QUALITY EVALUATION OF BISCUITS MADE FROM AMARANTHUS SEED (*Amaranthusspp*) AND TIGER NUT (*Cyperusesculentuslativum*) FLOUR BLEND.

ABSTRACT

This study investigated the production of flour and biscuit from blends of amaranth grain and tiger nutflours.The blend biscuits produced were analyzed for chemical composition properties. The tiger nut was substituted into amaranth grain flour at 5, 10, 15, 20 and 25% to produce amaranth grain-tiger nut flour blend which was used with other ingredients (fat, salt, baking powder and sugar) baked at 160^{o}C to produce amaranth grain-tiger nut biscuits. The chemical composition, physical and sensory properties of the biscuit were determined (AOAC 2012). The moisture, protein and carbohydrate content of the blend biscuit decreased from 9.38 to 8.58, 18.90 to 16.68 and 59.97 to 58.17 %, respectively, with the increase in added tiger nut (0 to25%). The fat, fibre and ash content of the blend biscuit increased from 6.87 to 10.41, 2.22 to 3.23 and 2.26 to 2.99% respectively with increase in added tiger nut flour. The flavonoids, lycopene, β-carotenoid and total carotenod content result increased from 2218.60 to 2277.60, 0.22 to 1.47, 0.93 to 2.23 and 12.79 to 27.19 mg/100g respectively, with increase in added tiger nut flour. The blend biscuit (25% tiger nut) had the highest values of fat, crude fibre and ash (10.41, 3.23 and 2.93%). The tiger nut incorporation had significant effects and could contribute to the improvement of the flour blend biscuits properties. The addition of tiger nut flour to amaranth seed flour in the production of biscuits has relativelyimproved the nutrient contents, particularly the fibreand phytochemicals (flavonoids, lycopene and β-carotenoid). Also the crispiness of the blend biscuit was greatly improved. The biscuit was accepted up to 25% of the tiger nut flour.

Key Words: Evaluation, Biscuits, cream coloured amaranth, tigernut

INTRODUCTION

Africa and indeed most tropical and sub-tropical countries are blessed with numerous seeds and nuts, which can be converted to flour productsbut manyare yet to be fully exploited. Cereal is any grass cultivated for the eatable component of its grain, botanically a type of fruit called caryopsis, which composes of the endosperm, germ and bran (IDRC, 2016). Exampleof examples includes wheat, barley, millet, oats, rye, fonio (Prod STAT, 2020). Cereal flour is the main ingredient of bread, which is a staple food for most cultures (IDRC, 2016).Wheat flour is unique among the cereals grain flours in that, when mixed with water, its protein component forms an elastic network capable of holding gas and developing a firm spongy structure during baking (Hazelton and walker, 1996).

Biscuits are a popular foodstuff consumed by a wide range of populations due to their varied taste, long shelf life and relatively low cost. Biscuit is a well-known product categorized as miscellaneous food product. It consists of three major components: flour, sugar, and fat, which compose biscuit dough and influence the quality of the final product (O'briena et al.,2003)

Tiger nut (*Cyperusesculentus*) is a tuber, mainly grown and harvested in Spain, West African countries like Nigeria, Senegal, or Ghana, and also in South America, as in Chile (De Castro *et al 2015*;Sánchez-Zapata *etal.,* 2012). From an economic point of view, tiger nut is described as an underutilized African crop with high potential for development (Bamishaiye and Bamishaiye, 2011). Because of its ecological plasticity and its invasive capacity, this plant is considered as a weed or a crop depending on the purpose its grown (De Castro *etal.,*2015). In West Africa, the tubers are often part of the diet as they are cheap, available all the year around, and have nutritional benefits (Bamishaiye and Bamishaiye, 2011). Recent market changes show how innovative tiger nut based beverages are rising around the Europe and this tuber is becoming popular in the United State of America (VanWyk, 2011).

Three varieties (Black, brown and yellow) are cultivated in Nigeria and among these, only two varieties (yellow and brown) are readily available in the market. The yellow variety is preferred over all other varieties because of its inherent properties like its bigger size and attractive colour (Bamishaiye and Bamishaiye, 2011). The yellow variety also yields more protein and possess less anti-nutritional factors especially polyphenols (Okafor *et al.,* 2003). Tiger nut is used in the production of refreshing purely natural milk. The tiger nut milk originated from Spain where it is known as *Chufa de horchata*while it is commonly called *kunnuaya*in Northern Nigeria (Udeozor, 2012).

Tiger nut produces high quality oil of up to about 25.5% fatcontent and 8% of protein (Adejuyitan, 2011). The protein in tiger nut is of high biological value 5.04–6.67% wet matter considering the many essential amino acids it contain (Sánchez-Zapata *etal.,*2012). These amino acids ranged from 29% for leucine to 87% for methionine plus cysteine for infant's/pre-school children, and 31% to 102%,respectively, for adults are higher than those proposed in the standard by the FAO/WHO (Akubor, 2004) and satisfy amino acid requirements of adults (Bosch *etal.*, 2003). Tiger nut has been reported to be an excellent source of some useful minerals (iron, calcium phosphorus, potassium, sodium, magnesium, zinc and traces of copper) and vitamin E that are essential for body growth and development (Oladeleand Aina, 2007).

Tiger-nut was also reported to have high content of oleic acid with positive effect on cholesterol level due to high content of vitamin E. The nut was found to be ideal for children, elderly and sports person (Martinez, 2003). They have been reported to be used in traditional medicine for treatment of indigestion, flatulence, diarrhea, dysentery and excessive thirst (Jaiyeoba and Opayemi, 2016).

Amaranth (*Amaranthus)*is a herbaceous annual plant with upright growth habit, cultivated for both its seeds which are used as a grain and its leaves which are used as a vegetable or green. Both leaves and seeds contain protein of an unusually high quality(Berkelaar and Alemu, 2008).Amaranth is a self-pollinated crop with wide variation in genotype due to varying amounts of out crossing and frequent interspecies and inter-varietal hybridization (Ray and Roy, 2009). Itwasrediscovered a most promising plant genus that may provide high-quality protein, unsaturated oil, and various other valuable constituents (Venskutonis and Kraujalis, 2013). Leaves of both thegrain and the vegetable types may be eaten raw or cooked (Berkelaar and Alemu, 2008). A partial replacement for wheat flour in food formulations with amaranth flour15% amaranth flour in the blend revealed the significant positive difference compared with wheat flour alone (Ayo, 2001).Owing to their significant starch, protein and lipid content, amaranth seeds can be considered as apromising raw material for the production of flour, starch and protein.

Amaranth contains 62% starch, 17% protein (Silva-Sanchez*et al*., 2008), 9-16% dietary fiber (Stalknechtand Schulz-Schaeffer, 1993) and are considered to be a good source of B vitamins and minerals (Gamel*et al*., 2014).Amaranth seeds being a good source of high-quality proteins are a valuable raw material for the preparation of protein concentrates. Consideringthe amino acid profile, amaranth contains a high content of the amino acid lysine (Garuda, 2004). Crude fat content in amaranth seed varies greatly as different scholars have reported different ranges, all these range from 4 -19.3% (Venskutonis and Kraujalis, 2013; Becker *et al*., 1981; Shevkani*et al*.,2014), However, it has more protein than maize, and the protein is of an unusually high quality (high in the amino acid lysine, which is the limiting one in cereals like maize, wheat and rice).

In recent years, researchers have investigated the physical, chemical and functional properties of various seedsand flours.This study is aimed at determining the physical and sensory properties of three varieties of amaranth grain flour-tiger nut flour blend biscuit.The objective of this study was to determine thequality evaluation of biscuits from cream coloured amaranth seed and tiger nut flour blend.

MATERIALS AND METHODS

Amaranth grains (*Amaranthusspp*) were purchased from a local market in Kaduna, while tiger nut (*Cyperusesculentuslavitum*) were purchased from Wukari new market in Taraba state, Nigeria. Baking powder, baking fat, sugar and salt were also purchased fromWukari new market in Taraba state.

Preparation of Raw Materials

Amaranth and Tigernut flour: According to the description by Ayo *et al* (2007), amaranth grains were cleaned manually by handpicking the chaff and dust, stones were removed by washing in clean water (sedimentation). The washed and stone freed grains were oven dried at 45℃ for 3hours and then milled using milling machine (model R175A). The flour was sieved using (0.3mn aperture) sieve, packed (polyethylene) and stored under room temperature.

The tiger nuts were cleaned, sorted, washed, drained, dried in an oven and grounded into flour. The flour samples were passed through a 45 µm mesh size sieve and stored at 4ºC until further use

Composite Flour Preparation: Tiger nut and amaranth flourswere mixed at different proportions (5, 10, 15, 20, 25 and 30 %) while one hundred percent (100%) amaranth flour and wheat was used as the control. The flours were thoroughly mixed using a Kenwood blender into a uniform blend (Ayo and Gidado 2017).

ANALYTICAL METHODS

Determination Proximate Composition

The flours and the most acceptable biscuitswere analyzed for proximate:- moisture, crude protein, ash, crude fat, carbohydrate content and crude fiber.

Moisture Content: Determined as described by AOAC (2012) methods. A two (2.0) gram of sample was accurately weighed into a previously dried and weighed glass crucible. It was then dried in a thermostatically controlled forced convection oven (Gallenkamp, England) at 50°C for 18 hours. The glass crucibles were removed and transferred into desiccators for cooling and weighed. Moisture content was determined by difference and expressed as a percentage.

$$\% \text{ Moiture content (M)} = \frac{W2 - W3}{W2 - W1} \times 100$$

W1 = Initial weight of crucible

W2 = Weight of crucible + sample before drying

W3 = Weight of crucible + sample after drying

Ash Content: A two (2.0) gram of sample was accurately weighed into a pre-ignited and previously weighed crucible, placed in a muffle furnace (Gallenkamp, England) and heated for 2 hours at 600^{o}C. After ashing, the crucibles were cooled below 200^{o}C in a furnace for 20 minutes and further cooled to room temperature in a desiccator. The crucibles and their contents were weighed, and the weight was reported as percentage ash content (AOAC, 2012)

$$\% \text{ Ash (dry basis)} = \frac{W3 - W1}{W2 - W1} \times 100.$$

Where:
W1 = Initial weight of empty crucible
W2 = Weight of crucible + sample before Charring and ashing
W3 = Weight of crucible + white ash

Crude fatContent: A two (2.0) gram of sample was transferred into a paper thimble plugged at the opening with glass wool to evenly distribute the solvent as it drops on the sample during extraction and placed into a thimble holder. The sample packet was placed in the butt tubes of the soxhlet extraction apparatus. The extraction flask was placed on an oven for about 5min at 110°C then cooled and weighed. The fat was extracted with petroleum ether for 2-3hours by gentle heating. The extraction flask was dismantled and allowed to cool. The ether was evaporated on steam or water bath until no odour of ether remains. It was then allowed to cool to room temperature and the extraction flask and its extract were recorded (AOAC, 2012).

$$\% \text{ Fat} = \frac{(W2 - W1) \times 100}{W}$$

Crude Fibre Content: The sample from the crude fat determination was transferred into a digestion flask. A 200ml of boiling sulphuric acid (H_2SO_4) solution and anti- foaming agent (asbestos) was added to the flask and immediately connected to a digestion flask with a condenser and heated. The sample was boiled for 30 min during which the entire sample was allowed to become thoroughly wetted while any of it was prevented from remaining on the sides of the flask and out of contact with the solvent. After 30 min, the flask was removed; its contents filtered through linen cloth in a funnel and washed with boiling water until the washings were no longer acidic. The sample with asbestos was washed back into the flask with 200 ml boiling sodium hydroxide (NaOH) solution. The flask was reconnected to the condenser and boiled for 30 minutes. The content were again filtered through linen cloth in a funnel and washed thoroughly with boiled water, then with 15ml of 95% ethanol. The residue was transferred into previously dried and weighed porcelain, in an oven at 110^{o}C to a constant weight. It was then cooled in a desiccator and weighed. The crucible and its contents were ignited in a muffle furnace at 550^{o}C for 30 min until the carbonaceous matter has been consumed. Cooled in a desiccator and weighed (AOAC, 2012).

% Crude fibre = the loss in weight after incineration x 100.

Protein content: The protein content of the samples was determined according to AOAC (2012). Half (0.5) gram of a finely grounded samples were weighed into a digestion flask and one kjeldahl catalyst tablet was added, 10ml of conc. H_2SO_4 was added and digested for 4 hours until a clear solution is obtained. The digest was cooled and transferred into 100ml volumetric flask and made up to mark with distilled water. 20ml of boric acid were dispensed into a conical flask and 5 drops of indicator and 75ml of distilled water was added to it 10 ml of the digest were dispensed into Kjedahl distillation flask, the conical and the distillation a flask were fixed in place and 20ml of 2% NaOH was added through the glass funnel into the digest. The steam exit was closed and timing started when the solution of the boric acid and indicator turned green. The distillation was done for 15 minutes and the distillate was titrated with 0.05NHCl.

%Total Nitrogen = Titre Value x Atomic mass of nitrogen × Normality of HCl used ×4

Therefore, the crude protein content is determined by multiplying percentage Nitrogen by a constant factor of 6.25 .

i.e. %crude protein = %N x 6.25.

Carbohydrate Content: Carbohydrate content was obtained by the difference: 100 - (MC + Ash + Crude protein + Fat + Crude fibre(Obinna-Echem and Robinson, 2019).

Determination of Phytochemical compositions

Flavonoids: The total flavonoids content of sample was estimated by aluminium chloride colorimetric method as described by Hossain *et al.* (2011).0.5mL of sample was taken in a test tube and added water (10mL) and 5% sodium nitrate (0.5mL) were mixed together then 10% aluminium chloride (0.3mL) was added into the test tube and kept for 10 min for complete reaction. Finally, 5% sodium hydroxide (1 mL) and distill water (10 mL) was added to the test tube. The absorbance was measured at a fixed wavelength 510 nm (UV/VIS spectrophotometer T60U, Leicestershire, UK). The estimation of total flavonoid content in sample was carried out in duplicate and the results was averaged. The total flavonoids were calculated using equation6.

X= (A. mo) / (Ao. m).............6

Where “X” is the flavonoid content, mg/g plant extract, “A” is the absorption of plant crude extract solution, “Ao” is the absorption of standard quercetin solution, “m” is the weight of crude drug extract in mg and “mo” is the weight of quercetin in the solution in mg.

Total carotenoids: The chlorophyll*a*, chlorophyll*b*and total carotenoids will be determined by the method described by Branisa*et al.*,(2014). Acetone-water mixture (4:1,v/v) will be used as a solvent. Theabsorbance maxima were read at 663.6 nm for chlorophyll*a*, 646.6 nm for chlorophyll*b*and470.0 nm for carotenoids. Contents of chlorophyll*a*, chlorophyll*b*and total carotenoids will be calculated using Equations 1, 2 and 3 respectively

$$\text{chlorophyll a}\ (\mu g/ml) = 12.25\text{A}_{6636} - 2.25\text{A}_{6466} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

$$\text{chlorophyll b}\ (\mu g/ml) = 20.31A_{6466} - 4.91A_{6636} \text{...}2$$

$$\text{total carotenoids}\ (\mu g/ml) = \frac{1000A_{470} - 2.27\ (\text{chl a}) - 81.4\ (\text{chl b})}{227} \text{....................}3$$

β-carotene and lycopene: The β-carotene and lycopene contents of the blend biscuitwere determined according to the methods described by Branisa*et al*. (2014). One gramweight of the blend biscuit will be homogenized with 10 mL of an acetone–hexane mixture (2:3) for 2 mm to uniform mass. Homogenates will be centrifuged at 5000 rpm for 10 minutes at 20 °C. The absorbance spectrum of each supernatant will be measured and the absorption maxima will be read at 453, 505, 645 and 663 nm (UV/VIS spectrophotometer Cary 50 Scan).β-carotene and lycopene content will be calculated using Equations: 4 and 5

$$\beta - \text{carotene} \frac{mg}{100ml} = 0.216A_{663} - 1.22A - 0.304A_{505} - 0.452A_{453} \text{..........................}4$$

$$lycopene(\mu g/100\text{ml}) = -0.0485A_{663} + 0.372A_{505} - 0.086_{453} \text{.................................}5$$

where A = absorbance.

Determination of Anti-nutritional factors

Alkaloids : This was done by the alkaline precipitation gravimetric method as described by Harbone (1973). Five grams (5 g) of the samples was weighed into 50 ml of 10% acetic acid solution in ethanol in a 250 ml beaker. The mixture was shaken and allowed to stand for 4 hours. The mixture was then filtered with Whatman No.42 filter paper. The filtrate was concentrated to one quarter of its original volume by evaporation using a steam bath.

Alkaloid in the extract was precipitated by drop-wise addition of ammonium hydroxide (NH_4OH) until full turbidity was obtained. The alkaloid precipitate was recovered by filtration using a weighed filter paper, and washed with 1% ammonia solution (NH4OH), dried in the oven at 80ºC for 1 hour. It was later cooled in a desiccator and reweighed. By weight difference, the weight of alkaloid was determined and expressed as a percentage of the sample analyzed, using the formula.

% Alkaloid = <u>W2−W1</u>× <u>100</u>

W 1

Where:

W = weight of sample

W1 = weight of empty filter paper

W2 = weight of paper + alkaloid precipitate

Phytates: The phytate content was determined according to the method described by Latta and Eskin (1980) later modified by Vaintraub and Lapteva (1988).0.5g of sample was extracted with 10ml 2,4% HCL for 1hr at ambient temperature and centrifuged (3000 rpm) for 30min. The clear supernatant was used for phytate estimation.1ml of wade reagent (0.03% solution of $FeCl_{3.}$ $6H_2O$ containing 0.3% sulfosalicylic acid in water) was added to 3ml of the sample solution and the mixtures were centrifuged.The absorbance at 500nm was measured using UV-VIS spectrophotometer. The phytate concentration was calculated from the difference between the absorbance of the control (3ml of water + 1ml wade reagent) and that of assayed sample. The concentrated of phytate was calculated using phytic acid standard curve and result were expressed as of phytic acids in mg per 100g dry weight. To prepare the phytic acid standard curve, a series of standard solution were prepared containing 5-40mg/ml phytic acid in water. 3ml of standards was pipetted into 15ml centrifuge tubes with 3ml of water used as a zero level. To each tube 1ml was added of the wade reagent, and the solution was mixed using a vortex mixer for 5s. The mixture was centrifuged for 10min and the supernatant read at 500nm by using water as a blank. By plotting the calibration curve (absorbance vs concentration) and one can find out the slope and intercept. The phytate content of the blend biscuitwere calculated using the following relation:

$$\text{Phytate (mg/100g)} = \frac{(Absorbance - intercept) \times 10}{(Slope \times density \times wt.sample) \times 3}$$

Physical Properties

Spread Ratio: The spread ratio was calculated by method described by Ayo *et al.*,(2007).The length and height of three rows and column were measured respectively of four well-formed biscuits. The spread ratio was calculated as diameter divided by height.

Weight: The weight of the tiger nut-amaranth seed composite biscuit was determined by weighing on an electronic weighing balance (Mettler PF160 Balance, Switzerland) (Ayo *et al.*, 2007).

Diameter and Thickness: The tiger nut-amaranth seed composite biscuit diameter and thickness were determined using venire calipers (Ayo *et al.*, 2007).

Breaking Strength: Breaking strength of tiger nut-amaranth seed composite biscuit was determined using the method described by Ayo *et al.*,(2018). Biscuit sample of 0.4cm and 5-20mm thickness respectively was placed centrally between two parallel metal bars (3cm apart) and weights were applied until the biscuit snapped. The least weight that caused the breaking of the biscuit was regarded as the break strength of the biscuit and bread.

Volume: The volume of the amaranth-tiger nut composite biscuit was determined using the formula.

$$V=\pi r^2 h$$

Sensory Evaluation

The sensory evaluation of the tiger nut-amaranth seed biscuits was carried out by twenty untrained panellists, randomly selected from (Department of Food Science and Technology Federal University Wukari, Nigeria) based on their familiarity with the biscuit. The biscuits appropriately coded (MVP, RPG, DMX, 3PG, HTM, CDS, 3ML and 2DX) and of the same size and temperature (29 ± 30℃) were placed in white plastic plates separated by compartment and placed in sensory laboratory. The panellists were instructed to evaluate the coded samples for colour, crispiness, aroma, taste, texture, and general acceptability. The panellists rinsed their mouths with bottled water after tasting each sample and were not allowed to make comment during evaluation to prevent influencing other panellist. A nine-point Hedonic scale with one (1) representing "extremely dislike" and nine (9) "extremely like" was used, presented as a questionnaire. The qualities assessed were color, texture, flavour, taste, crispness and general acceptability as described by(Ayo *et al*., 2018).

Statistical Analysis

Data will be expressed as mean ± standard deviations of triplicate scores. The significant differences between the groups will be assessed by two-way analysis of variance (ANOVA)and Duncan Multiple Range Test will be used to separate the means at $p < 0.05$. These will be done using the Statistical Package for Social Science (SPSS) software version 20. Microsoft excel (2007) will be used for plotting graphs.

RESULT AND DISCUSSION

Proximate Composition of Amaranth-Tiger nut Flour Blend

The result of proximate composition is given in Table 1 below. The moisture content, protein content, carbohydrate ranged from 8.58 to 9.38, 16.68 to 18.90, 58.17 to 59.97 %, with decreasing amaranth substitution using tiger nut from 0 to 25%. The fat, fibre and ash contents ranged from 6.87 to 10.41, 2.22 to 2.23, and 2.66 to 2.99 and increased with increasing tiger nut flour addition from (0 to 25%). The result are significant($p=0.05$).

The moisture content of the blend biscuit decreased with increase in added tiger nut flour which could be due to the low fiber content of amaranth seed flour when blended with tiger nut. The moisture content is lower than that of wheat biscuit.The moisture content of black coloured amaranth biscuit (15%) is higher than that of cream coloured amaranth biscuit.   This could mean stability and shelf life quality as reported by Ayo *et al.*,(2018).

The decrease in crude protein content with increasing tiger nut flour addition, recorded were found to be similar to the report of Ayo *et al*., (2018) and Ade-Omowaye*et al.,* (2008). The increase could be attributed to the low protein content of tiger nut as reported by Oladele and Aina, (2007). The 100% amaranth flour had the highest content of protein (18.90%) while the 25% amaranth tiger nut flour blend had the least (16.68%). This findsconforms to the earlier work of byAyo *et al*., (2018) and Ade-Omowaye*et al.,* (2008).

The fat content of the blend biscuit increased from 6.87 to 10.41% with increase in added tiger nut flour. The increase fat may be due to the higher level of fat (32.13%) in tiger nut as reported by Oladele and Aina, (2007). A fat content of 7.7 to 17.73 was reported by Ade-Omowaye*et al.*, (2008) and 13.57 to 17.54 % by Ayo *et al*., (2018) respectively with increase in tiger nut substitution.The fat values obtained from the composite blend samples in this study are highercompared to 100% wheat. Fat is a good carrier of fat soluble vitamins promoting the absorption of vitamin A and carotenoids (Bogert *et al*.,1994).

The crude fibre content of the flour blend biscuit increase from 2.22 to 3.23% with increase in added tiger nut flour (0 to 25%). The black colouredamaranth had 2.66 % fibre content and lower than that of cream colour(2.83%) at the same level of substitution (15%) which agreedwith the findings Schnetzler and Breene(1994).The increase in in fibre content could be as a result of the high fibre content of tiger nuts reported by –Suarez*et al* (2003).Dietary fibre is reported to have some beneficial effects on the muscles of small and large intestine, which include emptying of bowl and slow glucose absorption (Ayo *et al.,* 2018).The ash contentflour blend biscuit increased from 2.66 to 2.93% with increase in addedtiger nut flour.

The carbohydrate content of the flour blend biscuit on the other hand slightly decreased (59.97 to58.17%) with increasing tiger nut flour (0 to 25%). Akujobi (2018) reported decrease in carbohydrate from 70.23 to 59.51 for cocoa yam- tiger nut flour blend.Different products;-baggia and pan cakes could be produced from composite of amaranth and it showed decrease which may be due to composite formulation and reduction in nutrient prior to processing; baggia (39%)and pan cakes (22.65%)Muyonga*et al*.,(2014). The high amount of carbohydrate shows that the products are good source of energy (Ayo and Gidado, 2017).

Table 1: Proximate composition of Cream coloured amaranth seed – tiger nut flour blend biscuits

Materials	Proximate composition (%)					
Amaranth:Tiger nut	Moisture	Protein	Fat	Crude fibre	Ash	Carbohydrate
100:0	$9.38^{a}\pm1.41$	$18.90^{a}\pm1.41$	$6.87^{b}\pm1.41$	$2.22^{a}\pm1.41$	$2.66^{a}\pm1.41$	$59.97^{a}\pm7.07$
95:5	$9.15^{a}\pm1.41$	$18.44^{a}\pm1.41$	$7.98^{a}\pm2.12$	$2.42^{a}\pm1.41$	$2.68^{a}\pm1.41$	$58.35^{a}\pm4.95$
90:10	$9.222^{a}\pm1.41$	$17.73^{a}\pm1.41$	$8.09^{a}\pm1.41$	$2.62^{a}\pm1.41$	$2.73^{a}\pm1.41$	$59.46^{a}\pm5.66$
85:15	$9.08^{a}\pm1.41$	$17.52^{a}\pm1.41$	$8.69^{a}\pm1.41$	$2.83^{a}\pm1.41$	$2.92^{a}\pm1.41$	$59.09^{a}\pm5.66$
80:20	$8.83^{a}\pm1.41$	$17.06^{a}\pm1.41$	$9.80^{a}\pm2.12$	$3.02^{a}\pm1.41$	$2.86^{a}\pm1.41$	$58.42^{a}\pm6.36$
75:25	$8.58^{a}\pm1.41$	$16.68^{a}\pm1.41$	$10.41^{a}\pm2.12$	$3.23^{a}\pm1.41$	$2.93^{a}\pm1.41$	$58.17^{a}\pm6.36$
Wheat (100 %)	$10.30^{a}\pm1.41$	$10.71^{b}\pm1.4$	$3.54^{b}\pm1.41$	$1.80^{a}\pm1.41$	$1.62^{a}\pm1.41$	$72.04^{a}\pm4.25$
Black Amaranth (85:15)	$9.38^{a}\pm1.41$	$17.73^{a}\pm1.41$	$8.09^{a}\pm1.41$	$2.66^{a}\pm1.41$	$2.99^{a}\pm1.41$	$59.12^{a}\pm5.66$

Values are means ± standard deviation of 2 replicates. Means within a column with the same superscript were not significantly different (P>0.05)

Phytochemicals Amaranth-Tiger nut flour Blend

The result of phytochemical composition is shown in Table2. The flavonoid, lycopene, β-carotenoid and total carotenoid content of the blend biscuit increased from 2218.60 to 2277.60, 0.22 to1.47,0.93 to 1.04 and 12.79 to 27.19 mg/100g, respectively with increase (0 to 25%) added tiger nut flour blends respectively. The effect is significant ($p=0.05$).

The increasing flavonoid contentcould be due to the relative high content (236.17 mg/100g)of the same in the tiger nut (Oladele *et al*., 2017). Flavonoids are anti-oxidants, and couldlower cholesterol, inhibit tumor formation, and decrease tumor formation and protect against cancer and heart disease (Adebowale *et al.,*2008).

The β-carotene content of the flour blend increased (0.93 to 1.04 mg/100g)significantly with increasing amaranth substitution with tiger nut flour at $p>0.05$ significant level. The β-carotene of tiger nut flour was 6.13µg/100g (Souleymane *et al*.,(2015).

The total carotenoid of 100% amaranth is within the range similar to (1.69-17.61mg/100g) as reported by Tang and Tsao, (2017). Carotenoids have been proven to improve the recovery of night blindness and loss of appetite (Ayo and Gidado, 2017).

Anti-nutrients composition of Cream colour amaranth seed – tiger nut flour blend

The alkaloid and phytate contents increased from 0.005 to 0.49 %, with increase in added tiger nut (0 to 25%). The increase phytate content of the flour blend biscuit could be due to the relative high content of phytate in tiger nut 1.97 mg/100g tiger nut Chukwuma *et al.*, (2010).Content in light coloured seeds is lower or comparable to the quantity of growth inhibitors in common grain (trypsin inhibitor, phytates, saponins, and tannins), or are heat labile as lectins (Souci *et al*. 1994, Berghofer and Schoenlecher 2002). The relative low content of the anti-nutrient could be said to be of advantage as a phytochemical.

Table 2 :Phytochemical composition of Cream coloured amaranth seed – tiger nut flour blend biscuits

Materials Amaranth:Tiger nut	Flavonoid(mg/100g)	Lycopene(µ/100g)	β-carotenoid (mg/100g)	Total carotenoid(µ/ml)
100:0	2218.60^{b}±686.46	0.22^{f}±0.00	0.93^{a}±0.00	12.79^{f}±0.12
95:5	2232.40^{b}±1.41	0.61^{ec}±0.00	1.19^{a}±0.00	14.20^{e}±0.12
90:10	2241.22±0.02	0.77^{d}±0.00	1.45^{a}±0.00	17.33^{d}±0.10
85:15	2554.40^{b}±1.41	1.00^{c}±0.00	1.71^{a}±0.00	22.34^{c}±0.01
80:20	2265.40^{b}±1.41	1.19^{b}±0.02	1.97^{a}±0.56	25.99^{b}±0.01
75:25	2277.60^{b}±1.41	1.47^{a}±0.00	2.23^{a}±0.01	27.19^{a}±0.02
Wheat (100%)	13635.00^{a}±2498.92	0.37^{g}±0.00	1.04^{a}±0.00	10.06^{g}±0.21
Black Amaranth (85:15)	2260.12^{b}±1.41	0.27^{abc}±0.31	1.35^{a}±0.00	26.06^{b}±0.00

Values are means ± standard deviation of 2 replicates. Means within a column with the same superscript were not significantly different (P>0.05).

Table 3: Anti-nutrients composition of Cream colour amaranth seed – tiger nut flour blend biscuits

Blend Amaranth: Tiger nut	Phytate (mg/100g)	Alkaloid (%)
100:0	$0.005^{g}\pm0.00$	$0.0054^{c}\pm0.00$
95:5	$0.018^{f}\pm0.00$	$0.0064^{c}\pm0.00$
90:10	$0.020^{e}\pm0.00$	$0.0069^{c}\pm0.00$
85:15	$0.029^{c}\pm0.00$	$0.0078^{bc}\pm0.01$
80:20	$0.034^{b}\pm0.00$	$0.0162^{a}\pm0.00$
75:25	$0.049^{a}\pm0.00$	$0.0190^{a}\pm0.00$
Wheat (100 %)	$0.0010^{h}\pm0.00$	$0.004^{c}\pm0.00$
Black 85:15	$0.0044^{a}\pm0.00$	$0.0150^{ab}\pm0.00$

Values are means ± standard deviation of 2 replicates. Means within a column with the same superscript were not significantly different (P>0.05)

Physical Properties of Cream colour Amaranth seed – tiger nut Biscuits

The result of physical analysis of the amaranth-tiger nut biscuits are given in Table 4. The break strength decreased of the flour blend biscuits decreased 3.50 to 1.55 kg, while the volume, diameter and spread ratio increased from 20.40 to 23.65, 5.26 to 5.48, and 5.04 to 5.41 respectively with added tiger nut (0 to 25%). The relative reduction in the break strength though could be a problem in post handling of the biscuit (breakage), but could improve the digestibility of the product, hence the release of the nutrients to the body system.

Sensory Qualities of Cream colour amaranth seed – tiger nut flour blend biscuits

The result of the sensory evaluation is shown in Table 5. The aroma, crispiness, colour, texture, taste and general acceptability ranged from 6.43 to 6.90, 6.27 to 6.63, 5.83 to 6.07, 6.20 to 6.43, 6.60 to 6.63 and 6.37 to 7.23 for 0, 5, 10, 15, 20 and 25%amaranth tiger nut flour blends respectively. The effect is significant increase with increasing amaranth substitution with tiger nut flour at $p>0.05$ significant level. The effect of tiger nut incorporation into the flour blend to produce biscuit had significant effects on the aroma, crispiness, colour, texture, taste and general acceptability. The increase in crispiness could be due to the increasing fibre content which agrees with Ayo *et al*.,(2007). The biscuit having the highest spread ratio are considered more desirable (Chinma*et al*., 2011)

Table 4: Physical properties of Cream coloured amaranth seed – tiger nut flour blend biscuits

Materials	Physical properties				
Amaranth:Tiger nut	Weight (g)	Height (cm)	Diameter(cm)	Spread ratio	Break strength (Kg)
100:0	$20.40^{b}\pm0.28$	$1.05^{d}\pm0.02$	$5.26^{c}\pm0.06$	$5.04^{c}\pm0.06$	$3.50^{d}\pm1.06$
95:5	$20.65^{b}\pm0.21$	$1.08^{d}\pm0.03$	$5.57^{c}\pm0.02$	$5.16^{c}\pm0.14$	$3.29^{d}\pm1.06$
90:10	$20.45^{b}\pm0.70$	$1.03^{d}\pm0.04$	$5.33^{c}\pm0.03$	$5.18^{c}\pm0.18$	$2.85^{d}\pm1.06$
85:15	$21.35^{b}\pm0.49$	$1.02^{d}\pm0.02$	$5.21^{c}\pm0.04$	$5.21^{c}\pm0.05$	$2.37^{d}\pm0.28$
80:20	$20.65^{b}\pm0.70$	$1.08^{d}\pm0.03$	$5.55^{c}\pm0.00$	$5.39^{c}\pm0.22$	$1.75^{d}\pm1.03$
75:25	$23.65^{b}\pm0.77$	$1.05^{e}\pm0.02$	$5.48^{c}\pm0.04$	$5.41^{c}\pm0.21$	$1.55^{d}\pm0.00$
Wheat (100 %)	$19.90^{b}\pm0.57$	$1.03^{d}\pm0.00$	$5.15^{c}\pm0.07$	$5.19^{c}\pm0.70$	$3.00^{d}\pm0.28$
Black Amaranth (85:1)	$13.50^{b}\pm0.21$	$0.85^{e}\pm0.23$	$5.06^{d}\pm0.56$	$5.96^{c}\pm0.98$	$0.90^{f}\pm0.00$

Values are means ± standard deviation of 2 replicates. Means within a column with the same superscript were not significantly different ($P>0.05$)

Table 5: Sensory properties of Cream colour amaranth seed – tiger nut flour blend biscuits

Blend Amaranth:tiger nut	Aroma	Crispiness	Colour	Texture	Taste	General Acceptability
100:0	6.43^{a}±1.72	6.27^{a}±1.98	6.03^{a}±1.92	6.23^{a}±1.74	6.63^{a}±1.78	6.37^{a}±1.43
95:5	6.67^{a}±1.18	6.07^{ab}±1.76	5.50^{b}±1.98	6.23^{ab}±1.72	6.60^{a}±1.57	6.40^{ab}±1.40
90:10	6.53^{a}±1.68	6.03^{a}±1.88	5.83^{a}±1.80	6.10^{a}±2.03	6.37^{a}±1.87	6.53^{a}±1.18
85:15	6.87^{ab}±1.25	6.33^{ab}±1.94	6.07^{b}±1.96	6.43^{ab}±1.92	6.87^{ab}±1.80	7.10^{a}±1.63
80:20	6.88a±1.71	6.53a±1.97	5.90a±1.69	6.20a±1.75	6.60a±1.69	7.17a±9.68
75:25	6.90^{a}±153	6.63^{ab}±1.35	5.83^{b}±1.84	6.42^{ab}±1.82	6.59^{ab}±1.95	7.23^{ab}±2.12
Wheat (100 %)	7.77^{a}±1.41	7.20^{a}±1.49	7.93^{a}±1.28	7.57^{a}±1.70	7.55^{a}±1.70	8.03^{a}±1.27
Black Amaranth 85:15	5.33^{a}±2.35	5.12^{a}±2.17	4.40^{a}±2.31	5.10^{a}±2.17	4.87^{a}±2.49	5.23^{a}±2.65

Values are means ± standard deviation of 2 replicates. Means within a column with the same superscript were not significantly different (P>0.05).

CONCLUSION

The addition of tiger nut flour to amaranth seed flour in the production of biscuit has improvedits nutritionalparticularly with regard to its fat, minerals, fibre and phytochemicals (flavonoids, lycopene and β-carotenoid) content. Also the crispiness of the blend biscuit was greatly improved. The biscuit with 25% tiger nut flour was the most prefered.

REFERENCE

Adebowale A.A., Sanni S.A. and Oladopo F.O. (2008) Chemical, function and sensory properties of instant yam breadfruit flour. *Nigerian Food J*. 26 (1):2-12

Ade-Omowaye B.I., Akinwande B.A., Bolarinwa I.F. and Adebiyi A.O. (2008). Evaluation of tiger nut (Cyperus esculentus) - wheat composite flour and bread. *Afr.J. Food Sci.*, 2: 087-091.

Akubor P.I. (2004) Protein, physical and sensory properties of Nigerian snacks food (cake, chin chin and puff puff) prepared from cowpea wheat flour blends. *Int. J. Fd. Sci. Tech.* 39(4):419-424.

Akujobi I. (2018).Nutrient composition and sensory evaluation of cookies produced from cocoa yam (X*anthosomasagittifoliun*) and tiger nut (*cyperusesculentus*) flour blends. *International journal of innovative food, nutrition and sustainable agriculture*. 6(3):33-39.

AOAC, (2012). (Association of Official Analytical Chemists). Association of official Analytical Chemists, Official Methods of Analysis, AOAC International 19th edn. Washington Dc, 121-130

Ayo J.A. (2001). The effect of amaranth grain flour on the quality of bread. *Int. J. Food Prop*, 4:341-51.

AyoA., Nkama I. and Ibrahim A. (2007). Effect of achaflour on feed intake, body Weight, haematological and nutritional quality ofrabit. *Journal of Research in Bioscience*. 3(3):76-8

Ayo J.A., and Gidado F.E. (2017). Physicochemical, phytochemical and sensory evaluation of achacarrot flours blend biscuit current. *Journal of Applied Science and Technology*.

Article no. CJAST.38142 Previously known as *British Journal of Applied Science & Technology*. ISSN: 2231-0843, NLM ID: 101664541. 25(5):1-15.21

Ayo, J. A., Ojo M.A., Popoola, C.A., Ayo, V. A and Okpasu, A. (2018). Production and quality evaluation of acha-tigernut composite flour and biscuits. *Asian Food Science Journal* 1(3): 1-12

Bamishaiye, E. I. and Bamishaiye, O. M. (2011). Tigernut. As a plant, its derivatives and benefits. *African Journal of Food, Agriculture, Nutrition Development*, 11(5): 5157-5170.

Becker R., Wheeler E.L., Lorenz K., Stafford A.E., Grosjean O.K.and Betschart A.A. (1981). A compositional study ofamaranth grain. *Journal of Food Science,* 46(4):1175-1180.

Berghofer E. and Schoenlenchner R. (2002). Grain Amaranth. In: Belton P, Taylor J (eds.), Pseudocereals and less common cereals, grain properties and Utilization potential. Springer Verlag. pp 219-60

Berkelaar, D. and Alemu, J. (2008). Grain amaranth. ECHO Development Notes 91, ECHO, Florida, pp: 1-5.

Bogert J.L., Briggs GM and Galloway DH. (1994). Nutritional and Physical fitness. *Int. Food Sc. Nutri*.;45:225-230.

Bosch,L., Alegría,A. and Farré, R. (2005). RP-HPLC Determination of Tiger Nut and Orgeat Amino Acid Contents: *SAGE Publications.Fd Sci.Tech.Int.*11:33-40.

Branisa,J.,Jenisowa, Z., Porubska, M., Jomova, K. and Valko, M. (2014). Spectrophotomeic Determination of Chlorophylls and carotenoids, an effect of sonication and sample processing. *Journal of Microbiology, Biotechnology and Food Science*. 3(2):61-64.

Chinma C.E., Adewuyi A.O. and Abu J.O. (2011). Effect of germination on the chemical, functionaland pasting properties of flour from brown and yellow varieties of tigernut. *Fd. Res. Int*.; 42 (8):1004-1009

Chukwuma E.R., Obioma N. and Christopher OI. (2010).The phytochemical composition and somebiochemical effects of Nigeria Tiger nut Tuber. *Pakistan Journal of Nutrition*. 9(7):709-715.

De Castro, O., Gargiulo, R., Del Guacchio, E., Caputo, P. and De Luca, P. A molecular survey concerningtheoriginofCyperusesculentus(Cyperaceae, Poales): Two sides of the same coin (weed vs. crop).Ann. Bot.2015,115, 733–745.

Gamel T.H, Linssen J.P, Messallem A.S, Damir A.A and Shekib L.A. (2014). Effect of seed treatments on thechemical composition of two amaranth species: oil, sugars, fibres, minerals, and vitamins. *Journal of the Science of Food and Agriculture,* 86:82-89.

Harborne, J. B. (1973).PhytochemicalMethods.ChapmanandHallLtd.,Londonpp.49-188.

Hossain MA, Muhammad MD, Charles G, and Muhammad I. (2011). In vitro total phenolics, flavonoids contents and antioxidant activity of essential oil, various organic extracts from the leaves of tropical medicinal plant Tetrastigma from Sabah. *Asian Pacific Journal of Tropical Medicine*, 4(9): 717-721.

IDRC - International Development Research Centre". Archived from the original on 9 June 2016.

Jaiyeoba, K.F. and Opayemi, T.A. (2016). Development and nutrient assessment of maize based food fortified with tiger nut tuber (Cyperus esculentus). The International Journal of Science &Technoledge 4(10) 189-194

Latta, M., and M. Eskin. (1980). A simple and rapid colorimetric determination of phytate determination. *J. Agric. Food Chem*. 28:1313–1315.

Martinez V (2003). Scientific analysis of effects of tiger nut on heart diseases and related aspectsIn:Tiger Nut and Health.

Muyonga, J.H., Andabati, B. and Ssepuya, G. (2014). Effects of heat processing on selected grain amaranth physico-chemical properties.*Food Science and Nutrition,* 2, (1) 9-16. *Doi*, 10.10002/*fsn* 3-75.

Obinna-Echem,P.C.andRobinson,E.S.(2019).Proximatecomposition,physicalandsensory propertiesofbiscuitsproducedfromblendsofmaize(Zeamays)andtigernut(Cyperus esculentus)flour.*SkyJournalofFoodScience*,7(2):030-036.

O'Briena C.M., Chapmanb D, Neville D.P., Keogh MK and Arendt E.K. (2003). Effect of varying the micro-encapsulation process on *TheNigerian Journal of Nutritional Sciences* Vol. 32 No. 1 March 2011 61 functionality of hydrogenated vegetable fat in short dough biscuits. Fd. Res. Int.;36:215–21

Oladele, A. K. and Aina, J. O. (2007). Chemical composition and functional properties of flour produced from two varieties of tigernut (*Cyperusesculentus*). *African Journal of Biotechnology*, 6(21): 2473-2476.

ProdSTAT. FAOSTAT. Archived from the original on 10 February 2012. Retrieved 9 July 2020.

Ray, T. and Roy, S.C. (2009). Genetic diversity of Amaranthus spices from Indo- Gagetic plains reveled by RAPD analysis leading to development of ecotype-specific SCAR marker, J. Hered, 100 (3), 338-47. Doi 10.1093/jhered/esn 102.Eup 2008 Dec.

Sánchez-Zapata, E., Fernández-Lopez, J. and Pérez-Alvarez, J. A. (2012). Tigernut (*Cyperus esculentus)* commercialization: Health aspects, composition, properties and food applications. *Comprehensive Reviews in Food Science and Food Safety*, 11: 366-377.

Schnetzler KA and Breene WM (1994). Food uses and amaranth product research: a comprehensive review. In:PeredesLópez O (ed), Amaranth biology, chemistry and technology. CRC Press, Boca Raton, FL, 155-84.

Shevkani, K., Singh, N., Rana, J. C. and Kaur, A. (2014). Physicochemical, pasting and functional properties of amaranth seed flours: Effects of lipid removal. *Journal of Food Science,* 79 (7): 1271-1277.

Silva-Sanches C, Barbadela Rosa AP, Leon-Galvan MF, de Lumen BO, de Leon-Rodriguez A, and deMejìa E. (2004).Bioactive peptides in Amaranth (*Amaranthushypochondriacus*) seed. *Journal of Agricultural and Food Chemistry*, 56:1233-1240.

Stallknecht, G.F. and Schulz-Schaeffer, J.R. (1993). Amaranth rediscovered. pp; 211-218. J. Janick and J.E Simon (eds.). New crops. Wiley, New York.

Souci S.W., Fachmann W. and Kraut H.(1994). Food composition and nutrition tables, 5threvised andcompleted edition. Medpharm, Stuttgart Medpharm GmbH, Scientific Publishers, Stuttgart and CRC Press, Boca Raton, FL.23

Souleymane, B., Patrice, B., Gouyahali S., Moe Thida K. Brian P. and Stephen N.(2015). "Physiochemical characteristic and composition of three morphotypes of ceyperus esculentus tubers and tuber oils. *Jounal of analytical methods in chemistry*, vol. 2015. 10.155/2015/673547

Tang Y, and Tsao R. (2016). Phytochemicals in quinoa and amaranth grains and their antioxidant, anti-inflammatory, and potential health beneficial effects: a review. *MolNutr Food Res.* Jul;61(7). doi: 10.1002/mnfr.00767. Epub 2017 Apr 18. PMID: 28239982.

Udeozor, L. O. (2012). Tigernut-soy milk drink: Preparation, proximate composition and sensory qualities. *International Journal of Food Nutrition and Science*, 1(4): 18-26.

Van Wyk, B.E. (2011). The potential of South African plants in the development of new food and beverage products.*S. Afr. J. Bot.*77, 857–868.

Vaintraub, I.A., and N.A. Lapteva. (1988). Colorimetric determination of phytate in unpurified extracts of seeds and the products of their processing. Anal. Biochem. 175:227–230.

Venskutonis, P.R. and Kraujalis, P. (2013). Nutritional components of Amaranth seeds and vegetables: A Review on composition, properties and uses. Comprehensive Reviews in Food Science and Food Safety, 12 (4), 381–412. doi:10.1111/1541-4337.12021.

WalkerC.E. Aand HazeltonJ.L. (1996). Doughrheological tests. Cereal Foods World, 41,23-28