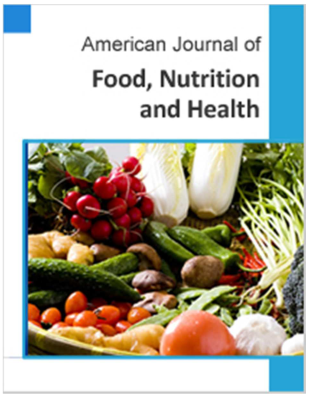
American Journal of Food, Nutrition and Health
2017; 2(3): 15-19
http://www.aascit.org/journal/ajfnh

American Association for Science and Technology



Influence of Pre-treatments on Mineral Composition and Functional Properties of *Anchomanes difformis* Flour

Seidu Kudirat Titilope[1, *], Ebiekuraju Elizabeth Tanimola[2], Lemomu Tajudeen Ireti[2], Akinola Olamilekan Ganiyu[2], Omidoyin Micheal Olawuyi[2], Kilanko Temitope[2], Onifade Damilola Christianah[2]

[1]Department of Food Technology, Federal Polytechnic, Ado-Ekiti, Nigeria
[2]Department of Science Technology, Federal Polytechnic, Ado-Ekiti, Nigeria

Email address
seidukt5@gmail.com (S. K. Titilope)
[*]Corresponding author

Keywords
A. difformis,
Pre-treatments,
Mineral Composition,
Pasting Properties,
Functional Properties

Received: July 29, 2017
Accepted: August 11, 2017
Published: September 14, 2017

Citation
Seidu Kudirat Titilope, Ebiekuraju Elizabeth Tanimola, Lemomu Tajudeen Ireti, Akinola Olamilekan Ganiyu, Omidoyin Micheal Olawuyi, Kilanko Temitope, Onifade Damilola Christianah. Influence of Pre-treatments on Mineral Composition and Functional Properties of *Anchomanes difformis* Flour. *American Journal of Food, Nutrition and Health.* Vol. 2, No. 3, 2017, pp. 15-19.

Abstract
Food security is of great concern in the developing countries especially in Nigeria, with the growing demands of an ever-increasing human population and current global food crisis. Rhizome of *Anchomanes difformis* was subjected to different steeping treatments (acid, alkali, NaCl, boiling and steeping); evaluated for mineral composition and functional properties using standard analytical techniques. The mineral composition showed potassium and calcium as the most abundant mineral in the flours (129.00 to 329.00 mg/100 g) and (39.50 to 74.00 mg/100 g) respectively; iron (9.30 to 57.20 mg/100 g) and Na/K (0.10 to 0.40). Water and oil absorption capacity ranged from 1.20 to 3.51 g/g and 1.35 to 2.30 g/g respectively; in-vitro starch digestibility (1.26 to 2.44 mg/g). Pasting characteristics showed final viscosity of 2.40 to 6818 cP; peak viscosity 16.00 to 4719 cP; set back 9.0 to 3779 cP; steeping and boiling decreased the pasting temperature while it was increased by NaCl. *A. difformis* flours possess potential for applications in food and other industries as such its utilisation will improve the formulation of value-added products.

1. Introduction

Some unconventional crops could serve as good source of nutrients and occasionally has the potential of broadening the present narrow food base for human consumption [1] but inadequate data on chemical composition and other properties of such plants have limits the prospects for their utilization [2]. The food situation in most developing tropical countries is worsening, due to population increase, poor soil fertility resulting into low harvest which ultimately results in high prices of available staple foods [3], which has resulted in high incidence of malnutrition. In this regard, research has geared towards indigenous unexploited crops of high nutritional and functional properties in ameliorating food insecurity.

Anchomanes difformis is a member of Araceae family [4], herbaceous plant with prickly stem having huge divided leaf and spathe that arise from a horizontal rhizome, prevalent in West Africa forest. It is sometimes called forest *Anchomanes* [5], while in Southwest Nigeria (Yoruba) it is known as *Abirisoko*, *Ogirisako* and *Igo* [6]. The rhizome is eaten after special preparation that entails prolonged washing and cooking of early shooting stage [5]. Different parts of *A. difformis* have been used in folk's medicine for the treatment of various ailments due to the presence of some active phytochemicals such as alkaloids, terpenoids glycosides tannins and saponins [7, 8].

The increase demands for tuber as food, pharmaceutical and other uses coupled with the need to attain food security, necessitate research into other unexploited carbohydrate sources different from yam, cassava, maize and potato to mention but a few. This study aimed at assessment of mineral composition, functional properties of *Anchomanes difformis* flour as influenced by various treatment methods to enhance industrial utilisation in order to reduce the burden on other carbohydrate sources such as cassava, corn, yam and potatoes.

2. Materials and Methods

2.1. Source of Materials

The *Anchomanes difformis* rhizome was harvested from a local farm in Ado-Ekiti, Ekiti State, Nigeria. All chemical used were of analytical grade.

2.2. Preparation of Flour

Fresh rhizome was washed, peeled, sliced to a thickness of 2 cm and divided into six portions; untreated portion (A), portion steeped in distilled water at 30°C for 24 h (B), portion boiled at 100°C for 20 min (C), portion steeped in 1% NaCl solution for 24 h (D), portion steeped in 1% NaOH for 24 h (E), portion steeped in 1% HCl solution for 24 h (F); all the potions were oven dried at 60°C 48 h. The dried samples were milled, sieved through 100 mm mesh size and kept in air-tight container prior to analysis.

2.3. Determination of Mineral Composition

Mineral composition was determined by the method described by [9]. A dried and ground sample (1–2 g) was pre-ashed on a bunsen flame for 20 min. Thereafter, the sample was ashed at 550°C in a muffle furnace. The resultant grayish-white ash was dissolved in 0.1 M HCl solution (10 ml) to break up the ash and leach the metals and made up to 100 ml with distilled water. The metals determined using a Perkin-Elmer 8650 atomic absorption spectrophotometer. Phosphorus was determined by using spectrophotometer, Vanodomolybdate reagent was used at 470 nm.

2.4. Determination of Bulk Density

Bulk density was determined using the procedure of [10]. A specified quantity of the flour sample was transferred into an already weighed measuring cylinder (W_1). The flour sample was gently tapped to eliminate air voids and the level was noted to be the volume of the sample and the cylinder containing flour was weighed (W_2). The bulk density was determined from the relation:

$$\% \text{ Bulk density} = \frac{(W_2 - W_1)}{\text{Volume of sample}} \; g/cm^3$$

2.5. Determination of Water and Oil Absorption Capacity

Water absorption capacity was determined using the method of [10] with slight modifications. Ten (10 ml) of distilled water was added to 1.0 g of flour in a beaker. The suspension was stirred using a magnetic stirrer (Stuart Model) for 5 min; centrifuged at 3500 rpm for 30 min. Water absorbed was calculated as the difference between the initial weight of the flour before the addition of water to the flour and the weight after decanting the supernatant. The same procedure was repeated for oil absorption capacity except that oil was used instead of water.

2.6. Determination of *in-vitro* Starch Digestibility

In–vitro starch digestibility of sample was determined using pancreatic amylase and alpha glucosidase [11]. About 50 mg of flour was dispersed in 1 ml of 0.2 M phosphate buffer pH 6.9. Approximately 20 mg of enzyme was dissolve in 50 ml of same buffer and 0.2 ml of both the sample and enzyme were added; heated for 5 min in a boiling water bath. After cooling the absorbance of the solution was read at 540 nm.

2.7. Determination of Pasting Properties

Pasting properties was evaluated by the procedure of [12] using a Rapid Visco Analyzer (RVA, Newport Scientific, RVA Super 3, Switzerland). The flour for RVA analysis was based on 3.5 g (dry weight) of flour and distilled water (25 g). The paddle was placed into the canister containing flour and water with paddle blade vigorously jogged through the flour severally after which the flour was transferred into the Rapid Visco Analyzer. Parameters recorded were pasting temperature (PT), peak viscosity (PV), trough viscosity (TV), final viscosity (FV), and peak time (PTime). Breakdown viscosity (BV) was calculated as the difference between PV minus TV, while setback viscosity (SV) was determined as the FV minus TV.

3. Results and Discussion

3.1. Effect of Steeping on Mineral Composition of *A. difformis* Flour

The mineral content of *A. difformis* flour in mg/100 g is depicted in Table 1. The treatments have significant effect on the mineral composition; the most abundant minerals in the flours were potassium and sodium with values ranging from 129.00 to 329.00 mg/100 g and 24.91 to 54.10 mg/ 100 g respectively. The results are in accordance to the observation of [13] who reported potassium as the most predominant mineral element in some lima bean coats. There have been similar observations reported for gingerbread plum [14] and watermelon seeds constituent [15].

Calcium content ranged between 39.50 and 70.00 mg/100 g; it helps in formation of bone and blood coagulation; high calcium content in the flours makes it an incredible source of calcium supplementation for pregnant and lactating women, as well as for children. The trace elements (iron, zinc and copper) detected, iron was the most highly concentrated with the value range of 9.30 to 57.20 mg/100 g; iron is an important constituent of haem in haemoglobin circulation which is essential in respiration [16]. The Sodium/potassium (Na/K) ratio is important in prevention and management of high blood pressure, Na/K ratio less than one is recommended [17]. The Na/K range of 0.10 – 0.40 in the flours would probably reduce high blood pressure; consumption of *A. difformis* flour will go a long way in promoting good health.

3.2. Effect of Treatments on the Functional Properties of *A. difformis* Flour

The functional properties of treated and untreated *A difformis* flours is depicted in Figure 1. The treatments significantly ($p \leq 0.05$) affected the functional properties of the flours. Water absorption capacity (WAC) was in the range of 1.2 to 3.51 g/g. Steeping and boiling increased WAC of the flours while other treatments (NaOH, HCl, NaCl) reduced it. This finding is in accordance to the observations of [18, 19] on *A. difformis* and *Colocasia esculenta* flours respectively. High WAC observed in flour coded C showed its ability to retain water against gravity [20], which underline its stability against moisture; an important factor sought after in most food industries [21]. The flours can be incorporated in such food formulations that involve dough handling to obtain high yield.

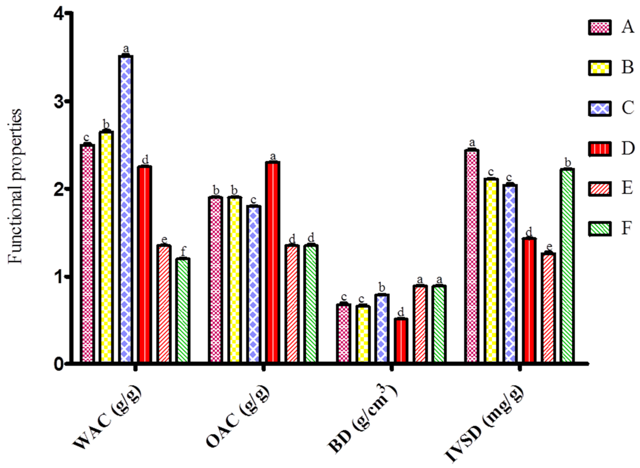


Figure 1. *Effect of treatments on the functional properties of A. difformis flours.*

Key
A-No treatment
B-Steeped in distilled water at 30°C for 24 h
C-Boiled in at 100°C for 20 min
D- Steeped in 1% NaCl solution for 24 h
E- Steeped in 1% NaOH for 24 h
F- Steeped in 1% HCl solution for 24 h
WAC- Water absorption capacity
OAC-Oil Absorption capacity
BD-Bulk density
IVSD- *In vitro* starch digestibility

Table 1. *Effect of treatments on the mineral composition of A. difformis flours (mg/100g).*

Elements	A	B	C	D	E	F
Magnesium	17.10±0.23c	39.90±0.13a	16.70±0.33c	32.19±0.22b	32.19±0.27b	10.90±0.25d
Manganese	7.30±0.11b	9.10±0.43a	6.60±0.20b	5.20±0.41c	5.40±0.22c	3.40±0.13d
Zinc	9.70±0.14b	24.40±0.09a	23.80±0.52a	7.40±0.26c	6.10±0.21c	4.60±0.11d
Sodium	45.00±0.50c	33.00±0.11d	31.10±0.35e	54.10±0.28a	24.91±0.33f	51.10±0.47b
Potassium	319.00±0.46b	329.00±0.12a	291.00±0.13d	314.00±0.10c	169.00±0.51e	129.00±0.28f
Calcium	58.50±0.21d	65.00±0.67c	70.00±0.13b	39.50±0.44f	74.00±0.16a	49.50±0.11e
Iron	15.60±0.23d	9.30±0.64f	10.50±0.18e	57.20±0.12a	28.80±0.16c	46.40±0.23b
Phosphorus	84.80±0.48a	66.20±0.68b	23.40±0.88c	19.59±0.24	12.91±0.11d	13.80±0.12d
Na/K	0.14±0.01b	0.10±0.01b	0.11±0.01b	0.17±0.02b	0.15±0.03b	0.40±0..02a

Values are means of triplicate determinations ± Standard deviation
Means with different letter in the same row are significantly different ($p \leq 0.05$).
Key
A-No treatment
B-Steeped in distilled water at 30°C for 24 h
C-Boiled in at 100°C for 20 min
D- Steeped in 1% NaCl solution for 24 h
E- Steeped in 1% NaOH for 24 h
F- Steeped in 1% HCl solution for 24 h

Apart from steeping in NaCl and distilled water, other treatments decreased oil absorption property (OAC) of the flours Figure 1. Significant differences were found among the treatments in OAC (1.35 to 1.90 g/g) of all the flours. The variations in OAC could be as a result of the non-polar side chains which bind the hydrocarbon side chain of oil. The various treatments condition could have caused possible exposition of hydrophobic groups resulting into changes in

OAC; this could have been responsible for the variations in OAC [14]. The OAC observed in this study revealed the potential of *A. difformis* flour in food applications that involve deep frying [22].

The flours showed relatively high bulk density (0.51 to 0.89 g/cm^3), NaCl and distilled water treatments reduced the bulk density while other treatments (NaOH, HCl and boiling) significantly ($p \leq 0.05$) increased it. The bulk densities of boiled, steeped in NaOH and HCl flours were generally higher. James *et al.* (2013) observed a similar increase in bulk density of blanched and sulphited cocoyam flours. The values (0.79, 0.89 and 0.89 g/cm^3) reported for boiled, steeped in NaOH and HCl flours respectively in this study were higher than reported values for pregelatinised cocoyam flour (0.73 g/cm^3) and unpregelatinised cocoyam flour (0.58 g/cm^3) [23]. Higher bulk density is desirable, since it helps to reduce the paste thickness which is an important factor in convalescent and child feeding.

Generally, low starch digestibility (1.26-2.22 mg/g) was observed in treated *A. difformis* flours when compared to untreated (2.44 mg/g) flour. The starch digestibility shows the rate at which starch present in *A. difformis* could digest in human body; high digestibility translate to high glycemic index. The glycemic index is a standard physiological basis for carbohydrate foods ranking base on the blood glucose production upon food ingestion [24]. The low starch digestibility of the flour underlines its potential application in the management of diabetes.

3.3. Effect of Treatments on Pasting Properties of *A. difformis* Flour

The pasting characteristic of *A. difformis* flour with different treatments is as shown in Table 2. A significant difference ($p \leq 0.05$) was observed in the pasting behaviour of flour among the treatments. Steeping in NaCl solution increased the pasting temperature while it was reduced by boiling as well as steeping in distilled water. However, pasting temperature could not be detected in flours treated with NaOH and HCl solution. Pasting temperature values (50.10 to 74.95°C) were lower than 85.89°C and 79.88°C reported for *D. alata* and *D. rotundata* flours respectively [25]. The high pasting temperature (70.10°C) observed in untreated flour characterised resistance of starch to swelling and rupturing during the heating processes.

Table 2. *Effect of various treatments on the pasting characteristics of A. difformis flours.*

Parameters	A	B	C	D	E	F
PT (°C)	70.10±0.10b	50.10±0.11c	50.20±0.10c	74.95±0.10a	ND	ND
PT (min)	7.00±0.01a	7.00±0.01a	5.27±0.01b	7.00±0.02a	7.00±0.01a	6.00±0.02b
PV (cP)	1930.00±0.23c	3804.00±0.12b	4719±0.17a	1826.00±0.32d	266.00±0.15e	16.00±0.10f
TV (cP)	1730.00±0.34c	3388.00±0.11a	3039±0.24b	1650.00±0.20e	189.00±0.10d	15.00±0.11f
FV (cP)	4364.00±0.21c	5014.00±0.15b	6818±0.23a	3371.00±0.21d	476.00±0.31e	2.40±0.12f
BD (cP)	220.00±0.11c	416.00±0.10b	1680±0.31a	176.00±0.22d	77.00±0.22e	1.00±0.01f
SB (cP)	2654.00±0.10b	1626.00±0.14d	3779±0.11a	1721.00±0.12c	278.00±0.12e	9.00±0.10f

Values are means of triplicate determinations ± Standard deviation
Means with different letter in the same row are significantly different ($p \leq 0.05$)
Key
A-No treatment, ND-Not detected; PT-Pasting temperature
B-Steeped in distilled water at 30°C for 24 h; PT-Peak time
C-Boiled in at 100°C for 20 min; PV-Peak viscosity
D- Steeped in 1% NaCl solution for 24 h; TV-Trough viscosity
E- Steeped in 1% NaOH for 24 h; FV- Final viscosity
F- Steeped in 1% HCl solution for 24 h; BD-Breakdown, SD- Setback

The flour sample C had the highest peak viscosity (4719 cP), final viscosity (6818 cP), breakdown viscosity (1680 cP) and setback (3779 cP). Lower peak viscosity observed in other flour samples is an indication that the carbohydrate components of the flour cannot be easily broken down and as the boiled flour until properly cooked. This measured the susceptibility of *A. difformis* starch granules to disintegration as this might not be desirable in food production [26]. Low breakdown value showed starch stability of the flours during heating period.

Setback viscosity an index of retrogradation of linear starch molecules during cooling and was reduced by the treatments except boiling Table 2. High setback has been linked to syneresis during freeze/thaw cycles [27], while low setback during flour paste cooling revealed greater resistance of *A. difformis* flour to retrogradation. The flours with lower setback values has lower tendency to retrograde and is a great asset in food products such as soup and sauce, where loss of viscosity and precipitation due to retrogradation is desirable [28]. The final viscosity was in the range of 2.40 to 6818 cP; it has been reported as the most commonly used parameter to determine viscous gel formation of starch-based material after cooking and cooling [29].

4. Conclusions

The findings showed that the treatments method had significant ($p \leq 0.05$) effect on some important parameters such as mineral composition, functional properties as well as pasting characteristics of *A. difformis.* The wide variation in flour parameters suggests diverse food utilisation for *A. difformis* flour.

References

[1] Viano, J., Massoti, V., Gaydou, E. M., Bourrreil, P. J. L., Ghiglione, Giraud, M. (1995). Compositional characteristics of 10 wild plant legumes from Mediterranean French pastures. *Journal of Agriculture Food Chemistry*, 43: 680-683.

[2] Vijayakumari, K., Siddhuraju, P., Janardhanan, K. (1994). Nutritional assessment and chemical composition of the lesser known tree legume, *Acacia leucophloea*. *Food Chemistry*, 50: 2858.

[3] Afolayan, M. O., Omojola, M. O., Onwualu, A. P., Thomas, S. A. (2012). Further physicochemical characterization of *Anchomanes difformis* starch. *Agriculture and Biology Journal of North America,* 3 (1): 31-38.

[4] Burkill, H. M. (2000). The useful plants of west tropical Africa. Kew UK: Royal Botanic Gardens.

[5] Oyetayo, V. O. (2007). Comparative studies of the phytochemical and antimicrobial properties of the leaf, stem and tuber of *Anchomanes difformis*. *Journal of Pharmaceutical Toxicology,* 2: 407-410.

[6] Soladoye, M. O., Sonibare, M. A., Nadi, A. O., Alabi, D. A. (2005). Indigenous angiosperm biodiversity of Olabisi Onabanjo University permanent site. *African Journal of Biotechnology,* 4 (5): 554-562.

[7] Osho, A. Adetunji, T. (2010). Antimicrobial activity of *Anchomanes difformis* (Blume). *Acta SATECH,* 3: 87-90.

[8] Abah ES, Egwari LO and Mosaku TO (2011) *In vitro* antimicrobial screening of *Anchomanes difformis* (Blume) Engl. leaves and rhizomes against selected pathogens of public health importance. *Advanced Biomedical Research,* 5: 221-225.

[9] Association of Official Analytical Chemists (AOAC) (2012). Association of Analytical Chemist, Official Methods of Analysis. (19th ed.) Horowitz, Maryland.

[10] Mepba, H. D., Eboh, L., Nwaojigwa, S. U. (2007). Chemical composition, functional and baking properties of wheat composite flour. *African Journal of Food Agriculture Nutrition and Development,* 7 (1): 1-22.

[11] Singh, U., Klierdeker, M. S., Jambunathan, R. (1982). Studies on desi and Kabuli chickpeas (*Cicer arieinum* L) cultivars. The level of protein inhibitors, level of oligosaccharides and in-vitro digestibility. *Journal of Food science,* 47: 510-412.

[12] Osundahunsi, O. F. (2003). Scanning electron microscope study and pasting properties of unripe and ripe plantain. *Journal of Food, Agriculture and Environment,* 7 (4): 182-1186.

[13] Seidu, K. T., Osundahunsi, O. F., Olaleye, M. T., Oluwalana, I. B. (2015). Amino acid composition, mineral contents and protein solubility of some lima bean (*Phaseolus lunatus* L. Walp) seeds coat. *Food Research International,* 73: 130-134.

[14] Amza, T., Amadou, I., Zhu, K., Zhou, H. (2011). Effect of extraction and isolation on physicochemical and functional properties of an underutilised seed protein: gingerbread plum (*Neocarya macrophylla*). *Food Research International,* 44: 2843-2850.

[15] Seidu, K. T., Otutu, O. L. (2016). Phytochemical composition and radical scavenging activities of watermelon (*Citrullus lanatus*) seed constituents. *Croatian Journal of Food Science and Technology,* 8 (2): 83-89.

[16] Antia, B. S., Akpan, E. J., Okon, P. A., Umoren, I. U. (2006). Proximate composition and phytochemical constituents of leaves of some *Acalypha species*. *Pakistan Journal of Nutrition*, 5: 166-168.

[17] Aremu, M. O., Olaofe, O., Akintayo, E. T. (2006) Compositional evaluation of cowpea (*Vigna unquiculata)* and scarlet runner bean (*Phaseolus coccineus)* varieties grown in Nigeria. *Journal of Food Agriculture and Environment,* 4 (2): 39-43.

[18] Adegunwa, M. O., Adebowale, A. A., Solano, E. O. (2012). Effect of thermal processing on the biochemical composition, antinutritional factors and functional properties of beniseeds (*Sesamum indicum*) flour. *American Journal of Biochemistry and Molecular Biology,* 2: 175-182.

[19] James, E. O., Peter, I. A., Charles, N. I., Joel, N. (2013). Chemical composition and effect of processing and flour particle size on physicochemical and organoleptic properties of cocoyam *(Colocasia esculenta var. esculenta)* flour. *Nigerian Food Journal,* 31 (2): 113-122.

[20] Moure, A., Sineiro, J., Domínguez, K., Parajó, J. C. (2006). Functionality of oilseed protein products: A review. *Food Research International*, 39: 945-963.

[21] Adebowale, K. O., Afolabi, T. A., Olu-Owolabi, B. I. (2006). Functional, physicochemical and retrogradation properties of sword bean (*Canavalia gladiate*) acetylated and oxidized starches. *Carbohydrate Polymer,* 65: 93-101.

[22] Atuonwu, A. C., Akobundu, E. N. T. (2012). Functional and pasting properties of pumpkin (*Cucurbita pepo*) seed products. *Journal of Agricultural and Veterinary sciences,* 2: 36-49.

[23] Ajewole, I. A., Ozo, O. N. (1994). Food gels from pregelatinized cocoyam *(Xanthosoma species)* flour: a comparative study. *Journal of Agriculture and Technology,* 2 (1): 63-66.

[24] Jenkins, D. J., Wolever, T. M., Taylor, R. H., Barker, H., Fielden, H., Baldwin, J. M., Bowling, A. C., Newman, H. C., Jenkins, A. L., Goff, D. V. (1981). Glycemic index of foods: a physiological basis for carbohydrate exchange. *American Journal of Clinical Nutrition*, 34 (3): 362-366.

[25] Wireko-Manu, F. D., Ellis, W. O., Oduro, I., Asiedu, R., Dixon, B. M. (2011). Physicochemical and pasting characteristics of water yam *(D. alata)* in comparison with pona (*D. rotundata*) from Ghana. *European Journal of Food Research Review*, 1: 149-158.

[26] Beta, T., Harold, C., Lioyd, W. R., John, R. N. T. (2001). Starch properties as affected by sorghum grain chemistry. *Journal of Food Science and Agriculture,* 81: 245-251.

[27] Adebowale, A. A., Sanni, L. O., Awonorin, S. O. (2005). Effect of texture modifiers on the physicochemical and sensory properties of dried fufu. *Food Science and Technology International,* 11: 373-382.

[28] Sanni, L. O., Kosoko, S. B., Adebowale, A. A., Adeoye, R. J. (2004). The influence of palm oil and chemical modification on the pasting and sensory properties of *fufu* flour. *International Journal of Food Property*, 7 (2): 229-237.

[29] Maziya-Dixon, B., Dixon, A. G. O., Adebowale, A. A. (2007). Targeting different end uses of cassava: genotypic variations for cyanogenic potentials and pasting properties. *International Journal of Food Science and Technology,* 42: 969-976.