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Quality Characteristics Of Cakes Prepared From Wheat And Unripe Plantain Flour Blends Enriched With Bambara Groundnut Protein Concentrate.

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ABSTRACT: *Cakes were produced from the substitution levels of wheat/plantain flour blends (0 – 100% and 0 – 70%), respectively and enriched with 0 – 30% levels of Bambara groundnut protein concentrate (BGPC). Quality characteristics of the resultant product was analysed to ascertain its sensory, physical and chemical properties. Acceptable cakes were produced from 70% wheat flour, 20% plantain flour and 10% BGPC with regards to colour which compared favourably with sample A (100% WF) except F and G samples which differs significantly with other samples. The texture of the cakes was also acceptable but F and G samples (6.5 and 6.4), respectively shows significant difference ($p < 0.05$) compared to others. The taste and overall acceptability were not significantly different at all levels of BGPC enrichment compared to sample A. There was no significant difference ($p > 0.05$) in all the samples in terms of the height except sample B with the value of 2.5cm. Highest weight of 194.2g was observed for sample B which was significantly different ($p < 0.05$) compared to other samples. Increase in BGPC further improved the volume and specific volume of the cake to 524cm^3 and 3.19cm^3/100g (sample G), respectively. A reduction in the values of carbohydrate, moisture and energy content of the cakes were observed at increased levels of protein concentrate. Protein content of the cakes was observed to improve progressively at increasing levels of enrichment and showed significant differences up to sample D (10.4%) while the highest protein value was reported at sample G (13.2%) with 30% protein concentrate. This confirms that the developed cakes have a better nutritional value than the control and could be used to combat protein energy – malnutrition.*

Key words: Cakes, Bambara groundnut, protein concentrate, unripe plantain, wheat flour.

INTRODUCTION

In recent years, more meals are eaten away from home, an increase in consumption of cereal foods such as biscuits/cookies, bread and cakes in Nigeria, especially among school children are on the increase. A number of different nutritional disorders may arise, depending on which nutrients are under or over abundant in these cereal products (Jade et al., 2013). Research efforts in developing countries have been focused on the improvement of protein quality of cereal products and other tuber crops. Various degrees of success has been reported in the areas such as fortification/enrichment of maize with soya bean (soy – ogi), cassava with soya flour, fermented yam flour supplemented with soy – flour for 'amala' – a popular West Africa food (Adeyemi et al., 1991). Enrichment of cereal-based products (cakes) with other protein sources such as oil seeds and legumes (Bambara groundnut) has received considerable attention to fight malnutrition (Okaka and Isieh, 1990). Malnutrition is the insufficient or imbalanced consumption of nutrients (O'Sullivan and Sheffrin, 2003). The World Health Organisation

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cited malnutrition as the gravest single threat to the world's public health (O'Sullivan and Sheffrin, 2003).

Cakes are soft bakery products produced by baking a batter containing flour, baking powders and beaten eggs with or without shortenings (IFIS, 2005). According to the final products desired, other ingredients such as flavourings, nuts, chocolate and dried fruits are also included. Cakes are a major snack in the fast food industry and highlight of many celebrations. They are highly cherished by women and children. It is a complete food, rich in fat and proteins. There are literally millions of cake recipes and can be classified based on their accompaniment such as coffee cakes, occasion cakes or based, primarily on ingredients and cooking techniques (Eke et al., 2008). Cake may be small and intended for individual consumption such as queen cake while longer cakes are cut, sliced and served as part of a meal or social functions. Zambrano et al., (2004) reported the development of low fat of light cakes by substituting the fat with either quar or xanthan gums. Jyotsna et al., (2007) reported the effect of substitution of wheat flour with whey protein concentrate (WPC) at the level of 10, 20 and 30% an egg replacer on the physical properties of the cake. Akubor (2004) reported the protein content, physical and sensory qualities of some Nigerian snack foods particularly cakes, chin-chi and puff-puff prepared from blends of cowpea and wheat flours. Plant proteins are gradually gaining acceptance as food ingredients. These are often used to enhance nutritional value of foods (Jones and Tung, 1983) formulated from carbohydrate based ingredients such as wheat and plantain. Cakes have been produced from composite flours of wheat and plantain by Kiin-Kabari and Eke-Ejiofor (2013). They observed that plantain flour can be used in substituting wheat flour in cake production up to 30%.

Plantain (*Musa paradisiaca*) is traditionally grown in West Africa for food and used as part of local staple diets or processed into more durable products such as flour that can be stored for later use (Dadzie, 1995). Plantain is a major source of energy for millions of people in these regions (Asiedu et al., 1992). It constitutes the cheapest source of carbohydrate foods in terms of cost per hectare, per tonne and per calorie. Many scientists have tried to determine the food value of plantain by carrying out proximate and detailed chemical analyses of mature unripe and ripe plantain including the peels. Ogazi et al., (1996) reported that feeding mainly on plantain cannot meet up the daily protein requirement. Therefore, protein supplementation with legumes such as Bambara groundnut with high amount of protein is essential. Bambara groundnut is an indigenous African legume and is one of the common crops found on the continent (Poulter, 1981). The seeds have high nutritional value and detailed compositional studies showed high protein content of 17 – 24%, 6.8% lysine and 1.3% of methionine. It is necessary to use Bambara groundnut flour as composite flour with wheat in baked product to take care of the widespread protein deficiency which is a global problem especially in developing countries. In fact, Bambara Groundnut has the potential in addressing the energy-protein malnutrition problem in developing countries because it is a proteinous food with a high amount of carbohydrate (Chinedu and Nyinyi, 2012: Mazahibet et al., 2013). However, one set back of Bambara Groundnut flour in baked product is the beany flour associated with it (Kiin-Kabari et al., 2015). Therefore, the purpose of this work is to prepare cakes from wheat/plantain composite flour blends enriched with Bambara groundnut protein concentrate and to analyse the quality characteristics of the produced cakes which included the physical, chemical and sensory properties of the product.

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MATERIALS AND METHODS

Collection of Materials

A local cultivar (agbagba) of plantain (*Musa paradisiaca*) was collected from the International Institute for Tropical Agriculture, (IITA) High Rainfall Station; Onne, agro-ecology, located at lat, 04^{o} 43^{1} N, long. 07^{o} 01; E and 10m, near Port Harcourt, Rivers State and used for this study. Bambara groundnut (Vigna subterrenea L. verdc) seeds were purchased from markets in Enugu, Enugu State, all in Nigeria.

Preparation of plantain flour

Plantain fruits (agbagba cultivar), obtained from hand number 2 from the proximal end of the bunch, as recommended by Baiyeri and Ortiz (1996), were peeled manually with the aid of stainless steel kitchen knives and the pulp was cut into uniform slices with thickness of about 1.5mm, soaked in 1.25% sodium metabisulphite for 5min to prevent discolouration and dried in air circulating oven (Gallenkamp S/No 90/02/190, UK) at 65^{o}C for 20h according to the method of Adeniji et al., (2007). The dried samples were milled to pass a 0.25mm sieve.

Preparation of Bambara groundnut flour

Bambara groundnut flour was prepared using the method described by Barimalaa et al., (1994). The beans were soaked for 24h in tap water and dehulled manually. The seeds were further boiled for 10 min, (1:4 bean to water ratio) in a stainless steel pot, drained and dried at 50^{o}C in an air circulating oven for 19h. The dried samples were milled (FOSS, Cyclotec 1093, Sweden) and sieved into flour using 0.25mm sieves.

Preparation of protein concentrates

The protein concentrates from Bambara groundnut flour (BGFC) were prepared using the alkaline wet extraction process described by Deshpande and Cheryan (1984) with little modification as reported by Giami and Isichei (1999), for fluted pumpkin seeds. Fifty (50g) sample was suspended in 300ml of 0.04m NaOH and the mixture was stirred at room temperature (28 ± 1^{o}C) for 1h, using a mechanical shaker. The pH of the slurry was adjusted to 10.8 using 1.0M NaOH and centrifuged at 3500 rev min^{-1} for 25 min to obtain a residue and a supernatant. The residue was re-suspended in 0.04M NaOH (200ml) and the extraction procedure repeated to increase the yield of protein. The pH of the combined extract was adjusted to 4.5 using 1M HCl to precipitate more proteins. The mixture was centrifuged at 3500 rev min^{-1} for 15 min to yield a precipitate (protein concentrate) which was washed twice with distilled water, adjusted to pH 7 using 1M NaOH, then air – dried for 48h at room temperature (28 ± 1^{o}C) and stored at 4^{o}C.

Preparation of flour blends

Cakes were prepared with graded levels of wheat/plantain flour enriched with Bambara groundnut protein concentrates. The graded levels ranged from 0 – 30% protein concentrates and 0 – 70% plantain flour with 100% wheat flour as the control.

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Table 1. Recipe for production of cakes from flour blends.

Formulations/Samples

Ingredients	A	B	C	D	E	F	G
WF (g)	200	0	180	160	140	120	100
PF (g)	0	195	10	25	40	55	70
BGPC (g)	0	5	10	15	20	25	30
Sugar (g)	125	125	125	125	125	125	125
Margarine (g)	125	125	125	125	125	125	125
Vanilla (ml)	5	5	5	5	5	5	5
Egg (whole)	3	3	3	3	3	3	3
Baking powder (g)	5	5	5	5	5	5	5
Water (ml)	25	25	25	25	25	25	25

Source: Author's computation.

Where WF = Wheat flour, PF = Plantain flour, BGPC = Bambara groundnut protein concentrate.

Production of plantain cakes

The quantities of ingredients shown in Table 1 were used and the creaming method of blending was adopted. Half the composite flour/blends were mixed with all the fat for about 2 min to obtain creamy dough, before adding the remaining composite flour and other ingredients. The baking powder was dissolved in water and also added to the mixture. Eggs were dispersed in little water and added to the mixture. About ¾ of the estimated water was added and the mixing carried out for another one minute. More water was added gradually and mixing continued until the dough was soft and greasy when touched. The dough was moulded into rolls, shaped and baked in the oven at 200^{o}C for 10 min.

Physical characteristics of the cakes

The physical characteristics of the enriched cakes were measures using the method outlined by Zoulias et al., (2002) and reported by Giami and Barber (2004) for fluted pumpkin cookies. Physical parameters measured included height, weight, volume and specific volume. The queen's cake volume was calculated using the cone equation below

Volume of cake (cm^3) = $\pi h\ (d^{2+} db + b^2)$ where d and b are upper and lower diameters of cake. The specific volume was determined by dividing the cake volume by the weight.

Sensory evaluation of the enriched cakes

Sensory evaluation of the cakes was carried out after baking using the method described by Giami and Barker (2004) for fluted pumpkin cookies. A panel of twenty (20) consumers comprising staff and student from Rivers State University of Science and Technology, Port Harcourt, Rivers State, Nigeria was used. Criteria for selection were that panellist were 18 years of age, regular consumers of the cakes and were neither sick nor allergic to any food. Panellists were trained in the use of sensory evaluation procedures. At each session, samples

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were served on white saucers, properly coded with 3-digit random numbers to prevent bias. The sensory attributes of the cakes including colour, taste, texture and overall acceptability was evaluated using a 9 – point hedonic scale with 1 representing the least score (dislike extremely) and 9 the highest score (like extremely), multiple comparison that was used to evaluate the differences between samples as described by Iwe (2002). Necessary precautions were taken to prevent carryover flavour during the tasting by ensuring that panellists rinse their mouth with water after each evaluation.

Chemical analysis

Crude protein (920.87), moisture content (925.10), fat (920.85), ash (923.03) and crude fibre (920.86) content of the cakes were determined according to the AOAC (2012) methods. Total available carbohydrate was determined using the Clegg anthrone method as described by Osborne and Voogt (1978). Energy was calculated using the Atwater factor as reported by Okoye (1992).

Statistical analysis

Results were expressed as mean values and standard deviation of three (3) determinations. Data were analysed using a one-way analyses of variance (ANOVA) using Statistical Package for Social Science (SPSS) version 20.0 software 2011 to test the level of significance ($P < 0.05$). Duncan New Multiple Range Test was used to separate the means where significant differences existed.

Results and Discussion

Physical characteristics of the cakes

The height of cakes prepared from the blends of wheat/plantain/BGPC ranged from 2.5cm to 3.8cm for samples B and A, respectively as shown in Table 2. Only sample B with the lowest height of 2.5cm was significantly different from others. The highest weight of 194.2g was recorded for sample B which was significantly different ($p < 0.05$) compared to others. However, the least weight was observed for sample A (163.4g) which shows that sample B without wheat flour was heavier than others. The cake volume decreased from 590cm^3 (sample A) to 325cm^3 (sample B).Increase in protein concentrate further improved the cake volume to 524cm^3 (sample G).The specific volume of cake followed the same pattern. Although, the values obtained in this study are higher than those reported by Akubor and Ishiwu (2013), for cakes supplemented with plantain peel flour. The differences in values may be due to differences in cake sizes and types which also affect the recipe formulation.

Table 2. Physical characteristics of cakes prepared from wheat/plantain/BGPC flour blends.

Samples	Height (cm)	Weight (g)	Volume (cm^3)	Specific volume (cm^3/g)
A	3.8±1.8^a	163.4±0.2^c	590±1.6^a	3.6±0.1^a
B	2.5±0.8^b	194.2±0.6^a	325±1.7^d	1.7±0.1^d
C	3.6±1.2^a	164.0±0.1^c	570±1.2^a	3.5±0.1^a
D	3.5±1.1^a	169.6±0.6^c	510±1.7^b	3.0±0.1^c
E	3.6±1.3^a	172.3±0.4^b	442±1.5^c	2.6±0.1^c

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F	3.7±0.9[a]	167.4±0.3[c]	485±1.6[c]	2.9±0.1[c]
G	3.7±0.8[a]	164.5±0.6[c]	524±1.6[b]	3.2±0.1[b]

[a,b,c,d] Means bearing the same superscript do not differ significantly ($p \leq 0.05$).

Means ± standard deviation of triplicate determinations.

Key:

Samples: A = WF/PF/BGPC (200:0:0), B = (0:195:5), C = (180:10:10), D = (160:25:15), E = (140:40:20), F = (120:55:25), G = (100:70:30)

Where WF = Wheat flour, PF = Plantain flour, BGPC = Bambara groundnut protein concentrate.

Sensory evaluation of the cakes

Acceptable queen cakes were prepared from 10% protein concentrate, 20% plantain flour and 70% wheat flour blends (sample E) with regards to colour which compared favourably with cakes prepared from 100% wheat flour (sample A). Although, samples F and G differ significantly with sample A (100% wheat flour), the panellist still found them acceptable. The slight changes in colour is due to thermal effect or reactions between amino acids and sugars (Be-miller and Whistler, 1996; Alobo, 2001). The texture of the plantain cakes was also judged by panellist as acceptable up to sample E which compared favourably with 100% wheat flour (sample A). The significant differences observed in samples E, F and G with regard to texture may be attributed to the reduction of gluten due to the increase in plantain flour addition. The taste and overall acceptability were not significantly different at all levels of enrichment when compared to cakes prepared from 100% wheat flour (sample A).

Table 3. Sensory scores for cakes prepared from wheat/plantain/BGPC flour blends.

Samples	Colour	Taste	Texture	Overall Acceptability
A	7.8[a]	7.2[a]	7.2[a]	7.5[a]
B	7.4[ab]	6.9[a]	7.0[a]	7.5[a]
C	7.6[a]	7.2[a]	7.2[a]	7.3[a]
D	7.7[a]	7.2[a]	7.1[a]	7.5[a]
E	7.7[a]	7.1[a]	6.9[ab]	7.1[a]
F	7.3[b]	7.4[a]	6.5[b]	7.0[a]
G	7.2[b]	7.6[a]	6.4[b]	7.2[a]

[a,b] Means bearing the same superscript within the same column do not differ significantly ($p > 0.05$).

Key:

Samples: A = WF/PF/BGPC (200:0:0), B = (0:195:5), C = (180:10:10), D = (160:25:15), E = (140:40:20), F = (120:55:25), G = (100:70:30)

Where WF = Wheat flour, PF = Plantain flour, BGPC = Bambara groundnut protein concentrate.

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Chemical analyses of the cakes

Addition of Bambara groundnut protein concentrates to composite flours of wheat/plantain for the production of cakes improved the crude protein of the cakes as presented in Table 4. The crude protein level increased from 8.6% to 13.2% (samples A – G), respectively, which was significantly different at $p \geq 0.05$ level of probability. However, it may not be economically desirable to use 30% BGPC to achieve that level of improvement. Although the protein content of cakes increased with the increase in the level of BGPC added, Edema et al., (2005) and Kiin-Kabari and Eke-Ejiofor (2013) reported a reverse order when plantain flour was substituted to wheat flour for cake production.

The moisture content of the cakes ranged from 19.2% (sample A) to 22.4% (sample E). The increase in moisture content with increase in the levels of substitution with BGPC may be attributed to the water absorption properties of proteins. This observation is in agreement with the work of Adebowale et al., (2008). They reported that addition of soy flour to plantain flour confers high water binding capacity of plantain flour which in turn improves the reconstitution and textural ability of plantain flour. Eke et al., (2008) also reported a range of moisture content from 21.1 to 23.2% for cakes consumed in Nigeria. The carbohydrate contents and energy values decreased progressively from 57.5% and 359.5 kcal/100g (sample A) to 47.2% and 328.2 kcal/100g (sample D), respectively. This decrease in carbohydrate is attributed to the increase in the levels of BGPC added. The energy values obtained in this work is lower compared to the range 403 – 460 kj reported for Nigerian cakes sold in Port Harcourt by Eke et al., (2008). These differences may be due to recipe formulation and methods of preparation. However, it is similar to 360.4 kj/100g reported by Adeniji and Empere (2001) for cakes developed from 100% flour of cardaba, a variety of cooking banana. Ash % increased with increase in plantain flour and Bambara groundnut protein concentrate.

Table 4. Chemical composition of cakes enriched with plantain flour and BGPC.

Samples	Crude Protein (%)	Carbohydrate (%)	Moisture content (%)	Fat (%)	Ash (%)	Crude fibre (%)	Energy (Kcal/100g)
A	8.6^{c}	57.7^{a}	19.2^{c}	11.6^{a}	1.8^{b}	1.1^{d}	359.5^{d}
B	8.5^{c}	56.8^{a}	21.1^{b}	10.9^{b}	1.8^{b}	0.9^{d}	349.2^{b}
C	9.3^{b}	53.2^{b}	20.8^{b}	11.3^{a}	2.2^{b}	3.2^{b}	341.8^{b}
D	10.4^{b}	51.6^{b}	21.6^{a}	9.9^{b}	1.9^{b}	4.6^{a}	328.2^{c}
E	11.6^{a}	50.4^{b}	22.4^{a}	10.4^{b}	2.4^{a}	2.8^{c}	333.3^{c}
F	12.5^{a}	48.3^{c}	20.9^{b}	11.5^{a}	2.6^{a}	4.2^{a}	339.3^{c}
G	13.2^{a}	47.2^{c}	21.7^{a}	11.6^{a}	2.8^{a}	3.5^{b}	339.0^{c}

Means bearing the same superscript within the same column do not differ significantly ($p > 0.05$).

Key:

Samples: A = WF/PF/BGPC (200:0:0), B = (0:195:5), C = (180:10:10), D = (160:25:15), E = (140:40:20), F = (120:55:25), G = (100:70:30)

Where WF = Wheat flour, PF = Plantain flour, BGPC = Bambara groundnut protein concentrate.

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CONCLUSION

Acceptable queen cakes were prepared from flour blends of 70% wheat flour, 20% plantain flour and enriched with 10% Bambara groundnut protein concentrate (sample E) with regards to colour, taste, texture and overall acceptability which compared favourably with the control. Protein contents of the cake were also improved up to 11.6% (sample E) and were higher than 8.6% protein obtained in the control. Apart from the weight which was heavier in sample B, all other physical characteristics of the cake compared favourably with the control. These shows that cake developed have a better nutritional value and can be used to combat protein energy malnutrition in the developing countries.

REFERENCES

Adeniji T.A and Empere C.E (2001). The development, production and quality evaluation of cake made from cooking banana flour. *Global Journal Pure Appl. Science,* 7(4), 633 – 635.

Adeniji T.A, Barimalaa I.S and Achnewhu S.C (2006). Physicochemical composition of green (unripe) plantain and banana hybrid fruits. *Global Journal Pure Appl. Science,* 12(1), 52 – 53.

Adeniji T.A, Sanni L.O, Barimalaa I.S and Hart A.D (2007). Nutritional composition of five new Nigerian musa hybrid cultivars. Implications for adoption in human nutrition. *Fruits,* 62, 135 – 142.

Adebowale Y.A, Adeyemi I.A and Oshodi A.A (2008). Functional and physicochemical properties of flour if six *Mucuna species*. *African Journal of Biotech.* 4(12), 1461 – 1468.

Adeyemi J.A, Akanbi C.T and Fasoro O.O (1991). Effect of soy fractions on some functional and rheological properties of maize-banana mixtures. *Journal of Food process, Presser,* 15, 31 – 43.

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 blend. *International Journal of Food Science and Technology*, 39(4), 419 – 424.

Alobo A.P (2001). Effect of sesame seed flour on millet biscuit characteristics plant. *Food Human Nutrition*, 56:195 – 200.

AOAC (2012). Official methods of analysis of AOAC International (19th ed.), Gaithersburg, M.D. USA.

Akubor P.I and Ishiwu (2013). Chemical composition, physical and sensory properties of cakes supplemented with plantain peel flour. *International Journal of Agriculture Policy and Research,* 1(4), 087 – 092.

Asiedu R, Ng S.Y.C, Vuylsteke D, Terauchi R and Hahn S.K (1992). Analyses of the need for biotechnology research on cassava, yam and plantain. In: Thottappilly G., Montil, Mohan Raj, D.R, Moore, A.W (Eds), Biotechnology. Enhancing research on tropical crops in Africa. CTA/IITA Co-Publication, IITA, Ibadan 376.

Baiyeri K.P and Ortiz (1996). Agronomic evaluation of plantain and other triploid musa, In: Creanen K; Ortiz R; Karamura E.B; Vuylsteke D.R (Eds), Proceedings of First International Conference on Banana Plantain Africa. Kampala Uganda, 12 – 18 Oct. 1996, *Beta Hortic* 540 (2000), 125 – 135.

ISSN 2056-5798(Print), ISSN 2056-5801(online)

Baramalaa I.S, Achinewhu S.C, Yibatama I and Amadi E.N (1994). Studies on the solid substrate fermentation of Bambara groundnut (*Vignasubterienea*). *Journal of Science, Food and Agriculture,* 66, 443 – 446.

Be-miller J.N and Whistler R.L (1996). Carbihydrates. In: Fernnema O.R. (ed) Food Chemistry 3rd Ed. New York. Marcel Dekker Inc. 157 – 253.

Chinedu SN and Nyinyi C.O (2012). Proximate analysis of sphenostylisoterocorpa and voandzeia substebanean consumed in South East Nigeria. *Journal of Agriculture Expansion and Rural Development,* x(3), 57-62.

Dadzie B.K (1995). Cooking qualities of blacksigators resistant plantain hybrids; Infomusa, 4(2), 7 – 9.

Deshpande S.S and Cheryan M (1984). Preparation and antinutritional characteristics of dry bean (*Phaseolousvalgaris L.*) protein concentrates. *Plant Foods Human Nutrition,* 54, 185 – 196.

Edema M.O, Sanni L.O and Sanni A.I (2005). Evaluation of maize – soybean flour blends for sour bread production in Nigeria. *African Journal of Biotechnology*, 4(9), 911 – 918.

Eke J, Achinewhu S.C and Sanni L (2008). Nutritional and sensory qualities of some Nigerian cakes. *Nigerian Food Journal,* 26(2), 12 – 13.

Giami S.Y and Isichei J (1999). Preparation and properties of flours and protein concentrates from raw, fermented and germinated fluted pumpkin (*Telfoririaoccidentalis Hook*) seeds. *Plants Foods Human Nutrition,* 454, 67 – 77.

Giami S.Y and Barber L.I (2004). Utilization of protein concentrates from ungerminated and germinated fluted pumpkin (*Telfoririaoccidentalis Hook*) seeds in cookies formulations. *Journal of the Science of Food and Agriculture,* 84, 1901 – 1907.

Iwe M.O (2002). Handbook of Sensory Methods and Analysis. Rejoin Communication Services, Enugu.

Jade G.P, Emeliza C.L, Jose A.F and J. Am (2013). Flour substitution and nutrient fortification of butter cookies with underutilized. *Journal of the Bioflux Society* 5(3), 115–120.

Jones L.J and Tung M.A (1983). Functional properties of modified oilseed protein concentrates and isolates. *Canadian Institute of Food Science Technology Journal*, 16, 57 – 62.

Jyotsna R.R, Sai Manohar R, Indrani D and Venkateswara R.G (2007). Effect of whey protein concentrate on the rheological and baking properties of eggless cake. *International Journal of Food Properties,* 10(3), 599 – 606.

Kiin-kabari D.B and Eke-Ejiofor J (2013). Physico-chemical and sensory properties of cakes and cookies produced from composite flour of wheat and plantain. *Wudpekcker Journal of Food Technology* 1(1), 009-013.

Kiin-Kabari D.B, Eke-Ejoifor J and Giami S.Y (2015). Functional and paroting properties of wheat flour/plantain flours enriched with Bambara groundnut protein concentrate. *International Journal of Food Science and Nutrition Engineering,* 5(2) 75 – 81.

Mazahibet A.M, Nuha M.O, Salawa I.S and Babiker E.E (2013). Some nutritional attributes of Bambara groundnut as influenced by domestic processes. *International Food Research Journal,* 20(3). 1165-1171

Ogazi P.O, Onewusi F.A, Ozumba A.U, Ogundipelto, Osita B.O.A and Lukambi F.A (1996). Development and sensory evaluatio9n of soyamusa: A soybean – plantain baby food. ISHS Acta Hortic. 540. International Conference on Banana and Plantain for Africa.

Ogazi P.O (1984). Plantain, production, processing and utilization. Paman Associate Publication Oxford, London UK, Edinburgh Melbourne, Aust. 566.

ISSN 2056-5798(Print), ISSN 2056-5801(online)

Okaka J.C and Isieh M.I (1990). Development and quality evaluation of cowpea – wheat biscuit. *Nigerian Food* Journal, 3, 63–69.

Okoye Z.S.C (1992). Chemical and biochemical indices of food quality. In: Biochemical aspects of Nutrition 137: Prentice – Hall of India Private Ltd. New Delhi – 110001.

Osborne D.R and Voogt P (1978). The analysis of nutrients in foods. London Academic Press, 130 – 134.

O' Sullivan A and Sheffrin S.M (2003). *Economic principles in action*. Upper saddle River, New Jersey: Prentice Hall.

Poulter N.H (1981). Properties of some protein fractions from Bambara groundnut (Voandreiasubterrenea L. Thouars). *Journal of the Science of Food and Agriculture,* 32, 44 – 50.

Zambrano F, Desinoy P, Ormenese R.C.S and Faria E.V (2004). The use of quar and xanthan gums in the production of "light" low fat cakes. *International Journal of Foods Science and Technology,* 39, 959 – 966.

Zoulias V.E, Oreopoulou V and kounalaki (2002). Effect of fat and sugar replacement on cookies properties. *Journal of the Science of Food and Agriculture,* 82, 1637 – 1644.

ISSN 2056-5798(Print), ISSN 2056-5801(online)