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Physicochemical and Sensory Evaluation of Chinchin Made from Blends of Wheat and Walnut Flours

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Abstract

Chinchin was made from A blend of wheat and walnut flours. Walnut flour was incorporated into the wheat flour at 2%, 4%, 6%, 8% and 10% levels. Significant differences ($p < 0.05$) were noticed in the functional properties of the flours in term of bulk density, water absorption capacity, oil absorption capacity and swelling capacity with values ranging from 0.77 - 1.48%, 0.84 - 1.28%, 0.24 - 0.64% and 1.19 - 1.29 respectively. Chinchin samples were evaluated for physical, chemical and sensory properties. Significant differences ($p < 0.05$) in the proximate composition showed values ranged from 1.52 - 3.87%, 4.42 - 12.66% ,2.30 - 8.45%, 1.93 - 2.75%, 0.23 - 2.04% and 73.82 - 88.90% for moisture, protein, fat, ash, crude fiber and carbohydrate contents respectively. Mineral evaluation showed that Mg, Ca, Fe and Zn ranged thus: 0.88 - 1.66 ppm, 0.24 - 0.58 ppm, 0.015 - 0.058 ppm, 0.004 - 0.023 ppm respectively; Tannins (0.87 - 3.74 mg/100g and Saponin, 0.22 - 0.73 mg/100g, while the L*, a* and b* values ranged thus: 29.01 - 45.49, 5.99 - 9.28, 6.08 - 15.65 respectively. Sensory evaluation is done by fifty assessors on the appearance, taste, texture, flavor and overall acceptability of the chinchin showed that the most preferred chinchin sample was the one with a 2% substitution level. These results suggested that African walnut flour can be incorporated into chinchin production to improve the nutritional intake of consumers and enhance the utilization of African walnut.

Keywords: *Chinchin; Wheat; Walnut*

Introduction

Foods, commonly referred to as snacks, are convenient foods, which can be eaten in-between meals. Due to urbanization and more women pursuing working carriers, an increasing proportion of household food budget in Nigeria especially is spent on snack food items, in which convenience and quality are perceived as most important [1]. The snack food industry is continually growing with new products becoming available every year. Snack foods are typically designed to be portable, satisfying and convenient and always in a ready to eat form. They are available in different forms of products such as chinchin, cookies, cake, biscuit and bread with diverse sensory, nutritional and storage capacity [2,3].

The African walnut (*Tetracarpidium conophorum*) has a long history as a food plant that is grown by peasant farmers across West African rain forest and India. African walnut is a perennial climbing shrub of 3 - 6m long and needs a tree for support. The climber bears capsules that are greenish when young and greenish/yellow when fully ripe. They contain four shelled seeds with brown shell and white/yellowish kernels. Its seeds are seasonal, take 4 - 6 months to mature and are mostly found between May and August [4,5] and in Nigeria, it is found mostly in the eastern and western parts [5]. The plant is mostly cultivated in the traditional settings for its nuts which can be cooked or roasted or sundried and consumed as snacks [6]. African walnut is rich in protein, carbohydrate and fat, but low in fiber and ash content [7]. The roasted seeds are usually grounded like melon seed to be used as a thickener in soup preparation, while dried walnut could also be grounded into flour to be used as composite flour during baking or in place of milk in tea preparation [8].

According to Bamishaiye and Bamishaiye [9], the word chinchin originated from West Africa. Chinchin is a fried snack popular in West Africa and the world over. It is of different shapes depending on choice, sweet, cookie-like and made from wheat flour and egg. Wheat flour is the main raw material needs to be enriched with adequate protein and fiber sources [10]. In most West African countries, chinchin is described based on its textural and mouth feel characteristics such as chewiness and crunchiness [11]. It is a snack with low moisture content and crunchier when compared to other snack foods like cookies and biscuits [10].

Composite flour is a blend of two or more flours in order to enrich flour for baking characteristics [12,13]. Composite flour is considered advantageous in developing countries, as it reduces the importation of wheat flour through capital flight and encourages the use of locally grown crops [14,15]. According to Mepba., *et al.* [16] the experience gained by using composite flour includes enhanced product technology and consumer acceptance among others, though it was reported that the percentage of wheat flour required to achieve a certain effect in composite flours depend heavily on the quality and quantity of wheat gluten and the nature of the product involved. Therefore, it is expected that when bakery and pastry products are produced using composite flour, their quality should be as similar as possible if not better to those of products made from wheat flour only.

Materials and Methods

African walnut was sourced from a farm at Ilesha, Osun State, while wheat flour and other principal ingredients like margarine, sugar, egg, nutmeg, flavor, and milk were purchased from the Zapata market, Ilorin, Kwara State, Nigeria.

Preparation of African walnut flour

The whole walnuts were initially sorted and washed completely to get rid of any adhering contaminants. They were then cooked for half an hour in an exceeding steel pot to get rid of the shells. With the help of a stainless-steel knife, they were deshelled. The shelled nuts were reduced into smaller sizes and blanched in warm water of 60ºC for 5 minutes. Blanched walnuts were dried in an oven operated at 60°C for 5 hours to get rid of moisture. They were then cooled, milled and sieved to fine walnut flour (Offia-Olua 2014).

Formulation of wheat and African walnut flour

Flour blends were made by substituting wheat flour with walnut flour at 2, 4, 6, 8 and 10% inclusion levels respectively, the control comprised 100% wheat flour.

Preparation of chinchin

The flour blends, sugar, margarine, egg, baking powder, nutmeg, milk and water were mixed together at an appropriate ratio in a large bowl. The dough was placed on a floured surface and kneaded until smooth and elastic. The kneaded dough was rolled out to approximately 1.5 cm thickness and cut into small squares of 1.5 cm by 1.5 cm in size and fried inside a deep fryer (MC 1800 model) at 180°C for 8 minutes until golden brown. They were drained of excess oil, cooled, packaged and stored at room temperature (26 ± 2°C) for analysis [10].

Functional properties

Bulk density was determined using Onwuka [17] method; Water absorption capacity [18]; Oil absorption capacity [19], while the Swelling capacity was determined using the AOAC [20] method.

Proximate composition

Protein, fat, crude fiber, moisture, ash and carbohydrate were determined by the method of Analysis of the Association of Official Analytical Chemists [21].

Mineral content of the chinchin samples

Mineral content of some selected elements such as iron, calcium, magnesium and zinc were determined using Analysis of the Association of Official Analytical Chemists [20] method.

Antinutritional properties of the chinchin samples

Antinutritional factors such as saponin and tannin were evaluated. The spectrophotometric method of Brunner [22] was used for saponin determination, while the method described by Makkar and Goodchild [23] was used for Tannin content determination.

Colour analysis of the chinchin samples

The color was done using CHN Spec heavy - duty Colour Meter Model CS - 220/260.

Sensory evaluation of the chinchin samples

The sensory attributes of the chinchin samples were determined using hedonic tests of Larmond [24]. Untrained laboratory taste panelists, though regular chinchin consumers, consisting of 50 staff and students from the university, assessed the chinchin samples on a 9-point hedonic scale where 1 and 9 represent dislike extremely and like extremely respectively. The attributes that were evaluated include color, taste, texture, crispness and overall acceptability.

Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using SPSS (version 16 of 2007).

Results and Discussion

Functional properties of the flour blends

Table 1 shows the functional properties of wheat and African walnut flour. The bulk density value for African walnut flour was 0.77%, while that of wheat flour was 1.47%. The bulk density is generally affected by particle size and density of flour. This is very important in determining the packaging requirement, raw materials handling and application, mostly in wet processing of foods [25-27]. However, flour samples have relatively high dispersibility values, making them reconstitute into the fine constituent dough during mixing [25,26].

Sample	Bulk density (%)	WAC (%)	OAC (%)	Swelling capacity (%)
AF	$0.77^{b} \pm 0.08$	$0.84^{b} \pm 0.00$	$0.64^{a} \pm 0.03$	$1.29^{a} \pm 0.04$
WF	$1.48^{a} \pm 0.05$	$1.28^{a} \pm 0.02$	$0.24^{b} \pm 0.01$	$1.19^{a} \pm 0.02$

Table 1: *Functional properties of wheat and African walnut flour.*

Keys: AF: African walnut flour, WF: Wheat flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along thesame rows with different superscripts are significantly (p < 0.05) different.

The water absorption capacity value for African walnut flour was 0.85% and wheat flour was 1.27%. Water absorption capacity improves the reconstitution ability of flour [27]. High water absorption is attributable to loose structure of starch polymers, but low values indicate compactness of structure [26,28], as seen in the compactness of the chinchin. An increase in water absorption capacity implies an increase in the digestibility of the product [29]. The oil absorption value for the walnut flour was 1.29% and wheat, 1.18%. The reduced oil absorption was an indication of good frying quality.

The swelling capacity value for African walnut flour was 0.64% and wheat flour, 0.24%. Moorthy and Ramanujan [30] reported that the swelling power of flour granule was an indication of the extent of associative forces within the granules and could also be related to the water absorption index of starch - based flour during heating. Increase in water absorption usually leads to decrease in swelling capacity, implying that the chinchin would be readily digestible.

Proximate composition of the chinchin samples

Table 2 shows the proximate composite of the samples at production and after eight weeks.

Sample	Moisture (%)	Ash (%)	CHO (%)	Protein (%)	Fat (%)	Fibre (%)
WF	$2.15^b \pm 0.33$	$2.54^{ab} \pm 0.11$	$83.85^a \pm 0.13$	$8.73^c \pm 0.08$	$1.57^d \pm 0.06$	$1.17^b \pm 0.49$
WAF1	$1.61^c \pm 0.08$	$1.89^c \pm 0.39$	$80.09^b \pm 0.79$	$12.72^a \pm 0.08$	$2.46^b \pm 0.08$	$1.24^b \pm 0.94$
WAF2	$2.19^b \pm 0.88$	$2.03^b \pm 0.06$	$79.58^c \pm 0.79$	$11.81^b \pm 0.04$	$2.36^b \pm 0.06$	$2.05^a \pm 0.00$
WAF3	$1.23^d \pm 0.40$	$2.07^b \pm 0.14$	$81.23^a \pm 0.95$	$11.51^b \pm 0.12$	$2.31^c \pm 0.01$	$1.65^a \pm 0.28$
WAF4	$2.47^a \pm 0.36$	$2.75^a \pm 0.00$	$80.12^b \pm 0.06$	$11.01^b \pm 0.49$	$2.39^b \pm 0.13$	$1.27^b \pm 0.05$
WAF5	$1.86^c \pm 0.26$	$2.09^b \pm 0.22$	$79.59^c \pm 0.23$	$12.44^a \pm 0.02$	$2.84^a \pm 0.01$	$1.18^b \pm 0.15$

Table 2a: *Proximate Composition of chinchin made from blends of wheat and African walnut flour during production.*
Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.
Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly (p < 0.05) different.

Sample	Moisture (%)	Ash (%)	CHO (%)	Protein (%)	Fat (%)	Fiber (%)
WF	$2.88^a \pm 0.02$	$2.41^b \pm 0.00$	$82.74^a \pm 0.02$	$8.51^c \pm 0.01$	$2.42^a \pm 0.00$	$1.05^d \pm 0.01$
WAF1	$2.44^b \pm 0.01$	$1.78^f \pm 0.01$	$79.88^c \pm 0.24$	$12.45^a \pm 0.22$	$2.34^b \pm 0.01$	$1.12^c \pm 0.01$
WAF2	$2.74^a \pm 0.01$	$1.92^e \pm 0.01$	$79.69^c \pm 0.03$	$11.67^b \pm 0.01$	$2.22^d \pm 0.01$	$1.93^a \pm 0.01$
WAF3	$1.60^d \pm 0.72$	$1.94^d \pm 0.01$	$81.35^b \pm 0.71$	$11.42^b \pm 0.01$	$2.20^d \pm 0.00$	$1.50^b \pm 0.00$
WAF4	$2.16^c \pm 0.01$	$2.65^a \pm 0.01$	$80.84^b \pm 0.02$	$11.89^b \pm 0.01$	$2.28^c \pm 0.01$	$0.19^e \pm 0.01$
WAF5	$2.64^b \pm 0.02$	$1.99^c \pm 0.01$	$79.36^c \pm 0.00$	$12.26^a \pm 0.01$	$2.36^a \pm 0.01$	$1.06^d \pm 0.01$

Table 2b: *Proximate composition of chinchin made from blends of wheat and African walnut flour (After 8weeks).*
Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.
Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly (p < 0.05) different.

The moisture content of the samples ranged from 1.23 - 3.19% at production with sample WAF2 (4% walnut inclusion) having the highest value and sample WAF3 (6% walnut inclusion), the lowest. There was slight increase in moisture to between 1.60 - 3.78% after eight weeks, attributable to low water absorption capacity. The values were still within a safe range that would have negligible or no effect on quality attribute of the product as reported by Mepba., *et al* [16]. Sanni., *et al.* [31] equally reported that the lower the moisture content of stored products, the better the shelf stability, because the reduced moisture content reduced the growth of microorganisms. There were significant differences ($p < 0.05$) in protein content of the chinchin samples. During production, the protein content of the samples ranged from 4.51 - 12.72%, with sample WAF1 having the highest value and sample WAF3 the lowest value. After eight weeks of storage, a negligible decrease in the protein content was observed, with values ranging from 4.42 - 12.45%, though Udedi., *et al.* [7] reported high protein content in African walnut.

Significant differences ($p < 0.05$) were recorded for the fat content. The values ranged from 2.31 - 2.83% with sample WAF5 (10% walnut inclusion) having the highest fat content and WAF3, the lowest during production. After eight weeks, the fat content decreased slightly to between 2.20 and 2.42%. Fasasi (2009) reported that a dry product with low fat content will help to increase the shelf life of samples by decreasing the chances of rancidity, as well as contribute to low energy value of food products, but with high fat content, high energy value and promotion of lipid oxidation is experienced. Ash content ranged from 1.89 - 2.53% with the highest value reported by the control sample (WF), while sample WAF1 had the lowest. It was noticed that the ash content of the samples increases with increasing quantities of walnut addition except for sample WAF5, which later decreased. The values were similar even after eight weeks of storage (1.77 - 2.64%). However, Akpoghelie., *et al.* (2016) reported 3.18% ash content in the nutritional composition of raw walnut seed, while Falola., *et al.* [32] reported an increase in the ash content of chinchin with increasing proportion of modified starch. High ash content of the samples could be attributed to high value of mineral content in African walnut.

Significant differences ($p < 0.05$) were noticed in the crude fibre of the chinchin samples, with values ranging from 0.27 - 2.05%. Sample WAF2 had the highest value, while sample WAF4, the lowest. A slight decrease in the fibre content was observed after storage, with the values dropping to between 0.19 and 1.93%, but still within recommended FAO/WHO [33] level of not more than 5%. The carbohydrate content of the samples ranged from 79.58 - 88.23%, with samples WAF2 having the lowest value and WAF3, the highest. After storage, the carbohydrate content ranged from 79.36 - 88.35%.

Antinutritional properties of the chinchin samples

Table 3 shows the result of the selected anti-nutrients compound determined. There was a significant difference ($p < 0.05$) in the tannin content. The values ranged from 0.87 - 3.74 mg/100g. The tannin content was increasing as the proportion of walnut substitution increased except for sample WAF5, which had a low value. The values decreased slightly during storage to between 0.59% and 2.63 mg/100g. Chijoke., *et al.* [34] reported that African walnut contains 0.89 mg/100 g of tannins.

Sample	Tannin (mg/100g)	Saponin (mg/100g)
WF	$1.09^{d} \pm 0.02$	0.73 ± 0.00
WAF1	$0.87^{e} \pm 0.03$	0.71 ± 0.01
WAF2	$1.62^{c} \pm 0.04$	0.73 ± 0.00
WAF3	$2.84^{b} \pm 0.11$	0.66 ± 0.02
WAF4	$3.74^{a} \pm 0.06$	0.22 ± 0.02
WAF5	$2.72^{b} \pm 0.09$	0.22 ± 0.02

Table 3a: *Anti-nutritional properties of chinchin samples (At production).*

Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly (p < 0.05) different.

Sample	Tannin (mg/100g)	Saponin (mg/100g)
WF	$1.01^{d} \pm 0.00$	$0.62^{a} \pm 0.01$
WAF1	$0.75^{e} \pm 0.00$	$0.58^{b} \pm 0.00$
WAF2	$1.53^{c} \pm 0.01$	$0.61^{a} \pm 0.01$
WAF3	$2.77^{a} \pm 0.01$	$0.56^{b} \pm 0.01$
WAF4	$0.59^{f} \pm 0.00$	$0.17^{c} \pm 0.00$
WAF5	$2.63^{b} \pm 0.02$	$0.16^{c} \pm 0.00$

Table 3b: *Antinutritional properties of chinchin samples (After 8 weeks).*

Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly (p < 0.05) different.

The saponin content ranged from 0.22 - 0.73 mg/100g with sample WAF2 having the highest value and sample WAF5, the lowest. A slight decrease in the saponin content was observed after eight weeks, with the values ranging from 0.16 - 0.62 mg/100 mg. The saponin content decreased as the proportion of walnut substitution was increased. Okwu and Okwu [35] reported that the presence of saponin in walnut has cytotoxic effect such as permeabilization of the intestine, as well as giving plants, bitter taste. Akindahunsi and Salawu [36] however reported that the bioavailability of the essential nutrients in plant foods could be reduced by the presence of anti-nutritional factors.

Mineral content of chinchin samples

Table 4a and 4b respectively showed the result of the selected mineral analyses carried out on the samples. The selected minerals were Mg, Ca, Fe and Zn. Their values ranged thus: 0.88 - 1.66 ppm, 0.24 - 0.55 ppm, 0.015 - 0.078 ppm and 0.004 - 0.023 ppm respectively. A slight decrease was observed in their values after eight weeks of storage, with values ranging thus: 0.82 - 1.59ppm, 0.19 - 0.52 ppm, 0.012 - 0.039 ppm and 0.002 - 0.019 ppm for Mg, Ca, Fe and Zn respectively. Significant differences ($p < 0.05$) in Fe and Zn were observed after eight weeks of storage corroborating the assertion of James, 2009 that African walnut is a rich source of mineral elements such as calcium, magnesium, sodium, potassium, and phosphorus. However, Raheena [37] said Ca is necessary for the ossification of bones and normal nerve impulse and transmission, while zinc is essential for enzymatic action and healing of wounds and burns.

Sample	Mg (ppm)	Ca (ppm)	Fe (ppm)	Zn (ppm)
WF	0.98 ± 0.00	0.55 ± 0.00	0.042 ± 0.00	0.016 ± 0.00
WAF1	1.66 ± 0.00	0.47 ± 0.00	0.015 ± 0.00	0.009 ± 0.00
WAF2	0.96 ± 0.00	0.49 ± 0.00	0.038 ± 0.00	0.014 ± 0.00
WAF3	1.55 ± 0.00	0.54 ± 0.00	0.023 ± 0.00	0.012 ± 0.00
WAF4	1.56 ± 0.00	0.24 ± 0.00	0.018 ± 0.00	0.004 ± 0.00
WAF5	0.88 ± 0.00	0.58 ± 0.00	0.078 ± 0.00	0.023 ± 0.00

Table 4a: *Mineral composition of chinchin samples (At production).*

Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly ($p < 0.05$) different.

Sample	Mg (ppm)	Ca (ppm)	Fe (ppm)	Zn (ppm)
WF	$0.93^c \pm 0.01$	$0.49^b \pm 0.01$	$0.039^b \pm 0.00$	$0.014^b \pm 0.00$
WAF1	$1.59^a \pm 0.01$	$0.44^c \pm 0.01$	$0.012^f \pm 0.00$	$0.007^e \pm 0.00$
WAF2	$0.92^c \pm 0.01$	$0.43^c \pm 0.01$	$0.035^c \pm 0.00$	$0.011^c \pm 0.00$
WAF3	$1.49^b \pm 0.01$	$0.49^b \pm 0.01$	$0.019^d \pm 0.00$	$0.009^d \pm 0.00$
WAF4	$1.48^b \pm 0.01$	$0.19^d \pm 0.01$	$0.016^e \pm 0.00$	$0.002^f \pm 0.00$
WAF5	$0.82^d \pm 0.01$	$0.52^a \pm 0.01$	$0.032^a \pm 0.00$	$0.019^a \pm 0.00$

Table 4b: *Mineral composition of chinchin samples (After 8 weeks).*

Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly ($p < 0.05$) different.

Colour analysis of the chinchin samples

The L*, a*, b* results of sample color are as shown in table 5. The "L" (lightness) values ranged from 29.01 - 45.49%, with sample WAF1 having the highest value, and sample WAF4, the lowest. The values does not follow a particular pattern, but sample with 2% walnut flour had the highest L* value, and WF4, the lowest. The "a" values ranged from 5.99 - 9.28% with sample WAF4 having the highest value and sample WAF1, the lowest. Apart from WF1, other treatments had higher values than the control. The "b" values ranged from 6.08 - 15.65 with sample WAF1 having the highest value and sample WAF4, the lowest. Outside sample WF1, the control sample WF was higher than other treatments of b*.

Sample	L	A	B
WF	$43.64^{ab} \pm 3.84$	$6.41^{a} \pm 1.51$	$14.57^{ab} \pm 2.23$
WAF1	$45.49^{a} \pm 2.81$	$5.99^{a} \pm 2.27$	$15.65^{a} \pm 1.63$
WAF2	$35.29^{c} \pm 1.02$	$6.77^{a} \pm 3.42$	$9.86^{cd} \pm 0.78$
WAF3	$39.68^{abc} \pm 0.78$	$7.34^{a} \pm 1.59$	$12.27^{abc} \pm 0.45$
WAF4	$29.01^{d} \pm 3.19$	$9.28^{a} \pm 1.27$	$6.08^{d} \pm 1.85$
WAF5	$37.79^{bc} \pm 1.88$	$7.89^{a} \pm 0.40$	$10.99^{bc} \pm 1.34$

Table 5: *Colour analysis of chinchin sample.*

Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly ($p < 0.05$) different.

Sensory evaluation of chinchin samples

Table 6 shows the result of the sensory evaluation carried out on the chinchin samples. A single way analysis of variance (ANOVA) was carried out, and the result showed that there were significant differences ($p < 0.05$) among the attributes measured. The appearance ranged from 6.40 - 7.57, with sample WAF1 rated highest, and sample WAF3, the lowest. WAF1 appearance was the most preferred. The taste values ranged from 6.13 - 7.23, with sample WAF1 having the highest value and sample WAF4, the lowest. Sample with 2% walnut flour was adjudged to have the best taste. The texture ranged from 5.97 - 7.37, with sample WAF3 having the lowest value and sample WAF1, the highest. The control sample was not different from sample with 10% walnut flour, but significantly different from samples WAF2, WAF3 and WAF4 respectively. Crispness values ranged from 5.53 - 7.03, with WAF2 having the lowest value and WAF1, the highest. Sample with the 8% and 10% walnut flour were not different, but significant differences were noticed between samples WF, WAF1 and WAF2 ($p < 0.05$).

Sample	Appearance	Taste	Texture	Crispness	Overall acceptability
WF	$7.07^{ab} \pm 1.59$	$6.47^{ab} \pm 1.50$	$6.73^{ab} \pm 1.51$	$6.43^{b} \pm 2.16$	$6.77^{ab} \pm 1.68$
WAF1	$7.57^{a} \pm 1.33$	$7.23^{a} \pm 1.63$	$7.37^{a} \pm 1.63$	$7.03^{a} \pm 2.04$	$7.47^{a} \pm 1.33$
WAF2	$7.40^{a} \pm 1.43$	$6.13^{b} \pm 1.91$	$6.30^{b} \pm 1.49$	$5.53^{c} \pm 1.85$	$6.57^{ab} \pm 1.04$
WAF3	$6.40^{b} \pm 2.18$	$6.00^{b} \pm 2.26$	$5.97^{b} \pm 2.39$	$5.90^{bc} \pm 2.39$	$6.10^{b} \pm 2.52$
WAF4	$7.03^{ab} \pm 1.16$	$6.47^{ab} \pm 1.50$	$6.57^{b} \pm 1.68$	$6.73^{ab} \pm 1.51$	$6.93^{ab} \pm 1.36$
WAF5	$6.90^{ab} \pm 1.13$	$6.70^{ab} \pm 1.32$	$6.83^{ab} \pm 1.23$	$6.83^{ab} \pm 1.62$	$7.13^{a} \pm 1.22$

Table 6: *Sensory evaluation of chinchin samples.*

Key: WF: 100%, WAF1: 98:2%, WAF2: 96:4%, WAF3: 94:6%, WAF4: 92:8%, WAF5: 90:10% wheat: African walnut flour.

Values are expressed as mean ± standard deviation of duplicate determination. Means along the same rows with different superscripts are significantly ($p < 0.05$) different.

The overall acceptability value ranged from 6.10 - 7.47, with samples WAF1 having the highest value and WAF3, the lowest. The control sample was not different from sample with 4% and 8% walnut flour. The sample with 2% walnut flour, WAF1, was the most acceptable in the overall sensory evaluation.

Conclusion

This study was able to demonstrate that wheat flour could be substituted with African walnut flour of up to 10% in chinchin production and compare favorably with that from plain wheat flour in terms of their quality attributes, which would definitely enhance greater utilization of walnut in many developing countries and reduce overdependence on wheat, support food diversification and food security.

Bibliography

1. Lasekan OO and Akintola AM. "Production and nutritional evaluation of puffed soy maize snacks". *Journal of Cereal Science* 24 (2002): 79-85.

2. Onoja US., *et al.* "Nutritional composition, functional properties and sensory evaluation of breads based on blends of Orarudi (Vigna sp) and wheat flour". *Journal of Food Science and Technology* 9.24 (2011): 1119-1126.

3. Mastromatteo M., *et al.* "Nutritional composition, functional properties and sensory evaluation of breads based on blends of Orarudu (*Vigna* sp) and wheat-flour". *Journal of Food Science and Technology* 9.24 (2013): 1119-1026.

4. Odoemelam SA. "Chemical composition and functional properties of conorphorn nut (*Tetracarpidium conorphorum*) flour". *International Journal of Food Science and Technology* 38 (2000): 729-734.

5. Ndie EC., *et al.* "Some physicochemical characteristics of defatted flour derived from African walnut (*Tetracarpidium conophorum*): an underutilized legume". *Pakistan Journal of Nutrition* 9.9 (2010): 909-911.

6. Akpuaka MU and Nwankwo E. "Extraction, analysis and utilization of dry oil from *Tetracarpidium conophorum*". *Bioresource Technology* 73 (2000): 195-196.

7. Udedi SC., *et al.* "Comparative proximate analyses of raw and cooked *Tetracarpidium conophorum* (African walnut) found in Awka, Anambra State, Nigeria". *Bioscience* 1.2 (2013): 114-118.

8. Ekwe CC and Ihemeje A. "Evaluation of physiochemical properties and preservation of African walnut (*Tetracarpidium conophorum*)". *Acad R Int* 4.6 (2013): 501-512.

9. Bamishaiye EI and Bamishaiye OM. "Tigernut as a plant, it's derivatives and benefits". *African Journal of Food, Agriculture, Nutrition and Development* 70.4 (2011): 236-250.

10. Akubor PI. "Protein contents, physical and sensory properties of Nigerian snack foods (cake, chin-chin and puff-puff) prepared from cowpea-wheat flour blends". *International Journal of Food Science and Technology* 39 (2004): 419-424.

11. Mepba HD., *et al.* "Effect of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables". *African Journal of Food, Agriculture, Nutrition and Development* 7.1 (2007): 23-26.

12. Milligan ED., *et al.* "Processing for production of edible soy flour". *Journal American Oil Chemistry Social* 58 (1981): 331.

13. Shittu T., *et al.* "Bread from composite cassava-wheat flour: I. Effect of baking time and temperature on some physical properties of bread loaf". *Food Research International* 40 (2007): 280-290.

14. Hugo LF., *et al.* "Malted sorghum as a functional ingredient in composite bread". *Cereal Science* 79.4 (2000): 428-432.

15. Hasmadi M., *et al.* "The effect of seaweed composite flour on the textural properties of dough and bread". *Journal of Applied Phycology* 26 (2014): 1057-1062.

16. Mepba HD., *et al.* "Microbiological quality of selected street foods in Port Harcourt, Nigeria". *Journal of Food Safety* 27 (2007): 208.

17. Onwuka GI. "Food analysis and Instrumentation: Theory and practice". Lagos: Napthali Print (2005): 133-137.

18. Diniz FM and Martin AM. "Effects of the extent of enzymatic hydrolysis on the functional properties of shark protein hydrolysate". *LWT-Food Science and Technology* 30.3 (1997): 266-272.

19. AOAC. "Official Methods of Analysis 17th edition Association of Official Analytical Chemists International. Washington, DC, USA (2005).

20. AOAC. "Official Methods of Analysis 20th edition Association of Official Analytical Chemists International. Washington, DC, USA (2010).

21. AOAC. "Official Methods of Analysis 17th edition Association of Official Analytical Chemists International. Washington, DC (2000).

22. Brunner J. "Direct Spectrophotometer Determination of Saponin". *Journal of Analytical Chemistry* 34.2 (1984): 1314-1326.

23. Makkar C and Goodchild A. "Phytochemical Composition, Cytotoxicity and Invitro antiplasmodial activity of fractions from Alafia bacteria olive (Hook For. Icon)". *Apocynaceae Journal of Food Science and Agriculture* 90.12 (1996): 547-590.

24. Larmond E. "Laboratory methods for sensory evaluation of foods (Series IV). Ottawa: Canadian Agricultural Publications (1991).

25. Adebowale A., *et al.* "Chemical composition and pasting properties of tapioca grit from different cassava varieties and roasting method". *African Journal of Food Science* 2 (2008): 77-82.

26. Adebowale AA., *et al.* "Functional properties and biscuit making potentials of sorghum-wheat flour composite". *American Journal of Food Technology* 7 (2012): 372-379.

27. Ajanaku KO., *et al.* "Nutritive value of sorghum ogi fortified with groundnut journal seed (Arachis hypogeal)". *American Journal of Food Technology* 79 (2012): 82-88.

28. Adebowale AA., *et al.* "Effect of texture modifies on the physiochemical and sensory properties of dried fufu". *Journal of Food Science and Technology International* 11 (2005): 373-385.

29. Ayele T and Nip WK. "Functional properties of raw and precooked taro (Colocasia esculenta) flours". *International Journal of Food Science and Technology* 29 (1994): 457-462.

30. Moorthy SN and Ramanujan T. "Variation in properties of starch in Cassava varieties in relation to age of the crop". *Starch/Starke* 38.2 (1986): 58-61.

31. Sanni LO., *et al.* "Proximate, functional, pasting and sensory qualities of instant yam flour". A Paper Presented at the 14th ISTRC Symposium Central Tuber Crops the Research Institute, Trivandrum (2006).

32. Falola AO., *et al.* "Modification and Quality Characteristics of Cocoyam Starch and its Potential for Chinchin Production". *Pakistan Journal of Nutrition* 13.12 (2014): 768-773.

33. FAO/WHO. Codex Alimentarius: Foods for special dietary uses (including foods for infants and children) Food and Agricultural Organization of the United Nations, World Health Organization, Rome (1994).

34. Chijoke OC., *et al*. "Studies on the phytochemical and nutritional properties of *Tetracarpidium conophorum* (black walnut) seeds". *Journal of Global Bioscience* 4.2 (2015): 1366-1372.

35. Okwu DE and Okwu ME. "Chemical composition of Spondia mombin plants". *Journal of Sustainable Agriculture and the Environment* 6 (2004): 140-147.

36. Akindahunsi AA and Salawu SO. "Phytochemical screening and nutrient and antinutrient composition of selected tropical green leafy vegetable". *African Journal of Biotechnology* 4 (2005): 497-501.

37. Raheena BM. "A Textbook of Foods, Nutrition and Dietics (Second Edition). Published by Sterling Publishers Private Ltd., New Delhi (2007): 106-109.

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