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Proximate and Mineral Compositions of Different Raw Cow's Milks in Minna

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ABSTRACT

Proximate and mineral compositions of different raw cow's milk in Minna environs of Niger State, Nigeria were determined using standard methods and EDRXF spectrophotometer. The moisture content ranged between 7.51-8.32%, the ash content 4.40- 13.13%, fat content 27.55-34.59% crude protein 30.38-42.72% and carbohydrate 9.10-22.27 % respectively. For mineral composition, the calcium content ranged between 200.10- 2830.50mg/100g, potassium between 1065.50-1611.40mg/100g, Mn between 12.70-13.70mg/100g, Fe 40.70-73.80mg/100g, Cu 45.00-56.60mg/100g, Zn 41.70-66.70mg/100g, Ni 50.70- 56.80mg/100g, Se Nd-6.40mg/100g, Cl 139.90-444.40mg/100g, I 997.50-1910.00mg/100g and Br 1.40-6.10mg/100g respectively. The statistical analysis of the obtained results at 95% confidence indicated that there were significant differences in the proximate and mineral compositions of the milk samples studied, with samples which were not exposed to open grazing having better proximate parameters, high micro minerals content and less concentration of trace metals.

INTRODUCTION

Milk is the natural secretion of the mammary glands, which plays a fundamental role in nutrition, growth, development and immunity [1]. The milk of each mammalian species is unique in composition and nutritional value [2]. Cow's milk and milk products have played an important role in human nutrition growth, and development. Fresh cow milk is reported to contain about 88% water [2]. Milk and milk products are important components in human food, since milk is one of the basic primary sources of nutrient in diets for growing children [3]. Milks are excellent sources of calcium, vitamin D, riboflavin, and phosphorus and good source of protein, potassium, vitamin A, vitamin B-12 and niacin. Milk and milk products supply three of the five minerals (Mg, Ca, K) that were identified as those most needed in children's diet [4].

Among foods, milk represents an important intake in a typical diet due to its high nutrient and mineral content. Increase in industrial and agricultural activities has resulted in increased concentration of metals in the environment. These metals are taken in by plants through absorption and consequently accumulate in their tissues. Animals that graze on such contaminated plants accumulate such metals in their tissues and milk if lactating [5]. The qualities of milk obtained from these animals are dependent on the species and the feeding habits. If the cow's diet is primarily forage from green, growing pastures her milk will contain more conjugated linoleic acid, vitamins and minerals, and slightly higher levels of omega 3 fatty acids. This milk is generally more yellow in colour, primarily because of the increased carotene [6]. A large amount of these metals taken in by plants and animals subsequently find their way into the food chain. Metals enter the human body through inhalation, ingestion or absorption through the skin [7]. The intake through ingestion depends on food habit. Cow milk which is a very important food stuff consumed by man is one of the major sources [8]. It has been reported that the content of the main elements in milk are fairly constant and undergoes slight changes depending on lactation phase, quality of nutrition and environmental conditions mainly chemical pollutants [8.9]. In recent times, the amount of metals in cow milk is widely studied, particularly in industrialized and polluted areas of the developed and the developing countries of the world since animals grazed freely on open fields are considered as bio-indicators of environmental pollution [10.11].

Trace metals in cow's milk are of interest because of their essential or toxic nature. For instance, Chromium and Manganese are essential but may become toxic at higher levels while lead and cadmium are toxic and can be cumulative [12].

Cadmium and lead are among the elements that have caused most concern in terms of adverse effects on human health [13]. Also some trace metals like copper, nickel, manganese, chromium and iron are essential in very low concentration for the survival of all forms of life [14], but when present in greater quantities, can be toxic to man. Different workers have reported various compositions of micro and, trace elements in cow milk [9, 15, 16]. To enhance public health, the quality of milk is continuously being monitored in order to ensure that the toxic elements in them are within the permissible limit that will not be injurious to health.

This work is aimed at carrying out a comparative study of proximate and mineral compositions of different milk samples collected from cows fed with commercially formulated feeds and those grazed locally with natural forage from green vegetation.

MATERIALS AND METHODS

Sample Collection:

This study was carried out in Minna area of Niger state Nigeria. Raw Cow milks were collected from the nomadic cattle herdsmen in pyata and Fadipe area of Minna and fed with natural forage. A controlled sample was collected from cows that were kept in a confinement within Maizube farm in Sabon Dagah area of Minna and fed with commercially processed feeds. To avoid contaminations, the plastic containers used for sample collection were cleaned by soaking them for 24hours in 10% HNO_3; then in distilled water for another 24hours after which the containers were rinsed with more distilled water, and then dried before used for collecting samples. The samples were packaged with the cleaned plastics containers and quickly transported and stored in an ice packed cooler at 0 ± 6^0C prior to pre-treatments for analysis.

Proximate Analysis

The proximate parameters moisture, fat, ash, crude fibre, crude protein and carbohydrates content were determined using the AOAC method [17].

Sample preparation for XRF (Spectrometer)

100ml of the milk sample was measured into an evaporating dish. The content was heated on water bath and heating mantle until a dry weight was obtained. The dried sample was allowed to cool and properly packaged with polyethylene wrapper, prior to analysis with EDXRF Spectrophotometer.

The dried samples were sieved using 2µm screen sieve (standard particle size for XRF pellets).About 5g of the sieved samples were weighed into weighing dishes followed by the addition of ultrabind in the ratio of 10:1 (i.e. 0.5g of ultrabind was added to 5g of the sample.) and the content mixed properly. Other pre-treatment procedures were carried out in order to produce a pellet shaped sample for EDXRF analysis.

Elemental Analysis

The elemental analyses of the pre-treated samples were performed using the Energy Dispersive X-ray Fluorescence (EDXRF) spectrometer model (XR-100CR. Manufactured by Amptek Inc. MA USA with a multichannel analyser detector. MCA8000A) at the centre for Energy Research and Development, Obafemi Awolowo University, Ile-Ife South-western Nigeria. Each sample pellet was irradiated for 1000 s at fixed condition of 25KV and 50mA. The spectral data analysis was done with the AXIL fitting program contained in the QXAS software package. The detector used for signal processing and data acquisition was coupled to a MCA8000A, Multichannel analyser supplied by Amptek Inc, MA USA.

Statistical Analysis
The data was analysed using one way analysis of variance (ANOVA) using Minitab 14 to examine the statistical significance of differences in the mean concentration of the proximate and mineral compositions of the different milk samples studied.

RESULTS AND DISCUSSION

The result of the proximate analysis (table 1) showed that the moisture contents of all the milk samples studied ranged from 7.51 to 8.32%, with sample collected from Pyata village having the highest moisture content and the sample collected from Maizube farm the least. The moisture contents of the milk samples studied were lower than that reported by Henry *et al.,* [18] This could be due to the fact that it was the dried weight of the milk samples that were analysed. The significant of moisture content in milk is that, high moisture content implies high water activity which supports microbial growth consequently reducing the shelf life of the milk sample. Low moisture contents on the other hand, implies low water activities, low water activities causes reduction in microbial growth and the predominant microbial culture consequently increasing the shelf life of the milk samples as a result of low availability of water for microbial growth [19].

The Fat contents of the milk samples were significantly different and it ranged from 27.55 to 34.59% with milk sample collected from Pyata village having the highest fat content and milk sample collected from Maizube farm, the least. The fat contents of all the milk samples were higher than the values reported by other workers [18, 20]. Again, this could be due to the fact that, it was the dried weight of the milk samples that were analysed.

Fat is widely known as a source of energy but excess fat contents in foods constitute health risk. [18]. For this reason, the milk sample collected from Maizube farm will be safer to consume than the milk samples collected from Fadipe area and Pyata village.

Table1: Results for proximate compositions of the milk samples per dried weight

Parameters	Maizube Milk	Fadipe Milk	Pyata Milk
Moisture (%)	7.51 $\pm$ 0.02	7.93 $\pm$ 0.01	8.32 $\pm$ 0.02
Ash (%)	13.13 $\pm$ 0.01	5.56 $\pm$ 0.01	4.43 $\pm$ 0.01
Crude protein (%)	42.72 $\pm$ 0.15	36.46 $\pm$ 0.01	30.38 $\pm$ 0.01
Fat (%)	27.55 $\pm$ 0.01	28.49 $\pm$ 0.01	34.59 $\pm$ 0.01
Carbohydrate (%)	9.09 $\pm$ 0.02	13.25 $\pm$ 7.19	22.27 $\pm$ 0.01

Values are mean of triplicate determinations. ±SD

The ash contents which is a reflection of the mineral compositions of the milk samples shows significant differences at $P \leq 0.05$ and it ranged from 4.43-13.13%. The milk sample collected from Maizube farm has the highest ash content of 13.13%. This could be due to the salt lick activities by the Maizube cattle. The ash contents of all the milk samples were higher than the values reported by other workers [18, 21].

The protein contents in the milk samples ranged from 30.38 to 42.72% and carbohydrate contents ranged from 9.10 to 22.27%. It is important to note that while the milk sample collected from Maizube farm has the highest protein content of (42.72%) and the least carbohydrate content of 9.10% respectively. The milk sample collected from Pyata village has the least protein content of 30.38% even though it has the highest carbohydrate and fat contents. The type of feeds giving to Maizube cows as well as lactation could be responsible for the high protein content seen in the milk sample collected from Maizube farm [18].

The result for mineral compositions in the milk samples are shown in Table 2. The essential mineral content in the studied samples are comparable with those reported by other workers in milk [9]. The calcium content ranged between 2000.10- 2830.50/100g. The milk sample collected from Pyata village contains the highest amount of Ca (2830.50/100g), while the milk sample collected from Fadipe area contains the least amount of Ca (2000.10/100g). The values are in line with the values reported by Dirienzo [22] in Whey and milk products which ranged between 500 to 2000mg/100g.

The potassium (K) concentrations for all the milk samples ranged between 1065.50 to 1611.44 mg/100g. These concentrations are lower than the values reported by Galina [23] of 1,2065mg/100g. The milk sample collected from Maizube farm has the highest K (1611.44 mg/100g) value, while the milk sample collected from Pyata village has the least value for K (1065.50/100g).

Table 2: Result for Elemental composition of the milk samples (n±SD) **(mg/100g)**

Elements	Maizube Milk	Fadipe Milk	Pyata Milk
Ca	2511.80 ± 40.10	2000.10 ± 41.50	2830.50 ± 49.40
K	1611.40 ± 37.80	1395.40 ± 40.40	1065.50 ± 35.80
Cl	139.90 ± 40.70	419.00 ± 26.50	444.40 ± 27.70
Mn	13.10 ± 1.30	13.70 ± 1.60	12.70 ± 1.50
Fe	63.90 ± 2.50	40.70 ± 23.00	73.80 ± 3.20
Cu	45.00 ± 1.60	44.30 ± 1.90	56.60 ± 2.10
I	997.50 ± 10.00	910.00 ± 10.00	1756.90 ± 10.00
Zn	41.70 ± 1.40	43.60 ± 1.70	66.70 ± 2.20
Br	4.40 ± 0.40	6.10 ± 0.60	1.40 ± 0.30
Ni	55.20 ± 1.90	50.70 ± 2.20	56.80 ± 2.30
Se	5.80 ± 0.50	6.40 ± 0.60	ND

ND = Not detected.

The concentration of Bromine (Br) in all the milk samples ranged from 1.4-6.1mg/100g; Chlorine(Cl) from 419.0-1339.9mg/100g and I from 997.5-1910mg/100g respectively.

The milk sample collected from Fadipe area has the highest concentration of Br and I while the milk sample collected from Maizube farm had the highest Cl content. The chloride concentration of some of the milk samples are lower than that reported by Galina [23] of 190.7mg/100g, except that from Maizube farm which is higher than this value. Br level in the milk sample collected from Pyata village is in line with that reported by Galina [23] of 1.7mg/100g.

High iodine (I) concentration in this study is a major concern because; these values are significantly higher than the values reported by Mireslaw [24] of 0.024-0.384ppm and 1.18-6.22ppm. I levels in milk reported by Dobrzanski [9] ranged from 530.4-588.8ppm. These values are line with the values obtained in this study. However, the values of I obtained in this study is still much higher. This could be due to differences in geographical locations as well as inter elemental interactions [25, 26]. Iodine is essential for the formation of thyroid hormones, prevention of goitre, criticism, associated with stunted growth and prevention of brain damage [27].

The trace mineral content in the studied milk samples compared favourably with those reported by other workers. The value of Zn ranged from 41.7-66.7mg/100g and Fe from 40.7-73.8mg/100g. The milk sample collected from Pyata village has the highest values for Zn and Fe. Zn is essential for physiological processes including development, lipid metabolism, brain and immune functions and deficiency of Zn, allows the body to be more susceptible to disease caused by viral, bacteria and fungi infections [28]. Iron on the other hand is an integral part of many proteins and enzymes that maintain good health. It is an essential component of proteins and is involved in oxygen transport. However, excess Fe may result in poisoning even death [29]. Other workers reported that dairy products are generally low in Fe and Zn contents [30, 31], while Patra *et al*., found no significant differences in the level of Fe and Zn in cow milk with respect to differences in breed [32].

The concentration of manganese (Mn) in all the milk samples showed no significant different at $P \leq 0.05$ and it ranged from (12.7-13.7mg/100g). The concentration of copper (Cu) in the milk samples collected from Maizube farm, Fadipe area and Pyata village were 45.0, 44.3, 56.6mg/100g respectively. The milk sample collected from Pyata village has the highest levels for Cu and the least concentration for Cu was found in the milk sample collected from Fadipe area. Cu is an important element in nutrition because it is an essential element for human health. However, excess Cu in the body is undesirable. It may lead to liver and kidney damage among other effects.

Nickel (Ni) concentration for the milk samples collected from Maizube farm, Fadipe Area, Pyata village were 55.2, 50.7, 56.8 mg/100g respectively. The milk sample collected from Pyata village contains the highest level of Ni while the milk sample collected from Fadipe area contained the least. The Ni concentration for all the milk samples were higher than that reported in cheese by Zane of 0.18mg/kg [33], and 0.27-1.2mg/100g by Florea *et al*., [34]) and 0.18ppm by Samaghuill [34]. However the Ni concentrations are in line with the values reported by Dobrzanski of 53.54 and 68.84ppm at the lower Silesia and Upper Silesia respectively [9]. Ni is known to be involved in the action and production of certain hormone like adrenaline and aldosterone among others [36].

Selenium (Se) concentration for the milk samples collected from Maizube farm and Fadipe area were 5.8 and 6.4 mg/100g respectively. Selenium was not found in the milk sample collected from Pyata village. This could be traced to variations in the feeds and grazing areas by the Cattles from this region. Se concentration obtained in this study is in line with the levels reported by LI-Quang *et al.*, as 8.8mg/100g [11]. Selenium is an essential element in nutrition, it function as an antioxidant as well as co-factor of enzymes which protects cell membranes from damage caused by peroxidation of lipids, thereby decreasing the risk of cancer, heart and blood vessels disease [37]. Selenium is a crucial nutrient for an HIV infected person [38, 39].

Table 3: Results for statistical analysis of proximate compositions of the milk Samples

Parameters	Maizube Milk	Fadipe Milk	Pyata Milk
Moisture (%)	7.51 ± 0.02^{a}	7.93 ± 0.01^{b}	8.32 ± 0.02^{c}
Ash (%)	13.13 ± 0.01^{c}	5.56 ± 0.01^{b}	4.43 ± 0.01^{a}
Crude protein (%)	42.72 ± 0.15^{c}	36.46 ± 0.01^{b}	30.38 ± 0.01^{a}
Fat (%)	27.55 ± 0.01^{a}	28.49 ± 0.01^{b}	34.59 ± 0.01^{c}
Carbohydrate	9.09 ± 0.02^{a}	13.25 ± 7.19^{ab}	22.27 ± 0.01^{b}

Data with the same superscript along the same row are not significantly different at p≥0.05

The result of the proximate and mineral content of the statistical analysis in the different milk samples using one way Anova at 95% confidence level are shown in Tables 3 and 4. From the result obtained from the statistical analysis, there are significant differences between the different milk samples from different sampling points in their proximate and mineral compositions as represented by different superscripts letters across rows P<0.05 (Tables 3 and 4), except for Mn levels in the milk samples that revealed no significant differences (ie P≥ 0.05) at 95% confidence level (Table 4). There is significant difference (P< 0.05) in the ash and protein content in milk samples from different sampling points, with Maizube farm having the highest of these parameters (Table3), indicating better protein and mineral content. These variations could be attributable to the feed intake by the different cows. Generally, the variations are randomly distributed across samples. There is no specific sampling point that has higher values for specific for all the parameters.

Table 4: Result for statistical analysis of mineral composition of the milk samples (mg/100g).

Elements	Maizube Milk	Fadipe Milk	Pyata Milk
Ca	2511.80 ± 40.10^{b}	2000.10 ± 41.50^{a}	2830.50 ± 49.40^{c}
K	1611.40 ± 37.80^{c}	1395.40 ± 40.40^{b}	1065.50 ± 35.80^{a}
Cl	139.9 ± 40.70^{c}	419.00 ± 26.50^{a}	444.40 ± 27.70^{b}
Mn	13.10 ± 1.30^{a}	13.70 ± 1.60^{a}	12.70 ± 1.50^{a}
Fe	63.90 ± 2.50^{a}	40.70 ± 23.00^{a}	73.80 ± 3.20^{c}
Cu	45.00 ± 1.60^{a}	44.30 ± 1.90^{a}	56.60 ± 2.10^{b}
I	997.50 ± 10.00^{a}	1910.00 ± 10.00^{c}	1756.90 ± 10.00^{b}
Zn	41.70 ± 1.40^{a}	43.60 ± 1.70^{b}	66.70 ± 2.20^{c}
Br	4.40 ± 0.40^{b}	6.10 ± 0.60^{c}	1.40 ± 0.30^{a}
Ni	55.20 ± 1.90^{a}	50.7 ± 2.2^{b}	56.80 ± 2.30^{c}
Se	5.80 ± 0.50^{b}	6.40 ± 0.60^{c}	ND

Data with the same superscript along the same row are not significantly different at p≥0.05.
ND = Not detected

When the obtained mineral composition in the milk samples were compared with recommended permissible daily dietary intake (Table 5) as reported by other workers [40], it was observed that the obtained result compared favourably in their composition and could therefore help to compliment the human daily dietary intake of these minerals.

Table 5: Comparison of daily intake of elements present in the milk samples analysed with recommended permissive values.

Elements (mg/20g)				**Recommended daily intake (mg)**			
				Men		**Women**	
Elements	**M**	**F**	**P**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Ca	502.36	400.02	566.10	1000	2500	1000	2500
K	322.28	279.08	213.10	-	3500	-	3500
Cl	267.98	83.80	88.88	-	3400	-	3400
Mn	2.62	2.74	2.54	1.80	11	2.3	11
Fe	12.78	8.14	14.76	18	45	8	45
Cu	9.00	8.86	11.32	0.90	10	0.9	10
I	199.50	382.00	351.38	0.15	1.00	0.15	1.00
Zn	8.34	8.72	13.34	8	40	11	40
Br	0.88	1.22	0.28	-	-	-	-
Ni	11.04	10.14	11.36	-	1.0	-	1.0
Se	1.16	1.28	0	0.05	0.40	0.05	0.40

*Source (Wyn, 2004); **M** = Maizube milk; **F** = Fadipe Milk; **P** = Pyata Milk*

CONCLUSION

The milk sample collected from Maizube farm recorded the highest percentage for protein which is required for growth and development and it has the lowest fat content associated with digestive and heart problems. This milk is also characterized by even distribution of mineral components, safe and necessary for the body at moderate concentrations. Based on these findings, the milk sample collected from Maizube farm is of the highest nutritional quality as compared with the milk samples collected from Fadipe area and Pyata village.

The statistical analysis at 95% confidence level revealed that there was significant differences in the proximate and mineral compositions of the milk samples studied (ie $p \leq 0.05$); except for Mn levels in the milk samples that revealed no significant differences at $p \geq 0.05$.

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