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Quality Evaluation of Commercial Yoghurts on Streets of Kano-Nigeria

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Abstract: The study was conducted to evaluate the physiochemical properties of commercial yoghurts offered for sale on the street of Kano metropolis. Different brands of yoghurts were randomly purchased from yoghurt vendors and designated A, B, C and D. The yoghurts were stored in refrigerator (4-10°C) and analysed alternately for 10 days. The Titratable Acidity (TA), moisture content, Total Solids (TS), Total Protein (TP), Total Fats (TF), ash, pH, viscosity and density of the yoghurts were determined. The results showed a significant ($p<0.001$) difference in TA (lactic acid %) which ranged between 0.58 and 1.31; moisture from 852.7-866.7 g kg^{-1}; TF from 3.7-15.7 g kg^{-1}; pH from 4.27-3.27 and TP from 32.3-36.2 g kg^{-1}. The difference between the lowest and highest viscosity ($p<0.01$) and density ($p<0.001$) of the yoghurt brands were 23.84 cp (for brand C), 47.50 cp (for B), 1.05 g dm^{-3} (for D) and 1.15 g dm^{-3} (for C), respectively. The TA correlated negatively with moisture ($r = -0.634$; $p<0.01$) and TF ($r = -0.831$; $p<0.01$) and positively with TS ($r = 0.626$; $p<0.01$) and ash ($r = 0.602$; $p<0.01$). The period of storage had no significant ($p>0.005$) effect on total solids, total fat, total protein and ash. However, the moisture content ($p<0.05$), titratable acidity ($p<0.001$) and pH ($p<0.05$) showed significant difference due to days of storage. It was concluded that the total solids, total fat and total protein of yoghurt brands were within the recommended levels while titratable acidity, pH and viscosity were slightly out of normal range during 10 days storage. It is recommended that yoghurt production should be standardized and supervised by the appropriate national food regulatory bodies.

Key words: Commercial yoghurt, titratable acidity, pH, density and viscosity

INTRODUCTION

Yoghurt is probably one of the most popular of all fermented milks in Nigeria today (Muhammad *et al*., 2000; Muhammad and Kwali, 2005). The origin of yoghurt is the Middle East and the evolution of this fermented product through the ages can be attributed to the cullinary skills of the nomadic people living in that part of the world (Tamime and Robinson, 1989). The main features of yoghurt making involved heating the milk over an open fire to concentrate it slightly, modify the properties of the casein, ensure gradual selection of lactic acid bacteria capable of tolerating high levels of lactic acid; to eradicate any pathogenic microrganism and to encourage the fermentation of the milk to take place at slightly higher temperature. The concentrated milk is heated to 63°C for 30 min and cooled to around 45°C and a mixture of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* are used as the starter cultures to induce fermentation for good aroma and less sour yoghurt (Jay, 2000).

Milks of different sources are used in yoghurt preparation and variation exists in quality of yoghurt depending on milk type. The flavour of yoghurt is mainly the result of complex biochemical reactions initiated by microbial activity, the milk which vary from species to species and whose characteristics is reflected in the end product. The major constituents of milk are: water, fat, protein, lactose and minerals (Webb *et al*., 1980). In order to over come the inherent variations in composition milk for yoghurt making the milk has to be standerdised or fortified to control qualities such as acidity, sweetness and consistency/viscosity of the coagulum to meet the demand of the consumer.

The percentage of solids-not-fat in milk for the manufacture of yoghurt is governed either directly by the legal standards of the country or indirectly by the manufacturer seeking to produce an end-product with certain physical properties and flavour aceptable to consumers. The best yoghurt is probably made from milk containing 15-16% total solids and it is of note that the composition of most commercial yoghurts falls within the range of 14-15% (Tamime and Robinson, 1989).

The yoghurt production is a biological process and cooling is one of the popular methods used to control the metabolic activity of the starter culture and its enzymes.

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Cooling of the coagulum commences directly after the product reaches the desired acidity of around pH 4.6 or 0.9% lactic acid depending on the type of yoghurt, method of cooling and efficiency of heat transfer (Gassem and Frank, 1991). Since, the yoghurt organisms show limited growth activity around 10°C, the primary objective of cooling is to drop the temperature of the coagulum from 30-40°C to less than 10°C as quickly as possible to control the final acidity of the product.

Physicochemical changes in yoghurt continue during storage, especially at temperature above 10°C. The commercial yoghurts sold in and around Kano metropolis are usually stored and marketed at prevailing ambient temperature which ranged between 20 and 47°C (Ibrahim, 2007). At this temperature, the changes that occur may affect the wholesomeness of the product. Therefore, the current study was designed to evaluate the physicochemical properties of commercial yoghurts offered for sale on the street of Kano, Nigeria.

MATERIALS AND METHODS

Study area: The study was conducted in Kano metropolis and Kano State is located on longitude 9°30'N and 12°30'N and latitude 8°42'E and 9°30'E in the Sudan Savannah zone of Nigeria. The state is characterized by two seasons, rainy which last May to September and dry season that last from October to April. The mean annual temperature ranges between 16-47°C and the mean annual rainfall ranges from 700-1160 mm.

Samples collection and analyses: A total of 20 yoghurt samples from four different registered brands were randomly purchased from different vendors within Kano metropolis during the month of September to October when the yoghurt production is high. The samples collected were designated A, B, C and D based on brand name and were carefully stored under refrigeration temperature of 4-10°C. The samples were analyzed for moisture, total solids, total fats, titratable acidity, pH (Using Swiss-made Metrohm model 460 pH m), total proteins and ash according to the procedure described by AOAC (1990) and Egan *et al*. (1981) as fresh yoghurt and at 24 h interval for 10 days. The density (using density bottle) and viscosity (Using viscosimeter HAAKE FW Model) of the samples were measured during the period of storage that lasted 21 days.

RESULTS AND DISCUSSION

Table 1 shows the physiochemical properties of yoghurt brands used in the study. A significant ($p<0.001$) different was recorded on all of the physicochemical parametres studied. The moisture contents of yoghurt brand D was the highest (866.9 g kg^{-1}) while, the lowest value (859.7 g kg^{-1}) was recorded on brand B which are similar to the reported moisture value range of 855.0-895.0 g kg^{-1} (O'Connor, 1995). The total solids differ significantly ($p<0.001$) among the yoghurt brands. The yoghurt brand B had the highest total solids value of 144.3 g kg^{-1} while, the lowest value of 133.3 g kg^{-1} was recorded on brand C. The total solids results obtained in this study, were lower than the reported findings of Ather (1986) and O'connor (1995). The variation in the total solids among the different brands of yoghurt is most probably due to difference in quality of milk used and to fortify; the quality control measures taken to ensure the consistency of the end product (Shahid *et al*., 2002). The composition of most commercial yoghurt falls within the range of 130-150 g kg^{-1} for total solids from manufacturers point of view (Tamine and Robinson, 1989). The fortification of the total solids in the yoghurt mix can be achieved by a number of different methods, such as addition of powdered milk, butter milk, whey powder, casein powder and traditional process based on the heat application.

The results showed a significant ($p<0.001$) difference in the total protein content among the brand of yoghurts. The yoghurt brand C showed significantly ($p<0.001$) higher level of total protein (34.0 g kg^{-1}) compared to brands A (32.5 g kg^{-1}) and was statistically at par with brand B (33.6 g kg^{-1}) and D (33.8 g kg^{-1}). The difference in the total protein content among the brands of yoghurt obtained might be due to the different level of protein fortification observed by the different manufacturers, by way of additions such as caseinate powder, concentrating the milk by ultra centrifugation, or to a lesser degree by the addition of high protein whey powder and/or butter milk powder (Tamime and Robinson, 1985). The fact that the protein content of yoghurt is often elevated by concentration, or addition of skim milk solids, means that it is an even more easier to use alternative source of protein than liquid milk. The ash content significantly ($p<0.001$) differs among the four brands of yoghurt with the highest (6.9 g kg^{-1}) and the lowest (6.4 g kg^{-1}) values are recorded on brand B and C, respectively. The ash contents measure the major mineral contents of yoghurt and changes less with processing and storage.

Table 2 shows the effect of period of storage on the physicochemical properties of yoghurts used in the study. No significant ($p>0.05$) differenc was recorded due to effect of day of storage on the moisture contents, total solids, fat, protein and ash. However, a significant difference was recorded on both titratable acidity

Table 1: Physiochemical properties of yoghurt brands used in the study

Brand	Physicochemical properties (g kg^{-1}) Moisture	Total solids	Total fat	Total protein	Ash	TA (lactic acid %)	pH
A	859.8	140.2	7.7	32.5	6.6	0.98	4.57
B	859.7	144.3	3.9	33.6	6.9	1.25	3.32
C	866.5	133.3	14.5	34.0	6.4	0.72	3.89
D	866.9	142.9	6.3	33.8	6.7	1.14	3.64
LS	***	***	***	***	***	***	***
SEM	0.07	0.07	0.04	0.04	0.02	0.02	0.11

TA = Titratable Acidity (lactic acid %); LS = Level of Significance; SEM = Standard Error the Mean

Table 2: Effect of Storage period on physiochemical properties of yoghurts

Day of storage	Physicochemical properties (g kg^{-1}) Moisture	Total solids	Total fat	Total protein	Ash	TA (lactic acid %)	pH
1st	858.4	141.6	7.9	33.8	6.6	0.88	3.90
3rd	857.9	143.1	7.7	33.6	6.6	0.97	4.05
5th	861.5	138.5	8.3	34.0	6.7	1.04	4.25
7th	859.9	140.1	8.1	34.3	6.7	1.09	3.57
9th	860.8	138.6	8.5	34.3	6.7	1.11	3.52
LS	*	ns	ns	ns	ns	***	*
SEM	0.06	0.06	0.04	0.04	0.02	0.02	0.02

TA = Titratable Acidity; LS = Level of Significance; SEM = Standard Error of the Mean, ns = not significant

Table 3: Correlation coefficients of physiochemical parameters of yoghurt

Parameters	Titratable acidity	Moisture	Total solids	Total fat	pH	Total protein
Moisture	-0.634**					
Total solids	0.626**	-0.993**				
Total fat	-0.831***	0.704***	-0.720***			
pH	-0.27^{ns}	0.112^{ns}	-0.105^{ns}	0.159^{ns}		
Total protein	-0.082^{ns}	0.070^{ns}	-0.081^{ns}	0.282^{ns}	-0.242^{ns}	
Ash	0.602**	-0.364^{ns}	0.389**	-0.570**	-0.288^{ns}	-0.202^{nts}

ns = not significant (* -p<0.05; ** -p<0.01, *** -p<0.001)

(p<0.001) and pH (p<0.001). Yoghurt brand C had the lowest titratable acidity (0.72% lactic acid) on day one, while, the highest value of 1.11% was recorded on brand D on the ninth day of storage. A titratable acidity value of 0.96 (lactic acid %) was earlier reported (Muhammad and Abubakar, 2006) after 21 days of storage. The titratable acidity has shown an increased trend due to storage from the first day to ninth day. An increased titratable acidity value of 0.87-1.16 (% l actic acid) was reported by Shahid *et al.* (2002) during storage. The highest (4.25) and the lowest (3.52) pH values were recorded on the 5 and 9th day of storage as shown in Table 2.

The correlation coeffients of physicochemical parametres of yoghurts used in the study are shown in Table 3. The moisture contents showed a significant (p<0.001) and negative correlation with total solids (r = -0.993) and positive with total fat (r = 0.704, p<0.001). However, a trend of positive relationship exists between pH, TP and moisture, though not statistically significant (p>0.05). The total solids correlated negatively (r = -0.720; p<0.001) with total fats and positively with the ash (r = 0.389, p<0.01). This result is contrary to the findings of Muhammad and Abubakar (2006), who reported a positive correlation between TS and TP in yoghurt replaced with different levels of soymilk. The titratable acidity correlated negatively (r = -0.634; p<0.01) with moisture, TF (r = -0.831, p<0.001) and positively with TS (r = 0.626; p<0.01) and ash (r = 0.602; p<0.01). The variation in moisture content due to brands is probably because lack of standardization of the raw milk.

Table 4 showed the interaction effect of brand and storage period on titratable acidity and pH of yoghurts used in the study. The results showed a significant increase in TA and decrease in pH from fresh to ninth day of storage among the yoghurt brands. The brand C maintained an acidity level of less than 0.83% lactic acid to the last day of storage significantly (p<0.001) lower brand A and D that showed an acidity levels of 1.01 and 1.05% on the 5th and 3rd day of storage, respectively. The controlled incubation and post production handling might be responsible for the variations observed in the acidity of the different brands of yoghurt (Shahid *et al.*, 2002). O'Connor (1995) quoted that the production of acid in milk, which is termed souring and depend on lactric acid in the yoghurt which provide a rough indication of its age and the manner in which it has been handled.

The pH value of the yoghurts tend to decrease significantly (p<0.01) with increase acidity from the 3rd day of storage among the brands. The pH values after 3rd day of storage ranged from 3.98-3.24 lower than the reported ranges of 4.49-4.94 (Muhammad *et al.*, 2005) and 4.20-4.58 (Laye *et al.*, 1993) for a brand of commercial non-fat yoghurt. The decreased pH with inreased storage time interval is expected due increase corboxylic and sulphydryl acids generated from various milk components. The high pH may give the yoghurt an unacceptable sour taste.

Table 4: Interaction effect of brand and storage period on titratable acidity and pH of yoghurt

Days of storage	Titratable acidity (lactic acid %) A	B	C	D	pH A	B	C	D
Fresh	0.86	1.13	0.58	0.95	4.01	3.39	4.27	3.91
3	0.97	1.22	0.65	1.05	3.98	3.32	3.93	3.86
5	1.01	1.28	0.72	1.15	3.95	3.31	3.79	3.51
7	1.02	1.30	0.80	1.25	3.70	3.24	3.76	3.56
9	1.03	1.31	0.83	1.29	3.68	3.27	3.71	3.44
LS			***				**	
SEM			0.001				0.01	

LS = Level of Significance; SEM = Standard Error of the Mean; TA = Titratable acidity (*** -p<0.001)

Table 5: Effect of brand on viscosity and density of the yoghurt used in the study

Brand	Viscosity (cp)	Density (g dm^{-3})
A	41.73	1.06
B	47.50	1.06
C	23.84	1.15
D	37.66	1.05
LS	***	***
SEM	0.06	0.02

LS = Level of Significance; SEM = Standard Error of the Mean; (*** -p<0.001) ns-not significant

Table 5 shows the effect of brand on viscosity and density of the yoghurts used in the study. A significant difference was recorded on both viscosity (p<0.001) and density (p<0.001). Yoghurt brand B had the highest viscosity of 47.50 cp, while, the lowest value of 23.84 cp was recorded on sample C. The variation in viscosity observed in the different brands of yoghurts could be attributed to one or more of the following factors, low total solids, insufficient heat treatment, homogenization of the milk, too low incubation temperature, low incubation rate and prolonged agitation. The yoghurt with low protein contents tend to have low viscosity due to low water-holding capacity of the coagulum (Samuelsson and Christiansen, 1978). The addition of hydrocolloids (stabilizers) and/or pectins from fruits improve the viscosity of yoghurts during storage. Reduction in viscosity might occur as a result of shaking during transport or storage of the product above 10°C (Anon, 1977).

The density of yoghurts showed significant difference (p<0.0) with the highest value of 1.09 g dm^{-3} and the lowest value of 1.05 g dm^{-3} recorded on brands C and D (statistically at par with brand A and B), respectively. The density of the yohurts is low in relation to the recorded viscosity and total solids values.

CONCLUSION

It was concluded that there exists a wide variations in the physicochemical parametres obtained from the different brands of yoghurt used in this study. There seem to be no standard quality procedure adopted for the production of yoghurts sold around Kano metropolis. If the essential requirements for manufacturing a high quality yoghurt were to be adopted it should include using milk of high quality; correct heat treatment, inoculation rate, incubation time and temperature; an active well-balanced contaminant free starter culture; a clean and well monitored plant and correct storage temperature of retail product below 10°C. The national food regulatory agencies should ensure that only yoghurts of standard quality are sold to consumers.

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