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A SURVEY OF LOCAL PREPARATION METHODS AND QUALITY OF KUNUN-ZAKI IN TWO METROPOLITAN TOWNS OF NORTHRN NIGERIA

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ABSTRACT

A structured questionnaire survey on ingredients and water sources as well as local production procedures used for making kunun-zaki in Maiduguri and Jos towns of Northern Nigeria was conducted in 2004. Bacteriological and physico-chemical quality of the randomly sampled kunun-zaki in various sites of the two locations were also determined using standard laboratory methods. The results from the respondents showed that the cereal grain, *Sorghum bicolour* (55%), *Zingiber officinale* (83.33%) as spicing/flavouring ingredient, malted rice (36.67%) as saccharifying adjunct, *Ipomea batatas* (31.67%) as sweetening agent and tap water (35%) as source of water (with percentage usage in parenthesis) formed the top most basic raw materials for making kunun-zaki in the two locations. It was also found that kunun-zaki made using hand-dug well water had significantly higher bacteriological loads than those made using bore-hole and tap waters at 5% significance. The total mean plate and coliform counts of the beverage samples obtained from the two location were 8.5×10^6 cfu/ml and 10.52 coliform cells /100ml respectively. The bacterial loads of the beverage samples in the two metropolitan towns did not differ significantly at 5% level of significance. Bacterial pathogens of significance found in the samples included Staphylococcus *aureus* (83.33%), *Bacillus cereus* (50.00%) E. *coli.* (26.50%) and *Shigella dysentariae* (23.34%) with the percentage occurrences in parenthesis respectively. The mean values of the pH, titratable acidity, specific viscousity and specific density of kunun-zaki were 4.37, 0.04%, 1.58 and 1.05 respectively with no significant differences between the values in the two towns. The significance of the results to good manufacturing practice and consumer health is discussed.

KEYWORDS: Kunun-zaki, Sorghum, millet, bacteriological quality, Northern Nigeria

INTRODUCTION

'Kunu' is a hausa compound word for all kinds of cereal –based beverages with specifications such as 'zaki' (sweet) 'gyada' (groundnut), 'tsamiya' (tamarind) normally attached to the word to denote the ingredient source or its sensory attribute. Hence, kunun-zaki, means sweet kunu. Kunun-zaki is actually a non alcoholic, non-carbonated sweetened and free-flowing gruel prepared traditionally and left to ferment by chance micro-organisms. It is consumed predominantly in Northern Nigeria as a thirst-quencher, an appetizer and/or an energy booster by all classes of the society. Studies by Gaffa *et al* (2002) has shown that kunun-zaki is the most preferred beverage, with about 73% of the sampled population consuming it daily and (26%) occasionally in Gombe and Bauchi States of Nigeria. In recent times, street hawking and consumption of kunun-zaki is fast spreading to southern parts of Nigeria, probably because it is cheaper and more satisfying than the carbonated beverages to the low income earners in the society. Although, kunun-zaki is produced all year round, its peak production period is within the dry season (October to April).

The major ingredients used for kunun-zaki production include sorghum, millet and maize which are used singly or in combination of any two of the cereals. Spices like ginger and cloves as well as sweetening agents such as malted rice and sweet potato are also used as secondary ingredients (Adeyemi and Umar, 1994).

A number of research work conducted and documented on kunun-zaki include the following: the microflora of the beverage (Onuorah *et al* 1987 and Egbere, 1988), nutritional value (Inatimi et al 1988) improvements in its production (Gaffa and Ayo, 2002 and microbial succession during its production (Gaffa and Gaffa, 2004). However, little or no report is available on the comparative methods and quality of the beverage in parts of Northern Nigeria where the beverage is a household relish. Since production and acceptability of kunun-zaki is expanding across social and ethnic divides in Nigeria, there is need to explore the traditional production techniques and quality characteristics of this beverage. The data obtained from the study would be useful guides for the design of Critical Control Points and Hazard Analysis (HACCP) which would in turn help to minimize microbial contamination in large scale fermentation of the beverage.

METHODS

Location of Sample Sites

Metropolitan towns of the northern states of Nigeria Maiduguri (capital of Borno state) and Jos (capital of Plateau state) were chosen for the research for strategic reasons. Maiduguri represents the far northern parts of Nigeria while Plateau is in the north central (Middle belt) region of Nigeria. Climatically, the two locations are in the two extremes of temperatures – with Maiduguri having a very hot climate while Jos is in about the coldest region in Nigeria. Maiduguri is located at 11 52°N and 13 14°E and is bounded by Chad and Cameroon republics, in the North and East respectively. Adamawa State is on the South while Kano on the West of Borno State. The town has a temperature range of between 28 and 40°C (Department of Geography and Meterology, University of Maiduguri, 2004). The major ethnic groups in Maiduguri are Kanuri, Shuwa, Marghi, Bura, Higgi and Gwoza with Hausa, Yoruba, Ibo, Fulani, and others as minority groups. Jos on the other hand is situated at 9 53°N and 8.51°E with an average height elevation of 1250m above sea level, a temperature range of 10°C to 30°C (Department of Geography University of

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Jos, 2004). The major ethnic groups are Berom, Anaguta, Mwaghavul, Angas, Hausa, Fulani, Igbo, Yoruba, and others as minority tribes.

Sample Collection

A total of 60 samples of kunun-zaki in polythene bags were randomly purchased at the various ten designated market sites (6 each) in Maiduguri and Jos respectively (figure 1). The samples were carefully immersed in ice packed insulated thermo cool container and brought to the laboratory where the sample were then aseptically transferred into 250ml sterilized specimen bottles. The bottles were then properly screw capped and then stored in a refrigerator (about 4°C) prior to microbiological and other analyses

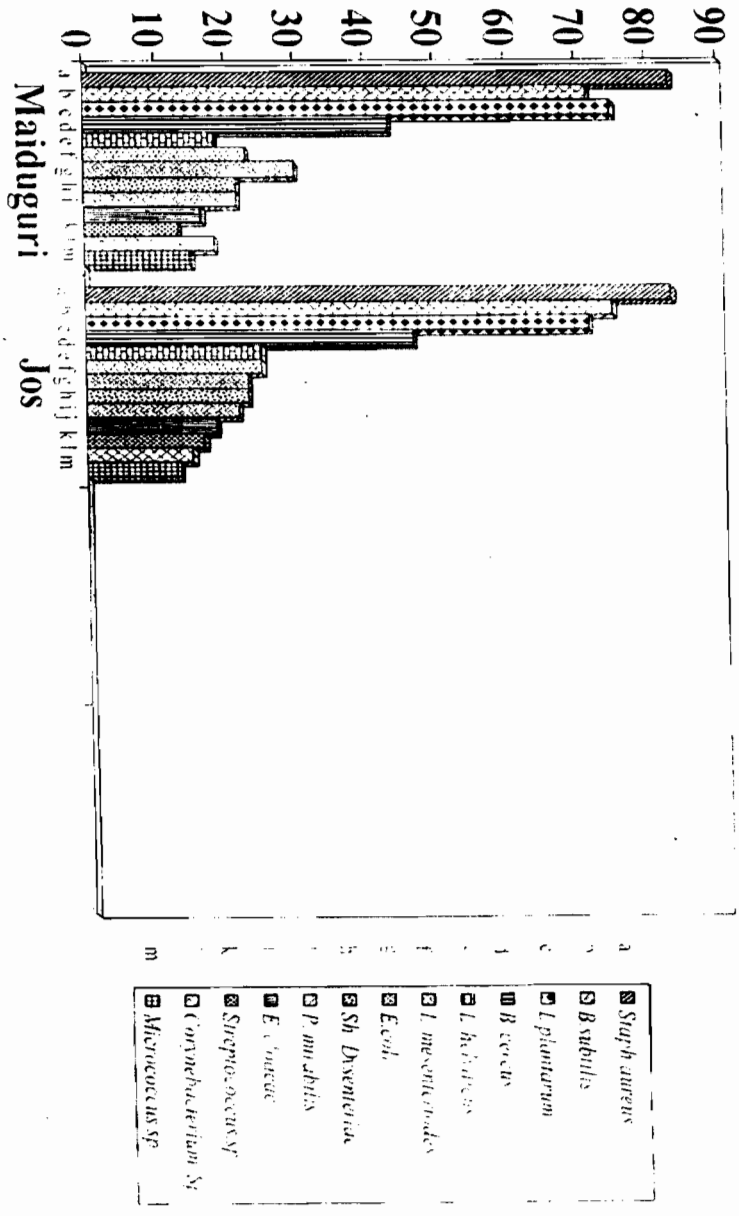

Fig. 2: The frequencies of occurrence for bacterial isolates in Kunun-zaki samples in Maiduguri and Jos

Data Collection

A questionnaire containing aspects of kunun-zaki production (– including raw materials equipment and water sources used, process unit and times, preservation and shelf-life of the beverage) was designed and used for data collection. The questionnaires were distributed to each of the women from whom samples were collected.

Bacteriological Analyses:

The total plate count by pour plating method and the most probable number techniques as described by Fawole and Oso (1988) were used for the determination of total bacterial and coliform counts respectively. The bacterial isolates in the samples were purified by repeated sub-culturing, characterised and identified using cultural and colony features, microscopic and biochemical characteristics as described by Fawole and Oso (1988). Final identification of isolates was by comparison of results obtained with literature standards using Bergey's Manual of Determinative bacteriology.

Determination of Physico-chemical Quality Properties

The pH values of the beverage samples was determined using a pH meter (pHep® 1 kaly Hanna Model) which has been previously standardized using buffer solutions of pH4 and 7 respectively The total titratable acidity (TTA) calculated as lactic acid was determined following the method described by Pearson (1973). The specific viscosity and specific density of the sample were determined using specific gravity bottles and Ostwald Fenke viscometer.

RESULTS

Table 1: Responses on Common raw materials and water sources used in the local production of Kunun-zaki in Maiduguri and Jos, Nigeria

S/No	Basic Cereals used	Maiduguri(%)	Jos(%)	Means(%)
1.	**Guinea Corn (*Sorghum bicolour*)**	40.00	70.00	55.00
	Millet (*Pennisetum typhoid*)	46.67	13.33	36.67
	Maize (*Zea. mays*)	10.00	10.00	10.00
	Rice (*Oryza, sativa*)	3.33	6.67	5.00
	Acha (*Digitaria exilis*)	0.00	3.33	1.67
2.	**Types of Sorghum**			
	a. Red Sorghum	93.33	93.33	93.33
	b. White Sorghum	0.00	3.33	1.67
	c. Yellow Sorghum	6.67	3.33	5.00
3.	**Enzyme Source/Sweetening Agents Used**			
	a. Malted rice	33.33	40.00	36.67
	b. Malted *Sorghum bicolour*	23.33	33.33	28.33
	c. Malted Acha	0.00	10.00	5.00
	d. Sweet potatoes (*Ipomea batatas*)	36.67	26.67	31.67
	e. Dangafara (*Cadaba Farinosa*)	6.67	0.00	3.33
	f. Sugar (*Sucrose*)	73.33	60.00	66.67
4.	**Spices Used**			
	a. Ginger (*Zingiber officinale*)	86.67	80.00	83.33
	b. Cloves (*Eugenia callophylloides*)	10.00	13.33	11.67
	c. Black pepper (*Piper nigrum*)	3.33	6.67	5.00
5.	**Water Sources used**			
	a. Pipe borne	40.00	30.00	35
	b. Hand dug well	16.67	36.67	26.67
	c. Bore hole	43.33	6.67	25.00
	d. Stream	0.00	26.63	13.34

Table 2: Variation in the Production procedures and equipment used in Maiduguri and Jos, Nigeria

S/No	Basic Cereals used	Maiduguri	Jos	Means
1.	**Cleaning of Grains**			
	a. Winnowing of grain	3.33	26.67	15.00
	b. Washing before steeping	93.33	83.33	88.33
	c. Manual sorting of stones/foreign matter	3.33	10.00	6.67
	d. Washing in cold water prior to steeping	86.67	66.67	76.67
	e. Washing in hot water prior to steeping	10.00	26.67	18.34
2.	**Steeping Process**			
	a. in plastic buckets	10.00	26.67	18.34
	b. in metallic drums	16.67	10.00	18.34
	c. in Calabash	3.33	0.00	1.67
	d. in earthen vessel	3.33	0.00	1.67
	e. in hot water	6.67	10.00	8.34
	f. in cold water	93.33	90.00	91.67
	g for 8 – 12 hours	93.33	60.00	76.67
	h for above 12 hours	6.67	43.33	25.00
3.	**Pre-processing of spices**			
	a Washing of spices prior to use	97.67	90.00	93.84
	b No washing of spices	3.33	10.00	6.67
	c Milling of spices together with the grains	60.00	53.33	56.67
	d Milling of spices separately	40.00	46.67	43.34
4.	**Sieving Process**			
	a. With sieve cloth (muslin cloth)]	90	93.33	91.67
	b With sieve mesh	10.00	6.67	8.34
	c Sieving before gelatinization/fermentation	6.67	10.00	8.34
	d Sieving after gelatinization	93.33	90.00	91.67
5	**Fermentation Process**			
	a. Not allowed to ferment	0.00	0.00	0.00
	b. Allowed to ferment	100.00	100.00	100.00
	c. Fermentation time above 12 – 14 hours	93.33	73.33	83.33
	d. Fermentation time above 14 hours	6.67	26.67	16.67
6	**Preservation**			
	Addition of Preservative?	0.00	0.00	0.00
	Yes	100.00	100.00	100.00
	No			
7.	**Shelf-life**			
	a. One day	66.67	2 00	34.34
	b. 2 days	33.33	76.67	55.00
	c. 3-5 days	0.00	21.33	10.67

Table 3: Means of Bacterial loads of Kunun-zaki samples obtained from various sampling sites in Maiduguri and Jos, Nigeria

Location/Sites	Total Plate Count ($X10^6$ cfu/ml)	Coliform Count MPN/100ml
Maiduguri		
a. Ngomari – costing	10.94	9.60
b. Jiddari	10.28	9.60
c. Pompamari	8.64	9.80
d. Gwange	9.66	7.40
e. Hausari	10.04	9.20
f. Ngomari	8.34	9.40
Means +SD (Maiduguri	**9.49 ± 1.07**	**9.16 ± 0.89**
Jos		
a. Angwan-rogo	6.10	12.80
b. Jenta	8.22	11.00
c. Terminus area	7.74	14.20
d. Tudun-wada	7.62	14.80
e. Nasarawa gwon	6.50	16.2
f. Gigiring	8.06	14.20
Means ±SD (Jos)	**7.37 ± 80.87**	**13.86 ± 1.78**
Total means for the two locations		

Key
SD = Standard Deviation
Cfu = Colony forming unit
MPN = Most Probable Number

Table 4: Bacterial loads of kunu-zaki samples sold in Maiduguri and Jos based on Water Sources used in the production of the Beverage.

Location/Water Sources	Total Plate	Tap Water	Hand-dug well	Borehole	Stream	Total Means
Maiduguri	Total Plate Count ($x10^6$ cfu/ml)	10.38±0.76	12.94 ± 1.52	7.69 ± 1.86	na	7.34
	Coliform Count (MPN/100ml)	8.58 ± 2.89	11.20 ± 3.76	8.90 ± 0.67	na	9.56
Jos	Total Plate Count ($x10^6$ cfu/ml)	5.22 ± 0.73	8.11 ± 0.67	6.15±1.89	10.77±2.16	7.37
	Coliform Count (MPN/100ml)	12.78±3.97	16.5 ± 6.34	5.20±1.15	10.33±2.86	11.20

Key
Na = Not applicable
Cfu = Colony forming unit

Table 5: Physico-Chemical Quality of Kunun-zaki Samples sold in Maiduguri and Jos Metropolitan Towns.

Location	pH	T.T.A	Specific Viscosity	Specific Density	Colour Gradings of Kunu-zaki (% of Number)			
					Brown	Milky	Grey	Ash
Maiduguri	4.31 ± 0.19^a	0.04 ± 0.008^b	1.46 ± 1.16^c	1.21±3.39d	24.00	40.00	20.00	16.00
Jos	4.42 ± 0.14^a	0.04 ± 0.003^b	1.69 ± 1.11^c	1.07±0.19d	64.00	6.00	26.00	4.00
Means of Means	4.37	0.04	1.58	1.05	44.00	23.00	23.00	10.00

Superscript of same letter in the same columns means there is no significant difference at 95% level of probability.

RESULTS AND DISCUSSION

Ingredients Used

The results in table 1 indicate that the major cereals in use for the production of kunun-zaki are guinea corn, millet and maize with preference dictated most likely by the dominant grain grown in an area. While millet was used most commonly in Maiduguri as it is the case in Bauchi and Gombe states as reported by Gaffa et al, 2002, in Jos, *Sorghum bicolour* (red variety of guinea corn) is used most commonly. The preference of saccharifying agents in both locations in descending order were malted rice, malted sorghum malted acha and *cadaba farinose* while sugar (sucrose) was the most commonly used sweetening agent at about 66% in both locations. Sweet potato was used as both saccharifying and sweetening agent in both areas (though more in Maiduguri) for kunun-zaki production.Malted acha is not used in Maiduguri most probably for its non-availability in the location.

Water Sources Used

The availability of the type of water sources in the locations may have contributed to the variations in the respective usage levels of the water sources. More of the respondents in Maiduguri (40%) used tap water than those in Jos (35%). Kunun makers in Jos however used water from hand-dug wells at (36.67%) than those in Maiduguri (16.67%). Maiduguru may be having more of boreholes (being in the far North where rains are scantier) than Jos metropolis. This may have explained why more of the respondents used bore holes in Maiduguri than those in Jos. The use of water from streams at about 26% in Jos is an inference that water may be very scarce in Jos at the time of this research and this could have negative health implications on consumers of the beverage made from such water source, considering the fact that stream waters were contaminated more with coliforms than other sources (Table 4).

Kunun-zaki production methods

Although, the results on Table 2 shows that almost all the makers of kunun-zaki undertake the cleaning of the grains of prior to the use of grains, only very few took the painstaking effort of hand-sorting out foreign matter and stones from the grains before use in both locations.

The steeping process in both locations by makers of kunun-zaki involved principally the use of plastic buckets (18.34%) metallic containers (18.34%) and use of cold water (91.67%) for a period of 8 – 12 hours (76.67%) with the percentage responses in brackets respectively. However, more makers of kunun-zaki in Jos use hot water for steeping and ferment the beverage for longer hours than those in Maiduguri. The relatively colder weather in Jos could have been responsible for the use of hot water by more people there. In most cases spices were pre-processed by washing (83.84%) and blended together with the steeped and drained grains (56.67%).

There were no obvious differences in the sieving process of malted grains for use. The wet-milled grains were sieved using muslin cloth (91.67%) and before pre-gelatinization (91.67%). All kunun-zaki makers left the pre-gelatinizated cereal slurry to ferment (100.00%). Although, the fermentation period in Jos is relatively longer (above, 14 hours) by (16.67%), majority of the kunun-zaki makers ferment the slurry for 12 – 14 hours (83.33%). Kunun-zaki by assessment do not receive any chemical preservation treatment traditionally and the product stores on the average for only 2 days. The beverage is reported by its maker to store longer for up to 5 days in Jos (21.33%) than in Maiduguri.

Food exposure to high ambient temperature has been known to degrade faster than that at low temperature since microbial activities are enzyme dependent and enzyme activity increases with increase in temperature. (Adams and Moss, 1999). This reason could be responsible for the relatively shorter life span of kunun-zaki in the hotter Maiduguri compared to that in Jos metropolis.

Bacterial loads of Kunun-zaki

Kunun-zaki samples in Maiduguri had significantly higher total plate count than those in Jos ($P \leq 0.05$). The higher total bacterial load in Maiduguri could be attributed principally to the higher temperature and which could have in turn contributed to the faster proliferation of the micro organism in the samples. The higher coliform count in Jos could be attributed to the fact that most of the water sources used in preparing the beverages samples were from hand-dug wells and streams and not from treated tap water. Generally the values of both total plate and coliform counts of the beverages were higher than the required standard values in ready to consume beverages (Adam and Moss, 1999).

The results on the bacterial loads of kunun-zaki made using different
water sources (Table 4) indicate that there is significant difference ($P \leq 0.5$) in the total plate counts between sources of water; with kunun-zaki made using water from hand-dug wells having the highest level of bacterial contamination (comparing tap water, hand-dug and bore hole water source only) This same trend of results is observed for the coliform count of the beverages as well. While kunun-zaki made in Jos using tap water was found to be least contaminated the beverage samples made from bore holes in Maiduguri was the least contaminated. The results imply that hand dug wells may be the major sources of bacterial contamination to hawked kunun-zaki in these locations and that treated tap water or bore-holes water sources could be better sources than hand-dug wells and streams. Generally, water used for food processing should meet minimal requirements as specified by legislation (Adams and Moss 1999).

Bacterial flora of the kunun zaki samples

The results of the bacterial flora of the beverage shows that it is a good harbour for pathogenic bacteria, namely *Staph. Aureus, B. cereus, Shigella dysentariae, E. coli* and *Proteus mirabilis* all of which have been implicated for causing gastrointestinal diseases to man (Adams and Moss (1999). This result agrees with the reports of Onuorah et al, (1987) and Egbere, (1988) who isolated some of these same organisms in kunun-zaki hawked in Makurdi and Zaria towns respectively. The presence of lactic acid bacteria (three lactobobilli and a Streptococcus species) in the beverage at such high prevalence (Figure 1) imply that kunun-zaki's acid based fermentation could have been carried out by these lactics which have been known to be good lactic acid producers. Indeed the probiotic benefits of lactics to health are well documented and have been advocated to consumers of fermented food like yoghurt which contain the live organisms normally used as starter cultures. Adams and Moss, 1999).

Physico-chemical properties of kunun-zaki

There was no significant difference in the physico-chemical parameters of pH, TTA (%) specific viscosity and specific density in the two locations (Maiduguri and Jos), meaning that the variation in ambient temperature and other parameters raw materials and production procedures in the two location do not impact significantly on the physico-chemical quality of the beverage. However, there were obvious differences in the colour gradings of kunun-zaki in the two locations. While brown coloured kunun-zaki was found predominant in Jos (64%) milky Kunun-zaki predominated in Maiduguri by 40%. Ash-coloured kunun-zaki was however least in dominance in the two locations. It could be inferred that that the type of cereal grain used in the production of kunun-zaki reflects directly on the colour of the finished kunun-zaki product. Guinea corn based kunun-zaki is naturally brownish while millet based kunun-zaki could be milky. The Ash and grey colourations in the few samples in the two locations could be due to colour imparted either by use of spices or other sources.

About 83% of respondents interviewed used ginger as flavouring spice while relatively few respondents use other spices like cloves (11.6%) and black pepper (5.001) with respective mean value of respondents in brackets above. More inhabitants were found to use spices in Jos that those in Maiduguri most probably due to the colder weather in Jos. Ginger and paper are known to impact peppery taste which some consumers claims drives away cold.

CONCLUSIONS

It could be concluded from this study that local preparation of kunun-zaki differed from location tc location and from one maker to another in terms of raw materials equipment and water sources used However, the predominantly used raw materials and production procedures employed by local kunun-zaki producers could be identifiable for adoption by prospective industrial producers of kunun-zaki The bacteriological quality of the beverage sample analysed is generally poor while the physico-chemical properties of the beverage did not differ significantly ($P < 0.05$) in the two

locations. The results of this work forms a good basis for the development of a Hazard Analyses and Critical Control Point (HACCP) for the quality control of the beverage.

REFERENCES

Adams, M. R. and Moss, M. O., 1999. *Food Microbiology*. The Royal Society of Chemistry Publ. Cambridge, U.K. pp 398.

Adeyemi I. A. and Umar, S., 1994. Effects of Method of Manufacture on Quality Characteristics of Kunun-zaki, a millet based beverage. *Nig. Food Journal* 12: 34 – 41.

Egbere, O. J., 1998. The Microbiology of Kunun-zaki: A Nigerian Sorghum based fermented Beverage. B.Sc. Thesis. *Food Science and Technology Department, University of Jos* (Makurdi Campus) Nigeria. Pp 78.

Gaffa, T. and Ayo J. A., 2002. Innovations in the Traditional Kunun-zaki products Process. Pakistan Journal of Nutrition 1 (5): 202 – 205.

Gaffa, T and Gaffa, A. T., 2004. Microbial Succession during Kunun-zaki production with Sorghum (*Sorghum bicolour)* grains. *World Journal of Microbiology* 20: 499 - 453

Gaffa, Jideani, I. A. and Nkama I., 2002. Traditional Production, Consumption, and storage of Kuni a non alcoholic cereal beverage Plant food for Human Nutrition 57:73-81.

Fawole, M. A. and Oso, B. A., 1988. *Laboratory Manual of Microbiology* Spectrum Books Publ. Ltd. Ibadan pp 121.

Inatimi, E. B. - Abasiekong, S. F. and Chiemeka, I., 1988. Kunun-zaki and tsamiya, a non-alcoholic beverage prepared from Sorghum grains. Chemical Analysis for nutrient contents of Fresh and ageing samples *Nig. J. Biotechnol* 5: 21- 22.

Onuorah, S. I., Adesiyu, A. A. and Adekoye, J. O., 1987. Occurrence of Staphylococci and Coliforms in Kunun-zaki and Utensils used in its preparation in Samaru Zaria J. Food Agric 1: 31 – 34.

Pearson, D., 1973. *Laboratory Techniques in Food Analysis*. Butteworths and Co (Publishers) Ltd. Pp 70 – 71.

Sapade, P. A. and Kassum, A. L., 1992. Rheological Characterization of Nigeria Liquid and Semi-liquid foods *Nig. Food Journal* 10: 23 – 33.