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Potentials of African Nutmeg (*Monodora myristica*) as a Flavourant in Cookie Production

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Abstract

African nutmeg, a possible local substitute for a commercial food flavourant, remains largely underutilized in Nigeria. Its application potential in cookie production was investigated in this study. African nutmeg (*Monodora myristica*) seed flour (ANM) was produced using a standard method. The flour was substituted for vanilla flavour (VFL) in ratio of 0, 1, 2, 3, and 3.5 g and functional properties of the flour blends (water absorption capacity (WAC), oil absorption capacity (OAC), and bulk density) were determined, using standard methods. Cookies were developed and characterized chemically, physically (colour) and organoleptically using the AOAC method, a colourimeter and sensory panellists respectively. Data were analysed using ANOVA at $p<0.05$. Replacement of vanilla with African nutmeg had no significant effect on bulk density (0.62 g cm^{-3}-0.68 g cm^{-3}), but significantly affected WAC (133-142 %) and OAC (147-156 %) of flour blends. Crude protein (9.44-15.49 %), crude fat (3.17-6.50 %), total ash (2-2.73 %) and crude fibre (0.12-0.23 %) contents of the cookie increased, whilst metabolizable energy (385.33-367 kcal) decreased. There were reductions in pH (6.83-6.53) and TSS (5.80-1.20). Brown index of the snack increased with addition of nutmeg. Antioxidant indicators (flavonoids, DPPH and phenol) varied among cookie samples. Antinutrients, saponin, tannin and oxalate, were within tolerable limits. All cookie samples were judged acceptable by the panellists, with SLZ being the most acceptable. An acceptable and nutritious snack was produced at 100 % replacement. *M. myristica* seed could serve as substitute for vanilla in the production of cookies and other related snacks.

Keywords: *Monodora myristica*; Snack; Flavourant; Food additive; Substitution

1 Introduction

Snacks are identified as foods eaten at times other than meals and could be mindfully or unmindfully consumed. They include a variety of products and can take different forms, including potato chips and cereal-based snacks (FAO, 2011; Sajilata & S. Singhal, 2005; Sumargo, 2016). Globally, the impact of snacks is felt daily mostly in big cities, possibly due to convenience driven lifestyles, job demands and dietary habits (Kruger, 2012; Olatoye & I. Lawal, 2016). Many people earn their livelihood through snack production and marketing (Norfezah, 2013). Quite often, some snacks are perceived to be sugary and their excessive consumption has been attributed to incidence of obesity, diabetes and coeliac diseases (Ajieroh, 2010). These might be connected with the composition of their ingredients.
Among other ingredients, flavourings remain

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indispensable with application of commercial flavourings in snack production being common, as this is meant to improve the taste and entice consumers. Ironically, some of these flavourings are synthetic and unhealthy. However, producing healthy snacks from locally available materials is the current trend and innovative development in the snack food industry. Consequently, it is necessary to explore natural flavourings and spices that may be considered as possible alternatives to synthetic ones (Enwereuzoh et al., 2015). One example of such possible alternatives is M. myristica, commonly known as African nutmeg. It is a perennial edible plant, belonging to the Ananacea family. It is a berry with many seeds grown in the evergreen forests of West Africa (Burubai, Akor, Igoni, & Puyate, 2007), with almost every part of the tree possessing both economic and medicinal usefulness. Its pod is used as a seasoning spice in Southern and Eastern Nigeria (Aladesanmi, 2007; Essien, Izunwane, Aremu, & Eka, 1994). The seeds, which are embedded in the white sweet-smelling pulp of the fruit are considered most economically important (Stephen, O., Oboh, & Eseosa, 2014). The seed powder is used as spices to prepare pepper soup and also used as stimulant to relieve constipation. Currently, the tendency to use the oil extracted from *M. myristica* and *Tetrapleura tetraptera* to flavour popcorn has proven to justify the use of the spices as flavourings with good acceptability and no adverse effect (Enwereuzoh et al., 2015). There have been few studies on the use of African nutmeg incorporated into snacks as it is mostly used in seasoning soups and salads. Largely, Nigerian food industries are still relying on the importation of flavourings at the expense of possible local substitutes (Enwereuzoh et al., 2015). Therefore, the objective of this research was to investigate the potential of African nutmeg as a flavouring agent in the production of cookies.

2 Materials and Methods

2.1 Sources of Materials

The African nutmeg was obtained from Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, Nigeria. The wheat flour, sugar, salt, egg, and vanilla were bought from modern market, Ilorin, Nigeria. The chemicals and reagents used were of analytical grade A and were obtained from Bumlab Nigeria Limited, Ring Road, Ibadan, Nigeria.

2.2 Production of African nutmeg powder

The seeds of *M. myristica* were shelled manually with the use of mortar and pestle and then milled into powder using an electric blender, sieved with a 250 μm mesh and bottled in a sterile plastic container prior to use.

2.3 Cookie production

The method described by Eneche (1999) was used to prepare cookies with slight modifications. A fluffy mixture of butter and sugar was obtained by manually mixing 125 g of baking butter with 120 g of sugar for 5 min. Another mixture of flour (250 g), salt (2.5 g) and baking powder (10 g) was prepared separately and combined with the butter-sugar mixture to get a dough. A measured amount of water (20 ml) was added gradually and the dough mixed continuously until a good textured, firm dough was obtained. The dough was kneaded on a clean flat surface for 4 min and transferred to a cutting table where a shape maker was pressed over the dough to give the desired shapes. Dough pieces were then transferred into liquid-fat-greased baking trays and baked at 150 ^{o}C for 20 min, cooled and packaged for analysis.

2.4 African nutmeg-vanilla flavour formulation for cookie

African nutmeg (ANM) was substituted for vanilla flavour (VFL) in different proportions of 0, 1, 2, 3, and 3.5 g i.e. (0, 30, 60, 90 and 100 %) respectively, to give five (5) samples (Table 1), according to the modified method described by Adeboye, Babajide, Shittu, Omemu, and Oluwatola (2013).

Table 1: Substitution of African nutmeg for vanilla flavour in cookie production

Samples	African nutmeg flour (g)	Vanilla flavour (g)
KMO	0.00 (0 %)	3.5 (100 %)
JLK	1.00 (30 %)	2.50 (70 %)
VRU	2.00 (60 %)	1.50 (40 %)
PQS	3.00 (90 %)	0.50 (10 %)
SLZ	3.50 (100 %)	0.00 (0 %)

2.5 Determination of functional properties of flour blends

Water absorption capacity (WAC) and oil absorption capacity (OAC) were determined using the method described by Sosulski (1962). For the WAC, 1 g of the sample was added into 15 ml of distilled water in a pre-weighed centrifuge tube, while for the OAC, oil with a known density was added to the sample. The tube with its contents was agitated for 2min and centrifuged at 4000 rpm for 20 min on a SorvallGLC-1 centrifuge (Model 06470, USA). The clear supernatant was discarded and the centrifuge tube was weighed with the sediment. The amount of water or oil bound by the sample was determined by difference and expressed as the weight of water bound by 100 g dry of flour. Bulk density was determined using the method of AOAC (2000). The flour sample (7 g) was weighed into a 50 ml graduated measuring cylinder. The cylinder was tapped gently against the palm of the hand until a constant volume was obtained, and the bulk density (BD) calculated as shown in equation 1.

$$\text{BD} = \frac{\text{weight of sample}}{\text{volume of sample after tapping}} \quad (1)$$

2.6 Determinations of proximate composition and energy values of cookie samples

Proximate composition, including crude protein, fat, moisture content, crude fibre, ash and carbohydrate of the cookie samples were carried out using standard methods described by AOAC (1995). The energy value of the cookie was calculated from percentages of major nutrients in kilojoules per 100 g and the values were converted to kcal by dividing them by the conversion factor (4.184) (Maclean et al., 2003) as shown in equation 2.

$$\text{EV(kcal)} = \frac{\text{Carb} \times 17 + \text{Prot} \times 17 + \text{Fat} \times 37}{4.184} \quad (2)$$

Where EV = Energy value and Carb, Prot and Fat are the composition in carbohydrates, proteins and fats

2.7 Determination of physicochemical properties of cookie samples

A Fisher pH meter (Model 210, Fisher Scientific) was used to determine the pH and an Abbe refractometer was used to determine the total soluble solids content (Brix) at 20 ^{o}C. The physical colour of the cookies was quantitatively determined with the aid of a hand-held Colour Tec PCM/PSMTM1 colour meter as described by Babajide and Odulate (2015) using a white tile as reference and recording the brightness (L*), redness (a*) and yellowness (b*) values, Hunter Lab values.

2.8 Determination of Antioxidant profile of formulated cookie

Phenol

Total phenol was determined by the Folin-Ciocalteu spectrophotometric method (AOAC, 1990). Extraction of total phenol was done by dissolving 200 mg of the sample in 10ml methanol (>99 % w/w). At room temperature, the mixture was shaken well for 30 min and centrifuged

at 500 rpm for about 15 min. The extract from each sample (1ml) was treated with an equal volume of Folin-Ciocalteu reagent together with addition of 2 % Na_2CO_3 solution. Standard phenol solution was prepared and diluted to the desired concentration. The standard solution (1ml) was treated with Folin-Ciocalteu reagent and Na_2CO_3 solution. A spectrophotometer was used to measure the absorbance of the resulting blue coloration at 560 nm. Measurement was made with a reagent blank at zero. The phenol content was calculated using the formula below:

$$\%phenol = \frac{100}{W} \times \frac{Au}{As} \times C \times \frac{Vt}{Va} \quad (3)$$

Where W = weight of sample, Au = absorbance of test sample, As = absorbance of standard phenol sample, C = concentration of standard phenol sample, Vt = total extract volume and Va = volume ofextract analysed.

Flavonoids

Flavonoid content was determined using the modified method of Harborne (1973). The cookie sample (5 g) was refluxed for 40 min and allowed to cool before being filtered. The filtrate was treated with an equal volume of ethyl acetate and then transferred to a separation funnel. The flavonoid extract (contained in the ethyl acetate portion) was collected using a filter paper. The weight was obtained after drying in the oven and cooling in a dessicator. The weight was expressed as percentage of weight of sample analyzed and was calculated as shown below:

$$\%flavonoid = \frac{W_2 - W_3}{W_1 of sample} \times 100 \quad (4)$$

Where W_2 and W_3 represent flavonoid extract in ethyl acetate portion before and after drying respectively. W_1 is the initial weight of sample.

DPPH (2, 2-dipheny-1-pycryl hydrazine)

The DPPH-radical scavenging activity of the cookies sample was determined using a modified method of Blois (1958) as reported by Cakir et al. (2003). Different concentrations (0 to 350 μg ml^{-1}) of sample extract were pipetted into clean, dry test tubes in triplicate and the volumes adjusted to 1 ml with 10 mM acetate buffer, pH 4.5. This was followed by the addition of 2 ml of 0.2 mM DPPH solution in methanol. The reaction mixture was mixed thoroughly by inversion and then incubated in the dark for 30 min. The absorbance was read at 517 nm against the blank that contained 1 ml of 10 mM acetate buffer, pH 4.5 and 2 ml of 0.2 mM DPPH solution in methanol. For ascorbic acid (1 mg mL^{-1}) and rutin (1 mg mL^{-1}) standard, the procedure described above was followed. Scavenging activity was evaluated in percentage, using the expression:

$$\% \text{ of scavenging activity} = \frac{Ac - Au}{Ac} \times 100 \quad (5)$$

Where Au = absorbance of test sample, Ac = absorbance of the control

2.9 Determination of anti nutrient contents of cookie samples

Tannin

Tannin content of the sample was determined by Folin Denis colorimetric method (Kirk, Sawyer, et al., 1991). 5 g of the cookie was weighed and thoroughly dissolved in 10 ml distilled water. The solution was shaken well for 30 min at room temperature and filtered to obtain the extract. Standard tannic solution was prepared and a 2 ml portion mixed with equal volume of distilled water in a separate 50 ml volumetric flask, to serve as standard and reagent blank respectively. Then 2 ml of each of the sample extracts were put into labeled flasks. Contents of each flask were mixed with 35 ml of distilled water and 1ml of the Folin Denis reagent was added to each, followed by addition of 2.5 ml of saturated Na_2CO_3 solution. Thereafter, each flask was diluted to the 50 ml mark with water and incubated for 90 min at room temperature. Absorbance was read using a spectrophotometer at 760 nm with the reagent blank at zero. The tannin content was calculated as shown below:

$$\%tannin = \frac{100}{W} \times \frac{Au}{As} \times C \times \frac{V_t}{V_a} \quad (6)$$

Where W = weight of sample, Au = absorbance of test sample, As = absorbance of the standard tannin solution, C = concentration of the standard tannin solution, V_t = total volume of extract, V_a = volume of extract analyzed.

Oxalate

The determination of oxalate content was carried out according to Day and Underwood (1986). One gram of each sample was put into separate plastic bottles followed by the addition of 75ml of 0.1N H_2SO_4. The content was mixed properly and allowed to extract for 1 h with constant agitation using a mechanical shaker. This was then filtered and 25 ml of the filtrate was titrated with 0.1ml $KMnO_4$ while hot (80-90 ^oC) until a purple colour was observed at the end point. The titre value (volume of $KMnO_4$ used at the end point) was then multiplied by 0.9004 to get the result expressed as mg g^{-1}.

Saponin

Modified method of Fenwick and Oakenfull (1981) was used to determine saponin content of the cookies. A reflux condenser containing pure acetone was used to extract saponin for 2 h. Exhaustive re-extraction over a heating mantle with methanol in the Soxhlet apparatus carried out for 2 h. Methanol was allowed to evaporate and the extract was weighed. Saponin content was calculated as a percentage of the sample.

2.10 Sensory evaluation:

Cookie samples were evaluated for sensory attributes; appearance, taste, crispness, flavor, hardness and acceptability using thirty panellists on a hedonic scale (9-point) where 1 represented dislike extremely and 9 extremely like (Iwe, 2002).

2.11 Statistical analysis

All analyses were carried out in triplicate and the results were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS version 21). Separation of means was carried out ($P \leq 0.05$) using the Duncan multiple range test.

3 Results and discussion

3.1 Functional properties of flour blends

Replacement of vanilla with African nutmeg had no significant effect on bulk density except for sample JLK and ranged from 0.62 g cm^{-3} to 0.68 g cm^{-3}. However, it significantly affected WAC (133 - 142 %) and OAC (147 - 156 %) of flour blends (Table 2). Water absorption capacity is an important functional property in the development of ready-to-eat foods, since a high WAC may assure product cohesiveness (Houssou & Ayernor, 2002). The WAC decreased as the amount of *M. myristica* increased. The oil absorption capacity (OAC) is a critical assessment of flavour retention and increases the palatability of foods (Kinsella & Melachouris, 1976). The addition of *M. myristica* decreased the OAC capacity of the flour blend. This could be as a result of the oil content of *M. myristica* (22.71-29.1 %), reported by Ekeanyanwu, Ogu, and Perpetua (2010) and Stephen et al. (2014).

3.2 Proximate composition of formulated cookie

The crude protein (9.44-15.49 %), crude fat (3.17-6.50 %), total ash (1.22-2.73 %) and crude fibre (0.12-0.23 %) contents of the cookies increased (Table 3), while metabolizable energy (385.33-367 kcal) decreased (Table 4) with addition of African nutmeg. In this study, the protein content was close to the value reported by Enwereuzoh et al. (2015) in similar study. Increased protein can contribute significantly to the recommended daily intake of proteins for adults (34-56 g day^{-1}) and children (13-19 g day^{-1}) (Food and Nutrition Board, 2002). Protein is an essential nutrient in the human diet as it helps to repair worn-out tissues (Baah, 2009). Fat content of the cookie was however lower (12.96–15.21 %) than documented by Giwa and Abiodun (2010) for a biscuit produced from composite flour of wheat and quality protein maize. It is important to note

Table 2: Functional properties of flour blends

Samples	Bulk density (g/cm^3)	WAC (%)	OAC (%)
KMO	$0.66^{a}\pm0.01$	$142^{a}\pm0.02$	$156^{a}\pm0.01$
JLK	$0.62^{b}\pm0.02$	$141^{ab}\pm0.02$	$155^{a}\pm0.01$
VRU	$0.67^{a}\pm0.02$	$139^{b}\pm0.04$	$152^{b}\pm0.02$
PQS	$0.68^{a}\pm0.01$	$135^{c}\pm0.01$	$151^{b}\pm0.01$
SLZ	$0.68^{a}\pm0.02$	$133^{d}\pm0.01$	$147^{c}\pm0.01$

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were significantly different ($P < 0.05$)

Table 3: Proximate composition of baked cookie (%)

Sample	Moisture	C. Protein	Crude fat	Crude ash	Crude fibre	Carbohydrate
KMO	$6.20^{d}\pm0.26$	$9.44^{d}\pm0.62$	$3.17^{d}\pm0.07$	$1.22^{c}\pm0.07$	$0.17^{c}\pm0.01$	$79.80^{a}\pm1.02$
JLK	$8.33^{c}\pm0.29$	$12.67^{c}\pm0.67$	$4.27^{c}\pm0.03$	$1.70^{b}\pm0.10$	$0.12^{d}\pm0.01$	$72.91^{b}\pm1.00$
VRU	$8.91^{b}\pm0.16$	$12.96^{bc}\pm0.80$	$4.45^{b}\pm0.09$	$1.74^{b}\pm0.10$	$0.17^{c}\pm0.00$	$71.77^{b}\pm1.14$
PQS	$9.20^{b}\pm0.96$	$14.44^{ab}c\pm0.95$	$4.49^{b}\pm0.01$	$1.82^{b}\pm0.07$	$0.19^{b}\pm0.01$	$69.85^{c}\pm0.89$
SLZ	$13.41^{a}\pm0.19$	$15.49^{a}\pm1.10$	$6.50^{a}\pm0.10$	$2.73^{a}\pm0.20$	$0.23^{a}\pm0.01$	$61.64^{d}\pm1.05$

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were significantly different ($P < 0.05$)

that the amount of fat in a food product plays a major role in its shelf life. High fat content could be undesirable in ready-to-eat snacks as it can promote rancidity, leading to development of unpleasant sensory properties (Ihekoronye & Ngoddy, 1985). Hence, the low fat was an added advantage with respect to the keeping quality of this cookie. Ash content (1.34-2.58 %) in this study was in agreement with reported by Eke, Achinewhu, and Sanni (2008) and was an indication of adequate mineral status of the cookie (Baah, 2009). Fibre is regarded as essential nutrient in human diet as it absorbs water and provides roughage for the bowels, assisting intestinal transit (Alaise & Linden, 1999). The crude fibre content was low, which is however helpful to the digestive process (Alaise & Linden, 1999). Substitution of African nutmeg for vanilla resulted in reduced carbohydrate (Table 3) and energy contents of the cookie (Table 4). This may help in the prevention of over-weight and obesity. Accurate information on energy value of foods is paramount, when it comes to the challenges of normal nutrition, under nutrition and obesity (Merrill & Watt, 1973).

3.3 Physicochemical properties and colour characteristics of formulated cookie

Substitution of African nutmeg for vanilla brought about significant ($p \leq 0.05$) reductions in pH (6.83-6.50) and TSS (5.80-1.20) (Table 5), with a concomitant increase in brown index (Table 6) of the cookie samples. The pH decreased with increased level of African nutmeg, with sample SLZ (100 %) exhibiting lowest pH value, hence highest acidity. Reduction of pH is an indication of improved shelf stability for this snack as most spoilage micro-organisms grow best at pH 6.8-7.2, close to neutral (Zahra & Safaa, 2015). Total soluble solid (TSS) followed similar trend. TSS is an indication of the amount of total soluble sugar, in particular sucrose contents of cookie samples. The control (KMO) had the highest value and SLZ (100 % African nutmeg) the least. This is a pointer to the suitability of cookie sam-

Table 4: Physicochemical properties of baked cookie

Samples	pH	TSS(Brix)
KMO	6.83^{a}±0.12	5.80
JLK	6.67^{ab}±0.06	5.00
VRU	6.63^{ab}±0.06	2.80
PQS	6.53^{b}±0.20	1.40
SLZ	6.50^{b}±0.00	1.20

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were significantly different ($P < 0.05$)

Table 5: Energy content of the different samples of cookie

Samples	Energy values (kcal)
KMO	390.62^{a}±0.12
JLK	385.48^{b}±0.11
VRU	383.63^{b}±0.01
PQS	382.18^{b}±0.00
SLZ	370.87^{c}±0.01

ple SLZ in control of dietary sugar intake, especially for overweight, obese and diabetic individuals. Most spices have been associated with a bitter principle which is believed to be capable of reducing blood sugar concentrations (Uhegbu, Iweala, & Kanu, 2011). The lightness, redness and yellowness as well as the brown index of the cookie were significantly affected by substitution of *M. myristica*. Brown index in particular increased with addition of African nutmeg (Figure 1). This might be attributed to the initial colour of African nutmeg and probable processing effect particularly, the baking temperature (Okafor & Ugwu, 2014). Colour is an essential parameter in judging quality of snack foods. It reflects the suitable of raw material used for preparation and provides information about the formulation and quality of the product (Abu-Salem & Abou-Arab, 2011).

3.4 Antioxidant profile of cookie samples

Replacement of vanilla flavour with *M. myristica* significantly ($p \leq 0.05$) influenced antioxidant characteristics among cookie samples, except flavonoids (Table 7). Sample SLZ (100 % African nutmeg) possessed highest values of total phenol and DPPH (2, 2-dipheny-2-pycryl hydrazine) contents. Similar results were documented by Stephen et al. (2014). Phenolic compounds have been reported to inhibit the activities of digestive and hydrolytic enzymes such as amylase, trypsin, chymotrypsin and lipase (Shetty, 1997). They also possess anti-carcinogenic, anti-viral, anti-microbial, anti-inflammatory, hypotensive and anti-oxidant activities (Shetty, 1997). The value 0.08 % obtained was slightly lower than values (0.18 %) reported by Uhegbu et al. (2011) and (0.15 %) Ndulaka, Ekaiko, Ogbonna, and Asiegbu (2016), in a similar study involving the incorporation of some spices into snacks. Flavonoids are potent water-soluble antioxidants and free radical scavengers which prevent oxidative cell damage and have strong anticancer and anti- ulcer activity (Agbaire, 2011). It might, in addition, offer protection against the different levels of carcinogenesis.

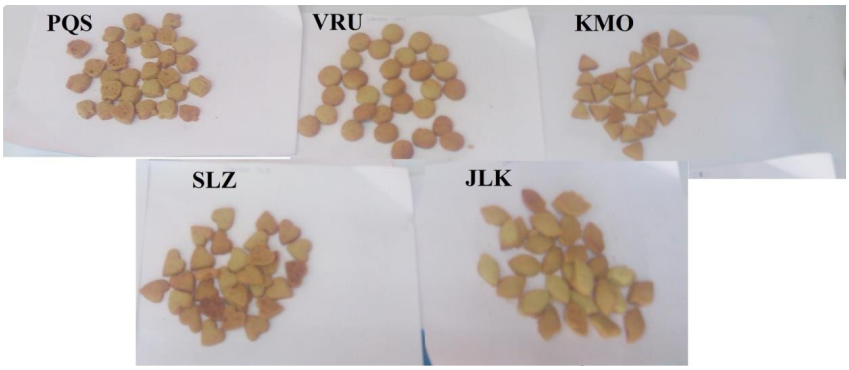

Figure 1: Cookie samples with different levels of African nutmeg as flavouring

Table 6: Colour characteristics of baked cookie samples

Samples	L*	a*	b*	BI
KMO	$48.38^{a}\pm0.29$	$7.42^{a}\pm0.03$	$21.61^{a}\pm0.05$	$51.57^{d}\pm0.07$
JLK	$48.43^{a}\pm0.07$	$3.83^{d}\pm0.02$	$19.62^{b}\pm0.01$	$51.62^{d}\pm0.03$
VRU	$47.18^{b}\pm0.04$	$3.78^{e}\pm0.06$	$19.20^{c}\pm0.03$	$52.82^{c}\pm0.04$
PQS	$46.43^{c}\pm0.03$	$5.48^{c}\pm0.06$	$18.84^{d}\pm0.01$	$53.57^{b}\pm0.03$
SLZ	$42.79^{d}\pm0.02$	$7.29^{b}\pm0.03$	$18.55^{e}\pm0.01$	$57.21^{a}\pm0.2$

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were significantly different ($P < 0.05$)

Table 7: Antioxidants profile of formulated cookie (%)

Samples	Flavonoid	Phenol	DPPH
KMO	$0.08^{a}\pm0.004$	$0.14^{e}\pm0.003$	$1.13^{c}\pm3.9$
JLK	$0.08^{a}\pm0.01$	$0.14^{d}\pm0.005$	$3.12^{b}\pm8.8$
VRU	$0.08^{a}\pm0.007$	$0.17^{c}\pm0.002$	$3.48^{b}\pm3.8$
PQS	$0.08^{a}\pm0.002$	$0.18^{b}\pm0.003$	$3.75^{b}\pm4.5$
SLZ	$0.08^{a}\pm0.008$	$0.24^{a}\pm0.004$	$5.22^{a}\pm1.7$

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were significantly different ($P < 0.05$)

Table 8: Anti-nutritional profile of cookie (%)

Samples	Saponin	Tannin	Oxalate
KMO	$0.45^{b}\pm0.12$	$0.16^{c}\pm0.02$	$0.11^{b}\pm0.02$
JLK	$0.53^{ab}\pm0.05$	$0.17^{bc}\pm0.006$	$0.11^{b}\pm0.02$
VRU	$0.77^{ab}\pm0.24$	$0.17^{bc}\pm0.008$	$0.13^{b}\pm0.05$
PQS	$0.77^{ab}\pm0.2$	$0.19^{b}\pm0.002$	$0.15^{b}\pm0.01$
SLZ	$0.82^{a}\pm0.21$	$0.21^{a}\pm0.008$	$0.20^{a}\pm0.00$

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were significantly different ($P < 0.05$)

Table 9: Sensory evaluation scores for cookies

Samples	Taste	Colour	Crispness	Flavour	Hardness	Overall acceptability
KMO	$7.23^{a}\pm1.61$	$7.77^{ab}\pm1.43$	$7.17^{a}\pm1.58$	$7.37^{a}\pm1.27$	$7.57^{a}\pm1.16$	$7.63^{a}\pm1.3$
JLK	$7.67^{a}\pm1.21$	$8.33^{a}\pm0.80$	$7.60^{a}\pm1.07$	$7.23^{ab}\pm1.38$	$7.83^{a}\pm1.34$	7.87^{a}a±1.07
VRU	$6.97^{a}\pm1.45$	$7.10^{b}\pm1.75$	$7.00^{a}\pm1.62$	$6.57^{b}\pm1.59$	$7.30^{a}\pm1.58$	$7.47^{a}\pm1.25$
PQS	$7.53^{a}\pm1.07$	$7.70^{ab}\pm1.02$	$7.33^{a}\pm1.09$	$7.10^{ab}\pm1.4$	$7.67^{a}\pm1.09$	$8.00^{a}\pm0.91$
SLZ	$7.37^{a}\pm1.10$	$7.30^{b}\pm1.34$	$7.50^{a}\pm0.97$	$7.40^{a}\pm1.04$	$7.43^{a}\pm1.25$	$7.80^{a}\pm0.76$

Mean ± standard deviation of triplicate readings, mean values followed by different superscripts within columns were were significantly different ($P < 0.05$)

3.5 Anti nutritional properties of cookie samples

The anti-nutrient content increased significantly ($p < 0.05$): saponin (0.45-0.82 %), tannin (0.16-0.21 %) and oxalate (0.11-0.20 %) with substitution of *M. myristica* for vanilla (Table 8). African nutmeg was earlier reported to be high in phytochemicals (Ekeanyanwu et al., 2010; Stephen et al., 2014). However, the levels of these phytochemicals in this product were within the ranges earlier considered safe in humans (Ugwu & Oranye, 2006). Health benefits of some of these phytochemicals are documented (Ugwu & Oranye, 2006). These include reductions of pathogenesis of cancer development and damage to intestinal tract (Makkar & Becker, 1996; Ugwu & Oranye, 2006). The low levels of tannin content in the cookie samples corresponded to the values reported by Uhegbu et al. (2011) and (Ndulaka et al., 2016).

3.6 Sensory attributes of formulated cookie

There was no significant difference ($p < 0.05$) between the mean sensory scores for most attributes of cookie samples and control, except in colour and flavour (Table 9). Cookie samples increased in brownness with increased levels of *M. myristica*, which may be due to the colour of the nutmeg powder. Similar trend was observed for flavour, which is the main criteria that makes the product to be liked or disliked (Abu-Salem & Abou-Arab, 2011). The assessment of flavour was done by the combination of taste and smell. Sample SLZ (100 % African nutmeg) was adjudged the most acceptable in terms of flavour by the panelists. The overall acceptability of the samples was based on their (panelist) individual performance on evaluation. Iwe (2002) considered a product with overall acceptability score of 7.0 as being accepted by consumer. It was observed that all samples were generally accepted by panellists, but SLZ (sample with 3.5 g of *M.*

myristica and 0 g of vanilla flavour) being the most acceptable.

4 Conclusions

Cookies of good nutritional standard and acceptable sensory qualities were produced from replacement of vanilla flavour with African nutmeg in the formulation. Functional properties of the flour blends were not affected markedly as a result of *M. myristica* seed flour substitution for vanilla flavour. Increased addition of *M. myristica* significantly influenced the proximate composition, physicochemical properties, phytochemical content and antioxidative potential of the cookies at the 95 % confidence level. The cookies compared very well with the control in virtually all the sensory attributes with sample SLZ (100 % replacement) being the most acceptable to the panellists. *M. myristica* seed could serve as a flavourant in the production of cookies and similar snacks and the replacement of vanilla flavour with African nutmeg is potentially possible. Studies on microbial characteristics and storage stability of such products are important and therefore recommended.

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