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NUTRITIONALLY IMPROVED COOKIES FROM COMPOSITE FLOUR: AFRICAN WALNUT (*Tetracarpidium conophorum*) WITH WHEAT

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Abstract
African walnut seed (*Tetracarpidium conophorum*) is rich in protein and phytochemical with great potentials for food application, but has limited uses in food industry. The African walnut seed was procured from Oje market and commercial wheat flour in Aleshiloye market, Ibadan. The commercial wheat and African walnut flours were composites of varying ratios; 100:0, 90:10, 80:20, 70:30 and 60:40 to prepare cookies and labeled samples X, A, B, C and D respectively. The proximate composition, anti-nutrients (oxalates, phytate and protease inhibitor), phyto-chemical (tannins, flavonoids, alkaloids, terpenoids, saponins, and Oxygen Radical Absorbance Capacity (ORAC) and sensory evaluation of the cookies were determined using standard methods. The result of proximate composition of cookies showed that carbohydrate (47.0-52.36%), protein (16.3-19.6%) and fat (18.5-19.2%) were the major components in the cookie samples. Other components including; moisture (7.7-8.4%), ash (4.1-4.2%) and fibre (0.9-1.8%) were generally low. Anti-nutrient factors of cookie samples ranged from 11.3-17.7mg/100g for Phytate and no traces of oxalates and protease inhibitors in all cookie samples. Control cookie sample had no traces of tannin, flavonoids and saponins, but enriched cookie ranged from 10.3-14.7mg/100g; 3.4-5.7mg/100g and 10.7-15.3mg/100g, respectively. Phytochemical constituents of cookie samples in ORAC ranged from 3.4-12.0mg/100g and alkaloids (3.7-7.7mg/100g). Organoleptic panelists preferred sample X to all other samples, followed by sample A. Inclusion of 10% African walnut flour compared favorably with wheat cookie in terms of sensory quality.

Keywords: African walnut, wheat flour, cookies, Phytochemical

Introduction

African walnut (*Tetracarpidium conophorum*) seed is a perennial agricultural plant. It is a climbing shrub that is indigenous to Africa and has enormous potentials for food and industrial uses (Enujiugha, 2003). The seeds are rich in protein (12.3-23.4%) and high nutrient density where 100 grams constitute 65.2 and 6.7g of fat and dietary fibre (Gomez *et al.,* 2007). Protein present in African walnut seed, supply many essential amino acids, thereby, encouraging the possibility of its use as additives in confectioneries and ice cream preparation. The increase in consumption is largely encouraging due to its nutritional value (Ozdemir and Akinci, 2004). However, the significant protein quality of the seeds including higher levels of essential amino acids and other nutrients compared to other nuts and the phytochemical suggest their potential for use in the development of functional foods (Oladiji *et al.,* 2010). Despite the array of nutrients in the seed, the presence of anti-nutrients such as saponin, oxalate and alkaloid responsible for the bitterness upon drinking of water limits its utilization (Awofadeju *et al.*, 2018; 2020). Olabinri *et al.* (2010) noted that African walnut is rich in antioxidant resulting from its bioactive polyphenols.

The kernels of African walnut are oil bearing and the cake left after expression of the oil contains protein (Awofadeju, 2020). The kernel is also a good source of vitamins and mineral (Ojobor *et al.,* 2015). Main reason nut is grouped amidst foods that are beneficial to human body and researchers deduced that intake of walnuts has better advantage on the skin and hair, reduces saturated fat, improves heart and enhances brain function (Burkill, 1984). Nevertheless, research efforts in recent times have continued to unlock the potentials of the seed through different processing methods to reduce the anti-nutrients and further enhance its utilization. For example, earlier study showed the possibility of reducing anti-nutrients in the African walnut seed by the means of applying heat in different ways such as oven drying, air drying and boiling (100°C for 45 minutes) (Awe *et al.*, 2015). To further enhance the utilization of the seeds, studies have incorporated processed African walnut flour in bread production (Awofadeju *et al.,* 2018) and biscuit (Olapade and Abu, 2019). By and large, few studies have explored processed African walnut seed in bakery applications other than wheat flour, for example in the enrichment of cookies. Wheat flour is fairly little in protein and essential amino acids which could be blended with other rich crops, thereby, boosting the nutritional composition of the product. Therefore, the aim of this study is to determine the nutritionally improved cookies made from composite flour (African walnut with wheat flour).

Materials and Methods

African walnut seeds and commercial wheat flour (Honey well) were procured from a local market in Ibadan. Other ingredients such as sugar and salt (Dangote), baking powder (Longman), margarine, egg and milk (Dano) were obtained from the same source.

Processing of African Walnut Flour

African walnut seed was sorted to remove the bad from good seeds, boiled for 45 minutes, cooled and de-shelled. The de-shelled nuts were cut into smaller sizes (3mm) to facilitate drying; oven-dried (45 ^{o}C for 20 minutes) to reduce the moisture content and milled in a Marlex blender. The flour was sieved to pass through 40-mesh sieve (British standard) and packaged in an airtight ziplock bag for further analysis.

Flour Blending

Wheat flour was mixed with African walnut flour at the varying ratios 100:0 (X-control), 90:10 (A), 80:20 (B), 70:30 (C), and 60:40 (D) and labeled samples X, A, B, C and D respectively, in a Kenwood blender. The blends were kept in a ziplock bag at room temperature pending their use.

Cookies Formulation and Preparation of Cookies

The basic formulation for the cookie was 100g flour, 25g margarine, 5g sugar, 0.1g salt and 5g whole eggs. Wheat flour was used as a standard for comparison. Sugar and margarine was mixed in a mixer till fluffiness is attained, 5grams of egg were added, baking powder, salt and flour were mixed in a mixer for thorough distribution until smooth batter is achieved. The batter obtained was flattened on a flat surface to a uniform thickness of 0.25cm and cut to a diameter of 4.6cm using cookie cutter, baked in an oven at 150^{o}C for 20 minutes, cooled and packaged for further analysis. The recipe and cookie preparation were made following the method of Abayomi *et al.* (2013).

Proximate Analysis

The samples (cookies) were subjected to proximate analysis using official methods AOAC (2010). The determination of moisture, crude fibre, crude protein, crude fat and ash contents were carried out. Carbohydrate content was calculated by difference.

Anti-nutritional and Phytochemical Analysis

Oxalate, Phytate and protease inhibitor content was determined by the method described by Chinma *et al*., (2021), while, tannins, flavonoids, alkaloids, saponins, terpenoids and ORAC were determined by Adebiyi *et al.* (2019)

Sensory Properties of Cookies

Sensory properties including; colour, aroma, taste, appearance, crispiness and general acceptability of the enriched cookies were assessed in comparison with the control wheat cookie using a 9-point hedonic scale (1 and 9 represent dislike extremely and like extremely, respectively). The cookies were evaluated by a consumer panel consisting of 25 members who are regular consumers of cookies. Participants were instructed to rinse their mouth with water before they began testing the samples and in-between sample testing.

Data Analysis

Each cookie sample was prepared in duplicate and analyses conducted in triplicates. Data obtained were subjected to one-way analysis of variance (ANOVA) and means separated with Fisher's Least Significant Difference (LSD) test ($p\leq 0.05$) using the Statistical Package for the Social Sciences (SPSS) Version 20 for Windows (SPSS Inc., Chicago IL, USA).

Results and Discussion

Proximate Composition

The proximate composition of cookies prepared from commercial wheat and African walnut flours blends are shown in Table 1. Carbohydrate, protein and fat were the major components in the cookie samples. Other components include; moisture, ash and fibre were generally low. The protein, fat and fibre contents of cookie samples showed a progressive increase as the African walnut flour inclusion increased with a decrease in the carbohydrate content of the cookies. Among the enriched cookies, the protein content ranged from 19.0 - 19.6%. Sample D scored higher content in protein (19.6%), while, control sample X (16.3%) had lower content. This is not surprising because cereals, including wheat generally have lower protein values compared to nuts, following the study of Awe *et al*. (2015), where African walnut was reported to contain 25% protein in dry basis. The high protein content in the African walnut-wheat blend cookies would be of great nutritional benefit in developing countries like Nigeria where cookies (confectioneries) are mainly carbohydrate and energy foods. Previous study recorded close values in cookie preparation from African walnut and wheat flours, displaying results ranging from 12.4-19.5% (Olapade and Abu, 2019). The carbohydrate content of the control (52.4%) is significantly higher than all other samples. Carbohydrate of enriched cookie samples ranged from 47.0-48.7%, where sample B had higher and sample C scored lower values. The results of carbohydrate in this study were within the range reported by earlier studies, which ranged from 42.8-62.7%. This is to ascertain that African walnut seed is highly rich in carbohydrate and protein contents. Fat content of enriched cookies ranged from 18.7-19.2%, while the higher content was observed in sample C and lower appeared in sample A and B (18.7%), with least in Control (sample X) (18.5 %). The high content of fat as evidenced in the African walnut flour inclusion may be because African walnut is an oil-rich seed compared to wheat. This is supported by the study of Enujiugha and Ayodele-Oni (2003) and Awofadeju (2020). More so, Awolu *et al*. (2015) described high fat content as a factor influencing the life span of flour due to oxidative activities. Earlier study revealed the oil content of African walnut to be 55.8-61.6% (Edem *et al.,* 2009). The percentage of fat content observed in the cookie samples would improve energy supply to the consumers (Okaka, 2005). The moisture content of cookie samples were below 12%, which conferred an advantage of better keeping quality of the flours and products, confirming that the product would not support growth of spoilage microorganisms as it can stand over a long period of time. According to Edema *et al*. (2015), who noted that moisture content of flour should not exceed 12%. The fibre content of cookie samples increased with increase in proportion of African walnut flour from 1.4-1.8%. Control cookie sample was lower relative to enriched cookie with the value of 0.9%. Report from Olapade and Abu (2019) negate the reaction of African walnut in the blends used for cookie preparation in this study. The negation could be attributed to varieties of seed, cultivation, location and processing of the cookies. The values of ash contents in this study are approximately 4% for all cookie samples.

Table 1: Proximate composition of cookies enriched with African walnut flour (%)

Sample	Protein	CHO	Fat	Moisture	Ash	Fibre
A	$18.9^{a}\pm0.10$	$48.6^{b}\pm0.28$	$18.7^{b}\pm0.10$	$8.2^{a}\pm0.15$	$4.2^{ab}\pm0.25$	$1.4^{b}\pm0.15$
B	$19.0^{a}\pm0.15$	$48.7^{b}\pm0.15$	$18.7^{b}\pm0.20$b	$7.7^{b}\pm0.15$	$4.1^{b}\pm0.10$	$1.7^{a}\pm0.05$
C	$19.4^{a}\pm0.15$	$47.0^{bc}\pm0.60$	$19.3^{a}\pm0.25$	$8.4^{a}\pm0.15$	$4.3^{a}\pm0.10$	$1.7^{a}\pm0.10$
D	$19.6^{a}\pm0.26$	$47.1^{bc}\pm0.17$	$19.2^{a}\pm0.15$	$8.2^{a}\pm0.15$	$4.1^{b}\pm0.15$	$1.8^{a}\pm0.15$
X	$16.3^{b}\pm0.10$	$52.36^{a}\pm0.15$	$18.^{bc}\pm0.15$	$7.7^{b}\pm0.15$	$4.2^{ab}\pm0.10$	$0.9^{c}\pm0.10$

Means with the same superscript along a column are not significantly different ($p \leq 0.05$)
NOTE: X- 100:0, A- 90:10, B- 80:20, C- 70:30, D- 60:40; CHO-Carbohydrate

Anti-nutritional factors of cookies

Anti-nutrient composition including; oxalates, phytate and protease inhibitor of the cookie samples were assessed to determine the safety of cookies for consumption and results shown in Table 2. Anti-nutrients are known to adversely affect the bioavailability and utilization of nutrients, resulting in different neurological disorders and in some severe cases, death (Olagunju *et al.,* 2018). The anti-nutrients determined in this study were selected because they are commonly associated with bitterness upon drinking of water in African walnut seed. Phytate among enriched cookies ranged from 15.3-17.7% and control cookie sample had 11.3%. The higher value among enriched cookies appeared in sample D, while the least occurred in sample B. The high content of Phytate in sample D could be attributed to high proportion of African walnut flour. Phytate can bind some essential minerals, for example phosphorus in the digestive tract and lead to mineral deficiencies (Soetan *et al.,* 2014). There was no detection of oxalate and protease inhibitors in all the cookie samples. This ascertains the safety of the cookies in consumers when consumed. This is also expected since the flours (wheat and African walnut) have passed through processing and heat reduces anti-nutrients (Soetan and Oyewole, 2009; Awe *et al*., 2015).

Table 2: Anti-nutritional factors of cookies enriched with African walnut flour (Mg/100g)

Sample	Oxalates	Phytate	Protease inhibitors
A	ND	$15.7^{bc}\pm1.15$	ND
B	ND	$15.3^{bc}\pm1.15$	ND
C	ND	$16.0^{b}\pm1.00$	ND
D	ND	$17.7^{a}\pm1.15$	ND
X	ND	$11.3^{d}\pm1.15$	ND

Means with the same superscript along a column are not significantly different ($p \leq 0.05$)
NOTE: X- - - - - ND-No detection

Phytochemical composition of cookies made from African walnut and wheat flours

The phytochemical composition of cookies prepared from African walnut and commercial wheat flours is shown in Table 3. Tannins (10.3-14.7mg/100g), flavonoids (3.4-5.7mg/100g), alkaloids (4.3-7.7%), saponins (10.7-15.3mg/100g) and ORAC (11.5-12.0mg/100g) were higher than the control sample. Control sample exhibited least values in alkaloids (3.7mg/100g) and ORAC (3.4mg/100g). Terpenoids was absent in all cookie samples and alkaloids in sample A. There was no detection of tannins, flavonoids and saponins in control sample. It is plausible to associate the absence of tannins, flavonoids and saponin in control sample to removal of bran during wheat processing. The value of tannins in this study is significantly higher than extruded ready-to-eat snacks made from tigernut, African yam bean and pearl millet which ranged from 1.05-1.21mg/100g (Awofadeju *et al.,* 2021). The noticeable differences owed to processing of ready-to-eat extruded breakfast snack, where soaking, heating and cooking drastically reduced the anti-nutritional factors in the materials. Mbaeyi (2005) confirmed that legumes possessed lower content of anti-nutrients after processing. as it was recorded for breakfast cereals made from pigeon pea and sorghum (0.035-0.130mg/100g). Beside the thermal on tannins effect during cooking, the solubility of flavonoids and alkaloids in water during cooking may also explain the reduction in these compounds.

Table 3: Phytochemical composition of cookies (mg/100g)

Sample	Tannins	Flavonoids	Alkaloids	Saponins	Terpenoids	ORAC*
A	$11.0^{b}\pm1.0$	$3.4^{b}\pm0.57$	ND	$15.3^{a}\pm0.57$	ND	$11.5^{ab}\pm0.15$
B	$14.7^{a}\pm0.57$	$5.3^{a}\pm0.57$	$4.3^{b}\pm0.57$	$11.0^{b}\pm1.00$	ND	$12.0^{a}\pm0.15$
C	$10.3^{c}\pm0.57$	$5.3^{a}\pm0.57$	$7.7^{a}\pm0.57$	$10.7^{c}\pm1.15$	ND	$11.5^{ab}\pm0.20$
D	$11.3^{b}\pm1.15$	$5.7^{a}\pm0.57$	$7.0^{a}\pm1.00$	$11.3^{b}\pm1.15$	ND	$11.8^{ab}\pm0.10$
X	ND	ND	$3.7^{c}\pm0.57$	ND	ND	$3.4^{c}\pm0.11$

Means with the same superscript along a column are not significantly different ($p \leq 0.05$)
NOTE: X- 100:0, A- 90:10, B- 80:20, C- 70:30, D- 60:40; **ND-No detection**

Sensory evaluation of African walnut-wheat flours cookies

The sensory properties of cookies are presented in Table 4. Control cookie sample exhibited higher ratings in general acceptability, followed by sample A (90 commercial wheat flour: 10 African walnut flour), while the lower value appeared in sample D (60:40). The minimum score in sample could be attributed to the percentage ratio of African walnut flour in the blends. The higher rating recorded for control sample is un-surprising as panelists are more familiar with baked goods produced from wheat. Inclusion of processed African walnut flour influenced the appearance, taste, texture, aroma and general acceptability of the cookies. However, Barber and Obinna-Echem (2016) assessed the nutritional composition, physical and sensory properties of wheat-African walnut cookies and recommended that the African walnut flour could be used as a partial substitute for wheat flour at a range of 5-15%.

Table 4 Sensory Evaluation of Cookies Fortified With Walnut Flour

Sample	Colour	Aroma	Taste	Appearance	Crispiness	General Acceptability
A	7. 3	7.3	7.5	7.5	7.3	7.6
B	6.7	6.5	6.5	6.5	6.7	6.7
C	6.4	6.7	5.1	5.5	5.4	5.5
D	5.3	4.8	5.2	5.4	5.5	5.3
X	8.0	8.3	8.0	8.1	8.2	8.3

NOTE: X- 100:0, A- 90:10, B- 80:20, C- 70:30, D- 60:40

Conclusion

The study revealed that cookies made from blends of African walnut and wheat flours improved the cookie samples compared with 100% wheat cookies. However, 100% wheat cookie sample was highly rated among the samples, followed by sample A (90:10). Though, the difference in rating was insignificant. Cookie sample D with the varying ratio of 60:40 was disliked by the panelists despite the higher value in protein content. This explains that no matter how nutritious a product, it might not be attracted by the consumers. Cookie samples made of 10% inclusion of African walnut flour ranked second in acceptance after the control (100:0).

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