PROXIMATE, ANTI-NUTRIENTS, MINERALS AND SENSORY PROPERTIES OF BISCUITS PRODUCED FROM WHEAT FLOUR AND THREE (3) VARIETIES OF EGGPLANT (*Solanuma ethiopicum, S. incanum, S. molengena*)

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ABSTRACT

The proximate, anti-nutrient, mineral properties and sensory evaluation of four biscuits sample were determined. The result of the chemical analysis indicates that moisture content, crude Ash, fibre, fat, protein and carbohydrate composition of the biscuits ranged from 6.95-8.75%, 0.4-5.12%, 1.90-7.15%, 11.72-16.0%, 7.6-15.16% and 53.10-74.1% respectively. There was a significant difference in fibre, fat, protein, carbohydrate content of the biscuit samples. The anti-nutrient analysis of the biscuit shows that phytate, tannin, oxalate, saponin and total phenol content ranged from 1.32-2.60mg/100g, 9.25-11.81 mg/100g, 5.85-10.97 mg/100g, 3.02-6.10DE/g, 11.25-18.41GAE/g respectively. The mineral analysis shows that calcium, potassium, magnesium and iron content ranged from 100.50-108.50mg/kg, 58.80-92.70 mg/kg, 115.40-120.50 mg/kg, 3914-54.30 mg/kg respectively. Generally the biscuit receives high rating in color, aroma, texture, taste and overall acceptability. The inclusion of 30% eggplant (Solanum Incanum) and 70% wheat in the biscuit improved the protein content which serves as a relief of malnutrition as well as good source of minerals and fibre which can help to reduce the risk of heart disease, prevent constipation and aids digestion.

Keywords: Biscuit, Egg Plant and Wheat flour

INTRODUCTION

Vegetables are useful components of the diet due to their contributions in forming a balanced diet (charity *et al*., 2018). They are found among a vast amount of plant species that can serve as readily available sources of fiber. The efficacies of various kinds of nutrients have been widely explored, and because of their nutritious and distribution in different localities this has availed the opportunity for individual and industry to have easy access to it in affordable ways. *Solanum* is a widely dispersed genus of the *Solanaceae* Family with over a thousand species, a tenth of which are indigenous African species. The dominant species are *S. macrocarpon* and *S. aethiopicu*m (Bonsu *et al*., 2002) and are commonly called garden eggs or locally known as Dauta in Hausa, Igbagba in Yoruba, and Afufa in Ibo.

Eggplants have indigenous medicinal uses which range from weight reduction to treatment of several ailments including asthma, skin infection and constipation (Safowora, 1993). They are very beneficial in control of hypertension and diabetes, and enhancement of antioxidant and anticancer activities in the body. According to American Diabetes Association (2009) eggplant can be used to manage degenerative conditions of the body such as elevated blood sugar and increased weight gain. This property is due to its high content of polyphenols authenticated by a study carried out by Nwanna *et.al* (2019).

Garden Egg (*Salanum aethiopicum, S. incanum, S. molengena*) contains huge amounts of fibre, vitamins and minerals, which helps in maintaining the function of the heart and regulate blood pressure (Deng *et al.,* 2013). Garden egg comes in different colour; the cream, the green colour, the purple, the red. (Ndife *et al*.,2019).

Wheat also provides substantial amount of a number of components which are essential or beneficial for health, notably protein, vitamins (Vitamin B), dietary fibre and phyto-chemicals (Nwanna *et al*., 2019). Wheat is an important source of carbohydrates, a leading source of vegetable protein in human food having a protein content of about 13% which is relatively high compared to other major cereals (Food and Agriculture Organization, 2017).

Biscuits are ready to eat, cheap and convenient food product consumed among all groups in many countries (Omoba and Omogbemile 2013). They are snacks produced from palatable dough that is transformed into appetizing product through the application of heat in the oven (Gbenga-Fabasiwa *et al.,* 2018). It can be made from hard or soft dough which has been reported to be rich in fat and carbohydrate. Biscuit has very low moisture content, considered as a better vehicle for fortification and enrichment with micro and macro nutrients (Ashwarth, 2015, Omoba and Isah 2018). Biscuit has been suggested as a better use of composite flour than bread due to their ready to eat form, wide consumption, relatively long shelf life and good eating quality (Horns *et al.,* 2007). The aim of this research work were to produce biscuit from the blends of wheat and eggplant varieties in order to ascertain the nutrient quality of the biscuits

MATERIALS AND METHODS

Source of raw materials.

The raw materials are wheat and garden egg varieties (*Solanumaethiopicum, Solanumincanum, SolanumMelongena*) which were purchased locally from Anyigba central market in Dekina Local Government Area of Kogi State, Nigeria.

Sample Preparation

Processing of Wheat grain into flour

1 kg wheat grains were winnowed sorted to remove the extraneous materials and damaged seeds. Washed in warm water and dried in air dryer (AFOS Limited, Kingston upon Hull, United Kingdom) at 40°C for 72 hours. While, dried wheat grain were grounded with grinder (Stainless Steel Vertical Type High Speed Grinding and Pulverizing Machine, Model RT-34, WHL Machinery, Selangor, Malaysia) and further sieved through 500meshes.

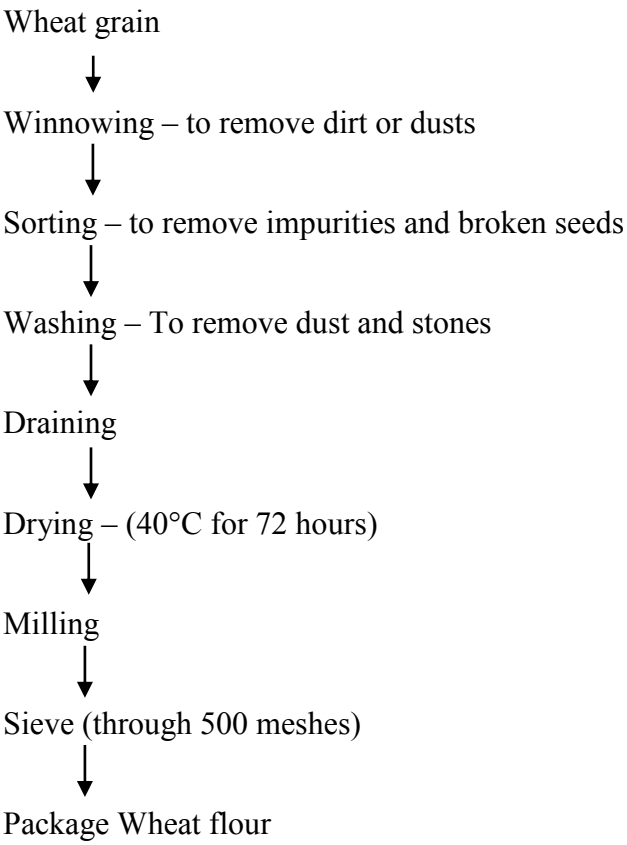

Figure 1: The above flow chart showing the Preparation of Wheat flour.

Processing of Garden Egg into Flour

Method of (Uthumporn *et al*., (2015) was adopted; Fresh eggplants was washed with distill water to remove all the soil and unwanted dirt followed by size reduction to facilitate or quicken the drying, with air dryer (AFOS Limited, Kingston upon Hull, United Kingdom) at 40°C for 72 hours. While, dried eggplants were grounded with grinder (Stainless Steel Vertical Type High Speed Grinding and Pulverizing Machine, Model RT-34, WHL Machinery, Selangor, Malaysia) and further sieved through 500meshes sieved.

The eggplant flour were then kept and sealed in polypropylene plastic bag and subsequently in airtight container. The flour was then stored in refrigerator at 4°C prior to use.

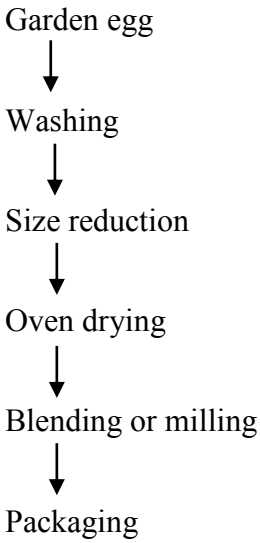

Figure 2: shows the Preparation flow chart of garden eggplant powder (Uthumporn*et al*., (2015)

Biscuit Production

Biscuit was prepared according to the method of AACC 2019 (see fig. 3) with modification in the recipe (table 1). The dry ingredients were blended together until uniform mixtures of the ingredients were obtained; the flour was weighed alongside with other ingredients.

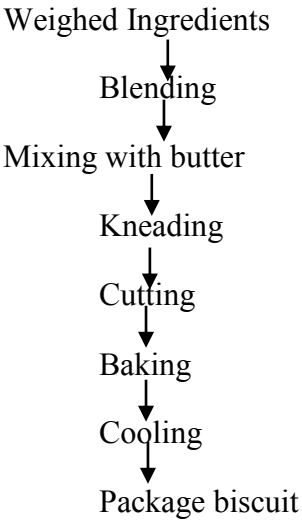

Figure 3: shows the process flow chart of biscuits production. (AACC 2019)**.**

Table 1: Formulation Table for the flour blends

Sample	Wheat (%)	*Solanumaethiopicum*(%)	*Solanumincanum*(%)	*SolanumMelongena*(%)
AAA	Control (Fibre Active Biscuit)			
BBB	70	30	-	-
CCC	70	-	30	-
DDD	70	-	-	30

Sample codes
Sample AAA= control (Fibre active biscuit).
Sample BBB = (70% wheat + 30% S. *aethiopicum*).
Sample CCC = (70% wheat + 30% S. *incanum*).
Sample DDD = (70% wheat + 30% S. *melogena*).

Chemical analysis of the biscuits

Proximate analysis such as moisture content, Ash, fiber, crude fat, protein and carbohydrate were determined according to the methods described by Association of Official Analytical Chemist (2012).

Minerals Composition

Mineral composition such as iron, potassium, magnesium and calcium were determined by Atomic Absorption Spectrometer as described by AOAC (2012).

Anti-Nutrient Composition

Anti-nutrients properties of the biscuits such as the phytate, oxalate, tannin, saponin, and total phenol were by (Asharani *et al*., 2010) methods.

Sensory Evaluation

Twenty (20) untrained panelist of undergraduate students from the Faculty of Agriculture, Kogi State University, Anyigba, Nigeria, was used to assess the quality of the Biscuit. Each panelists were asked to score each Biscuit samples using a 9-point hedonic scale (i.e 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,1- Dislike extremely).

Statistical Analysis

Data were obtained in triplicate; one-way analysis of variance (ANOVA) was used to analyse the result using Statistical Package for Social Sciences (SPSS). Means were separated using Duncan's new multiple range test (DNMRT). Statistical significance was accepted at $p \leq 0.05$.

RESULTS AND DISCUSSION

Proximate composition of Biscuit Samples

Table 1 shows the proximate composition of biscuit produced from wheat and eggplant varieties.

Table 1: Proximate composition of Biscuit Samples

SAMPLE CODE	MOISTURE CONTENT (%)	CRUDE ASH (%)	CRUDE FIBRE (%)	CRUDE FAT (%)	CRUDE PROTEIN (%)	CARBOHYDRATE (%)
AAA	5.59±0.18^{d}	0.4±0.06^{d}	0.9±0.04^{d}	12.0±0.05^{a}	7.6±0.00^{d}	74.1±0.20^{a}
BBB	6.95±0.05^{c}	4.78±0.03^{c}	6.95±0.05^{c}	11.72±0.02^{d}	14.53±0.05^{c}	55.08±0.15^{b}
CCC	7.48±0.03^{b}	5.00±0.00^{b}	7.26±0.03^{a}	12.01±0.01^{b}	15.16±0.02^{a}	53.10±0.00^{c}
DDD	8.75±0.03^{a}	5.12±0.03^{a}	7.15±0.05^{b}	11.97±0.01^{c}	14.96±0.04^{b}	52.05±0.02^{d}

Mean ± standard deviation of three replicate; mean values with the same superscript letter within the same column do not differ significantly (p> 0.05)

KEY

AAA = Control (Fibre Active Biscuit).
BBB = *SolanumAethiopicum* 30%, Wheat 70%.
CCC = *SolanumIncanum* 30%, Wheat 70%.
DDD = *SolanumMolengena* 30%, Wheat 70%.

The moisture content of the biscuit samples ranged from 6.59-8.75%. Sample AAA has the least value (6.59%), while sample DDD has the highest value (8.75%). Moisture content did not differ significantly ($p>0.05$) among the samples. High moisture (8.75%) although within acceptable limit for food storage as recommended (USDA 2017) which states 1-15% safe moisture content as optimal range for storage of cereal grains.

The ash content also increased variably. It ranged between 0.4 and 5.12%. Sample AAA has the least value (0.4%), while sample DDD had highest (5.12%). The incorporation of eggplant increased the ash content significantly. The ash content help to determine the amount and types of minerals in food, it also gives an idea of the total quantity of the mineral elements in the food (Iwe*et al*. 2016).

The crude fibre content ranged from 1.90 to 7.26%. Sample AAA with least value (1.90%), while sample CCC has the highest value (7.26%). Incorporation of eggplant in the biscuit increased the fiber content. Fibre intake is of great importance because it aids digestion, helps prevent constipation, aid waste elimination in the body and guide against anthraetes. Ayo *et al.,* (2013).

The fat content of the biscuit ranged from 11.73 to 16.0%. Sample AAA with the highest value (16.0%), while sample BBB has the least value (11.72%). The body uses fat asa fuel source and fat is the ajor storage form of energy in the body (Kure *et al*., 2000). Crude protein content of the sample ranged from 7.6 and 15.16%. Sample CCC has the highest value (5.16%), while sample AAA has the least value (7.6%). The protein content of the biscuit varies significantly ($p>0.05$), supplementation of the biscuit with wheat flavor increase the protein content. Protein plys a part in the organoleptic properties of food being the source of amino acides. These results are in agreement with Pearson (2008), who reported that protein of wheat bran is appraised as a high grade protein due to the variation of amino acids and type of protein in crude extract. In addition, combination of cereals and vegetable provide better overall amino acide balance (Udoamaka *et al*., 2014).

The carbohydrate content of the biscuit ranged from 52.05 to 74.1%. Sample AAA having the highest value (74.1%) and sample DDD has the least value (52.05%). Biscuits have high level of carbohydrate since they are mainly cereals and some of them have sugar added. The values obtained were near to the limit allowed for barbohydrate by Brazilian legislation (56.80-74.61%).

Anti-Nutrient Properties of Biscuit Samples

The data presented in Table 2 shows the anti-nutrient properties of biscuit produced from wheat and eggplant flour.

Table 2: Anti-Nutrient Properties of Biscuit Samples

Sample Code	Phytate (mg/100g)	Tanin (mg/100g)	Oxalate (mg/100g)	Saponin (DE/g)	Total Phenol (GAE/g)
AAA	1.32 ± 0.14^{d}	10.09 ± 0.03^{d}	9.70 ± 0.18^{b}	6.10 ± 0.08^{a}	10.11 ± 0.07^{d}
BBB	1.46 ± 0.04^{b}	09.25 ± 0.10^{c}	5.85 ± 0.05^{d}	3.02 ± 0.00^{d}	11.25 ± 0.08^{c}
CCC	2.45 ± 0.07^{c}	10.50 ± 0.05^{b}	8.28 ± 0.01^{c}	3.71 ± 0.01^{c}	14.17 ± 0.00^{b}
DDD	2.60 ± 0.57^{a}	11.81 ± 0.05^{a}	10.97 ± 0.11^{a}	4.02 ± 0.04^{b}	18.41 ± 0.85^{a}

Mean±standard deviation of three replicates; mean values with the same superscript letter within the same column do not differ significantly (p0.05)

AAA = Control (Fibre Active Biscuit)

BBB = *Solanum aethiopicum* 30%, wheat 70%

CCC = *Solanum incanum* 30%, wheat 70%

DDD = *Solanum molengena* 30%, wheat 70%

Phytate ranged between 1.32 and 2.60Mg/100g. Sample AAA had the highest (2.60Mg/100g), while sample DDD had the least. Incorporation of eggplants reduced the phytate level of the biscuit samples. According to Chandra *et al*. (2012), phytate is the most effective anti-nutrient in food and a cause of mineral ions deficiencies in human. Tannin renaged from 9.25 and 11.81Mg/100g. Sample BBB had the least (9.25Mg/100g) while sample DDD had the highest (11.81Mg/100g).

Oxalate ranged 5.85 and 10.97Mg/100g. Sample BBB has the least (5.85Mg/100g) while sample DDD has the highest (10.97Mg/100g). Saponin ranged from 3.02 to 6.10DE/g. Sample AAA had the highest (6.10DE/g), while sample BBB had the least value (3.02DE/g). It is an anti-nutrient that may have possible health benefits in terms of reducing serum cholesterol (Ercan and El, 2016). Total phenol ranged between 11.25 and 18.41GAE/g. Sample DDD had the highest (18.41GAE/g), while sample AAA had the least (11.25GAE/g). Phenolic compounds are vital in defense responses, such as anti-aging, anti-inflammatory, anti-oxidant and anti-proliferative activities.

Mineral Composition of Biscuit Samples

The mineral composition of biscuit of samples are presented in Table 3.

Table 3: Mineral Composition of Biscuit Samples

Sample Code	Ca (mg/kg)	K (mg/kg)	Mg (mg/kg)	Fe (mg/kg)
AAA	100.60 ± 0.04^{c}	58.80 ± 0.05^{d}	116.01 ± 0.15^{d}	48.71 ± 0.17^{c}
BBB	105.90 ± 0.05^{b}	85.40 ± 0.02^{b}	120.50 ± 0.04^{a}	39.14 ± 0.02^{d}
CCC	108.50 ± 0.02^{a}	79.10 ± 0.01^{c}	115.40 ± 0.01^{c}	54.30 ± 0.03^{a}
DDD	100.50 ± 0.01^{d}	92.70 ± 0.05^{a}	117.60 ± 0.05^{b}	43.20 ± 0.01^{b}

Mean±standard deviation of three replicates; mean values with the same superscript letter within the same column do not differ significantly (p0.05)
AAA = Control (Fibre Active Biscuit)
BBB = *Solanum aethiopicum* 30%, wheat 70%
CCC = *Solanum incanum* 30%, wheat 70%
DDD = *Solanum molengena* 30%, wheat 70%

The data presented in Table 3 shows that calcium ranged from 100.50 and 108.50mg/kg. Sample CCC had the highest value (108.50mg/kg), while DDD has the least value (100.50mg/kg). The calcium content increased with increase in the addition of eggplant flour. Calcium aids in the formation of bones and plays a role in maintaining the working of the heart and muscular. This finding agrees with Yusuf *et al*. (2015) who also reported that, consumption of enough calcium can lower the rist of high blood ppressure during pregnancy.

Potassium content ranged from 58.80 to 92.70mg/kg. Sample DDD has the highest value (92.70mg/kg), while sample AAA had the least value (58.80mg/kg). Inclusion of eggplant flour into the biscuits increased the potassium content of the biscuit samples. This is good because it is required to maintain osmotic balance of the body fluid, the pH of the body, to regulate muscle and nerve irritability, control glucose absorption and ehance normal retention of protein during growth (Arinathan *et al*. 2013).

The magnesium of the biscuit ranged from 115.40 and 117.60mg/kg. Sample CCC had the least value (115.40mg/kg), while sample DDD had the highest value (117.60mg/kg). The magnesium content do not differ significantly ($p>0.05$). Without magnesium, calcium may not be fully utilized and under-absorption problem may occur resulting in arthritis, menstrual cramp and some premenstrual symptoms (Islamiyat *et al*. 2016).

Iron ranged between 39.14 and 54.30mg/kg. Sample BBB having the least value (39.14mg/kg), while CCC has the highest value (54.30mg/kg). The iron content do not differ significantly ($p>0.05$). Iron is a major compotent of haemoglobin that carries oxygen to all parts of the body. Iron also has a critical role within cells assisting in oxygen cell function (Islamiyat *et al*. 2016).

Sensory Attribute Scores of Biscuit Samples

Sensory attribute score of biscuit sample containing different variesties of eggplant and wheat flour is presented in Table 4. The colour rating ranged between 7.00 and 8.20. Sample CCC has the highest (8.20), while BBB has the least (7.00). The colour of the biscuit samples do not differ significantly ($p>0.05$). Colour is a vital quality attribute of food and plays an important role in sensory and consumer acceptance of products (Purlis, 2010). The colour changes may be due to Millard reactions that occur during biscuit baking. The result obtained in this study is similar to the result obtained by Charity *et al*., (2019) on colour rating in eggplant powder (6.40 – 7.48).

The aroma ranged from 6.990 to 8.00. The sample AAA (control) had the highest (8.00), while sample DDD had the least (6.90). This is in line with the report of Charity *et al*. (2019) on eggplant poweder. Incorporation of eggplant into the biscuit reduced the aroma content of the biscuits. Flavour is the main criteria that makes the product to be liked or disliked (Abu-Salem and Abou-Arab, 2011). The sensations of taste and smell are functions of flavour which is a complex of sensations (Iwe, 2007). Food flavour according to Ihekoronye and Ngoddy (1985) arises from a subtle interaction of taste and aroma, which imparts a pleasing and displeasing sensory experience to a consumer.

Table 4. Sensory Attribute Scores of Biscuit Samples

SAMPLE CODE	COLOUR	AROMA	TEXTURE	TASTE	OVERALL ACCEPTABILITY
AAA	8.10±0.74[a]	8.00±0.94[a]	7.90±0.99[a]	8.50±0.53[a]	8.12±0.63[a]
BBB	7.00±0.81[b]	7.10±0.87[b]	7.00±0.66[b]	7.00±0.81[b]	7.02±0.63[b]
CCC	8.20±0.92[a]	7.70±0.82[ab]	8.00±0.66[a]	8.20±0.78[a]	8.05±0.64[a]
DDD	6.90±0.99[b]	6.90±0.94[c]	7.30±0.82[ab]	7.00±0.82[b]	7.02±0.68[b]

Mean ± standard deviation of three replicate; mean values with the same superscript letter within the same column do not differ significantly (p> 0.05)

KEY

AAA = Control (Fibre Active Biscuit).
BBB = *SolanumAethiopicum* 30%, Wheat 70%.
CCC = *SolanumIncanum* 30%, Wheat 70%.
DDD = *SolanumMolengena* 30%, Wheat 70%.

The texture of the biscuit ranged from 7.00 to 8.00. Highest was observed in Sample CCC (8.00), while sample BBB has the least (7.00).this finding was not agreement of charity et al 2019, who reported on eggplant powder (4.72 - 5.88).The addition of eggplant increase the texture of the biscuit. Texture is a very important quality characteristic which makes a significant contribution to the overall quality acceptance of food products.

The taste ranged between 7.00 to 8.50%. Commercial biscuit had the higher score value (8.50), while the lower score value (7.00) was observed in biscuit with eggplants. No significant difference (p> 0.05) was observed in the taste of sample BBB and DDD had the least value (7.00).these may be due to addition of eggplant, the sense of taste provide to its ingestion and uptake into the body (Iwe, 2007). The overall acceptability score was higher in the commercial biscuit (8.12) sample AAA, and rated lower in biscuit with eggplant (7.02%). Enriched biscuit could be rated lower as a result of addition eggplants which could reduce the palatability.

CONCLUSION

This study shows that high nutrient biscuit can be produced from wheat and eggplant (*Salanum aethiopicum S. incanum, S. molengena*) flour, the biscuit is capable of increasing the protein and fibre content which can help in some health conditions. The inclusion of wheat in the biscuit improved the protein content which serves as a relief of malnutrition as well as good source of iron, calcium, fibre which can help to reduce the risk of heart disease. The incorporation of sample CCC *Solanum Incanum* 30% and Wheat 70%. Would helped to improve the proximate, minerals anti-nutrient properties.

This could serve as an easiest means of tackling and reducing micronutrient deficiency such as calcium, iron, among others and improve health status of the vulnerable groups. The research work had shown the potential of developing proteineous and high fibre biscuit in order to increase the nutritional quality of biscuit consumed so as to help in lowering heart disease, regulating blood pressure, prevent constipation and aids digestion.

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