ORIGINAL RESEARCH PAPER

The Proximate Composition of Fresh and Fermented Milk in Parts of Nasarawa State, Nigeria

ABSTRACT

This study assessed the proximate composition of fresh and fermented milk in parts of Nasarawa State, Nigeria. A total of 180 samples comprising of fresh milk, bulk milk, *nono***,** and *kindirmo* were collected over a period of six (6) months (May to October, 2017) from six (6) Local Government Areas (two Local Government Areas from the three Senatorial Zones in the State). Proximate parameters – dry matter (total solids), crude protein, crude fibre, oil, ash and nitrogen-free extract (soluble carbohydrates), were determined using the methods of the Association of Official Analytical Chemists (AOAC). The results of the proximate analysis showed that bulk milk samples generally had the most nutritional content than the other sample types in most of the sampled areas. A statistically significant difference ($p<0.05$) was found between the mean values of dry matter (total solids), oil, and ash contents of bulk milk samples and *nono* in the sampled areas. The mean dry matter content of bulk milk samples collected from Nasarawa Local Government Area was 9.04±0.01, while that of *nono* samples collected from this area was 7.28±0.72. Fresh and bulk milk samples collected from Nasarawa, Keffi, Wamba, and Lafia Local Government Areas were found to contain more minerals (ash) compared to *kindirmo* samples collected and this may be attributed to the loss of some of the minerals during the processing of fresh milk to make *kindirmo*. The mean value of ash content of fresh milk and *kindirmo* samples from Nasarawa Local Government Area was 0.72±0.04 and 0.64±0.01, respectively, while the mean value of ash content of fresh milk of fresh milk and *kindirmo* samples from Keffi Local Government Area was 0.78±0.01 and 0.71±0.02 respectively. The samples were found to contain little or no fibre and this is not surprisingly as milk is not known to be a major source of fibre. Variations in the proximate composition of some fresh milk samples collected from the sampled areas may be attributed to genetic differences within a breed as all the cows from which the samples were collected, were of the same breed (White Fulani). All the samples analysed met the specifications for proximate composition stipulated by the Codex Alimentarius Commission.

Key words: Proximate composition, fresh milk, fermented milk, Nasarawa State, Nigeria.

1.0 INTRODUCTION

Milk is one of the most valuable foods that contain practically all the nutrients required by human beings for normal growth and development. Milk is sometimes referred to as the 'nature's complete food'. Milk plays a fundamental role in providing nourishment and immunological protection for the mammalian young. Milk earned this reputation by providing many of the essential nutrients that human beings require for normal functioning of the body. Milk serve as an excellent source of proteins and have abundant minerals, particularly, calcium, and vitamins [13].

Milk appears to be effective in promoting muscle growth [15]. Milk is utilised in the production of at least 400 different fermented products all over the world [18]. Some of these fermented products indigenous to Nigeria are: *nono*, *kindirmo*, and cheese. *Kindirmoi* is a fermented milk product mostly consumed by the Hausas and Fulanis in the northern part of the country. *Kindirmo* is a full fat or partially-skimmed milk; whereas, *nono* is skimmed (defatted) milk. The realisation of the nutritional attributes of milk is clearly demonstrated by the implementation of 'School Milk Programmes' all over the world [19].

The major chemical constituents of milk include: water, fats, proteins, carbohydrates, minerals, organic acids, enzymes, and vitamins. The type/breed of animals and the quality of their feeds can lead to variations in the flavour, colour, and compositions of milk drawn from them [12]. Many factors can affect the milk composition. These factors are: breed variation, cow-to-cow variation, herd-to-herd variation (including management practices and composition of the feeds), seasonal variations, and geographic variations [18]. In many developing countries of the world like Nigeria, nomadic herdsmen move about in search of green pasture. In Nigeria, a large

portion of the milk production is done mainly by the Fulani who control about 96% of the entire cattle population as reported by [23] and the milk is produced from indigenous cattle breeds which are kept by the Fulani herdsmen. The cattle are seldom fed standard feeds. The composition of milk drawn from the cows reflects the kinds of feeds consumed by them.

The nutritional composition of milk is important in assessing the properties of the milk. There is paucity of information on the proximate composition of fresh and fermented milk in parts of Nasarawa State, Nigeria. Therefore, the objective of this work was to determine the proximate composition of fresh and fermented milk in parts of Nasarawa State, Nigeria.

2.0 MATERIALS AND METHODS

2.1 The Study Area

This study was carried out in Nasarawa State, Nigeria. Nasarawa State is situated between latitude 70^0 40' 0"N and 90^0 40' 0"N, and longitude 70^0 0' 0"E and 90^0 30' 0"E. The State has thirteen (13) Local Government Areas (Fig. 2). The state is bounded to the north by Kaduna State, Plateau State to the northeast, Taraba State to the southeast, Benue State to the south, Kogi State to the southwest, and the Federal Capital Territory (FCT), Abuja, to the west (Fig. 1). These positions were taken using Taiwan-made Etrex® high sensitive Geographic Positioning System (GPS) receiver.

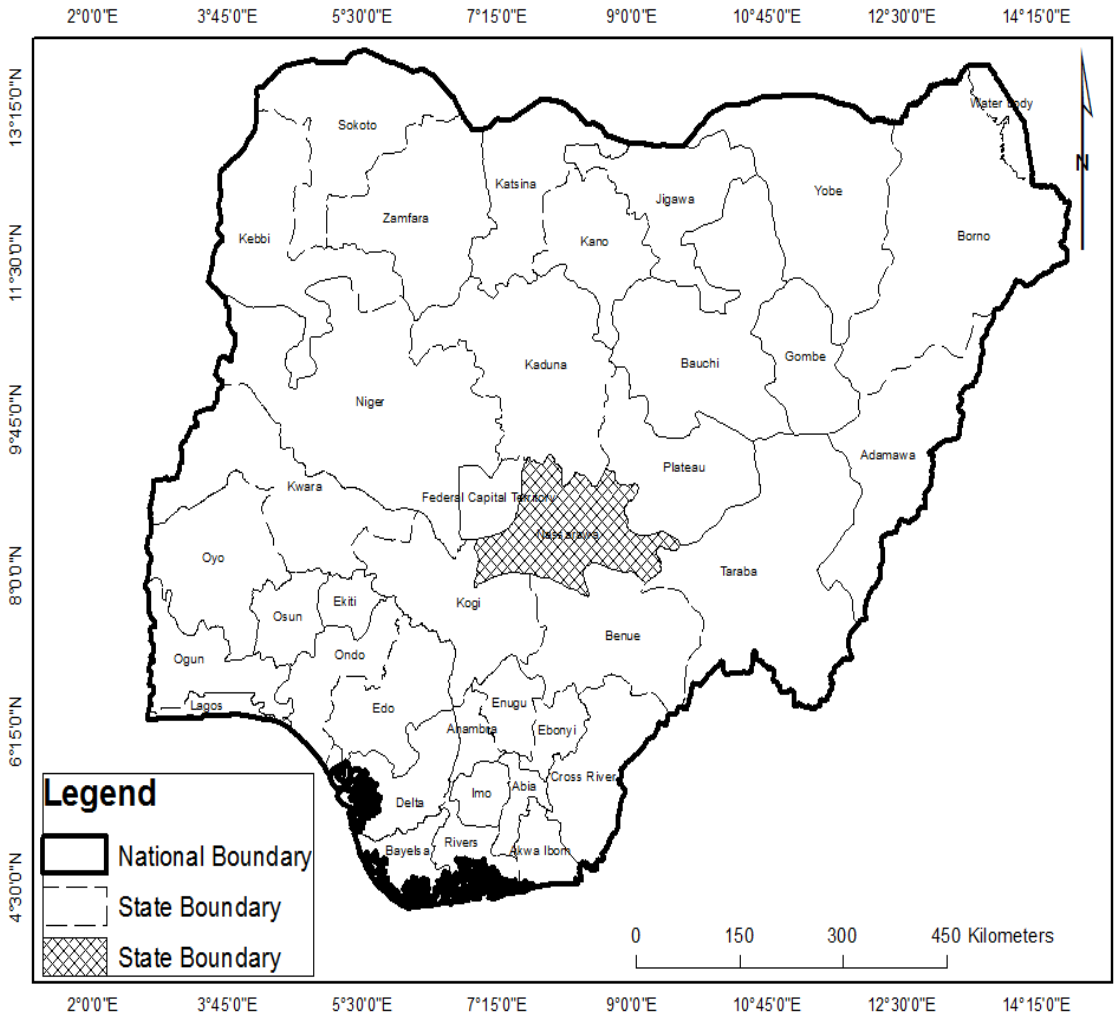

Figure 1: A Map of Nigeria showing the Position of Nasarawa State

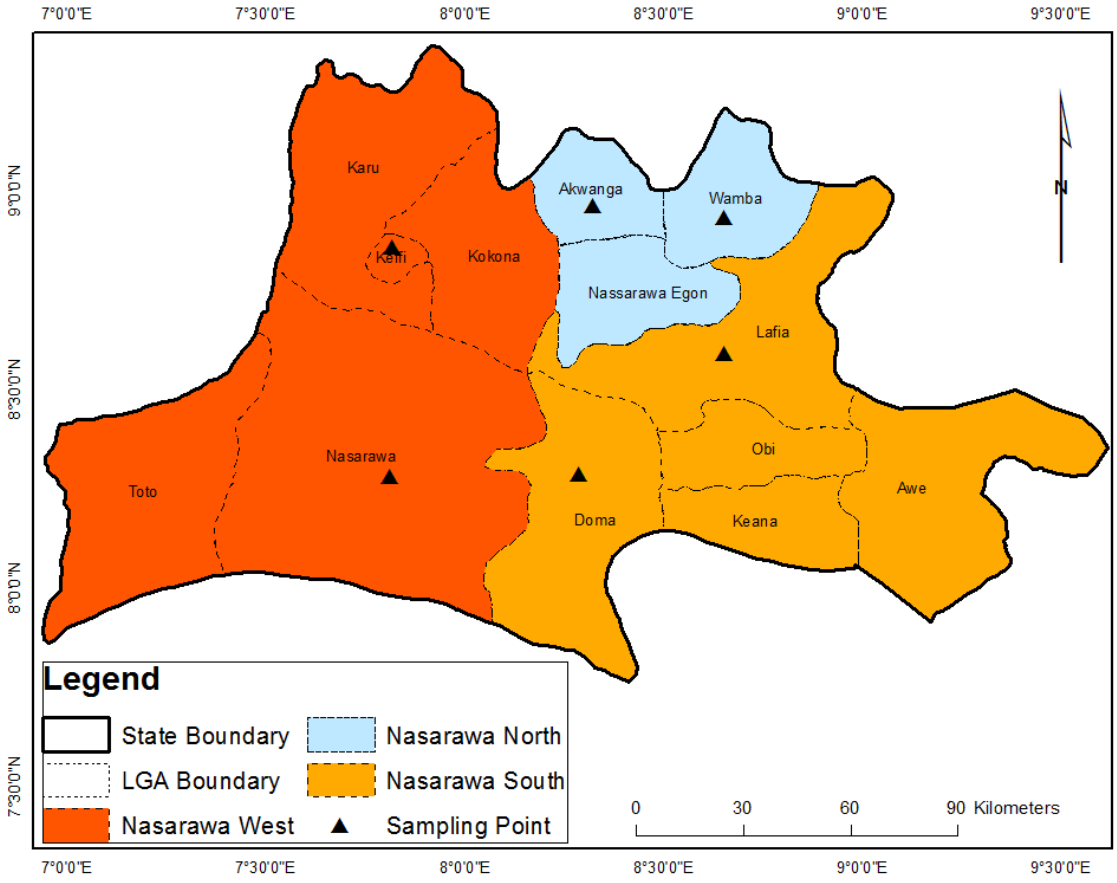

Figure 2: A Map of Nasarawa State Showing the Sampling Areas

2.2 Sampling Collection

Thirty (30) cow milk and milk products samples were randomly collected from each of the Local Government Areas selected for this study viz: Akwanga and Wamba (Nasarawa North); Lafia and Doma (Nasarawa South); Keffi and Nasarawa (Nasarawa West) respectively from May to October, 2017. Proportionate sampling method was used in collecting fresh raw milk samples from lactating cows at the accessible Fulani settlements. This was done by taking 50% of the number of lactating cows in a herd at the settlements. On the whole, 34 fresh raw milk samples were collected. Herds were visited during milking time, where 30ml of composite fresh cow milk

samples were collected directly from the milking cows and placed into sterile bottles. Each sample (25ml) was collected into sterile screw-capped plastic bottles and labelled appropriately.

Fourteen (14) bulk milk samples were collected from the accessible Fulani settlements in each town selected for this study. The bulk fresh milk samples were collected after the milk have been collected and pooled. Twenty two (22) *nono* and locally-pasteurised milk, *kindirmo* samples were randomly purchased from vendors in the towns selected for this study.

All samples were placed in separate sterile plastic bags to prevent spillage and cross contamination. Samples were then stored in a cooler with ice blocks and transported to the Biochemical Laboratory of the Institute for Agricultural Research (IAR), Samaru, Zaria, for analyses.

2.3 Determination of the Proximate Composition of the Fresh and Fermented Milk Samples

The procedures of Association of Official Analytical Chemists [7] was employed in determining the dry matter, crude protein, crude fibre, oil, and nitrogen-free extracts (carbohydrate) contents of the samples.

2.4 Statistical Analyses

The data gathered in this study was analysed using one-way analysis of variance (ANOVA) using SPSS Version 20 to determine the statistically significant differences between the means of the proximate concentration of the different milk samples in the different sampling areas. P-values of 0.05 were considered statistically significant for all comparisons.

3.0 RESULTS AND DISCUSSION

3.1 The Proximate Composition of Fresh and Fermented Milk Samples Collected from Nasarawa Local Government Area

The dry matter (total soilds) content of fresh milk samples collected from Nasarawa ranged from 7.80 to 9.02%, which is within the 12.8% recommended by the Food and Agricultural Organisation (FAO) Codex Alimentarius [10] . Higher levels of dry matter in milk results primarily from higher concentrations of protein compounds [9]. This assertion is reflected in the higher mean values of crude proteins in fresh milk compared to the mean values of *nono* and *kindirmo* samples. Some of these protein compounds might have been lost during the processing of milk to make *kindirmo*, which involve heating the milk to high temperature; this heating could have destroyed some of the proteins contained therein. Producers of *kindirmo* are not knowledgeable of the temperature-time combination that is required to achieve sufficient pasteurisation that minimally affects the nutrient composition of milk.

The mean crude protein content of fresh milk samples collected from this area ranged from 8.50 to 10.50%, which was lower than the range of 30.38 to 42.72% reported by [5] from Minna, Niger State, Nigeria. This disparity in crude protein content of fresh milk samples could be attributed to the quality of the feed given to the cows as the values recorded in Minna, were gotten from samples obtained from cows reared in commercial dairy farms where adequate attention is given to the quality of feed given to the animals, in contrast with the samples analysed in this study which were obtained from nomadic Fulani settlements where the cows are reared extensively. Under this system, adequate attention is not given to the quality of feed given to cows as they are made to move long distances in search of pasture or crop residues in farms

left after harvest. In addition, the differences in crude protein content of the samples could be attributed to genetic factors (breed).

The oil content of fresh milk samples in this area varied from 8.53 to 11.36%, which was lower than the mean oil content of milk of 27.10% reported by [11] who recorded a mean oil value of 9.63±0.30 in Jos North Local Government Area, Plateau State, Nigeria. The differences in the mean oil value of milk could be attributed to the differences within a breed and stage of lactation. Quality of feed fed to the cows could not have accounted for the differences in oil content of the milk because the cows were raised under the same system (extensive system) and were of the same breeds. According to the European Union quality standards for milk, fat content should not less than 3.5% [21]. Consequently, the average fat content (9.68±0.30) recorded for fresh milk collected from this area, was within the recommended standard. Milk is regarded as the most important constituent of milk, which is present in all milk products [14].

The mean ash content of fresh milk collected from this area was 0.72±0.04. This value was slightly lower than the 0.76±0.01 reported by [22] from Shashemene town, southern Ethiopia. The disparity in the mean ash content of milk samples analysed could be attributed to the types of feed given to the animals and also breed variability. Mineral concentration in milk is related to the physical-chemical equilibria which are important in processing, nutritive value, and keeping quality (shelf life) of dairy products. The minerals include phosphorus, chloride, and citrates of calcium, potassium, sodium and magnesium. Their concentration in milk is < 1%, but they are involved in heat stability and alcohol coagulation of milk, age-thickening, of sweetened condensed milk [16].

The mean value (79.86±0.46) of nitrogen-free extracts (soluble carbohydrates) of fresh milk samples collected from this area was higher than the mean of 4.69±0.00 recorded for fresh milk by [22]. The variation in the carbohydrate contents of the samples might be due to the action of lactose-hydrolysing enzymes (lactase) produced by bacteria present in the milk because of storage temperature variation. But this factor cannot be said to have caused the differences in carbohydrate contents in the two studies conducted because, the samples were kept at refrigeration temperature in the course of transporting them from the collection points to the laboratory for analysis.

Table 1: The Proximate Composition of Fresh and Fermented Milk Samples Collected from Nasarawa Local Government Area

Sample	DM (%)	CP (%)	CF (%)	Oil (%)	Ash (%)	NFE (%)
	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM
NSF	8.56 ±0.18[a]	9.38±0.27[a]	0.00±0.00[a]	9.68 ±0.30[b]	0.72±0.04[a]	79.86 ±0.46[a]
NSB	9.04 ±0.01[a]	9.10±0.46[a]	0.00±0.00[a]	9.83 ±0.02[b]	0.78±0.00[a]	80.29 ±0.48[a]
NSN	7.28 ±0.27[b]	8.73±0.63[a]	0.00 ±0.00 [a]	12.48±0.30[a]	0.62±0.07[a]	78.20 ±0.71[a]
NSK	8.55 ±0.27[a]	7.26±0.62[a]	0.00±0.00[a]	13.01±0.30[a]	0.64±0.01[a]	79.09 ±0.42[a]
P – Value	0.001	0.050	-	0.000	0.289	0.127

*For each parameter, means with different superscripts along columns vary significantly ($p<0.05$) using one-way ANOVA, SEM= standard error of mean. DM= Dry matter; CP= Crude protein; CF= Crude fibre; NFE= Nitrogen-free exracts; NSF = Nasarawa Fresh Milk; NSB = Nasarawa Bulk Milk; NSN = Nasarawa *Nono*; NSK = Nasarawa *Kindirmo*.

3.2 The Proximate Composition of Fresh and Fermented Milk Samples Collected from Keffi Local Government Area

The mean dry matter (total solids) content of fresh milk samples collected from Keffi was 8.32±0.29 (Table 2), which was higher than the 7.93±0.01 reported by [5] from a dairy farm in Minna, Niger State, Nigeria. Conversely, however, it was slightly lower than the 8.89±2.07 reported by [2]. Variability between the breeds of cows, within a breed, and stage of lactation might have accounted for the differences in the dry matter content of the milk samples.

The mean crude protein content of 8.59±0.05 recorded for fresh milk samples collected from this area (Keffi) in this study was higher than the mean value of 5.90±0.40 and the 3.68±0.11 reported by [8] and [4] from Sokoto and Ado-Ekiti respectively. These differences in crude protein content may be connected with the quality of feeds consumed by the cows. Variation

between breeds could not have accounted for these differences because virtually all the cows were of the same breed (white Fulani). However, variability within a breed might have accounted for these differences.

The mean oil content of 9.09±0.30 recorded for fresh milk samples collected from this area was higher than the 3.12±013 and 0.73±0.01 reported by [8] in Sokoto, Nigeria, and [6] from the Oromia Regional State, Ethiopia respectively. Differences in crude protein content could be associated with variation in feeding regime, genetic endowments of cows within a breed and between breeds, age, season, and health status of the milked cows [20]. Season, however, could not have accounted for the differences in the crude protein contents of fresh milk samples collected from this area since they were collected during the same period of time (from May to October, 2017).

The mean ash content of fresh milk samples collected from this area was 0.78±0.01, which was in consonance with the mean value recorded by [11] in Jos North Local Government Area, Plateau State, Nigeria. This similarity in ash content may be attributed to the fact that, the cows were of the breed (white Fulani) and were reared using the same management practice (semi-extensive system).

The crude protein content of 9.47±0.84 recorded for bulk milk samples collected from this area (Keffi), was higher than the mean crude protein of reported by [1] and [17] in Sudan who recorded mean crude protein values of 3.84 and 4.63 respectively. This variation could be attributed to differences between the breeds of milked cows and environmental factors (weather conditions). The marked difference ($p<0.05$) observed between the mean values of crude protein of fresh milk and bulk milk samples in this area could be attributed to the fact that, the bulk tank served as a ‘collection tank’ into which milk collected from individual cow was emptied. It is

possible that each individual cow had contributed the protein contained in its milk into the pooled milk.

The mean oil content of 9.81±0.00 recorded for bulk milk samples collected from this area was lower than the 28.49±0.01 recorded by [5] in Minna, Nigeria. This variation in oil content of the milk samples could be attributed to differences between the breeds of cow and management practices used in rearing them. The cows from whom milk were collected in this area were local breeds (White Fulani) which are reared extensively in contrast to the cows from Minna which were exotic breeds that are reared in a dairy farm using the intensive system in which adequate feeding and healthcare is ensured.

The mean dry matter content of 7.41±0.29 recorded for *kindirmo* varied significantly with the dry matter of a similar product recorded by [2] in Ougadougou, Burkina Faso. They recorded a mean dry matter content of 26.24±2.41. *Kindirmo* is a milk product produced by boiling fresh milk for about 20 min. The boiled milk is then allowed to cool and ferment overnight by spontaneous fermentation in a local calabash. After fermentation, water is added to the product to dilute it leading to an increase in the visible quantity of the product [19]. A statistically significant difference ($p<0.05$) was observed between the mean values of dry matter in fresh milk and *kindirmo* samples in this area.

The mean oil content of *kindirmo* samples collected from this area (11.34±0.34) was quite high compared to the 4.40±0.10 recorded by [19] in a study carried out to assess the physico-chemical and nutritional quality of dairy cattle products in Minna, Niger State, Nigeria. A statistically significant difference ($p<0.05$) was observed between the mean oil content of fresh milk

(9.09±0.30) and *kindirmo* (11.34±0.34) in this area which is in consonance with the findings of [19] who also observed a statistically significant difference ($p<0.05$) between the mean values of oil *kindirmo* and fresh milk in Minna, Nigeria. This significant difference could be attributed to the fact that, the *kindirmo* was made with fresh milk collected from different cows with each cow contributing different amount of oil to make up the overall oil content of the *kindirmo*.

The mean ash content of *kindirmo* samples (0.71±0.02) recorded in this area is in consonance with the mean ash content of 0.73±0.01 recorded by [8] in Sokoto, Nigeria. However, it varied significantly with the mean ash content of 1.50±0.00 recorded for *kindirmo* by [19] in Minna, Nigeria. The variation in the ash content of the samples can be associated with differences in feeding regime, stage of lactation, and health status of the milked cows [19] because *kindirmo* is produced using the same method and processing could not have accounted for the difference in ash content. The statistically significant difference ($p<0.05$) observed between the mean values of ash content of fresh milk, bulk milk, and *kindirmo* samples. The mean values were higher in fresh milk and bulk milk samples than in *kindirmo* samples. The comparatively low ash content recorded for *kindirmo* samples in this area could have resulted from the processes involved in the treatment of fresh milk to make *kindirmo*.

Table 2: The Proximate Composition of Fresh and Fermented Milk Samples Collected from Keffi Local Government Area

Sample	DM (%) Mean±SEM	CP (%) Mean±SEM	CF (%) Mean±SEM	Oil (%) Mean±SEM	Ash (%) Mean±SEM	NFE (%) Mean±SEM
KFM	8.32±0.29^{ab}	8.59±0.05^{b}	0.00±0.00^{a}	9.09 ±0.30^{c}	0.78±0.01^{a}	81.54 ± 0.34^{a}
KFB	8.71 ±0.19^{a}	9.47±0.84^{ab}	0.00±0.00^{a}	9.81±0.00^{bc}	0.76±0.02^{ab}	79.97 ± 0.87^{a}
KFN	6.19 ±0.23^{c}	11.15±0.16^{a}	0.00±0.00^{a}	12.60±0.46^{a}	0.62 ±0.01^{c}	76.93 ± 1.22^{a}
KFK	7.41 ±0.29^{b}	9.82±0.72^{ab}	0.00±0.00^{a}	11.34±0.34^{ab}	0.71 ±0.02^{b}	78.13 ± 0.76^{a}
P – Value	0.000	0.031	-	0.000	0.000	0.059

*For each parameter, means with different superscripts along columns vary significantly ($p<0.05$) using one-way ANOVA, SEM= standard error of mean. DM= Dry matter; CP= Crude protein; CF= Crude fibre; NFE= Nitrogen-free exracts; KFM = Keffi Fresh Milk; KFB = Keffi Bulk Milk; KFN = Keffi *Nono*; KFK = Keffi *Kindirmo*.

3.3 The Proximate Composition of Fresh and Fermented Milk Samples Collected from Akwanga Local Government Area

There was no statistically significant difference ($p>0.05$) between the mean values of dry matter of the different milk sample types collected from Akwanga (Table 3). However, the mean values were higher in *kindirmo* samples than in *nono* and fresh milk samples. This difference in mean values could have resulted from the addition of fresh milk during the process involved in the production of *kindirmo* and *nono*.

A statistically significant difference ($p<0.05$) was observed between the mean values of crude protein of the samples collected from this area. The mean crude protein of *kindirmo* samples (10.52±0.23) was higher than the 9.32±0.70 and 8.87±0.24 recorded for bulk milk and fresh milk samples respectively. This finding is surprising because, the protein content of fresh milk (an unprocessed food), should under ideal conditions, be more than that of *kindirmo* (processed food). This disparity may not be unconnected with milk adulteration, as there has been a suspicion among consumers, that milk producers and hawkers, sometimes, add certain substances to milk in order to increase its quantity with attendant increase in profit margin. The mean value of crude protein of (10.52±0.23) recorded for *kindirmo* in this area was slightly lower than the 11.60±0.10 reported by [19] from Minna, Niger State, Nigeria.

The mean oil values of bulk milk samples (9.84±0.02), was higher than that of fresh milk samples (9.17±0.32). This disparity could be attributed to the fact that, the bulk tank contained milk drawn from different cows with each milked cow contributing its share of oil in contrast with fresh milk samples, which were drawn from individual cows.

Table 3: The Proximate Composition of Fresh and Fermented Milk Samples Collected from Akwanga Local Government Area

Sample	DM (%) Mean±SEM	CP (%) Mean±SEM	CF (%) Mean±SEM	Oil (%) Mean±SEM	Ash (%) Mean±SEM	NFE (%) Mean±SEM
AKF	8.23±0.28[a]	8.87 ±0.24[c]	0.000±0.000[a]	9.17 ± 0.32[c]	0.76±0.01[a]	81.21±0.48[a]
AKB	8.85±0.17[a]	9.32±0.70[bc]	0.000±0.000[a]	9.84 ±0.02[b]	0.79±0.01[a]	80.06±0.68[a]
AKN	8.50±0.35[a]	10.96±0.24[a]	0.005±0.002[a]	9.29 ± 0.28[c]	0.99±0.03[a]	72.31±6.46[a]
AKK	9.48±0.22[a]	10.52±0.23[ab]	0.005±0.002[a]	10.82±0.49[a]	0.89±0.08[a]	78.03±0.65[a]
P – Value	0.055	0.007	0.493	0.033	0.125	0.639

*For each parameter, means with different superscripts along columns vary significantly ($p<0.05$) using one-way ANOVA, SEM= standard error of mean. DM= Dry matter; CP= Crude protein; CF= Crude fibre; NFE= Nitrogen-free exracts; AKF = Akwanga Fresh Milk; AKB = Akwanga Bulk Milk; AKN = Akwanga *Nono*; AKK = 'Akwanga *Kindirmo*.

3.4 The Proximate Composition of Fresh and Fermented Milk Samples Collected from Wamba Local Government Area

A statistically significant difference ($p<0.05$) was observed between the mean values of dry matter (total solids) of fresh milk and *kindirmo* samples in Wamba (Table 4). The mean values were higher in *kindirmo* (9.52±0.25) than in fresh milk samples (8.75±0.28) (Table 4). Higher levels of dry matter in milk results primarily from higher concentrations of protein compounds [9]. This agrees with an observation made in the samples collected from this area as the mean crude protein content of *kindirmo* samples (10.68±0.24), was found to be higher than that of fresh milk samples (8.73±0.04). However, this is baffling because, *kindirmo* was produced from fresh milk; therefore, much variation between the two in terms of dry matter content should not

be expected. This disparity in crude protein content of the samples may not be unconnected with adulteration which is the addition of certain substances to milk in order to increase visible quantity, reduce production cost, or for some other deceptive purposes. Adulteration can be deliberate or accidental.

A statistically significant difference ($p<0.05$) was observed between the mean values of crude protein in bulk milk samples (10.30±0.28) and fresh milk samples (8.73±0.04). This difference could be as a result of the fact that, the bulk tank contained milk drawn from different cow whose milk are of different compositions in contrast to fresh milk samples which were drawn from individual cows.

Table 4: The Proximate Composition of Fresh and Fermented Milk Samples Collected from Wamba Local Government Area

Sample	DM (%) Mean±SEM	CP (%) Mean±SEM	CF (%) Mean±SEM	Oil (%) Mean±SEM	Ash (%) Mean±SEM	NFE (%) Mean±SEM
WMF	8.75±0.28^{b}	8.73 ±0.04^{b}	0.000±0.00^{a}	9.54±0.30^{a}	0.82±0.02^{a}	80.91 ±0.29^{a}
WMB	9.62±0.90^{a}	10.30±0.28^{a}	0.000±0.00^{a}	9.40±0.47^{a}	0.92±0.10^{a}	79.39 ±0.09^{a}
WMN	8.38±0.29^{b}	11.33±0.25^{a}	0.003±0.00^{a}	9.53±0.38^{a}	0.92±0.04^{a}	79.25 ±0.97^{a}
WMK	9.52±0.25^{a}	10.68±0.24^{a}	0.001±0.00^{a}	9.69±0.30^{a}	1.00±0.05^{a}	78.63 ±0.32^{a}
P – Value	0.032	0.000	0.468	0.975	0.185	0.380

*For each parameter, means with different superscripts along columns vary significantly ($p<0.05$) using one-way ANOVA, SEM= standard error of mean. DM= Dry matter; CP= Crude protein; CF= Crude fibre; NFE= Nitrogen-free exracts; WMF = Wamba Fresh Milk; WMB = Wamba Bulk Milk; WMN = Wamba *Nono*; WMK = Wamba *Kindirmo*.

3.5 The Proximate Composition of Fresh and Fermented Milk Samples Collected from Lafia Local Government Area

The mean dry matter values varied among the different sample types collected from Lafia. A statistically significant difference ($p<0.05$) (Table 5) was observed between the mean values of dry matter of bulk milk samples (9.74±0.52) and fresh milk samples (8.44±0.27) in this area. This difference in mean dry matter content might have stemmed from the fact that, bulk milk is a mixture of milk of varying compositions drawn from different milked cows in comparison with fresh milk samples drawn from individual milked cows. High dry matter of milk is synonymous with 'high milk total solids' and is believed to have resulted from high concentrations of protein compounds [9]. This lend credence to an observation made in this area vis-à-vis the crude protein content of bulk milk samples (10.35±0.18) which was found to be higher than that of fresh milk samples (9.21±0.35).

The mean crude protein of fresh milk samples recorded in this area is far below the 42.72±0.15 reported by [5] in Minna, Niger State, Nigeria. This difference in crude protein content of the milk could be attributed to the difference between the breeds of cattle at the Fulani settlements from which the fresh milk samples in this study were drawn, and the fresh milk samples drawn from cows at commercial dairy farms in Minna. In addition, feeding regimen might accounted for these differences because in dairy farms, adequate attention is paid to the quantity and quality of feeds given to the cows and this translates to an increase in milk yield and quality, unlike the management system at the Fulani settlements where heavy reliance is placed on pasture.

A statistically significant difference ($p<0.05$) was observed between the mean values of oil in *kindirmo* and fresh milk samples collected from this area. The mean oil content of *kindirmo* (11.71±0.49) was higher than the 9.50±0.15 and 9.21±0.30 recorded for fresh milk and bulk milk samples respectively. This finding agrees with a trend recorded by [19] who recorded the mean values of oil of 4.40±0.10 and 2.50±0.00 for *kindirmo* and fresh milk samples respectively. This difference in mean oil content between *kindirmo* and fresh milk can be as a result of the fact that, *kindirmo* is a mixture of milk of different compositions drawn from different milked cows, unlike the fresh milk which were drawn from individual cows.

Table 5: The Proximate Composition of Fresh and Fermented Milk Samples Collected from Lafia Local Government Area

Sample	DM (%) Mean±SEM	CP (%) Mean±SEM	CF (%) Mean±SEM	Oil (%) Mean±SEM	Ash (%) Mean±SEM	NFE (%) Mean±SEM
LFM	8.44±0.27[b]	9.21 ±0.35[a]	0.00 ±0.00[a]	9.50 ± 0.15[b]	0.74±0.02[b]	80.05±0.86[a]
LFB	9.74±0.52[a]	10.35±0.18[a]	0.00 ±0.00[a]	9.21 ± 0.30[b]	0.95±0.05[a]	79.49±0.07[a]
LFN	6.82±0.29[c]	9.78 ± 0.54[a]	0.00 ±0.00[a]	11.98 ± 0.38[a]	0.59±0.03[c]	77.65±0.70[a]
LFK	8.11±0.33[b]	10.17±0.96[a]	0.00 ±0.00[a]	11.71 ± 0.49[a]	0.70±0.01[b]	77.42±0.68[a]
P – Value	0.000	0.834	-	0.001	0.000	0.078

*For each parameter, means with different superscripts along columns vary significantly ($p<0.05$) using one-way ANOVA, SEM= standard error of mean. DM= Dry matter; CP= Crude protein; CF= Crude fibre; NFE= Nitrogen-free exracts; LFM = Lafia Fresh Milk; LFB = Lafia Bulk Milk; LFN = Lafia *Nono*; LFK = Lafia *Kindirmo*.

3.6 The Proximate Composition of Fresh and Fermented Milk Samples Collected from Doma Local Government Area

The mean dry matter content of samples collected from Doma varied from one sample type to another (Table 6). The mean dry matter value was higher in bulk milk compared to fresh milk and *nono* samples. A statistically significant difference ($p<0.05$) was observed between the mean values of dry matter in bulk milk and fresh milk samples (Table 6). As advanced by [9], higher dry matter values results majorly from higher concentrations of protein compounds. This assertion lend credence to an observation made in this area as the mean crude protein content of bulk milk samples (10.08±0.12) was found to be higher the 9.11±0.32 recorded for fresh milk

samples. No statistically significant difference ($p>0.05$) was however, found between the mean value of crude protein in bulk milk and fresh milk samples.

A statistically significant difference ($p<0.05$) was found between the mean values of dry matter in fresh milk and *nono* samples in this area. This difference could be attributed to the decrease in protein contents of the samples, which might have resulted from the activities of proteolytic enzymes produced by bacteria present in *nono* which was acquired during handling and processing.

Table 6: The Proximate Composition of Fresh and Fermented Milk Samples Collected from Doma Local Government Area

Sample	DM (%)	CP (%)	CF (%)	Oil (%)	Ash (%)	NFE (%)
	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM	Mean±SEM
DMF	8.32 ±0.30^{b}	9.11 ±0.32^{a}	0.00±0.00^{a}	9.44 ±0.14^{b}	0.76±0.03^{ab}	80.70 ± 0.46^{a}
DMB	9.69 ±0.73^{a}	10.08±0.12^{a}	0.00±0.00^{a}	9.38 ±0.48^{b}	0.91 ±0.10^{a}	79.13 ± 0.24^{a}
DMN	6.86 ±0.23^{c}	9.29 ± 0.45^{a}	0.00±0.00^{a}	11.66±0.32^{a}	0.62 ±0.07^{b}	78.44 ± 0.57^{a}
DMK	9.32±0.22^{ab}	10.45±0.38^{a}	0.00±0.00^{a}	9.65 ±0.23^{b}	0.98 ±0.04^{a}	78.92 ± 0.41^{a}
P – Value	0.000	0.129	-	0.000	0.001	0.079

*For each parameter, means with different superscripts along columns vary significantly ($p<0.05$) using one-way ANOVA, SEM= standard error of mean. DM= Dry matter; CP= Crude protein; CF= Crude fibre; NFE= Nitrogen-free exracts; DMF = Doma Fresh Milk; DMB= Doma Bulk Milk; DMN = Doma *Nono*; DMK = Doma *Kindirmo*.

4.0 CONCLUSION

The proximate composition of milk and milk products (fresh milk, bulk milk, *nono*, and *kindirmo*) collected from different parts of Nasarawa State were determined using the procedure of Association of Official Analytical Chemists (AOAC). Findings in this study revealed that, bulk milk generally had the most nutritional content than fresh milk, *nono*, and *kindirmo* in most of the sampled areas. A statistically significant difference ($p<0.05$) was found between the mean values of dry matter (total solids), oil, and ash contents of bulk milk samples and *nono*. Fresh and bulk milk samples were found to have contained more minerals (ash) in some areas, namely, Nasarawa, Keffi, Wamba, and Lafia, than *kindirmo* samples and this may be attributed to the loss of some of the minerals during the processing of fresh milk to make *kindirmo*. Surprisingly, *kindirmo* samples collected from Keffi, Akwanga, Wamba, Lafia, and Doma, were found to have contained more crude protein than fresh and bulk milk samples. This may not be unconnected with milk adulteration because, since *kindirmo* was made from fresh cow milk, such great variations in protein content should not be expected. Overall, majority of the milk and milk products analysed in this study, satisfied the minimum requirements for milk and milk products recommended by the European Union Quality Standards and the Food and Agricultural Organisation (FAO). There were, however, slight variations in the proximate compositions of the different sample types, which may be attributed to health status of the milked cows, and differences within a breed (the cows were of the same breed).

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