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PRODUCTION AND COMPARATIVE QUALITY EVALUATION OF CHIN-CHIN SNACKS FROM MAIZE, SOYBEAN AND ORANGE FLESHED SWEET POTATO FLOUR BLENDS.

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ABSTRACT

Most snacks are prepared from basically cereal flours which are nutritionally inadequate. There is the need to complement the nutrient content of these snacks by varying the food sources. Chin-chin snacks were produced from composite flours of Maize, soybean and OFSP with the following formation; sample A (50%: 25%: 25%), B (25%: 25%: 50%), C (25%: 50%: 25%), D (0%: 50%: 50%) and E (50%: 50%: 0%). Wheat flour (100%) served as the control F. The flour bends were analysed for functional properties while the chin-chin snacks were analysed for their nutrient and sensory qualities. The result of functional properties of the flours showed that bulk density of wheat flour (F) was the highest (0.746 g/ml). OFSP flour enhanced the water absorption capacity of the flour blends. Flour blends with soybean recorded higher values in foam capacity (11.20 - 22.55%). In proximate composition, the moisture was low (3.80 – 4.80%) in the chin-chin. Higher fibre content (2.60 - 4.20%) was obtained in samples containing higher proportion (50%) of OFSP. Samples D (19.38%) and C (18.80%) with higher soybean, recorded higher protein values. The mineral and the vitamin contents of snacks from composite flours were higher than that of the control F. Vitamin B_1, B_2, B_3 and β-carotene contents of the snacks were enhanced by OFSP. The sensory evaluation showed preference for snack F (100% wheat flour) followed by snack A (50% maize, 25% soybean and 25% OFSP). However, improved nutrient dense chin-chin snacks were produced from the composite flours.

Keywords: Proximate, Antinutrients, Phytochemicals, Composite, Sensory

INTRODUCTION

Snack foods have been part of human diet for a long time and have contributed tremendously to economy of every nation (Lasekan and Akintola, 2002). The demand for snacks is attributed to the rapid population and urbanization of both developed and developing countries (Ugwuanyi *et al*., 2020). Snacks contribute an important part of many consumers' daily nutrient and caloric intake (Awoyale *et al*., 2011). The most widely consumed snacks are cereal based products, which generally are low in nutrient density. They are generally regarded as convenience food and have been part of the human diet for a long time (Lasekan and Akintola, 2002). Snacks foods are cheap, easy to eat and readily available on the streets, shops, schools, among others (Ugwuanyi *et al*., 2020). Chin-chin is a fried snack popular in West African countries especially Nigeria. It is a sweet, hard, fried or baked product made of wheat flour dough and other ingredients (Akubor, 2004; Mepba *et al*., 2007).

Legumes are the edible seeds of leguminous plants belonging to the family *Leguminosae*. They are known to contain doubled amount of protein compared to cereals and this is usually added to the cereal based snacks to improve their protein content (Enwere, 1998; Fasogbon et al., 2017). Legumes has been successfully used in baked products to obtain protein-enriched products with improved amino acid balance (Mohammed *et al*., 2012). Soybean (*Glycine max*) is a rich source of protein, fat, carbohydrate, vitamins, minerals, and water. It is regarded as poor man's meat in the developing countries where animal products are costly. It is a right substitute to mitigate the challenge of protein energy malnutrition (Enwere, 1998; Fasoyiro *et al*., 2006).

Orange-fleshed sweet potato (OFSP) is one of the sweet potato varieties being promoted in sub-Saharan Africa as a food-based measure to complement other efforts in reducing the occurrence of vitamin A deficiency (Hotz *et al*., 2012; Tumwegamire *et al*., 2004). In spite of its high nutritional value, OFSP is underutilized in Nigeria compared with other root and tuber crops consumed (Baafi *et al*., 2015). OFSP has been found to be a good composite to wheat flour if pureed for snacks. It is grown in many tropical and subtropical regions. Among the world's major food crops, seet potato produces the highest amount of edible energy per hectare per day (Singh *et al*., 2008). Among the root and tuber crops, sweet potato is the only one that has a positive per capita annual rate of increase in production in sub-Saharan Africa (Tumwegamire *et al*., 2004).

The concept of composite flour technology initiated by the Food and Agriculture Organization (FAO) in 1964 was to support developing countries by encouraging the use of indigenous crops such soybean, maize and others in partial substitution of wheat flour (Wan and Kinsella, 1991; Enwere, 1998), and reduce over dependency on wheat flour as the sole cereal for pastries and confectioneries. Composite flour is considered advantageous in developing countries as it reduces the importation of wheat flour and encourages the use of locally grown crops as flour (Singh *et al.,* 2008). Thus, several developing countries have encouraged the initiation of programs to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour. The objectives of this work therefore, was to produce chin-chin snacks from the flour blends of maize, soybean and orange flesh sweet potatoes (OFSP), evaluate and compare its quality composition with conventional chin-chin from wheat flour.

MATERIALS AND METHODS

Source of materials

Raw materials for this research (maize grains, soybean seeds, wheat flour, butter, egg, sugar, nutmeg, baking powder, vanilla oil, powdered milk, salt and vegetable oil) were purchased at Umuahia main market (Ubani), Abia state, while orange fleshed sweet potatoes (OFSP) was obtained from National Root Crop Research Institute (NRCI) Umudike, Abia State, Nigeria.

Preparation of flours

OFSP: was produced using the method of Bibiana *et al.* (2014). OFSP tubers were washed, peeled and grated. The grated OFSP was spread out on trays and oven dried at 60 ºC for 24 hours. The dried OFSP was milled using a hammer mill (9FC-360A JinJuhong machinery, China), sieved through a 500 µm mesh and stored in air tight containers in a cold room at 4 ºC prior to use.

Soybean flour: The method of Okoye *et al.* (2008) was adopted; the soybean seeds were cleaned, sorted to remove pests, insects and other contaminants. Thereafter, it was soaked for 6 h to remove anti-nutrients inherent in soybean and then dehulled and dried in an air oven (Kappa Catering Equipment, Italy) at 60 ºC. This was followed by toasting at 120 ºC for 10 minutes, it was then milled and allowed to pass through 500 um mesh size to obtain fine flour, the flour was stored at 4 ºC prior to time of use.

Preparation of maize flour: Maize flour was produced according to the method of Awoyale *et al*. (2011).The maize grains were sorted by hand to remove stones, chaff, and damaged grains. The cleaned maize was washed with distilled water, dried in an oven at 60 ºC for 4 h and milled in an attrition mill and sieved with a 500 um mesh.

Formulation of composite flours

The flour composition ratio for chin-chin production is presented in Table 1.

Flours from maize, soybean and orange flesh potatoes (OFP) were blended to up one hundred gram flour for the chin-chin production, while chin-chin from 100% wheat flour served control.

Table 1: Composite flour formulation (%)

Flour	A	B	C	D	E	F
Maize	50	25	25	0	50	0
Soybean	25	25	50	50	50	0
OFSP	25	50	25	50	0	0
Wheat	0	0	0	0	0	100
Total:	100	100	100	100	100	100

Production of chin-chin

Each composite flours (100 g) was put in a bowl followed by the addition of 2 g of salt and 0.5 g of ground nutmeg respectively. 25 g of sugar, 10 g of powdered milk, 1g of baking powder, were manually mixed with 25 g of margarine to form a batter. The batter was then mixed with flours and 20 ml of water was added to the mixture, which was thoroughly kneaded to make fairly stiff dough. The dough was rolled tightly to 1cm thickness on a board and cut into uniform cubes and were fried in deep hot vegetable oil at 180 ºC for 8 min until golden brown was observed. The chin-chin was drained off oil, cooled and packaged in an air tight container for analysis.

METHODS OF ANALYSIS

Proximate analysis

The determination of the chemical composition of the samples for moisture, ash, protein, fat, and fiber contents were determined by methods described by AOAC (2010). Carbohydrate content was determined by difference using the Atwater factors

Mineral analysis

Each sample was digested by the wet ashing method prior to mineral content determination using atomic absorption spectrophotometer for Ca, Mg and Fe and Corning 400 flame photometer for K and Na (AOAC, 2005). The Phosphorus content was determined colorimetrically with Jenway 6100 spectrophotometer using the method described by Nielsen (2003).

Vitamin analysis

The spectrophotometric method described by Jacobs, (1999).was used; the absorbance of the sample and the standard solutions were measured with a UV-Spectrophotometer at their respective wavelengths. The concentrations of the vitamins in the prepared samples were run against known standards calibrated curve**.**

Functional properties analysis

The bulk density, water and oil absorption capacities, foaming capacity and of the flour samples were evaluated according to the method of Onwuka (2018).

Phytochemical analysis

The AlCl3 method of Harborne (1993) was used for the determination of the total flavonoid content. The tannin content was determined using the Follin-Dennis spectrophotometric method as described by Pearson (1976). The spectrophotometric and titration methods described by

Onwuka (2005) were used to determine the phytate, oxalate and hydrogen

Sensory analysis

Sensory evaluation of the chin-chin was carried out using a 9-point Hedonic scale as described by (Iwe, 2010). 20 semi-trained panellists from the department of Food Science and Technology, Michael Okpara University of Agriculture, Umudike were used. The 9-point Hedonic scale ranged from extremely like (9) to extremely dislike (1), while 5 is neither like or dislike Each sample was evaluated for flavour, colour, taste, texture and overall acceptability.

Statistical analysis

Data are presented as mean ± standard deviations. The results obtained were subjected to Analysis of Variance (ANOVA) using Statistical package for social sciences (SPSS version 20). Means were separated using Duncan's multiple Range Test (DMRT). Significant difference was determined at $P < 0.05$.

RESULTS AND DISCUSSION

Functional properties of flour blends

Functional properties of flour blends are presented in Table 2. Bulk density of the flour samples ranged from 0.667- 0.746 g/ml. Bulk density of wheat flour (F) was higher (0.746 g/ml) than recorded for composite flours (0.667 – 0.728 g/ml). There was significant difference ($p<0.05$) in bulk density of the flour blends. Omoniyi *et al*. (2016) reported higher bulk density value for sweet potato and soybean composite flour. The high bulk density value recorded for the flour blends might likely aid its industrial applications, and also its application in bakery industry. High bulk density of a material is also important in relation to handling requirements and packaging (Linus-Chibuezeh *et al*., 2017).

The water absorption capacity (OAC) of the flour blends ranged from 1.20 g/ml (sample F) to 2.60 g/ml (sample B). There was significant difference ($p<0.05$) in OAC of the flour blends. The result showed that OFSP flour enhanced the water absorption capacity of the flour blends. Similar observation was reported by Omoniyi *et al*. (2016) for sweet potato and Bambara nut flour blends. Also, Wan and Kinsella (1991) had earlier reported that the ability of food materials to absorb water is sometimes attributed to the starch content. This suggests that increase in water absorption in the blends can be useful in bakery products such as bread, cakes, cookies that requires hydration to improve dough handling characteristics.

The oil absorption capacity (OAC) of the flour blends ranged from 1.35 – 2.20 g/ml. Sample B recorded highest value in OAC, while control sample (100% wheat flour) had the least. The result showed that OFSP flour increased the OAC of the flour blends. Similar relationship had been suggested by Oyeyinka *et al*. (2014). Wan and Kinsella (1991) also attributed the mechanism of oil absorption to interaction between fat and non-polar chain of protein as well as the physical entrapment of oil. This affirms the reason for the higher value obtained with increase in wheat flour in the blends. Oil absorption capacity is important as it could influence the acceptability and storage stability of food products.

The foam capacity of the flour blends ranged from 10.55% (sample B) to 22.55% (sample C). Flour from 25% maize, 50% soybean and 25% OFSP recorded highest value in foam capacity (22.55%). There was significant difference ($p<0.05$) in foam capacity of the composite flours. The blends containing higher proportion of soybean showed higher foam capacity values (16.23 - 22.55%). This is not surprising as legumes have been reported to have high foam capacity due to their high protein content (Omoniyi *et al*., 2016).

Table 2: Functional Properties of the Composite Flours.

Samples	Bulk density (g/ml)	WAC (g/ml)	OAC (g/ml)	Foam capacity (%)
A	0.676^{e}±0.03	2.40^{b}±0.14	1.80^{b}±0.14	18.43^{c}±0.25
B	0.667^{f}±0.00	2.60^{a}±0.00	2.20^{a}±1.14	11.20^{e}±0.07
C	0.728^{b}±0.00	2.00^{c}±0.00	1.45^{cd}±0.07	22.55^{a}±0.07
D	0.688^{d}±0.02	2.30^{b}±0.14	1.60^{bc}±0.00	16.23^{d}±.13
E	0.714^{c}±0.3	2.20^{b}±0.00	1.55^{cd}±0.07	20.24^{b}±0.10
F	0.746^{a}±0.06	1.20^{d}±0.00	1.35^{d}±0.07	10.55^{f}±0.00

Values are mean ±SD. Values on the same column with different superscript are significantly different ($p<0.05$)

Sample: A- Maize 50%: Soybean 25%: OFSP 25%; B- Maize 25%: Soybean 25%: OFSP 50%; C- Maize 25%: Soybean 50%: OFSP 25%; D- Maize 0%: Soybean 50%: OFSP 50%; E- Maize 50%: Soybean 50%: OFSP 0%

F- 100% wheat

Proximate composition of chin-chin snacks

The proximate composition of chin-chin snacks is shown in Table 3.

The moisture content of the chin-chin ranged from 3.80 – 4.80%. Moisture content was higher in 100% wheat flour chin-chin (F) and sample A (4.80%) respectively. These value which were significantly ($p<0.05$) higher compared to other products. Wahab *et al*. (2018) reported moisture content of 3.18-3.54% for chin-chin from wheat and *cissus populnea* stem composite flours. The values were within the range reported to have no adverse effect on quality attribute of the product (Mepba *et al.,* 2007, Adebayo-Oyetoro *et al*., 2017). The low moisture content exhibited by the chin-chin samples is an indication that the products will have shelf stability (Ezeama, 2007).

The ash content of the chin-chin ranged from 1.90 – 3.65%. There was significant difference ($p<0.05$) in ash content of the chin-chin samples. Combined effect of the various flour blends produced chin-chin with higher ash content compared with the control sample F (100% wheat flour). Ndife *et al.*

(2011) stated that ash content is a rough estimate of the mineral contents of foods.

Fat content of the chin-chin ranged from 12.60 – 16.70%. Significantly ($p<0.05$) low fat value was recorded for 100% wheat chin-chin (F). This corresponds with result from Table 1, which revealed that wheat flour (F) recorded lower oil absorption capacity compared with the blended flours. Increase in the fat content of the products may have resulted from frying. Higher fat content recorded for samples with high proportion of soybean is corroborated by Omoniyi *et al*. (2016) which stated that soybean is a high fat food. Adebayo-Oyetoro *et al*. (2017) reported higher fat values (21.05 - 36.67%) for chin-chin from wheat-tiger-nut flour blends, while Wahab *et al*. (2018) reported low fat content (6.33 - 10.66%) for chin-chin from wheat and *Cissus populnea* stem flour blends.

The fibre content of chin-chin snacks ranged from 2.10 – 4.20%. Higher fibre content was obtained in samples containing higher proportion (50%) of OFSP than in the others. This is not surprising as OFSP is reported to have high fibre content (Akubor, 2004). There was significant difference in fibre content of the chin-chin. Foods with more fibre make an effective anti-constipation, lower cholesterol level in the blood and reduce the risk of various cancers (Wardlaw and Kessel, 2005). According to FAO/WHO, the recommended fibre contents of food products consumed should not exceed 5%. Fibre content reported in this work is within safe limits.

Significantly ($p<0.05$) lower crude protein (10.25%) was recorded in control sample (F) compared with other products (Table 3). Chin-chin from flour blends containing higher soybean, sample D (19.38%) and C (18.80%), recorded higher protein values. Omoniyi *et al*. (2016) stated that soybean (a legume) is rich in protein. Wahab *et al*. (2018) reported lower protein (5.22 - 12.98%) for chin-chin from wheat and *Cissus populnea* stem flour blends, Adebayo-Oyetoro *et al*. (2017) also reported lower protein values (7.66 - 11.58%) for wheat-tiger-nut chin-chin, which is an indication that composite flour from maize, soybean and OFSP will be superior in providing protein when consumed.

The carbohydrate content of the chin-chin ranged of 52.28 – 65.10%. Samples with higher proportion (50%) of OFSP had higher values than other composite flours. However, the control flour (F) had significantly higher ($p<0.05$) value compared to other composite flours. Carbohydrate content of the products is within the range of 52.95 - 62.76 reported by Adebayo-Oyetoro *et al*. (2017) for chin-chin from wheat-tiger-nut flour blends. The high carbohydrate values showed that all samples can serve as energy rich sources.

Table 3: Proximate Composition of Chin-chin Samples (%)

Samples	Moisture	Ash	Fat	Fibre	Protein	Carbohydrate
A	4.80^a±0.14	2.60^d±0.14	14.70^c±0.14	2.60^b±0.14	14.75^d±0.00	61.05^b±0.14
B	4.70^a±0.14	2.25^e±0.07	12.60^e±0.00	4.20^a±0.28	11.73^e±0.00	64.53^a±0.21
C	3.80^c±0.00	3.20^b±0.00	16.35^{ab}±0.21	3.20^b±0.28	18.80^b±0.00	54.65^d±0.49
D	4.40^b±0.14	3.00^c±0.00	15.80^b±0.14	4.05^a±0.07	15.28^c±0.18	57.48^c±0.18
E	4.20^b±0.00	3.65^a±0.07	16.70^a±0.14	3.80^a±0.14	19.38^a±0.18	52.28^e±0.18
F	4.80^a±0.28	1.90^f±0.14	13.85^d±0.78	2.10^d±0.14	10.25^f±0.00	65.10^a±0.49

Values are mean ±SD. Values on the same column with different superscript are significantly different ($p<0.05$). Sample A- Maize 50%: Soybean 25%: OFSP 25%; B- Maize 25%: Soybean 25%: OFSP 50%; C- Maize 25%: Soybean 50%: OFSP 25%; D- Maize 0%: Soybean 50%: OFSP 50%; E- Maize 50%: Soybean 50%: OFSP 0%; F- 100% wheat flour (Control)

Mineral composition of chin-chin snaks

The mineral composition of chin-chin snacks is presented in Table 4.

The result shows that the calcium content of the chin-chin ranged from 122.75 mg/100g to 286.15 mg/100g. There was significant difference ($p<0.05$) in the calcium content of the chin-chin samples. Higher calcium was observed in chin-chin containing higher levels of maize and soybean. Fasogbon *et al*. (2017) reported calcium content of 738.60-1262.60 mg/kg for chin-chin produced with wheat enriched with underutilized vegetables. Atobatele and Afolabi (2016) also reported improved calcium for soy-maize fortified cookies. Calcium is necessary for supporting bone formation and growth.

The magnesium content of the chin-chin samples was significantly different ($p<0.05$) and ranged from 88.62 mg/100g (control) – 178.05 mg/100g (Sample A). The higher values obtained for composite flour chin-chin samples compared with the control (F) showed that combining maize, soybean and OFSP flour enhanced the magnesium content of the snakst. Value obtained in this study was higher than the range of 5.60 – 13.60 mg/100g reported for maize-wheat chin-chin (Ojinnaka *et al*., 2016). Olubukola *et al*. (2017) reported a comparable range of 92.32 – 176.23mg/100g for chin-chin made from wheat flour enriched with pumpkin and spinach vegetables. Magnesium is essential to good health because it helps to maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune system and keeps bones strong.

The sodium, potassium and phosphorus content of the samples range from 12.13 – 46.35, 195.95 – 412.59, and 78.23 – 139.17 mg/100g respectively. The control sample had lower values compared to composite flour samples. Sample B had the highest sodium content (46.35%), sample C had the highest potassium content 412.59%., while sample A had the highest phosphorus content (139.17%). Higher potassium content (261.30 – 425.89 mg/100g) was reported by Olubukola *et al*. (2017) for chin-chin made from wheat flour enriched with pumpkin and spinach vegetables. This could be due the fact that vegetable are known to have high potassium content (Hossain *et al.*, 2014). Igbabul *et al*. (2014) reported a lower phosphorus content of 50 – 70 mg/100g for bread made from wheat, maize and OFSP flour. Chin-chin rich in these nutrients would enhance the health of both children and adults when consumed (Igbabul *et al*., 2014).

Table 4: Mineral Composition of Chin-chin Samples (mg/100kg)

Samples	Calcium	Magnesium	Sodium	Potassium	Phosphorus
A	$286.15^a\pm0.00$	$178.05^a\pm0.85$	$28.05^e\pm0.69$	$234.43^c\pm0.07$	$139.17^a\pm0.57$
B	$193.79^e\pm0.79$	$143.11^e\pm0.30$	$46.35^a\pm0.00$	$329.22^d\pm0.45$	$97.19^e\pm1.18$
C	$218.93^c\pm0.55$	$154.35^c\pm0.00$	$33.66^d\pm0.79$	$412.59^a\pm0.00$	$112.32^c\pm0.00$
D	$206.38^d\pm0.00$	$148.89^d\pm0.32$	$38.99^b\pm0.29$	$366.39^b\pm12.73$	$103.87^d\pm0.86$
E	$243.41^b\pm0.58$	$162.92^b\pm0.38$	$35.22^c\pm0.00$	$292.25^e\pm1.13$	$121.99^b\pm0.84$
F	$122.75^f\pm0.92$	$88.62^f\pm0.06$	$12.13^f\pm0.74$	$195.95^f\pm0.57$	$78.23^f\pm0.00$

Values are mean ±SD. Values on the same column with different superscript are significantly different ($p<0.05$). Sample A- Maize 50%: Soybean 25%: OFSP 25%; B- Maize 25%: Soybean 25%: OFSP 50%; C- Maize 25%: Soybean 50%: OFSP 25%; D- Maize 0%: Soybean 50%: OFSP 50%; E- Maize 50%: Soybean 50%: OFSP 0%; F- 100% wheat flour (Control)

Vitamin composition from of chin-chin snacks

Table 5 shows the vitamin B_1 content of the chin-chin samples to range from 0.021 to 0.135 mg/100g. There was significant difference ($p<0.05$) in thiamine content of the chin-chin sacks. The trend of the values showed that OFSP improved the B_1 content of the samples. This supports the report of Temesgen (2015) that OFSP is high in vitamin B_1. The entire composite flour chin-chin snacks had higher values (0.041 – 0.135 mg/100g) than the control F (0.021 mg/100g). This suggests that blending maize, soybean and OFSP flour resulted in snacks with higher vitamin B_1 than using wheat flour only (control).

Vitamin B_2 content ranged 0.038 to 0.086 mg/100g. Vitamin B_2 of the snacks were more enhanced by OFSP, followed by soybean as shown in the result. This is in accordance with the submission of Igbabul *et al*. (2014) who reported that OFSP has higher B_2 vitamin than maize. The report suggests that addition of higher level of OFSP in flour blends enhanced their vitamin B_2 content of the snacks.

Vitamin B_3 and beta carotene content of the chin-chin samples ranged from 0.41 – 1.31 mg/10g and 3.13 – 215.8 µg/g respectively. There were significant differences ($p<0.05$) in the niacin and beta carotene contents of the chin-chin samples. Chin-chin snacks containing higher quantity of OFSP had higher values in beta carotene. Sample B had the highest value in beta carotene (215.18 µg/g) followed by sample D (202.03 µg/g) and sample A (65.26 µg/g) respectively. The trend obtained in this is in line with the report of Igbabul *et al*. (2014) and Temesgen (2015) that OFSP contains high amount of vitamins, especially, beta carotene. Vitamins are required for the proper functioning of the body fluid systems (Tadesse *et al*., 2015).

Table 5: Vitamin Composition of the Chin-chin Samples

Samples	B_1 (mg/100g)	B_2 (mg/100g)	B_3 (mg/100g)	Beta-carotene (µg/g)
A	$0.083^b\pm0.02$	$0.045^d\pm0.69$	$0.77^b\pm0.03$	$65.26^c\pm0.55$
B	$0.135^a\pm0.04$	$0.086^a\pm0.00$	$1.31^a\pm0.04$	$215.18^a\pm.122$
C	$0.041^d\pm0.02$	$0.05^{6c}\pm0.00$	$0.58^c\pm0.03$	$53.53^d\pm0.48$
D	$0.065^c\pm0.03$	$0.070^b\pm0.02$	$0.73^b\pm0.00$	$202.03^b\pm0.65$
E	$0.071^c\pm0.04$	$0.053^c\pm0.01$	$0.75^b\pm0.01$	$8.43^e\pm0.00$
F	$0.021^e\pm0.03$	$0.038^e\pm0.03$	$0.41^d\pm0.03$	$3.13^f\pm0.04$

Values are mean ±SD. Values on the same column with different superscript are significantly different ($p<0.05$)
Sample: A- Maize 50%: Soybean 25%: OFSP 25%; B- Maize 25%: Soybean 25%: OFSP 50%; C- Maize 25%: Soybean 50%: OFSP 25%; D- Maize 0%: Soybean 50%: OFSP 50%; E- Maize 50%: Soybean 50%: OFSP 0%; F- 100% wheat flour (Control)

Phytochemical composition of chin-chin snacks

Table 7 presents the result of the phytochemical composition of chin-chin samples.

The highest tannin (1.75 - 2.78 mg/100g), phytate (1.80 - 2.60 mg/100g) and flavonoid (1.20 – 1.80 mg/100g) contents were found in samples C and D which contained the highest quantity of soybean. This supports the report of Fasoyiro *et al*. (2006) that legumes are high in anti-nutrients. Higher oxalate (5.34 mg/100g) and HCN (0.78 mg/100g) contents were obtained in sample B. Habtamu (2014) reported high HCN (4.23 – 823mg/10g) and oxalate (8.16 – 12.67mg/100g) content for Artichoke tubers. Tewodros *et al*. (2018) also reported high value HCN for different yam species in Ethiopia. The control (F) had lower tannin (0.42 mg/100g), phytate (0.19 mg/100g), oxalate and HCN (0.08 mg/100g) contents compared to the composite chin-chin samples. Tannin compounds have some antibacterial effects (Akinyma *et al*., 2001), antiviral and anti-parasitic effects in human body

(Wardlaw and Kessel, 2005). Flavonoid is a potent antioxidant and free radical scavenger and guard cell membranes from damage (Noda *et al*., 2000). Excessive ingestion of antinutritional compounds like phytate, oxalate and cyanogenic glycosides can be lethal to human health (Alector, 1995; Akinyma *et al*., 2001). However, values obtained in this work were very low and therefore safe for human consumption.

Table 6: Phytochemical Composition of the Chin-chin Samples (mg/100g)

Samples	Tannin	Phytate	Oxalate	Flavonoid	HCN
A	0.85^{e}±0.00	0.32^{d}±0.00	1.40^{e}±0.07	0.25^{e}±0.03	0.21^{c}±0.00
B	1.31^{d}±0.02	0.19^{e}±0.00	5.34^{a}±0.08	2.70^{a}±0.00	0.76^{a}±0.08
C	2.78^{a}±0.00	2.60^{a}±0.07	3.59^{c}±0.19	1.20^{c}±0.14	0.31^{c}±0.00
D	1.75^{b}±0.03	1.80^{b}±0.21	4.27^{b}±0.00	1.80^{b}±0.21	0.50^{b}±0.14
E	1.54^{c}±0.00	1.25^{c}±0.00	2.65^{d}±0.00	0.90^{d}±0.00	0.63^{ab}±0.00
F	0.42^{f}±0.00	0.19^{e}±0.00	0.82^{f}±0.06	0.65^{d}±0.00	0.08^{d}±0.01

Values are mean ±SD. Values on the same column with different superscript are significantly different ($p<0.05$). Sample A- Maize 50%: Soybean 25%: OFSP 25%; B- Maize 25%: Soybean 25%: OFSP 50%; C- Maize 25%: Soybean 50%: OFSP 25%; D- Maize 0%: Soybean 50%: OFSP 50%; E- Maize 50%: Soybean 50%: OFSP 0%; F- 100% wheat flour (Control)

Sensory evaluation of chin-chin snacks

Table 7 shows the result of the sensory evaluation of chin-chin samples.

The control (F) from 100% wheat flour, had higher score in all the sensory parameters evaluated compared to the composite chin-chin snacks. Sample D was the least preferred in all the parameters. Sample A (6.80) and E (6.20) with 50% maize had the highest scores for crispiness among the composite chin-chin snacks. Taste scores were low in composite chin-chin samples of C (4.60) and D (4.20) with high soybean levels. Soybean was reported by Ndife et al. (2011) to impose beany taste and flavour on food products, especially when incorporated at a high level. The high inclusion of OFSP (50%) in sample B (5.50) and D (4.40) resulted in their low colour scores. The panellists were not familiar with the reddish colour imparted by OSFP flour to these chin-chin. Sample A with a flour mix of maize 50%, soybean 25%, OFSP 25% was most preferred composite chin-chin. Overall, the control chin-chin was the most acceptable (7.30), other composite chin-chin also had favourable responses (5.20 – 6.70), except for sample D (4.62). General/overall acceptability is the combination of all the other sensory attributes (Iwe *et al*., 2017).

Table 7: Sensory Evaluation of Chin-Chin Samples

Samples	Taste	Colour	Aroma	Crispiness	General Acceptability
A	6.60^{b}±0.68	6.40^{b}±0.30	7.00^{ab}±0.79	6.80^{ab}±1.01	6.70^{ab}±0.80
B	6.20^{b}±1.11	5.50^{c}±1.05	6.20^{bc}±1.11	6.00^{b}±1.12	6.00^{bc}±1.12
C	4.60^{c}±1.23	5.80^{bc}±1.01	5.60^{cd}±1.73	5.00^{c}±1.23	5.20^{cd}±1.70
D	4.20^{c}±1.77	4.40^{d}±1.60	4.80^{d}±1.64	4.60^{c}±1.84	4.62^{d}±1.67
E	5.00^{c}±1.38	6.20^{bc}±1.20	6.60^{b}±0.94	6.20^{b}±1.20	5.60^{c}±1.05
F	7.40^{a}±1.14	7.20^{a}±1.20	7.50^{a}±1.24	7.40^{a}±1.14	7.30^{a}±1.03

Values are mean ±SD. Values on the same column with different superscript are significantly different ($p<0.05$)

Sample A- Maize 50%: Soybean 25%: OFSP 25%; B- Maize 25%: Soybean 25%: OFSP 50%; C- Maize 25%: Soybean 50%: OFSP 25%; D- Maize 0%: Soybean 50%: OFSP 50%; E- Maize 50%: Soybean 50%: OFSP 0%; F- 100% wheat flour (Control)

CONCLUSION

High nutrient dense chin-chin snacks were produced from flour blends of maize, soybean and orange-flesh sweet potato. The result obtained showed that the composite flour mixture of maize, soybean and OFSP resulted in improved quality flour with better functional properties. More so the chin-chin snacks had better nutrient quality indexes (proximate, mineral and vitamin compositions) compared to the 100% wheat flour chin-chin. Anti-nutrient compositions of the chin-chin were within safe limits for human consumption. The sensory evaluation showed that the panellists had higher preference for chin-chin made from 100% wheat flour, followed by the chin-chin made from 50% maize, 25% soybean and 25% OFSP (sample A). Therefore, the use of maize-soybean-OFSP blends in composite flour technology to reduce over dependency on wheat as sole flour for pastries and confectionaries and for improved nutritious snacks is recommended.

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