EVALUATION OF THE PROXIMATE AND SENSORY PROPERTIES OF BISCUITS PRODUCED FROM AERIAL YAM FLOUR (*Dioscorea bulbifera*)

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ABSTRACT

Biscuit samples were produced with wheat flour substituted with aerial yam flour at different levels of 10%, 20%, 30%, 40%, 50%, 60%, up to 100% respectively. The result of the functional properties obtained showed that bulk density of the aerial yam flour was 0.55g/ml, water and oil absorption of 3.86 and 2.68 respectively. Also swelling index of 5.9ml/g and pH of 5.13.These results were observed to be related to that of wheat flour. The proximate and sensory evaluation of these products were carried out using standard methods. The result obtained, indicated that the protein content of sample UV 100% aerial yam biscuit was 10.24 and was significantly different ($p \leq 0.05$) to that of sample ST 100% wheat flour biscuit with 9.65.Similarly moisture content were generally high ranging from 5.31 in 100% wheat biscuit to 12.26 in 80%wheat flour+20%yam flour. From the sensory evaluation, the sample with 100% wheat flour had highest overall acceptability with 8.478, followed by 10% substitution with aerial yam flour, then 20% substitution with aerial yam flour, as well as 30%, 40% and 50% substitution which were accepted with values of:7.478, 7.1304, 6.3913, 6.0869,and 6.3043 respectively. Therefore, it could be ascertained that aerial yam flour could be used for substitution in wheat flour in production of biscuit and its related products up to 50% substitution and still be accepted by the consumers.

Keywords: **Aerial Yam, Proximate Composition, Sensory Evaluation**

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INTRODUCTION

Aerial yam (*Dioscorea bulbifera*) is a specie of yam grown throughout the world. This bulbils-bearing yam which belongs to the Order Dioscoreal, Family Dioscoreaceae, and Genus Dioscorea is unpopular specie among the edible yam species. It is cultivated in the Southeast Asia, West Africa, and South and Central America. The wild form also occurs in both Asia and Africa[1]. This yam specie is known with common names such as potato yam, cheeky yam, bulbils- bearing yam bitter yam it is also known as Igname bulbifere, igname pousse enl` air (France), brotwurzel, karotoffel-yam (Germany) Gaithi, karu-kunda, ratalu (Portugal), Inhame (Hindu). Where as in Spanish speaking countries, it is called criollo (Venezuela) De Aire (Colombia); De Gunda, Volador (Cuba), papa Cimarrona (Mexico)".In Nigeria especially in the eastern region of the country (Anambra, Enugu, Abia and Imo state), air yam is known as "Adu" where as in Rivers State it is called "Odu"[2]. It is one of the most widely spread across the world, unlike traditional yam, bitter yam produces aerial bulbs which looks like potatoes.

The proximate composition of yam including *dioscroea bulbifera* shows that the proximate principle vary widely among species, levels of maturity, between different parts of the tubers and bulbs and cooking procedure[3]. Consequently, ash, proteins, moisture, and fibre and carbohydrate content vary among species and between cultivars[4]. The nutritional and chemical composition of air yam is characterized by high level of moisture and dry matter which varies as a result of environmental conditions with which it is cultivated. The compositions includes moisture which ranges from 63-67%, protein 1-12-1.5%, fat 0.04, fibre 0.70-1.0% ash 1.08-1.5% and carbohydrate varying from 22-33% which constitute the bulk of the dry matter content of the potatoes yam. It also contains toxic substance such as dioscorine and saponin which can be destroyed during processing[5].

The main use of *Dioscorea bulbifera* involves its it can be prepared and processed into edible food by boiling, frying or roasting or eaten as cooked vegetables as the case may be. Checking yam can be made into paste after boiling and eaten with soup or can as well be processed into various forms such as crisps and chips or flakes. It is easy to correct this yam specie into shelf stable and convenient forms such as flours which can be used as human and animal feeds[6].

However, *Dioscorea bulbifera* contains some which if not properly removed during processing becomes poisonous when consumed. Some varieties tend to darken during cooking. This unpopular specie of yam is labour intensive to process and it is reported to contain inferior to that of most regular foods and as such it is almost going into extinction[7].

Therefore, the objectives of this work are:

- To produce aerial yam flour processed from aerial yam *Dioscorea bulbifera* and ascertains its nutritional quality.
- To determine how the yam flour will function in food system through the functional and sensory evaluation of the products, by using the flour in the production of biscuit.
- Also save this yam specie from going into extinction and avoid post harvest losses.

It is hope that the success of this work will help ease the pressure on wheat flour in the food industries, by providing alternative source of flour production.

MATERIALS AND METHODS

Materials

Aerial yam (*Dioscorea bulbifera*) was purchased from Oye Uga market, a local market in Uga town Aguata L.G.A in Anambra state. Wheat flour was purchased from Eke-Ukwu market, a local market in Owerri Municipal L.G.A Imo state.

Chemical Reagents

- The petroleum ether (n-hexane) was gotten from a scientific laboratory (Metlab) in Owerri town Municipal in Imo state.
The acid (hydrogen chloride) and the base (sodium hydroxide) Na0H used for the analysis were obtained from Food Science and Technology laboratory in Federal University of Technology Owerri Imo State. They were all of analytical grade.

Methods

The aerial yam bulbils were washed with clean water to remove adhering soil and other undesirable materials. The yam samples were then sorted and hand-peeled using kitchen knives and sliced into sizes of 2 to 3cm in thickness. The slices were soaked in water while peeling to avoid enzymic browning and also to remove the bitter compound from the sliced samples. The slices were then blanched with hot water at 80^{o}c for 8mins after which the yam slices were transferred into the cabinet oven dryer to dry at 86^{o}c for 4hour. the dried yam slice were milled using locally fabricated hammer mill and screened through a 1mm test sieve to obtain the powdery yam flour and them stored in an air tight container prior to analysis as shown in Fig 1 below.

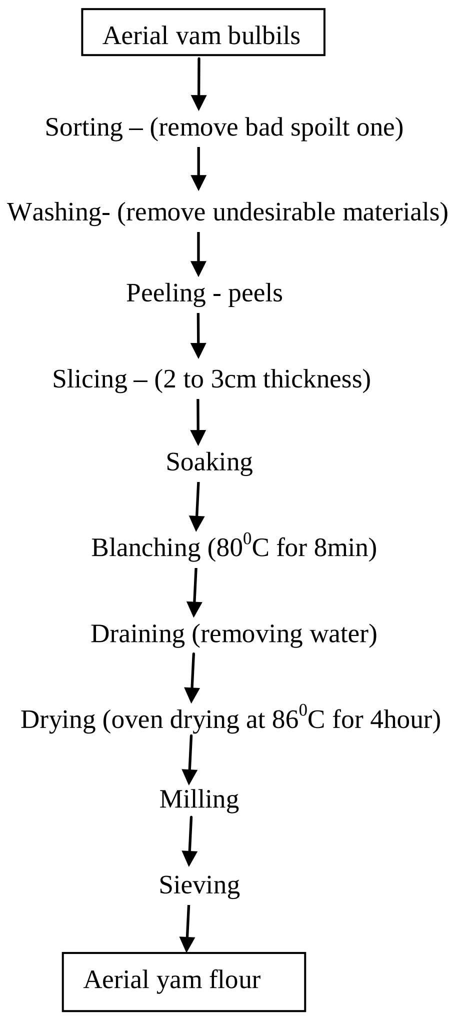

Fig 1: Flow Diagram for the Production of Aerial Yam (*Dioscorea bulbifera*) Flour.

Plate 1: Aerial Yam (*Dioscorea bulbifera*).

Proximate Composition

The proximate composition analysis of the aerial yam composite biscuit was carried out according to [15].

Determination of Moisture Content

The oven drying method was used as described by [15] the aluminum pans were thoroughly washed, dried in the oven at 85°C for 30min and put inside the desiccators to cool. Each of the pans were weighed together with the dish and then placed inside the oven and was heated for more 20min value maintaining the temperature of 105°c, the samples weighed. This was repeated until the weight became constant. The percentage of moisture content (MC) was calculated from the weight loss using the formula below

$$\% \text{ moisture content} = \frac{w_2 - w_3 \text{ x } 100}{W_2 - w_1} = \frac{\text{Weight loss after drying x100}}{\text{Weight of the sample before drying}}$$

W_1 = initial weight of empty pan
W_2= weight of the pan +sample before drying
W_3= final weight of pan+ sample after drying

Determination of Ash Content

The [15] was used. The crucibles were washed, dried in hot aim oven at 105°C and cooled in a desiccators. 2g of the sample were charred into the crumbles on a heater inside a fume cupboard to drive off the smoke. The sample were transferred into a preheated muffle furnace at 550°c and left at this temperature for two until when gray ash resulted. The residence was then cooled in a desiccators than weighed the percentage of ash (dry matter basis) was calculated as follows

$$\% \text{ ash} = \frac{W_3 - W_1 \text{ x } 100}{W_2}$$

Weight of original sample
W_1= weight of the empty crucible
W_2= weight of crucible +sample before ashing+w3= weight of crucible + sample after ashing

Determination of Fat Content

The soxhlet fat extraction methods as designed by [15] was used the 250ml boiling flask was cleaned dried in the oven at 105°c for 30min. The flask was then transferred into a desicator and allowed to cool. The flask was then labeled, weighed and then filled with

300ml petroleum either. 2g of the sample were weighed into a correspondingly labeled thimble. The extraction thimble tightly plugged with cotton wool. The soxhlet apparatus was assembled and allowed to reflux for either was collected in the top of the container in the set up and drained into another container for re-use. The flask was removed and dried at 103°c for the transferred from the oven into a desicator and allowed to cool and then weighed the percentage fat was calculated as follows.

$$\% \text{ Fat} = \frac{\text{Weight of defatted sample x100}}{\text{Weight of sample}}$$

Determination of Crude Protein Content

The micro kjeldahl method as described by [16] was used. 2 kilogram of the sample was weighed out into a micro kjeldahl flask, 5g of anhydrous sodium sulphate, 1g of copper sulphate and a spark of selenium, 25ml of concentrated sulphuric acid and 5 glass beads were introduced into the micro kjeldahl flask to prevent bump during heating the solution was heated gently in a fume cupboard and then heating increased with occasional shaking till the solution turned to green colour the black particle showing at the mouth and neck of the flask was showing at the mouth and neck of the flask was cooled and washed down with distilled water. The mixture (contents) was reheated gently until the green colour disappeared and then allowed to cool, after cooling the digest was transferred with several washing into a 250ml volumetric flask and made up to the mark with distilled water. The Markham distillation apparatus was steamed for 15min before use under the condenser a 100ml council flask containing 5ml of boric indicator was placed such that the condenser tip is under the liquid 5ml of the digest was pipette into the body of the apparatus through a small funnel aperture, then washed down with distilled water followed by 5ml of 60% NaOH with distilled solution and steamed for 5min. the receiving flask was removed and the top of the condenser was washed down into the flask. The condenser water was then removed. The solution in the receiving flask was titrated using 0.01N hydrochloric acid and the nitrogen was calculated and converted to protein content of the food using a factor (6.25)

Calculation: % nitrogen = V_S-V_B x N acid x 0.01401 x 100

V_S= vol. (ml) of acid required to titrate sample

V_B= vol. (ml) of acid required to titrate the blank

N_{acid} = normality of acid (0.01N)

W= weight of sample in grams

% crude protein = % N x conversion factor (6.25)

Determination of Crude Fibre

The method of [15] was used 2g of the sample was defatted with petroleum either the defatted sample was boiled under refuse for about 30min with 200ml of a solution containing 1.25 grams H_2SO_4 in 100ml and then filter through a linen on a fluted funnel and then washed with boiling water until the washing are no longer acid, the residue was transferred into a beaker and boiled for another 30min with 200ml of solution containing 1.25g of carbonate- free Na0H per 100ml. the final residue was filtered through a thin and washed with boiling water then the residue was then dried in a hot air oven and weighed the dries residue was incinerated cooled and weighed. The crude fibre was incinerated as weight loss after incineration x 100.

Determination of Carbohydrate Content

The carbohydrate content was determined by difference using the formula.

% Available carbohydrate = 100 (% moisture + % ash + % protein + % fat + % crude fibre)

Determination of Energy Value of the Food

The energy value was determined by the method as described by [14]. The energy value of the food sample was calculated as follows:

Energy value in kilojoules = (% carbohydrate x 17 + % protein + 17 + % fat x 37)

The value was then converted to kilo calories per 100g.

Sensory Evaluation

The processed yam flour was used in composite with wheat flour to produce biscuit which was subjected to sensory evaluation. The ratio of the aerial yam composite flour used for the biscuit production is as follows (90%WF+10%YF; 80%WF+20%YF; 70%WF+30YF; 60%WF+40%YF; 50%WF+50%YF; 40%WF+60%YF; 30%WF+70%YF; 20%WF+80YF; 10%WF+90%YF, 100%YF, and the control being 100%WF)

Totally up to 11 samples. A scoring difference test and a 9Point hedonic scale test was used in assess the intensity and overall acceptability of the product. A panel consisting of twenty-three (23) untrained panelist who are regular consumers of biscuit were used for the sensory test. They were asked to evaluate the aerial yam composite for appearance Taste, Flavour/aroma, texture, crispiness and overall acceptability using the questionnaire provided for the scoring difference test ranging from 9=like extremely 8=like very much; 7=like moderately;6=like slightly 5= neither like nor dislike; 4= dislike slightly; 3= dislike moderately; 2 = dislike very much; and 1 = dislike extremely as described by [17].

Statistical Analysis

All data were subjected to analysis of variance (ANOVA) while their means were separated using least square difference (LSD).

RESULTS AND DISCUSSION

Functional Properties of Aerial Yam Flour (*Dioscorea bulbifera*)

The functional properties of the aerial yam flour (*Dioscroea bulbifera*) showed low water absorption of 3.86g with swelling index of 5.90ml/g and least gelation of 4.0 but related to that of wheat flour. Water absorption capacity of the flour will determine the rate of water absorption by the flour sample which will affect the rate at which the water granules swell during reconstitution of the flour. The swelling index depends on the water intake of the flour. This could be the reason for the high moisture content found in sample UV (100%Yam flour)during proximate analysis hence the gelatin concentration of air yam is lower when compound to that of other yam species. The difference could be due to the difference in amylose content of the yams. [18] reported that amylose molecules are believed to form gels more rapidly than amylopectin molecules. The greater the percentage of amylose fraction, the quicker the formation of gels. This result agreed with [19] and [20] who showed that the resultant structural and organleoleptic characteristics of food product are reflection in single or combination of the specific starch or flour fractions.

Table 1: The Proximate Composition of the Biscuit Samples

PARAMETER /SAMPLE	MOISTURE	ASH CONTENT	CRUDE FIBRE	FAT CONTENT	CRUDE PROTEIN	CARBOHYD RATE
ST	5.51^{g}	1.68^{e}	0.31^{d}	25.49^{h}	9.65^{b}	57.37^{ab}
AB	5.31^{g}	1.13^{f}	0.41^{cd}	24.33^{j}	9.515^{b}	58.99^{a}
CD	4.50^{h}	1.73^{de}	0.45^{cd}	27.23^{e}	8.21^{cde}	57.89^{ab}
EF	6.75^{e}	1.70^{e}	0.36^{cd}	33.92^{a}	8.39^{c}	48.89^{de}
GH	7.28^{d}	1.85^{cde}	0.61^{cd}	28.20^{c}	8.17^{cde}	53.9^{bc}
IJ	8.53^{c}	1.99^{bcd}	0.71^{c}	24.88^{I}	8.08^{e}	55.82^{ab}
KL	6.80^{e}	1.83^{cde}	0.70^{c}	26.44^{g}	7.74^{g}	56.52^{ab}
MN	8.74^{c}	2.04^{abc}	1.12^{b}	26.71^{f}	8.21^{cde}	53.15^{bcd}
OP	12.26^{a}	2.07^{abc}	1.17^{b}	31.20^{b}	8.15^{de}	45.15^{ef}
QR	10.58^{b}	2.15^{ab}	1.57^{a}	26.52^{fg}	8.33^{cd}	50.87^{cd}
UV	10.87^{b}	2.30^{a}	1.72^{a}	27.62^{d}	10.24^{a}	41.78^{f}
LSD	0.306	0.265	0.359	0.192	0.228	4.888

Means with the same superscripts in the same column are not significantly different at (p≥o.05)

Key

ST1 = 00% Wheat Flour (WF); AB=90% WF+10% YF;CD=80% WF+20% YF; EF=70% WF+30% YF
GH = 60% WF+40% YF; IJ=50% WF+50% YF; KL=40% WF+60% YF; MN=30% WF+70% YF
OP = 20% WF +80% YF; QR=10% WF + 90% YF; UV=100% YAM FLOUR (YF)

From the proximate table above, the moisture level in the sample ST (100%WF)and UV(100%YF) were found to be significantly different at ($p \leq 0.05$) with ST(100%WF) having the lowest moisture content and UV(100%YF) the highest respectively. In other samples (AB to QR) the moisture contents increased with increase in aerial yam composite. This increase in moisture level brought about decrease in dry matter content of the biscuit sample with AB(90%WF+10%YF) having the highest content of dry matter, and as such was not significantly different from ST(100%WF) sample. This increase was due to the fact that aerial yam flour initially had high moisture content man wheat flour.

The ash content of the biscuit sample UV (100%YF) was at the highest level but decreased with respect to increase in percentage composition with wheat flour. However there was no significant difference in ash content of the sample starting from UV(100%YF to MN(30%WF+70%YF) with UV to MN having the highest levels of ash content as compared to ST(100%WF) sample which had the lowest content of ash.

The result also showed that the biscuit samples all had low crude fibre contents. These low fibres content are as a result of the sieving operations done during processing of the flour which was subsequently used for the biscuit production, although the UV (100%YF) had the highest level of crude fiber when compared with the other biscuit samples. Sample AB (90%WF+10%YF) to KL (40%WF+60%YF)) indicated no significant difference between them at ($p \geq 0.05$) with ST (100%WF) having the least fibre content

The fat content of the Biscuit sample were all significant different from one another at ($p<0.05$). This difference in fat content together with their moisture level especially in sample EF (70%WF+30%YF) and GH (60%WF+40%YF) were responsible for their poor crispiness as well as their textural quality characteristics as indicated in table 2

The protein level of the samples from the result from table 1 above shows that the sample had a protein ranging from 10.24 in UV (100%YF) to 7.74 in KL (40%WF+60%YF).Some are significantly different at ($p \leq 0.05$) from other for instance, UV (100%YF) contained the highest level of protein while sample CD (80%WF+20%YF) to OP (20%WF+80%YF) had no significant different between them. Except KL (40%WF+60%YF) which had the lowest protein content.

The carbohydrate content of the samples ranging from (41.76-58.99), indicated that the biscuit are rich in carbohydrate and as such are starch food. Although the levels of the carbohydrate content vary within them, it makes this biscuit an energy giving food and a reliable food product. However, the proximate composition showed a high nutrient level in the samples of the biscuit produced.

Table 2: Sensory Evaluation of the Aerial Yam Composite Biscuit

PARAMETER /SAMPLE	APPEARANCE	TASTE	TEXTURE	FLAVOR /AROMA	CRISPINESS	OVERALL ACCEPTABILITY
ST	8.6087^{a}	8.4348^{a}	8.4348^{a}	8.0879^{a}	8.4348^{a}	8.4783^{a}
AB	6.6522^{bc}	7.5217^{b}	7.0000^{b}	7.0435^{b}	7.7391^{ab}	7.4783^{b}
CD	6.7391^{bc}	7.1739^{b}	6.9565^{b}	6.6523^{b}	7.0435^{bc}	7.1304^{bc}
EF	6.5217^{bc}	5.6522^{cde}	5.5652^{cd}	6.6957^{cd}	4.4348^{e}	6.3913^{cd}
GH	6.8696^{b}	5.8261^{cd}	5.8261^{cd}	5.6957^{cd}	4.5652^{e}	6.0869^{de}
IJ	6.3043^{bc}	6.3043^{bc}	6.2174^{bc}	5.5652^{de}	6.3043^{cd}	6.3043^{cd}
KL	6.0870^{bcd}	5.4783^{cdef}	5.9130^{cd}	6.0879^{c}	4.3913^{e}	5.8261^{def}
MN	5.7391^{cd}	5.2609^{defg}	5.3043^{cde}	5.6087^{de}	3.6087^{e}	5.5652^{def}
OP	5.2609^{d}	4.5217^{g}	4.2609^{f}	5.2174^{ef}	4.2609^{e}	4.4783^{g}
QR	5.7391^{cd}	4.6522^{fg}	4.5652^{ef}	4.6522^{g}	4.4348^{e}	5.2174^{efg}
UV	6.0000^{bcd}	4.9130^{efg}	5.0870^{def}	5.0000^{fg}	4.4348^{e}	5.1739^{fg}
LSD	1.037	0.879	0.919	0.448	1.027	0.904

Note: the means with different superscripts along the columns are significant different at ($p<0.05$)

Key:
ST100% Wheat Flour (WF); AB=90% WF+10% YF; CD=80% WF+20% YF; EF=70% WF+30% YF
GH=60% WF+40% YF; IJ=50% WF+50% YF; KL=40% WF+60% YF; MN=30% WF+70% YF
OP=20% WF +80% YF; QR=10% WF + 90% YF; UV=100% YAM FLOUR (YF)

Table 2 shows data on sensory analysis of the biscuit sample produced with different substitution of aerial yam flour in composite with wheat flour

Appearance

The ST(100%WF)sample has the highest mean value in appearance showing a reflection of the fact that wheat flour is still the traditional flour for biscuit production and its viewed as a standard for comparison. The UV (100%YF) sample was found to be significant different in appearance when compared to that of ST (100%WF) at ($p<0.05$).The appearance of UV(100%YF) is as a result of the characteristic colour of the yam flour used, impacted by non enzymic browning during the processing of the yam flour. This change in appearance between the two parent flour samples (WF and YF) resulted in a downward decrease in appearance of the biscuit as the composition of the yam flour increased. The result showed that this change in appearance was still acceptable up to 60% substitution with the yam flour

Taste

The taste result showed that there was significant difference ($p\leq0.05$) in the taste of the biscuit sample ranging from (8.43-4.52). The AB (90%WF+10%YF) and CD (80%WF+20%YF) samples has no significant difference between them at ($p<0.05$) and their taste was close to that of ST (100%WF), but are significant different from the ST samples. Although there was significant difference between the biscuit samples, they were very much acceptable up to 50% substitution with yam flour

Texture

The texture of the biscuit samples were significant difference at ($p<0.05$) when compared with that of the ST (100%WF) sample. The difference could be as a result of high moisture content of the original yam flour and to an extent the fat content of the biscuit as shown in proximate analysis result in table 1 which was generally high. The decrease in the textural quality of the sample especially in sample EF (70%WF+30%YF) and GH (60%WF+40%YF) were as a result of the high moisture as the yam flour increased in composition and also the level of fat content in the biscuit which subsequently resulted in variation in the texture of the biscuits produced. It is important to note that the level of moisture or liquid or semi-solid used during mixing operation will reflect in the textural quality of the biscuit to be produced.

Flavor/aroma

From the result obtained, the flavor of ST sample (100%WF) being the traditional flour for baking operations and biscuit production has its characteristic flavour. The flavour of UV(100%YF) sample have been reported by (Hammer, 1998) to have inferior flavour and is significantly different ($p<0.05$) to that of ST(100%WF) sample. This difference reflected in the biscuit samples with increase in the yam flour composite. The flavour of the biscuit which decrease as the substitution with yam flour increased were still acceptable up to 50% composite.

Crispiness

The crispiness of the biscuit samples were noticed to vary, though crispiness decreased as the aerial yam composite increased. There was a significant difference ($P<0.05$) between ST (100%WF) and all the other samples except AB(90%WF+10%YF) which did not have significant difference ($P\geq 0.05$) with it. The decrease in crispiness especially the sharp drop in EF(70%WF+30%YF) and GH(60%WF+40%YF) samples were due to high level of fat content present in them. Biscuits with high fat content tend to have low crispiness and as such should be monitored during mixing operations. Though sample AB(90%WF+10%YF) was not significantly different to ST(100%WF) and CD(80%WF+20%YF) not significantly different from AB(90%WF+10%YF), the crispiness of the biscuit sample were acceptable up to sample IJ(50%WF+50%YF) containing 50% yam flour composite.

Overall Acceptability

The result showed that there was significant difference between the biscuit sample with respect to sample ST (100%WF). The overall acceptability of the samples was based on their individual performance on evaluation. The appearance, taste and texture of the samples, as well as their flavour and crispiness, all contributed to the general characteristic performance of the biscuits however, the degree of acceptability of the different samples with respect to their proximate composition was ascertained to be up to 50% composite, hence a declining trend in overall acceptability was observed with increasing level of yam flour for all the sensory characteristics.

CONCLUSION

The study shows that the biscuit sample produced with wheat flour, substituted with aerial yam flour, at different levels of composition, were significantly different ($P\leq 0.05$) in terms of the proximate and sensory properties. The result showed that the fat content of the biscuit sample were at a high level and this affected the crispiness of the biscuits and also that aerial yam flour contributed to the nutrient composition of biscuit samples. The proximate composition of the sample IJ (50%WF+50%YF) and its degree of acceptance in sensory properties indicates that the use of aerial yam flour for substitution in wheat flour for production of biscuit and its related products up top 50% substitution quite acceptable.

Further studies should be carried out on aerial yam flour to ascertain its baking potential in baking operations, especially in the appearance of the yam flour. It is also recommended that this yam flour should be used up to 50% substitution for wheat flour in biscuit production and its related products

Therefore, it is a good energy food source and a good substitution for wheat flour, especially in baking, considering the high cost of wheat flour.

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