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NUTRITIONAL AND SENSORY ACCEPTABILITY OF CANDY TRADITIONALLY MADE FROM VARIOUS NUTS IN NIGERIA

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ABSTRACT
This research aims to evaluate the nutritional composition and consumer acceptability of traditional candies made from various nuts. The study employed proximate and mineral analyses following the methods, while sensory evaluation was conducted using a nine-point hedonic scale. Results indicated significant differences ($p < 0.05$) among the candies, with mineral composition ranging from calcium 3.04 mg/kg, magnesium 9.06 mg/kg, potassium 390.02 mg/kg, sodium 667.43 mg/kg, phosphorus 22.31 mg/kg, manganese 9.05 mg/kg, to iron 2.80 mg/kg. Proximate analysis revealed a moisture content of 8.34%, fat of 13.45%, protein of 16.67%, fiber of 4.03%, carbohydrate of 55.02%, and an energy value of 407.81 kcal/kg. Sensory evaluation yielded scores of 6.86 for appearance, 7.63 for color, 6.80 for texture, 6.71 for flavor, 6.87 for hardness, 7.30 for fracturability, 6.97 for sweetness, 6.43 for clarity, 5.77 for stickiness, and 7.21 for overall acceptability. These findings suggest that traditional nut-based candies possess diverse nutritional properties and sensory attributes that may complement daily dietary requirements and potentially address mineral deficiencies. Furthermore, these products could enhance the utilization of locally available food materials and serve as functional snacks in regions with limited access to diverse nutritional resources.

Keywords: Traditional candies, nutritional composition, nut candy processing and sensory attribute.

INTRODUCTION

Candy is a popular confectionery made from a mixture of sugar, natural and artificial sweeteners, flavorings, coloring agents, and sometimes preservatives (BSN, 2008). Its production process and varied ingredients affect its physical and sensory characteristics. Candy's appeal lies in its affordability, sweetness, and sensory attraction, making it a favorite among people of all ages, especially children. While candy is primarily composed of sweeteners, some types offer nutritional value, while others reduce caloric intake, depending on their intended use (Kurt et al. 2022). Additional sweeteners like corn syrup, molasses, and sugars are used due to their cost-effectiveness and accessibility. The food industry is shifting towards incorporating natural ingredients to enhance the nutritional profile and sensory experience of food products (Rutkowska et al. 2019). This trend is evident in beverages and confectionery (Neves et al. 2019). Certain foods are rich in xanthones, flavonoids, and organic acids, which provide hepatic, anti-inflammatory, anti-tumor, and antioxidant properties (Cho et al. 2019). According to the National Health and Nutrition Examination Survey (NHANES, 2010), 31% of American children aged 2-18 years consume candy daily, with an average intake of 40g (176Kcal) per day (Duyff et al. 2015). Globally, approximately 30% of the population faces malnutrition and other deficiency diseases (Pelto & Armar-Klemesu, 2011). Despite candy's widespread consumption, it is known to contain poor nutritional ingredients. However, nuts offer a cheap and excellent source of nutrients, ranging from macronutrients to micronutrients, which can replace artificial ingredients. This study examines the nutritional, mineral, and sensory attributes of candy produced from various nuts, which have proven to be a useful source of nutrients.

Peanuts, categorized within the legume family, are often misconstrued as nuts; they harbor a plethora of antioxidants, amino acids, and flavonoids. Their fat content predominantly consists of healthy polyunsaturated and monounsaturated fatty acids, with minimal saturated fat content, rendering them advantageous for human health Natalie *et al.* (2018). Cashew nuts are popularly incorporated into snacks and dishes for their creamy texture and are rich in monounsaturated fats, vitamins, and calories, imparting significant nutritional value. They offer a pleasant flavor and can be consumed roasted, fried, or as an ingredient. Cashews share similar nutritional attributes with groundnut seeds, offering protein, essential oils, vitamins, and minerals (Fat and Oil News, 1988; Manay *et al.* (1987). Groundnuts serve as an excellent source of soluble vitamins, aiding in antioxidation and inhibiting free radical formation through oxidative hindrance. They contribute to energy production in mitochondria and contain coenzymes crucial for carbohydrate and amino acid metabolism, potentially preventing diseases associated with the nervous and cardiovascular systems Blomhoff *et al.* (2006). Consumable in raw, cooked, or roasted forms, groundnuts are an economical source of protein, minerals, vitamins, fats, and carbohydrates, playing a pivotal role in addressing malnutrition in developing nations Food and Nutrition Board, (2002). Sesame, among the oldest condiments, encompasses a variety of species across tropical Africa, Asia, and India Saydut *et al.* (2008). Renowned for its stable oil with antioxidant properties, sesame finds utility in replacing fats in various food industries like baking, confectionery, and mayonnaise Noon (2003). Sesame oil boasts a low cholesterol level, potentially mitigating cardiovascular diseases, and synergizes with alpha-tocopherol to reduce serum cholesterol levels. Rich in polyunsaturated fatty acids, sesame and vitamin E, sesame oil offers blood pressure-lowering effects compared to pharmaceuticals (http://iqm.nlm.nih.gov). Additionally, sesame is a rich source of macro- and micronutrients, including minerals, vitamins, dietary lignans, and proteins. Tigernut a small tuber of Cyperus esculentus L., dubbed the underground walnut, exhibits prolific growth and is nutritionally rich in fat, carbohydrates, fiber, vitamins, and minerals. Its nutritional composition varies geographically based on soil conditions, with versatile consumption methods ranging from raw to toasted or coated with sweeteners. Tigernut possess medicinal significance and contain organic acids, alkaloids, and phenols, along with edible monounsaturated fatty

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acids akin to olive oil Roselló-Soto *et al.* (2018). Its nutrient profile benefits diabetic patients and aids in digestive function challenges, while its rich fiber content aids in preventing colon cancer, obesity, and gastrointestinal issues Viuda-Martos *et al.,* (2015). Tigernut natural antioxidant properties, attributed to flavonoids, further bolster their nutritional appeal Jing *et al.* (2018). Almonds, scientifically termed Prunus dulcis, belong to the Rosaceae family and boast a unique nut kernel Gradziel (2020). Widely employed in confectionery, snack food, and bakery industries, almonds offer a rich array of micronutrients, bioactive antioxidant lipids, and macronutrients. Associated health benefits include cardiovascular disease risk reduction, cholesterol moderation, and prevention of chronic ailments Abbey *et al.* (1994). Regular consumption of almonds not only provides antioxidant effects but also reduces the risk of colon cancer (Davis and Christine 2001). Their global popularity stems from their health benefits and sensory appeal.

MATERIALS AND METHODS:

Sample Collection: Fully mature nuts (groundnut, Tigernut, almond nut, cashew nut and sesame nut) 1kg each were procured from Terminus Jos main market in clean polyethylene bags and carefully transported to university of Maiduguri department food science and technology food processing laboratory. Other ingredients such as white sugar was also sourced from Terminus Jos main market. All chemicals and materials utilized were of analytical grade.

Preparation of Nuts

The nuts were processed as follow

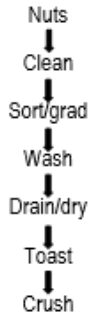

Figure 1: Nuts preparation

The candies were produced by heating sugar with little addition of water to 130^{0}C for 3-7minut to form a syrup and caramelized follow by gradual addition of the nuts and mixing to for a uniform mixture and quickly transfer to aluminum foil sheet to shape and cut and allow to cool. nuts to sugar in 2:1 ration is presented in **figure 2**.

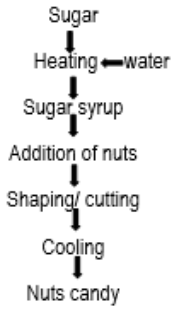

Figure 2: candy processing (Hartel and Hartel, 2013)

Proximate Analysis

The proximate composition of Candy was determined for moisture content, ash, fat, protein and total carbohydrate following standard methods of Association of Official Analytical Chemists AOAC (2012). Each process was performed in triplicate.

A sensory evaluation of nut-based candies was conducted with a 50-member screened panel to assess appearance, flavor, texture, color, clarity, sourness, sweetness, hardness, fracturability, stickiness, and overall acceptability (ISO 8586:2012). A nine-point hedonic scale (9 = extremely like, 1 = extremely dislike) was used. To minimize bias, samples were coded and presented randomly (Lawless & Heymann, 2021). The panelists received standardized instructions to ensure evaluation consistency

RESULTS

Plate 1: Appearance of Candies Prepared from Different Nuts

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Table 1 Mineral Composition of The Various Candy from Different Nuts

	Parameters 1								
Sample code	**Ca(mg/kg)**	**Mg(mg/kg)**	**K(mg/kg)**	**Na(mg/kg)**	**P(mg/kg)**	**Mn(mg/kg)**	**Fe(mg/kg)**	**Zn(mg/kg)**	**cu(mg/kg)**
X	4.15^{a} ±0.14	7.16^{b}±0.12	403.50^{c}±9.19	772.50^{a}±17.68	42.03^{a}±0.01	6.59^{d}±0.16	3.92^{a}±0.11	4.20^{a}±0.14	1.21^{b}±0.06
B	3.60^{b} ±0.99	7.12^{b}±0.25	398.77^{c}±2.51	719.40^{a}±55.72	40.75^{a}±1.83	6.59^{d}±0.16	3.35^{ab}±0.78	4.04^{a}±0.06	1.16^{c}±0.11b
C	3.24^{bc} ±0.44	7.12^{b}±0.19	500.55^{b}±1.35	723.00^{a}±60.81	21.47^{ab}±0.35	6.74^{c}±0.78	2.37^{bc}±0.68	3.95^{a}±0.07	0.90^{cd}±0.22
D	3.60^{b} ±0.00	7.22^{b}±0.00	600.45^{a}±0.00	765.00^{a}±0.00	3.60^{b}±0.00	7.97^{b}±0.00	1.90^{c}±0.00	3.95^{a}±0.00	0.70^{d}±0.00
E	2.42^{d}±0.01	16.61^{a}±0.01	66.80^{d}±0.54	357.26^{b}±0.68	3.71^{b}±0.01	9.11^{a}±0.00	2.43^{bc}±0.00	2.62^{b}±0.53	2.42^{a}±0.01
Mean	3.40	9.05	394.02	667.43	22.31	7.31	2.80	3.75	1.28
Cv	14.35	1.66	16.08	5.65	50.94	12.06	16.61	6.63	8.81

1 value are mean with standard ± deviation duplicate determination in any column bearing similar subscript have no significant difference (P≤0.05) X= Groundnut candy B= Tiger nut candy C= Almond candy D= Cashew nut candy E= sesame.

DISCUSSION

As presented in **Table1** the mineral composition of the study revealed significant ($p < 0.05$) variations in the mineral composition of different nut-based candies. Cashew nut candy (D) contained the highest levels of potassium (600.45 mg/kg), manganese (7.97 mg/kg), and sodium (765.00 mg/kg) concentrations. Sesame candy (E) was particularly rich in magnesium (16.61 mg/kg), copper (2.42 mg/kg), and manganese (9.11 mg/kg) levels. Groundnut candy (X) had the highest calcium (4.15 mg/kg) and iron (3.92 mg/kg) content. Conversely, sesame candy (E) showed significantly notably lower potassium (66.80 mg/kg) and sodium (357.26 mg/kg) levels. The findings suggest nutritional diversity of nut-based candies demonstrating their potential as functional snacks that can supplement dietary mineral intake.

Table 2 The Proximate Composition of the various Candies from Different Nuts.

	Parameters 1						
Sample code	**Moisture(%)**	**Protein (%)**	**Fat (%)**	**Ash (%)**	**Fiber**	**Carbohydrate(%)**	**Energy (Kal/kg)**
X	8.13^{c}±0.18	17.11^{b}±0.16	16.17^{b}±0.04	2.00^{c}±0.06	3.72^{c}±0.24	52.86^{c}±0.25	425.48^{b}±1.29
B	9.10^{a}±0.00	9.81^{c}±0.01	3.26^{d}±0.01	2.02^{c}±0.00	2.43^{d}±0.00	73.38^{a}±0.03	362.10^{e}±0.07
C	8.62^{b}±0.02	17.05^{b}±0.01	13.26^{c}±0.08	2.33^{b}±0.00	5.45^{b}±0.41	53.30^{c}±0.33	400.72^{d}±2.15
D	8.46^{bc}±0.23	22.60^{a}±0.28	18.35^{a}±0.21	3.73^{a}±0.02	6.29^{a}±0.11	40.56^{d}±0.86	417.81^{c}±0.38
E	7.41^{d}±0.30	16.76^{b}±1.05	16.22^{b}±0.03	2.37^{b}±0.05	2.26^{d}±0.03	54.98^{b}±0.70	432.96^{a}±1.13
Mean	8.34	16.67	13.45	2.49	4.03	55.02	407.81
Cv	2.25	2.94	0.77	1.40	5.41	0.96	0.30

1 value are mean with standard ± deviation duplicate determination in any column bearing similar subscript have no significant difference (P≤0.05). X= Groundnut candy B= Tiger nut candy C= Almond candy D= Cashew nut candy E= sesame candy

The proximate composition of nut-based candies as presented in **Table 2** revealed diverse nutritional contributions, suggesting their potential as dietary snack. Moisture content ranged from 7.41% in sesame candy (E) to 9.10% in tiger nut candy (B). Protein content was highest in cashew nut candy (D) (22.60%), followed by groundnut candy (X) (17.11%) and almond candy (C) (17.05%), while tiger nut candy (B) had the lowest protein content (9.81%). The fat content was highest in cashew nut candy (D) (18.35%), followed by sesame candy (E) (16.22%) and groundnut candy (X) (16.17%), whereas tiger nut candy (B) had the lowest fat content (3.26%), making it a lower-fat option among the samples.

In this study, the ash content was highest in cashew nut candy (D) (3.73%), while groundnut candy (X) had the lowest (2.00%). Dietary fiber content varied significantly, with cashew nut candy (D) exhibiting the highest value (6.29%), followed by almond candy (C) (5.45%), whereas sesame candy (E) recorded the lowest (2.26%). Carbohydrate content was most abundant in tiger nut candy (B) (73.38%), making it the most carbohydrate-dense among the samples, while cashew nut candy (D) had the lowest (40.56%).

In terms of energy value, sesame candy (E) exhibited the highest caloric content (432.96 kcal/kg), followed by groundnut candy (X) (425.48 kcal/kg) and cashew nut candy (D) (417.81 kcal/kg), whereas tiger nut candy (B) had the lowest energy value (362.10 kcal/kg).

Table 3 Sensory Analysis of The Various Candies from Nuts

Sample code	Appearance	Flavor	Texture	Color	Clarity	Sweetness	Hardness	Fractubility	Stickiness	Overall acceptability
X	7.00^{a}±1.80	6.36^{b}±1.34	6.43^{c}±1.55	7.29^{d}±1.77	6.64^{a}±1.95	6.14^{c}±1.46	6.21^{c}±2.72	6.50^{c}±2.10	5.07^{b}±2.67	7.86^{a}±1.41
B	5.67^{b}±0.16	5.47^{b}±1.03	4.33^{e}±1.29	7.97^{b}±1.68	6.07^{b}±2.31	6.71^{bc}±1.96	3.81^{d}±1.82	5.33^{d}±2.29	5.47^{b}±2.07	7.19^{b}±2.15
C	7.20^{a}±1.14	7.00^{a}±2.20	8.00^{a}±2.17	9.00^{a}±2.25	6.47^{b}±2.50	8.10^{a}±2.15	8.68^{a}±2.04	8.00^{a}±2.23	5.93^{a}±2.52	6.43^{c}±1.65
D	7.20^{a}±1.57	6.00^{b}±0.96	6.47^{c}±1.64	3.17^{e}±1.93	6.73^{a}±1.67	5.76^{c}±1.96	6.38^{c}±2.68	7.91^{a}±1.88	6.00^{a}±2.56	7.12^{b}±1.85
E	7.27^{a}±1.83	7.40^{a}±1.72	6.67^{b}±1.35	7.75^{c}±1.35	6.27^{b}±2.46	7.48^{ab}±2.31	7.08^{b}±1.15	6.86^{b}±2.36	6.33^{a}±1.88	7.56^{a}±1.94
Mean	6.86	6.71	6.80	7.62	6.43	6.97	6.87	7.30	5.77	7.21
Cv	31.03	27.52	18.49	8.23	34.29	26.81	17.43	10.66	40.83	24.17

value is mean with standard ± deviation duplicate determination in any column bearing similar subscript have no significant difference (P≤0.05).
X= Groundnut candy B= Tiger nut candy C= Almond candy D= Cashew nut candy E= sesame candy

The results of sensory analysis as presented in **Table 3** the Organoleptic attributes of the candies such as appearance, flavor, texture, clarity, color, sweetness, hardness, fracturability, stickiness and overall acceptability. sesame candy (E), Almond candy (C), Cashew nut candy (D) have higher appearance 7.27 and Tiger nut candy (B) with the lower score 5.67. sesame candy (E), Almond candy (C) have higher score of 7.40 while sample Tiger nut candy (B), Cashew nut candy (D) with lower score of 5.47 of flavor. Almond candy (C) has the higher score 8.00 while Tiger nut candy (B) with lower score 4.33 in term of texture. Almond candy (C) has the higher score of color while Cashew nut candy (D) with the list 3.17. clarify was score higher in Cashew nut candy (D) and Groundnut candy (X) 6.73 while sample Tiger nut candy (B) sesame candy (E), Almond candy (C) with lower score 6.27. sweetness score was higher in Almond candy (C) 8.10 while Cashew nut candy (D) was the list 5.56. hardness score in Almond candy (C) 8.68 while Tiger nut candy (B) has the lowest 3.18. fracturbility score was higher in Almond candy (C) and Cashew nut candy (D) 8.00 while Tiger nut candy (B) with the list 5.33. stickiness is higher in Almond candy (C), Cashew nut candy (D) sesame candy (E) 6.33 and Groundnut candy (X) and Tiger nut candy (B) with lower score of 5.07. the overall acceptability is Groundnut candy (X), sesame candy (E) with score 7.88 while the list score is in Almond candy (C) with 6.43. despite the Variations in preference all the product are within the acceptable limit.

Statistical analysis

The data were presented as mean ± standard deviation and subjected to analysis of variance (ANOVA) using Statistical Tool for Agricultural Research (STAR) version 2.0.1. Duncan's Multiple Range Test (DMRT) was employed to determine significant differences among triplicate samples, with statistical significance set at $p \leq 0.05$.

Conclusion

In conclusion, this study demonstrates the significant nutritional value of local candies made from indigenous nuts, providing essential macronutrients and minerals crucial for optimal health, growth, and development. The high mineral content, particularly calcium and phosphorus, in these candies can help combat mineral deficiency diseases and support normal bodily functions. Furthermore, promoting the production and consumption of these local candies can improve social well-being, nutritional status, livelihoods, and food security, ultimately mitigating malnutrition and non-communicable diseases. Additionally, this can foster innovation and reduce reliance on imported candies, contributing to a more sustainable and self-sufficient food system.

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