Proximate Composition and Organoleptic Properties of Chin-Chin from Flour Blends of Wheat, Orange Fleshed Sweet-Potato Enriched with Pigeon- Pea

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ABSTRACT

The consumption of snacks developed from composite flours is increasing steadily due to their potential health benefits. Chin-chin produced from wheat flour (WF), Orange fleshed sweet-potato flour (OFSPF) and Pigeon pea flour (PPF) blends at different ratios of 5:80:15%; 10:70:20%; 15:60:25% and 20:50:30% WF-OFSPF-PPF, were investigated for their proximate composition. Chin-chin samples prepared from the flour blends were subjected to proximate analysis and organoleptic evaluation using standard laboratory methods. Wheat chin-chin (100%WF) serves as a control sample. The data generated were statistically analyzed by One-way Analysis of Variance (ANOVA) using SPSS (version 21). The proximate composition of the flour blends ranged from 7.03- 9.82% moisture, 0.79- 2.89% ash, 6.40- 21.34% protein, 1.84-16.36% fat, 0.17-2.47% fiber, 59.96- 78.04% carbohydrate and 370.08- 442.12 kcal/100g energy value. The composite chin-chin have composition range of 1.62- 2.71% moisture, 0.88- 1.92% ash, 15.59-16.23% fat, 2.34-2.54% fiber, 9.45-13.50% protein, 64.18-67.52% carbohydrate and 447.41- 459.92 kcal/100g energy value respectively. The mean sensory scores for the chin-chin samples ranged from 5.35-7.67 taste, 5.05-7.25 colour, 5.15-6.45 aroma, 6.05-7.95 crunchiness and 5.25-7.75 overall acceptability, respectively. In conclusion, the inclusion of pigeon pea and OFSPF significantly improved the nutritional quality of the chin-chin samples. However, the control sample had higher sensory scores compared to the composite chin-chin samples, but they were all accepted.

Keywords: *Wheat flour, Pigeon pea flour, Chin-chin, Proximate composition, Organoleptic properties*

INTRODUCTION

Chin-chin is a golden- brownish crispy snack that is usually prepared from wheat flour, butter, milk, sugar, egg and other customary baking ingredients (Akubor, 2004) by baking or frying process. It is a popular snack consumed in West Africa by wide range of people, especially school going children, adolescent girls and high mobility groups (Singh *et al.,* 2011). Most of the bakery products (doughnuts, pies, cookies, cakes and buns) which are cereal-based (usually produced from wheat flour) have low nutritional values, with poor sources of protein (Lasekan and Akintola, 2002; Brink and Belay, 2006). Consequently, high competition in markets, increased demand for natural, healthy and functional products has prompted an intense search to improve the nutritive value and functionality of these bakery products by modifying their nutritive compositions. This effect have been achieved by incorporating an increasing ratios of enriched materials from plant sources other than wheat in basic recipes with the attempts to increase chin-chin's protein and mineral contents for quality and availability (Tyagi *et al.*, 2006) or increase dietary fiber and improve the prebiotic characteristics of the product (Gallagher *et al.*, 2003). Composite flour is desirable in this regard because it improves the nutritional value of food products, such as bakery products.

However, several studies have established the possibility of producing chin-chin from different locally available composite flour with tremendous success recorded in their sensory, physical and chemical properties. Adebayo-Oyetoro *et al.* (2017) and Emelike and Ebere (2016) reported the quality of chin-chin enriched with tigernut and moringa leaf powder respectively. Moreover, maize-wheat flour blends enriched with edible palm weevils (*Rhynchophorus phoenicis*) (Ojinnaka *et al.,* (2016), wheat flour - modified cocoyam starch blends (Falola *et al.*, 2014) and composite millet-wheat flour (Adegunwa *et al.*, 2014) were used for the production of chin-chin respectively with the aim of contributing to nutrition security and healthy life of current and future generations. Orange fleshed sweet-potato (OFSP) is a naturally bio-fortified crop with a great potential to be used in food- based intervention programs to address vitamin A deficiency (VAD) owing to its richness in carotene. Compared to other sweet-potato varieties, OFSP has some additional advantages, such as orange colour, sweet taste and high vitamin A. It is also a rich source of vitamin, calcium, dietary fiber, protein and as well offers numerous health benefits including stronger bones and teeth, lower cholesterol levels, prevention of cardiovascular disease and reduction of mammary and prostrate cancers. The incorporation of OFSP into wheat-based products, such as chapattis and mandazis (Bechoff *et al.*, 2011), bread and biscuits (Low and Van Jaarsveld, 2008) or to prepare a soft porridge have been promoted. OFSP are mainly eaten boiled, steamed or processed into products, such as sun-dried OFSP flour or chips. Orange-fleshed sweet potato (OFSP) flour serve as a source of energy and nutrients, β-carotene (pro-vitamin A), minerals (Ca, P, Fe, Zn and K) and also add natural sweetness, color, flavor and dietary fiber to processed food products (Woolfe, 1992). Processing of OFSP into flour can make it more accepted as a traditionally processed food and possibility of incorporating β-carotene in cookies. The high fiber contents of sweet-potato flour increases its utility in various new food product developments. Addition of various proportion of OFSP flour in wheat can increase the fiber and carotenoids contents that help in the lowering of wheat gluten level and as well prevent celiac disease (Tilman *et al.,* 2003).

Pigeon peas (*Cajanus cajan*) is an underutilized legume that is commonly referred to as ?Otili' in South-West, Nigeria (Adebowala and Maliki, 2011). Pigeon pea has been reported to contain 20-22% protein, 1.2% fat, 65% carbohydrate and 3.8% ash (FAO, 1982). The seeds are not widely consumed in Nigeria because of its hard- to-cook phenomenon and dearth of information on its utilization.

However, since emphasis has recently been shifted from the use of wheat flour exclusively to the utilization of indigenous and affordable food raw materials for baked products production (Apata and Ologhobo, 1994; Osagie, 1998). Composite flour blends can be an adequate complementary base for such formulation. The research work therefore evaluates the proximate composition and organoleptic properties of chin-chin produced from flour blends of wheat, orange fleshed sweet-potato and pigeon pea.

MATERIALS AND METHODS

Source of Materials

Orange fleshed sweet-potato tubers were obtained from Joseph Ayo Babalola University teaching and research farm in Ikeji-Arakeji, Nigeria. Pigeon-pea, wheat flour, granulated sugar, powdered milk, baking fat, salt, spice and baking powder were procured from Ilesa market, Osun state, Nigeria.

Production of Orange Fleshed Sweet-Potato Flour (OFSPF) and Pigeon-pea Flour

Orange fleshed sweet-potato tubers are sorted, washed, peeled, sliced into chips of about 4-5 mm thickness with knife and then blanched in hot water (98oC for3 min.) (Omah and Okaka, 2015). The blanched chips are dried in a cabinet drier (65oC for 9 h), milled to achieve flour of 100 µm particle size. The resulting flour was packaged in high density polyethylene and stored in an air-tight container at 4oC prior to further analysis.

Pigeon-pea flour was produced according to the method described by Omah and Okafor (2015) with slight modification. The peas were sorted and soaked in water (95oC for 30 min.), dehulled, dried in a cabinet drier (60oC for 8 h), cooled, milled with an attrition mill, packed in high density polyethylene and stored for further analysis.

Composite Flour Formulation

The blends of Wheat flour (WF), Orange-fleshed sweet-potato flour (OFSPF) and pigeon pea flour (PPF) were mixed at the ratio of 5:80:15%, 10:70:20%, 15:60 25%, 20:50:30% and coded as WOP_1, WOP_2, WOP_3 and WOP_4 respectively as shown in Table 1. Wheat flour (WF-100%) serves as the control sample.

Table 1: Composition of the flour blends

Sample codes	Wheat flour (WF) (g) :	OFSPF (g)	: Pigeon pea flour (PPF) (g)
WF	100	0	0
WOP_1	5	80	15
WOP_2	10	70	20
WOP_3	15	60	25
WOP_4	20	50	30

WF- Wheat flour, OFSPF – orange-fleshed sweet potato flour, PPF- Pigeon pea flour
WF – 100% Wheat flour, WOP_1– 5% WF: 80% OFSPF: 15% PPF, WOP_2 – 10% WF: 70% OFSPF: 20% PPF, WOP_3 – 15% WF: 60% OFSPF: 25% PPF, WOP_4 – 20% WF: 50% OFSPF: 30% PPF

Preparation of Chin-Chin Samples

The method described by Emelike (2006) was adopted for the production of chin-chin with slight modification, which was the addition of suya spice. Table 2 shows the recipes for chin-chin production. The composite flour was weighed into clean bowls separately and other dry ingredients, such as baking powder, salt, spice and sugar were weighed, sieved into the bowls and hand-mixed thoroughly to ensure uniformity. After mixing, the baking fat was rubbed-in and a milk solution was turned in and mixed to form dough. The dough was placed on a floured surface and kneaded until smooth and elastic. The kneaded dough was rolled out and then cut into small squares of about 2 cm by 2 cm in size. Frying of the dough (cubes) was done in an electrically heated deep fryer (Michaki model, 2.5L) containing vegetable oil, that was preheated to temperature of 180oC prior to frying of the chin-chin for 7 minuntil golden brown. The chin-chin were allowed to cool, then packaged and stored at room temperature prior to further analysis

Table 2: Recipes for chin-chin production from flour blends of Wheat – Orange fleshed Sweet- potato – Pigeon pea

Sample code	Wheat flour (%)	OFSPF (%)	PPF (%)	Sugar (g)	Baking fat (g)	Baking powder (g)	Baking powder	Water L	Salt (g)	Spice (g)
WF	100	0	0	13	10	5	1	1	3	
WOP_1	5	80	15	13	10	5	1	1	3	
WOP_2	10	70	20	13	10	5	1	1	3	
WOP_3	15	60	25	13	10	5	1	1	3	
WOP_4	20	50	30	13	10	5	1	1	3	

OFSPF: orange - fleshed sweet potato flour, PPF: Pigeon - pea flour
WF – 100% Wheat flour, WOP_1– 5% WF: 80% OFSPF: 15% PPF, WOP_2 – 10% WF: 70% OFSPF: 20% PPF, WOP_3 – 15% WF: 60% OFSPF: 25% PPF, WOP_4– 20% WF: 50% OFSPF: 30% PPF

Proximate Composition of Fours and Chin-Chin Samples

The proximate composition of the flours and the chin-chin samples were analyzed for moisture, protein, fat, crude fibre and ash contents according to the methods described in AOAC (2010). The carbohydrate (CHO) content was calculated by difference as: CHO= 100- (% moisture + %protein + %fat + % ash). Food energy value (Kcal/100g) was determined according to the method of Marero *et al.* (1998) using the factor [(4 × % Protein) + (4 × % Carbohydrate) + (9× % Fat).

Sensory Evaluation of Chin-Chin Samples

A preference test was conducted to evaluate and differentiate the sensory properties of the composite chin-chin from the control sample (Retapol and Hooker, 2006). Ten panelists made of students and members of staff in Food Science and Technology Department, Joseph Ayo Babalola University, Nigeria were chosen based on their familiarity and experience with wheat-based chin-chin to compare each coded sample on basis of some specified attributes (taste, colour, aroma and crunchiness). The chin-chin samples were presented in coded form on white plastic plates and randomly presented to the panelists. The panelists were provided with portable water to rinse their mouth between evaluations. Each sensory attribute was rated on a 9-point hedonic scale, where points 1 and 9 denote poor and excellent attributes respectively. Each panelist assigned scores for each attribute as against the maximum score of 9 and their responses were analyzed statistically.

Data obtained were analyzed using analysis of variance (ANOVA) (Steel and Torrie, 1980), using a statistical package for the Social Sciences, SPSS (version 21). Mean separation was done using Duncan multiple range test and significance difference was accepted at 5% probability level.

RESULTS AND DISCUSSION

Proximate Composition of the Composite Flours

The results of the proximate compositions of wheat flour (WF), pigeon-pea flour (PPF), orange fleshed sweet-potato flour (OFSPF) and their blends at different proportions are depicted in Table 3. The moisture content of the flour samples ranged from 7.03% (100% PPF) to 9.82% (100% OFSPF). There was no significant ($p>0.05\%$) difference in the moisture content of the composite flour. The increase in the moisture content of the composite flour may be attributed to the increasing substitution levels of OFSPF. This implies that the composite flour may be susceptible to spoilage by microbial invasion especially by mold and fungi (Ihekoronye and Ngoddy, 1985). These results were in agreement with the values reported by Ezeocha and Onwuneme (2016) for the moisture content of composite flour prepared from sweet-potato and tigernut. A similar finding was observed by Adebowale *et al.* (2009) for increasing moisture content in sweet-potato-wheat composite flour. The moisture content of flour determines its storage stability. Moreover, Sanni *et al.* (2006) reported that the lower the moisture contents of a flour to be stored, the higher the storage-stability. The ash content ranged between 0.79% and 2.89% with OFSPP (100%) and pigeon pea flour (100%) having the lowest and highest values respectively. The result showed that the composite flours had comparable ash values, with the exception of sample WOP_1, which have the least value among the flour blends. Ash content is a reflection of the mineral matter in a food product. However, it is evident from the result that, the ash content of the composite flour increased with the increasing substitution level of pigeon-pea flour and as well with the decreasing level of OFSPF respectively. This may be attributed to the fact that pigeon- pea flour contains the highest percentage of ash (2.89%) than wheat flour and OFSPF respectively. The protein content of the flour samples ranged from 6.40 to 21.34%, with OFSPP (100%) having the least value, while sample WOP_5 (20% WF: 50%OFSPF: 30% PPF) had the highest protein content as was expected. There was significant ($p<0.05\%$) differences among the composite flour. The protein content of the composite flours increased with increasing pigeon- pea flour substitution levels. This is expected since pigeon- pea is a rich source of protein, when compared with wheat and OFSP flours. Moreover, it was obvious from the results that pigeon-pea flour and wheat flour contributed higher protein content in the composite flour, thus reflecting them as better sources of protein compared to OFSPF. Similarly, Ezeocha and Onwuneme (2016) reported a decrease in the protein content of wheat - sweet-potato- tigernut composite flour due to low protein contents in sweet-potato and tigernut flour. The fat content ranged from 1.84 to 16.36% for the flour samples. The control sample (100%WF) and 100% PPF had the lowest and highest values respectively. It was evident from the results that, the fat content of the composite flours increased with increasing pigeon- pea flour substitution levels. Fasisi (2009) reported that low fat content in flour samples increased the shelf-life of the material by decreasing the chances of rancidity and also contribute to low energy value. The fiber content of the flour samples ranged between 0.17 and 2.47% in which 100% PPF and 100% OFSPP had the lowest and highest values respectively. The significant ($p<0.05\%$) variation in the fiber content of the composite flour may be attributed to the increasing inclusion level of

OFSPF, as was expected. The low fiber content observed in pigeon pea flour could be attributed to the removal of the pea coats which are known as rich sources of fiber. Dietary fiber intake is essential in human diet because of its numerous health benefits in the reduction of the risk of several developing diseases, such as coronary heart disease, hypertension, diabetes, obesity, stroke and gastro-intestinal disorders (Anderson *et al.,* 2009). The carbohydrate content of the flour samples ranged from 59.96 to 78.04%, with sample WOP_5 (20% WF: 50% OFSPF: 30% PPF) and the control sample (100%WF) having the lowest and highest values respectively. Significant differences ($p<0.05$) exist among the flour samples. The carbohydrate content of the composite flour decreased with pigeon pea flour addition in the blends, and this could be attributed to the fact that flours from leguminous plants are poor sources of carbohydrate. Pigeon pea flour had lower carbohydrate values compared to other flours in the study, thus indicating that OFSP tubers and cereals are good sources of carbohydrate. The energy value of the flour samples ranged between 370.08 in the control sample (100% WF) and 444.12 kcal/100g in PPF (100%). The energy values of the flour samples WOP_1 and WOP_2; WOP_3 and WOP_4 were comparable respectively, but differed significantly ($p<0.05\%$) from other flour blends. The increase in the energy value of the composite flour could be attributed to increase in both carbohydrate and protein values of the samples (Adebowale and Maliki, 2011).

Table 3: Proximate Compositions of Flour Blends of Wheat- Orange fleshed Sweet Potato - Pigeon-pea

Samples Code	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	CHO (%)	Energy value (Kcal/100g)
WF	8.53^{c}	1.25^{b}	10.34^{f}	1.84^{g}	1.13^{e}	78.04^{a}	370.08^{e}
WOP_1	9.55^{b}	1.10^{d}	19.66^{d}	7.12^{e}	1.01^{e}	62.57^{c}	393.00^{c}
WOP_2	9.56^{b}	1.20^{c}	19.89^{c}	7.22^{d}	1.56^{d}	62.13^{d}	393.06^{c}
WOP_3	9.54^{b}	1.25^{b}	20.33^{b}	7.76^{c}	1.66^{c}	61.12^{e}	395.64^{b}
WOP_4	9.53^{b}	1.26^{b}	21.34^{a}	7.91^{b}	1.84^{b}	59.96^{f}	396.39^{b}
OFSPF	9.82^{a}	0.79^{d}	6.40^{g}	5.36^{f}	2.47^{a}	77.63^{b}	384.36^{d}
PPF	7.03^{d}	2.89^{a}	12.86^{e}	16.36^{a}	0.17^{f}	60.86^{e}	442.12^{a}

Means in the same column with the same superscript are not significantly different ($p>0.05$)
Values are means of duplicate determinations.
WF 100% Wheat flour, WOP_1 5% WF: 80% OFSPF: 15% PPF, WOP_2 10% WF: 70% OFSPF: 20% PPF, WOP_3 15% WF: 60% OFSPF: 25% PPF, WOP_4 20% WF: 50% OFSPF: 30% PPF

Proximate Composition of Chin-Chin Samples

The results of the proximate compositions and energy values of chin-chin samples produced from the composite flour are presented in Table 4. The moisture content of the chin-chin samples was significantly ($p<0.05$) different, ranging from 1.62 to 2.71%; control sample (100% WF) and WOP_4 (20% WF: 50% OFSPF: 30% PPF) had the lowest and highest values respectively.

Generally, the moisture content of the composite chin-chin increased with increasing substitution level of PPF and decreasing inclusion level of OFSPF. It was also observed from the results that the composite chin-chin had higher moisture contents compared to the control sample.

However, the moisture of the chin-chin samples was low (<10%) to reduce the chances of spoilage by micro-organisms and consequently guarantee good storage stability (Ayo *et al.*, 2007). The results obtained in the study converse with the moisture content of chin-chin produced from flour blends of wheat-tigernut (3.00-5.29%; Adebayo-Oyetoro *et al.*, 2017), millet-wheat (3.98-5.04%; Adegunwa *et al.*, 2014), modified cocoyam- wheat (1.41-5.05%; Falola *et al.,* 2011) respectively. Chin-chin with low moisture content generally have prolonged shelf-life.

Chin-chin samples had significant ($p<0.05\%$) different ash content which ranged from 0.88 to 1.92%; control sample (100%WF) and sample WOP_4 (20% WF: 50% OFSPF: 30% PPF) had the lowest and highest values respectively. Generally, the composite chin-chin samples had higher ash contents than the control sample, which is directly related to the mineral compositions of the flour blends. The high ash content in the composite chin-chin could be attributed to the increasing substitution levels of pigeon-pea flour. Adegunwa, *et al.* (2014) and Falola *et al.* (2011) reported higher ash contents (4.97-6.10%) and (1.16- 4.00%) for chin-chin samples produced from flour blends of millet-wheat and modified cocoyam-wheat respectively. Conversely, low ash content (0.47-1.08%) is obtained in chin-chin samples produced from flour blends of wheat- and tigernut (Adebayo-Oyetoro *et al.*, 2017). The fat content of the chin-chin samples ranged from 15.59 to 16.23%, with the control sample (100% WF) and WOP_4 (20% WF: 50% OFSPF: 30% PPF) having the lowest and highest values respectively. The fat content of the chin-chin samples increased with the increasing substitution level of PPF and decreasing inclusion level of OFSPF. The high fat content of the chin-chin may be attributed to the high amount of fat added and absorbed during preparation and frying respectively.

The range in the study was significantly lower than those reported by Adebayo-Oyetoro *et al.* (2017) for the fat content (21.05-36.67%) of chin-chin produced from wheat and tigernut flour blends, but higher than those produced from flour blends of millet-wheat (7.56 - 8.13%; Adegunwa *et al.*, 2014) and modified cocoyam-wheat (7.81-8.27%; Falola *et al.,* 2011) respectively. The presence of high fat content in the chin-chin indicates high calorific value and could serve as a lubricant that improves product quality in terms of texture. In addition, fat is a rich source of energy and is essential as carriers of fat soluble vitamins; A, D, E and K. The crude fiber content of the chin-chin samples ranged between 2.34% in the control sample (100%WF) and 2.54% (WOP_4-20% WF: 50% OFSPF: 30% PPF). These values were higher than chin-chin samples produced from flour blends of modified cocoyam-wheat (0.77-2.15% ; Falola *et al.,* 2011) and wheat- tigernut blends (0.28- 0.66% ; Adebayo-Oyetoro *et al.*, 2017) respectively, but lower than those produced from blends of millet-wheat (4.56-5.23%; Adegunwa *et al.*, 2014).

The composite chin-chin samples were not significantly different ($p>0.05$) from one another, but significantly different ($p<0.05$) from the control sample. OFSPF is relatively a good source of dietary fiber, which explains the higher values reported in the study. Crude fiber is an indication of roughage/bulkiness of a sample and its presence in food products serves in reducing constipation by facilitating bowel movement (peristalsis) and preventing many gastrointestinal diseases in man (Abiodun *et al*., 2012). The protein content of the chin-chin samples ranged from 9.45 to 13.50%; control sample and sample WOP_4 (20% WF: 50% OFSPF: 30% PPF) had the lowest and highest values respectively.

The composite chin-chin samples were significantly ($p<0.05$) different from the control sample. However, increase in the protein content of the composite chin-chin could be attributed to the increase in the proportion of pigeon-peas in the chin-chin formulation recipe. Pigeon pea flour is a richer source of protein compared to other flours in the study. The protein content of the composite chin-chin samples in the study is higher than values reported in other studies for composite chin-chin (7.66-11.58, Adebayo-Oyetoro *et al*., 2017; 6.80- 9.25%, Falola *et al.,* 2011) respectively, but lower than those produced from flour blends of millet-wheat (12.63-19.90%; Adegunwa *et al*., 2014). Food products rich in protein content are of great nutritional importance in developing countries, such as Nigeria, where protein malnutrition prevails (Anuonye *et al*., 2012; Okpala and Okoli, 2011). Most children require protein for growth, repair and maintenance of the body. Protein is an essential building material necessary for the maintenance of all body parts, such as blood, hair, bones, brain, nails, skin muscles and body fluid (Mahan and Escott-Stump, 2008). The carbohydrate content of the chin-chin samples ranged from 64.18 to 67.52% and significant ($p<0.05$) difference exists among the samples. Chin-chin made from 100%WF and 20%WF: 50%OFSPF: 30%PPF (WOP_4) had the highest and lowest values respectively.

The high carbohydrate contents of the chin-chin could be attributed to the inclusion of WF and OFSPF in the formulation. The values were higher compared with 49.7-52.0%, for biscuits produced from carrot pomace powder and germinated chicken peas blends (Baljeet *et al*., 2014). The energy value of the chin-chin samples ranged between 447.411 and 459.92 Kcal/100g. Samples made from 100% WF (control sample) had the highest value while sample WOP_2 had the least value. Significant ($p<0.05$) differences exist among the composite chin-chin. The fat, protein and carbohydrate values contributed to the energy value of the chin-chin. Chin-chin are energy-giving foods which are consumed by both young and old, especially in-between or after meals

Table 4: Proximate composition of chin-chin samples produced from composite flour blends

Sample Codes	Moisture (%)	Ash (%)	Fat (%)	Fiber (%)	Protein (%)	CHO (%)	Energy value (Kcal/100g)
WF (100%)	1.62^{d}	0.88^{d}	15.59^{d}	2.34^{b}	9.45^{c}	67.46^{a}	459.92^{a}
WOP_1 (5:80:15)	2.48^{c}	1.43^{d}	15.65^{c}	2.49^{a}	11.73^{d}	66.73^{b}	454.78^{c}
WOP_2 (10:70:20)	2.51^{c}	1.72^{c}	15.69^{c}	2.50^{a}	12.37^{c}	64.62^{c}	447.41^{d}
WOP_3 (15:60:25)	2.62^{b}	1.84^{b}	15.82^{b}	2.52^{a}	12.58^{b}	67.52^{a}	455.22^{c}
WOP_4 (20:50:30)	2.71^{a}	1.92^{a}	16.23^{a}	2.54^{a}	13.50^{a}	64.18^{d}	456.84^{b}

Means in the same column with the same superscript are not significantly different (p>0.05)
Values are means of duplicate determinations.
WF 100% Wheat flour, WOP_1 5% WF: 80% OFSPF: 15% PPF, WOP_2 10% WF: 70% OFSPF: 20% PPF, WOP_3 15% WF: 60% OFSPF: 25% PPF, WOP_4 20% WF: 50% OFSPF: 30% PPF

Sensory Evaluation of Chin-Chin Samples

The results of the sensory evaluation of the chin-chin samples are presented in Table 5. The mean scores for the taste of the chin-chin samples ranged between 5.35 for sample WOP_4 (20% WF: 50% OFSPF: 30% PPF) and 7.67 for the control sample. Significant ($p<0.05$) difference exist among the chin-chin samples and this could be attributed to the unfamiliarity and unpreparedness of the panelists to explore new chin-chin samples with suya spice. The scores in the study is comparable with those reported for composite chin-chin made from flour blends of millet-wheat and modified cocoyam-wheat (4.94 -7.72; Adegunwa *et al*., 2014) and (5.60-7.12; Falola *et al.,* 2011) respectively, but higher than 4.0-5.5 as recorded by Hussein *et al.*, (2015).

Colour is an important sensory attribute of any food because of its acceptability. With regard to the colour of the chin-chin samples, the mean scores ranged from 5.05 to 7.25, with sample WOP_3 (15%WF: 60% OFSPF: 25% PPF) and 100% WF having the least and highest scores respectively. However, there was significant ($p<0.05$) difference between the control sample and the composite chin-chin samples. The composite chin-chin samples had deep-brown colouration, as this may be attributed to the reaction between sugar in OFSPF and amino acids in PPF (known as Maillard reaction). Obviously, the inclusion levels of OFSPF and PPF greatly influenced the colour of the chin-chin as evident in the scores recorded by the panelists. Similar color mean scores were recorded for composite chin-chin made from modified cocoyam-wheat flour blends (5.20- 7.40; Falola *et al.,* 2011) but higher than those prepared from composite wheat-sweat potato flour (3.6-5.6; Hussein *et al.*, 2015). The aroma of the chin-chin samples had mean sensory scores ranging between 5.15 and 6.45. Chin-chin samples made from 100% WF (control) and sample WOP_1 are not significantly different from each, but different from others. The high aroma score of sample WOP_1 could be attributed to the slight beany flavor compared to others with low scores, owing to the noticeable high proportion of

PPF. Conversely, Hussein *et al.* (2015) reported a low aroma scores for chin-chin samples made from flour blends of wheat and sweat potato. The mean scores for the crunchiness of the chin-chin samples were significantly different from each other with the increasing substitution level of PPF and decreasing inclusion level of OFSPF. The scores ranged from 6.05 to 7.95 for 100%WF (control) and WOP_1 respectively. This result disagrees with the scores obtained for composite chin-chin samples made from flour blends of wheat- tigernut blends (3.67-7.61; Adebayo-Oyetoro *et al.*, 2017), wheat-sweat potato and modified cocoyam-wheat (5.52-6.88; Hussein *et al.*, 2015) respectively. Crunchiness is another important criterion perceived when snacks are chewed between the molars and is usually expressed in terms of hardness and factorability.

The mean scores for the overall acceptability of the chin-chin samples ranged between 5.25 for sample WOP_4 (20%WF: 50%OFSPF: 30%PPF) and 7.75 for the control sample (100%WF). Significant ($p<0.05$) difference exist among the composite chin-chin samples. The scores decreased as the substitution level of PPF increased and with decreasing inclusion level of OFSPF. It is worth-noting that the composite chin-chin samples were generally acceptable, since higher ratings of more than 4.5 was obtained, which is the minimum acceptable values on the nine point hedonic scale.

Table 5: Mean sensory scores of chin-chin produced from flour blends of wheat- Orange fleshed sweet-potato- Pigeon-pea

Sample codes	Taste	Colour	Aroma	Crunchiness	Overall acceptability
WF	7.67^a	7.25^a	6.45^a	7.95^a	7.75^a
WOP_1	5.75^c	6.65^b	6.35^a	6.05^e	6.55^b
WOP_2	6.05^b	5.85^c	5.15^d	6.75^d	6.25^c
WOP_3	5.55^d	5.05^e	5.35^c	6.85^c	5.75^d
WOP_4	5.35^e	5.65^d	5.55^b	7.25^b	5.25^e

Mean values with the same superscript within the same column are not significantly different ($p>0.0$
are means of duplicate determinations.
WF – 100% Wheat flour, WOP_1 – 5% WF: 80% OFSPF: 15% PPF, WOP_2 – 10% WF: 70% OFSPF:
WOP_3 – 15% WF: 60% OFSPF: 25% PPF, WOP_4 – 20% WF: 50% OFSPF: 30% PPF

CONCLUSIONS

The study shows that chin-chin samples with improved nutritional and sensory properties can be produced from composite flour blends of wheat, orange fleshed sweet-potato and pigeon peas and will assist Food processors to realize local and affordable raw materials for chin-chin production. The study revealed that chin-chin samples produced from 5%WF: 80% OFSPF: 15% PPF compares favorably with the control sample and they were most acceptable among others, in terms of colour and aroma.

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