Physicochemical and Sensory Quality Assessment of 'Nono' Sold In Mangu Local Government Area of Plateau State, Nigeria

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Abstract- A study was conducted on 'nono' (locally fermented cow milk) sold in Mangu Local Government Area of Plateau State to assess its physicochemical quality and sensory characteristics. A total of 300 'nono' samples were randomly collected from 10 purposively selected markets in the study area for laboratory assessment. The overall means for temperature, pH, specific gravity (SG), and titratable acidity (TA) were 27.80±2.90ºC, 5.78±0.76, 1.029±0.01g/ml and 0.186±0.03% respectively. A significant difference (P<0.05) was established among the means of these variables from the different markets. The overall means for total solids, solids-not-fat, fat, protein, ash and lactose contents of the product were 12.38±0.66%, 8.55±0.37%, 3.83±0.46%, 3.01±0.27%, 0.97±4.00% and 4.15±0.27% respectively. A statistically significant difference (P<0.05) was also found among these variables. The overall means for the taste, aroma, colour, appearance and general acceptability of the product were 5.19±3.06, 5.06±1.16, 5.18±1.08, 5.19±1.14 and 5.38±1.09 respectively. The sensory evaluation of the product revealed no statistically significant difference (P>0.05) among the markets. It was concluded that the physical and chemical composition of 'nono' sold in the study area as at the time of this research were within the recommended quality standards of whole milk and milk products.

Index Terms- Assessment, Chemical quality, Nono, physical quality, Sensory quality

I. Introduction

In Nigeria, locally fermented raw cow milk is known as 'nono' (Makut et al., 2014). Obande and Azua (2013) also viewed nono as a general name used for locally fermented cow milk, and that it is widely consumed in many African countries, including Nigeria. Nono is Nigerian locally fermented milk product commonly prepared by Hausa/Fulani cattle rearers (Adesokan et al., 2011).

Milk and its products such as nono form part of the human diet all over the world. Milk quality continues to be a topic of intense debate in the dairy industry and in medical and public health sectors (Oliver et al., 2009). Production of the best quantities of good quality milk and milk products (nono inclusive) is an important aspect of standard dairy practice (Maduka et al., 2013). The demand of consumers for safe and high quality milk has placed a significant responsibility on dairy producers, retailers and manufacturers to produce and market safe milk and milk products (Gemechu et al., 2015). Bhatia et al. (2015) stated that the quality and safety of milk encompasses milk characteristics such as chemical composition, Physical properties, microbiological quality, and sensory properties. This implies that 'nono' with good sensory properties (free from unusual odour, taste, colour, and so on), adequate microbiological status (absence of pathogenic organisms and other microbial contaminants), standard physical properties (such as temperature, specific gravity, pH, titratable acidity, among others), and standard chemical composition (such as total solid fat, solid-not-fat, protein, ash, lactose, among others) can be considered safe and qualitative for human and public consumption.

Physicochemical analysis is an important tool to monitor the quality of milk and their dairy products (Teklemichael et al., 2015). The physical characteristics such as temperature, pH, specific gravity, titratable acidity, among others, as well as the chemical characteristics such as total solid, solids-not-fat, fat, protein, ash and lactose are important parameters in studying the physicochemical compositions of milk (Imran et al., 2008). The acceptability of milk and milk products is also determined by the evaluation of the sensory qualities such as texture, appearance, taste, aroma, colour and overall acceptability (Wakil et al., 2014).The objective of this study is to assess the physical, chemical and sensory characteristics of locally fermented cow milk (nono) sold in Mangu Local Government Area of Plateau State.

II. MATERIALS AND METHODS

The Study Area

This research work was carried out in Mangu Local Government Area of Plateau State, Nigeria (Figure 3). The Local Government is situated in the south Eastern part of the state, and it is one of the local governments that make up the Plateau central senatorial zone. Mangu which lies about 77 kilometers south of Jos, is a semi-urban settlement with a huge farming population. It is located on Latitude 9º31'N and Longitude 9º06'E. The Local Government has nine (9) districts with a population of 294,931 people as at 2006 census, and has a land area of 1,653 square kilometers.

Sample Collection

The sample collection method of Ogbonna (2011) was adopted in this study. Nono samples were purchased from ten (10) different markets all within Mangu Local Government Area. Thirty (30) samples were randomly purchased at intervals from nono sellers in each of Mangu market, Pushit market, Kerang market, Ampang market, Panyam market, Gindiri market, Mangun market, Kombun market, Chanso market and Kadunu market. The selection of these markets was based on cattle population, nono hawkers and patronage. The purchased samples were transported to the central diagnostic laboratory of the National Veterinary Research Institute (NVRI) Vom in sterile corked plastic tubes parked in an iced container for physicochemical and sensory properties analyses.

III. DETERMINATION OF PHYSICOCHEMICAL PROPERTIES OF NONO

Determination of temperature and pH

The temperature of the nono samples was determined at the collection point using thermometer while the pH of the samples were determined in the laboratory using a digital pH-meter as described by Teklemichael et al. (2015).

Determination of specific gravity

Fresh nono sample was filled sufficiently into a glass cylinder (100ml capacity). Then, lactometer was hold by the tip and inserted into the nono. The lactometer was allowed to float freely until it reached equilibrium. Then the lactometer reading at the lower meniscus was recorded. At the same time, thermometer was inserted into the nono sample and the temperature of the nono was recorded (Gemechu et al., 2015). The following formula was used to calculate the specific gravity of the nono:

$$\text{Specific gravity} = (L/1000) + 1$$

Where L = corrected lactometer reading at a given temperature, that is, for every degree above 15.56oC, 0.2 was subtracted from the lactometer reading.

Determination of titratable acidity

Titratable acidity of the nono samples was determined according to the method of the Association of Official Analytical Chemists (AOAC) as described by Gemechu et al. (2015). 9ml of nono sample was pipetted into a beaker and 3 to 5 drops of 1% phenolphthalein indicator was added to it. The nono sample was then titrated with 0.1N NaOH solution until a faint pink color persisted. The titratable acidity, expressed as % lactic acid, was finally calculated using the following formula:

$$\text{Titratable acidity(\%)} = \frac{N/10\text{NaOH (ml)} \times 0.009}{\text{Weight of nono sample}} \times 100$$

Determination of total solids

For the determination of total solids content, fresh nono sample was thoroughly mixed and 5g was transferred to a pre-weighed and dried flat bottom crucible as described by Teklemichael et al. (2015) and Gemechu et al. (2015). The nono samples were dried in a hot air oven (Model-EDSC made in England) at 102ºC for three hours. Finally, the dried samples were taken out of the oven and placed in desiccators to cool at room temperature. Then samples were weighed again and total solid was calculated as:

$$\text{Total Solids (\%)} = \frac{CW + ODS - CW}{\text{Sample weight}} \times 100$$

Where CW= Crucible weight, ODS = Oven dry sample.

Determination of crude protein

Total protein content of the nono samples was determined according to the Kjeldahl method of the Association of Official Analytical Chemists (AOAC) as described by Gemechu et al. (2015) and Teklemichael et al. (2015). For digestion, 5g of nono sample was warmed in a water bath at 38ºC and poured into a Kjeldahl flask. A mixture of 15g potassium sulphate, 1ml of copper Sulphate solution and 25ml of concentrated Sulphuric acid was added into the flask and mixed gently. The digestion was carried out in a digestion block until a clear solution appeared. Then, it was allowed to cool at room temperature. The digested solution was diluted with 250ml of distilled water.

For distillation, digestion flask was placed in the distillation equipment. 75ml of 40% sodium hydroxide solution were added into it. Then ammonia was distilled and 50ml of 40% boric acid solution using bromocresol green indicator were added until blue colour appeared. Finally, the sample was titrated with 0.1N hydrochloric acid solution from a burette until a faint pink colour solution was formed and the burette reading was taken to the nearest 0.01ml. Blank test was carried out using the above procedure except that water was used instead of test sample. The percentage of nitrogen in the nono samples were calculated as follows:

$$N(\%) = \frac{(Vs-Vb)\ \text{HCl consumed} \times \text{NHCl} \times 1.4007}{\text{Sample weight}} \times 100$$

$$CP(\%) = N(\%) \times 6.38$$

Where N (%) = Percentage nitrogen by weight, Vs = Volume of HCl used for titration of sample, Vb = Volume of HCl used for titration of the blank, CP (%) = Percentage of crude protein.

Determination of fat content

Fat content was determined by Gerber method according to Teklemichael et al. (2015) and Gemechu et al. (2015). 11ml of nono sample was mixed with 10ml of commercial sulfuric acid (having a specific gravity of 1.82). The mixture was dispensed into butyrometer and 1ml of amyl alcohol was added into the butyrometer having the sulfuric acid and then closed with rubber cork. After closing the butyrometer using a butyrometer stopper, the content was shaken and inverted several times until the nono sample was completely digested by the acid. Then, the butyrometer was placed in a water bath at 65oC for five minutes. The sample was centrifuged in Gerber centrifuge machine for five minutes at 1100 rpm. Finally the sample was taken back to the water bath at 65oC for 5 minutes and fat percentage was recorded from the butyrometer reading.

Determination of ash content

The ash content of the nono samples was determined gravimetrically according to Gemechu et al. (2015). The dried nono samples used for determination of total solids content were ignited in a muffle furnace (Model EF5 made in Holland) at a temperature of 550oC until they were free from carbon (heating continued until black colour disappeared or the ash residue appears grayish to white) for four hours, and then the samples were transferred to the desiccators to cool down. Finally, the ash content was calculated according as:

$$\text{Ash content (\%)} = \frac{\text{Residue weight}}{\text{Sample weight}} \times 100$$

Determination of solids-not-fat content

The solids-not-fat (SNF) content of the nono was determined by subtracting the fat percentage from the total solids percentage (Teklemichael et al., 2015; Gemechu et al., 2015) as:

SNF content (%) = Total solids (%) - Fat (%)

Determination of lactose content

The lactose content was determined by subtracting the fat, protein and total ash percentages from the percentage of the total solids (Gemechu et al., 2015) as:

Lactose (%) = % Total Solids - (% Fat + % Protein + % Total ash)

IV. EVALUATION OF SENSORY PROPERTIES OF NONO

The method of Zahraddeen (2006) was adopted for the sensory evaluation of the nono samples collected. A 30 – member panel of sensory judges comprising of students and staff of Federal College of Animal Production and Husbandry NVRI Vom who are familiar with quality attributes of milk and milk products was constituted. Each panelist rated each nono sample three times for taste, aroma, colour, appearance and overall acceptability and the average rating of organoleptic property per nono sample per panelist was determined. The ratings were based on Hedonic scale ranging from 9 representing "Like extremely" to 1 representing "dislike extremely". Data were classified based on taste, aroma, colour, appearance and overall acceptability for the nono samples.

V. STATISTICAL ANALYSIS

The data obtained for the physical characteristics, chemical characteristics, and sensory properties were subjected to analysis of variance (ANOVA) using the Minitab version 17.0 software to determine differences among the respective characteristics. Significance was determined at 5% probability level.

VI. RESULTS

Mean Values ± Standard Deviation for Chemical Quality of Nono Samples

The mean values (%) for chemical characteristics of nono are presented in table 1. The mean values of Total Solids (TS) ranged between 12.02±0.79 and 12.78±0.47 with an overall mean value of 12.38±0.66 from the different markets. Solids-not-fat mean values were between 8.45±0.83 and 8.60±0.16 with an overall mean value of 8.55±0.37. Also, the mean values of fat were between 3.56±0.25 and 4.04±0.46 with an overall mean value of 3.83±0.46 from the different markets. That of protein was between 2.85±0.48 and 3.10±0.26 with an overall mean value of 3.01±0.27.

The table also indicates that ash mean values ranged between 0.72±0.07 and 3.07±12.64 with an overall mean value of 0.97±4.00 from the different markets. Whereas lactose mean values were between 4.04±0.17 and 4.33±0.50 with an overall mean value of 4.15±0.27 from the different markets. Furthermore, a statistically significant difference ($P<0.05$) was established among the mean values of the chemical characteristics of nono samples from the different markets in the study area.

Table 1: Mean values (%) ± standard deviation for Chemical quality of nono samples obtained from different markets in Mangu L.G.A

Variables	Markets										Overall means
	MGU (n=30)	PUSH (n=30)	PAN (n=30)	KER (n=30)	AMP (n=30)	MGN (n=30)	KOM (n=30)	GIN (n=30)	CHAN (n=30)	KAD (n=30)	
TS	12.02^{a} ±0.79	12.22^{a}± 0.76	12.53^{a}± 0.65	12.28^{a} ±0.73	12.78^{a}± 0.47	12.63^{a}± 0.59	12.05^{a} ±0.74	12.41^{a} ±0.47	12.31^{a} ±0.40	12.53± 0.56	12.38± 0.66
SNF	8.57^{b}± 0.44	8.51^{b}± 0.34	8.45^{b}± 0.83	8.55^{b}± 0.27	8.51^{b}± 0.38	8.60^{b}± 0.16	8.54^{b}± 0.25	8.58^{b}± 0.18	8.57^{b}± 0.16	8.60^{b}± 0.21	8.55± 0.37
Fat	3.97^{c}± 0.69	4.04^{b}± 0.46	3.90^{c}± 0.62	3.98^{c}± 0.58	3.79^{d}± 0.34	3.56^{d}± 0.25	3.74^{d}± 0.32	3.86^{c}± 0.32	3.67^{d}± 0.24	3.76^{d}± 0.32	3.83± 0.46
Protein	2.85^{b}± 0.48	2.98^{b}± 0.26	3.08^{d}± 0.23	3.04^{d}± 0.20	3.10^{d}± 0.26	3.02^{d}± 0.32	2.98^{b}± 0.20	2.98^{b}± 0.20	2.96^{b}± 0.17	3.08^{d}± 0.17	3.01± 0.27
Ash	0.75^{e}± 0.08	3.07^{f}± 12.64	0.74^{e}± 0.05	0.74^{e}± 0.06	0.76^{e}± 0.05	0.72^{e}± 0.07	0.74^{e}± 0.04	0.74^{e}± 0.05	0.73^{e}± 0.05	0.73^{e}± 0.05	0.97± 4.00
Lactose	4.33^{a}± 0.50	4.11^{d}± 0.27	4.18^{d}± 0.21	4.14^{d}± 0.23	4.21^{a}± 0.21	4.12^{d}± 0.21	4.05^{c}± 0.19	4.04^{c}± 0.17	4.17^{d}± 0.22	4.15^{d}± 0.25	4.15± 0.27

Means followed by different superscript letters are significantly different (P<0.05) using Tukey Pairwise comparisons test. TS=total solid, SNF=Solid-not-fat; MGU=Mangu, PUSH=Pushit market, PAN= Payam market, KER=Kerang market, AMP=Ampang market, MGN=Mangun market, KOM=Kombun market, GIN=Gindiri market, CHAN=Chanso market, KAD=Kadunu market, n = Number of samples per market.

Mean Values ± Standard Deviation for Physical Quality of Nono Samples

The overall mean values of temperature, pH, specific gravity (SG) and titratable acidity (TTA) from different markets in the study area were 27.80±2.90, 5.78±0.76, 1.029±0.01 and 0.186±0.03 respectively (Table 2). Mean values of temperature (^{0}C) were between 27.10±2.40 and 28.80±2.61 while pH fell between 5.10±0.77 and 6.10±0.65. Also, the mean values of specific gravity (SG) were between 1.025±0.00 and 1.032±0.01 while titratable acidity (TA) fell between 0.180±0.03 and 0.199±0.02 from the different markets. More so, there was a statistically significant difference (P<0.05) among the variables tested from the nono samples obtained from the different markets in the study area (Table 2).

Table 2: Mean values ± standard deviation for physical quality of nono samples obtained from different markets in Mangu L.G.A

Variables	Markets										Overall means
	MGU (n=30)	PUSH (n=30)	PAN (n=30)	KER (n=30)	AMP (n=30)	MGN (n=30)	KOM (n=30)	GIN (n=30)	CHAN (n=30)	KAD (n=30)	
Tempt(^{o}C)	28.80^{a} ±2.61	26.67^{a} ±3.85	28.23^{a} ±3.33	27.73^{a} ±3.34	27.10^{a} ±2.40	27.57^{a} ±2.42	28.27^{a} ±2.61	28.43^{a} ±2.84	27.43^{a} ±0.46	27.80^{a} ±2.52	27.80 ±2.90
pH	6.10^{b} ±0.65	5.10^{b} ±0.77	5.60^{b} ±0.64	5.75^{b} ±0.66	5.82^{b} ±0.68	5.97^{b} ±0.68	5.65^{b} ±0.88	5.46^{b} ±0.76	5.73^{b} ±0.84	5.74^{b} ±0.83	5.78 ±0.76
SG	1.029^{c} ±0.01	1.029^{c} ±0.01	1.028^{c} ±0.01	1.025^{c} ±0.00	1.028^{c} ±0.01	1.032^{c} ±0.01	1.030^{c} ±0.01	1.031^{c} ±0.01	1.031^{c} ±0.01	1.032^{c} ±0.01	1.029 ±0.01
TA (%)	0.188^{c} ±0.03	0.188^{c} ±0.03	0.181^{c} ±0.04	0.187^{c} ±0.03	0.188^{c} ±0.03	0.188^{c} ±0.03	0.199^{c} ±0.02	0.184^{c} ±0.03	0.182^{c} ±0.03	0.180^{c} ±0.03	0.186 ±0.03

Means followed by different superscript letters are significantly different (P<0.05) using Tukey pairwise comparisons test. Tempt= temperature, pH=Potential of hydrogen (measure of acidity or alkalinity), SG=Specific gravity, TA=titratable acidity, n=number of sample.

Mean Values ± Standard Deviation for Sensory Evaluation of Nono Samples

Table 3 shows that the overall mean values for taste, aroma, colour, appearance and general acceptability of nono samples from the different markets in the study area were 5.19±3.06, 5.06±1.16, 5.18±1.08, 5.19±1.14 and 5.38±1.09 respectively. The results also shows that the nono sampled in the study area were fairly acceptable for public consumption based on their sensory quality. Consequently, no statistically significant difference (P>0.05) was established among the mean values of the sensory characteristics of nono samples from the different markets in the study area.

Table 3: Mean values ± standard deviation for sensory evaluation of nono samples obtained from different markets in Mangu L.G.A

	Markets										
Variables	MGU (n=30)	PUSH (n=30)	PAN (n=30)	KER (n=30)	AMP (n=30)	MGN (n=30)	KOM (n=30)	GIN (n=30)	CHAN (n=30)	KAD (n=30)	Overall means
Taste	6.03± 9.17	4.77± 1.22	5.20± 1.30	5.70± 1.11	5.33± 1.18	5.17± 1.05	5.17± 1.02	4.80± 1.19	5.00± 0.87	5.33± 1.03	5.19± 3.06
Aroma	4.77± 1.46	4.33± 1.42	5.23± 1.14	4.90± 1.27	5.47± 1.04	5.23± 0.97	5.37± 0.96	4.93± 0.94	5.30± 0.95	5.07± 0.94	5.06± 1.16
Colour	4.77± 1.31	4.90± 1.21	5.10± 0.92	5.37± 1.16	5.53± 1.22	5.37± 1.03	5.43± 0.90	5.10± 0.96	5.20± 0.89	5.03± 0.96	5.18± 1.08
Appearance	4.80± 1.16	4.63± 1.40	5.57± 0.94	4.97± 1.25	5.70± 1.09	5.73± 0.98	5.13± 0.94	5.10± 1.23	5.03± 1.00	5.27± 1.02	5.19± 1.14
General Acceptability	4.67± 1.32	4.93± 1.17	5.57± 1.17	5.70± 1.12	5.50± 1.08	5.70± 0.99	5.37± 0.85	5.60± 0.89	5.50± 0.94	5.27± 0.98	5.38± 1.09

Means do not show significant difference (P>0.05). MGU = Mangu, PUSH = Pushit market, PAN= Payam market, KER = Kerang market, AMP=Ampang market, MGN=Mangun market, KOM=Kombun market, GIN=Gindiri market, CHAN = Chanso market, KAD = Kadunu market, n = Number of samples per market.

VII. DISCUSSION

Mean Values for Chemical Quality of Nono Samples

The means of the total solids (TS) content of nono samples collected from the different markets in the study area revealed no statistically significant difference at 5% level of significance. The means of total solids content ranged from 12.02% to 12.78% corresponding to an overall mean of 12.38% (Table 1). The average total solids content (12.38%) recorded in this study is not in line with the findings of Gemechu *et al*. (2015) who recorded an average total solids content of 12.87% higher. The European Union established quality standards for total solids content of cow milk is not to be less than 12.50% (Food and Agricultural Organization/World Health Organization (FAO/WHO), 2007). This implies that the average total solids content of 12.38% of the nono samples in the present study was less than the recommended standards. Different values for total solids content of milk and milk products samples have been reported by different scholars. The variation could be due to difference in breed, feeding and management practices which have important effects on milk composition and quality (Teklemichael *et al*., 2015).

The overall mean solids-not-fat (SNF) content of the nono samples in the study area was 8.55% with an average mean range of 8.45% to 8.60%. However, the means of the solids-not-fat content of the nono samples from the different markets did not show significant difference at 5% level of significance (Table 1). The overall mean of solids-not-fat content in the present study agrees with the findings of Gemechu *et al*. (2015) but was higher than the findings of Teklemichael *et al*. (2015) who recorded the overall means of 8.59% and 8.00% respectively. Also, the average solids-not-fat content of the nono samples obtained was less than the findings of Bille *et al*. (2009) and Fikrineh *et al*. (2012) who reported higher values of 8.70% and 9.10% respectively from raw cow's milk samples. The differences observed in the solids-not-fat content of milk and milk products could be due to difference in the feeding practices, season, milking method, and lactation period (Gemechu *et al*., 2015). According to the European Union established quality standards for cow milk and milk products, solids-not-fat content should not be less than 8.50% (Tamime, 2009). Accordingly, the average solids-not-fat content (8.55%) recorded for nono samples in the present were within the recommended standards.

Fat content of nono samples in this study had an overall mean of 3.83% (Table 1). This result was lower than the earlier findings of Fikrineh *et al*. (2012) and Gemechu *et al*. (2015) who reported the fat contents of 5.48% and 4.28% respectively for cow milk samples. The difference might be due to variability among the breeds of cows, within a breed, and stage of lactation (Gemechu *et al*., 2015). Consequently, fat content of nono samples collected from pushit market was significantly higher ($P<0.05$) than the fat content of nono samples collected from other markets (Table 9). However, according to the European Union established quality standards for whole milk and milk products, fat content should not be less than 3.5% (Tamime, 2009). This implies that the average fat content of 3.83% obtained in this study was within the recommended standards.

Protein content of nono samples obtained from Panyam, Kerang, Ampang, Mangun and Kadunu markets were significantly higher ($P<0.05$) than nono samples obtained from the other markets in the study area (Table 1). This difference might be due to variability among the breeds of cows, within a breed, feed, and stage of lactation (Gemachu *et al*. 2015). The overall mean protein content in this study was 3.01% (Table 1). This result obtained is lower than the 3.43% obtained by Gemechu *et al*. (2015) and the 3.48% reported by Abd-Elrahman *et al*. (2009). However, the result almost agrees with the 3.20% lower protein content of milk reported by Mirzadeh (2010). According to the European Union established quality standards for whole milk and milk products, total protein content should not be less than 2.9% (Tamime, 2009). Therefore, the average protein content of 3.01% obtained from nono samples in this study was within the recommended established standards.

The ash content of nono samples collected from Pushit market was significantly higher ($P<0.05$) than nono samples collected from the other markets (Table 1). The overall mean ash content of 0.97% obtained in this study is higher than the 0.74% recorded by Gemechu *et al*. (2015) and the 0.72% obtained by Teklemichael *et al*. (2015). The ash content of cow milk remains relatively constant between the range of 0.7% to 0.8% (Gemechu *et al*., 2015 and Teklemichael *et al*., 2015). The high ash content of 0.97% recorded in the present study could also be due to the breed, stage of lactation, and feed of the animals.

Lactose content of nono samples obtained from Kombun and Gindiri markets are significantly lower ($P<0.05$) than nono samples collected from the other markets (Table 1). This difference might be due to the action of lactose hydrolyzing enzymes produced by microorganisms as a result of storage temperature variation (Gemechu *et al*., 2015). The lactose content of nono samples in this current study had an overall mean of 4.15%. This result is lower than the overall mean lactose content of 4.43% recorded by Gemechu *et al*. (2015). According to the European Union established quality standards for whole milk and milk products, lactose content should not be less than 4.2% (Tamime, 2009). This implies that the average lactose content (4.15% which is approximately 4.20%) recorded in this study was within the recommended standards.

Mean Values for Physical Quality of Nono Samples

The pH is the parameter that determines the sample's acidity and alkalinity. The pH values of nono samples collected from different markets in the study area show no significant difference ($P< 0.05$). The mean pH values of the nono samples collected ranges between 5.10 and 6.10 with an overall mean pH of 5.78 (Table 2). This mean range is in disagreement with the pH of fermented milk ranged between 4.17 and 4.80 obtained by Tankoano *et al*. (2016) and 3.84 to 4.48 recorded by Omafuvbe and Enyioha (2011). According to Codex Alimentarius (2004) in Tankoano *et al.* (2016), the pH of fermented milks should not exceed 4.5. However, the mean pH values of nono samples obtained in this study are higher than the recommended value. This implies that the nono in the said area do not meet the standard pH requirement of fermented milks.

The mean temperature of nono samples obtained from different markets in the study area shows no statistically significant difference (P< 0.05). The mean temperature ranged between 26.67ºC and 28.89ºC with an overall mean of 27.80ºC (Table 2). This result is not in line with the mean temperature range of 19.67ºC - 29.67ºC corresponding to overall mean temperature of 22.83ºC obtained by Gemechu *et al*. (2015). In this study, the overall mean temperature was 27.80ºC. This was higher than the findings of Egwaikhide and Faremi (2010). The industrial Standard recommends for fermented milk products is a holding temperature not higher than 8ºC (Omola *et al*., 2014). In the study area, the lack of cooling system and refrigerator for nono storage might increase the microbial counts. As a result of this, the temperature of the nono samples in the current study was very high. This might be contributed for the increase number of microbial contaminants in the study area.

Specific gravity (SG) of the nono samples ranges from 1.025g/ml to 1.032g/ml corresponding to an overall mean of 1.029g/ml (Table 2). This result is almost in line with the findings of Gemechu *et al*. (2015) who recorded the range of 1.029g/ml to 1.031g/ml with an overall mean of 1.030g/ml. The specific gravity of normal milk ranges from 1.027 – 1.035g/ml with a corresponding mean value of 1.032g/ml (Tamime, 2009). In this current study, specific gravity of nono samples collected from different markets in the study area falls within the range. According to Gemechu *et al*. (2015), the higher value of specific gravity (1.035g/ml) indicates skimming off fat whereas the lower value than normal value of specific gravity of milk (1.020g/ml) is indicative of addition of water. Abebe and Markos (2009) also confirmed that addition of water or other substances changes the specific gravity of milk and milk products. Furthermore, adulteration of milk and milk products with water that was usually done in order to increase the quantity of milk lowers milk's specific gravity while addition of solids such as sugar or flour into milk and removing the butter fat increases the specific gravity of milk beyond 1.035g/ml (Gemechu *et al*., 2015). The specific gravity is mainly due to the presence of water contents and small concentrations of fats, proteins, vitamins, enzymes and minerals in the sample (Imran *et al*., 2008).

The mean titratable acidity (TA) obtained in this study show no significant difference (P<0.05) among the nono samples collected from different markets (Table 2). The titratable acidity ranges between 0.180 to 0.199% with an overall mean percentage of 0.186%. This is closely related to the range of 0.163 to 0.213% recorded by Gemechu *et al*. (2015). Normal milk and milk products have an apparent acidity of 0.14 to 0.16% as lactic acid (Teklemichael *et al*., 2015). This implies that the titratable acidity obtained in this present study is higher than the recommended standard. Asaminew and Eyassu (2011) also reported higher acidity of 0.23 and 0.28% lactic acid for milk and milk products samples in Bahir Dar Zuria District. This might be due to microbial growth and multiplication during transportation of milk and longer storage of the milk before sale or nono production (Gemachu *et al*., 2015).

Mean Values for Sensory Evaluation of Nono Samples

The sensory evaluation which was conducted on a 9 point Hedonic Scale on taste, aroma, colour, appearance and general acceptability revealed that the nono sold in the study area was relatively of good quality (Table 3). The overall mean values of the organoleptic properties (taste, aroma, colour, appearance and general acceptability) were 5.19, 5.06, 5.18, 5.19 and 5.38 respectively (Table 3). This result is lower than the rating obtained by Adedayo *et al*. (2013) who recorded 6.63, 7.78, 6.75 and 7.02 for smell, colour, taste and general acceptance respectively in their study. However, there was no statistically significant difference among the properties rated (P>0.05) (Table 3). From the figures obtained, little or no difference exists in all the sensory attributes among the nono samples obtained from the different markets in the study area. Reasons for not rating the nono samples too high by the panelists could be due to the activities of some microorganisms implicated in the product and some physicochemical changes (Wakil *et al*., 2014).

VIII. CONCLUSION

From the findings of this study, it is concluded that nono produced and marketed in the study area as at the time of this research was not safe for public consumption and can be a source of milk-borne infections since some of the physicochemical qualities evaluated were not within the recommended and acceptable standards. Also, consumption of nono and other milk products made from raw cow milk can result into health problems. This is supported by evidence of changes in some of the physical and chemical properties of the product evaluated.

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