Effect of Processing Methods and Raw Materials on Quality Attributes and Sensory Properties of *Fura*

Adebayo-Oyetoro AO[1]*, Ogundipe O O[1]; Lofinmakin F K[1], Obisanya O S[1], Adeyeye S A O[2] and Ogundipe F.O[3]

[1]*Department of Food Technology, Yaba College of Technology, Yaba, Lagos, Nigeria*
[2]*Department of Food Science and Technology, Mountain Top University, Lagos-Ibadan expressway, Prayer city, Lagos, Nigeria*
[3]*Department of Biological Science, Yaba College of Technology, Lagos, Nigeria*

*Corresponding Author: Adebayo-Oyetoro AO, Department of Food Technology, Yaba College of Technology, Yaba, Lagos, Nigeria.

Abstract

This study assessed the effect of processing methods and raw materials on quality attributes and sensory properties of *fura* (a Nigerian cereal food). Sorghum grains were sorted and soaked for 12 hours in water at ambient temperature of $32 \pm 2°C$ and sprouted for 48 hours at the same temperature. The sprouted grains were washed, dried and milled. The flour obtained was divided into two portions; the first part was fermented at ambient room temperature for 48 hours to produce germinated and fermented sample while the second part was not fermented. The cleaned ungerminated grains were milled and the flour obtained was also divided into two portions. The first portion was wetted, fermented and used to produce *fura*. The second portion was used to produce traditional *fura* without fermentation. *Fura* samples were evaluated using standard methods. Germination and fermentation showed significant increase at ($p < 0.05$) in ash, crude fibre, fat, carbohydrate and pasting characteristics. The crude fibre ranged from 0.60 - 1.07%. Combination of fermentation and germination brought a significant decrease in value of carbohydrate in *fura* with the least value of $64.74 \pm 0.03\%$. Germinated *fura* sample showed the highest value in the final viscosity with values 16.30 ± 1.13 RVU and untreated *fura* sample with the least value of 11.10 ± 0.14 RVU. The growth of microorganisms in the samples is insignificant and it was due to fermentation carried out on the samples. The sensory pane lists rated the *fura* samples from fermented raw material sample highly for all the sensory parameters investigated, also the results of bulk and swelling capacity also revealed that germination and fermentation increased the swelling and bulk density.

Keywords: Sorghum; Fura; Germination; Fermentation; Traditional

Introduction

Fermentation of cereal based foods is a common practice in Africa for food preservation [1,2]. Currently, a variety of fermented foods are produced from cereals at household and semi industrial scale. These foods are used as weaning food for infants and children [3,4] and also for adults.

In tropical Africa, cereal grains are hulled and used to produce thick porridges, which are known by various names in different parts of the continent. In West Africa particularly in Nigeria, Ghana and Burkina Faso, one of such thick porridges is called "*Fura*" – a semi-solid dumping cereal meal [5]. "*Fura*" originated from the Hausa/Fulani's and is produced from the flour, blended with species, compressed into balls and boiled for thirty minutes. While still hot, the cooked dough is pounded in mortar with the pestle (with addition of hot water) until a smooth, slightly elastic cohesive lump *Fura* is formed [6,7].

Traditional *fura* processing has been developed largely as an art handed down from one generation to the other, rather than through scientific principles. Although procedures and equipment used for *fura* processing are relatively simple, the microbiology and biochemistry aspects have not been adequately researched. Physical aspects (temperature, time, relative humidity and level of agitation and aera-

tion) of the processing of millet into *fura* are poorly controlled, and production techniques are not standardized [8]. The process therefore results in products of variable quality. Poor hygienic practices and improper handling during *fura* production, post-fermentation processing (pounding with mortar and pestle, molding with bare hands), and at the point of sale, may render the products susceptible to contamination. The fermentation process in traditional *fura* processing, like many other traditional fermentation processes occurs spontaneously and difficult to control [8].

Although fermented foods traditionally have constituted a significant proportion of our diet, Nigerians have exhibited an ambivalent attitude in terms of consumers' taste and preferences for it. Most of the available beverages in Nigerian markets are either imported or produced under a franchise agreement with foreign-based multi-national companies [9].

The study examined the effect of processing methods and raw materials on quality attributes and sensory properties of *fura*. This research work would help in producing indigenous beverage that would meet needs of the people as well as create job opportunities for people.

Materials and Methods

Materials: Sorghum grains were obtained from Ojuwoye market in Mushin area, Lagos, Nigeria, together with the spices such as red pepper (*Capsicum annum*), ginger (*Zingiber officinale*), and cloves (*Syzygium aromaticum*).

Methods: Processing of sorghum into *fura* (4 samples) was by the methods of Inyang and Zakari [6] and Bello and Suberu [7] with modifications. 2.5kg quantity of cleaned millet grains were washed and then allowed to soak in water for 12 hours (1:3w/v) at ambient temperature (32 ± 2°C) followed by draining and uniformly spreading them on wet cotton cloth. The grains were covered with another cotton cloth and water was sprinkled on the top for germination at ambient temperature (32 ± 2°C) for 48 hours. Water was sprinkled at an interval of 4 hours to keep the cloth and the grains moist. The condition was maintained in a well-ventilated and 32 ± 2oC ambient temperature until the grains germinated and sprouted. At the end of the sprouting, the malted grains were dried in hot air oven at 100°C for 6 hours to about 12% moisture content.

The dried, germinated grains were dehulled followed by the addition of spices before milling using hammer mill. This flour was divided into two portions. The first portion was fermented while the second was not. About 1 kg of the germinated flour mixture (flour+spices) was weighed into plastic container and 1.5l of water was added. The content were stored, covered with aluminum foil and allowed to ferment naturally at room temperature for 48 hours with occasional stirring of the mixture for proper aeration.

The paste was molded into balls, steamed at 100°C for 1 hour. The balls was cooled, broken into small pieces and dried in a cabinet dryer at 60°C for 1hour to about 7% moisture. The dried *fura* was milled with a hammer mill to flour of particle size of about 322µm, to give germinated and fermented instant *fura* (GFF). The second portion of the germinated flour, was steamed, dried and milled into flour to give germinated *fura* (GF). Similar method as above was used to produce fermented *fura*, except that the grains were not germinated. Untreated *fura* (UF) was also produced following the traditional process. The products were packed in polyethylene bag and stored at ambient temperature for analysis.

Physico-chemical properties determination of the sample: The pH was determined by method of Oyewole (2001) and titratable acidity by AOAC method [10].

Proximate Determination: Proximate composition was determined by using AOAC methods (2000).

Determination of pasting properties: Pasting properties were determined by Rapid ViscoAnalyser (RVA) as described by Deffenbaugh and Walker (1989).

Determination of functional properties: Bulk density was determined by method of Onwuka [11] and swelling capacity by the method of Robertson., *et al* (2000).

Sensory evaluation: This was done by the method of Akinjayeju and Enude (2002).

Microbiological analysis: This was carried out by the method of Hedges (2002).

Data Analysis

Data were means of triplicates ± standard deviation. Duncan multiple range tests was used to compare significant differences between the means (p ≤ 0.05). For this analysis IBMSPSS Statistics (version21.0) was employed.

Results and Discussion

Table 1 showed the proximate composition of instant *fura* from germinated and fermented sorghum flour. This revealed significant decrease in moisture level at (p ‹ 0.05) in moisture levels with germination and fermentation. It was observed that there was decrease in moisture levels with germination and fermentation ranged between 10.04 ± 0.02% for UFF to 6.85 ± 0.11% in FFF. The result was different from the findings of Inyang and Zakari [6] which showed significant level of moisture in instant *fura* flour ranging from 7.3% in untreated grain UFF to 7.6% in combination of germination and fermentation TGFF. The fat content of the sample showed significant increase ranging from 13.51 ± 0.21% in TGFF to 24.03 ± 0.04% in GFF. It was observed that *fura* from the combination of germination and fermentation has the least amount of fat. This could as a result of increase activities of the lipolytic enzymes during germination which hydrolyses fats to lower molecules. Meanwhile low lipid levels are associated with increase in the shelf life as shown by Raham and Aal (1986). Germination and fermentation reduced the ash content and germinated grain has the least value of ash while the UFF has the highest level of ash. The ash levels are 2.89 ± 0.01% in UFF 2.06 ± 0.04% in TGFF, 1.69 ± 0.03% in FFF and 1.15 ± 0.06% in GFF. This was lower than the findings of Inyang and Zakari [6] on *fura* produced from millet which showed an increase in ash content. The result agreed with the findings of Atti (2000) and Michodjehoun., *et al.* (2005).

Sample	Moisture content (%)	Ash (%)	Fat (%)	Crude fibre (%)	Protein (%)
TGFF	8.53 ± 0.13[b]	2.06 ± 0.04[b]	13.51 ± 0.21[d]	1.07 ± 0.01[a]	2.84 ± 0.04[b]
UFF	10.04 ± 0.02[a]	2.89 ± 0.01[a]	18.01 ± 0.01[b]	1.00 ± 0.01[a]	3.07 ± 0.06[a]
GFF	7.53 ± 0.01[c]	1.15 ± 0.06[c]	24.03 ± 0.04[a]	0.60 ± 0.01[c]	1.96 ± 0.03[d]
FFF	6.85 ± 0.11[d]	1.69 ± 0.03[c]	14.65 ± 0.23[c]	0.78 ± 0.01[b]	2.24 ± 0.04[c]

Table 1: *Proximate Composition of Instant fura.*

Mean values are from duplicate samples at p< 0.05

TGFF: Germinated and fermented fura; UFF: Untreated fura; GFF: Germinated fura; FFF: Fermented fura

The crude fibre of the samples ranged from 0.60 ± 0.01% in GFF to 1.07 ± 0.01% in TGFF. Sample GFF has the least amount of crude fibre while sample TGFF has the highest level of crude fibre. Low crude fibre values were obtained in this study and this could be as a result of solubilisation of carbohydrates and lignocelluloses by the activities of microorganisms (Hwei-Ming., *et al.* 1994 and Balagopalan, 1996). The protein level of the sample significantly decreased upon processing as a result of protein denaturation at high temperature during drying as well as effects of microbial and enzyme activities during processing. The temperature was observed to denature the protein present in the samples. Also the result obtained in this and previous studies are however contrasted by the result of Nwabugwu and Onweluzo (2005) who reported reduction in the protein contents of sprouted pigeon pea compared to unsprouted sample, which was attributed to protein hydrolysis. The level of protein ranged from 2.89 ± 0.01% in UFF to 1.15 ± 0.06% GFF. Protein was also to increase as a result of germination and fermentation.

Carbohydrate content of the samples decreased significantly (p < 0.05). This could be associated with microbial and enzyme activities as a result of germination and fermentation [12].

Table 2 showed the result of sensory evaluation of *fura* sample based on colour, taste, aroma, texture and overall acceptability. Mean scores obtained for the different sensory attributes of the four *fura* samples were within the range of commercially acceptable values (4-9) recommended by Akinjayeju and Enude (2002).

Sample	Colour	Taste	Aroma	Texture	Overall
GFF	5.50 ± 2.37[b]	5.25 ± 1.89[b]	5.50 ± 1.91[c]	5.75 ± 1.89[b]	6.10 ± 2.05[c]
UFF	5.95 ± 1.61[b]	5.80 ± 1.44[a]	5.35 ± 1.84[c]	5.50 ± 1.54[b]	6.25 ± 1.74[b]
TGFF	6.50 ± 1.43[a]	5.70 ± 1.49[b]	6.15 ± 1.60[b]	6.05 ± 1.96[a]	6.70 ± 1.69[b]
FFF	6.95 ± 1.39[a]	5.85 ± 1.53[a]	6.35 ± 1.31[a]	6.25 ± 1.45[a]	7.05 ± 1.00[a]

Table 2: *Sensory Evaluation of Instant Fura.*

Mean values are from duplicate samples at p-value < 0.05

TGFF: Germinated and fermented fura; UFF: Untreated fura; GFF: Germinated fura; FFF: Fermented fura

Sample FFF has the highest scores than the other samples in terms of color, texture, aroma, taste and overall acceptability. Sample TGFF has the second highest acceptability, followed by sample UFF, sample GFF has the least level of acceptability. The colour of the sample FFF showed the highest acceptability level by the panellists with a mean value of 6.95 ± 1.39, while sample GFF has the least mean value in terms of color (5.50 ± 2.37). Sample FFF also shows the highest acceptability in taste and aroma with mean values of 5.85 ± 1.53 and 6.35 ± 1.31 respectively, while sample TGFF has the least mean value of 5.25 ± 1.89 based on taste. Sample UFF has the lowest aroma with the mean value of 5.35 ± 1.84. The result of texture showed that there was no significant difference between sample TGFF and UFF. This work has demonstrated that acceptable *fura* can be produced from fermented flour, unlike other researchers which recorded acceptability of sprouted samples to fermented sample, Owusu Kwarteng., *et al.* [8] showed acceptability on the sprouted samples, also Inyang and Zakari [6] also showed similar result in their work. The acceptability of the FFF sample agreed with the report of Umeh., *et al.* (2014).

Table 3 showed the result of the pasting properties of *fura*. Pasting characteristics of flour are important quality index in predicting the behavior of flour paste during and after cooking so as to ascertain the stability of its gel (Sanni., *et al.* 2005 and Richard., *et al.* 1991). Peak viscosity is the maximum viscosity attained during or soon after the heating portion of the test in RVU. Peak viscosity indicates the water binding capacity of the starch or mixture and it occurs at the equilibrium point between swelling causing an increase in viscosity rupture and alignment causing its decrease. The peak viscosity indicates the water–binding capacity of the flour samples, and is important to the user in order to obtain a useable starch paste (Adeyemi, 1989). Sample GFF has the highest peak viscosity value of 11.25 ± 0.49 and UFF has the least value of 8.10 ± 0.00.

	Peak (RVU)	Pasting Temp (^{0}C)	Trough (RVU)	Breakdown (RVU)	Final Visc (RVU)	Setback (RVU)	Peak Time (min)
TGFF	10.55 ± 0.64	80.80 ± 0.14	9.50 ± 0.71	0.00 ± 0.00	14.35 ± 0.49	4.95 ± 0.07	6.97 ± 0.05
FFF	10.80 ± 0.00	81.73 ± 0.04	9.60 ± 0.14	1.20 ± 0.14	14.75 ± 0.07	5.15 ± 0.21	7.00 ± 0.00
GFF	11.25 ± 0.49	80.80 ± 0.14	11.05 ± 0.49	0.20 ± 0.00	16.30 ± 1.13	5.25 ± 0.64	6.47 ± 0.09
UFF	8.10 ± 0.00	80.80 ± 0.14	7.70 ± 0.00	0.40 ± 0.00	11.10 ± 0.14	3.40 ± 0.14	7.00 ± 0.00

Table 3: *Pasting properties of Fura.*

Mean values are from duplicate samples at p-value < 0.05

TGFF: Germinated and fermented fura; UFF: Untreated fura; GFF: Germinated fura; FFF: Fermented fura

From this result the peak viscosity value of the control sample (UFF) was lower than the experimental samples, with a mean value of 8.10 ± 0.14RVU, while sample FFF has the highest mean value of 10.80 ± 0.00 RVU. Higher peak value is as an indication of high starch content and it relates to the water binding capacity of starch [13]. The trough which is the minimum viscosity value measures the ability of paste to withstand breakdown during cooling ranged between 11.05 ± 0.49RVU in sample GFF which recorded the highest value and sample 7.70 ± 0.00RVU in sample UFF which recorded the lowest value. The breakdown value is an index of stability in starch (Onimawo and Akubor., *et al.* 2005). Samples with low breakdown values indicated high stability (Beta., *et al.* 2000). Sample FFF is observed to have the highest breakdown value while sample TGFF has the lowest breakdown value.

The untreated *fura* (UFF) has the least final viscosity of 11.10±0.14RVU. Viscosity depends on the shape and swelling power of the granule and amylopectin granules interaction (Ring., *et al.* 1987). Fermentation process was observed to have increased the final viscosity values in sorghum. The highest final viscosity was in fermented *fura* with mean value of 14.75 ± 0.07 RVU. The higher the setback value the lower the staling rate of the product (Adeyemi and Idowu1990). Sample GFF showed the highest setback with mean value of 5.25 ± 0.64RVU and sample UFF with the least setback has the value of 3.40 ± 0.14RVU. Peak time is the measure of cooking time for starch to attain peak viscosity and it is the time it takes flour to gel and form a paste during cooking [13]. Sample FFF and UFF is recorded to have the highest peak time 7.00 ± 0.00 and 7.00 ± 0.00 respectively and sample GFF has the lowest peak time 6.47 ± 0.09. Pasting temperature was observed to be highest in sample FFF with a value of 81.73 ± 0.04. It was observed that there is no significant difference in the rest of the samples. Higher pasting characteristics imply higher water binding capacity, higher gelatinization and lower swelling properties of the sample (Onimawo and Akubor., *et al.* 2005).

Functional properties of *fura* are presented in table 4. Sample TGFF recorded highest bulk density of 1.42 ± 0.02%while sample GFF recorded the highest swelling capacity of 19.10 ± 0.14%. The higher the bulk density the greater the quantity of materials that can be packaged within specified packaging space (Fagbemi, 1999). According to Peleg and Bagley (1983), bulk density depends on the combined effects of interrelated factors such as the intensity of attractive inter-particle forces, particle size, and number of contact points.

Sample	Bulk density (%)	Swelling capacity (%)
TGFF	1.42 ± 0.02	11.20 ± 0.00
UFF	1.28 ± 0.04	11.21 ± 0.01
GFF	1.32 ± 0.02	19.10 ± 0.14
FFF	1.33 ± 0.01	10.25 ± 0.07

Table 4: *Functional Properties of Instant Fura.*

Mean values are from duplicate samples at p-value < 0.05

TGFF: Germinated and fermented fura; UFF: Untreated fura; GFF: Germinated fura; FFF: Fermented fura

Physiochemical properties

Total titratable acidity (TTA) and pH were carried out on the fermented sample and the result shows that there was significant decrease in pH from 5 after 24 hours to 3 after 48 hours and TTA shows a slight decrease from 48 g/l after 24 hours to 46 g/l after 48 hours of fermentation. Increase in total titratable acidity of fermented *fura* showed that the secretion of some organic acids might have occurred. These results are in agreement with those of many researchers [14-21]. The decrease in pH of all fermented samples was an indication of reduced alkalinity in order to hydrolyze the available carbohydrate to acid or the breakdown of protein to low molecular weight amino acids. This was in agreement with the findings of Pederson (1995); Caplica and Fitzgeralt (1999) and Sahlin (1999). The reduction in pH is also in agreement with Chavanand Kadam (1989) which stated that during fermentation, pH decreases with a concomitant increase in acidity as lactic acid accumulates due to microbial activity. The TTA of the fermenting product increased as fermentation progressed indicating that the acidity of the product were released in the fermenting liquor for the products to detoxify (Umeh and Odibo., *et al.* 2013 a & b).

The microbial results were shown in table 5 and 6. The result obtained shows that there are no presence of pathogenic microorganism that may be potential source of food borne infection and some related diseases for the consumers of this product.

LABEL	Gram	Motility	Glucose	Lactose	Mannitol	Maltose	Indole	Methyl Red	Vogesproskauer	Citrate	H_2S	Sucrose	Urea	Oxidase	Coagulase	Catalase	Probable bacteria isolate
C	+	+	+	+	+	+	-	-	+	-	-	+	-	-	NA	+	*Bacillus subtilis*
B	-	+	+	+	+	+	+	+	-	-	-	NA	-	-	NA	+	*Eschericia coli*
A	+	-	+	+	+	+	NA	+	-	+	-	+	+	-	-	+	*Staphylococcus saphrophyticus*
D	+	+	+	+	-	+	-	-	+	-	-	+	-	-	NA	+	*Bacillus specie*

Table 5: *Biochemical characterisation of the bacteria isolates.*

S/N	Label	TBC (X10^6 CFU/g)	A	B	C	D	E
1	UFF	0.1	+	-	-	-	-
2	FFF	0.2	-	+	+	-	-
3	GFF	1.4	+	+	+	-	-
4	TGFF	1.1	+	+	+	-	-

Table 6: *Total viable bacteria count for fura.*

TGFF: Treated germinated and fermented fura; UFF: Untreated fura; GFF: Germinated fura; FFF: Fermented fura

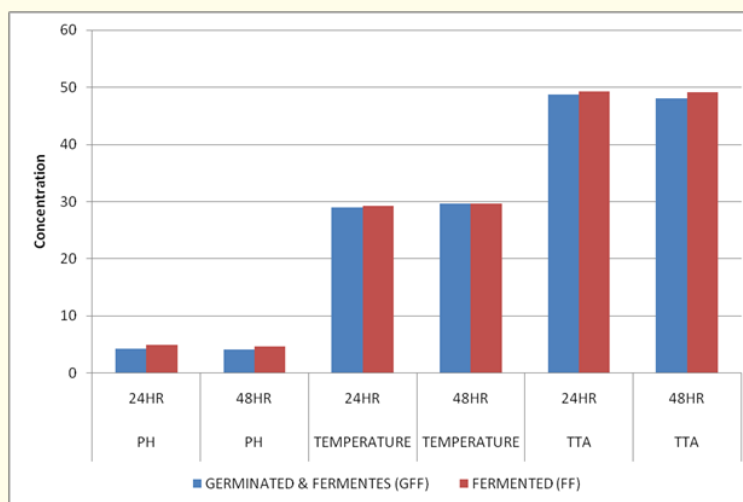*A=Staphylococcus saprophyticus; B= Escherichia coli; C= Bacillus subtilis; D= Bacillus*

Figure 1: *Effect of Fermentation and Germination on Chemical Composition of Instant Fura.*

TGFF: Treated germinated and fermented fura; UFF: Untreated fura; GFF: Germinated fura; FFF: Fermented fura

The total viable bacteria count in all the samples were within the standards of 1.0×10^2cfu/ml (NAFDAC, 2009). These characteristics hereby recorded that the microorganism present in these samples were insignificant and the microorganisms present are due to the fermentation of the products. The microorganisms counted was then characterized so as to identify the types of microorganisms present in the samples, of which different nutrient agar was used so as to know the types of organisms.

In sample UFF there is insignificant presence of *Staphylococcus saprophyticus* with a count of 0.1×10^6, sample FFF shows an insignificant presence of *Escherichial coli* and *Bacillus subtilis* with a count of 0.2×10^6, sample GFF shows the presence of *Staphylococcus saprophyticus, Escherichial coli* and *Bacillus subtilis* with the total count of 1.4×106 which is insignificant according to NAFDAC, 2009, sample TGFF shows insignificant presence of *Staphylococcus saprophyticus, Escherichial coli* and *Bacillus subtilis* with a total count of 1.1×10^6. Hence, these microbial enzyme activities causes reduction in fibre content and increase in both reducing and total soluble sugars this could lead to increase in carbohydrate value (Odetokun, 2000). The result agreed with the previous findings of Evans., *et al.* (2003) and Oboh and Akindahunsi (2003), as well as the work of Akharaiyi and Omoya (2008) on effect of processing methods on the microbiological quality of liquid pap *ogi* prepared from maize.

Conclusion

The study showed that germination and fermentation of sorghum prior to *fura* production increased ash, crude fibre, and pasting properties of the product. However, it was observed that the protein content was reduced contrary to the findings of other researchers. The study has also demonstrated that the combined effects of germination and fermentation significantly enhanced the acceptability of the sample. And in this study the results of pasting properties showed that peak viscosity of the flour progressively increased as the time/temperature increased due to the increased ability of the starch granules to absorb water.

Bibliography

1. Achi OK. "The potential for upgrading traditional fermented foods through biotechnology". *African Journal of Biotechnology* 4.5 (2005): 375-380.

2. Achi OK and Ukwuru M. "Cereal-Based Fermented Foods of Africa as Functional Foods". *International Journal of Microbiology and Application* 2.4 (2015): 71-83.

3. Lei V and Jakobsen M. "Microbiological characterization and probiotic potential of koko and koko sour water, African spontaneously fermented millet porridge and drink". *Journal of Applied Microbiology* 96.2 (2004): 384-397.

4. Kalui CM., *et al*. "Partial characterization and identification of lactic acid bacteria involved in the production of ikii: a traditional fermented maize porridge by the Kamba of Kenya". *Journal of Tropical, Microbiology and Biotechnology* 4.1 (2008): 3-15.

5. Jideani VA., *et al*. "Survey of fura production in some northern states of Nigeria". *Plant Food for Human Nutrition* 56.1 (2001): 23-26.

6. Inyang CU and Zakari UM. "Effects of germination and fermentation of pearl millet on proximate, chemical and sensory properties of instant fura; A Nigerian cereal food". *Pakistan Journal of Nutrition* 7.1 (2008): 9-12.

7. Bello I M and Suberu H A. "Organoleptic acceptance of "fura" produced with malted grains of Pennisetumtyphoides (Burm;F) (STAPF AND HUBBARD)". *International Journal of Applied Biological Research* 2 (2009): 121-125.

8. Owusu-KwartengJ., *et al*. "Process characteristics and microbiology offura produced in Ghana". *Nature and Science* 8.8 (2010): 41-51.

9. Animashaun JO., *et al*. "An analysis of determinants of consumption of fermented traditional drinks in kwara state, Nigeria". *Agriculture and Forestry* 59.3 (2013): 137-146.

10. Association of official and Analytical Chemists in Official Method of Analysis of Association of Analytical Chemists. AOAC, Washington (2005).

11. Onwuka G I. "Food Analysis and Instrumentation: Theory and Practice". *Napthali Prints, Lagos* (2005).

12. Lasekan OO. "Effect of germination on alpha-amylase activities and rheological properties of sorghum (sorghum bi color) and acha (Digilariaexilis) grains". *Journal of Food Science and Technology* 33 (1996): 329-331.

13. Adebowale KO., *et al*. "Effect of heat moist treatment and annealing on the physico chemical properties of red sorghum". *African Journal of Biotechnology* 4.9 (2005): 928-933.

14. Hamad AM and Field ML. "Evaluation of the protein quality and available lysine of germinated and fermentated cereals". Journal of Food Science 44.2 (1979): 456-459.

15. Adeyemi IA and S Umar. "Effect of method of manufacture on quality characteristics of kunuzaki a millet based beverage". *Nigerian Food Journal* 12 (1994): 44-41.

16. Association of Official and Analytical Chemists in official method of analysis of Association of Analytical Chemists, 15th edition. AOAC, Washington (1990).

17. Dimple Singh-Ackbarali and Rohanie Maharaj. "Sensory Evaluation as a tool in determining acceptability of innovative products developed by undergraduate students in Food Science and Technology at the University of Trinidad Tobago". *Journal of Curriculum and Teaching* 3.1 (2014): 10-27.

18. Kulkani KD., *et al*. "Sorghum malt-based weaning foodformulations: Properties, functional properties, nutritive value". *Food and Nutrition Bulletin* 13 (1991): 322-329.

19. Applications manual for the Rapid ViscoAnalyzer using thermocline for windows. Newport Scientific Pty Ltd., ½ Apollo Street, Warriewood NSW 2102, Australia (1998): 2-26.

20. Onimawo IA and Egbekun MK. "Comprehensive Food Science and Nutrition". Revised ed. Grace Foundation Publications, Jos, Nigeria (2002).

21. Osuntogun B and Aboaba OO. "Microbiolgical and physico-chemical evaluation of some non-alcoholic beverages". *Pakistan Journal of Nutrition* 3.3 (2004): 188-192.