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Production and Evaluation of Biscuits from African Yam Bean *(Sphenostylis stenocarpa*) and Wheat *(Triticum aestivum)* Flours.

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ABSTRACT

Composite biscuits were made by supplementing wheat flour (WF) with African yam bean flour (AYBF) after the seeds have been sorted, sun dried, roasted, some soaked, dehulled, winnowed, milled, and sieved into fine flour using a sieve size of 0.4mm and used at various ratios. (WF/AYBF 100:0, 75:25, 50:50,25:75,0:100). The 100% wheat flour biscuit served as the control. Sensory evaluation of the biscuits were determined and subjected to Statistical Analysis of Variance (ANOVA) and means were separated using the Generalized Linear Model (GLM) of SAS system. The means were separated using Fischer LSD and judged significantly different at 95% confidence level ($P<0.05$). The biscuit samples had proximate composition ranging from 6.35 – 11.45% Moisture content, 0.48 to 4.21% Ash, 0.88 to 2.28% Crude fibre, 12.75 to 22.0% Protein, 1.43 to 2.34% Crude fat, 63.30 to 73.01% Carbohydrate. The functional properties of the biscuit samples ranges from 0.53 to 0.71g/ml Bulk density, 14.70 to 20.40% Water absorption capacity, 0.60 to 11.81% Oil absorption capacity, 5.52 to 43.21% Foam capacity, 64.00 to 190.00 seconds Wettability, 6.01 to 15.37% Gelation capacity and 15.10 to 52.10% Emulsion capacity. The anti-nutritional composition of the biscuit samples ranges from 106.40 to 191.20mg/100g Trypsin inhibitor, 1.69 to 74.40mg/100g Phytic acid and 0.08 to 0.45mg/100g Tannins. Sensory evaluation results showed that all the biscuit samples had high rating for all evaluated attributes. The 75:25%and 50:50% of AYBF supplementation compared favourably with control (100% WF). Biscuits from other substitution levels were generally acceptable as they were neither liked nor disliked by the panelists.

Key words: Composite biscuits, African Yam Bean Flour, Wheat flour ,evaluation.

1.0 Introduction

Biscuits are one of the popular cereal foods, consumed in Nigeria. They are ready to eat, convenient and inexpensive food products, containing digestive and dietary principles of vital importance (Kulkarni, 1997). They are nutritive snacks produced from unpalatable dough that is transformed into appetizing products through the application of heat in the oven (Olaoye *et al.,* 2007). Most of these foods are however poor sources of protein and such contribute to poor nutritional quality (Akpapunam and Darbe, 1994; Aloba 2001). Being a ready to eat convenient food product, it is important to be fortified with vitamins and minerals (Elizabeth *et al.,* 1999) and enriched with other protein sources such as oil seeds and legumes.

Although legumes are an important part of traditional diets around the world, they are often neglected in typical Western diets. Legumes are inexpensive, nutrient – dense sources of protein that can substitute dietary animal protein (Anderson *et al.,* 1999). Not only are legumes excellent sources of essential minerals, but they are also rich in dietary fibre and other phytochemicals that may affect health.

African Yam Bean (AYB) botanically known as *Sphenostylis stenocarpa* (Hochsts. Ex A. Rich) is an underutilized grain legume in Nigeria. It is an important legume in Africa, a lesser – known legume of the tropical and sub – tropical areas of the world which has attracted research in recent times (Azeke *et al.,* 2005). This legume has been reported to be of importance in the management of chronic diseases like diabetes, hypertension, and cardiovascular diseases because of its high dietary fibre content (Enwere, 1998). It is eaten roasted as groundnut or boiled and blinded with ingredients like oil, pepper onions and salt.

Wheat is one of the most important crops grown round the world and it's considered as almost first among cereal largely due to the fact that its grain contains protein with unique chemical and physical properties, and other essential nutrient (Khan and Zeb, 2007). It has been recommended that blending of legume with cereal or root crops in the diet could improve the overall nutrition. This led to the objectives of this work which are:

- To produce flour from raw and roasted African yam bean (AYB).
- To make a composite flour blends of AYB flour and wheat flour at different substitution levels.
- To determine the proximate composition of the raw and roasted AYB.
- To determine the functional and anti-nutritional properties of the raw and roasted African yam bean flours.
- To ascertain the palatability and acceptability of biscuits made from composite flour blends of raw and roasted AYB and wheat using Sensory Evaluation.

2.0 Materials and Methods

2.1 Source of raw materials

The two different species of African Yam bean (the white and the brown types) were purchased at Nkwo market of Abiriba in Ohafia Local Government Area of Abia State, Nigeria. The wheat was purchased at new market Aba, Abia State, Nigeria. The chemicals and equipments used for the analysis were obtained from the laboratory of the Dept. of Food Science and Technology, Michael Okpara University of Agriculture Umudike, Nigeria.

2.2 Production of roasted African yam bean AYB flour:

Here, the African yam bean flour was prepared using the indigenous method of producing it. The AYB seeds were sorted, sun dried for 2 days to enable efficient roasting, then roasted. The seeds were put into a traditional clay pot, placed on a tripod stand and fueled with firewood. The pot was first heated for five minutes and a small quantity of the AYB seeds was introduced into the pot. They were allowed for three minutes to make a pop sound before turning it with a wooden pestle in a clockwise direction for 45 minutes.

2.3 Production of Raw African Yam Bean Flour

The White African yam bean seeds were sorted, soaked in cold water for 45minutes to loosen the seed coats. The seeds were rasped between palms and the loosened testa was removed by floatation in water. The dehulled seeds were dried and ground into fine flour and sieved using a sieve size of 0.4mm.

2.4 Formulation of composite flour

African yam bean flour and wheat flour were blended at different ratios to obtain 10 blends. The ratios were (wheat flour: AYB raw flour and wheat flour: AYB roasted flour) 100:0%, 75:25%. 50:50%, 25:75%, 0:100%. The blends were thoroughly mixed using a mixer as described by Oyewole *et al.*, (1996).

2.5 Proximate analysis

Proximate analysis carried out the various flour samples include the moisture content, total ash, crude protein, crude fat, carbohydrate and crude fibre determined using AOAC method (1990) as described by Onwuka (2005).

2.6 Anti-nutritional factors determination

The anti nutritional factors determined on the raw and roasted samples included the tannin, phytate, and trypsin inhibitor contents.

The method of Pearson (1976) was used for the tannin content determination.The phytate content was determined using the method described by Oberlease (1973).

2.7 Trypsin Inhibitor Determination

The trypsin inhibitor activity (TIA) assay used the spectrophotometric method described by Arntfield *et al.* (1985).

2.8 Biscuit production

For the biscuit production, the recipe and method used is as described by Oyewole *et al.* (1996).The ingredients used included, margarine (40g), sugar (30g), egg (1), milk powder (10g), baking powder (2g), salt (0.5g) and composite flour (100g).

The margarine and sugar were mixed in a bowl and creamed until the mixture became light and fluffy. One whole egg and milk powder were added to the cream while mixing. After 40 minutes of mixing, composite flour, baking powder and salt were slowly introduced into the mixture. The dough obtained was rolled on a flat rolling board sprinkled with flour to a uniform thickness using wooden rolling pin.

Biscuit cutter was used to cut the dough into fine shapes which were placed on well greased baking trays. It was baked in an electric oven at 150^0C for 20 minutes until they are pale brown in colour.

The same method was used for other ratios of the composite blends.

2.9 Sensory Evaluation

The method described by (Iwe, 2002) was used for the sensory analysis. The organoleptic properties of the biscuit samples made from African yam bean flour and wheat flour which served as control were tasted by 20 semi-trained panelists randomly selected from the staff and students of Michael Okpara University of Agriculture, Umudike Abia State, Nigeria.

All products were put on different coded dishes and served to the panelists. Quality attributes such as Appearance, Colour, Texture, Taste, Flavour, Mouth feel and General acceptability of the products were scored on a 9 point hedonic scale. The degree of likeness was expressed as follows: Like extremely 9, Like very much 8, Like moderately 7, Like slightly 6, Neither like nor dislike 5, Dislike slightly 4, Dislike moderately 3, Dislike very much 2, Dislike extremely 1.

2.10 Data Analysis

The data collected from the proximate, functional, anti- nutritional and sensory analyses were subjected to analysis of variance using the Generalized Linear Model (GLM) of SAS (1992). SAS system for personal computer 1002-SAS institute Inc. carry, NC. Means were separated with Fischer's LSD and judged significantly different at 95% confidence level ($p<0.05$.)

3.0 Results and Discussions

3.1 Proximate Composition of Biscuits from African Yam Bean Flour**.**

The proximate composition of biscuit samples from African yam bean flour is presented in Table 1.0.

From the table 1.0, wheat flour had the highest moisture content (11.45%) which is significantly higher ($p< 0.05$) than the moisture contents of brown raw & roasted, and white raw and roasted AYB (7.68% and 6.46%) and (7.44% and 6.35% respectively). This slight difference could be associated to the level of environmental factors, experimental methods of analysis, soaking and roasting of the seeds and the type of specie used.

At 5% level of confidence, roasted brown AYB had the highest ash content (4.21%), followed by roasted white AYB which had an ash content of (4.17%) and raw brown AYB which had (4.05%). Raw white AYB had ash content of 3.97% while wheat had the least ash content of 0.48%. The percentage of ash obtained in this study showed that African yam bean will be rich in minerals.

Although the crude fat content of the flours were low, roasted brown AYB being richer in fat could be useful in improving palatability of foods in which it is incorporated.

From the result in table 1.0, it was observed that roasted brown AYB had the highest protein content of 22.0%, followed by roasted white AYB which had a protein content of 21.76%.Raw brown and raw white AYB had a protein content of 20.28% and 20.10% respectively.

The high protein content of the varieties is an indication that its use could help reduce protein-deficiency conditions such as kwashiorkor.

3.2 Functional Properties

Functional properties of flour samples from African yam bean flour is presented in table 2.The bulk density ranged from 0.53 to 0.71g/ml among the flour samples. Bulk density values decreased gradually with roasting. Raw brown AYB had the highest bulk density of 0.71g/ml, followed by raw white AYB 0.70g/ml. Wheat had bulk density of 0.58g/ml while roasted brown and white AYBs had bulk densities of 0.56g/ml and 0.53g/ml respectively). The bulk density values obtained were generally higher than that obtained by Edema *et al.,* (2005) for flour from commercially sold soybean (0.38g/ml). However the values obtained from this study were comparable with the values reported by Okaka and Potter (1979) for cowpea (0.60g/ml).

Water Absorption capacity ranged between 14.70%-20.40%. The values decreased with roasting. Raw white AYB flour had a value of 15.20%, followed by raw brown AYB flour which had a value of 15.00%. Wheat had the highest mean value of 20.40% while roasted white and roasted brown AYB flour had values of 14.80% and 14.70 respectively. Values obtained from this study are greater than reported for flours from soybean (1.12%) Alfaro *et al.* (2004); mucuna (1.20%), Adebowale *et al.* (2005); and lupin seed flour (1.20%) Sathe *et al.* (1982).This result suggests that roasted African yam bean flour may find application in the production of some baked products.

Wheat had the highest oil absorption capacity due to less affinity to absorb more oil, whereas roasted brown AYB had the lesser oil absorption capacity. The higher the oil in the flour the least the affinity to absorb oil. Akubor, (2003) reported that hydration is required to improve the handling characteristics of baked products.

The Emulsion capacity of flours ranged from 15.10-52.10% which is considerably high; hence the sample with high emulsion capacity (raw brown AYB) can be useful in food processing as high emulsion capacity is reported to make flour useful in production of products like cake, mayonnaise and salad dressing (Akubor, 2003).

3.3 Anti-nutritional properties

The anti-nutritional properties of African yam bean and wheat flour are represented in table 3.0.
From the result in the table3.0, the tannin content in the flours were low but raw brown African yam bean had the highest tannin with the mean value of 0.45mg/100g followed by Raw white African yam bean with mean value of 0.42mg/100g and they were significantly different ($P \leq 0.05$) from other samples. Wheat had the least tannin content of (0.08mg/100g). Onwuka, (2005), reported that the presence of tannins can cause browning or other pigmentation problems in both fresh food and processed products. He also stated that tannins can provoke an astringent reaction in the mouth and make the food unpalatable and that they can complex with and thus precipitates proteins in the gut, reducing the digestibility or inhibiting digestive enzymes and micro-organisms. Roasting decreased the tannin content up to (0.25mg/100g) in roasted brown AYB and (0.27mg/100g) in roasted white AYB. Since tannins are mostly located at the seed coat (Singh, 1988) dehulling which took place after roasting must have contributed to the reduction of the level of tannin.

The sensory scores obtained from different blends of raw and roasted brown African yam bean and raw and roasted white African yam bean are presented in Tables 4.1 and 4.2. respectively.

There was a significant difference at ($P<0.05$) in appearance among biscuit samples.
In terms of flavour, the biscuits were not significantly different ($P>0.05$) from each other there was a difference in taste. This difference observed in taste was as a result of the level of substitution of wheat flour and African yam bean flour. Naturally African yam bean has a beany flavour which can affect the taste of the biscuit.

Sample 402 (75% wheat and 25% raw brown AYB), 702 (75% wheat and 25% roasted brown AYB), 403(50% wheat: 50% raw brown AYB) compared favourably with the control and they were not significantly different from each other.

The flavour of sample 401 (100% wheat: 100 raw AYB) and 701 (100 Wheat: 0% roasted AYB) as rated by the panelist are 7.50 and 7.00 respectively. This implies that the flavour of the biscuit which served as control were liked moderately by the panelists. Sample 402 (75% wheat and 25% raw brown AYB) and 702 (75% wheat: 25% roasted brown AYB) compared favourably with the control in terms of flavour because of the level of substitution and they were not significantly different.

All the biscuit samples were generally accepted by the panelists in terms of appearance, colour, texture, taste, flavour and mouth feel except for sample 405 (wheat 0: roasted AYBF, 100) and 705 (wheat 0: roasted AYBF, 100) which were only made from raw and roasted AYBF. Sensory scores of the biscuits from composite raw and roasted white AYBF are presented in table 4.2 below.

The taste of three biscuit samples 501 ((wheat, 100: roasted AYBF, 0), 601 (wheat, 100 roasted AYBF, 0) and 502 (wheat: 75: raw white yam beans 25) were liked moderately by all the panelists. The texture of all the biscuit samples was acceptable to the panelist.

Generally, from the table the most acceptable biscuit samples were the ones which served as control. The samples 505 (0% wheat and 100% raw white AYB) and 605(0% wheat and 100% roasted white AYB) were neither like nor disliked.

4.0 Conclusion

This study indicates that biscuits with higher protein content can be produced from composite flour of wheat and African yam bean flour, as biscuit samples made from 75: 25% and 50:50% AYBF supplementation compared favorably with control (100% WF). The African yam bean flours could be used to fortify conventional flours which are low in protein and consumption of foods based on these African yam bean varieties would be an important step towards alleviating protein energy malnutrition in the developing countries. Furthermore, biscuit production from wheat flour blended with African yam bean may be an answer to increase in consumption and utilization of this lesser known legume with the resultant effect of increased intake of quality protein, minerals and dietary fibre.
It is therefore recommended that substitution of AYB flour at 75:25% and 50:50% levels should be embarked upon by biscuit industries as this will help in conserving national foreign exchange and improving the nutritional value of biscuit.

References

Adebowale, Y.A., Adeyemi, I. A. & Oshodi, A A. (2005). Functional and Physico-chemical properties of flours of six mucuna species. *African Journal of Biotechnology* 4(12): 146-1468.
Akpapunam, M. A. & Darbe, J.W. (1994). Chemical Compostion and Functional Properties of Blended Maize, Bambara Groundnut Flour for Cookies production. *Plant Food Hum. Nutri* 46: 147-155.
Akubor, P. I (2004): Protein Content, Physical and Sensory Properties of Biscuit prepared from soybean/ maize flour Blends. In: *Procedings of the 28th Annual conference I G M of the Nigerian Institute of Food Science and Technology* (NIFST), University of Ibadan Nigeria, Pp 46-47.
Alfaro, M. J., Alvarez I., Khor E.L., Padika, F. C. (2004). Functional Properties of protein products from Barinus nut. *American Journal of Nutrition* 54:223-228.
Aloba, A. P. (2001). Effect of Sesame Seed Flour on Millet Biscuit Characteristics. *Plant Food Hum. Nutri*. 56:195-200
Anderson, J .W, Smith, B .M., Washnock, C. S. Cardiovascular and renal benefits of dry bean and soybean intake. *Am J.Clin Nutr.* (1999) 70 (3 suppl): 4645-4745. (Pubmed).
Arntfield S. D., Ismond M. A.H. and Murray E. D. (1985) The fate of antinutritional factors during the preparation of faba bean protein Isolate using micellization technique. *Can. Inst. Food Sci. Innol. J.* 18, 137- 143.
AOAC (1990) Association of official Analytical Chemists (AOAC) (1990). Official methods of Analysis, 15th Ed. Washington, DC. Associated of Analytical Chemistry P. 1546.
Azeke, M. A .B. Fretzdorft, H. Buencing – Pfare, W. Holzapfel and T. Betsche, (2005). Nutritional value of African yam bean (*Spenostylis stenocarpa*): Improvement by Lactic acid fermentation. *J. Food Sci. Agric.* 85(2): 963-970.
Dhingra, S. & Jood, S. (2005). Organoleptic and Nutritioanl Evaluation of Wheat Breads Supplemented with Soy bean and Barley Flour. *Food Chem. J.* 77:479-488.

Edema, M. O., Sanni, L.O. & Abiodun, I. S. (2005) Evaluation of maize – soybean flour blends for sour maize bread production in Nigeria. *African Journal of Biotechnology* 4:911-918.
Elizabeth van Stuijvenberg, M. Jane, D.K., Mieke, F. Marita, K. Diana, G. K., & Spinnler, B. A. J. (1999). Effect of Iron –Iodine –and B- carotene – Forfified Biscuit on the Micronutrient Status of Primary School Children. *American Journal of Clinical Nutrition*, Vol. 69, 403, 497-503.
Enwere,N. J. (1998). Foods of plants Origin: Processing and Utilization with Recipes and Technology profiles. 1st Edn. Afro-orbis Publications Limited.Nigeria. Pp: 56-60.
Iwe, M,O., 2002. Handbook of Sensory Methods and Analysis. 1st Edn. Enugu: Rejoint communication Ltd. Pp.71.
Khan, I. K. & Zeb, A. (2007). Nutritional Composition of Pakistani Wheat varieties J. Zhejiang. Univ. Sci. B.8(8): 555-559.
Kulkarni S. D. (1997). Roasted Soy bean in Cookies. Influence on product Quality. *J. Food Sci. Technology*, 34:503-505.
Oberleas D. (1973) Phytates In: Toxicants Occurring naturally in Foods (Strong F.ed) *National Academy of Sciences*, Washington D.C. pp 363- 37
Okaka . J.C. & Potter,N. (1979). Physico-chemical and Functional Properties of cowpea Powder processed to reduce beany flavour. *Journal of Food Science* 44:1235-1240.
Olaoye, O. A., Onilude ,A. A.& Oladoye, C.O. (2007). Breadfruit flour in biscuit making: *Afr. J. Food Sci*. Pp. 20-23.
Onwuka, G. I. (2005). Food Analysis and Instrumention. Theory and practice. Naphtali Prints, Lagos, Nigeria. ISBN: 978047686.
Oyewole, O. B., Sanni, L.O. & Ogunjobi, M.A. (1996). Production of biscuits using cassava flour. *Nig. Food Journal* 14:24-28.

Pearson,D. (1976). The Chemical Analysis of Food. 7th ed. Churchill, Living stone, Edinburgh.
Saka, J. O., Ajibade, S. R., Adeniyan, O. N., Olowoyo, R. B.& Ogunbodede, B. A. (2004). Survey of Under-utilized grain legume production systems in South – West agricultural zone of Nigeria. *J. of Agricultural and Food information* 6:93-108.
SAS Institute (1992). SAS. System for personal computers 1002- SAS Institute Inc., Cary, NC, USA.
Sathe,S.K.,Desphande,S.S.and Salunkhe, D. K.(1982). Functional Properties of Lupin seed (*Lupinus mutabilis*) protein and protein concentrates. *Journal of Food Science* 47:491-497.

Table 1.0 : Proximate composition of biscuit samples from African yam bean (*Sphenostylis stenocarpa*) and Wheat flours.

Samples	Moisture(%)	Ash(%)	Crude fibre (%)	Crude Protein (%)	Crude fat (%)	Carbohydrate(%)
Wheat flour	11.45^{a}	0.48^{d}	0.88^{d}	12.75^{c}	1.43^{d}	73.01^{a}
RBAYBF	7.68^{b}	4.05^{bc}	2.16^{ab}	20.28^{b}	1.93^{bc}	63.9^{bc}
RWAYBF	7.44^{b}	3.97^{c}	2.28^{a}	20.10^{b}	1.86^{c}	64.4^{b}
rBAYBF	6.46^{c}	4.21^{a}	1.73^{c}	22.0^{a}	2.34^{a}	63.3^{d}
rWAYBF	6.35^{c}	4.17^{ab}	1.87^{bc}	21.76^{a}	2.20^{ab}	63.7^{cd}
FLSD 0.05	0.8357	0.1141	0.3419	0.3316	0.2922	0.5568

Key: $^{a-d}$ Means with the same superscripts within each column are not significantly different (P>0.05)
WF = Wheat flour
RBAYBF = Raw brown African yam bean flour
RWAYBF = Raw white African yam bean flour
rBAYBF = Roasted brown African yam bean flour
rWAYBF = Roasted white African yam bean flour.

Table 2: Functional properties of wheat and African yam bean flour samples

Samples	Bulk Density (g/ml)	Water absorption capacity(%)	Oil absorption capacity(%)	Foam Capacity (%)	Wettability (seconds)	Gelation Capacity (%)	Emulsion Capacity (%)
Raw brown	0.71^{a}	15.00^{b}	0.81^{b}	43.21^{a}	0.71^{a}	0.71^{a}	0.71^{a}
Raw white	0.70^{a}	15.20^{b}	0.70^{bc}	41.50^{b}	64.00^{e}	0.71^{a}	0.71^{a}
Wheat flour	0.58^{b}	020.40^{a}	11.81^{a}	18.11^{c}	190.00^{a}	0.71^{a}	0.71^{a}
Roasted Brown	0.56^{b}	14.70^{b}	0.61^{a}	6.49^{d}	67.00^{b}	0.71^{a}	0.71^{a}
Roasted White	0.53^{b}	14.18^{b}	0.60^{c}	5.52^{e}	66.00^{c}	0.71^{a}	0.71^{a}

Key: $^{a-d}$ Means with the same superscript within each column are not significantly different.

Table 3: Anti-Nutritional Properties of wheat and African Yam Bean Flour (AYBF)

Samples	Trypsin Inhibitor (mg/100g)	Phytic acid (mg/100g)	Tannins(mg/100g)
Raw brown AYBF	191.20^{a}	2.20^{b}	0.45^{a}
Raw White AYBF	187.30^{b}	2.17^{b}	0.42^{b}
Wheat	132.80^{c}	74.40^{a}	0.08^{d}
Roasted White AYBF	112.30^{d}	1.69^{c}	0.27^{c}
Raw brown AYBF	106.40^{e}	1.76^{bc}	0.25^{c}
$FLSD_{0.05}$	1.6565	0.4748	0.0282

Key: $^{a-e}$ Means with the same superscripts within each column are not significantly different ($P>0.05$)

Table 4.1: Sensory Evaluation of Biscuits produced from different Blends of raw and roasted brown African yam beans

Processing	Codes	Wheat/AYB(%)	Appearance	Colour	Taste	Texture	Flavour	Mouth feel	General Acceptability
Raw	401	100:0	7.75^{a}	$.55^{a}$	7.70^{a}	7.45^{a}	7.50^{a}	7.40^{a}	7.75^{a}
Roasted	701	100:0	7.80^{a}	7.75^{a}	7.25^{a}	7.40^{a}	7.00^{a}	7.20^{a}	7.35^{a}
Raw	402	75:25	7.20^{a}	7.10^{a}	6.85^{b}	6.90^{ab}	6.85^{ab}	6.70^{b}	6.95^{ab}
Roasted	702	75:25	7.25^{a}	7.35^{a}	7.10^{a}	7.15^{a}	6.90^{ab}	6.95^{ab}	6.90^{ab}
Raw	403	50:50	7.20^{a}	7.00^{a}	6.85^{b}	6.70^{b}	6.25^{bc}	6.50^{b}	6.60^{bc}
Roasted	703	50:50	7.10^{a}	7.35^{a}	6.35^{bc}	6.25^{b}	5.85^{b}	6.50^{b}	6.60^{b}
Row	404	25:75	6.45^{c}	6.65^{b}	5.95^{c}	6.35^{b}	6.05^{c}	5.65^{c}	6.10^{bc}
Roasted	704	25:75	6.75^{b}	6.95^{b}	6.05^{bc}	6.25^{b}	5.95^{b}	5.85^{bc}	6.00^{bc}
Raw	405	0:100	6.35^{c}	6.05^{bc}	5.85^{c}	6.25^{b}	5.55^{c}	5.90^{bc}	5.95^{c}
Roasted	705	0:100	5.55^{d}	5.35^{c}	5.20^{c}	5.50^{b}	5.25^{b}	5.45^{c}	5.25^{c}
$FLSD_{0.05}$			0.6199	0.71545	0.83385	0.7377	0.7857	0.82215	0.79125

Key a-d: Means with the same superscripts within each column are not significantly different ($P>0.05$)

Table 4.2: Sensory Evaluation of Biscuit produced from different Blends of raw and roasted White African yam bean

Processing	Codes	Wheat/AYB (%)	Appearance	Colour	Taste	Texture	Flavour	Mouth feel	General Acceptability
Raw	501	100:0	7.60^{a}	7.60^{a}	7.95^{a}	7.45^{a}	7.35^{a}	$7.40^{a}\pm$	7.85^{a}
Roasted	601	100:0	7.75^{a}	7.75^{a}	7.20^{a}	7.35^{a}	7.25^{a}	7.20^{a}	7.35^{a}
Raw	502	75:25	7.35^{a}	7.00^{a}	7.00^{a}	7.00^{a}	7.10^{a}	6.70^{b}	6.95^{ab}
Roasted	602	75:25	6.95^{b}	6.45^{b}	6.25^{b}	6.25^{b}	6.45^{b}	6.35^{b}	6.70^{b}
Raw	503	50:50	7.50^{a}	7.20^{a}	6.85^{b}	7.00^{a}	6.45^{b}	6.70^{b}	6.95^{ab}
Roasted	603	50:50	6.70^{b}	7.00^{a}	6.50^{b}	6.45^{b}	6.30^{b}	6.15^{b}	6.45^{b}
Raw	504	25:75	6.60^{b}	6.05^{bc}	5.70^{c}	5.85^{c}	5.70^{c}	5.70^{c}	5.95^{c}
Roasted	604	25:75	6.70^{b}	6.75^{b}	6.25^{b}	5.95^{c}	5.95^{bc}	5.90^{c}	6.05^{bc}
Raw	505	0:100	6.95^{b}	6.70^{b}	5.85^{c}	5.75^{c}	5.50^{c}	5.60^{c}	5.65^{c}
Roasted	605	0:100	6.40^{b}	6.40^{b}	5.75^{c}	6.05^{b}	5.50^{c}	5.30^{c}	5.50^{c}
$FLSD_{0.05}$			0.6276	0.63065	0.7524	0.69825	0.71795	0.7693	0.63515

Key a-d: Means with the same superscripts within each column are not significantly different (P>0.05)