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Chemical and organoleptic properties of Chinchin produced from flour blends of wheat, defatted peanut and orange peels

Abstract

Chinchin was produced from flour blends of Wheat, DPF and OPF with the following formation: sample A (100%: 00%: 00%), B (90%: 5%: 5%), C (85%: 10%: 5%), D (80%: 15%: 5%) and E (75%: 20%: 5%). Sample A served as the control. The samples were analyzed for their nutrient and sensory qualities using standard methods. The proximate composition of the chin-chin revealed a significant ($p<0.05$) increase in moisture content (5.05-7.59%), fat (13.84-20.34%), protein (10.34-19.15%), ash (1.50-5.42%), and fiber content (2.68-6.01%) with a decrease in carbohydrate content (66.59 to 41.49%) as substitution with DPF increased. There was no significant difference between samples with respect to their Energy contents. The anti-nutritional properties: phytates, tannins, and trypsin inhibitor content ranged from 0.002 to 0.005%, 0.010 to 0.026% and 0.001 to 0.008mg/g respectively. The mineral content of the chinchin ranged from 153.23 to 415.69mg/100g for Ca, 79.86 to 127.17mg/100g for Mg, 111.37 to 268.87mg/100g for Fe, 136.42 to 300.08mg/100g for K, 10.09 to 25.75 mg/100g for Zn. The sensory evaluation showed preference for sample A (100% wheat flour) followed by sample E and C in that order. However, all samples were generally acceptable. This study therefore demonstrated that DPF and OPF can be utilized for the development of chin-chin with improved nutritional and organoleptic attributes.

Keywords: Chinchin, proximate composition, defatted peanut flour, orange peel flour, organoleptic attributes

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Introduction

Snacks have become a major portion of human nutrition in most countries around the world due to its increasing consumption pattern.[1] This because consumers have increasingly and recently been demanding for healthy foods that can provide quick and affordable sources of nutrients. The food industry in a bid to respond to this has resorted to the development and production of "convenient products". This demand has initiated the need to produce foods like snacks (that provide both convenience and nutrition). Most snacks are prepared basically from cereal flours which are nutritionally inadequate. There is the need to complement the nutrient content of these snacks by varying the food sources. Chinchin (one of these snacks) is a fried snack popular in West Africa. It is a sweet, hard, doughnut-like baked or fried dough of wheat flour and other customary baking items. It is deep-fried until golden brown and crispy.[2–4] This golden-brown crunchy food product is eaten amongst several age brackets. It is available in various shapes and sizes and is also widely accepted and promoted for commercial production and marketing by entrepreneurs.[5]

Chinchin, just like biscuits and cookies, has proven to be an excellent vehicle for providing and/or improving the nutritional quality of foods by the incorporation of less expensive high-quality proteins, vitamins, minerals, dietary fiber, functional ingredients, etc. This had been done by incorporating nutrient sources of protein, fiber, micronutrients and so on[6] The gap between the protein requirement and supply can be abridged by amino acid fortification, use of protein mixture (protein supplementation and complementation), genetic modification of food crops and identification and evaluation of under exploited sources.[7] The food processing industry can better bridge this gap by supplementation and/or complementation.

Wheat (*Triticum* spp.) is one of the major grains in the diet of a vast proportion of the world's population. It falls among the 'big three' cereal crops (including rice and maize), with over 600 million tons being harvested annually. It is the most important staple food of about 2billion people (36% of world population). Worldwide, wheat provides nearly 55% of the carbohydrates and 20% of the food calories consumed globally.[8]

Most snacks are prepared basically from cereal flours which are nutritionally inadequate. There is the need to complement the nutrient content of these snacks by varying the food sources[9] Wheat has been used in most cases solely to produce chinchin and other pastry products. However, there have been recent strides in the incorporation of other flours from legumes, tubers, vegetables or fruit-based in what the food processing industry terms composite flour technology.

Peanuts or groundnuts[10] have been reported in many food product developments due to its outstandingly high protein content. Used undefatted peanut powder in the production of chinchin and demonstrated that it can be used to replace egg in the whole recipe of chinchin production. Peanut, which is a rich source of protein and essential amino acids, can help in preventing malnutrition-especially protein energy.[11] The nutritional importance of peanuts is due to the energy and growth supplementing constituents present in them. These include carbohydrates, lipids, proteins, vitamins, minerals, some organic acids, and purines. It is estimated that as much as 30% of the population from many countries in the world are suffering from malnutrition.[12,13] Arginine, an amino acid that plays an important role in strengthening the body's immune system, regulating hormone and blood sugar levels and promoting male fertility is present in highest levels in peanuts more than any other food.[14] Peanut flour has been used in various products in the bread and pastry industry. Peanut flour is made from crushed, fully or partly defatted peanuts. Depending on the quantity of fat removed, is highly protein-dense, providing up to 52.2g/100g-for undefatted[15,16] The incorporation of peanut flour in the production of snacks or bakery products in general, is more beneficial to the people due its nutritional and medicinal properties.[17–20]

Orange (*Citrus sinensis* L) is one of the most important fruits in the tropical and sub-tropical regions of the world. Its fruits are usually eaten fresh, used for making canned orange juice, frozen juice concentrates, jams, and jellies and many others.[21] Orange peels have shown great preservative potentials but unfortunately these peels are not efficiently exploited and made use of in the food industry for product development. Many food processors are still using artificial preservatives as a means of extending shelf life of their products. It has been noted that orange processing industries generate huge amounts of orange peel and pulp as by products from the industrial extraction of orange juices.[22] It is known that orange peels contain significant levels of nutritional and phytochemical properties which can contribute to body's nutrition and also medical purposes.[23] Orange peel powder has been made use of in the food industry owing to its enormous potentials as it pertains to functional properties.[24] reported a very high content of dietary fiber (73.61% dry matter (DM)), minerals (ash = 2.72% DM), and total phenolic compounds (534mg gallic acid equivalent (GAE)/100 g of DM) in orange peel flour fortified cookies. The use of orange peel powder in this study as it has been in previous studies will greatly contribute to the dietary fiber, antioxidant properties, flavor and functional properties of the new food products developed from them.[25,26] This study is therefore intended to make use of defatted peanut flour and orange peel flour for the production of chinchin snack.

Materials

Sourcing of materials

Peanuts were bought from Wadata Market Makurdi, Benue State in Nigeria. Wheat flour, Sugar, salt, Margarine, baking powder, Eggs, Milk and Vegetable oil and vanilla flavor were be purchased from the Modern Market Makurdi. Oranges were procured from the Railway market in Makurdi-Benue State. The materials were taken to the CEFTER Laboratory, Benue State University (BSU) for processing.

Equipment

The equipment used for the study were mixer, blender, hygrometer, pH meter, desiccator, furnace, autoclave, microscope, milling machine, oven (Hipman 60), rollers, sieves (0.5 mm and 0.7 mm), measuring cylinder and weighing scale. The apparatus was obtained from the Chemistry Laboratory, Benue State University, Makurdi.

Raw material preparation

Wheat flour

Wheat flour (All-purpose) processed according to international standards was used for the study. It was bought from Wurukum Market Makurdi, Benue State-Nigeria.

Preparation of defatted peanut flour

Dried peanuts (*Arachis hypogaea*) were first sorted to remove extraneous materials. The nuts will be toasted in an oven at 150°C for 30 min and allowed to cool to room temperature. The nuts were skinned, milled and defatted using a Screw press. The resulting cake was size-reduced and dried in an oven, pulverized, and sieved to obtain fine flour with minimal fats and rich in protein.[27]

Preparation of orange peel flour

The procured oranges were sorted to look out for bruised oranges and potentially mold-infested oranges. It was further washed under clean running water, manually scrubbed, cleaned, and allowed to dry on standing and exposure to air. Oranges were peeled using sharp knives; taking care that only the outer cover of the fruits otherwise called flavedo which contains chromoplasts and oil sacs were included. This was in a bit to minimize the inclusion of albedo which is an inner layer of spongy white tissue. The peels were then dried at 50oC for 24hours. It was later grounded, sieved and stored in zipper lock bags for further.[28]

Formulation of flour blends

The chinchin was prepared from different blends of refined wheat flour, partially defatted peanut flour and orange peel flour. The various ratio formulations for the chinchin composite flour are shown in Table 1.

Table 1 Flour based formulation for chinchin

Ingredient (%)			
Samples	Wheat flour	Defatted peanut flour	Orange peel flour
A	100	0	0
B	90	5	5
C	85	10	5
D	80	15	5
E	75	20	5

Chinchin preparation

Chinchin was prepared using the method outlined by[29] (Figure 1) with slight modifications. Hundred grams (100 g) of the composite flour was weighed and sieved (250-micron particle size). All other ingredients (sugar, salt, and baking powder) were also added. Margarine, eggs, and milk were turned in and mixed to form dough. The dough was briefly kneaded, rolled out (2 cm thick) and cut into small squares (2 cm by 2 cm). It was deep fried (180 °C, 8 min) till it turns golden brown. It will then be drained, cooled, packaged (in Low Density Polyethylene-LDPE) and stored at room temperature (28±2 °C).

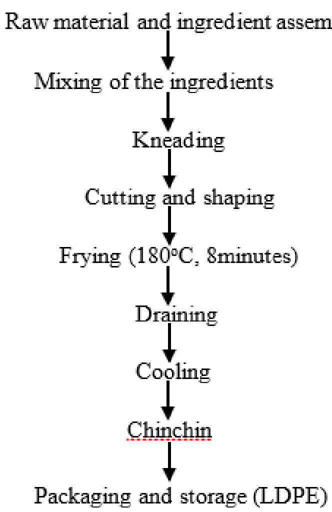

Figure 1 Flow chart for the production of chinchin.

Analytical methods

Proximate analysis of flour and chinchin samples

The proximate analysis of the composite flours were determined by the official methods of AOAC[30] Carbohydrate was determined

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by difference (100 - the sum of the content of protein, fat, ash, and moisture). Energy was calculated using Attwater factor (fat x 9 + carbohydrate x 4 + protein x 4 kcal/100 g).

Determination of minerals

The minerals Ca, K, Mg, Fe, and Zn were determined. Atomic Absorption Spectrophotometer was used for the determination of Ca, K, Fe, Mg and Zn. The optimum range for each element will be prepared and all the operational instruction for setting up the instrument for the analysis of specific element was strictly followed.[31]The ash residues were digested with 5 mL of concentrated nitric acid, filtered and the filtrate transferred 100 mL volumetric flask and diluted with distilled water to 100 mL volume. This was done for all the samples, and stored at room temperature pending AAS analysis.[32,33]

Anti-nutritional analysis of samples

Tannins were determined by the Follins Dennis titrating method as described by[34] Phytates were determined by the Young and Greaves methods with slight modification as described by[35] Trypsin was determined by the method as described by Omoboyowa.[36]

Results and discussion

Values represent mean±SD of triplicate determinations. Means in the same column with different superscripts are significantly different at $p<0.05$.

The proximate composition of the chinchin samples is presented on Table 2

The moisture content ranged from 5.05% (sample A) to 7.59% in sample E. There was a significant increase ($p<0.05$) in the moisture content with increasing incorporation of DPF. The increase in moisture content could be attributed to increase in the hydrophilic property of fiber in the PDPF and OPF as the level of incorporation increased. Moisture content indicates the shelf-stability of a product; such that, the lower the moisture content, the better the shelf stability of such products.[37] The result of this study are slightly higher than those reported[38] (4.35–5.34%) who produced a maize-wheat chinchin enriched with Rhinocerous phoneicis and[39] (3.98-5.05%) who produced chinchin from a millet-wheat composite flour. The trend in results also agree with other studies.[40]

The protein content of the chinchin samples vary significantly with sample A having the least (10.34%) while the highest was observed in sample E (19.15%). There was a significant increase ($p<0.05$) in the protein content as the level of incorporation of DPF increased. These results agree with those by[41]who produced chinchin from millet and wheat.[42] reported protein content of 11.1 to 14.9%, while reported protein content of 10.51-14.58%. This shows that the chinchin herein produced are very rich in protein. The protein content in this study was also higher than those reported by[43] for wheat-soursop flour chinchin of 5.32-7.94%.

The substitution with DPF in the chinchin samples resulted to an increase in the fat content of the chinchin samples from 13.84%-20.34%. Chinchin with 20% DPF (sample E) had the highest fat content while the control sample (sample A) recorded the least. This increase in the fat content differed significantly among all the samples. The increase in the fat content could be due to the substitution effect as a result of some residual fat content in the DPF. This result confirms a study by[44] for substitution with defatted peanut flour in a peanut flour-based cookie. The results in this study are lower than those reported by[44–47] reported lower fat content values (11.67-17.34%) and (9.93-15.82%) for maize-wheat chinchin and vegetable enriched chinchin respectively. The high fat content of the chinchin samples was expected as was shown by the significant increase in the OAC of the flours with increase in the level of incorporation with DPF. This high fat content could also be attributed to absorption of oil by the samples during frying as well as the difference in the recipes.

The ash content of the chinchin samples ranged from 1.48-5.42% with sample E having the highest while sample A(control) having the least. An increase in the ash content of the chinchin samples was seen as substitution with DPF increased. All samples were significantly different ($p<0.05$) from each other. The increase in ash content could be attributed to the high ash content of DPF of 6.52% .[48] also reported an increase in the ash content of cookies produced from defatted peanut flour. The ash content in this study was higher than those reported by several studies on the production of chinchin.[49–52] However, the trend in results are comparable to those reported by[53] in wheat-germinated finger millet-based chinchin. The ash content of a product indicates a rough estimate of its mineral content.[54] This study therefore indicates that the chinchin samples would contribute enormous mineral elements to the body.

The fiber content of the samples ranged from 2.68-6.00% with sample E having the highest value while sample A (the control) having the least. There was a significant increase ($p<0.05$) in the fiber content of chinchin samples as substitution with DPF increases. The significant increase in the fiber content of the samples could be attributed to the high fiber content (10.48%) in DPF (Table 2) and also reported by[55]11.02%. Crude fiber content of this study were lower than those obtained in peanut-based cookies by.[56] While the fiber content in this study is comparatively higher than that reported by[57,58] who produced chinchin from different composite flours; the results were also comparable to those by in their wheat-millet chinchin.

A significant decrease ($p<0.05$) was observed in the carbohydrate content, which ranged from 66.62-41.49% with sample A (control) having the highest value while sample E had the lowest. The increase in the proportion of PDPF brought about a decrease in the carbohydrate content chinchin samples. This result is in concordance with findings from who reported a decrease in carbohydrate content (55.14-42.94%) and (62.76-52.95%) who produced chinchin from wheat-walnut and wheat-tigernut flour respectively. The carbohydrate content in this study are higher than those in the study by but lower than those.

The energy content of the chinchin samples ranged from 425.60kCal in sample E to 434.36kCal in the control sample (A). There was no significant difference ($p<0.05$) in the energy content of the chinchin samples as the proportion of DPF increased. The results in this study are higher than those reported who reported values ranging from 393.34kCal-401.68kCal and 402.65kCal- 414.08kCal respectively for wheat-soursop and wheat-walnut flour chinchin respectively.

The anti-nutritional factors in the composite flours are presented in Table 3

The phytate contents of the chinchin ranged from 0.002 to 0.005% as the level of incorporation of DPF increased. As observed, the chinchin samples had significantly lower contents far below permissible limits of 0.05%. Sample A was significantly different from the test samples (B to E), having the lowest concentration of 0.002%, while sample E with the highest level of incorporation had 0.005% probably due to the concentration of phytates in DPF and OPF.[49] Phytic acid has been known to decrease the availability of some minerals (calcium, iron, magnesium and zinc) as well as protein, when bound to protein; it induces a decrease of solubility and functionality of the protein.

Plant seeds utilize phytate as a source of inorganic phosphate during germination and thus tend to increase palatability, nutritional value and the mineral composition. The results obtained are lower than those reported by who produced cookies from Composite Flours of Wheat and Banana Peel Flours. These results on the other hand are higher than those presented by who produced chinchin from maize, soybean and orange fleshed sweet potato.

The tannin contents ranged from 0.010% to 0.026% for sample A to sample E. As seen, the level of incorporation of DPF didn't have ($p<0.05$) any significant effect on the tannin content of the chinchin produced. This could be due to proper processing which reduced the level of tannin contents significantly. However a significant increase could be noticed between sample A and sample B. this could be due to the addition of the DPF with significant amounts of tannins. Tannins are considered nutritionally undesirable because they precipitate proteins, inhibit digestive enzymes and affect the utilization of vitamins and minerals. Taking in of large amounts of tannins may result in adverse health effects, such as impaired microbial enzyme activity such by forming irreversible as well as reversible complexes with these enzymes. The results in this study are lower than those reported by.[51,52]

The trypsin inhibitor contents of the chinchin samples ranged from 0.001mg/g to 0.008mg/g for sample A to sample E. Increasing levels of incorporation of DPF had a significant effect on the trypsin inhibitors in the chinchin. This could be due to the fact that peanuts are known just like many legumes to contain high concentrations of trypsin inhibitors. The presence of protease inhibitors in the diet had been reported to form an irreversible trypsin enzyme-trypsin inhibitor complex, causing a trypsin drop in the intestine and a decrease in the diet protein digestibility, leading to slower growth. In this condition, the organism increases the secretory activity of the pancreas, which could cause pancreatic hypertrophy and hyperplasia. The results of this study follow the same trend as those reported by but are lower comparatively.

The mineral content of chinchin samples produced from flour blends of defatted peanuts, orange peel and wheat are shown on Table 4

The result shows that the calcium content of the chinchin ranged from 153.23mg/100g to 415.69mg/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 DPF and OPF. reported calcium content of 122.75- 286.15 mg/100g for chinchin produced from wheat, soybeans and orange fleshed sweet potatoes. Studies have also reported improved calcium for wheat-almond-carrot flour fortified cookies.

The Iron content of the chinchin samples increased significantly ($p<0.05$) from 111.37-268.87mg/100g with sample A having the least while sample E had the highest. This could be due to the high iron content of peanuts as reported by (USDA, 2015) and values reported here follow the same trend as reported but are comparatively higher reported even lower values of iron for kokoro-a maize-based snack enriched with soy flour.

The potassium content of the samples ranged from 136.42 300.08mg/100g. There was a significant increase ($p<0.05$) in the potassium content as the level of incorporation of DPF and OPF increased. This could be due to the fact that peanuts are rich in potassium values are lower than those reported by (but are higher than those reported for kokoro (1.67-3.75mg/100g) who reported 74.80-116.27mg/100g for palm weevil enriched chinchin.

The magnesium content of the chin-chin samples was significantly different ($p<0.05$) and ranged from 79.86mg/100g (sample A)-127.17mg/100g (Sample E). The higher values obtained for composite flour chin-chin samples compared with the control (A) showed that combining wheat, DPF and OPF flour enhanced the magnesium content of the snacks. Values obtained in this study was higher than the range of 5.60-13.60 mg/100g reported for maize-wheat chinchin. 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.

Zinc content varied with significant differences among the samples. The zinc content values for all samples ranged between 14.79 and 38.88mg/100g. Sample E had highest value of 38.88mg/100g while sample A (control) had the lowest value of 14.79mg/100g. This result showed that there is a significant increase ($p<0.05$) in zinc content of the samples as the amount of DPF and OPF incorporated into chinchin is increased. This result is similar to the trend reported by on chinchin enriched with polyphenol Extracted from Amaranthus viridis, who reported an increase in zinc content from 2.37-3.50mg/100g with increase in incorporation of extracted polyphenol. These result trend however disagree with those by Zinc is an essential micronutrient that helps in the formation of protein in the body thus positively influencing blood formation, wound healing, taste perception, growth and maintenance of all tissues and healthy immune system components of many enzymes.

Sensory attributes of the chinchin produced from blends of wheat, defatted peanut flour, and orange peel flour on Table 5

The mean scores for color of all the chinchin products ranged from 6.43 to 8.13. The score for the control sample (sample A) was significantly higher ($p<0.05$) with respect to samples B, C and D but was not significantly different with respect to sample E. The control (100% wheat biscuit) was the most preferred in terms of color with a mean score of 8.13 which indicates 'like very much'. Samples B to D were generally 'moderately liked' since their mean scores were between 6.43 and 7.30 indicating 'like slightly'-like moderately on the hedonic scale. Sample E compared favorably ($p>0.05$) with sample A (control) as it was not significantly different from the control. The least preferred was sample B mean score of 6.43 which from the hedonic scale represents 'like slightly'. According color is known as the only quality that consumers can base their purchasing decisions. The low score for color observed for the composite biscuit may be due to the slight brown color of the biscuits. This may have given an impression of 'over-fried' products; thus, affecting their preference. The browning of the composite chinchin could be due to caramelization of the sugars in biscuits. It could also be due to Maillard reactions as the protein contributed by peanut might have reacted with sugar during the frying process.

The preference scores of tastes ranged between 7.03 and 7.95. The 100% wheat chinchin (sample A) was most preferred (with mean score of 7.95); however, it was not significantly ($p>0.05$) different from the composite chinchin. These scores indicate a taste preference 'like moderately'. Sample D was the least preferred with a mean score of 7.03 indicating 'like moderately'. The low taste score for sample D and generally for the composite chinchin could be attributed to the residual orange peel 'bitter taste' which contains alkaloids. The lower preference scores for the composite chinchin could be due to the inclusion of peanut which gave it a nutty taste.

Table 2 Proximate composition of chinchin

Percentage (%)							kCal/100g
Sample Code	**Moisture**	**Fat**	**Protein**	**Ash**	**Fiber**	**Carbohydrate**	**Total calories**
A	5.05a±0.01	13.84a±0.18	10.34a±0.10	1.50a±0.06	2.68a±0.07	66.59e±0.20	434.34b±0.44
B	5.52b±0.00	17.08b±0.02	14.61b±0.13	2.47b±0.01	4.53b±0.08	55.79d±0.23	435.30b±0.25
C	5.82c±0.09	18.68c±0.00	16.22c±0.25	3.92c±0.83	5.08c±0.01	50.28c±1.17	434.13b±3.70
D	6.12d±0.04	18.99d±0.01	17.99c±0.24	4.24c±0.17	5.57c,d±0.9	47.10b±0.01	431.21b±0.84
E	7.59e±0.02	20.34e±0.11	19.15±0.32	5.42d±0.04	6.01d±0.64	41.49a±0.91	425.60a±3.31

Table 3 Antinutritional composition of chinchin

Sample	Phytates (%)	Tannins (%)	Trypsin inhibitors (mg/g)
A	0.002a±0.001	0.010a±0.000	0.001a±0.000
B	0.004c±0.001	0.017b±0.004	0.004b±0.001
C	0.002a,b±0.000	0.012a±0.001	0.005c±0.000
D	0.003b±0.001	0.018b±0.002	0.007d±0.000
E	0.005d±0.001	0.026c±0.001	0.008e±0.000

Table 4 Mineral composition of chinchin produced from composite flours

Mg/100g					
Sample	**Calcium**	**Iron**	**Potassium**	**Magnesium**	**Zinc**
A	153.23a±0.01	111.37a±0.01	136.42a±1.00	79.86a±0.81	14.79a±0.72
B	222.46b±1.01	127.13b±0.01	160.70b±0.53	90.049a±0.97	23.08b±0.01
C	314.34c±50.01	178.28c±2.00	211.85c±0.48	113.900c±1.55	30.23c±0.01
D	367.23d±5.00	232.48d±4.51	266.73d±0.61	121.22d±0.44	34.77d±0.01
E	415.69e±0.01	268.87e±1.01	300.08e±1.01	127.17e±2.30	38.88e±0.01

Table 5 Sensory attributes

Sample	Appearance	Aroma	Crunchiness	Taste	Overall acceptability
A	8.13c±0.86	7.40a±0.97	7.93b±0.87	7.90b±0.92	8.17c±0.99
B	7.20b±0.83	7.60a±0.75	7.60a,b±0.60	7.65b±0.75	7.48a,b±0.49
C	7.30b±0.76	7.50a±0.99	7.35a±0.95	7.35a.b±1.19	7.65b±0.93
D	6.43a±0.68	7.20a±1.007	7.33a±1.16	7.03a±1.00	7.13a±1.01
E	7.73c±0.98	7.60a±1.10	7.60a,b±1.25	7.50a,b±1.20	7.70b,c±0.92

Aroma is the main decisive factor that makes a product to be liked or disliked. The mean scores for aroma ranged from 7.20 (sample D) to 7.60 (sample E). Sample E chinchin was the most preferred in terms of aroma. There was however no significant difference ($p > 0.05$) between the control and the composite chinchin. This means that the composite chinchin compared favorably with the control sample. This could be due to the great aromatic flavor contributed by orange peel flour as well as the defatted peanut flour (owing to caramelization and Maillard reaction of defatted peanut flour giving highly flavored product). The Panelists accepted all the composite chinchin since their mean score indicated 'like moderately' on the hedonic scale.

Sound is thought to be the forgotten flavor sense; such that one can tell a lot about the texture of a food-think crispy, crunchy, and crackly just from the mastication sounds heard wile biting or chewing. This represents the key textural attributes of dry snacks product; denoting freshness and high quality. Crunchiness mean scores ranged between 7.33 and 7.90 indicating 'like moderately' as on the hedonic scale. The control (sample A) was not significantly different ($p>0.05$) from the composite chinchin. However, sample D had the least mean score (7.33) while sample A the control sample had the highest mean score depicting that it is the crunchiest. From the result of this study, the crunchiness of the chinchin decreased with increasing proportion of partially defatted peanut flour. The 100% wheat flour (sample A) was however crunchier than the composite chinchin.

The "overall acceptability" mean scores recorded by the chinchin samples ranged between 7.13 and 8.17 with sample D recording the lowest mean of 7.13 which indicates 'like moderately' on the hedonic scale. There was however no significant difference ($p<0.05$) in terms of overall acceptability between the composite chinchin and the control chinchin (sample A). However, sample A (the control sample) had the highest mean score (8.17) while sample D had the least mean score of 7.13. This could be attributed to similar characteristics of the composite chinchin in terms of color, crispiness, taste, and aroma to the control (100% wheat). The comparatively lower ratings for the composite chinchin samples with respect to sample A (control sample) could be due to the slight color difference (brown) and the taste (contributed by orange peel flour and partially defatted peanut flour). The chinchin samples C and E compared more favorably with the control sample in terms of overall acceptability. The overall acceptability shows how much or less a product is globally accepted. Acceptability may not always depend solely on the sensory attributes of the product but also on other determinants such as physiological, behavioral and cognitive factors, related to the consumer.

Conclusion

The present study showed that defatted peanut flour and orange peel flour have great potentials in the production of highly nutritious chin-chin. This composite flour was shown to significantly improve the nutritional composition in terms of protein, ash, fat, and crude fiber contents while carbohydrate content was observed to decrease. Energy content of the chinchin decreased as substitution of partially defatted peanut flour increased. Interestingly too, it was noticed that the antinutrients in both flour and chinchin samples were well within permissible limits. The higher ash, protein, crude fiber and low carbohydrate contents of chinchin prepared from wheat and partially defatted peanut-orange peel flour blends has nutritional advantage over 100% wheat flour chinchin especially for individuals with health problems requiring protein, fiber and mineral rich foods and low in carbohydrate. This will be a good way of preventing, digestive disorder in children, diabetics, and lactose intolerance in patients. Sensory results showed that the composite chinchin samples were all generally acceptable by the panelists but were however significantly lower than the control sample (sample A). However, sample C (85Wheat:10DPF:5OPF) and sample E (75Wheat:20DPF:5OPF) were most acceptable among the composite chinchin samples. Substitution of partially defatted peanut flour and orange peel flour with wheat flour at the level of 10:5% and 20:5% respectively compared favorably with the control sample suggesting that acceptable chinchin could be produced at up to 20% substitution with partially defatted peanut flour. This result therefore indicates that the use of partially defatted peanut flour for the production of chinchin would greatly enhance the utilization of this high-protein dense cake which has not been efficiently used in this part of the world. Use of orange peel powder too has expanded the scope of valorization of orange peels and has in one way solved the problem caused by environmental pollution.

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Conflicts of interest

Authors declare no conflict of interests.

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