <sup>a</sup>	24.24±0.54 <sup>b</sup>	33.89±0.29 <sup>a</sup>	27.01±0.81 <sup>b</sup>
Cu	0.26±0.02 <sup>a</sup>	0.18±0.02 <sup>a</sup>	0.18±0.03 <sup>a</sup>	0.15±0.02 <sup>a</sup>	0.21±0.04 <sup>a</sup>	0.11±0.03 <sup>a</sup>
Ca/P	0.70±0.04 <sup>a</sup>	0.64±0.05 <sup>a</sup>	0.95±0.07 <sup>a</sup>	0.97±0.08 <sup>a</sup>	0.91±0.10 <sup>a</sup>	0.86±0.11 <sup>a</sup>
Na/K	0.37±0.02 <sup>a</sup>	0.35±0.03 <sup>a</sup>	0.45±0.04 <sup>a</sup>	0.44±0.03 <sup>a</sup>	0.46±0.03 <sup>a</sup>	0.38±0.02 <sup>a</sup>

RBC = Red Bororo cow, SGC = Sokoto Gudali cow, WFC = White Fulani cow. RS = Rainy season, DS = Dry season. Mean±S.D with different alphabet superscripts letter are significantly different at ( $P < 0.05$ ) between season

### Collection of milk samples and Analysis

Conventional hand-milking was done by the Fulani herdsman on the farm between 06.00hrs and 07.30hrs on a daily basis. Raw milk samples (100cm<sup>3</sup>) were collected from five lactating cow and sheep breeds. Samples were collected by 07.30am before morning grazing. Representative samples of milk obtained from each breeds were bulked separated and collected into clean, white plastic container of 120cm<sup>3</sup> capacities. Routine veterinary care relating to the diseases, injuries, and treatment of farm and domestic animals was given to each cow and sheep, and their nipples were also sterilized with cotton diluted with ethanol prior to milking. The samples were then transported to the laboratory in an ice filled box for analysis.

### Mineral concentrations

The mineral concentrations were determined using Atomic Absorption Spectrophotometer (Kemtech Analytical Alpha-4 model) for Ca, Fe, Mg, Mn, Zn and Cu, while Flame emission spectrophotometer (Kemtech Analytical Alpha-4 model) was used to determine Na and K using appropriate instrumental conditions for each element. P was determined using UV-Visible spectrophotometer (UNICAM UV 1 model) at 450nm.

### Statistical Analysis

Values presented were the means and standard deviations for three replicates. Statistical analysis was carried out by student t-test using SPSS Version 11.0 software package (SPSS Inc., Chicago Illinois, USA) significant difference was defined at  $P < 0.05$  using Duncan's multiple range tests.

**Table 2 Elemental composition of raw milk of sheep breeds during RS and DS (mg/L)**

	BS		US		YS	
	RS	DS	RS	DS	RS	DS
Ca	434.68±2.89 <sup>a</sup>	406.87±4.02 <sup>b</sup>	466.45±3.05 <sup>a</sup>	425.09±4.11 <sup>b</sup>	398.54±0.98 <sup>a</sup>	330.11±0.97 <sup>b</sup>
K	945.01±5.23 <sup>a</sup>	824.41±6.10 <sup>b</sup>	670.50±1.99 <sup>a</sup>	637.91±5.42 <sup>b</sup>	709.04±6.50 <sup>a</sup>	666.74±4.54 <sup>b</sup>
P	592.00±5.90 <sup>a</sup>	409.08±6.03 <sup>b</sup>	469.00±4.20 <sup>a</sup>	427.08±5.29 <sup>b</sup>	354.00±6.11 <sup>a</sup>	320.45±6.79 <sup>b</sup>
Na	400.00±4.72 <sup>a</sup>	389.98±4.39 <sup>a</sup>	360.01±3.69 <sup>a</sup>	310.07±6.45 <sup>b</sup>	300.00±8.67 <sup>a</sup>	260.34±6.44 <sup>b</sup>
Fe	7.80±0.10 <sup>a</sup>	7.18±0.05 <sup>a</sup>	8.46±0.05 <sup>a</sup>	8.09±0.06 <sup>a</sup>	9.28±0.03 <sup>a</sup>	8.34±0.06 <sup>a</sup>
Mg	94.66±0.05 <sup>a</sup>	82.98±0.70 <sup>b</sup>	106.77±0.28 <sup>a</sup>	97.98±0.24 <sup>b</sup>	89.64±0.22 <sup>a</sup>	80.09±0.53 <sup>b</sup>
Mn	0.05±0.01 <sup>a</sup>	0.04±0.01 <sup>a</sup>	0.03±0.01 <sup>a</sup>	0.02±0.01 <sup>a</sup>	0.04±0.01 <sup>a</sup>	0.03±0.01 <sup>a</sup>
Zn	63.27±0.05 <sup>a</sup>	46.08±0.05 <sup>b</sup>	75.11±0.06 <sup>a</sup>	63.98±0.05 <sup>b</sup>	54.27±0.05 <sup>a</sup>	43.69±0.06 <sup>b</sup>
Cu	0.23±0.03 <sup>a</sup>	0.16±0.04 <sup>a</sup>	0.34±0.03 <sup>a</sup>	0.26±0.03 <sup>a</sup>	0.46±0.03 <sup>a</sup>	0.34±0.03 <sup>b</sup>
Ca/P	0.92±0.09 <sup>a</sup>	1.00±0.05 <sup>a</sup>	1.00±0.11 <sup>a</sup>	1.00±0.13 <sup>a</sup>	1.13±0.14 <sup>a</sup>	1.03±0.06 <sup>a</sup>
Na/K	0.42±0.05 <sup>a</sup>	0.47±0.06 <sup>a</sup>	0.54±0.07 <sup>a</sup>	0.49±0.07 <sup>a</sup>	0.42±0.05 <sup>a</sup>	0.39±0.04 <sup>a</sup>

BS = Balami sheep, US = Uda sheep, YS = Yankasa sheep, RS = Rainy season, DS= Dry season.

Mean±S.D with different alphabet superscripts letter are significantly different at ( $P < 0.05$ ) between season

Variation in the raw milk elemental composition of cow and sheep during rainy (RS) and dry (DS) seasons is shown in Table 1 – 2. The present study showed season affected elemental composition of the raw milk in all the breeds. Ca, K, P, Na, Mg and Zn were affected by season at ( $P < 0.05$ ), while Fe, Mn and Cu were not affected by season ( $P < 0.05$ ) in all the breeds of the cow and sheep. K, P, Na and Mn were higher in the raw milk of cow breeds during RS, while Ca, Fe, Mg, Zn and Cu were higher during RS in the raw milk of sheep breeds. Studies by other authors confirm this observation, having detected more magnesium and zinc in sheep milk than in cow milk (Belewu, Aiyegbusi 2002, Soliman 2005, Park *et al.*, 2007, Ceballos *et al.*, 2009, and Zamberlin *et al.*, 2012). Among the cow breeds, raw milk from RBC contains higher concentration of Ca, P, Fe, Mn and Cu during RS compared to DS, while raw milk from WFC contains higher concentration of K, Na, Mg and Zn during RS compared to DS. However, sheep breeds raw milk from BS contains higher K, P, Na and Mn during RS, raw milk from US contains higher Ca, Mg and Zn during RS, while raw milk from YS contains higher Fe and Cu during RS. The difference in milk mineral concentrations between RS and DS is due to a "dilution effect" as reported by Guler (2007), which is related to animal feeding behaviour and changes in pasture composition. Considering the medicinal value, it is known that calcium is responsible for many regulatory functions such as normal cardiac rhythm maintenance, blood clotting, hormone secretion, muscle contraction and enzyme activation (El-Hamdani *et al.*, 2016).

The highest Ca concentration among cow breeds was observed during RS (416.94±5.80mg/L, 368.56±4.60mg/L and 398.57±3.78mg/L) and lowest concentration was observed during DS (361.77±2.51mg/L, 338.45±1.24mg/L and 350.87±1.23mg/L) for the raw milk of RBC, SGC

and WFC. The range of Ca (361.77 – 416.94mg/L) for the raw milk of cow breeds during DS and RS were lower than (1136 – 1153mg/L) reported by Nantapo *et al.*, (2013) for milk of cow breeds during dry and wet seasons. However, sheep breeds raw milk Ca concentration were (434.68±2.89mg/L, 466.45±3.05mg/L and 398.54±2.98mg/L) and (406.87±4.02mg/L, 425.09±4.11mg/L and 330.11±2.97mg/L) for the raw milk of BS, US and YS during RS and DS respectively. Farzad *et al.*, (2016) reported (821.57 – 1016.24mg/L) for sheep milk during dry and wet season which is higher than the current report. The highest Ca concentration across the breeds was recorded during RS (466.45±3.05mg/L) in the raw milk of US sheep breed, while the lowest concentration was recorded during DS (338.45±1.24mg/L) in the raw milk of SGC cow breed. The daily required intake of Ca according to the Institute of Medicine (IOM, 2004) is 700 mg/L for 1 – 3years and 1200 mg/L for adults. The concentration of Ca in the raw milk of cow and sheep does not meet the required daily intake for both children and adults for the RS and DS.

The results pertaining to K concentration of the raw milk of cow and sheep showed significant ( $P < 0.05$ ) variation between seasons. The highest K concentration in the raw milk of cow breeds was recorded during RS as (1040.80±4.92mg/L, 910.04±4.58mg/L and 1180.50±5.66mg/L) while the lowest concentration was recorded during DS as (901.20±4.99mg/L, 867.24±4.80mg/L and 1050.90±8.66mg/L) for the raw milk of RBC, SGC and WFC. Nantapo *et al.*, (2013) reported no significant difference among milk of cow breeds, with the range of (1467.00 – 1501.00mg/L) for dry and wet seasons which is higher than the values of the present report. Similarly, raw milk of BS, US and YS recorded higher K concentration during RS (945.01±5.23mg/L, 670.50±1.99mg/L and

709.04±6.50mg/L) while lowest concentration was recorded during DS (824.41±6.10mg/L, 637.91±5.42mg/L and 666.74±4.54mg/L). Similar to the present report is that of Farzad *et al.*, (2016), who reported higher K concentration during wet season than dry season in sheep milk with values ranging from (1253.08 – 1614.35mg/L) higher than the present report. The highest K concentration across the breeds was recorded during RS (1180.50±5.66mg/L) in the raw milk of WFC cow breed, while the lowest concentration was recorded during DS (666.74±4.54mg/L) in the raw milk of YS sheep breed. According to Institute of Medicine (IOM, 2004), the adequate daily required intake of K is 700 mg/L for 1 – 3years and 500 mg/L for adults, the levels of K concentration in the raw milk samples for cow and sheep breeds are higher than the required daily intake for children and adults, except for the raw milk of US which is close to the daily required intake for children but higher than that of the adults.

Phosphorus is a major element with many important biological functions in the human body. P concentrations for cow and sheep breeds showed significant ( $P < 0.05$ ) difference among the season (Table 1 – 2). Higher P concentration in the raw milk of RBC, SGC and WFC was obtained during RS with the following concentrations (592.87±5.97mg/L, 388.12±5.23mg/L and 437.05±9.62mg/L), while lower concentration was recorded during DS (567.45±8.33mg/L, 350.11±5.81mg/L and 409.23±5.50mg/L). The concentration of P in the present study is lower than (903.00 – 986.00mg/L) for cow milk during wet and dry seasons reported by Nantapo *et al.*, (2013). Also raw milk of BS, US and YS had higher P during RS (492.00±5.90mg/L, 469.00±4.20mg/L and 354.00±3.11mg/L), while lower concentrations were recorded during DS and the values were (409.08±6.03mg/L, 427.08±5.29mg/L and 320.45±6.79mg/L). The results of the present study is higher than (219.15 – 298.52mg/L) of sheep milk for dry and wet season reported by Farzad *et al.*, (2016). The highest P concentration across the breeds was recorded during RS (592.87±5.97mg/L) in the raw milk of RBC cow breed, while the lowest concentration was recorded during DS (320.45±6.79mg/L) in the raw milk of YS sheep breed. According to Institute of Medicine, (IOM 2004), the daily required intake of P is 460 mg/L for 1 – 3years and 1250 mg/L for adults. P concentration in the raw milk of cow and sheep breeds is below the daily required intake for both children and adult, except the raw milk of RBC which met the daily required intake, while the raw milk of BS is above the daily required intake for children.

Na concentration for the raw milk of RBC, SGC and WFC were high during RS and the values ranged from (350.60 – 545.09mg/L), while DS had lowest concentrations and ranged from (317.23 – 402.17mg/L). The value of Na in the present study

was higher than (251.00 – 307.00mg/L) for breeds of cow milk reported by Nantapo *et al.*, (2013). The concentration of Na for the raw milk of BS, US and YS during RS ranged from (300.00 – 400.00mg/L), while DS which had lowest concentration ranged from (260.34 – 389.98mg/L) respectively. The highest Na concentration across the breeds was recorded during RS (554.09±5.34mg/L) in the raw milk of WFC cow breed, while the lowest concentration was recorded during DS (260.34±6.44mg/L) in the raw milk of YS sheep breed.

Magnesium plays an important role in many physiological processes such as metabolism of proteins and nucleic acids, neuromuscular transmission and muscle contraction, bone growth and blood pressure regulation. Magnesium is also a co-factor of many enzymes (Riond *et al.*, 1995). Mg concentrations for the raw milk of cow and sheep breeds showed significant difference ( $P < 0.05$ ) among the season (Table 1 – 2). Higher Mg concentration for the raw milk of RBC, SGC and WFC was obtained during RS with the following concentrations (80.57±0.22mg/L, 90.64±0.50mg/L and 94.47±0.54mg/L), and lower concentrations was recorded during DS (78.34±0.35mg/L, 80.11±0.11mg/L and 80.22±0.47mg/L). Also raw milk of BS, US and YS had higher Mg during RS (94.66±.50mg/L, 106.77±0.28mg/L and 89.64±0.22mg/L), while DS values were (82.98±0.70mg/L, 97.98±0.24mg/L and 80.09±0.53mg/L). The highest Mg concentration across the breeds was recorded during RS (106.77±0.28mg/L) in the raw milk of US sheep breed, while the lowest concentration was recorded during DS (78.34±0.35mg/L) in the raw milk of RBC cow breed.

Zn is essential for physiological processes, lipid metabolism, brain and immune function. Zn deficiency causes a body's sensitivity to various diseases and viral, bacterial and fungal infections. The concentration of Zn in the raw milk of across the breeds of the selected ruminants ranged from (18.23 – 75.11mg/L) with the concentration highest in RS (75.11±0.06mg/L) in US of sheep breeds and lowest in DS (18.23±0.53mg/L) in RBC of cow breeds. The range of Zn concentration for RBC, SGC and WFC was significantly highest ( $P < 0.05$ ) during RS and the values ranged from (21.20 – 33.89mg/L), while DS which had lowest concentration and ranged from (18.23 – 27.01mg/L). Zn level was found to be higher in the RS compared to DS which is in accordance with the findings of Erdogan *et al.*, (2006) in dairy cow. The range of Zn in the raw milk of BS, US and YS during RS was from (54.27 – 75.11mg/L), while DS which had lowest concentrations ranged from (43.69 – 63.98mg/L) respectively. The daily required intake of Zn as recommended by the Institute of Medicine (IOM, 2004) for children 1 – 3 years is 3 mg/L, while for adults is 7 – 13 mg/L. The concentration of Zn in the raw milk of cow and

sheep breeds in the present study is higher than the daily required intake as recommended by the Institute of Medicine (IOM, 2004) for children and adult.

However the concentration of Fe, Mn, and Cu were low in the raw milk of cow and sheep breeds. For Fe the concentration across the breeds ranged from (6.01 – 9.28mg/L) with RS (9.28±0.03mg/L) having highest concentration in the raw milk of YS and DS (6.01±0.04mg/L) had lowest concentration. Mn concentration across the breeds ranged from (0.01 – 0.07mg/L) with RS (0.07±0.01mg/L) having highest concentration in the raw milk of RBC and DS (0.01±0.01mg/L) had lowest concentrations in the raw milk of YS. Similarly Cu concentration across the breeds ranged from (0.11 – 0.46mg/L) with RS (0.46±0.03mg/L) having highest concentration in the raw milk of YS and DS (0.11±0.03mg/L) had lowest concentration in the raw milk of WFC. The mean values of milk Cu and Mn were higher than that reported by Arora *et al.*, (2005) and Zafar *et al.*, (2006) during wet and dry seasons for sheep milk. The concentration of Fe in the raw milk of cow and sheep in the current report met the daily required intake as recommended by the Institute of Medicine (IOM, 2004) for children, but is below that of adult. Mn concentration in the raw milk of cow and sheep breeds is within the estimated safe and adequate Daily Dietary intake, except for the raw milk of RBC which is higher than the recommended level. On the other hand Cu concentration is below the provisional tolerable daily intake (PTDI) in the raw milk of cow and sheep breeds.

Sodium to potassium ratio is necessary to human health. It maintains blood plasma equilibrium with milk, there will be a variation in the concentration of Na, which is offset by variation of K, Na/K ratio can then be used to assess the health of dairy cattle. The range of Na/K across the breeds of cow and sheep was (0.35 – 0.54) which is highest during RS in the raw milk of US sheep breeds and lowest during DS in the raw milk of RBC cow breeds. Similarly Ca/P ration across the breeds ranged from (0.62 – 1.13) which is highest during RS in the raw milk of YS sheep breeds and lowest during DS in the raw milk of SGC cow breeds. The ratios for Na/K and Ca/P are within the Recommended Daily Intake (RDI) of < 1.00 and 1 – 1.3 (NRC, 1998) except for Ca/P in the raw milk of cow breed which is below the RDI.

The seasonal variation in the composition of the milk, as is known, is due to changes in the bio-availability and quality of the pastures throughout the year and to an increase in the proteolytic activity associated to the age of lactation of the animal. Essential minerals are in higher demand for metabolic and physiological activities. Phosphorus, zinc, iron and even calcium are required for enzyme activities. This accounts for the higher concentrations of these elements or

minerals during the RS and or breeding period (Quayam, 1984). Another reason for higher contents of minerals during the RS might be attributed to more nutrients, dietary materials as well as increase in minerals washed into the natural habitats. However, the results contrast the report of Koda *et al.*, (1995) in which essential minerals are said to be homeostatically regulated by species-specific metabolism. Beside the above mentioned factors, a combination of other factors such as size, sex and seasons of the year are other possible reasons for the variability in chemical and mineral composition (Adebisi and Fasakin 1997).

## CONCLUSION

The highest concentration of the nutritional elements of the raw milk was observed during the rainy season when the animals were at pasture. Ca, K, P, Na, Mg and Zn were affected by season ( $P < 0.05$ ), while Fe, Mn and Cu were not affected by season ( $P < 0.05$ ) in all the breeds of cow and sheep. K, P, Na and Mn were highest in the raw milk of cow breeds during RS, while Ca, Fe, Mg, Zn and Cu were highest during RS in sheep breeds. Among the cow breeds, raw milk from RBC contains highest concentration of Ca, P, Fe, Mn and Cu during RS compared to DS, while raw milk from WFC contains highest concentration of K, Na, Mg and Zn during RS compared to DS. However, sheep breeds raw milk from BS contains higher K, P, Na and Mn during RS, raw milk from US contains higher Ca, Mg and Zn during RS, while raw milk from YS contains higher Fe and Cu during RS.

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