

1 Nutritive assessment of Milk from Fulani Herds in the Derived Savanna Zone

2 of Nigeria

3 Abstract

4 The quality assessment of fresh cow milk in Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin in the
5 derived Savanna Zone of Nigeria were carried out in a completely randomized design to
6 determine the nutrient composition and microbial load. Four fresh cow milk samples each were
7 collected from Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin and preserved for seven days with
8 0.01cm Potassium Permanganate later kept in the refrigerator at 4⁰C before taken to laboratory
9 for analysis. The moisture content of fresh cow milk from different location ranged between
10 60.03-88.62%, the crude protein 3.62-3.86%, ash 0.57-0.75%, crude fat 3.40-3.59%, lactose
11 4.50-5.93%, solid-non-fat 4.49-9.70% and solid fat 12.08-13.46%. For mineral composition the
12 Potassium content from different locations ranged between 0.49-0.64%, Calcium 0.21-0.23%,
13 Magnesium 0.19-0.41%, Zinc 2.54-2.83%, Iron 0.32-0.56%, Copper 1.31-1.61%, Selenium 0.03-
14 0.06%, Lead 0.00-0.14% and Cobalt 0.21-0.26%. The samples of fresh cow milk collected from
15 Ogbomoso, Arolu and Ife-Odan had no traces of Salmonella and *E. coli* and thus low
16 level of microbial count. Therefore, it can be concluded from this study that with the exceptions
17 Of the microbial counts, lead content there were no differences in all other parameters considered
18 among the various locations in the zone.

19 Introduction

20 Protein of animal origin as constituted in meat, milk, cheese and egg provides concentrated
21 sources of amino acid in suitable proportion for human needs. As reported by FAO (1998), an
22 average human being requires daily minimum of 7.5g of animal protein per kilogram body
23 weight to stay healthy. However, an average Nigerian consumes only 3.5g per kilogram body
24 weight (FAO/WHO, 1985). Milk is defined as white liquid produced by female of the warm

blooded animals for the feeding of their young ones (Oyewole, *et al.*, 1997). 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 (Apelegan, 2012). Milk has a natural healing potential in the case of inhalation of poisonous gas, convulsion, digestive disturbance and replacement of damaged cell and tissues (Lacent, 1988). Cow milk is rich in calcium and potassium mineral elements (Chamberlin, 1989). Lactose is the carbohydrate of milk and makes milk sweet. Milk fats are useful in the production of butter and cheese (Adeneye, 1991). Cow milk is also a good source of protein and vitamins most especially thiamine, riboflavin and cyanocobalamin which are of practical importance in the diet (Beck, 2003). The cattle owned by the fulanis constitute the majority of the national herd (Rim, 1992). In Nigeria, cattle milk production is almost entirely from range cattle of Fulani herd pastoralists who are accustomed to the extensive system of production (Alemede and Sadiq, 2008a). Cattle have been reported as the traditional source of milk for human consumption in Nigeria (Ibeawuchi, *et al.*, 2003) and the milk they produce is of low yield and poor quality.

The cattle are mostly owned by the Fulani. Fulani are indigenous tribe of the northern Nigeria. Their primary occupation is nomadism and 60% of total cattle in Nigeria are owned by them (Akinlade, 2009). Similarly, Fulani have been classified based on their livestock rearing practices and their ethnicity into nomadic, semi-nomadic, semi-settled and settled.

The study is therefore designed to investigate the nutritional quality of milk of indigenous cow traditionally managed by Fulani herdsmen in the derived savanna zone of Nigeria.

Materials and methods

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. Ogbomoso: This environment has an annual

45 rainfall of 1247mm and latitude 8° North and longitude $4^{\circ} 15$ East, temperature of 27°C , 300-
 46 600mm above sea level. Ife Odan: Temperature: 33°C / 91.4°C wind: 5.8 km/h east/northern. It is
 47 96km away from Ibadan. Cloud: scattered at 1500ft, latitude: 7.83° , longitude 4.13° . The time
 48 zone in Ife-Odan is Africa/ Lagos, sunshine at 6:40 and sunset at 18:23. Iseyin: Latitude at 8.5°
 49 latitude 4.55° Longitude at an average elevation of 290m, temperature of 36°C . It has an annual
 50 rainfall of 210mm. Oyo has a temperature of 28°C , Latitude 8° , Longitude 4° and an annual
 51 rainfall of 1316mm, (World weather online, 2012).

52 *Materials/ Sample Collection*

53 An average of 200ml of cow milk each was collected from each Fulani household settlement
 54 popularly called 'ruga' and 4 ' rugas' were considered per location in completely randomized
 55 design covering five different locations; Ogbomoso, Arolu, Ife-Odan, Oyo and Iseyin. **Milk**
 56 **Sample was collected from total milk collected from each ruga.** Reagents
 57 (0.01cm^3 Potassium Permanganate) were used to preserve the samples for seven days in the
 58 Refrigerator before they were taken to the laboratory for analysis. The Potassium Permanganate
 59 used prevented alteration in the chemical and mineral composition of the fresh cow milk
 60 as well as changes that could occur in colour, texture and bacterial growth of the milk samples.

61 *Chemical Analysis*

62 The proximate composition were analyzed according to the recommended methods of
 63 A.O.A.C., (2005). The mineral concentrations were determined using a Kemtech Analytical
 64 Alpha-4 Model atomic absorption spectrophotometer for Ca, Fe, Mg, Zn and Cu while flame
 65 emission spectrophotometer (Kemtech Analytical Alpha-4 model) was used to determine K
 66 using appropriate instrumental conditions for each element. Phosphorus was determined using a
 67 UNICAM UV-1 Model Visible spectrophotometer.

Direction of Enteric Bacteria on Selective Media

Quantitative analysis for the direction 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 *Enterobacter aerogenes* can be differentiated on this media on the basis of size and the presence of a green metallic sheen (Atlas *et al.*, 1995). *E. coli* colonies in this medium are small and have a metallic sheen, whereas *E. aerogenes* colonies usually lack the sheen and are larger (Chatterjee *et al.*, 2006). 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).

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.

Results

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 ($P < 0.05$)

difference between proximate composition of the milk and location. The moisture content of fresh cow milk samples collected from Iseyin and Ife Odan were significantly ($P<0.05$) higher than the value obtained from (Ogbomoso, Arolu and Oyo zones) and values ranged from (60.03-88.62%). The crude protein contents in the fresh cow milk samples ranged from 3.62-3.86%. Higher crude protein contents were 3.86, 3.85 and 3.81% recorded for Oyo, Ogbomoso, Arolu and Ife Odan areas respectively. While the least value of 3.62% was recorded for Iseyin location. The ash content which is reflection of the mineral contents of the milk samples show significant ($P<0.05$) differences and it ranged from 0.57 – 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 (4-13%) reported by Ajai *et al.*, (2012) also lower than the value (0.78%) reported by Tona *et al.*, 2013. The crude fat contents of the milk sample collected from different location (Ogbomoso, Arolu, Ife odan, Oyo and Iseyin) Showed no significant ($P>0.05$) difference. The value ranged from (3.40-3.59). Lactose were significantly ($P<0.05$) higher in values for cow raw milk collected from Ogbomoso, Arolu and Oyo locations (5.88, 5.79 and 5.93%) but least value were observed for milk sample obtained from Ife Odan and Iseyin (4.66 and 4.50%).

The value of solid nonfat (SNF%) of raw cow milk collected from different locations of Ogbomoso, Arolu, Ife odan , Oyo and Iseyin ranged from (4.49-9.70%) and for total solid fat from (12.08-13.46%).

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 0.49 to 0.64%. The milk sample collected from Oyo, Arolu and Ogbomoso (0.64, 0.63 and 0.62%) were significantly higher in value than that value recorded for Iseyin and Ife-Odan (0.49 and 0.46%). Calcium (Ca) and Phosphorus (P), 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 (Ogbomoso, Arolu, Ife odan, Oyo and Iseyin zone) ranged between 0.14 to 0.19%. Higher significantly 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 2.54 to 2.83% and Fe from 0.32 to 0.56%. The milk sample collected from Ogbomoso, Arolu and Oyo had the higher values for Zn and 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 0.03 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 0.21 – 0.26%. The milk samples collected from Iseyin and Oyo locations had highest Co and Pb.

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 were observed for microbial count from Ogbomoso (1.21×10^3), Arolu (1.02×10^3) and Ife-Odan (1.09×10^3). Milk collected from Oyo and Iseyin were highly contaminated with heavy microbial count, of *Salmonella* and *E coli* respectively.

Discussion

The values recorded for moisture content for fresh cow milk from different location fell within the value of 88.27% recorded by Alemode and Sodiq (2008). The significant of moisture contents in milk is that, high moisture content implies high water activities which support microbial growth consequently reduce the shelf life of the milk sample. Low moisture content on the other hand, implies low water activities causing reduction in microbial growth and the predominantly microbial culture consequently increasing the shelf life of the milk samples as a result of low availability of water for microbial growth (Ajai *et al.*.,2012).

The crude protein content recorded for milk samples collected at different locations were higher than that value (3.61%) reported by Tona *et al.*, 2013. 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 availability of salt lick activities after grazing in the zones. The value recorded

significantly lower than the value (4-13%) reported by Ajai *et al.*, (2012) also lower than the value (0.78%) reported by Tona *et al.*, 2013. The fat contents of the entire milk sample were lower than the values (27.55-34.59%) reported by Ajai *et al.*, 2012. Also lower than the values (4.02%) reported by Tona *et al.*, 2013 on raw cow milk sample collected from Ogbomoso location. Fat is widely known as a source of energy but excess fat contents in food constitute health risk (Henry *et al.*, 2003) for this reason, the milk sample collected from different location was safer for consumption. The values recorded for lactose were higher than the values (5.00%) reported by Enb *et al.*, (2009). 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). Thus, the cow milk in ogbomoso, Oyo and Arolu were safe for human consumption.

Minerals composition

The implication of lower value of potassium content in milk can lead to Lethargic condition with high incidence of comas and death; also can lead to diarrhea, distended abdomen and untidy appearance (Adesina, 2012). 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 (Soetan, *et al.*, 2010). The rapidly growing animals apparently have a higher requirement for potassium, and increasing the protein level increases the requirement. One of the most vital concentrations of milk to human nutrition is the Calcium and Phosphorus it supplies (Adesina, 2012). Calcium plays an important role in bones formation and metabolism, muscle contraction, nerve transmission and blood clotting. Calcium and phosphorous are required in

178 large amount and for promotion of rapid growth of neonate. It also ensures bone growth and
179 development of soft tissues. Phosphorous is involved in maintaining body pH, in storage and
180 transfer of energy (Adesina, 2012). Both elements are needed for tissue and bone development
181 while deficiency result in slow growth, depraved appetite, unthrifty appearance and rickets (N R
182 C, 1978). Higher significantly value of Mg contents were observed from milk samples collected
183 from Ogbomoso, Arolu and Oyo (0.17, 0.18 and 0.19%). The implication of the lower Mg
184 content from milk will lead to hyper irritability with convulsions, loss of equilibrium and
185 trembling tetany (Adesina, 2012).

Zn is essential for physiological processes including development, lipid metabolism,

186 brain and immune function and deficiency of Zn allow body to be more susceptible to disease
187 caused by viral, bacterial and fungi infection (Adesina, 2012). Iron on the other hand is an
189 integral part of many proteins and enzymes that maintain good health. It is an essential
190 component of proteins and is involved in oxygen transport. However, excess Fe may result in
191 poisoning even death (Chandra, 1990).

192 The milk sample collected from Oyo, Arolu and Ogbomoso had the higher levels for Cu and
193 the least concentration for Cu were found in the milk sample collected from Iseyin and Ifeodan.
194 Cu is an important element in nutrition because it is an essential element for human health.
195 However, excess in the body is undesirable. It may lead to liver and kidney damage among other
196 effects.

197 Higher significantly value of Se content were observed from milk sample collected from Oyo,
198 Ogbomoso and Arolu (0.06, 0.05 and 0.05%). The lower values were observed for milk collected
199 from Iseyin and Ife odan. The selenium concentration observed in this study is lower than value
200 reported by Tona *et al.*, (2013). 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 (Rayman, 2000)

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 1smg/kg set by 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 such pollutants and could be excreted into milk at various levels (Abou – Arab *et al.*, 1994) and also may be reached the milk through poor handling procedures.

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 (1.21×10^3), Arolu (1.02×10^3) and Ife-Odan (1.09×10^3). Milk collected from Oyo and Iseyin were highly contaminated with Microbial count, *Salmonella* and *E coli* respectively.

Conclusion and Recommendation

This work, investigated the on- farm nutritive content and the bacteria contamination 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 (pasteurization, packaging and storage) of raw milk, especially those collected or purchased directly from Fulani rugas or those being hawked by Fulani women in town and villages is recommended to eliminate or reduce to atolerable level, the presence of these microbes before consumption by humans.

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Table 1: Effect of Locations on Proximate Composition of Cow Milk in Derived Savanna Zone.

PARAMETER	OGBOMOSO	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	11.92	12.83	11.82	13.11	0.23
%SNF	8.88	9.70	8.43	8.95	8.30	0.35
%ASH	0.71	0.73 ^a	0.67 ^b	0.75 ^a	0.65 ^c	0.04

Means along the same row with difference superscripts differ significant (P <0.05) difference

M- Moisture, CP-Crude Protein, CF- Crude Fat, TS-Total Solid Fat, SNF- Solid Non Fat.

Table 2: Effect of Locations on Mineral Composition of Cow Milk in Derived Savanna Zone.

PARAMETER	OGBOMOSO	AROLU	IFE-ODAN	OYO	ISEYIN	SED
%K	0.62 ^a	0.63 ^a	0.49 ^b	0.64 ^a	0.46 ^c	0.031
%Ca	0.22	0.22	0.21	0.23	0.21	0.00
%P	0.21	0.22	0.21	0.22	0.21	0.00
%Mg	0.17	0.18	0.16	0.19	0.16	0.009
%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	0.009
%Pb	0.00 ^c	0.00 ^c	0.00 ^c	0.14 ^a	0.13 ^b	0.004
%Co	0.10 ^c	0.10 ^c	0.10 ^c	0.26 ^a	0.21 ^b	0.009

Means along the same row with difference superscripts differ significant (P <0.05) difference

Table 3: Effect of Locations on the Bacterial Count of Milk in Derived Savanna Zone.

PARAMETER	OGBOMOSO	AROLU	IFE-ODAN	OYO	ISEYIN	SEM
Microbial Count	1.21x10 ³	1.02x10 ³	1.09x10 ³	9.3x10 ³	5.4x10 ³	21.29x10 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

Cfu/g in forming unit per gram of milk sample SEM is the standard mean of error.