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Physico-Chemical and Nutritional Qualities of Dairy Cattle Products

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Abstract

This study investigated the physicochemical and nutritional qualities of fresh milk, *nono* and *kindirmo* from two dairy farm settlements in Bida Local Government. Samples were collected and evaluated for their physico-chemical properties (pH, titritable acidity and viscosity) and nutritional qualities (the proximate composition, minerals and vitamins). The pH of the samples differed significantly ($p<0.05$).There were also significant differences in the proximate contents ($p<0.05$). The results of the analyses showed that the moisture content (%) of the products ranged from 6.5-12.4; fat content was between 2.5 and 4.4%. The mineral composition of the three milk (mg/ml) ranged from 4.0-5.2 for nitrogen, 0.2-2.6 (phosphorus), 0.0-1.2 (potassium) while the vitamin composition (mg/ml) of the three dairy products ranged 0.0-0.3 (thiamine), 0.2-0.3 (vit B), and 1.4-1.7 (vit B_{12}). These results were compared with the compositional quality of other workers and international quality standards.

Key words: *nono, kindirmo, fresh milk, physico-chemical, nutritional properties*

1.0 Introduction

Milk is one of the most valuable foods containing practically all nutrients. Milk is often regarded as being nature's most complete food. The role of milk in nature is to nourish and provide immunological protection for the mammalian young. It earns this reputation by providing many of the nutrients which are essential for the growth of the human body. Being an excellent source of protein and having an abundance of vitamins and minerals, particularly calcium, milk can make a positive contribution to the health of a nation (Igbabul and Amove, 2014). Medical research study has shown that for a woman desiring to have a child her fertility can be increased by feeding on dairy products (Benkerroum *et al*., 2009). Milk appears to be effective in promoting muscle growth (Lawaland Adedeji, 2013). It is utilized in the production of at least 400 different fermented products all over the world (Okeke *et al*., 2014). Some of these fermented products are *nono, kindirmo,* dahi and cheese. *Kindirmo* is a fermented milk product mostly consumed by the Hausas (Fulanis) in northern Nigeria. *Kindirmo* is a full fat or partially cultured skimmed milk while *nono* is the skimmed (defatted) cultured milk. The realization of its nutritional attributes is clearly illustrated by the implementation of numerous 'school milk programmes' worldwide.

The major chemical components of milk include water, fats, proteins, carbohydrates, minerals, organic acid enzymes and vitamins. The type of animal, its quality, and its diet can lead to differences in the colour, flavour, and composition of milk [6]. There are many factors that can affect milk composition such as breed variations, cow to cow variations, herd to herd variations - including management and feed considerations, seasonal variations and geographic variations (Millogo *et al*., 2008). In many developing countries like Nigeria most pastoralists move about in search for green pasture. In Nigeria a major part of the local milk production is done mainly by the Fulani who control at least 96% of the cattle population (Yunusa, 2011) and the milk produced is from indigenous cattle breeds which are kept primarily by the pastoralist tribesmen. The cattle are rarely given standard feeds. The kinds of feed intake later reflect in the composition of their milk

The nutritional composition of milk is important in determining the properties of milk. In order to assess the quality of milk, milk samples including milk powder, milk from market, raw milk, human and animal from various countries such as Pakistan, Canada and Nigeria have been extensively studied. To our best of knowledge, studies on the physico-chemical composition of *nono, kindirmo* marketed at Bida, Nigeria has not been reported. Therefore, the objective of this paper is to determine physico-chemical and nutritional quality of dairy cattle products

2.0 Materials and Methods

2.1 Sampling

A Hundred and fifty samples of fresh milk, *nono* and kindirmo from two sites was collected in sterile sampling bottles transported to Centre for Genetic and Engineering Laboratory (STEP-B Lab), Federal University of Technology Minna for analysis.

2.2 Determination of Physico-chemical Properties

2.2.1 Determination of dynamic viscosity of milk samples

Viscometer (NDJ-I) was used to determine the viscosity of the milk samples. The temperature of the sample was determined with a thermometer at 30±2^{o}C. The spindle size four (4) was dropped in 500ml of milk and the rotator was set for 60 resolutions per minutes. The rotator was allowed to swing for 15 seconds. The readings on the dials were taken 3 times for each sample. The average was multiplied by the spindle size coefficient from the coefficient table and then recorded.

2.2.2 pH

The pH of the samples was determined using a pH meter. The electrode of the pH meter was standardized by dipping it into sterile water after which two different buffers (4.0 and 7.0) were used. The set electrode was then used for the various samples and readings were recorded.

2.2.3 Titratable acidity (TTA).

Thirty millilitres of each sample: (fresh milk, *nono* and *kindirmo*) were boiled on hot plate to remove carbon. These were allowed to cool and the initial volume was restored by adding sterile distilled water. Ten millilitres aliquot of diluted samples were transferred into a conical flask and a drop of phenolphthalein indicator was added and titrated with 0.05M NaOH until a pink colour appeared. The titratable acidity was then calculated (Field, 1977).

2.3 Proximate analysis

2.3.1 Moisture content

Using vacuum oven method, 5ml of each sample was transferred into pre-weighed drying dish. The dish and contents were weighed. This was placed in pressure oven and dried for 5hrs at 100^{o}C under pressure 100mHg. The dish was then placed in desiccators to cool. The samples were re-weighed and difference in weight was recorded. Percent moisture was calculated **(AOAC, 1990).**

2.3.2 Ash content

Five (5) millilitres of samples were weighed into a dried weighed dish. The sample dish was re-weighed and then transferred into oven at 95^{o}C for 6hrs.The dish residue was re-weighed and Ash percent calculated **(AOAC, 1990).**

2.3.3 Crude fibre

Two grams of samples were defatted with petroleum ether, boiled in 1.25g of H_2SO_4 and filtered. This was washed in boiling water, dried in oven, and weighed. % of crude fibre = loss in weight x after incineration x 100 (AOAC, 2000)

2.3.4 Fat

Five grams of samples were mixed with methanol and chloroform. This was then centrifuged. The chloroform layer was removed and the fat residue weighed and percent fat calculated thus:
% fat = weight of fat/Weight of sample X100 (AOAC, 2000).

2.3.5 Crude protein content determination

The crude protein was determined using titration. Ten millilitres of milk sample was transferred with a pipette into a conical flask containing 1.0ml of phenolphthalein and 0.4ml potassium oxalate solution and was then left for 2 mins. The stocks was neutralized and left for 2mins to a faint colour using a burette. Approximately 2ml of 0.1M 40% formaldehyde solution was added. The titration continued until a pink colour appeared and the amount of 0.1M required for the second titration was recorded. The protein % was calculated as described by (AOAC, 2000)

2.3.6 Carbohydrate determination

Twenty millilitres of hydrochloric acid (HCl) and 150ml of distilled water were added to 2.5ml of milk. This was refluxed for 2hours in a flask. The solution was then cooled and neutralized with 5N NaOH. The glucose content was determined by adding 5ml of anthrone reagent to 1ml of each of the standard solution. This was boiled in water bath for 20mins the sample with standard solution. The concentration of the test sample was obtained from the absorbance by interpolation as described by (AOAC, 1990)

2.3.7 Milk energy value

The milk energy content was determined by burning 2ml of the sample in par adiabatic oxygen bomb calorimeter. The heat of combustion of the sample was calculated (Gregory & Okpara, 2005)**.**

2.4 Elemental Analysis

2.4.1 Determination of calcium and magnesium

Ten grams (10g) milk and milk products were first digested with 20mls of mixture (650ml conc. HNO_3; 80ml perchloric acid; 20ml conc. H_2SO_4). Calibrated curves are prepared for each element using standard solution. The aliquots of the diluted clear digest were used for atomic absorption spectrophotometry using filter paper that matches the elements as described by [(Gregory & Okpara, 2005)**.**

2.4.2 Determination of sodium and potassium

One gram of the samples was digested with 20ml of acid mixtures as mentioned above and the diluted aliquots are taken for photometry using flame analyzer. Absorbance for sodium (Na) was read at 767nm while potassium was read at 589nm.The concentration sodium and potassium was obtained from the calibration curves obtained from the standard (Gregory & Okpara, 2005)**.**

2.4.3 Determination of phosphorus and sulphur

This was determined by molybdate method using hydroquinone as reducing agent. A mixture of 0.1 sodium sulphate and 10ml of hydroquinone was added to 0.5ml of the mineral digest. This was agitated and allowed to stand for 30min.The blue colour that developed was quantified using a calorimeter at 660nm against a standard curve as described by (Gregory & Okpara, 2005)**.**

2.4.4 Determination of vitamin C

One hundred millilitres of distilled water was added to samples to make a paste after which it was filtered to get a clear solution. Exactly 10ml of the filtrate was transferred with a pipette into a flask and 2.5ml acetone was added. This was then titrated with indophenols solution to a faint pink colour which persisted for 15secs.The concentration of ascorbic acid was expressed as mg ascorbic acid equivalent to 1ml of the dye solution as described by [(Gregory & Okpara, 2005)**..**

2.5 Determination of Vitamins

2.5.1 Determination of vitamin A

After saponification of the samples with potassium hydroxide, retinol was extracted by solvent partition using a mixture of xylene-kerosene (1:4). The optical absorbance of the samples extract was read at 460nm for determination of carotenoids and at 328nm for retinol determination. The extracts of the samples were then irradiated with ultraviolent light and its absorbance read again at 328nm.The difference in optical absorbance at 328nm before and after irradiation of the samples corresponds to the amount of retinol present in the concentration of carotenoids and retinol is calculated.

Retinol=A^o (328-A^I X 637. Where A^o (460) X480= A^o= initial optical absorbance reading, A^I= optical absorbance after ultraviolent irradiation as described by (Gregory & Okpara, 2005)**.**

2.5.2 Determination of riboflavin

Riboflavin was determined by extracting the samples with dilute hydrochloric acid. The interfering substances were removed by treatment with $KMnO_4$. Riboflavin was then determined in a fluorimeter at 450-500nm wavelength. The intensity of fluorescence is proportional to the concentration which was calculated as described by (Gregory & Okpara, 2005)**.**

2.5.3 Determination of thiamine

Milk samples were treated with diluted HCl to extract thiamine complex which was then treated with phosphatase to liberate free thiamine. It was purified passing through Base Exchange silicate alkaline column to remove interfering compounds. The column was eluted with ferricyanide to oxidize thiamine to thiochrom which was measured flourometrically (sample and blank). The vitamins were determined in triplicates titrimetrically and flourometrically as described by (Gregory & Okpara, 2005)**.**

2.6 Data Analysis

Analysis of Variance (ANOVA) was carried out for the physico-chemical and nutritional properties (pH, TTA, viscosity, proximate vitamins, minerals). The mean scores were computed and significant differences among the mean was determined using 2006 Statistical Packages for Social Sciences (SPSS) For Windows version 15.0.

3.0 Results and Discussion

3.1 Physicochemical and proximate Content of samples

The physicochemical contents of milk and milk products (fresh milk, *nono* and *kindirmo*) collected from Madobia and Project quarters in this study revealed that the viscosity, pH and titratable acidity of milk and its products were at variance. Significant differences ($p<0.05$) were noted amongst the milk products obtained from Madobia. A similar trend was observed in the milk products collected from Project quarters. These differences could be due to the procedure used in *kindirmo* processing such as the addition of water to *nono* after production. There were significant difference ($p<0.05$) in the viscosity of fresh milk, *nono* and kindirmo. Table1 shows the

viscosity of milk products *kindirmo* has the highest viscosity followed by *nono* and fresh milk at (30±2°C). The mean viscosity (cP) of the milk samples included 180, 213 and 270 for fresh milk, *nono* and kindirmo respectively. Significant differences ($p<0.05$) were observed amongst the milk products obtained from Madobia. A similar trend was observed in the milk samples collected from Project quarters. These differences could be due to the procedure involved in kindirmo processing. Generally, viscosity of a product is said to vary with changes in the temperature of the food (Yamamoto *et al*., 2010).

The pH of fresh milk 6.5 as recorded in this study was within the range of 6.4-6.8 reported by (Rahman & Salaria, 2005). The low pH of *nono* (3.74) is not unexpected as *nono* is a fermented product and may be due to the activities of the lactic acid bacteria which were isolated from the *nono*. There were also significant differences in the titratable acidity of the three products as n*ono* had the highest value (3.74). This may account for the reason why *nono* has a sour taste.

The moisture content obtained in this study 6.5-12.4% was quiet low compared to moisture content 86.99% reported by [16]. The disparity in the moisture content may be due to the regular supply of water to cattle from the standard farms that the researcher studied. Also the results obtained in the proximate content of the milk and milk products as evaluated in this study compared favourably with that of other workers such as (Invensys, 2002). They reported fat and ash content of raw milk to be (4.14 and 0.778%) and this is comparable with the result of this study (fat - 2.53 and ash-1.00%). The fat content of milk is of economic importance because milk is sold on the basis of its fat content (Pieter *et al*., 2007). The potassium content obtained in this study was 1.2 in 100mg/ml which was less than 3841-17200mg/l as recommended by (WHO, 1989).

Table 1: Viscosity of Milk Products from Madobia and Project Quarter

	Locations/Viscosity (cP) [1,2]	
Dairy products	Madobia	Project quarters
Fresh milk	180.0±1.0^{c}	150.0±1.7^{c}
Nono	213.3±11.5^{b}	364.0±6.9^{b}
Kindirmo	270.0±6.4^{a}	441.0±3.6^{a}

[1] Each value is the mean + S.D of 50 determinations
[2] Different letters within the same column are significantly different ($p<0.05$)

Table 2: Physiochemical properties of milk and milk products

	Analyses[1,2]	
Milk product	pH	Titratable acidity
Fresh milk	6.5±0.1^{a}	0.1±0.1^{b}
Nono	3.7±0.1^{c}	0.9±0.1^{a}
Kindirimo	4.1±0.0^{b}	0.9±0.1^{a}

[1] Each value is the mean + S.D of 50 determinations
[2] Different letters within the same column are significantly different ($p<0.05$)

Table 3: Proximate contents of milk and milk products

	Fresh milk		*Nono*		*Kindirmo*	
Analyses (%)	Madobia	Project quarters	Madobia	Project quarters	Madobia	Project quarters
Moisture	12.4±0.3^{a}	12.4±0.3^{a}	6.5±0.0^{c}	6.5±0.0^{c}	11.6±0.1^{b}	11.6±0.1^{b}
Fat	2.5±0.0^{c}	2.5±0.0^{c}	3.7±0.1^{b}	36±0.0^{b}	4.4±0.1^{a}	4.4±0.1^{a}
Crude proteins	25.9±0.1^{c}	25.8±0.1^{c}	27.6±0.1^{b}	27.7±0.2^{b}	33.0±0.0^{a}	33.0±0.5^{a}
Crude fibre	2.0±0.5^{a}	2.0±0.5	2.0±0.0^{a}	2.0±0.0^{a}	15±0.0^{a}	1.5±0.0^{a}
Ash	1.8±0.3^{a}	1.0±0.5	1.25±0.8^{a}	1.77±0.3^{ab}	1.50±0.0^{a}	2.00±0.5^{a}
Carbohydrates	55.5±0.0^{b}	55.5±0.0^{b}	59.3±0.6^{a}	59.3±0.6^{a}	49.7±2.1^{c}	49.7±2.1^{c}
Energy value(kj)	348.0±0.2^{b}	348.4±0.6^{b}	379.0 ±2.8^{a}	379.4±2.8^{a}	370.9±7.2^{a}	370.9±7.2^{a}

[1] Each value is the mean + S.D of 50 determinations
[2] Different letters within the same row are significantly different ($p<0.05$)

3.2 Mineral and Vitamin Content of Milk and Milk Products

The vitamin content as shown in Table 5 of this study revealed that fresh milk had higher vitamin content than *kindirmo* and *nono*. This may be a reflection from the high vitamin content that the cattle obtained from the feed concentrate. The reduction in level of vitamin of *nono* and *kindirmo* may be as a result of the processing procedures that might have denatured the vitamin (pasteurization and defatting; (Mohammad *et al*., 2008).

The nutritional content of milk and milk products as obtained in this study (Table 1-4) shows that there were variations in all the nutritional parameters. These may be as a result of nutritional variation among the different cows and their feed concentrates. Akinyosoye (2015) reported that milk compositions are affected by breed variation, management, seasonal variations and geographical changes. In Nigeria most herdsmen move from one place to another in search for pastures. No standard concentrate are given to the cattle. Many developing countries are suffering from shortages of fluid milk and other dairy products prevalence diseases from parasite (Lawal and Adedeji, 2013)

Table 4: Mineral composition of milk and milk products from two sites

	Fresh milk		*Nono*			*Kindirmo*
Analyses (100 mg/ml)	Madobia	Project quarters	Madobia	Project quarters	Madobia	Project quarters
Nitrogen	4.0±0.1[c]	4.0±0.1[c]	4.5±0.1[b]	4.5±0.1[b]	5.2±0.0[a]	5.2±0.0[a]
Phosphorus	2.4±0.1[b]	2.4±0.1[b]	0.2±0.0[c]	1.3±0.0[c]	2.6±0.0[a]	2.6±0.1[a]
Potasium	0.2±0.00[b]	1.2±0.1[a]	0.4±0.1	0.4±0.1[c]	0.0+0.0[b]	0.6±0.0[b]
Sodium	1.1±0.1[b]	0.4±0.0[b]	0.1±0.0[c]	0.2±0.0[c]	0.5±0.0[a]	0.5±0.0[a]
Calcium	0.5±0.0[c]	0.5±0.4[c]	1.7±0.0[b]	1.7±0.0[b]	2.1±0.1[a]	2.7±0.1[b]
Magnesium	0.3±0.0[b]	0.3±0.0[a]	0.3±0.2[c]	0.3±0.0[a]	0.2±0.0[a]	0.2±0.0[b]
Sulphur	1.2±0.0[a]	0.2±0.0[b]	0.1±0.0[c]	0.2±0.0[c]	0.2±0.0[a]	0.3±0.0[a]

[1]Each value is the mean + SD of 50 determinations
[2]Different letters within the row are significantly different at $p<0.05$

Table 5: Vitamin composition of milk and milk products from two sites

	Fresh milk		*Nono*		*Kindirmo*	
Analyses	Madobia	Project quarters	Madobia	Project quarters	Madobia	Project quarters
Vitamin C (mg/ml)	0.1±0.001[a]	0.1±0.004[a]	0.1±0.002[c]	0.1±0.005[c]	0.1±0.001[b]	0.1±0.002[b]
Vitamin A (mg/ml)	0.0±0.000[a]	0.0±0.005[a]	0.0±0.001[c]	0.0±0.002[c]	0.0±0.001[b]	0.0±0.001[b]
Riboflavin (mg/g)	0.2±0.001[a]	0.2±0.008[a]	0.2±0.002[b]	0.2±0.001[b]	0.2±0.001[c]	0.2±0.001[c]
Thiamine (mg/g)	1.5±0.043[b]	1.5±0.023[a]	1.4±0.221[c]	1.1±0.776[a]	1.5±0.006[a]	1.5±0.004[a]
Vitamin B (mg/ml)	0.3±0.001[b]	0.3±0.007[a]	0.2±0.001[c]	0.2±0.002[c]	0.3±0.003[a]	0.3±0.004[b]
Vitamin B_{12} (mg/ml)	1.7±0.040[a]	1.6±0.157[a]	1.4±0.005[b]	1.4±0.003[b]	1.4±0.061[c]	1.4±0.061[c]

[1]Each value is the mean + SD of 50 determinations
[2]Different letters within the row are significantly different ($p<0.05$)

4.0 Conclusion

The physicochemical contents of milk and milk products (fresh milk, *nono* and *kindirmo*) collected from two local farm settlements in this study revealed that *kindirmo* has more nutritional content than *nono*. This findings revealed that the milk and milk products that were sampled are of low mineral quality when compared with WHO standard. The nutritional content of milk and milk products as obtained in this study shows that there were variations in all the nutritional parameters. These may be as a result of nutritional variation among the different cows and their feed concentrates. In order to raise the nutritional quality of the milk products, the Fulani who are the major producers of dairy cattle product in Nigeria should be educated through Nomadic school on the use of improved dairy ration options based on locally available agro- industrial by-products whole grains, crop residues and highly nutritive concentrates for optimum milk production.

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