# QUALITY ASSESSMENT OF CHIN-CHIN PRODUCED FROM WHEAT, ORANGE-FLESHED SWEET POTATO (OFSP) AND DEFATTED SEA PURSE (*DIOCLEA REFLEXA)* SEED FLOUR BLENDS

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**Abstract**

*Chin-chin snacks were produced from composite flours of wheat (WF), orange-fleshed sweet potato (OFSP) and defatted Dioclea reflexa seed (DDRS) with the flour blends; 100% (control), 87.5%:10%:2.5%, 80%:15%:5%, 72.5%:20%:7.5%, 65%:25%:10%, and 55%:30%:15% respectively as WF:OFSP:DDRS. Functional properties of the flour blends were analysed while proximate, selected minerals (potassium, iron, and zinc), vitamin A and sensory qualities were determined for the chin-chin samples. Functional properties results revealed that water absorption capacity (161.34%), least gelation capacity (10%) and emulsion capacity (16.50) of the wheat flour was the prominent Incorporation of OFSP and DDRS enhanced the foaming capacity (21.40%-28.35%), swelling capacity (6.27%-8.95%) and dispersibility (52.50%-68.35 %) of the flour blends. Proximate analysis revealed significantly increased in the protein, fat, crude fibre, ash and moisture contents of the chin-chin samples. Potassium, iron, zinc and vitamin A contents of chin-chin from composite flours were significantly higher than the control (100% wheat chin-chin). The control, 100% wheat chin-chin appeared to be the most preferred for overall acceptability, the chin-chin from 87.5%WF:10% OFSP:2.5% DDRS flour blend had the highest score for taste, colour, crispiness and appearance. Hence, highly-nutritious snacks had been formulated from wheat, OFSP and DDRS composite flours. The newly formulated snack food (chin-chin) could be ideal food for school feeding programmes and to address the micro nutrient deficiency that is prevalent in the sub-Saharan African regions.*

**KEYWORDS**: Chin-chin; *Dioclea reflexa*; Orange fleshed sweet potato; composite flour.

## Introduction

Snack foods are inexpensive, easy to prepare, and widely accessible in public places including streets, shops, and schools (Jeaheng & Han, 2020). Snacks play a crucial role in the daily nutrient and calorie consumption of quite a number of consumers (Awoyale et al. 2011). In both developed and developing countries fast urbanization and population growth are to blame for the increase in snack demand. Wheat flour is the main ingredient for the production of snacks like cake, chin-chin, doughnuts, and biscuits, among others. A fried, crispy snack called chin-chin is consumed in many parts of West Africa between breakfast and lunch (Obomeghei & Ebabhamiegbebho, 2020). It is mainly prepared using wheat flour, margarine, eggs, and additional elements to resemble cookies. Before frying, the dough formed is typically kneaded and cut into little pieces, then eaten as a snack (Akubor, 2004). According to Awoyale et al. (2011), they are typically also highly high in calories, fat, and carbohydrates but lacking in fiber, vitamins, and minerals. The depletion of Nigeria's foreign reserves due to the cost of importing wheat has called for an alternative flour material that are readily available within our locality to substitute for wheat-based products, in addition to products made from wheat that are low in protein and other macronutrients (Lemchi et al., 2016). The use of different flours in place of wheat flour in some recipes for snacks made from wheat help to reduce over-dependency on imported wheat and promote more utilization indigenous food crops, hence guarantee food and nutritional securities.

The orange-fleshed sweet potato (OFSP) is a biofortified with (beta)-carotene (carotenoid), a precursor to vitamin A that also significantly contributes to vitamin A, C, and mineral nutrition in humans (Satheesh & Solomon, 2019). To address the issue of Vitamin A deficiency, OFSP was created to make -carotene nutritious available to everyone. Unfortunately, compared to other root crops used in Nigeria, OFSP is underutilized (Baffi et al., 2015). Increased intake of orange-fleshed sweet potatoes along with beta-carotene, the provitamin A, can provide young children and adults with enough calories, vitamin C, and other micronutrients.

*Dioclea reflexa* (DR) is a legume sometimes referred to as sea purse or horse eye. In the tropical area, it is widely dispersed (Ajatta et al., 2021). Southern Nigerian tribes have distinct names for DR; the Yoruba call it "agbarin," the Ibo call it "capenter," and the Efiks call it "ilaba." *Dioclea reflexa* is an affordable source of fat and protein for both domestic and commercial use. *Dioclea reflexa* has a lot of protein (Akinyede et al., 2005), defatted *Dioclea reflexa* flour has a protein content of 46.85 g/100 g. It also contains a wealth of additional macro and micronutrients that can speed up metabolic processes and enhance growth and development in people of all ages. The crop of legumes, with significant nutritional value, is underutilized (Akinyede et al., 2017). However, it has only a few uses in the eastern part of Nigeria, including the treatment of piles, making soup, and serving as an agronomic cover crop (Ajatta et al., 2021).

Ani et al. (2022) argue that incorporating locally accessible underutilized crops like OFSP and *Dioclea reflexa* into affordable snacks rich in protein, fiber, and healthy fat would not only reduce malnutrition due to the Nigeria's high rate of poverty but also lessen the country's over-reliance on wheat importation and increase the use of locally accessible crops. The potential of OFSP in snacks has attracted the attention of many researchers. High-quality chin-chin was produced by Ndife et al. (2020) using a composite flour made of maize, soyabean, and orange-fleshed sweet potatoes. If pureed for snacks, OFSP was reportedly a good alternative to wheat flour (Afoakwah et al., 2021). The assessment of the functional characteristics of composite flours made from wheat, OFSP, and defatted *Dioclea reflexa* seeds, as well as the nutritional and sensory attributes of chin-chin snacks made from the flour combination, were the main objectives of this study.

**Methods and methods**
**Materials**

*Dioclea reflexa* (sea purse) dried seeds were procured from a farm in Idogo, Yewa South Local Government, Ogun State, Nigeria for the study. OFSP roots were obtained from a farm in Abeokuta, Ogun State while the other ingredients (Vegetable oil, milk, eggs, margarine, sugar, nutmeg, and wheat flour) were obtained from a trader in Ilaro, Ogun State, Nigeria

**Preparation of sample**

Orange fleshed sweet potato (OFSP) flour

OFSP was prepared using the technique proposed by Bibiana et al. (2014). OFSP roots were peeled, washed in potable, clean water and grated. Spread out on trays, the grated OFSP was dried in a cabinet drier (Presto Model: FAD-70) for 24 hours at 60 °C. Prior to usage, the dried OFSP was sieved through a 500-mesh screen and ground using a hammer mill. The flour was thereafter stored in an airtight container.

Defatted sea purse flour

The defatted sea purse flour was made using a slightly modified version of the technique by Oyeleke et al (2012). *Dioclea reflexa* seeds were separated into good and poor seeds. After being sorted, the *Dioclea reflexa* seeds were parboiled and sun dried to allow the endocarp to open. The seeds were then dehulled and sun dried for seven (7) days to bring the moisture content down to 10 ± 2%. To create sea purse flour, it was ground using a disc attrition mill (900–2400 rpm). The fine portion of the flour was recovered after being filtered through a 2mm screen. The full-fat flour was defatted by soaking it in n-hexane for 24 hours. After that, the flour was separated from the solvent and the resultant oil. The flour was placed in a cabinet dryer at 60 °C to evaporate the remaining solvent. The flour was stored in a sterile zip-lock bag prior to usage.

Formulation of composite flour

Composite flour of wheat, orange-fleshed sweet potato and defatted *Dioclea reflexa* seed were prepared using the proportions presented in the table 1:

**Table 1: Flour blends prepared for chin-chin production (%)**

| | Samples | | | | | |
|---|---|---|---|---|---|---|
| **Flour** | **A** | **B** | **C** | **D** | **E** | **F** |
| **Wheat** | 100 | 87.5 | 80 | 72.5 | 65 | 55 |
| **Orange fleshed-sweet potato** | 0 | 10 | 15 | 20 | 25 | 30 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Defatted *Dioclea reflexa* seed** | 0 | 2.5 | 5 | 7.5 | 10 | 15 |

Key:
A = 100% wheat flour only
B = 87.5% wheat, 10% orange-fleshed sweet potato and 2.5% deffated *Dioclea reflexa* flour blends
C = 80% wheat, 15% orange-fleshed sweet potato and 5% deffated *Dioclea reflexa* flour blends
D= 72.5% wheat, 20% orange-fleshed sweet potato and 7.5% deffated *Dioclea reflexa* flour blends
E = 65% wheat, 25% orange-fleshed sweet potato and 10% deffated *Dioclea reflexa* flour blends
F = 55% wheat, 30% orange-fleshed sweet potato and 15% deffated *Dioclea reflexa* flour blends

Production of chin-chin

Production of the chin-chin was done using Ndife et al. (2020) approach. The following ingredients were well combined with 100 g of each flour blend: salt(2g), sugar (25g), milk powder (10g), baking powder (1g), and nutmeg powder (0.5g). Then, 25 g of margarine was added to make a batter. 20ml of cold water was added after thoroughly kneading the batter and flour mixture to form a fairly hard dough. The finished product was tightly rolled to a thickness of 1 cm on a stainless-steel surface, cut into uniform cubes, and deep-fried for 8 minutes at 180 $^{O}$C in vegetable oil. Oil was taken out of the chin-chin, cooled, and then placed in an airtight container prior to analysis.

**Analyses**

**Determination of flours' functional properties**

The flour samples' WAC was determined using the Beuchat, (1977) method as modified by Idowu et al. (2019). Coffman and Garcia, (1977) technique was used to determine the LGC and foaming capacity. The Adeleke and Oyedeji (2010) method was used to determine the stability of the emulsion. Takashi and Seib, (1988) described method as modified by Adebowale et al. (2012) was used to determine the swelling capacity of the flour blends. The Kulkarni et al. (1991) technique was used to determine dispersibility.

**Determination of chin-chin samples' proximate composition**

Chin-chin samples made from the composite flours and wheat flour were subjected proximate analysis. Using AOAC, (2012) techniques, the chin-chin samples were examined for protein, ash, crude fiber, crude fat, and moisture. Carbohydrate was estimated by difference: [100 – (Σ protein, moisture, ash, fiber and fat contents)].

**Determination of chin-chin samples' mineral composition**

AOAC (2010) method was used to determine the mineral elements. Following digestion in conc. sulphuric acid (2.00 ml) and 25.00 ml of potassium, iron, and zinc, the elements were measured with an AAS (Thermo scientific S Series Model GE 7123454) in a fume hood. The mixture was gently cooked on a hot plate over low to medium heat in a digester while a perchloric acid fume was present. It was heated vigorously for 30 seconds, let to cool, and then 50 ml of distilled water was added. The mixture was added to a Pyrex volumetric flask, let to cool fully, and then thoroughly filtered with a wash bottle. The AAS was then used to read the solution.

**Determination of Vitamin A content of chin-chin samples**

For the determination of vitamin A, Achinkanu et al.'s (2013) method was utilized. The chin-chin sample was weighed at one gram (1g), macerated in a test tube with 20 ml of n-hexane for 10 minutes, and then centrifuged for 10 minutes. The n-hexane was evaporated in a pot of boiling water once the test tubes had dried out. Then 2ml of 0.5N alcoholic potassium hydroxide was added, and the mixture heated for 30 minutes in a water bath. The liquid was then vigorously stirred after 3 ml of n-hexane was added. The n-hexane was transported to another set of test tubes, where it was evaporated until dry there. To the residual, two (2) ml of ethanol were added. 1ml of 0.2% ferric chloride in ethanol was added to another volume. Then 1ml of 0.5% 1-dipyridyl in ethanol was added, and finally 1ml of ethanol was added to bring a the total to 5mls. After blending the solution, absorbance at 520 nm was measured in comparison to a blank.

**Sensory evaluation of the product (Chin-chin)**

Twenty (25) semi-trained panelists who are familiar with the quality characteristics of chin-chin snacks were engaged for the actual evaluation of the chin-chin samples: for taste, colour, appearance, crispiness, and overall acceptability. Panelists were chosen from the students and staff of the Department of Food Technology at Federal Polytechnic, Ilaro, Ogun State, Nigeria. Each panelist was asked to rate each parameter on a hedonic scale of 1 to 9, where 1 and 9 respectively signify dislike extremely and like extremely

**Statistical Analysis**

A one-way analysis of variance was used to test the significant ($p \leq 0.05$) differences. The data obtained were put through Analysis of Variance (ANOVA) using Statistical package for social sciences (SPSS version 20). Means separation was done using Duncan's multiple Range Test (DMRT). Results were displayed in tables as mean ± standard deviation.

**Results and discussion**

**Discussion on the functional properties of composite flours**

The functional properties of composite flours produced from wheat, orange-fleshed sweet potatoes, and defatted *Dioclea reflexa* seeds are shown in Table 2. The capacity for emulsion (EC), least gelation (LGC), water absorption (WAC), and protein solubility (PC) significantly decreased ($p < 0.05$) as a result of the partial replacement of wheat flour with OFSP and defatted *Dioclea reflexa* seed (DDRS), while the capacity for foaming (FC), swelling (SC), and dispersibility (DIS) significantly increased. The flour blends' water absorption capacities (WAC) ranged from 142.65 to 171.10%. The value for sample C (a blend of 55% wheat, 30% OFSP, and 15% DDRS flour) was the highest, while sample F had the least value. According to Iwe and Agiriga (2015), WAC of flour reveals varying levels of starch availability for water binding sites as well as varying protein concentrations and levels of water interaction. The flour molecular structure and its particle size may also be to blame for this (Achinkanu *et* al., 2013). The wheat and OFSP flour's ability to absorb water in different ratios indicates that they can be used to bake a wider range of goods. Due to their capacity to imbibe water and swell for improved food composition, flours with high WAC suggest that they can be utilized as thickeners (Adebowale et al., 2012). According to reports, flour with a high WAC may not be able to maintain its quality over time since WAC represents the maximum amount of water that a food can absorb and hold onto (Iwe et al., 2015). Therefore, it is important to maintain adequate flour storage.

The flour sample's least gelation capacity (LGC) ranged from 6% to 10%. The value for sample F (a blend of 55% wheat, 30% OFSP, and 15% DDRS flour) was the least, while the highest value recorded for 100% wheat flour. According to Ugwuanyi et al. (2016), different ratios of various ingredients, such as proteins, carbohydrates, and lipids, in diverse flours may explain variances in the gelling properties. This implies that interactions among these components may significantly affect functional capabilities. A lower LGC enhances the gelling properties of the protein components in the snack recipe. However, the low gelation concentration of the OFSP and DDRSP flour blends may be advantageous when manufacturing curd or as an additive for other gel-forming ingredients in a snack product. The samples' emulsion capacities (ECs) ranged from 10.05% to 16.50%, with sample F (a blend of 55% wheat, 30% OFSP, and 15% DDRS) having the lowest value and 100% wheat flour having the highest. Akubor (2004) asserts that high EC flour functions as an emulsifier to delay aging in baked items and lengthen their shelf life.

The flour blends' foaming capacities (FC) ranged from 21.40 to 28.35. Sample A appeared as having the lowest value, whereas sample F (55% wheat, 30% OFSP, and 15% DDRS flour blend) had the greatest value. Proteins can scatter and absorb at the air-water interface during mixing, which alters surface tension, which has an effect on foaming capacity

(Al-Barnawi, 2020). In some food products, protein is a key component of the foaming agent. It is known that flexible proteins can froth more effectively than globular proteins. The high protein content of defatted *Dioclea reflexa* seed flour may be to blame for the strong foaming capacity of the flour blends used in this investigation (Arteaga et al., 2021)

Swelling capacity of the flour blends (SC) varied from 6.27% to 8.95%. Sample A (100% wheat flour) gave the lowest value, whereas Sample F (55% wheat, 30% OFSP, and 15% DDRS flour blend) had the highest value. The flour blends' dispersibility (DIS) ranged from 52.50 to 68.35. 100% wheat flour was found as having the lowest value, whereas sample F (55% wheat, 30% OFSP, and 15% DDRS flour blend) had the highest value. The ability of flour blends to be rehydrated with water is measured by an index called dispersibility; the higher the dispersability value, the better and simpler the reconstitution of the flour blend is (Adamu & Akhere, 2020). All of the flour blend's relatively high dispersability value suggests that it will reconstruct quickly into fine constituent dough after mixing (Adebowale et al., 2012).

**Table 2: Functional properties chin-chin produced from wheat, OFSP and defatted *Dioclea reflexa* seed composite flours**

| SAMPLE | WAC [%] | LGC[%] | EC [%] | FC [%] | SC [%] | DIS[%] |
|---|---|---|---|---|---|---|
| A | 161.34±0.16$^{d}$ | 10±0.01$^{d}$ | 16.50±0.28$^{e}$ | 21.40±0.28$^{a}$ | 6.27±0.08$^{c}$ | 52.50±0.42$^{a}$ |
| B | 171.10±0.03$^{f}$ | 8.0±0.01$^{c}$ | 15.45±0.21$^{d}$ | 22.65±0.21$^{b}$ | 7.05±0.05$^{e}$ | 58.35±0.35$^{b}$ |
| C | 168.22±0.15$^{e}$ | 8.0±0.02$^{c}$ | 14.80±0.00$^{c}$ | 24.55±0.35$^{c}$ | 5.09±0.04$^{a}$ | 61.80±0.14$^{d}$ |
| D | 156.77±0.06$^{c}$ | 7.0±0.02$^{b}$ | 14.40±0.28$^{c}$ | 25.60±0.28$^{d}$ | 5.69±0.04$^{b}$ | 60.70±0.28$^{c}$ |
| E | 146.65±0.38$^{b}$ | 6.0±0.01$^{a}$ | 12.70±0.14$^{b}$ | 26.25±0.21$^{e}$ | 6.75±0.03$^{d}$ | 67.60±0.42$^{e}$ |
| F | 142.65±0.30$^{a}$ | 6.0±0.01$^{a}$ | 11.05±0.04$^{a}$ | 28.35±0.21$^{d}$ | 8.95±0.04$^{f}$ | 68.35±0.21$^{e}$ |

*Values are means of replicate determinations ± SD. Values across column with different alphabet are significantly different (p<0.05).*

A = 100% wheat flour only
B = 87.5% wheat, 10% orange-fleshed sweet potato and 2.5% deffated *Dioclea reflexa* flour blends
C = 80% wheat, 15% orange-fleshed sweet potato and 5% deffated *Dioclea reflexa* flour blends
D= 72.5% wheat, 20% orange-fleshed sweet potato and 7.5% deffated *Dioclea reflexa* flour blends
E = 65% wheat, 25% orange-fleshed sweet potato and 10% deffated *Dioclea reflexa* flour blends
F = 55% wheat, 30% orange-fleshed sweet potato and 15% deffated *Dioclea reflexa* flour blends

**Discussion on the proximate composition of chin-chin**

Table 3 shows the proximate composition of chin-chin made from wheat, OFSP, and defatted *Dioclea reflexa* seed (DDRS) flours. Chin-chin has a moisture range of 10.67% to 12.72%. The chin-chin made from 100% wheat flour had the lowest value, whereas sample F (55% wheat, 30% OFSP, and 15% DDRS flour blend) had the highest value. These moisture contents are considerably (p<0.05) greater than values for comparable items reported by other researchers. Wahab et al. (2018) Chin-chin made from wheat and *Cissus populnea* stem flour blend had a moisture level of 3.18–3.54%, according to Wahab et al. (2018), 3.80 to 4.80% for chin-chin made from maize, OFSP, and soyabean composite flours were reported by Ndife et al. in 2020. This suggests that the chin-chin cannot be stored for an extended period of time (Burri, 2011), which could have a negative impact on quality (Adebayo-Oyetoro et al., 2017).

The protein content ranged from 8.23 % to 12.42 % for sample A (100 % wheat flour), and F (55 % wheat, 30 % OFSP and 15 % DDRS flour blend) respectively. The protein content increased with increase in OFSP and DDRS flours incorporation for the chin chin. This pattern was also noted by Afoakwah et al. (2021), who reported that when wheat flour was substituted with up to 50% OFSP puree, the protein level of chin-chin varied from 9.23% to 10.16%. Bibina et al. (2014) discovered that chin-chin prepared from a combination of wheat and Cissus populnea stem flour had a lower protein level of 5.22%-12.98%. The protein content of chin-chin prepared from combinations of wheat and tiger-nut flour ranged from 7.66 to 11.58% (Adebayo-Oyetoro et al. 2017). Akinyede et al. (2005) found that the protein content of defatted Dioclea reflexa seed flour is 46.85%. Therefore, the steady increase in protein content with level of integration can be attributed to the addition of defatted Dioclea reflexa seed flour.

For samples A (100% wheat flour) and F (55% wheat, 30% OFSP, and 15% DDRS flour), the fat percentage ranged from 16.63 to 18.97%, respectively. The amount of fat in the chi-chin increased significantly ($p > 0.05$) with increasing levels of OFSP and DDRS incorporation. Adebayo-Oyetoro et al. (2017) showed greater fat values for samples made from wheat-tiger-nut flour blends, while Wahab et al. (2018) reported lower fat contents (6.33–10.66%). The range of fat content (13.85 - 16.35 %) for chin-chin prepared from maize, soyabean, and OFSP composite flour reported by Ndife et al. (2020) is comparable to the fat content discovered in this work, though.

According to Awoyale et al. (2011), ash concentration provides a rough measure of the mineral content of foods. For samples A (100 percent wheat flour) and F (55 percent wheat, 30 percent OFSP, and 15 percent DDRS flour blend), the ash concentration varied from 1.23% to 2.52%. The effects of various flour blends combined to form chin-chin with a higher ash level as compared to control sample A (100% wheat flour). The level of ash is in line with what Afoakwah et al. (2021) observed. The fiber content of the chin-chin snacks ranged from 1.30 to 1.68%. With increased substitution of wheat flour, there was a substantial increase ($p < 0.05$) in the fiber content. Given that OFSP flour has been shown to contain a significant amount of fiber, the gradual increase in fiber content is not surprising (Akubor, 2004). The highest fiber content was found in the sample F made from 55% wheat, 30% OFSP, and 15% DDRS flour.

The samples' carbohydrates contents ranged from 48.31 % to 61.87 % for sample F (55 % wheat, 30 % OFSP and 15 % DDRS flour blend) and sample A (100 % wheat flour) respectively. The amount of carbohydrates in the chin-chin is significantly reduced ($p < 0.05$) when wheat flour is partially replaced with OFSP and DDRS flours. The sample with the lowest quantity of carbohydrate had the highest percentage of OFSP (30%) in it. In contrast, the sample with the highest OFSP (50%) had the highest carbohydrate content, according to Ndife et al. (2020) findings. Adebayo-Oyetoro et al. (2017) reported the range of 60.50-71.52% for the carbohydrate contents.

**Table 3: Proximate composition of chin-chin produced from wheat, OFSP and defatted *Dioclea reflexa* seed composite flours**

| SAMPLE | CRUDE PROTEIN | CRUDE FAT | CRUDE FIBRE | ASH | MOISTURE | CARBO-HYDRATES |
|---|---|---|---|---|---|---|
| **A** | $8.23±0.02^a$ | $16.63±1.81^b$ | $1.30±0.02^b$ | $1.32±0.07^a$ | $10.67±0.11^a$ | $61.87±2.75^d$ |
| **B** | $8.53±0.01^b$ | $16.38±1.27^a$ | $1.23±0.04^a$ | $2.12±0.01^b$ | $10.82±0.29^b$ | $60.89±2.10^d$ |
| **C** | $9.72±0.07^c$ | $18.07±0.38^c$ | $1.25±0.07^c$ | $2.17±0.03^b$ | $10.81±0.29^b$ | $57.97±1.73^c$ |
| **D** | $10.87±0.12^c$ | $17.97±0.17^c$ | $1.38±0.01^c$ | $2.30±0.02^c$ | $11.73±0.33^c$ | $55.78±0.87^c$ |
| **E** | $12.18±0.09^e$ | $18.23±1.27^d$ | $1.62±0.05^d$ | $2.37±0.06^c$ | $12.01±0.08^d$ | $53.59±1.25^b$ |
| **F** | $12.42±0.07^f$ | $18.97±1.80^e$ | $1.68±0.05^d$ | $2.52±0.01^d$ | $12.72±0.04^e$ | $48.31±1.81^a$ |

*Values are means of replicate determinations ± SD. Values across column with different alphabet are significantly different ($p<0.05$).*

A = 100% wheat flour only
B = 87.5% wheat, 10% orange-fleshed sweet potato and 2.5% deffated *Dioclea reflexa* flour blends
C = 80% wheat, 15% orange-fleshed sweet potato and 5% deffated *Dioclea reflexa* flour blends
D= 72.5% wheat, 20% orange-fleshed sweet potato and 7.5% deffated *Dioclea reflexa* flour blends
E = 65% wheat, 25% orange-fleshed sweet potato and 10% deffated *Dioclea reflexa* flour blends
F = 55% wheat, 30% orange-fleshed sweet potato and 15% deffated *Dioclea reflexa* flour blends.

**Discussion on the selected minerals and vitamin A composition of chin-chin**

The results of the composition of specific minerals and vitamin A in chin-chin manufactured from wheat, orange-fleshed sweet potatoes, and defatted Dioclea reflexa seed composite flours are shown in Table 4. A significant increase ($p < 0.05$) was seen in every mineral as the level of substitution of OFSP and DDRS increased. Sample F (55% wheat flour, 30% OFSPF, and 15% DDRS) had the greatest value for the determination of all the mineral elements, while Sample A (100% wheat) had the lowest. Potassium was detected in the range of 217.83 mg to 268.23 mg/100 g. Taiwo and Famuwagun (2022) found that chin-chin prepared from wheat flour improved with pumpkin and spinach vegetables had a higher range of potassium content (261.30 -425.89 mg/100 g). The potassium concentration of OFSP ranged from 138 to 334 mg/100 g, according to Endrias et al. (2016). The range for iron was 36.14 to 42.72 mg. Iron is used to make hemoglobin, a component of blood cells that carries oxygen throughout the body through the blood stream. Zinc levels per 100 grams in chin-chin ranged from 12.12 mg to 14.65 mg.

The vitamin A content of chin-chin made from composite flour of wheat, OFSP, and *Dioclea reflexa*. Vitamin A is an essential element for several physiological processes in addition to sustaining the integrity and functionality of all epithelial surface tissues (Clare, 2013). Sample A (100 % wheat) had the lowest amount of vitamin A, 15.40 mg, while Sample F (55 % wheat flour, 30 % OFSPF, and 15 % DDRS) had the largest amount, 55 mg. The range of vitamin A content was 15.40 mg to 18.79 mg. The rise in vitamin A with amount of inclusion can be attributed to the high vitamin A content of OFSP (Aniedu et al., 2015). These results showed that there was a significant difference in all of the samples ($p < 0.05$). Ndife et al. (2020), who worked on chin-chin made from maize, soybean, and OFSP, published a similar report.

**Table 4: Selected mineral and vitamin A composition (mg/100g) of chin-chin obtained from wheat, OFSP and defatted sea purse composite flours**

| SAMPLE | POTASSIUM | IRON | ZINC | VITAMIN A |
|---|---|---|---|---|
| A | 217.83±0.02[a] | 36.14±0.01[a] | 12.12±0.00[a] | 15.40±0.39[a] |
| B | 238.89±0.04[b] | 38.92±0.01[b] | 12.83±0.02[c] | 15.77±0.06[ab] |
| C | 246.12±0.02[c] | 40.08±0.06[c] | 12.93±0.02[c] | 16.13±0.02[b] |
| D | 254.11±0.01[d] | 41.66±0.01[d] | 13.66±0.02[d] | 16.75±0.04[c] |
| E | 261.82±0.01[e] | 42.12±0.05[e] | 14.33±0.01[e] | 18.18±0.05[d] |
| F | 268.23±0.01[f] | 42.72±0.01[f] | 14.65±0.01[e] | 18.79±0.04[e] |

*Values are means of duplicate determinations ± SD. Mean values across column with different alphabet are significantly different (p<0.05).*

A = 100% wheat flour only
B = 87.5% wheat, 10% orange-fleshed sweet potato and 2.5% deffated *Dioclea reflexa* flour blends
C = 80% wheat, 15% orange-fleshed sweet potato and 5% deffated *Dioclea reflexa* flour blends
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F = 55% wheat, 30% orange-fleshed sweet potato and 15% deffated *Dioclea reflexa* flour blends

### 3.4 Sensory Evaluation (Consumer Acceptability of chin-chin)

The findings of the sensory evaluation of chin-chin produced from a blend of flours made from sea purse, wheat, and OFSP. Except for crispiness, every one of the chin-chin's assessed quality traits revealed significant variations ($P < 0.05$). The chin-chin produced from flour blends compared favorably to the control, even though practically all of the parameters evaluated suggested that the control sample prepared from 100% wheat flour was preferred. None of the chin-chin sample members scored lower than 5, which is neither like or dislike. The chin-chin sample, which contained 87.5% wheat flour, 10% OFSP, and 2.5% DDRS, had the highest value for color at 7.55, while sample F, which contained a blend of 65% wheat, 30% OFSP, and 15% DDRS flour, had the lowest at 5.35. Similar results were reported by Ndife et al. (2020) for chin-chin made from a composite flour of maize, soyabeans, and OFSP.Taste is the most crucial element in a consumer's preference choosing. The least preferred samples were sample D (72.5%

wheat flour, 20% OFSP flour, and 7.5% DDRS flour), followed by sample F (55.5% wheat flour, 30% OFSP flour, and 15% DDRS flour), both of which had a score of 6.65. The chin-chin sample, which contained 87.5% wheat flour, 10% OFSP, and 2.5% DDRS flour, received a score of 7.55. The highest appearance rating was awarded to Sample B, which comprised 87.5% wheat flour, 10% OFSP flour, and 2.5% DDRS flour, while the lowest rating was given to Sample F, which had 60% wheat flour, 30% OFSP flour, and 10% DDRS flour. In terms of the crispiness of the chin-chin, sample B (87.5% wheat flour, 10% OFSP flour, and 2.5% DDRS flour) was preferred, followed by sample A. All of the samples' hedonic scale values fell between 7.90 and 7.15; this suggests that the samples were all liked, or "liked very much". Sample from 100% wheat flour scored the highest overall acceptability rating of 7.90, which is equivalent to "like very much," but other samples were equally well received, with sample F (60 percent wheat flour, 30 percent OFSP flour, and 10 percent DDRS flour) receiving the lowest rating of 6.60, which is just above "like slightly" with a rating of 6. The acceptance for the control sample can be due to the fact that consumers are more acquainted with chin-chin made wheat flour. Changes in the parameters tested were noted as the level of OFSP and DDRS replacement rose. Similar results were obtained when bread was made using composite flour of wheat, soy, and plantain flour.

**Table 4: Sensory properties of chin-chin produced from wheat, OFSP and defatted sea purse composite flours**

| SAMPLE | COLOUR | TASTE | APPEAR-ANCE | CRISPI-NESS | OVERALL ACCEPTABLITY |
|---|---|---|---|---|---|
| **A** | $6.50{\pm}1.19^{b}$ | $7.00{\pm}1.03^{ab}$ | $6.80{\pm}0.89^{ab}$ | $7.55{\pm}0.10^{b}$ | $7.90{\pm}0.79^{c}$ |
| **B** | $7.77{\pm}0.92^{c}$ | $7.55{\pm}123^{b}$ | $7.20{\pm}1.20^{b}$ | $7.90{\pm}1.22^{c}$ | $7.50{\pm}0.90^{bc}$ |
| **C** | $7.55{\pm}0.83^{c}$ | $6.90{\pm}1.24^{ab}$ | $7.01{\pm}0.86^{ab}$ | $7.55{\pm}1.28^{b}$ | $7.25{\pm}1.09^{abc}$ |
| **D** | $7.45{\pm}0.10^{c}$ | $6.65{\pm}1.57^{a}$ | $6.55{\pm}0.94^{ab}$ | $7.55{\pm}1.24^{b}$ | $7.20{\pm}1.15^{abc}$ |
| **E** | $5.75{\pm}1.59^{ab}$ | $6.80{\pm}1.24^{ab}$ | $6.40{\pm}0.88^{a}$ | $7.20{\pm}1.64^{a}$ | $7.00{\pm}1.08^{ab}$ |
| **F** | $5.35{\pm}1.93^{a}$ | $6.35{\pm}0.99^{a}$ | $6.35{\pm}1.18^{a}$ | $7.15{\pm}1.18^{a}$ | $6.60{\pm}1.54^{a}$ |

*Values (9-point hedonic score) are means of replicate determinations ± SD (Standard deviation). Mean values across column with different alphabet are significantly different ($p<0.05$).*

A = 100% wheat flour only
B = 87.5% wheat, 10% orange-fleshed sweet potato and 2.5% deffated *Dioclea reflexa* flour blends
C = 80% wheat, 15% orange-fleshed sweet potato and 5% deffated *Dioclea reflexa* flour blends
D= 72.5% wheat, 20% orange-fleshed sweet potato and 7.5% deffated *Dioclea reflexa* flour blends
E = 65% wheat, 25% orange-fleshed sweet potato and 10% deffated *Dioclea reflexa* flour blends
F = 55% wheat, 30% orange-fleshed sweet potato and 15% deffated *Dioclea reflexa* flour blends

## Conclusion

The nutritional quality of the chin-chin developed was improved by partially replacement of wheat flour with varying amounts of orange fleshed sweet potato (OFSP) and defatted *Dioclea reflexa* seed (DDRS), which led to significant increases in the protein, ash, fat, and fiber contents of the chin-chin samples as well as a significant increase in the potassium, iron, and zinc contents of the chin-chin with level of inclusion. Hence, highly-nutritious snacks had been formulated from wheat, OFSP and DDRS composite flours.

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