



CHEMICAL COMPOSITION AND CONSUMER ACCEPTABILITY OF COOKIES FLAVOURED WITH VANILLA - *AIDAN* (*Tetrapleura tetraptera*) BLENDS

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Aidan is an underutilised spice with characteristic fragrant and pungent aromatic odour, similar to vanilla flavour. Chemical composition and consumer acceptability of cookies flavoured with vanilla-Aidan blends were investigated. Aidan pulp was milled and substituted for vanilla powder (25-100%) in cookies formulation. Cookies were characterised for chemical contents and sensory properties using standard methods and panellists test. Data were analysed using ANOVA at $\alpha_{0.05}$. The study revealed that chemical contents, (except carbohydrate and metabolizable energy) and sensory properties of cookies significantly improved with increase in addition of Aidan. Moisture content of the cookies ranged between (1.83-3.77%), crude protein (9.83-12.86%), ash (0.55-0.71%), fat (0.98-1.29%), fibre (0.35-0.46%), carbohydrate (81.35-86.45%) and metabolizable energy (380.60-393.94 kcal). Mineral content was significantly influenced, with phosphorus content ranging between (64.00-142.67mg/100g), iron (2.62-6.53 mg/100g) and zinc (3.80 mg/100g- 4.47 mg/100g). The ranges of tannin, phytate, flavonoid and phenolic compounds in mg/100g were 0.07-0.08, 0.17-0.23, 0.53-0.82 and 0.76-1.53 respectively. Mean scores for cookies appearance, taste, aroma, crispness and over all acceptability ranged between 7.23-8.17, 7.30-7.87, 7.33-8.07, 7.20-7.80 and 7.72-8.31, respectively. Panellists accepted sample with 3 g (75%) of Aidan and 1 g (25%) of vanilla the most. Acceptable cookies with good nutritional composition can be produced, using vanilla-Aidan blends as a flavouring agent.

Keywords: *Tetrapleura tetraptera*, cookies, spices, consumer acceptability, functional food

INTRODUCTION

In Nigeria, like many other developing countries, the increasing phenomenon of urbanisation coupled with the growing number of working mothers, have contributed greatly to the popularity and increased consumption of snack foods such as cookies and biscuits (1). Snack food industry is expanding rapidly all over the world, nonetheless, the 21st century saw the revolution of snack foods towards functional snacks (2-3). Snack making from suitable blends of appropriate food materials with incorporation of nutrients (vitamin, minerals, protein, low fat, high fibre, fat replacers, gluten free ingredients) and/or phytochemicals (anthocyanin, phenolics or flavonoids) constitutes better vehicles of nutrients conveyor and health promoters (3-5). They are regarded as functional snacks

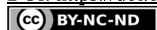
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known to possess additional health benefit, apart from basic nutrient. Similarly, replacement of synthetic components of the snack ingredients with more natural ones constitutes another avenue of producing less expensive functional food with bioactive substances (6-7). Thus, there is the need to explore natural flavourings and spices with noteworthy impact on organoleptic and functional properties of snacks. Such edible products with flavouring characteristics include fruits, seeds, leaves, flowers, nuts, pulp and oils from naturally occurring plants with pungent or aromatic characteristics, which have been previously used to season foods. Reportedly, an underutilised spice with characteristic fragrant and pungent aromatic odour in Nigeria is *Aidan*, according to (6). It is botanically known as *Tetrapleura tetraptera* and belongs to the family Fabaceae (formerly Leguminosae: Mimosoideae). It is commonly known as “Aidan” among the Yoruba ethnic group of south western Nigeria, “Agbolo” among the Igala people of North central Nigeria, and “dawo” among the Hausa people of Northern Nigeria. It is used as a popular seasoning spice in these areas. Compared with other commonly used spices, it is a rich source of phytochemicals which contribute to its documented biological and pharmacological activities, including cardiovascular, anti-inflammatory, hypoglycaemic, anti-hypertensive, anti-ulcerative, anti-microbial, and emulsifying properties (8-10). Currently, the use of the oil extracted from *Tetrapleura tetraptera* to flavour popcorn was documented (6). However, use of *Aidan* power in contrast with extracted flavour could be free of impurities from extraction solvents. Literature report on the use of *Aidan* powder in frequently consumed snacks like cookies as flavourings is rare. Substitution of *Aidan* powder, a natural flavouring spice for synthetic and imported flavours may bring about production of less expensive, nutritive and healthy cookies. Therefore, chemical and sensory characteristics of cookies flavoured with vanilla- *Aidan* blends in cookies production was investigated.

EXPERIMENTAL

Dried pulp of *Tetrapleura tetraptera* was obtained from Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, Nigeria. Wheat flour, sugar, salt and egg were purchased from Malete market, Ilorin and brought to Food processing Laboratory, Department of Food Science and Technology, Kwara State University, Nigeria. The chemicals and reagents used were of analytical grade and were obtained from Bumlub Nigeria Limited, Ring Road, Ibadan, Nigeria. The *Tetrapleura tetraptera* pulp was pounded using mortar and pestle to promote its surface area. It was then milled using an electric blender, sieved with a 250 µm mesh and bottled in a sterile plastic container prior to use. The cookie was formulated using the modified method of Eneche (11). The formulation was done in a way that all ingredients were kept constant, except *Aidan* and vanilla power. Vanilla powder was substituted by *Aidan* powder (25%-100%) in the formulation. The baking butter (125 g) and sugar (120 g) were mixed together manually for 5 min to get a fluffy mixture of butter and sugar. The flour (250 g), salt (2.5 g), egg (60 g) and baking powder (9 g) were mixed together and then mixed with the butter-sugar mixture to get a dough. The measured amount of water (20 ml) was gradually added into the bowl and continuous mixed until good textured, firm dough was obtained. The dough was kneaded on a clean



flat surface for 4 min and transferred to a cutting table with which a shape maker was pressed over the dough to give desired shapes. The cut dough pieces were then transferred into fluid-fat- greased baking trays and baked at 180 °C for 45 min, cooled and packaged. Cookie samples were coded as C₀, C₂₅, C₅₀, C₇₅ and C₁₀₀ for Cookie containing 0% Aidan, 25% Aidan, 50% Aidan, 75% Aidan and 100% Aidan respectively. Methods described by AOAC (12) was used to determine the proximate composition, including crude protein, fat, moisture content, crude fibre, ash and carbohydrate content of the ground cookie samples. Five grams of each sample was oven dried at 105 °C until constant weight is obtained. Moisture content was calculated as percentage of weight loss to the original weight. The micro kjeldahl method was used to determine crude Protein. One-gram sample was weighed into the digestion tubes and 15ml of conc. sulphuric acid was added followed by mixing and then addition of two tablets of kjeldahl selenium catalyst to the flask. The mixture was digested at 420 °C until the solution turned colourless and fuming ceased. 75 ml of distilled water was quickly added to the mixture to avoid caking. The digest was distilled with 50 ml of 40% sodium Hydroxide solution. The distillate (100 ml) was the collected into 25 ml boric acid mixture prepared by mixing 250 ml of 4% (w/v) boric acid, 14 ml and 20 ml of 0.02 g methyl red and 0.02 bromocresol green, respectively and made up to one liter with deionised water. The ammonium borate produced was titrated with standard 0.1N hydrochloric acid solution until green colour just disappeared. Blank were prepared and treated in a similar way. Percentage Nitrogen was calculated using the equation below:

$$\%N = \frac{1.401 \times (\text{ml HCL sample} - \text{ml HCL titre of blank}) \times \text{NHCL}}{\text{Sample weight}} \quad \text{Eq. 1}$$

$$\% \text{ crude protein} = \% N \times \text{conversion factor (6.25)} \quad \text{Eq. 2}$$

The soxhlet fat extraction methods was used to determine crude fat content. A 250 ml boiling flask was cleaned and dried in the oven at 105 °C for 30 min. The flask was moved into a desiccator and then allowed to cool. The flask was labeled, weighed and then filled with 300 ml petroleum ether. 2 grams of the sample was accurately weighed into a correspondingly labeled thimble. The extraction thimble was tightly plugged with cotton wool. The soxhlet apparatus was assembled and allowed to reflux for ether was collected on the top of the container in the set up and drained into another container for re-use. The flask was removed and dried at 103 °C before being transferred from oven into a desiccator for cooling and re-weighing. The percentage fat was calculated as follows:

$$\% \text{ Fat} = \text{Weight of defatted sample} \times 100 / \text{Weight of sample} \quad \text{Eq. 3}$$

For ash content, three grams of dried samples from moisture determination was charred on a heater until it carbonized then incinerated in a muffle furnace at 550 °C for 6 hours the residue was weighed and aseptically kept. For crude fibre content, 100 ml TCA (Trichloroacetic acid) digestion reagent made up of 500 ml acetic acid, 450 ml distilled water, 50 ml conc. HNO₃ and 20 g TCA was added to 1 g of defatted sample. The suspension was boiled under reflux for exactly 40 min. The solution was filtered through a



whatman no. 4 filter paper of known weight. Residue was washed six times with hot water and once with industrial spirit. The filter paper and content were transferred into a known weight of porcelain dish and dried overnight at 100 °C. The porcelain dish was transferred into desiccators to cool, weighed and charred in a muffle furnace at 600 °C for 5 hour. This was allowed to cool and then reweighed. The carbohydrate content was determined by difference using the formula.

$$\% \text{ Carbohydrate} = 100 - (\% \text{ moisture} + \% \text{ ash} + \% \text{ protein} + \% \text{ fat} + \% \text{ fibre}) \quad \text{Eq. 4}$$

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), according to (13) as shown in equation 1.

$$EV \text{ (kcal)} = (\text{Carb.} \times 17 + \text{Prot.} \times 17 + \text{Fat} \times 37) / 4.184 \quad \text{Eq. 5}$$

Where *EV* - Energy value and *Carb.*, *Prot.* and *Fat* are the percentages of carbohydrates, proteins and fats.

The content of phosphorus (P), iron (Fe) and zinc (Zn) minerals in each cookie sample was determined by digesting 2.0 g of the flour sample using the Atomic Absorption Spectrophotometric method as outlined in the Association of Official Analytical Chemists' Approved method 968.08 AOAC (14). The Folin-Denis colorimetric method described by (15) was used to determined tannin content. Five grams of the sample flour was dispersed in 50 ml of distilled water and shaken. The mixture was allowed to stand for 30min at 28 °C before it was filtered through Whatman No. 42 grade of filter paper. Preparation of a standard tannic acid solution was carried out. From the standard solution, 2 ml and equal volume of distilled water was dispersed into a separate 50 ml volumetric flask. This serve as standard and reagent blank respectively. Then, 2 ml each of the sample extracts were put in their respective labelled flask. The contents of each flask were then mixed with 35 ml distilled water and 1 ml of the Folin-Denis reagent was added to each. This was followed by addition of 2.5 ml saturated Na₂CO₃ solution. The content of each flask was made up to 50 ml with distilled water and allowed to incubate at 28 °C for 90 min. Their respective absorbance was measured in a spectrophotometer (Jenway 6305 UV) at 760 nm using the reagent blank to calibrate the instrument at zero. Calculation of tannin content was as show below:

$$\% \text{ tannin} = \frac{100}{W} \times \frac{au}{as} \times c \times \frac{vt}{va} \quad \text{Eq. 6}$$

Where *W* - weight of sample; *au* - absorbance of test sample; *as* - absorbance of the standard tannin solution. *c* - concentration of standard tannin solution; *vt* - total volume of extract; *va* - volume of extract analysed. Phytate content was determined according to the method of Young and Greaves (16). About four grams (4 g) of the sample flour were soaked in 100 ml of 2% HCl for 3 hours and then filtered. Thereafter, 25 ml of the filtrate was placed in the conical flask. A 5 ml of 0.3 % ammonium thiocyanate solution was added as an indicator and 53.3 ml of distilled water was also introduced to attain the



desired acidity. This was titrated with standard FeCl_3 solution until a brownish yellow colour was appeared persisting for 5 min.

$$\text{Phytate in mg/100 g} = \text{titre value} \times 564.11 \quad \text{Eq. 7}$$

The gravimetric method was used (17) to determine the total flavonoid content, following ethyl lactate precipitation. Five-gram (5.0 g) sample was measured and mixed with 100 ml of 2% HCl solution and boiled for 30 minutes. It was allowed to cool and then filtered through Whatman No. 42 filter paper. The filtrate was treated with dropwise addition of ethyl lactate until full precipitation was obtained. The filtrate was recovered using a weighed filter paper and dried in the oven at 100 °C for 30 minutes. Cooling was done in a desiccator and reweighed. The weight of flavonoid was obtained by difference and expressed as percentage of the sample weight analysed. The formula below was used to calculate the flavonoid content.

$$\% \text{ Flavonoid} = (100 (W2-W1))/(Wt. \text{ of sample}) \quad \text{Eq. 8}$$

$W1$ - wt. of empty filter paper

$W2$ - wt. of paper + Flavonoid precipitate

Determination of total phenolic content of the sample was determined using Folin-Ciocalteu spectrophotometric method. Two grams (0.2 g) of the sample was extracted with 10 ml of pure methanol. One millilitre of the filtrate (extract) was mixed with equal volume of Folin-Ciocalteu reagent in a test tube. Also, 1 ml of standard phenol solution was treated the same way. One millilitre of saturated sodium bicarbonate solution was added to each tube and their respective content was calculated using the formula below:

$$\% \text{ Total Phenolics} = \frac{100}{w} \times \frac{AU}{AS} \times \frac{c}{100} \times \frac{Vt}{Va} \times D \quad \text{Eq.9}$$

W - weight of sample

Au - Absorbance of test sample

As - Absorbance of standard tannin solution

V_t - total volume of extract

C - concentration of the standard tannin solution

V_a - Volume of extract analysed

D - Dilution factor where necessary

Sensory evaluation was conducted on cookie samples for appearance, taste, aroma, crispness and overall acceptability using multiple comparison analysis. The samples were presented to thirty-man, untrained panellists mainly, undergraduate students who are familiar with cookies, to evaluate and score them on a 9-point Hedonic scale. On the scale, 9 represented = like extremely and 1 = dislike extremely (18). All obtained data in, replicated were statistically analysed using a one-way analysis of variance (ANOVA) and means were separated by Duncan's Multiple Range Test (DMRT) using the Statistical



package for social science (SPSS) IBM VERSION 21.0 package (Armonk, New York). Significance was accepted at 0.05 probability level.

RESULTS AND DISCUSSION

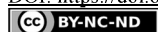
Proximate composition and metabolizable energy of cookies flavoured with *Aidan* as substitute for vanilla

The moisture content of the cookies ranged between 1.83% and 3.77% and were lower than (6.20-13.41%) reported by (7) in similar study involving substitution of vanilla by African nutmeg in cookies production (Table 1). The low moisture content suggested their microbial stability (19). The crude protein, fat, ash and fibre contents of the cookies ranged between (9.83-12.86%), (0.98-1.29%), (0.55-0.71%) and (0.35-0.46%) respectively. The carbohydrates (81.35-86.45) and metabolizable energy (380.60-393.94 kcal) however decreased with substitution of vanilla by *T. tetrapleura*. The protein content was close to the value reported by (6-7) in similar studies. The 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) (20). For long, protein has been well regarded as essential nutrient in the human diet as it helps to repair worn-out tissues (21). Low fat content of the cookies (0.98-1.29%) is desirable, being a ready-to-eat snacks. Usually, the amount of fat in a food product plays a major role in its shelf life. High fat content can promote rancidity, leading to development of unpleasant sensory properties (22). Hence, the low fat was an advantage with respect to the keeping quality of this cookie. Ash content (0.55-0.71%) was in accordance with reported values by Eke *et al.* (23), and was an indication of adequate mineral status of the cookie (21). Fibre is regarded as essential nutrient in human diet as it absorbs water and provides roughage for the bowels, assisting intestinal transit (24). The crude fibre content was low, which is however helpful to the digestive process (24). Substitution of *T. tetrapleura* for vanilla resulted in reduced carbohydrate and energy contents of the cookie. This may help in the prevention of overweight and obesity. Accurate information on energy value of foods is paramount, when it comes to the challenges of normal nutrition, undernutrition and obesity.

Table 1. Proximate composition and metabolizable energy of cookies flavoured with *Aidan* as substitute for vanilla

Sample	Crude Moisture (%)	Crude Protein (%)	Crude Fat (%)	Crude Ash (%)	Crude fibre (%)	Carbohydrate (%)	M. E. (kcal)
C ₀	1.83 ^d ±0.29	9.83 ^c ±0.30	0.98 ^c ±0.03	0.55 ^c ±0.02	0.35 ^c ±0.01	86.45 ^a ±0.40	393.94
C ₂₅	2.67 ^c ±0.58	11.69±0.17	1.17±0.01	0.65 ^b ±0.01	0.42 ^b ±0.01	83.40 ^b ±0.56	391.02
C ₅₀	3.00 ^{bc} ±0.01	12.22 ^{ab} ±0.59	1.22 ^{ab} ±0.06	0.68 ^{ab} ±0.03	0.44 ^{ab} ±0.02	82.44 ^c ±0.70	380.60
C ₇₅	3.33 ^{ab} ±0.29	12.86 ^a ±0.17	1.29 ^a ±0.02	0.71 ^a ±0.01	0.46 ^a ±0.01	81.35 ^d ±1.92	388.47
C ₁₀₀	3.77 ^a ±0.25	12.06 ^b ±0.48	1.21 ^b ±0.05	0.67 ^b ±0.03	0.43 ^b ±0.02	81.87 ^{cd} ±0.40	386.42

Means with the same superscript in the same column are not significantly different (P≤0.05) Key: M. E. – metabolizable energy.



Mineral content of cookies flavoured with Aidan as substitute for vanilla

Mineral contents varied significantly ($p \leq 0.05$) among the samples of cookies flavoured with *Aidan* as a substitute for vanilla (Table 2). Phosphorus ranged between (64.00-142.67 mg/100 g), iron (2.62-6.53 mg/100 g) and zinc (3.80-4.47 mg/100 g). Minerals are essential for health and as such are part of all aspects of cellular function and they are involved in different structural components of human beings. Some mineral elements form an integral part of enzyme or protein structure. They are vital for normal growth, maintenance, effective immune system and prevention of cell damage (25). Phosphorus makes up to 1% of a person's total weight, it plays an important role in how the body uses carbohydrates and fats. it is normally required for bone growth, kidney function and cell growth (26). Iron is known to be an essential constituent of haemoglobin found in blood and contributes to the combat of anaemia (27). Deficiency of zinc in humans is widely recognized as important malnutrition problem, especially in areas of high cereal and low animal food consumption. Indicators of zinc deficiency include low blood plasma/serum zinc concentration, and stunting prevalence (25).

Table 2. Mineral composition (mg/100 g) of cookies flavoured with *Aidan* as substitute for vanilla flavour

Sample	Phosphorous (mg/100 g)	Iron (mg/100 g)	Zinc (mg/100 g)
C ₀	64.00 ^c ±10.58	2.62 ^b ±1.49	3.80 ^c ±0.14
C ₂₅	105.60 ^b ±0.25	3.44 ^b ±0.75	3.99 ^b ±0.09
C ₅₀	109.33 ^b ±2.31	4.05 ^b ±2.18	4.08 ^b ±0.03
C ₇₅	140.00 ^a ±4.00	5.02 ^{ab} ±0.31	4.05 ^b ±0.09
C ₁₀₀	142.67 ^b ±33.5	6.53 ^a ±0.64	4.47 ^a ±0.06

Means with the same superscript in the same column are not significantly different ($P \leq 0.05$)

Phytochemical profile of cookies with Aidan as substitute for vanilla flavour

Phytochemical contents of cookies flavoured with *Aidan* as substitute for vanilla flavour varied significantly ($p \leq 0.05$) among the samples (Table 3). The ranges of tannin, phytate, flavonoid and phenolic compounds in mg/100 g were 0.07-0.08, 0.17-0.23) 0.53-0.82 and 0.76-1.53, respectively. However, some phytochemicals become antinutrients when ingested in high quantities. They interfere with digestive enzyme, for example, tannins have been reported to form complexes with proteins, reducing their digestibility and palatability (28). Tannins also inhibit the absorption of minerals like iron and zinc, but their concentrations in foods are known to decline during cooking (29-31). Similarly, phytates are known to adversely affect mineral bioavailability (31). However, the levels of these phytochemicals in this product were within the ranges earlier considered safe in humans (32). Besides, health benefits of some of these phytochemicals are documented (32). These include reductions of pathogenesis of cancer development and damage to intestinal tract (31-33). The low tannin content in the cookie samples corresponded to the



values reported by (34, 35). Inhibition of the activities of digestive and hydrolytic enzymes such as amylase, trypsin, chymotrypsin and lipase by phenolic compounds have been reported (36). They also possess anticarcinogenic, antiviral, antimicrobial, anti-inflammatory, hypotensive and antioxidant activities (36). According to Agbaire et al. (37), flavonoids are known to be potent water-soluble antioxidants and free radical scavengers which prevent oxidative cell damage. They also have strong anticancer and antiulcer activity. Flavonoids might, in addition, offer protection against the different levels of carcinogenesis. Therefore, since functional snacks usually possess additional health benefit apart from basic nutrient, cookies flavoured with *Aidan* as substitute for vanilla flavour may be considered as one.

Table 3. Phytochemical content (mg/100 g) of cookies flavoured with *Aidan* as substitute for vanilla flavour

Sample	Tannin (mg/100 g)	Phytate (mg/100 g)	Flavonoid (mg/100 g)	Total phenolics (mg/100 g)
C ₀	0.07 ^b ±0.00	0.17 ^c ±0.01	0.53 ^c ±0.02	0.76 ^b ±0.04
C ₂₅	0.07 ^{ab} ±0.00	0.18 ^c ±0.01	0.67 ^b ±0.07	0.91 ^b ±0.06
C ₅₀	0.08 ^{ab} ±0.01	0.21 ^b ±0.02	0.68 ^b ±0.04	0.95 ^b ±0.20
C ₇₅	0.08 ^a ±0.01	0.23 ^a ±0.01	0.77 ^{ab} ±0.07	1.00 ^b ±0.17
C ₁₀₀	0.08 ^{ab} ±0.00	0.23 ^a ±0.11	0.82 ^a ±0.07	1.53 ^a ±0.02

Means with the same superscript in the same column are not significantly different ($P \leq 0.05$)

Sensory properties of cookies with *Aidan* as substitute for vanilla flavour

Table 4. shows the results for the sensory evaluation of the cookies. There was no significant difference ($p < 0.05$) between the mean sensory scores for most attributes of cookie samples and control, especially taste and crispness. Mean scores for cookies appearance, taste, aroma, crispness and over all acceptability ranged between 7.23 - 8.17, 7.30 - 7.87, 7.33 - 8.07, 7.20 - 7.80 and 7.72 - 8.31, respectively. The intensity of brown colour increased in cookie samples with increase in substitution levels of *aidan* for vanilla. It may be due to the colour of the *aidan* powder. Panellists accepted sample with 75% of *Aidan* and 25% of vanilla the most, though it was observed that all samples were generally accepted by panellists. The overall acceptability of the samples was based on the judgement of the panellists as perceived by their sensory organs based on the appearance, taste, aroma and crispness. Iwe (18), considered a product with overall acceptability score of 7.0 as being accepted by consumer. The sensory attributes of foods, which are detectable by human senses are often used as food quality indices and may also serve as references during food selections (38).

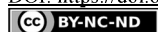


Table 4. Sensory attributes of cookies flavoured with *aidan* as substitute for vanilla flavour

Sample	Appearance	Taste	Aroma	Crispness	Overall acceptability
C ₀	7.93 ^{ab} ±0.87	7.87 ^a ±0.82	7.60 ^{ab} ±1.07 [*]	7.80 ^a ±1.06	7.83 ^{ab} ±0.97
C ₂₅	7.23 ^c ±1.10	7.77 ^a ±0.99	7.57 ^{ab} ±0.94	7.63 ^a ±1.03	7.76 ^b ±0.79
C ₅₀	7.33 ^{bc} ±1.32	7.30 ^a ±1.29	7.33 ^b ±1.15	7.20 ^a ±1.19	7.72 ^b ±0.99
C ₇₅	8.17 ^a ±1.15	7.60 ^a ±14.65	8.07 ^a ±1.14	7.93 ^a ±16.66	8.31 ^a ±0.97
C ₁₀₀	7.73 ^{abc} ±1.11	7.67 ^a ±0.66	7.40 ^b ±0.93	7.53 ^a ±1.38	7.86 ^{ab} ±0.74

Means with the same superscript in the same column are not significantly different (P≤0.05)

CONCLUSIONS

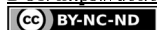
Substitution of vanilla powder by *Tetrapleura tetraptera* powder as a flavouring agent during cookies production yielded acceptable cookies with adequate nutritional composition. The cookie samples had adequate proximate composition, metabolizable energy, mineral (phosphorus, zinc and iron) and phytochemical (phenolics and flavonoids) contents which are essential for human health. However, low contents of antinutrient (tannin and phytate) which could reduce the digestibility and palatability of cookies when ingested were observed, but fell within tolerable limits. *Tetrapleura tetraptera* powder can be utilized as substitute for vanilla powder to obtain nutritious and acceptable cookies or similar snacks. Further study on antioxidant properties of such product is recommended.

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