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Effect of Local Preservatives on Quality of Traditional Dry-Yam Slices 'Gbodo' and its Products

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Abstract: The effect of local preservatives (sorghum grains and stalk, 'ogi'-water, 'abafe' leaves (*Piliostigma thonningii*), agehu/aganho stem bark (*Khaya ivorensis*) and their combinations) on the quality of traditional dry-yam slices 'gbodo' and its products were investigated. The samples were analysed for pH, peroxidase enzyme activity, brown colour index, sensory properties, bacterial and fungal counts. Samples parboiled with abafe, agehu and their combinations have lower pH and negative peroxidase enzyme activity before and after storage. The samples parboiled with sorghum grains, sorghum stalk, 'abafe', 'ogi' water respectively and the one with no preservative had 26-28% browness, which were not significantly different from each other at $p>0.05$. The samples parboiled with no preservative was significantly different ($p<0.05$) from all other samples in terms of colour of 'gbodo' and significantly different in terms of easy of breaking compared with the sample parboiled with 'ogi'-water and sorghum grains. There were significant differences ($p<0.05$) in colour and taste of 'amala' made from 'gbodo' parboiled with local preservatives, especially the ones parboiled with combinations of local preservatives. There is a positive correlation (0.2331) between the results of instrument measurement and sensory measurement of colour of gbodo/elubo produced from yams parboiled with or without local preservatives. Local preservatives- 'abafe' and 'agehu' added singly or in combinations- during yam parboiling had anti-bacterial and anti-fungi effects on 'gbodo', before and after 3 months of storage.

Key words: Local preservatives · parboiling · dry-yam slices

INTRODUCTION

Yam, Dioscorea (*spp.*) is an important source of carbohydrate for many people of the sub-Sahara region, especially in the yam zone of West Africa [1]. Yam is cultivated throughout the tropics and in many parts of the sub-tropics and temperate zones [2]. In West Africa and New Guinea, yam is one of the primary agricultural commodities [3]. There are over 150 species of yam grown throughout the world [4]. Babaleye [5] reported that yam contributes more than 200 dietary calories per capita daily for more than 150 million people in West Africa and serves as an important source of income to the people.

In some West African countries such as Nigeria, Benin and Ghana, yams are processed into dry-yam tubers/slices and flour [6]. Dry-yam tubers/slices are processed by peeling, some times slicing, parboiling in hot water (at 40-60°C for 1-3 h), steeping for about a day and sun-dried, this is called "Gbodo" in the Yoruba land of Nigeria [7]. The traditionally processed parboiled dryed yam is called "gbodo" when gbodo is milled into flour, it is called "Elubo" which when stirred into boiling water- make a thick paste known as "Amala", eaten with soup by the consumers [8, 9]. The main quality attributes of gbodo/elubo/amala are colour, texture and taste [9]. Most consumers prefer a light brownish, elastic, non sticky amala with a slightly sweet taste, while a slightly bitter taste is also tolerated [9-11].

Some dry-yam processors in Nigeria usually add certain substances such as sorghum grains or stalks, some plant leaves or bark of stem or ogi-water (decanted water from fermented maize paste) during parboiling of yam. Little information is available on roles of these substances in gbodo production, while Dumaine *et al.*

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[12] reported that parboiling of yam with plant bark helps in dry-yam perservation against weevil infestation. There is need to investgate some other roles of different plant parts in this regard thus the objective of this study is to determine the effect of local preservatives on sensory and microbiological qualities of dry-yam 'gbodo'.

MATERIALS AND METHODS

Raw materials: The Yam used was of local variety- "Ijedo" (*Dioscorea esculenta)*, purchased from Odo-oba in Oyo state, Nigeria. The yam tubers were of six to eight months old.

Sorghum grains and sorghum stalks were purchased from Lafenwa market, Abeokuta, Nigeria. Abafe leaves (*Piliostigma thonningii*) and agehu/aganho stem bark (*Khaya ivorensis*) plucked from the parent plants. "Ogi" - water (water decant from fermented maize paste).

Processing of yam to dry-yam "Gbodo": Yam was processed to dry-yam "gbodo" in the laboratory following the method described by Ige and Akintunde [13] with some modifications. The white yam tubers were thoroughly washed with clean water to remove adhering soil and other undesirable materials from the yam and to reduce microbial growth on the final product. Peeling was done using a sharp knife. The peeled yam were sliced into size of 2 - >3 cm in thickness so as to hasten the process of drying. The sliced yam were parboiled at 50°C for 2 h in water baths, (Clifon, England), then left in the parboiling water for 24 h in order to become flabby, after which they were drained and dried at 60°C for minimum of 3 days in a cabinet dryer, the dried samples were weighed at intervals to obtain a constant weight. The dried yam were then packaged in polyethene bags and stored at -4°C before further analyses. Amala was prepared by stirring milled gbodo (elubo), in boiling water to form paste and analysed as required.

Effect of local preservatives during parboiling on quality of dry-yam: Substances such as red sorghum grains, sorghum stalks, abafe leaves (*Piliostigma thonningii*), agehu/aganho stem bark (*Khaya ivorensis*) and "ogi" water (water decant from fermented maize paste) were added to each sample during parboiling as applied by the local processor and were analysed for their effect on instrumental colour measurement, sensory and microbiological qualities. Their pH and enzyme activities were also measured.

pH determination: The pH was determined for each sample using Jenway pH meter (Model 3015, Serial No. 1647, UK) [14].

Peroxidase enzyme activity determination: 0.5% guaiacol was dissolved into 50% alcohol solution, 2.8 mL of 30% Hydrogen peroxide was also dissolved in 1 L of water. Then 5 drops of the guaiacol solution is dropped followed by 5 drops of Hydrogen peroxide solution on the the yam flour sample. Colour change indicates that the enzymes are still active [15].

$$\text{Peroxidase} + H_2O_2 \rightarrow H_2O + O_2$$

$$O_2 + \text{Guaiacol} \rightarrow \text{brown colour}$$

Instrumental colour measurement of yam flour (elubo) and yam paste (amala): The colour of yam flour and pastes were determined using a portable PCM™ Colour Tec colourimeter SN30002421, Accuracy Microsensors, Inc., Pittsford, New York, USA. The instrument was first standardized with a Xero x 80 g/m^2 white paper to have CIE whiteness D 65. A measured sample of the yam flour/paste is weighed into a transparent bag and the colorimeter is placed on the bag, light rays are being reflected on the sample, the reflected rays sends the signal back to the tri stimulus filter which is connected to the phototubes. The colour measurement circuit records l, a and b co- ordinates of the samples.

The values determined by the colorimeter include L, a and b which were then converted to colour coordinates system L*, a* and b* values. The brown index which is most important in this study was calculated as (100-L*). L* 0.00 indicate darkness and 100.00 indicate whiteness.

Microbiological counts of dry-yam (gbodo/elubo) and amala: Microbiological analyses included Total Aerobic plate count and Fungal count. The total plate count was determined by diluting the samples serially and plating 1ml of the aliquots separately on triplicate plates of Nutrient agar (Oxoid) and incubating at 28 ± 2°C for 48 h [16]. The Fungal count was determined by plating 1 mL aliquots of the samples on acidified Potato Dextrose Agar (Oxoid) in order to suppress bacterial growth. This was done by acidifying to a pH 3.5 with 1 mL 10% lactic acid solution and incubating at room temperature (28 ± 2°C) for 48 h [16].

Sensory analysis: Scoring Difference method was used perceive the intensity of colour characteristics of gbodo produced with different local preservatives during parboiling.

Samples of gbodo/ elubo/amala were presented to twenty trained panelists. The sensory evaluation for gbodo, elubo or amala were carried out on different days respectively. Panelists were asked to evaluate the samples, using the questionnaires provided for Scoring Difference Test for intensity of colour (browness) as 1=very dark brown, 2=dark brown, 3=slightly brown, 4=moderately brown, 5=light brown and 6=very light brown. While the hardness (brittleness /easy of breaking) as 1=very hard to break, 2=hard to break, 3=slightly hard to break, 4=moderately break, 5=easily break and 6=crumbs very easily for gbodo. The yam flour samples were prepared into amala dough/paste and were also presented to the panelists to identify any difference between the colour and taste (1=very bitter, 2=bitter, 3=slightly bitter, 4=bland, 5=slightly sweet and 6=sweet) of dough of cooked yam flour (amala) using Scoring Difference Test.

Statistical analysis: Analysis of variance (ANOVA) was used to determine differences in moisture content, instrumental colour measurement and sensory properties. Turkey's Studentized range test was performed for post-hoc multiple comparisons [17].

RESULTS AND DISCUSSION

Effect of local preservatives on pH and Peroxidase Activity of gbodo/elubo and amala: The pH of initial samples of elubo varies from 3.78 for sample parboiled with "ogi"-water to 4.91 for sample parboiled with abafe leaves, while the pH of Gbodo/elubo stored for 3 months varies from 4.03 (sample parboiled with abafe, agehu and sorghum grains) to 5.02 (sample parboiled with on preservative). The pH of amala made from gbodo/elubo before storage varies from 5.18 (sample parboiled with "ogi"-water) to 6.03 (sample parboiled with on preservative). The pH of amala made from gbodo samples stored for 3 months, varies from 5.24 (sample parboiled with agehu and sorghum grains) to 6.45 (sample parboiled with no preservative) (Table 1). Sample parboiled with no preservative, sample parboiled with sorghum grains and sample parboiled with "ogi"-water have positive peroxidase enzyme activity before and after storage while the other samples have negative peroxidase enzyme activity (Table 1). Peroxidase enzyme reaction are pH dependent, the pH of maximum action is known as the optimum pH for most enzyme, the optimum is about pH 7 and if the medium becomes strongly acid or alkaline, the enzyme is inactivated, however, some enzymes only operate in acid or alkaline medium [17]. The positive peroxidase enzyme activity of the sample parboiled with "ogi"-water indicated that the enzyme present are such that could with stand acid medium. The acidic of the "ogi"-water parboiled sample could be due to the acidity of "ogi"-water which increases during the steeping of yam as a result of increase in acid producing microorganisms, such as *Aspergillus niger* [18, 19]. The negative enzyme activity of the samples parboiled with agehu, abafe leaves and combinations of local preservatives could be due to their destruction effect on some of the microorganisms present in the samples. The positive enzyme activity is due mainly to the presence of polyphenoloxidase PPO activity and less due to the peroxidase enzymes POD because POD is more sensitive to heat at 60-65°C for 20 min [20, 21]. Thus,

Table 1: Effect of local preservatives on pH and Peroxidase enzyme activities of elubo and amala

Sample parboiled with:	Gbodo/Elubo				Amala	
	Initial:		After 3 months storage:		Initial:	After 3 months storage :
	pH	Enz. Act.	pH	Enz. Act.	pH	pH
No preservative	5.54	+	5.02	+	6.03	6.45
Sorghum grains	4.08	+	4.47	+	5.68	5.81
Sorghum stalk	4.56	-	4.81	-	5.94	5.87
Abafe leaves	4.91	-	4.85	-	5.37	5.43
Agehu stem	4.66	-	4.46	-	5.31	5.52
"ogi" water	3.78	+	4.11	+	5.18	5.38
Abafe+Agehu	4.33	-	4.38	-	5.45	5.76
Abafe+sorghum grains	4.58	-	4.64	-	5.48	5.51
Agehu+sorghum grains	4.47	-	4.46	-	5.76	5.24
Abafe+Agehu+sorghum grains	3.96	-	4.03	-	5.31	5.29

Table 2 : Effect of local preservatives on instrumental colour measurement of gbodo/elubo and amala

Sample parboiled with:	Gbodo/ Elubo			Amala		
	L*	Brown index (100-L*)	Hue value	L*	Brown index (100-L*)	Hue value
No preservative	73.46^{a}	26.54^{b}	77.76^{ab}	42.55^{ab}	57.45^{bc}	86.39^{a}
Sorghum grains	73.50^{a}	26.50^{b}	84.00^{a}	50.60^{a}	49.40^{cd}	81.80^{b}
Sorghum stalk	72.36^{a}	27.64^{b}	87.83^{a}	46.43^{ab}	53.57^{c}	63.32^{c}
Abafe leaves	72.20^{a}	27.80^{b}	77.99^{ab}	51.11^{a}	48.89^{cd}	38.05^{d}
Agehu stem	67.07^{ab}	32.93^{a}	79.74^{ab}	38.92^{b}	61.08^{b}	81.29^{b}
"ogi" water	73.35^{a}	26.65^{b}	77.98^{ab}	36.75^{b}	63.25^{b}	87.89^{a}
Abafe+Agehu	65.55^{ab}	34.45^{a}	78.50^{ab}	30.84^{c}	69.16^{a}	88.34^{a}
Abafe+sorghum grains	68.04^{ab}	31.96^{a}	77.64^{ab}	32.45^{c}	67.55^{a}	88.51^{a}
Agehu+sorghum grains	68.34^{ab}	31.66^{a}	77.81^{ab}	31.61^{c}	68.39^{a}	87.93^{a}
Abafe+Agehu+sorghum grains	60.21^{b}	39.79^{a}	78.23^{ab}	30.20^{c}	69.80^{a}	88.71^{a}

+Mean values of the same super-script letters in a column are not significantly different at p>0.05

the browning of amala could be linked to the total phenol contents of the flour. The increase of pH after preparation of samples into amala could be due to the water used to stir elubo flour into amala which brings down the acidity of the samples.

Effect of local preservatives on instrumental colour measurement of gbodo/elubo: The lightness (L*) and brown index (100-L*) values are most relevant in this study, thus, gbodo/elubo sample with combination of agehu, abafe and sorghum grains added during parboling, have the highest brown index (100-L* value of 39.79) among the samples. The samples with added sorghum grains, sorghum stalk, abafe, "ogi"-water and the one with no preservative have 100-L * of 26.54, 26.50, 27.64, 27.80 and 26. 65, respectively (Table 2) which indicated that they are about 75% white in appearance, thus having about 26-28% browness, which were not significantly different from each other at p>0.05. The brown index of amala samples increases at double rate, with the amala sample parboiled with combination of agehu, abafe and sorghum grains having the highest brown index of 69.80 which is closely followed by that of combination of abafe and agehu (69.16) (Table 2). The addition of local preservatives during parboiling of yam indicate their ability to increase browness of gbodo/elubo flour. It is also important to note that the increase in discolouration when flour is being cooked to prepare amala could also be linked to thermal degradation of originally colourless complex phenolics (proanthochanidins and lignins) to coloured phenols (anthocyanidins) [22]. Thus, the brown colour of amala could be linked to the total phenol contents of the flour. The Hue values of samples parboiled with sorghum grains and sorghum stalk were high (84.00, 87.83, respctively) which could be due to impactation of the red colour of sorghum to the gbodo samples.

Sensory evaluation Gbodo/Elubo and amala parboiled with local preservatives: There was no significant difference (p>0.05) in the colour of gbodo samples parboiled with abafe, agehu and all samples parboiled with mixtures of local preservatives- these were moderately brown in colour. There was also no significant difference (p>0.05) in colour of samples parboiled with sorghum grains, sorghum stalks and "ogi"-water, which were brown in colour. The samples parboiled with no preservative was significantly different (p<0.05) from all other samples, which was light brown in colour (Table 3). In Table 3, there was no significant difference (p>0.05) in hardness of gbodo parboiled with mixtures of abafe and agehu, abafe, agehu, sorghum grains and gbodo parboiled with no preservative, which were hard to break. There was no significant difference (p>0.05) between the hardness of gbodo parboiled with sorghum stalk, abafe, agehu, mixture of abafe and sorghum grains and mixture of agehu and sorghum grains respectively, which were slightly hard to break. There was also no significantly difference (p>0.05) between the hardness of gbodo parboiled with sorghum grains and "ogi"-water respectively, which breaks moderately.

There was no significant difference (p>0.05) between the colour of amala made from gbodo parboiled with sorghum grains, sorghum stalk and the one with no preservative, which were moderately brown in colour. There was no significant difference (p>0.05) between the colour of amala made from gbodo parboiled with abafe, agehu, "ogi"-water and mixtures of local preservatives, which were brown in colour (Table 3).

Table 3: Sensory evaluation Gbodo/Elubo and Amala parboiled with local preservatives

Sample parboiled with:	Gbodo		Amala	
	Colour	Hardness/Ease of Breaking	Colour	Taste
No preservative	5.13[a]	5.35[a]	3.89[a]	4.14b
Sorghum grains	3.32[c]	3.06[c]	4.12[a]	4.92[a]
Sorghum stalk	3.40[c]	4.12[b]	4.19[a]	4.05[b]
Abafe leaves	4.21[b]	4.34[b]	3.22[b]	3.13[c]
Agehu stem	4.05[b]	4.31[b]	3.08[b]	3.49[bc]
"ogi" water	3.26[c]	3.09[c]	3.16[b]	4.18[b]
Abafe+Agehu	4.11[b]	4.97[a]	3.54[ab]	3.16[c]
Abafe+sorghum grains	4.15[b]	4.07[b]	3.07[b]	3.21[c]
Agehu+sorghum grains	3.95[b]	4.16[b]	3.20[b]	3.05[c]
Abafe+Agehu+sorghum grains	4.23[b]	4.28[b]	3.14[b]	3.19[c]

+Mean values of the same super-script letters in a column are not significantly different at p>0.05

Table 4: Correlation between Peak viscosity, pH and Colour of gbodo/elubo with and without local preservatives

	Peak viscosity	pH	Instrumental colour measurement	Sensory colour measurement
Peak viscosity	1			
pH	0.430355	1		
Instr. colour	-0.8315	-0.30818	1	
Sens. colour	0.082639	0.759282	0.233095	1

Table 5: Moisture content and Microbial analyses of gbodo parboiled with local preservatives

Sample parboiled with:	After processing			After 3 months of storage		
	Moisture content %	Total plate count (cfu g^{-1})	Fungal count (cfu g^{-1})	Moisture content %	Total plate count (cfu g^{-1})	Fungal count (cfu g^{-1})
No preservatives	9.12[a]	$7.1x10^3$	$9.2x10^3$	13.22[a]	$5.7x10^4$	$7.3x10^4$
Sorghum grains	8.68[a]	$2.3x10^4$	$5.3x10^4$	12.64[a]	$6.4x10^4$	$2.6x10^5$
Sorghum stalk	10.16[a]	$2.7x10^4$	$4.8x10^4$	13.27[a]	$5.8x10^4$	$2.8x10^5$
Abafe leaves	9.80[a]	$9.1x10^2$	$7.6x10^2$	12.07[a]	$3.0x10^2$	$2.2x10^2$
Agehu stem	9.45[a]	$7.4x10^2$	$8.4x10^2$	11.43[a]	$9.0x10^2$	$2.4x10^2$
"ogi" water	9.62[a]	$3.5x10^4$	$6.9x10^4$	12.05[a]	$6.3x10^4$	$4.1x10^5$
Abafe+Agehu	9.22[a]	$7.9x10^2$	$4.7x10^2$	11.88[a]	$2.7x10^2$	$1.1x10^2$
Abafe+sorghum grains	9.75[a]	$2.5x10^3$	$4.2x10^3$	10.47[a]	$4.2x10^2$	$2.5x10^2$
Agehu+sorghum grains	9.48[a]	$4.4x10^3$	$3.5x10^2$	12.22[a]	$3.4x10^2$	$1.8x10^2$
Abafe+Agehu+sorghum grains	8.85[a]	$5.8x10^2$	$3.7x10^2$	12.13[a]	$2.4x10^2$	$1.2x10^2$

+Mean values of the same super-script letters in a column are not significantly different at p>0.05

There was no significant difference (p>0.05) between the taste of amala made from gbodo parboiled with abafe, agehu and all mixtures, which were slightly bitter in taste. There was also no significant different (p>0.05) between the taste of amala made from gbodo parboiled with sorghum stalk, Ogi-water and the one with no preservative, which have bland taste. But the amala made from gbodo parboiled with sorghum grains was significantly different (p<0.05) from all other samples, which was slightly sweet (Table 3). There is a positive correlation (0.2331) (Table 4) between the results of instrument measurement and sensory measurement of colour of gbodo/elubo produced from yams parboiled with or without local preservatives.

Microbial quality of gbodo parboiled with / without local preservatives: The moisture content of 'gbodo' parboiled with/without local preservatives vary 8.68% to 10.16% before storage (Table 5), their moisture content were within the range of recommended value for flour samples of 7-13% [23]. There is a linear relationship between the incedence of microorganisms and moisture content of samples, also gbodo/elubo is a rich carbohydrate source for yeast and mould growth [24]. After 3 months of storage, their moisture contents increased and vary from 10.47% to 13.27%. Local preservatives in (sample parboiled with abafe), (sample parboiled with agehu), (sample parboiled with abafe and agehu) and (sample parboiled with abafe,

agehu and sorghum grains) had anti-bacterial and anti-fungi effects on gbodo before and after storing for three months at ambient temperature in the usual packaging material used by the processors (polypropylene sack) (Table 5). The anti-microbial effects abafe and agehu on gbodo samples with which they were parboiled with could confirm the findings of Joseph *et al.* [25] that Abafe was found to have the ability to inhibit prostaglandin synthesis (*in vitro*) and have anti-bacterial activities against staphylococci aureus while Agehu was evaluated for their antifungal activity against plant pathogenic fungus [26]. There was reduction of microbial load of samples parboiled with mixtures of local preservatives after storing for three months. This could be the reason why those who add mixtures of local preservatives do so.

In conclusion, the use of local preservatives especially 'abafe' and 'agehu' in the production of dry-yam 'gbodo' have significant effect on most especially the sensory and microbiological qualities of 'gbodo' and its products.

REFERENCES

1. Akissoe, N.H., J.D. Hounhouigan, C. Mestres and M. Nago, 2003. How blanching and drying affect the colour and functional characteristics of yam (*Dioscorea cayenensis-rotundata*) flours. Food Chemistry, 82: 257-264.
2. Kordylas, J.M., 1990. Processing and Preservation of Tropical and Subtropical Foods. Macmillan Publishers Ltd. London and Basingstoke, 49-71, 128-136, 324-340 and 350-374.
3. Coursey, D.G., 1983. Yams. In Chan, H.T. Ed. Handbook of tropical foods, New York, NY, Dekker, pp: 555-601.
4. Purseglove, J.W., 1991. Tropical Crops: Dictoyledons. Longman Scientific and Technical. Co-published in the United States with John Wiley and Sons. New York.
5. Babaleye, T., 2003. Raising the status of the yam, a major food crop in West Africa. ANB-BIA SUPPLEMENT ISSUE/EDITION. No. 463-01/10/2003, pp: 1-3.
6. Bricas, N., P. Vernier, E. Ategbo, J. Hounhouigan, E. Mitchikpe, K.E. N'kpenu and G. Orkwor, 1997. Le development de la filiere cossettes d'igname en Afrique de l'Quest. Cahiers de la recherché Development, 44: 100-114.
7. Onayemi, O. and N.N. Potter, 1974. Preparation and storage properties of drum dried white yam (*Dioscorea rotundata* Poir) flakes. J. Food Sci., 39: 559-562.
8. Akingbala, J.O., T.B. Oguntimein and A.O. Sobande, 1995. Physico-chemical properties and acceptability of yam flour substituted with soy flour. Plant Food for Human Nutr., 48: 73-80.
9. Akissoe, N.H., J.D. Hounhouigan, N. Bricas, P. Vernier, M.C. Nago and O.A. Olorunda, 2001. Physical, chemical and sensory evaluation of dried yam (*Dioscorea rotundata*) tubers, flour and amala- a flour-derived product. Tropical Science, 41: 151-156.
10. Hounhouigan, D.J., A.P. Kayode, N. Bricas and C.M. Nago, 2003. Desirable culinary and sensory characteristics of yams in urban Benin. Benin J. Agric. Sci., 21: 2815-2820.
11. Mestres, C., S. Dorthe, N. Akissoé and J.D. Hounhouigan, 2004. Prediction of Sensorial Properties (Color and Taste) of Amala, a Paste From Yam Chips Flour of West Africa, Through Flour Biochemical Properties. Plant Foods for Human Nutrition, 59: 93-99.
12. Dumaine, F., D. Dufour, C. Mestres, J.M. Meot, C. Bada and D.J. Hounhouigan, 2000. Effect of post-harvest treatments on dried yam (*Dioscorea cayenenis-rotundata*) tubers quality. International Society for Tropical Root Crops (ISTRC) 2000, Tsukuba, Ibaraki, Japan.
13. Ige, M.T. and F.O. Akintunde, 1981. Studies on the local techniques of yam flour production. J. Food Technol., 16: 303-311.
14. Wescott, C.C., 1978. pH Measurement. Academic Press, New York.
15. United State Department of Agriculture, 1975. Enzyme Inactivation Test. Washington D.C. File case, 135-A-12.
16. Frasier, W.C. and D.C. Westhoff, 1978. Food Microbiology. Mc GrawHill Book Company, Singapore, pp: 421-424.
17. Ihekoronye, A.I. and P.O. Ngoddy, 1985. Integrated Food Science and Technology for the Tropics. Macmillan Publishers, London and Basingstoke, pp: 283-289.
18. Adebajo, L.O., O. Idowu and A.M. Adesanya, 1994. Mycoflora and mycotoxin production in Nigeria corn and corn based snacks. Mycopathologia, 126: 183-192.

19. Adegoke, G.O., 2004. Understanding Food Microbiology. Shalom Press, Ibadan, Nigeria. 2nd edition, pp: 1-216.
20. Ikediobi, C.O. and H.N. Obasuyi, 1982. Purification and properties of o-diphenolase from white yam tubers. Phytochemistry, 21: 2815-2820.
21. Omidiji, O. and J. Okzupor, 1996. Time course of PPO-related browning. Journal of the Science of Food and Agriculture, 70: 190-196.
22. Swain, T. and W.E. Hillis, 1959. The phenolics constituents of prunus domestica. I The quantitative analysis of phenlic compounds. Journal of the Science of Food and Agriculture, 10: 63-68.
23. Christensen, C.M. and H.H. Kaufmann, 1973. Maintenance of quality in stored grains and seeds. Agricultural Extension Service, University of Minnesota Folder 226, 1965.
24. Uraih, N. and G. Ogbadu, 1980. Incidence of Aflatoxin in Nigerian sorghum. Microbios, 10: 139-142.
25. Joseph, C.I., O.O. Francis, O.O. Abiodun, N.O. Irukaku and B. Lar, 1997. Anti flammatory and antibacterial activities of C-methyl flavonoids from *Pilistigma thonningii*. Society of Chemical Industry. John Wiley and Sons, Ltd., 61: 186-190.
26. Abdelgaleil, S.A.M., F. Hashinaga and M. Nakatani, 2005. Anti-fungal effect of diethyl extrat of *Khaya ivorensis*. Pest Management Science, 61: 186-190.