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Nutritive Assessment of Milk from Fulani Herds in the Derived Savanna Zone of Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author J. A. Akinlade designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript and managed literature searches. Authors J. A. Alalade and MKA managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The quality assessment of fresh cow milk collected from Fulani herds in Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin in the derived Savanna Zone of Nigeria were carried out in a Completely randomized design with emphasis on the nutrient composition and microbial loads.
Four fresh cow milk samples from separate settlements (rugas) were from Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin and preserved for seven days with 0.01 cm Potassium permanganate and kept in the refrigerator at 4℃ before laboratory an alyses. The moisture content of fresh cow milk from different locations ranged between 87.46-88.62%, the crude protein 3.26-3.85%, ash 0.65-

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0.75%, crude fat 3.49-3.55%, Lactose 0.46-0.64% and solid-non-fat 8.3-9.7%. Mineral composition of the milk showed that potassium content from different locations ranged between 0.46-0.64 percent, Calcium 0.21-0.23%, Magnesium 0.16-0.19%, Zinc 2.34-2.83%, Iron 0.32-0.56%, Copper 1.31-1.61%, Selenium 0.04-0.06%, Lead 0.00-0.14% and Cobalt 0.10-0.26%. Samples of fresh cow milk collected from Ogbomoso, Arolu and Ife-Odan had no traces of Salmonella and *E. coli* and thus contained low level of microbial count. Therefore, it can be concluded from this study that with the exceptions of the microbial counts, and lead contents there were no differences in all other parameters considered among the various locations in the zone.

Keywords: Microbial load; locations; milk; nutrients; composition.

1. INTRODUCTION

Protein of animal origin as constituted in meat, milk, cheese and egg provides concentrated sources of amino acid in suitable proportion for human needs [1], reported that an average human being requires a minimum of 7.5 g of animal protein per kilogram body weight daily to stay healthy. However, an average Nigerian consumes only 3.5 g per kilogram body weight daily [1]. Milk is defined as white liquid produced by female of the warm blooded animals essentially for the feeding of their young ones [2].

Milk is very important in human diet and act as a good source of protein for body growth, tissue repair and other vital functions. Milk and its products are component of human food as they constitute about one-sixth of all the food eaten by man. It is often described as nature's most perfect single food for newborn mammals and an important food supplement for adult.

Cow milk is rich in calcium and potassium mineral elements [3]. Milk fats are useful in the production of butter and cheese [4]. Cow milk is also a good source of protein and vitamins most especially thiamine, riboflavin and cyanocobalamin which are of practical importance in human diet [3].

The cattle owned by the fulanis constitute the majority (estimated 60%) of the national herd [6], and In Nigeria, milk production is almost entirely from range cattle owned by Fulani pastoralists [5]. Milk production from Fulani cattle have been reported as the traditional source of milk for human consumption in Nigeria [6].

This study is therefore designed to investigate the nutritional quality of milk of indigenous cows traditional managed by Fulani herdsmen in the derived savanna zone of Nigeria. White Fulani cattle also being referred to as Bunaji is the predominant breed of cattle kept the Fulani in Nigeria. The colour ranges from white to ash with no other colour markings, the average weight is 250-300 kg, though predominantly kept in the northern parts of the country, its rearing has spread to the southern and eastern parts of the country.

2. MATERIALS AND METHODS

2.1 Description of the Study Environment

Milk samples were collected at Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin which are located in the derived savanna zone of Nigeria.

2.2 Materials/ Sample Collection

An average of 200 ml of cow milk each was collected from each Fulani household settlement popularly called 'ruga' and 4'rugas' samples were considered per location in a completely randomized design covering five different locations; Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin. Milk sample was collected from total milk collected from each site (4 mixed samples were collected from each 'rugas'). Reagents (*0.01 cm^3* Potassium Permanganate) were used to preserve the samples for seven days in the refrigerator before they were taken to the laboratory for analysis. The Potassium Permanganate used prevented alteration in the chemical and mineral composition of the fresh cow milk as well as changes that could occur, texture and bacterial growth of the milk samples.

2.3 Chemical Analysis

The proximate compositions were analyzed according to the recommended methods of [7]. The mineral concentrations were determined using a Kemtech Analytical Alpha-4 Model atomic absorption spectrophotometer for Ca, Fe, Mg, Zn and Cu while flame emission spectrophotometer (Kemtech Analytical Alpha-4

model) was used to determine K using appropriate instrumental conditions for each element. Phosphorus was determined using a UNICAMUV-1Modelvisible spectrophotometer.

2.4 Description of Enteric Bacteria on Selective Media

Quantitative analysis for the description and isolation of enteric microorganism was done by plating the serially diluted milk samples on selective media. MacConkey agar (LOT no. 0000112122) was used to isolate Gram negative lactose fermenting (coliforms) and non-fermenting microorganism. The media contains crystal violet dye and bile salts which inhibit Gram positive bacteria. Lactose fermenting (pink) isolates on MacConkey agar was sub- cultured, gram stained, and confirmed on eosin methylene blue (EMB) agar (LOT no. 0000129529). Lactose fermenters such as *Escherichia coli* and *Enterobacteraero genes* can be differentiated on this media on the basis of size and the presence of a green metallic sheen. *E. coli* colonies in this medium are small and have a metallic sheen, whereas *E.aerogenes* coloniesusually lack the sheen and are larger [8]. The lactose non-fermenting Gram negative non-coliform (colorless) isolates were also sub-cultured and confirmed on selective media. Salmonella shigella (SS) agar (LOT no. 0000125020) was used for the isolation of salmonella and shigella sp. Representative salmonella colonies with typical black appearance were carried out using supplied indole motility (SIM) medium (LOT no. 0000133572).

2.5 Statistical Analysis

Data obtained were subjected to analysis of variance using General linear model of SAS, 2000. The significant means were separated using Duncan multiple range test [9].

3. RESULTS

3.1 Proximate Composition

Table 1 shows the proximate composition of fresh milk samples collected from different locations (Ogbomoso, Arolu, Ife odan, Oyo and Iseyin zone). There were significant ($P<0.05$) effect of location on proximate composition of the milk. The moisture contents did not show any difference among the locations, though the values obtained from Iseyin and Arolu were higher (87.46-88.62%). The crude protein contents in the fresh cow milk samples ranged from 3.26-3.85%.

Higher crude protein contents of 3.85, 3.65 and 3.56% were recorded for Oyo, Ogbomoso and arolu areas respectively. While the least value of 3.26% was recorded for Iseyin location. The ash content which is reflection of the mineral contents of the milk samples showed Significant ($P<0.05$) differences and it ranged from 0.65 – 0.75%. The higher values were recorded for samples collected from Oyo, Arolu and Ogbomoso (0.75, 0.73 and 0.71%) respectively. The value recorded was significantly lower than the value of (4-13%) reported by [10] also similarly lower than the value (0.78%) reported by [10].

The crude fat contents of the milk sample collected from different locations (Ogbomoso, Arolu, Ife odan, Oyo and Iseyin) showedno significant ($P>0.05$) difference. Lactose were 5.82, 5.88, 5.91 and 4.73 for Ogbomoso, Arolu, Ife Odan, Oyo and Iseyin respectively.

The value of solid nonfat (SNF%) of raw cow milk collected from different locations of Ogbomoso, Arolu, Ife odan, Oyo and Iseyin ranged from (8.30-9.70%) and for total solid fat from (11.53-13.11%).

3.2 Mineral Composition

The results of mineral compositions of raw cow milk in different locations (Ogbomoso, Arolu, Ife Odan, Oyo and Iseyin) in derived savanna zone of Nigeria are presented in Table 2. The potassium (K) concentration for all the milk samples collected from different locations ranged between 0.46 to 0.64%. The potassium content of milk collected from Oyo, Arolu and Ogbomoso (0.64, 0.63and 0.62%) were significantly higher in value tha that value recorded for Iseyin and Ife-Odan (0.49 and 0.46). There were no significant ($P>0.05$) difference in both calcium (%Ca) and phosphorus (% P) content. The value of Ca ranged from 0.21 to 0.23% and P from 0.21 to 0.22%. The milk collected from different locations of Ogbomoso, Arolu, Ife odan, Oyo and Iseyin had good quality of Ca and P contents.

The Magnesium content of raw cow milk collected from different locations ranged between 0.16 to 0.19%. Higher value of Mg contents were observed from milk samples collected from Ogbomoso, Arolu and Oyo (0.17, 0.18 and 0.19%). The trace mineral content in the studies

milk samples compared favorably with those reported by other workers. The value of Zn ranged from 2.34 to 2.83% and Fe from 0.32 to0.56%. The milk sample collected from Ogbomoso, Arolu and Oyo had the higher values for Znand Fe. The concentration of copper (Cu) in the milk sample collected from Ogbomoso, Arolu, Ifeodan, Oyo and Iseyin were 1.53, 1.56, 1.36, 1.61 and 1.31% respectively.

The milk sample collected from Oyo, Arolu and Ogbomoso had the higher levels for Cu and the least concentration for Cu were found in the milk sample collected from Iseyin and Ifeodan. Selenium (Se) content of raw milk collected from different locations (Ogbomoso, Arolu, Ifeodan, Oyo and Iseyin zone ranged between 0.04 to 0.06%. Higher significantly value of Se content were observed from milk sample collected from Oyo, Ogbomoso and Arolu 0.06, 0.05 and 0.05%. The lower values were observed for milk collected from Iseyin and Ife odan.

The trace mineral content in the studied milk samples compared favourably with those reported by others workers. The value of Pb ranged from 0.00-0.14% and Co from 0.10 – 0.26%.

The milk samples collected from Iseyin and Oyo locations had highest Co and Pb contents.

3.3 Bacterial Count

Effect of locations on the bacterial counts of fresh cow milk in derived savanna zone is presented in Table 3. The samples of fresh cow milk collected from Ogbomoso, Arolu and Ife-Odan had no traces of *Salmonella* and *E. coli* but lower values when compared with microbial count from Ogbomoso ($1.21x10^3$), Arolu ($1.02x10^3$) and Ife-Odan ($1.09x10^3$). Milk collected from Oyo and Iseyin were highly contaminated with heavy microbial count, of *Salmonella* and *E. coli,* respectively.

4. DISCUSSION

The values recorded for moisture content for fresh cow milk from different location fell within the value of 88.27% reported by [6].

Table 1. Effects of locations on proximate composition of cow milk in derived savanna

Parameter	Ogomosho	Arolu	Ife-Odan	Oyo	Iseyin	SED
%M	87.46	88.03	87.77	87.52	88.62	0.39
%CP	3.65	3.56	3.45	3.85	3.26	0.33
%CF	3.49	3.54	3.55	3.52	3.55	0.25
%TS	11.53^C	11.92^c	12.83^b	11.82^c	13.11^a	0.23
%SNF	8.88^b	9.70^a	8.43^b	8.95^b	8.30	0.35
%LAC	5.82	5.88	5.91	4.73	5.93	0.40
%ASH	0.71	0.73	0.67	0.75	0.65	0.04

Means along the same row with difference superscripts differ significant (P <0.05). M- Moisture, CP- Crude protein, CF- Crude oil, TS- Total Solid Fat, SNF- Solid Non Fat, SED-Standard Error of Difference

Table 2. Effect of locations on mineral composition of cow milk in derived savanna zone

Parameters	Ogbomosho	Arolu	Ife-Odan	Oyo	Iseyin	SED
%K	0.62^a	0.63^a	0.49^b	0.64^a	0.46^c	0.03
%Ca	0.22	0.22	0.21	0.23	0.21	0.01
%P	0.21	0.22	0.21	0.22	0.21	0.01
%Mg	0.17	0.18	0.16	0.19	0.16	0.01
%Zn	2.81^a	2.73^a	2.40^b	2.83^a	2.34^c	0.40
%Fe	0.55^a	0.56^a	0.37^b	0.56^a	0.32^c	0.02
%Cu	1.56^a	1.56^a	1.36^b	1.61^a	1.31^c	0.41
%Se	0.05^b	0.05^b	0.04^c	0.06^a	0.04^c	0.01
%Pb	0.00^c	0.00^c	0.00^c	0.14^a	0.13^b	0.01
%Co	0.10^c	0.10	0.10^c	0.26^a	0.21^b	0.01

Means along the same row with different superscripts differ (P<0.05). M- Moisture, CP- Crude protein, CF- Crude oil, TS- Total Solid Fat, SNF- Solid Non Fat, SED-Standard Error of Difference

Table 3. Effects of locations on the bacterial count of milk in derived savanna zone

Parameter	Ogbomosho	Arolu	Ife-Odan	Oyo	Iseyin	SED
Microbial count	$1.21x10^3$	$1.02x10^3$	$1.09x10^3$	$9.3x10^3$	$5.4x10^2$	$1.29x10^3$
Salmonella	0.00	0.00	0.00	$1.7x10^3$	$1.9x10^3$	0.129x10
E. coli	0.00	0.00	0.00	$2.8x10^3$	$1.3x10^3$	0.19x10

The crude protein content recorded for milk samples collected at different locations were higher than that value (3.61%) reported by [10]. Higher ash content was observed for cow milk samples collected from Oyo Arolu and Ogbomoso (0.75, 0.73 and 0.71%). This could be due to the provision of salt lick after grazing in the zones. The value recorded was significantly lower than the value (4-13%) reported by [11] also lower than the value (0.78%) reported by [10]. The fat contents of the entire milk sample were lower than the values (27.55-34.59%) reported by [11]. Also lower than the values (4.02%) reported by [10]. Fat is widely known as a source of energy but excess fat contents in food constitute health risk (Henry 2003) for this reason, the milk sample collected from different location was safer for consumption. The values recorded for lactose was higher than (5.00%) reported by [11]. The milk samples collected from Ogbomoso, Arolu and Oyo had higher value than their counterpart for solid nonfat. The total solid fat was higher for Iseyin (13.11%) followed by Ife odan (12.83%), while least values were obtained for fresh cow milk sample from (Ogbomoso, Oyo and Arolu).

4.1 Minerals Composition

Potassium deficiency affects the collecting tubules of the kidney, resulting in the inability to concentrate urine, and also causes alterations of gastric Secretions and intestinal motility [2]. The rapidly growing animals apparently have a higher requirement for potassium, and increasing the protein level increases the requirement. One of the most vital contributions of milk to human nutrition is the Calcium and Phosphorus it supplies [12] Calcium plays an important role in bones formation and metabolism, muscle contraction, nerve transmission and blood clotting. Calcium and phosphorous are required in large amount and for promotion of rapid growth of neonate. It also ensures bone growth and development of soft tissues. Phosphorous is involved in maintaining body pH, in storage and transfer of energy [13]. Both elements are needed for tissue and bone development while deficiency result in slow growth, depraved appetite, unthrifty appearance and rickets (N RC, 1978). Higher value of Mg contents were observed from milk samples collected from Ogbomoso, Arolu and Oyo (0.17, 0.18 and 0.19%). The implication of the lower Mg content from milk will lead to hyper irritability with convulsions, loss of equilibrium and trembling tetany [14]. Zn is essential for physiological processes including development, lipid metabolism, brain and immune function and deficiency of Zn allow body to more susceptible to disease caused by viral, bacteria and fungi infection [14]. 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 [15].

The milk sample collected from Oyo, Arolu and Ogbomoso had higher levels of Cu and the least concentration for Cu was found in the milk sample collected from Iseyin and Ifeodan. Cu is an important element in nutrition because it is an essential element for human health.

However, excess in the body is undesirable. It may lead to liver and kidney damage among other effects.

Higher value of Se content was observed from milk sample collected from Oyo, Ogbomoso and Arolu (0.06, 0.05 and 0.05%). The lower values were observed for milk Collected from Iseyin and Ife odan. The selenium concentration observed in this study is lower than value reported by [10]. 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. Selenium is a crucial nutrition for an HIV infection person [16].

The milk samples collected from Iseyin and Oyo zone had highest Co and Pb. The mean values for Pb was below the general statutory limit of 1 smg/kg set by for the lead in food regulations (TLFR, 1979). High levels of heavy metal in Iseyin and Oyo zones may be attributed to the

high contamination of animal feed and water by pollutants and could be excreted into milk at various levels and also through poor handling procedures.

4.2 Bacterial Count

The samples of fresh cow milk collected from Ogbomoso, Arolu and Ife-Odan had no traces of *Salmonella* and *E. coli* but lower values were observed for microbial count on Ogbomoso ($1.21x10^3$), Arolu ($1.02x10^3$) and Ife-Odan ($1.09x10^3$). Milk collected from Oyo and Iseyin were highly contaminated with Microbial count, *Salmonella* and *E. coli* respectively.

5. CONCLUSION AND RECOMMENDATION

This work, investigated the on- farm nutritive content and the bacteria contents of milk from extensively managed cattle by Fulani in the derived Savanna Zone, of Nigeria. It could be concluded that fresh cow milk collected from Ogbomoso, Arolu and Ife-Odan had higher values of proximate and mineral contents. High sanitary practices should be encouraged before, during and after collection of milk samples from respective animals.

Handling and processing including pasteurization, packaging and even storage of raw milk, especially those collected or purchased directly from Fulani settlements called rugas or those being hawked by Fulani women in town, villages and road sides is recommended to eliminate or reduce to a tolerable level, the presence of these microbes before consumption by humans. However, consumption of milk procured from Iseyin and Arolu areas should if possible be completely discountenance as traces of lead in the milk make it consumption worst.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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