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Physical, Chemical and Sensory Properties of Baked Products from Blends of Wheat and African Yam Bean (*Sphenostylis stenocarpa*) Water-Extractable Proteins

*Ade, I.C., Ingbian, E.K. and Abu, J.O.[1]

ABSTRACT
Blends of wheat flour (WF) and African yam bean water-extractable proteins (AYBWEP) were processed into bread and cookies in the following ratios: 100: 0; 95: 5; 90: 10; 85: 15; 80: 20. The proximate composition, physical, chemical properties and sensory properties of bread and cookies samples from the blends were determined. Breads and cookies produced from the resultant blends were significantly higher ($p < 0.05$) in protein (16.39% – 18.36%) than the control (11.80% – 12.58%). Carbohydrate content decreased from 60.74% with addition of AYBWEP to 52.81% following 20% substitution. The pH of bread samples prepared from whole wheat flour and blends of wheat flour and AYBWEP were significantly different ($p < 0.05$) while bulk density and specific volume were not significantly different ($p > 0.05$). The pH of bread samples and cookies decreased with increase in the proportion of the AYBWEP blend from 5% to 20%. The highest specific volume (3.70ml/g) was observed in bread samples prepared from the control 100: 0 blends while the 80:20 blends had the lowest specific volume (3.10 ml/g). There was no significant difference ($p > 0.05$) in the bulk density and thickness of the cookies. The cookies prepared using 80: 20 blends had the higher diameter (22.53 cm) and spread factor (54.03 cm) compared to the control. Generally, acceptability of the bread and cookies decreased with higher ratios of AYBWEP inclusion. The sensory acceptability scores showed the best AYBWEP substitution level for making bread and cookies was 5% and 10% of the AYBWEP respectively. The results are discussed in the context of the growing importance of promoting the processing and utilization of lesser known local crops in baked products.enrichment.

Keywords: Wheat flour substitution, African Yam Bean water-extractable proteins, bread, cookies, physical, chemical and sensory properties.

Introduction
In most parts of the world, baked goods, based on wheat flour in particular, are popular foodstuffs. The consumption of these products has been consistently increasing in countries like Nigeria (Edema *et al*., 2005). Reports indicate that the price of wheat flour rose from $200.00 per ton in 1996 to $400.00 in 1999 (Kessel, 2003). Wheat as a major source of raw material for the production of these baked products also lacks some nutrients. Blends of flours using protein concentrates from legumes are desirable in cereal flours not only for increasing the quantity of protein but because they also increase the levels of some amino acids, especially lysine which is normally lacking in the flour (Ihekoronye and Ngoddy, 1985).

The potential use of composite flours for bread and cookies making has been evaluated by several authors. Agu *et al*. (2007) reported the use of composite flour of wheat and African breadfruit in biscuit-making.

[1] Department of Food Science and Technology, University of Agriculture, PMB 2373, Makurdi, Nigeria.
* corrresponding author: catagher@yahoo.com

Wheat flour was also replaced with cowpea flour at various levels for the production of baked products such as bread (McWatters *et al.*, 2004) and cakes (Akubor, 2004). Also, Akpapunam and Darbe (1994) reported the production of cookies from blends of maize and Bambara groundnut.

African yam bean (*Sphenostylis stenocarpa*), a lesser-known legume, grows along with yam and cassava. It can be used extensively in various dietary preparations and supplementation of the protein requirements of many families throughout the year. However, the legume's potential is largely unexploited, due to its characteristic problem of hard to cook phenomenon, poor digestibility and flatulence.

According to Abu and Minnaar (2005), legume protein and starch concentrates rather than their corresponding flours are employed in food products owing to reasons of better functionality of the concentrates, as well as enhanced elimination of anti-nutritional factors. In this study, the effect of substituting wheat flour with African yam bean water-extractable proteins on the physicochemical and sensory properties of bread and cookies was determined.

Material and Methods

Source of materials

The cream coat African yam bean (*Sphenostylis stenocarpa*) used in this study was purchased from Chikwan market in Cross River State. The equipment used came from Food Science and Technology department, Federal University of Agriculture Makurdi and Benue Brewery Limited, Makurdi, Benue State.

Preparation of African yam bean flour

The African yam bean flour was prepared according to the modification of methods described by Enwere (1998). The cleaned African yam bean seeds were soaked in water (30^{o}C, 12 h) and dehulled manually. Dehulled seeds were drained and dried (600C, 10 h) to less than 10% moisture in the hot air oven (Genlab widness, Model T12H). The dried cotyledons were allowed to cool and milled into flour using laboratory attrition mill (Atlas model ED-5).

Preparation of African yam bean water-extractable proteins

Water-extractable proteins were prepared from African yam bean flour following the methods cited in Abu *et al.* (2007). African yam bean flour (200 g) was mixed in deionized water (200 ml) and only stirred using a 78-1 magnetic stirrer hotplate for 60 min at ambient tempreature. The resultant solution was kept in a fridge (4^{o}C, 30 min) for insoluble materials to sediment. The supernatant was decanted and centrifuged (2500 g, 30 min) using a minor centrifuge (MSE England). The supernatant was dried in a hot air oven (45^{o}C, 48 h) to obtain dry flakes, which were then milled using a blender (HR 1702) to obtain powdered water-extractable proteins. The water-extractable proteins were analyzed for moisture and protein following AOAC (2000) methods.

Baking process

The five blends of wheat/African yam bean flours used were 100/0; 95/5; 90/10; 85/15; and 80/20 for both bread and cookies preparations. Bread and cookies were prepared according to the methods described by Balami *et al.* (2004) and Nishibori and Kawakishi (1990) respectively.

Proximate analysis

The moisture, crude protein, fat, crude fiber and ash contents were determined following the procedure outlined by AOAC (2000), while carbohydrate was calculated by difference (Kirk and Sawyer, 1997).

Physical and chemical analysis

The flour blends analysed for pH, bulk density and gelation capacity were determined using standard methods (Onwuka, 2005) while swelling index was based on the method reported by Sathe and Salunkhe (1981). In addition, the physical and chemical properties of the composite breads and cookies were determined using standard methods. The breads were analyzed for bulk density, pH, loaf volume and specific volume using standard methods (Onwuka, 2005; NSO, 1979). For the cookies, the thickness, diameter and spread ratio were determined using methods of AACC (2000).

Sensory evaluation

A voluntary panel of 15 judges made up of males and females were selected from the University of Agriculture Makurdi, Benue State. Panelists were educated on testing terminologies and requested to evaluate the various breads and cookies samples for appearance, aroma, crust, internal texture, taste and overall acceptability using a 7-point Hedonic scale where 7 was equivalent to like extremely and 1 meant dislike extremely as described by Iwe (2002) and Ihekoronye and Ngoddy (1985).

Statistical Analysis

Data were obtained in triplicate (n-3). Means and standard deviations (SD) were recorded. Sensory evaluation data were analyzed using analysis of variance (ANOVA) as described by Iwe (2002). Least significant difference (LSD) were used to ascertain differences between samples at $p < 0.05$.

Results and Discussion

Chemical properties of composite bread and cookies

The pH of both bread and cookies prepared decreased significantly from 5.30 to 4.20 and 6.33 to 5.33 respectively with increase in substitution levels of African yam bean water-extractable proteins. Whole wheat bread and cookies had the highest value of 5.30 and 6.33 respectively. This observation suggests that there were structural changes, probably folding of molecules as the protein level increased to expose less hydrophilic amino acid residue. This may make the protein less amphiphilic. According to Kirk and Sawyer (1991), knowledge of the hydrogen ion activity of a food product is useful in assessing the extent by which spoilage due to enzyme and micro-organisms can occur. The measurement of pH is important in assessing the effectiveness of the preservation and in monitoring performance during processing.

Physical properties of composite bread and cookies

The results of the physical properties of the bread and cookies samples are presented in Tables 2 and 3 respectively. The bulk density decreased from 0.68 to 0.60 g/cm^3 and 0.60 to 0.57 g/cm^3 for bread and cookies respectively following the addition of 20% AYBWEP. The values were similar to those for Bambara groundnut (0.60 to 0.75 g/cm^3) reported by Onimawo *et al.* (1998). Bulk density is very important in determining the packaging requirement, material handling and application in wet processing in the food industry (Karuna *et al.*, 1996). These workers reported that bulk density of sweet potato and soy flour extrudates with increased soy in the mixture. They attributed this to a direct influence of increased protein content.

Spread factor is the ratio that depends on the values of the thickness and diameter of the cookies. Significant differences occurred on the spread factor of the cookies. Highest spread factor (54.03) was observed in the cookies from 80% wheat/20% AYBWEP blend and the lowest value (46.69) was found in 95% wheat/05% AYPWEP blend. Results regarding the physical evaluation of the cookies are similar with that reported by Abu *et al.* (2007) and Akpapunam and Darde (1994). The low spread factor value of the control sample showed that starch polymer molecules are highly bound with the granules and swelling is limited when heated. On cooling, the starch rapidly forms a rigid gel with capacity characteristics of large molecular aggregates (Priestley, 1979). When a dough or batter becomes less viscous, it tends to spread more thereby increasing in diameter and consequently the spread factor.

The weight of the loaf after baking is also very important. It defines the water holding capacity of the flour, which defines the productivity of the bread. There were significant differences ($p < 0.05$) in the weight and loaf volume of bread samples. The bread prepared from 95% wheat flour and 5% AYBWEP had the highest value of 165.32 g and 552.10 ml/g while 100% wheat flour bread had the lowest value of 100.6l g and 372.01 ml/g for weight and loaf volume respectively. This means that the composite flours may be better for higher loaf.

Specific loaf volume (SLV) which is the integral of weight volume of the loaf relating to the rising power of the loaf during baking ranged from 3.70 – 3.10 ml/g. According to NSO (1976), bread shall be considered as having a good volume and weight ratio if not less than 4 ml /g when tested by rape seed displacement method. These effects were expected, as the amount of gluten, which imparts high volume in bread loaf, was decreased by the addition of gluten-free African yam bean water extractable protein flour in the bread formulation. Partial replacement of wheat with non-glutinous flour has been shown to result in lower bread volume. Banks *et al.* (1997) observed a significant decrease in baked volumes of muffins made with added defatted soy flour.

Table 1: Proximate composition of bread and cookies prepared from whole flour and blends of wheat flour and African yam bean water extractable proteins (AYBWEP) flour

Samples	Moisture Protein	Crude	Ether Extract	Ash	Crude fibre	Carbohydrate
WFB	29.33 ± 0.40^{a}	11.80 ± 0.70^{c}	2.01 ± 0.22^{a}	1.16 ± 0.11^{a}	1.68 ± 0.13^{a}	54.02 ± 0.68^{a}
WAPB$_1$	25.65 ± 0.30^{b}	16.39 ± 0.33^{a}	1.59 ± 0.07^{a}	1.33 ± 0.34^{a}	2.23 ± 0.34^{a}	52.81 ± 0.10b
WAPB$_2$	28.40 ± 0.45^{a}	17.36 ± 0.37^{a}	1.55 ± 0.05^{a}	1.43 ± 0.14^{a}	2.04 ± 0.11^{a}	49.22 ± 0.80c
L.S.D	1.6	4.6				1.76
COOKIES						
WFC	8.37 ± 0.30	12.58 ± 0.25^{c}	14.49 ± 0.64^{a}	1.57 ± 0.21^{a}	2.25 ± 0.15	60.74 ± 0.65^{a}
WAPC$_1$	7.10 ± 0.09	15.90 ± 0.48^{b}	16.42 ± 0.81^{a}	1.06 ± 0.04^{a}	1.52 ± 0.10	58.00 ± 0.34^{b}
WAPC$_2$	8.00 ± 0.21	18.36 ± 0.64^{a}	16.20 ± 0.83^{a}	1.12 ± 0.06^{a}	1.73 ± 0.10	54.59 ± 0.15^{c}
L.S.D		2.60			0.50	1.69
AYPC$_{100}$	1.40 ± 0.12	65 ± 0.72				

Means with the same superscript in a column are not significantly different ($p > 0.05$)
WFB: Bread produced from 100% wheat flour
WAPB$_1$: Bread produced from composite flour of 95% wheat and 5% African Yam bean water extractable proteins flour
WAPB$_2$: Bread produced from composite flour of 90% wheat and 10% African Yam bean water extractable proteins flour
WFC: 100% wheat flour cookies
WAPC$_1$: 95% wheat 5% African yam bean water extractable proteins flour
WAPC$_2$: 90% wheat 10% African yam bean water extractable proteins flour
AYPC: 100% African yam bean water extractable proteins flour.

Table 2: Physico-chemical properties of breads prepared from whole-wheat flour and blends of wheat flour and African yam bean water extractable proteins (AYBWEP) flour

Samples	Bulk Density	pH	Weight (g)	Loaf volume (ml)	Specific volume (ml/g)
WFB	0.68 ± 0.01^{a}	5.30 ± 0.16^{a}	100.61 ± 1.11^{c}	372.01 ± 0.58^{e}	3.70
WAPB$_1$	0.54 ± 0.00^{a}	5.27 ± 0.17^{a}	16.32 ± 1.28^{a}	552.10 ± 0.56^{a}	3.34
WAPB$_2$	0.59 ± 0.00^{a}	5.03 ± 0.05^{b}	142.20 ± 1.49^{d}	473.46 ± 0.13^{c}	3.33
WAPB$_3$	0.52 ± 0.01^{a}	4.24 ± 0.19^{c}	152.13 ± 1.18^{b}	496.11 ± 0.09^{b}	3.26
WAPB$_4$	0.52 ± 0.00^{a}	4.20 ± 0.13^{c}	145.48 ± 0.64^{c}	451.00 ± 0.14^{d}	3.10
L.S.D		0.16	2.72	1.44	

Means with the same superscript in a column are not significantly different ($p > 0.05$)
WFB: 100% wheat flour bread
WAPB$_1$: 95% wheat and 5% African yam bean water extractable proteins (AYBWEP) flour
WAPB$_2$: 90% wheat and 10% African yam bean water extractable proteins (AYBWEP) flour
WAPB$_3$: 85% wheat 15% African yam bean water extractable proteins (AYBWEP) flour
WAPC$_4$: 80% wheat 20% African yam bean water extractable proteins (AYBWEP) flour

Table 3: Physico-chemical properties of cookies prepared from whole-wheat flour and blends of wheat flour and African yam bean water extractable proteins (AYBWEP) flour

Samples	Bulk density) (g/cm^3)	pH	Diameter (cm)	Thickness (cm)	Spread Factor
WFC	0.60 ± 0.02^a	6.33 ± 0.03^a	21.93 ± 0.18^a	4.47 ± 0.05^a	49.06 ± 0.05^b
$WAPC_1$	0.58 ± 0.01^a	6.30 ± 0.09^a	20.87 ± 0.55^c	4.47 ± 0.06^a	46.69 ± 0.08^c
$WAPC_2$	0.58 ± 0.00^a	5.93 ± 0.07^b	21.90 ± 0.33^{ab}	4.70 ± 0.09^a	46.60 ± 0.11^c
$WAPC_3$	0.57 ± 0.01^a	5.67 ± 0.08c	21.40 ± 0.24^b	3.97 ± 0.07^a	53.90 ± 0.16^a
$WAPC_4$	0.57 ± 0.01^a	5.53 ± 0.03c	22.53 ± 0.49^a	4.17 ± 0.14^a	54.03 ± 0.39^a
L.S.D		0.23	0.69		0.41

Means with the same superscript in a column are not significantly different ($p > 0.05$)

WFC: 100% wheat flour cookies
$WAPC_1$: 95% wheat and 5% African yam bean water extractable proteins (AYBWEP) flour
$WAPC_2$: 90% wheat and 10% African yam bean water extractable proteins (AYBWEP) flour
$WAPC_3$: 85% wheat 15% African yam bean water extractable proteins (AYBWEP) flour
$WAPC_4$: 80% wheat 20% African yam bean water extractable proteins (AYBWEP) flour

Table 4: Mean sensory scores of breads prepared from wheat flour and blends of wheat flour and African yam bean water extractable proteins (AYBWEP) flour

Samples code	Crust colour	Crust characteristics	Flavour	Crumb colour	Cell Str. (Grain)	Internal texture	Overall acceptability
WFB	6.47^a	6.20^a	6.40^a	6.27^a	6.13^a	6.00^a	6.60^a
$WAPB_1$	6.07^a	6.07^a	5.93^{ab}	5.93^{ab}	6.13a	5.87^a	6.33^a
$WAPB_2$	4.93^{ab}	5.07^{ab}	5.13^b	5.13^{ab}	5.53^{ab}	5.47^a	5.40^b
$WAPB_3$	4.60^b	5.00^b	4.93^{bc}	4.67^b	5.07^b	5.07^a	4.80^b
$WAPC_4$	4.13^b	4.80^b	4.47^c	4.33^b	5.07^b	5.20^a	4.67^b
L.S.D	1.02	1.01	1.27	0.51	0.92		0.76

Means with the same superscript in a column are not significantly different ($p > 0.05$)

WFB: 100% wheat flour cookies
$WAPB_1$: 95% wheat and 5% African yam bean water extractable proteins (AYBWEP) flour
$WAPB_2$: 90% wheat and 10% African yam bean water extractable proteins (AYBWEP) flour
$WAPB_3$: 85% wheat 15% African yam bean water extractable proteins (AYBWEP) flour
$WAPB_4$: 80% wheat 20% African yam bean water extractable proteins (AYBWEP) flour

Sensory properties of baked products

The sensory results (Tables 4 and 5) indicated that acceptable baked products that were not distinguished from the control for most of the sensory properties were made from 5% and 10% substitution of AYBWEP for bread and cookies samples respectively.

The bread and cookies showed no significant differences in terms of internal texture and flavour respectively. The inability of the panelists to detect the characteristic beany flavour associated with most cookies produced from legumes implies that the African yam bean water-extractable proteins have minimal impact on the taste and flavour of bread and cookies at the levels used. Partial substitutions of wheat flour using non-wheat flours have been suggested by other authors (Addo *et al.*, 1989; Akubor, 2004; Abu *et al.*, 2007).

The acceptability of bread and cookies produced decreased as the level of AYBWEP increased as indicated by most of the sensory properties. The above results were in agreement with Ogunsua (1987), who reported that process modification and slight change in the physical, chemical properties of ingredients in blended foods may also affect the sensory evaluation in terms of slight changes.

The proximate composition of the control (100% wheat) and two samples each of bread and cookies are presented in Table 1. The protein and moisture values of 100% AYBWEP are also shown in the same Table. The highest protein content observed in the blend samples (16.39% – 18.36%) compared to the control (11.80% – 12.58%) was expected since the protein content of the AYPWEP in the study (65%) was higher than the control.

The protein content of African yam been seeds has been reported to be higher than wheat (Enwere, 1998). Similar results were reported by Akpapunam and Darbe (1994) and McWatters et al. (2004) for cookies fortified with Bambara groundnut and bread fortified with cowpea flour respectively. Combinations of the two flours significantly increased the protein contents of the blends when compared to the control. The carbohydrate contents of the bread decreased with increase in AYBWEP substitution.

Table 5: Mean sensory scores of cookies prepared from wheat flour and blends of wheat flour and African yam bean water extractable proteins (AYBWEP) flour

Samples Code	Crust Colour	Crust Characteristics	Flavour	Crumb Colour	Cell Str. (Grain)	Internal Texture	Overall Acceptability
WFC	6.07^{ab}	6.00^{b}	6.47^{a}	6.20^{a}	5.87^{ab}	6.27^{a}	6.33^{a}
$WAPC_1$	6.40^{a}	6.33^{a}	5.80^{a}	6.33^{a}	6.47^{a}	6.27^{a}	6.27^{a}
$WAPC_2$	5.80^{ab}	5.87^{b}	6.07^{a}	5.73^{b}	5.87^{ab}	5.80^{b}	6.27^{a}
$WAPC_3$	6.07^{ab}	5.40^{c}	5.73^{a}	5.67^{b}	5.93^{ab}	5.74^{b}	5.67^{b}
$WAPC_4$	5.20^{b}	5.20^{c}	5.53^{a}	5.33c	5.47^{ab}	5.27c	5.33^{b}
L.S.D	0.99	0.28		0.25	0.89	0.25	0.54

Means with the same superscript in a column are not significantly different ($p > 0.05$)
WFB: 100% wheat flour cookies
$WAPC_1$: 95% wheat and 5% African Yam bean water extractable proteins (AYBWEP) flour
$WAPC_2$: 90% wheat and 10% African Yam bean water extractable proteins (AYBWEP) flour
$WAPC_3$: 85% wheat 15% African Yam bean water extractable proteins (AYBWEP) flour
$WAPC_4$: 80% wheat 20% African Yam bean water extractable proteins (AYBWEP) flour

Conclusion

Bread and cookies of acceptable sensory attributes were produced with up to 5% and 10% of African yam bean water-extractable proteins respectively. This present study shows that there exists potential for African yam bean (*Sphenostylis stenocarpa*) incorporation into baked products.

This would be of economic importance in many developing countries such as Nigeria and Africa as a whole in promoting the use, utilization and processing of local crops.

References

AACC (2000). *Approved Method of the American Association of Cereal Chemists* 10th ed. St. Paul, MN.

Abu, J.O. and Minnaar, A. (2005). Diversifying utilization of cowpeas: Use of gamma irradiation to modify functional properties. International edible legumes conference and 4th world cowpea congress held from April 17 – 21 April 2005, Durban, South Africa.

Abu, J.O., Icheikwura, J.O. and Ingbian, E.K. (2007). Replacement of wheat flour with cowpea starch concentrates: Effects on physical and sensory properties of biscuits and cakes. *Int. J. of Food Science, Technology and Nutrition.* 1 (1): 31 – 38.

Addo, A.A., Akinola, J.O. and Yusuf, H. (1989). Chemical composition and organoleptic properties of biscuits fortified with pigeon pea flour. *Nig. J. Nutr.* 23: 24 – 28.

Agu, H.O., Ayo, J.A., Paul, A.M. and Folorunsho, F. (2007). Quality characteristics of biscuits made from wheat and African breadfruit (*Treculia Africana*). *Nigerian Food Journal* 25: 19 – 25.

Akpapunam, M.A. and Darbe, J.W. (1994). Chemical composition and functional properties of blends of maize and Bambara groundnut flours for cookie production. *Plant Foods for Human Nutrition* 46 (2): 147 – 155.

Akubor, P.I. (2004). Protein contents, physical and sensory properties of Nigerian snack foods (cake, chin-chin and puff-puff) prepared from cowpea-wheat flour blends. *International Journal of Food Science and Technology* 39 (4): 419 – 424.

AOAC (2000). *Official Methods of Analysis.* 17th ed. Association of Official Analytical Chemists, Washington, D.C.

Balami, Y.A., Bolaji, P.T., Hamza, F., Bahago, E.J., Komolafe, G., Onyeiwu, S.C. and Hassan, A. (2004). *Practical Manual on Food Technology, Nutrition and Dietetics for Schools and Industries*, 2nd ed. National Science and Technology Forum, Kaduna Polytechnic, Kaduna, Nigeria.

Banks, W.T., Wang, C. and Susan, M. (1997). Partially defatted soy flour effect on sensory and physical characteristic of baked products. *Journal of Consumer Studies and Human Economics.* 21: 151 – 156.

Edema, M. O., Sanni, L.O. and Sanni., A.L. (2005). Evaluation of maize – soybean flour blends for soy-maize bread production in Nigeria. *African Journal of Biotechnology* 4: 911 – 918.

Enwere, N.J. (1998). *Foods of Plant Origin.* 1st ed. Afro-Orbis Publ. Nig, pp. 301 – 400.

Ihekoronye, A.I. and Ngoddy, P.O. (1985). *Integrated Food Science and Technology for the Tropics.* Macmillan Publishers Ltd., pp. 180 – 181, 189.

Iwe, M.O. and Onuh, J.O. (1992). Functional and sensory property of soybean and sweet potato flour mixtures. *Lebensinwis. Technol.* 25: 567 – 573.

Iwe, M.O. (2002). *Handbook of Sensory Methods and Analysis.* Rejoint Communications service Ltd. Enugu, Nigeria, pp. 71 – 75.

Karuna, D., Noel, G. and Dilip, K. (1996). Food and Nutrition Bulletin Vol. 17, No. 2, United Nation Chemistry.

Kessel, F. (2003). Foreign countries policies and programs. http//www.fas.usda.gov/grain. Retrieved on November 8, 2008.

Kirk, R.S. and Sawyer, R. (1991). *Pearson's Composition and Analysis of Foods.* 9th ed. Longman Group Ltd, UK, pp. 188-189,223.

McWatters, R.H., Philips, R.D., Walker, S.L., McCullough, S.E., Mensa-Wilmot, Y., Saalia, E.K., Hung, Y.C. and Palterson, S. P. (2004). Baking performance and consumer acceptability of raw and extruded cowpea flour breads. *Journal of Food Quality* 27: 337 – 351.

Nishibori, S. and Kawakishi, S. (1990). Effects of dough materials on flavour formation in baked cookies. *J. Food Science.* 55(2): 409 – 412.

NSO (1979). *Standard for White Bread.* Nigerian Standards Organization. Federal Ministry of Industries, Lagos. NIS 75, pp 10 – 13.

Ogunsua, A.O. (1987). Process modification of bread and biscuit using non-wheat flour. In: Processing on the use of non-wheat flour for bread production. *Nig. Journal of Food Science and Technology:* pp. 61 – 68.

Onimawo, I.A., Momoh, A.A. and Usman, A. (1998). Proximate Composition and functional properties of flour cultivars of Bambara groundnut (*Voandzeia subterranean*). *Plant Foods for Human Nutrition* 53: 153 – 158.

Onwuka, G.I. (2005). *Food Analysis and Instrumentation: Theory and Practice.* Naphthali prints, Surulere, Lagos, Nigeria. pp. 63 – 75, 133 – 137.

Priestly, J.R. (1979). *Effect of Heating on Foodstuffs.* National Food Research Institute Pretoria, South Africa Applied Science Publishers Ltd. London, p. 72 – 73, 377.

Sathe, S.K. and Salunke, D.K. (1981). Functional properties of the great Northern bean protein: Emulsion, foaming, viscosity and gelation properties. *Journal of Food Science*, 46: 71 – 74.