Nutritional Profile and Sensory Attributes of a Novel Snack From Blends of Walnut and Groundnut Paste

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ABSTRACT

Background: *Nutrient-rich snacks are gaining more interest among school children and adults due to increased awareness on healthy foods. African walnut is an underutilized crop in tropical region, but rich in antioxidants and micronutrients. However, despite the nutritional and health benefits of the nut, it is less commonly consumed due to its bitter after-taste.*

Objective: *This study aimed at increasing the consumption of walnut through value addition to the nut.*

Method: *Fresh raw walnuts, groundnut and sugar were procured from a local market in Nigeria, the walnuts were boiled, and groundnuts were roasted, both were milled into powder. The varying proportions of walnut and groundnut powder (90:10; 80:20; 70:30; 40:60) were mixed with 80g of caramelized sugar to produce walnut-groundnut snacks. The snacks were evaluated for proximate, mineral and vitamin composition, and sensory attributes.*

Result: *This study showed that nutrient-dense and acceptable snack can be produced from blends of walnut and groundnut. The inclusion of groundnut significantly increased the protein (16.59-18.96%), fat (21.00-26.00%), and ash content (0.30- 0.57%) of the snack. The snack was also rich in phosphorus and magnesium and contains high levels of vitamins B1 (75-84 ppm), B3 (100-150 ppm), B6 (660-1500 ppm), and E (1650-5410 ppm). Walnut-groundnut snack containing 80% walnut was highly rated in terms of appearance, texture, colour, taste, aroma, and overall acceptance.*

Conclusion: *Consumption of this snack will increase the utilization of walnuts and serve as healthy snacks for consumers, thus improving the health status of African populace.*

Keywords: Walnut, snack, phytochemicals, sensory attributes, proximate composition.

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INTRODUCTION

African walnuts (Tetracarpidium conophoram) are abundant in essential nutrients and bioactive phytochemicals. They are rich in polyunsaturated fatty acids, specifically α-linolenic and linoleic acids, as well as phytosterols which have been demonstrated to enhance brain health and function, even as individuals age [1,2]. Each 100 g of walnuts contains 38 g of linoleic acid (LA) and 9 g of alpha-linolenic acid (ALA), along with 4.4 g of saturated fatty acids (specifically palmitic acid, 16:0) and 8.7 g of monounsaturated fatty acids (specifically oleic acid, 18:1) [2]. Polyunsaturated fatty acids play a role in decreasing the likelihood of cardiovascular illnesses, with walnuts and walnut oil being the primary sources of these beneficial fatty acids [3]. In addition, polyunsaturated fatty acids play a crucial role in maintaining brain health, and various phytochemical compounds enhance neuronal processes, thereby promoting overall well-being [2]. According to Obeta et al [4], African walnut has anti-lipidemic, anti-diabetic, anti-malarial and anti-cancer properties. Furthermore, walnuts contain a wide range of essential nutrients, such as polyphenols, vitamin E, folate, ellagitannins, ellagic acid monomers, polymeric tannins, melatonin, pectin, flavonoids, carotenoids, alkaloids, nitrogen-containing or organosulfur compounds, and various minerals [3,4].

Several types of polyphenolic compounds are found in walnuts which include hydroxycinnamic acids such as chlorigenic acid, caffeic acid, P-coumaric acid, ferrulic acid, and sinapic acid; hydrobenzoic acids like syringic acid and ellagic acid; and compounds like gallic acid, glansrin, juglone, and syringaldehyde [3]. Polyphenols in walnut not only decrease the number of oxidants and inflammation in brain cells, but it also improves communication between neurons, increases the production of new neurons, and enhances the removal of harmful protein clumps [5]. Docosahexaenoic acid (DHA) and Omega-3 fat eicosapentaenoic acid (EPA) are both very important for brain health because they help lower oxidative stress, change how the immune system works, keep synapses flexible, keep neuronal membranes stable, control gene expression, and encourage neurogenesis [2,6]. Hence, polyphenols present in walnut help keep calcium levels in check in the striatum and hippocampus, which are two important brain areas that handle primary and secondary memory [1].

Groundnut (Arachis hypogaea) is a highly nutritious food for human consumption because of its abundance in dietary protein, calories, vital fatty acids, vitamins, and minerals [7]. It is a nutrient-rich base in therapeutic foods that can meet up to 46% of the recommended daily intake of essential vitamins, particularly vitamin E, energy from its oils and fats, and dietary fibre [8]. Additionally, it is an important source of biologically active compounds such as arginine, resveratrol, phytosterols, amino acids, stilbenes, and flavonoids [8]. Furthermore, extensive clinical trials have demonstrated that consistent consumption of groundnuts has a beneficial impact on cardiovascular diseases, type 2 diabetes, and Alzheimer's disease [7,8]. Moreover, these bioactive molecules have anti-inflammatory, antioxidant, anticancer, and antitumor properties [9]. Groundnuts have extensive applications in the food business, where they are utilized for the manufacturing of flour, protein concentrates and isolates, confectioneries, oils, and drinks or used as snacks [10].

Snacks are perceived by many people as convenient foods that are cheap and easily accessible. Their consumption is increasing recently in developing countries due to people's busy lifestyle [11]. However, most of the conventional snacks lack vital nutrients, and are either caloric dense or contains high saturated fat and sodium [12]. Blending of walnut and groundnut will likely increase the utilization of walnut. This blend could have practical application in food industry because the walnut-groundnut paste can be used to make smoothies or shakes or cookies. The walnut-groundnut paste is rich protein, B-vitamins, and minerals, which are essential for healthy living [3,10]. In addition, walnut, which is a major component of the snack has antioxidant, anti-inflammatory, anti-chelating and high blood pressure control activities [3]. Thus, this makes the snack a functional food. However, the walnut-groundnut snacks could benefit health-conscious consumers by supplementing their protein and other nutrients intake. The use of African walnut in snack making will open new market for confectionery industry. The aim of the study was to produce an acceptable snack from walnut and groundnut blends and to evaluate the nutritional composition and acceptability of the snack.

MATERIALS AND METHODS

Fresh raw walnuts, groundnut and sugar were procured from a local market in Nigeria.

Preparation of Groundnut Paste

The groundnut paste was prepared from modified method of [13]. The groundnut (1 kg) was immersed in hot water [(60 ºC; 5 min); 1: 3 w/v] to soften the skin and enhance its digestion. It was thereafter drained in a sieve until fully strained, and then roasted for 15 min with salt in a pan placed on a gas cooker set at medium heating. The groundnut was constantly mixed with the hot salt during the roasting process to achieve uniformly roasted nuts. The roasted groundnut was cooled at ambient temperature for a duration of 30 mins, then peeled by vigorously rubbing it between the palms and subsequently removing the outer coatings. The peeled groundnuts were ground into a smooth paste using a Kenwood food processor blender running at maximum speed for a duration of 2–3 min. The groundnut paste was stored in an airtight jar prior to use.

Preparation of Walnut Paste

The walnuts (1 kg) were washed, added to water (1:2; w/v) and boiled for 45 min over medium gas heating. The boiled walnuts were cooled at ambient temperature, the walnut was deshelled by cracking the shell with mortar and pestle, the nut was removed and milled with Kenwood food processor blender operated at full speed (1200 rpm) for about 5-6 mins to ground into paste and stored in a tightly packed container.

Preparation of walnut-groundnut snack

The walnut and groundnut paste were mixed in the following ratios: 100:0, 90:10, 80:20, 70:30, 60:40, and 50:50 based on preliminary study. The snack was prepared by thoroughly mixing each proportion of the walnut-groundnut mix with 80 g of hot caramelized sugar, then rolling and shaping the mixture using cookie cutters. The snacks were allowed to cool at ambient temperature for 20 min and packaged in low-density polyethylene prior to analysis. Figure 1 shows the flow chart illustrating the process of preparing the walnut-groundnut snack.

Determination of Proximate Composition of Walnut-Groundnut Snack

The crude protein, crude fat, crude fibre, ash, and moisture contents of the snack samples was determined using [14], while carbohydrate was determined by difference, that is by subtracting the sum of the percentage protein, fat, fibre, ash and moisture from 100%.

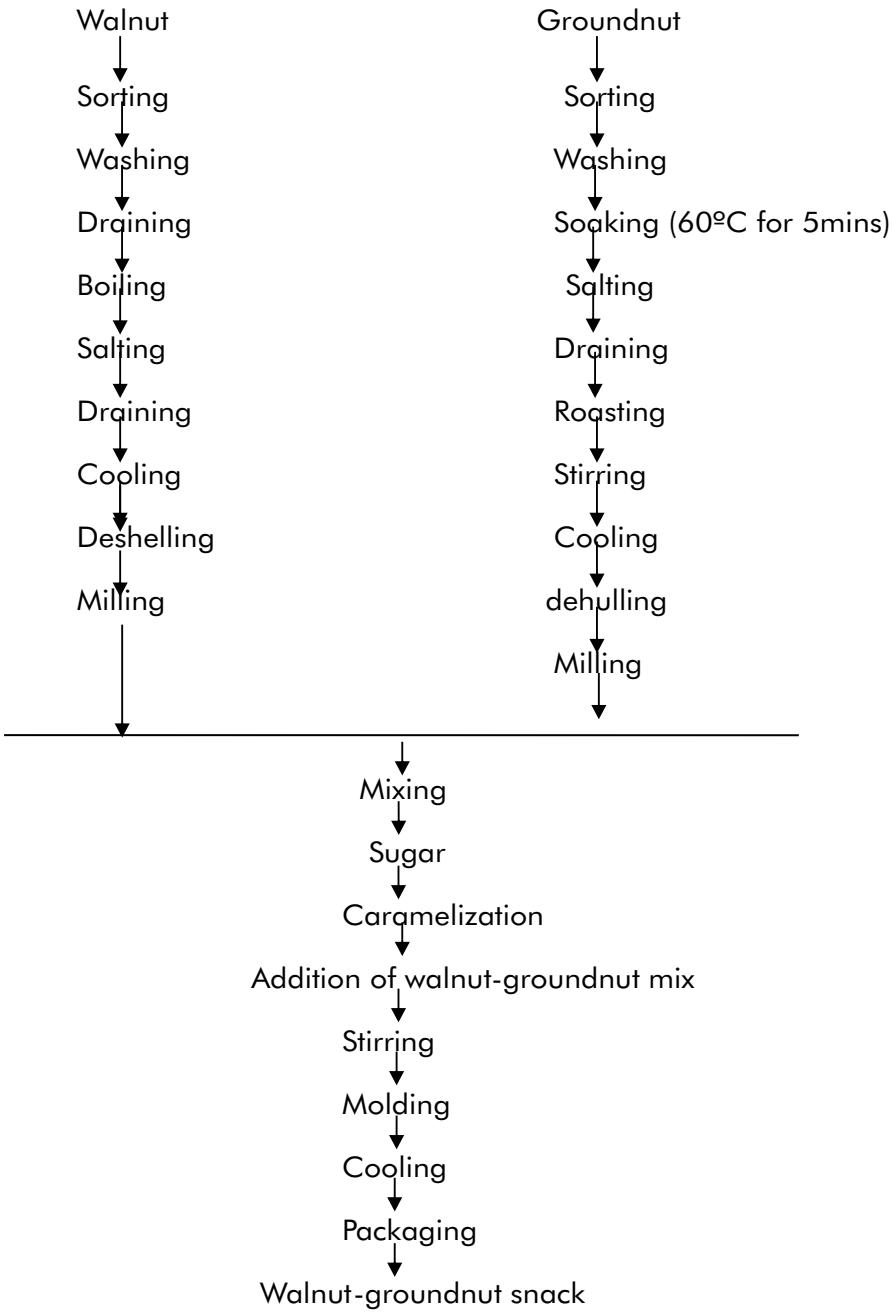

Fig 1: Flow chart for the production of walnut-groundnut snack

Determination of Mineral Content

The snack samples were ground into fine powder, measured (5 g), and transferred into a container called a crucible. The crucible was then placed into a high-temperature combustion chamber called a muffle furnace and heated to 550 °C in order to combust off any organic material and leave only the inorganic ash. The ash was dissolved in a 100 cm^2 solution of hydrochloric acid (10%) and utilized for an evaluation of mineral content. The determination of mineral elements was conducted using the Atomic Absorption Spectrophotometer (AAS) to measure the radiation of each bulk of the 20 A model. The hollow cathode lamp provided the resonance line for each mineral. An analysis was conducted using standard calibration. The atomic absorption spectrophotometer (AAS) method of [14], was used to measure the mineral content (phosphorus, magnesium, and copper) of the walnut-groundnut snack.

Vitamin Analysis

The vitamin contents (B1, B3, B6 and E) of the walnut-groundnut snack samples were determined using standard analytical method [15].

Sensory Evaluation

The walnut-groundnut snack samples and the control sample (100% walnut snack) underwent sensory evaluation by a group of 50 untrained panellists randomly chosen from the student and staff population of Ladoke Akintola University of Technology (LAUTECH), located in Ogbomoso, Oyo State, Nigeria. The snacks were labelled with numerical codes and served to the panellists on disposable plates. The panellists were tasked with assessing the snacks based on their color, taste, aroma, texture, appearance, and general acceptability using a 9-point hedonic scale, where a rating of 1 indicated extreme dislike and a rating of 9 indicated extreme liking [16].

Statistical analysis

All data obtained from proximate analysis were analysed using IBM SPSS statistical software (SPSS 20.0 for Windows, SPSS Inc., Chicago, Illinois, United States). Analysis of variance (One-way ANOVA) and the Duncan test were both used to compare the means at a significance level of $p<0.05$.

RESULTS

Plate 1 shows the images of the walnut-groundnut snacks. The results of the proximate composition of the walnut-groundnut snack are presented in Table 1.

Plate I: Walnut-groundnut snack.

Table I: Proximate composition (%) of walnut-groundnut snack

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude Fibre (%)	Carbohydrate (%)
A	3.33±0.58^{b}	16.59±0.04^{a}	21.00±1.00^{a}	0.30±0.00^{a}	0.35±0.04^{c}	58.43±1.24^{a}
B	1.43±0.12^{a}	16.99±0.04^{b}	21.33±1.53^{a}	0.40±0.10^{ab}	0.37±0.04^{c}	59.48±1.58^{b}
C	1.20±0.26^{a}	17.21±0.04^{c}	24.00±1.00^{b}	0.47±0.06^{bc}	0.31±0.04^{bc}	56.81±0.92^{ab}
D	1.13±0.15^{a}	17.64±0.04^{d}	26.00±0.00^{c}	0.57±0.06^{c}	0.26±0.07^{ab}	54.40±0.14^{a}
E	1.67±0.29^{a}	18.96±0.04^{e}	24.67±0.58^{bc}	0.53±0.06^{c}	0.20±0.00^{a}	53.97±0.81^{a}

Mean±standard deviation ($n=3$). Values with different superscript letters in the same column are significantly difference at $p<0.05$. A = 100:0 (100% walnut snack); B = 90: 10 (walnut: groundnut); C = 80:20 (walnut: groundnut); D = 70:30 (walnut: groundnut); E = 60:40 (walnut: groundnut).

The mineral composition of the walnut-groundnut snack is presented in figure 2. The vitamin contents of the snacks are shown in Table 2. Figure 3 show the acceptance score of the consumers among the ratio of walnut-groundnut snacks, encompassing aspects such as appearance, color, aroma, taste, texture, and overall acceptability.

DISCUSSION

Proximate composition of walnut-groundnut snack

There was no significant difference (P>0.05) in the moisture content of all the ratios of the blends. However, there was significant difference (P<0.05) between the control and all the blends, with the 100% walnut snack having the highest moisture contents of 3.3%. This is possibly due to the reduction in moisture contents of groundnuts during roasting. This observation is in agreement with that of [17] who reported lower moisture contents for Wheat-African walnut cookies compared to the control sample. In this instance, it was anticipated that low moisture content obtained from this study is desirable because it indicates that the snack would have extended shelf-life due to its tendency to inhibits the development of microorganisms that causes spoilage [18].

The protein content of the walnut-groundnut snacks was significantly higher than that of the 100% walnut snack especially at higher substitution level. The value of protein gotten for 100% walnut in this study is higher than that of the one reported by [19,20]

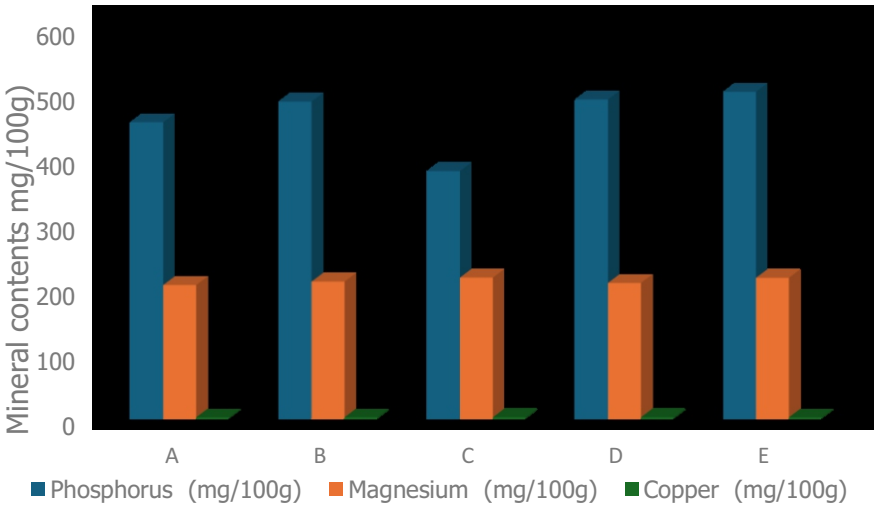

Figure II: Mineral contents of walnut-groundnut snack.

A = 100:0 (100% walnut snack); B = 90: 10 (walnut: groundnut); C = 80:20 (walnut: groundnut); D = 70:30 (walnut: groundnut); E = 60:40 (walnut: groundnut).

Table II: Vitamin contents of walnut-groundnut snack

Sample	Vitamin B1 (mg/kg)	Vitamin B3 (mg/kg)	Vitamin B6 (mg/kg)	Vitamin E (mg/kg)
A	82 ± 0.002^{bc}	120 ± 0.00^{b}	660 ± 0.04^{a}	2350 ± 0.76^{a}
B	75 ± 0.001^{a}	100 ± 0.01^{a}	880 ± 0.03^{b}	3630 ± 0.29^{b}
C	77 ± 0.001^{a}	110 ± 0.00^{a}	1500 ± 0.07^{e}	1650 ± 0.31^{a}
D	78 ± 0.002^{gb}	130 ± 0.00^{c}	950 ± 0.03^{c}	4690 ± 0.31^{c}
E	84 ± 0.004^{c}	150 ± 0.01^{d}	1280 ± 0.01^{d}	5410 ± 0.07^{c}

Mean±standard deviation ($n=3$). Values with different superscript letters in the same column are significantly difference at $p<0.05$. A = 100:0 (100% walnut snack); B = 90: 10 (walnut: groundnut); C = 80:20 (walnut: groundnut); D = 70:30 (walnut: groundnut); E = 60:40 (walnut: groundnut).

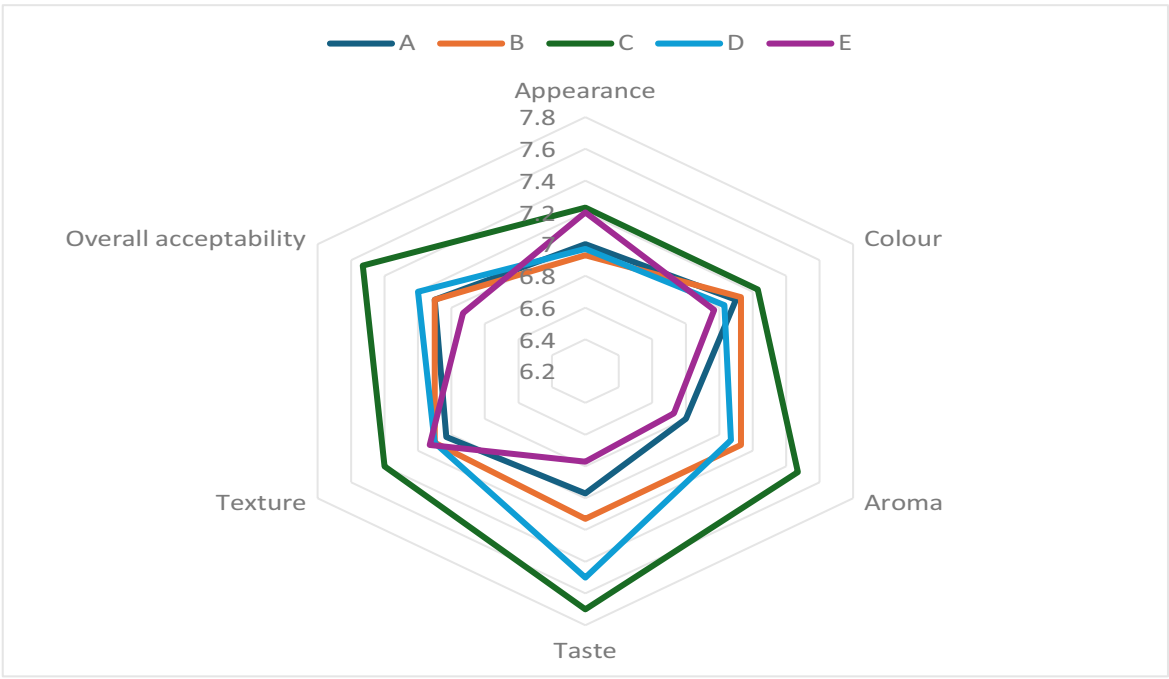

Figure III: Sensory evaluation of walnut-groundnut

snack. A = 100:0 (100% walnut snack); B = 90: 10 (walnut: groundnut); C = 80:20 (walnut: groundnut); D = 70:30 (walnut: groundnut); E = 60:40 (walnut: groundnut).

which indicated that roasting improves the protein content of the walnut snack. Also, there were significant difference ($P<0.05$) in the protein content of all the ratio of the blend and the control. This could be due to the high protein contents of groundnut. According to [21] groundnuts are a good source of protein and have high lysine content, making it a good complement for nuts that are low in lysine. The protein content of the walnut-groundnut snacks is lower than the protein contents (40.25%-42.28%) of robo produced from blends of melon and groundnut [9]. This could be due to relatively low protein content (10.6 – 18.8%) in walnut [5].

The fat contents of the snack increased with increased in the proportion of groundnut paste in the walnut-groundnut snack. This could be because groundnut is an oil seed with oil contents of more than 20% [22] which reported it to typically ranged s from 47% to 50%. The value of fat content obtained for 100% walnut in this study is lower than that of the one reported by [19,20] This could be due to varietal differences in the walnuts. The low-fat content of walnut-groundnut snacks might be due to exposure to high temperatures during roasting which lead to the oxidation of unsaturated fatty acids which alter the presence of fat in the nuts [23] and prevent it from rancidity during storage [11]. Hence, this makes it suitable for those who prefer low-fat snacks which could contribute to reducing the risk of cardiovascular diseases.

The ash content of the walnut-groundnut snack increased (0.30 – 0.57%) as the level of the groundnut paste increased in the samples. There were significant differences ($p< 0.05$) for lesser ratio of groundnut but no significant differences ($p>0.05$) as the ratio of groundnut increases in the blends. This indicates the availability of high levels of minerals in the walnut-groundnut snack, as a results of high mineral contents in walnut. The increase in the ash content of the snack as the ratio of groundnut increased from 0-30% is in conformity with the report of [11], who reported significant increase in the ash content of soy-walnut milk drinks.

There was no statistically significant difference ($p>0.05$) observed in the crude fibre content between the control and the10% groundnut substitution. However, a noteworthy decrease in crude fibre was observed with an increasing addition of groundnuts. The obtained result is in contradiction with the findings of [11], which indicated the absence of fibre in the soy-walnut drinks due to the removal of solid raw components.

The present study suggests that incorporating whole walnut in snack making enhances the fibre content of the snack. Thus, the snacks with lower ratio of groundnut in walnut-groundnut snacks may positively impact the digestive system.

There was no significant difference ($p > 0.05$) in the carbohydrate content of all the snack samples. Nevertheless, a notable decrease in carbohydrate content was observed with an increasing addition of groundnuts, similar to the crude fibre trend. This trend may be attributed to the higher fat contents in snacks with more groundnut substitutions, resulting in higher energy value. The high carbohydrate content in walnut-groundnut snacks could confer a higher calorific value, rendering them a valuable source of energy for consumers [11,12]. This implies that walnut-groundnut snacks could serve as a significant energy source in the diets of both adults and children.

Mineral composition of walnut-groundnut snack

The phosphorus and magnesium content of the snacks were significantly different ($p<0.05$) for all samples (Fig 2). Also, as the addition of % groundnut increase there was increase in the amount phosphorus and magnesium present in the walnut-groundnut snacks. This might be due to high amount of phosphorus and magnesium present in groundnut [7,22] which implies that walnut which is a good food item in terms of essential element will be improved with addition of groundnut. However, phosphorus and magnesium has been reported to be major mineral present in walnut [24]. In the present study, the phosphorus (380 - 502 mg/100g) and magnesium contents (208 – 216 mg/100g) of the snacks was higher than that of the raw walnut as reported by [2,24,25] which reported magnesium to be average range of 158 mg/100g and phosphorus average range of 346 mg/100g. In addition, [5] reported the phosphorus and magnesium contents of walnut-soup to be (54 - 58 mg/100g) and (21 – 71 mg/100g) respectively. Bolarinwa et al. [11] also reported that the magnesium content in their study on the development and quality evaluation of soy-walnut milk drinks ranged from 19.85 to 59.51 ppm, which is consistent with the results obtained in the present study. There was no significant difference ($p>0.05$) in the copper contents of walnut-groundnut snacks among all samples. The supplementation with groundnut did not affect the presence of copper in the walnut-groundnut snacks due to the low level (1.15 to 2.0 mg/100g) of copper in both walnut and groundnut [22,25], which falls within the range of values obtained in this study. Thus, the mineral contents of walnut-groundnut snacks could help to keep the heart, brain, kidney, muscle tissues, reduce the osteoporosis in elderly people and keep the other important organs of human body in good state.

Vitamin composition of walnut-groundnut snack

Vitamins B6 and Vitamin E were highest in the control sample (100% walnut snack) than the walnut-groundnut snack samples. This could be due to high levels of these vitamins in walnut. However, there were significant differences ($p<0.05$) between vitamin B1 and B3 contents of the walnut-groundnut snacks. This could be due to the differences in the vitamin contents of the walnut and groundnut. According to past studies, vitamin B1 contents of walnut and groundnut was reported to be 341 mg/kg [6] and 640 mg/kg [21], respectively. In general, vitamin B3 contents (120 – 150 mg/kg) was similar to the vitamin B3 contents (130 - 423 mg/kg) reported for ready to eat snacks made from blends of breadfruit, cashew nut and coconut [26]

Sensory Evaluation

Generally, snack appearance is associated with the attractiveness of the product [27]. No statistically significant difference ($p>0.05$) in the appearance of the walnut-groundnut snack was detected among all samples which indicate that all the panellists liked the appearance of the snacks. Color, being a crucial attribute influencing food acceptability, reflects ingredient suitability, material appropriateness for food preparation, and provides information about product formation and quality [27]. There were no significant differences ($p>0.05$) in the colour rating of the walnut-groundnut snacks by the panellists.

Aroma, an integral component influencing taste and overall acceptance before consumption, is an essential parameter in assessing the acceptability of formulated food [11,28] There was no significant difference ($p>0.05$) between the aroma of the control and 60% walnut snacks (Fig 3). Additionally, no statistically significant difference ($p>0.05$) was observed between samples 90 and 80% walnut snacks. However, Sample C, which consists of 80% walnut and 20% groundnut, is the most preferred sample with the highest rating of 7.47 for aroma, while the least desired sample was the 60% walnut snacks with a rating of 6.73.

Taste is a crucial factor in sensory evaluation [11]. Among all the snacks' samples 80% walnut snack

was highly rated (7.70) for taste while the 60% walnut snack had the least score (6.77) for taste. There was no statistically significant difference ($p>0.05$) between control and 90% walnut snack in terms of taste. Similarly, all the snack samples were not significantly difference ($p<0.05$) in terms of texture. This indicates that the panellists liked the crunchiness of the samples. The texture refers to the dominant physical properties of a product that govern its chewability or swallowability at the time of intake and could be hard, fibrous, and crunchy texture [27,28]. Furthermore, the 80% walnut snack had the highest sensory scores for overall acceptance probably due to its highest scores in appearance (7.23), color (7.23), aroma (7.47), taste (7.70), and texture (7.40). On the other hand, there was no significant differences ($p<0.05$) in the overall acceptance of the control, 90% and 70% walnut snack. This could be due to the high level of walnuts in this snack blends.

CONCLUSION

A highly nutritious, palatable, and acceptable snack can be produced through the incorporation of groundnut to walnut paste. The formulation of a walnut-groundnut snack using the blends of 80% walnut with 20% groundnut resulted in a product with high protein, mineral and vitamin contents that is also highly acceptable by consumers. The consumption of this snack has the potential to enhance protein and micronutrient intake among children and adults, contribute to increased utilization of walnuts, improved overall health, and creating new market opportunities for the food industry. Further studies should focus on the amino acid profile of the snack and the storage stability of the product. Once these demonstrates favourable outcomes, the development of value-added products on a pilot scale can be carried out, benefiting both producers and consumers.

Conflicts Of Interest

There is no potential for a conflict of interest as the research does not involve any third parties that could potentially influence the findings.

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