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MINERAL COMPOSITION OF THE RAW MILK OF COW AND SHEEP BREEDS FROM KANO AND JIGAWA STATES, NIGERIA

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Abstract

The study evaluates the effects of breeds on the mineral compositions of the raw milk of cow and sheep breeds. The study was conducted at Fulani settlement 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 study showed that K had the highest concentration, while Mn had the lowest in the raw milk of cow and sheep breed. Within the raw milk of the cow breeds Ca, P, Fe, Mn and Cu were highest in the raw milk of Red Bororo cow (RBC), K, Na and Zn were highest in the raw milk of White Fulani cow (WFC), while Mg was highest in the raw milk of Sokoto Gudali cow (SGC). For sheep breeds Ca, Mg and Zn were highest in the raw milk of Uda sheep (US), K, P, Na and Mn were highest in the raw milk of Balami sheep (BS), while Fe and Cu were highest in the raw milk of Yankasa sheep (YS). The results of the mineral concentrations across the breeds of cow and sheep showed that K, Na, and Mn were highest in the raw milk of cow breeds, while Ca, P, Mg and Zn were highest in the raw milk of sheep breeds. Most of the Mineral elements concentrations are below the standard requirements for human consumption. There is a need for improvement of the local breeds in the nutritional elements to meet the standard requirements.

Key words: Raw milk, Cow, Sheep, Breeds, Mineral Composition.

INTRODUCTION

In Nigeria, milk production from local breeds of cattle represents an important component of agric business 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 (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 of cattle. Milk as a food of outstanding interest is designed by nature to be a complete food for every young mammal (Allan, 1991).

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%). 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). 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 (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. It has been shown that the quality of milk intended for consumption and processing varies subject to cattle breed (Poulsen *et al.,* 2012). Hence there is a need to assess the local breeds of dairy cow and sheep in Nigeria to ascertain the best nutritionally enriched milk. This study therefore assessed the nutritional elements composition of raw milk from traditionally managed local cow and sheep breeds raised among Fulani rearers within Kano and Jigawa States, Nigeria.

MATERIALS AND METHODS

Collection of milk samples and Analysis:

Conventional hand-milking was done by the Fulani herdsmen on the farm between 06.00hrs and 07.30hrs on a daily basis. Raw milk samples (100cm^3) 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^3 capacities. 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 represented are 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) Significance difference was defined at $P<0.05$ using Duncan's multiple range tests.

RESULTS AND DISCUSSIONS

The elemental compositions of the raw milk of cow and sheep breeds are depicted in Table 1 – 2 below. The results of the present analysis showed that K had the highest concentration, while Mn had the lowest in all the breeds of cow and sheep. The concentrations of K, Na, and Mn were highest in the raw milk of cow breeds, while Ca, P, Mg and Zn were highest in the raw milk of sheep breeds. The concentrations of Ca, K, P, Na, Mg and Zn were affected ($P < 0.05$) by breeds, while Fe, Mn, Cu, Ca/P and Na/K were not affected ($P < 0.05$) by breeds in the raw milk of cow and sheep breeds.

Table 1 Elemental composition (mg/L) of the raw milk of cow breeds from Kano and Jigawa States

	RBC	SGC	WFC	RDI (Young)	RDI (Adult)
Ca	381.47±4.5^a	354.98±2.0^b	370.98±2.9^a	700	1200
K	1069.9±6.8^a	886.25±5.7^b	1123.1±7.0^c	700	500
P	471.09±6.4^a	366.89±6.0^b	372.78±6.8^b	460	1250
Na	380.22±4.8^a	398.51±7.0^b	428.9±6.54^c		2000
Fe	7.03±0.07^a	6.81±0.05^a	6.96±0.04^a	7	15
Mg	79.21±0.23^a	88.13±2.03^b	86.34±0.52^c	80	360 - 400
Mn	0.07±0.01^a	0.05±0.01^a	0.04±0.01^a	0.02	0.05
Zn	20.21±0.51^a	28.99±0.31^b	30.99±0.43^c	3	7 – 13
Cu	0.23±0.02 ^{a}	0.18±0.02^a	0.20±0.03^a		3
Ca/P	0.81±0.05^a	0.97±0.05^a	1.00±0.09^a	1 – 3	1 – 3
Na/K	0.36±0.02^a	0.45±0.04^a	0.38±0.03^a	< 1.0	< 1.0

RBC = Red Bororo cow, SGC = Sokoto Gudali cow, WFC = White Fulani cow.
Mean±S.D with different alphabet superscripts are significantly different ($P<0.05$) between breeds.

Table 2 Elemental composition (mg/L) of the raw milk of sheep breeds form Kano and Jigawa States

	BS	US	YS	RDI (Young)	RDI (Adult)
Ca	443.98±2.8^a	460.12±3.1^b	377.9±2.89^c	700	1200
K	892.92±5.7^a	662.05±4.8^b	671.92±4.0^b	700	500
P	599.98±6.0^a	531.08±5.3^b	539.33±2.3^b	460	1250
Na	391.56±2.8^a	328.14±1.9^b	276.34±2.1^c		2000
Fe	7.47±0.08 ^{a}	8.18±0.109^b	9.47±0.09^c	7	15
Mg	88.45±0.74^a	99.78±0.81^b	88.01±0.79^a	80	360 - 400
Mn	0.04±0.01^a	0.03±0.01^a	0.03±0.01^a	0.02	0.05
Zn	56.98±0.45^a	68.81±0.51^b	50.29±0.48^c	3	7 – 13
Cu	0.20±0.01^a	0.31±0.02^a	0.34±0.02^a		3
Ca/P	0.74±0.10^a	0.87±0.13^a	0.70±0.11^a	1 – 3	1 – 3
Na/K	0.44±0.06^a	0.50±0.08^a	0.41±0.04^a	< 1.0	< 1.0

BS = Balami sheep, US = Uda sheep, YS = Yankasa sheep.
Mean±S.D with different alphabet superscripts are significantly different at ($P<0.5$)

Concentrations of mineral elements in the raw milk of cow and sheep breeds

Ca is vital in building strong bones and teeth, promoting nerve and muscle function, helping blood clot, and activating the enzymes that convert food into energy (Barba and Russo, 2006). Phosphorus is the second most important element when it comes to maintaining bone

health and integrity, after calcium (Forman and Nelson, 1993). It works with sodium to control the body's water balance, which helps maintain healthy blood pressure (Slonim and Pollack, 2006).

Ca and P concentrations within the raw milk of cow breeds ranged from (354.98 – 381.47mg/L) and (366.89 – 471.1mg/L), with the highest value in the raw milk of RBC and lowest in the raw milk of SGC. The values are lower than 500mg/L for Ca and 780mg/L for P in the milk of white Fulani cows reported by Dandare *et al.,* (2014). The concentration of Ca in the raw milk of sheep breeds ranged from (377.90 – 460.12mg/L), the lowest value being recorded in the raw milk of YS and highest in the raw milk of US. The range of Ca concentration in the present study is higher than (136 – 200mg/L) for sheep breeds reported by Simun *et al.,* (2012). P concentration among sheep breeds ranged from 531.08 in the raw milk of US to 599.98mg/L in the raw milk of BS, This value were higher than (80 – 145mg/L) for sheep breeds reported by Simun *et al.,* (2012). The range of Ca and P concentrations across the breeds were between (354.98 – 460.12mg/L) and (366.89 – 599.98mg/L). The lowest was recorded in the raw milk of SGC cow breed and the highest was recorded in the raw milk of US and BS sheep breeds. The current work agrees with the report of Al-Wabel N. (2008), who reports that Ca concentration was highest in sheep breeds. The daily required intake of Ca according to the Institute of Medicine (IOM, 2004) is 700mg/L for 1 – 3years and 1200mg/L for adults. On the other hand according to Institute of Medicine, (2004), the daily required intake of P is 460mg/L for 1 – 3years and 1250mg/L for adults. The concentration of Ca and P in the raw milk of cow and sheep breeds does not meet the required daily intake for both children and adults, except the raw milk of RBC which met the daily required intake, while BS is above the daily required intake for children.

The ratios of Ca to P of raw milk from cow breeds in the present study were RBC (0.81±0.05), SGC (0.97±0.05) and WFC (1.00±0.09) respectively. These values are lower than Ca:P ratio reported by Belewu and Aiyegbusi (2002). Ca:P ratio among sheep breeds was US (0.87±0.13) followed by BS (0.74±0.10) and then YS (0.70±0.11) respectively. The ratio of Ca:P of sheep breeds in the present report is lower than (1.4 – 1.7) reported by Simun *et al.,* (2012) for milk of sheep breeds. Sheep breeds Ca:P ratio is below the permissible values for the dietary reference intake (DRI) for health safety of Ca to P ratio which is 1—1.3 (Virpi *et al.,* 2010). On the other hand RBC and SGC are close to the range and WFC is within the range.
Na is the major cation in the extra cellular fluids and is an important regulator of osmotic pressure, acid base balance and cellular membrane potential. The concentration of Na and K among cow breeds ranged from (380.22 – 428.90mg/L) and (886.25 – 1123.10mg/L), with the highest value in the raw milk of WFC and lowest in the raw milk of SGC and RBC respectively. The values are lower than (1800.52 – 2200.30mg/L) for K and (470.03 – 570.67mg/L) for Na reported by Tona *et al.,* (2015) in grazing white Fulani cows. The Na concentration of the raw milk of sheep breeds ranged between 276.34±2.10mg/L in the raw milk of YS to 391.56±2.80 in the raw milk of BS, while K concentration was lowest in the raw

milk of US (662.05±4.80mg/L) and highest in the raw milk of BS (892.92±5.70mg/L). The value of Na and K concentration of raw milk of sheep breeds in the present report are higher than (29 – 31mg/L) and (174 – 190mg/L) reported by Simun *et al.,* (2012) for milk of sheep breeds. The difference might be due to period of study and location. The range of Na and K concentrations across the breeds was between (276.34 – 428.90mg/L) and (622.05 – 1123.10mg/L). The lowest was recorded in the raw milk of YS and US sheep breeds and the highest was recorded in the raw milk of WFC cow breeds. The report of the current study agree with the report of Al-Wabel, (2008), who report that K concentration was highest in sheep and lowest in cow breeds. The adequate daily required intake of K is 700mg/L for 1 – 3years and 500mg/L for adults, while Na is 2000mg/L for the adults (IOM, 2004). The levels of Na concentration in the raw milk samples are quite low when compared with the required daily intake for children and adults, while the levels of K concentration in the raw milk samples are higher than the required daily intake for children and adults, except for US which is close to the daily required intake for children but higher than that of the adults.

Sodium to potassium ratio is necessary in discussing healthy food. Both sodium and potassium are essential minerals required for the maintenance of the fluid balances in the body. Much more potassium than sodium or ratio value less than 1 is desirable. This proportion helps in promoting normal blood pressure. Na: K ratio of more than 1 can lead to hypertension. The ratios of Na to K of raw cow milk breeds in the present study were RBC (0.36±0.02), SGC (0.45±0.04) and WFC (0.38±0.09) respectively. The values are lower than that reported by Belewu *et al.,* (2002. Na:K ratio among sheep breeds was US (0.50±0.08) followed by BS (0.44±0.06) and then YS (0.41±0.04) respectively. While the ratio across the breeds of the selected ruminants ranged from 0.36±0.02 in the raw milk of WFC cow breeds to 0.50±0.08 in the raw milk of US sheep breeds. The ratio of Na to K of raw milk of cow and sheep breeds in the present study and are comparable to the permissible value of less than 1.00 (NRC, 2005).

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 (Zamberlin *et al.,* 2012). The concentration of Mg among cow breeds ranged from (79.21 – 88.13mg/L), with highest value recorded in the raw milk of SGC and lowest in the raw milk of RBC. The value is lower than (137.00 – 144.00mg/L) reported by Adesina, (2012) for white Fulani, Red Bororo and Muturu cow breeds. The determined concentration of Mg among sheep breeds ranged from (88.01 – 99.78mg/L). The lowest concentration of 88.01±0.79mg/L was obtained in the raw milk of YS and the highest 99.78±0.81mg/L was recorded in the raw milk of US. The value of Mg concentration of sheep breeds in the present report was higher than (8 – 19mg/L) reported by Simun *et al.,* (2012). The concentration of Mg across the breeds was highest in the raw milk of US (99.78±0.81mg/L) sheep breeds while lowest value was recorded in the raw milk of RBC (79.21±0.23mg/L) cow breed. Children between ages of 1 – 3 years need 80mg/L.

Those between 4 – 8 years need 130mg/L, children 9 – 13 years need 240mg/L, while adult need 360 – 410mg/L daily (IMO, 2004). Based on this raw milk from cow breed met the needed requirements by children between 1 – 3 years, but is below the needed requirements for other group above these years.

Zinc is one of the essential elements found in almost every cell, where it stimulate the activity of over 100 enzymes needed for various biochemical reactions (IOM, 2004). Deficiency in zinc allows the body to be more susceptible to diseases caused by viral, bacteria and fungi infections (Shankar *et al.,* 1998).

The range of Zinc among the raw milk of cow breeds was (20.21 – 30.99mg/L) which is significantly ($P < 0.05$) highest in the raw milk of WFC and lowest in the raw milk of RBC. The value obtained in the present report is higher than (4.84 – 5.27mg/l) reported by Adesina, (2012) for White Fulani, Red Bororo and Muturu cow breeds. The determined concentration of Zn among sheep breeds ranged from (50.29 – 68.81mg/L). The lowest concentration of 50.29±0.48mg/L was obtained in YS and the highest 68.81±0.51mg/L was recorded in US. Lower concentration of Zn in sheep breeds was reported by Al Wabel, (2008).

Higher concentration of Zn across the breeds was recorded in the raw milk of US (68.81±0.51mg/L) sheep breeds, while lowest was recorded in the raw milk of RBC (20.21±0.51mg/L) cow breeds. This agrees with the report of Al-Wabel, (2008), who reports that Zn concentration was highest in sheep breeds and lowest in cow breeds. The daily required intake of Zn for children 1 – 3years is 3mg/L, while for adults is 7 – 13mg/L (IOM, 2004). The concentration of Zn in the raw milk of cow and sheep breeds in the present study is higher than the daily required intake of Zn for children and adult.

Fe, Mn and Cu were in small quantity compared to other determined elements in the raw milk samples. Fe is an essential component of proteins and is involved in oxygen transport, however excess Fe may result in poisoning even death (Dalman *et al.,* 1986). Manganese is an essential nutrient that is important for normal processes in the human body, though adverse effect have been reported at higher dose (Ogabiela *et al.,* 2010). On the other hand Cu plays the roles in photosynthesis, respiratory electron transport chains, ethylene sensing, cell wall metabolism, oxidative stress protection and biogenesis of molybdenum cofactor (Umar *et al.,* 2015). Fe, Mn and Cu concentrations among cow breeds ranged from (6.81 – 7.03mg/L), (0.04 – 0.07mg/L) and (0.18 – 0.23mg/L) respectively. The values are highest in the raw milk of RBC and lowest in the raw milk of SGC and WFC. The value of Fe and Cu in the present report is comparable to the value obtained by Ogabiela *et al.,* 2011 for fresh cow milk breeds from Kano, while that of Mn was lower than that reported by Ogabiela *et al.,* 2011 for fresh cow milk breeds from Kano. Fe, Mn and Cu concentrations among sheep breeds ranged from (7.47 – 9.47mg/L), (0.03 – 0.04mg/L) and (0.20 – 0.34mg/L) respectively. The value of

Fe in the present study is higher than that reported by Al Wabel, (2008), while that of Mn and Cu is lower than that reported by Al Wabel, (2008). On the other hand, Fe, Mn and Cu concentrations across the breeds of cow and sheep ranged from (6.81 – 9.47mg/L), (0.03 – 0.07mg/L) and (0.18 – 0.34mg/L) respectively. The daily required intake of Fe is 7mg/L for children 1 – 3years and 15mg/L for adults, copper is 3mg/L, while Mn is 0.02 – 0.05mg/L (IOM, 2004). The concentration of Fe in the raw milk of cow and sheep in the current report met the daily required intake of Fe for children, but is below that of adult. Mn concentration of the raw milk of cow, sheep is within the estimated safe and adequate Daily Dietary intake of Mn, except for RBC which is higher than the recommended level. On the other hand Cu concentration is below the provisional tolerable daily intake (PTDI).

There is a variation in the elemental composition within and across the breeds of the selected ruminants. The variation in the milk samples depends on so many factors. Some of these factors are genetics, stages of lactation, daily variation, parity, type of diet, age, udder health and season (Myburg *et al.,* 2012). According to Haenlein and Anke (2011), higher levels of some mineral compositions in milk (including Ca, Mg, Zn, and Fe) could also be attributed to some deficiencies of other minerals (e.g., cadmium) in the animal feed.

Conclusion

From the results of the present study breed affect certain mineral element composition of the raw milk of cow and sheep breeds. K had the highest concentration, while Mn had the lowest in all the breeds of cow and sheep. The results of the mineral concentrations across the breeds of cow and sheep showed that K, Na, and Mn were highest in the raw milk of cow breeds, while Ca, P, Mg and Zn were highest in the raw milk of sheep breeds. There is a need to improve the quality of the local breed through breeding, nutrition, improved management system as well as creating awareness on the nutritional value of milk.

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