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QUALITY EVALUATION OF CHIN CHIN FROM BLENDS OF WHEAT FLOUR AND COMBINED PROCESSED PIGEON PEA (*Cajanus cajan*) FLOUR

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Abstract
Pigeon pea is an important legume which can be utilized in combating the protein-calorie malnutrition and micronutrient deficiencies prevalent in Nigeria and may also serve as a nutraceutical when added to wheat flour for the production of bakery products. The study aimed at the production of *Chin chin* from wheat flour supplemented with combined sprouted/fermented pigeon pea flour and evaluating the proximate, mineral, phytochemical and sensory properties of the products. Wheat flour was blended with combined processed pigeon pea flour at the following proportion: 100:0, 95:5, 90:10, 85:15, 80:20, 75:25 and 70:30 (where 100:0 served as control) and subjected to analysis using standard methods. The proximate results showed significant ($p<0,05$) increment in protein, fat, crude fibre and ash and decrease in carbohydrate contents of the Chin chin samples as the substitution of combined sprouted/fermented pigeon pea flour to wheat flour increased with values of 15.60-34.10%, 2.85-5.65%, 1.01-5.50%, 1.00-4.98% and 44.77-74.53% respectively. The results for minerals composition showed that calcium, potassium, magnesium, phosphorus, iron and sodium ranged from 111.12-165.30mg/100, 168.20-256.43mg/100g, 74.25-145.01mg/100g, 64.33-120.21mg/100g, 20.10-21.25 and 11.15-15.02mg/100g respectively. The phytochemicals contents were significantly different ($p<0.05$) from each other with values ranging from 0.53-0.81mg/100g for flavonoid, 0.41-0.55mg/100g for saponin, 0.22-0.38mg/100g for alkaloid and 0.30-0.45mg/100g for tannin. The sensory evaluation results showed that all the samples were acceptable to the panelists.

Keywords: Chin chin, proximate, mineral, phytochemical, sensory properties, combined processed pigeon pea flour

Introduction

Snacks make up a significant part of the people's nutrient intake as a source of carbohydrate, protein, minerals, phytonutrients and vitamins and can be eaten any time. According to Lobstein *et al*. (2004), the three main meals eaten in a day may not be enough to provide all the nutrients needed for growth, hence eating of snacks between meals is essential to make up for the required nutrients. Chin chin is a fried or baked snack which is prepared in different shapes and sizes and commonly eaten among the people of Nigeria. Akubor (2004) reported that Chin chin is a sweet cookie-like product manufactured from wheat flour and egg. Chin chin is prepared from a mixture of flour, sugar, salt, baking powder, egg, fat, nutmeg and water. Wheat flour which is the major ingredient for Chin chin production is rich in carbohydrate but low in protein, minerals and essential phytochemicals (Ihekoronye and Ngoddy, 1985). Therefore, efforts are being made to enrich Chin chin with legumes (such as pigeon pea) in order to improve its nutritional composition. Chitra *et al*. (1996) noted that the supplementation of cereals with protein rich legumes is one of the best remedies to protein-calorie malnutrition in developing countries. According to Edema *et al*. (2005), the inclusion of not more than 10% protein supplements will produce nutritionally balanced and acceptable baked products. Among edible legumes in the world, pigeon pea ranked fifth in importance (Rao *et al*., 1986). Pigeon pea (*Cajanus cajan*) is an underutilized legume with broad potentials (Amaefule and Nwagbara, 2004). Oboh (2006) reported that pigeon pea are functional foods that promote good health and have therapeutic properties containing several phenolic compounds and antioxidant properties. They have low glycemic indexes and sodium content (Foster-Powell and Miller, 1995). Pigeon pea contains protein (17.9 – 24.3%), carbohydrate (58.7%), crude fibre (1.2-8.10%), and fat (0.6-3.8%) (Rao *et al*., 1986; Amarteifio *et al*., 2002). Pigeon pea is also rich in minerals such as calcium, magnesium, zinc, phosphorus, iron, among others (Amarteifio *et al*., 2002; Nwanekezi *et al*., 2017). Pigeon pea is also a source of

phytochemicals such as saponins, tannins, flavonoids, etc., which have health promoting effects on man. According to Okwu (2004), legumes (e.g. pigeon pea) synthesize variety of phytochemicals such as isoflavones, flavonoids, phenolic compounds, lignins, alkaloids and cyanogenic glycosides in their cells. These phytochemicals regulate, protect and control various diseases in men and women such as prostate cancer, testicular cancer, breast cancer, cystic ovaries, endometriosis, and semen quality (Verger and Leblane, 2003). Despite the high nutritional composition of pigeon pea, it is still not common in some parts of Nigeria and it still has no industrial applications. This can be attributed to its high content of antinutritional factors, flatulence causing oligosaccharides and the hard-to-cook syndrome, which hampers its use as food. Different processing methods have been used by some researchers to improve the nutritional composition of pigeon pea such as boiling, fermentation, sprouting, toasting, etc. Sprouting has been used to overcome the antinutrients associated with untreated grains (Sangronis and Machado, 2007). Fermentation removes antinutritional factors and improves nutritional status of grains (Edema and Sanni, 2006). However, it has been reported that the use of two or more combined processing methods drastically reduced antinutritional factors and markedly improved the nutritional composition of pigeon pea (Nwanekezi *et al.*, 2017; Arukwe, 2021). Combined sprouted/fermented pigeon pea flour was added to Chin chin formulation to improve its nutritional content. The acceptance of the wheat flour Chin chin supplemented with combined sprouted/fermented pigeon pea flour would increase the utilization of pigeon pea flour in the bakery industry. The study aimed at the production of Chin chin from wheat flour supplemented with combined sprouted/fermented pigeon pea flour and evaluating the proximate composition, mineral composition, phytochemical content and sensory properties of the products.

Materials and Methods

Materials collection

The materials, wheat flour and pigeon pea seeds were purchased from New market in Aba, Abia State, Nigeria. Other ingredients used for this study were procured from the same market.

Production of combined sprouted/fermented pigeon pea flour

One kilogram (1kg) of pigeon pea seeds were sorted and extraneous materials removed. Sprouting of pigeon pea seeds was done using the method described by Ariahu *et al*. (1999). The seeds were washed and soaked in water for 30 min and the water drained. The grains were then spread in a single layer on a moistened jute bag and allowed to germinate at room temperature for 3 days. During this period of sprouting, the grains were sprayed with water at intervals of 12 hours until the last day of sprouting. The sprouted seeds were dehulled and the rootlets removed. Then the grains were wrapped in plantain leaves and allowed to ferment for 4 days according to the method described by Ikemefuna (1998). After fermentation, the grains were dried in an oven at 60^0C for 7 h and milled into flour with disc attrition mill (Asiko AII, Addis Nigeria), sieved with standard 1.0 mm mesh sieve and packaged in polyethylene bag for analysis.

Supplementation of wheat flour with combined sprouted/fermented pigeon pea flour

Supplementation of wheat flour with combined sprouted/fermented pigeon pea flour was done by blending the flours in the ratios of 100:0, 95:5, 90:10, 85:15, 80:20, 75:25 and 70:30 of wheat flour: combined sprouted/fermented pigeon pea flour respectively, where 100:0 served as control.

Preparation of Chin chin from blends of wheat and combined sprouted/fermented pigeon pea flours

The Chin chin was prepared using the traditional method with slight modification. The ingredients used were flour (250g), margarine (40g), salt (3g), egg (3), sugar (30g), baking powder (1g), nutmeg flavor (5g) and vegetable oil (100cl). The flour was weighed out in a bowl, salt, baking powder and nutmeg powder were added and mixed. Then the sugar dissolved in water was added to the flour and mixed together. The beaten eggs were also added to the flour and mixed to stiff dough. The dough was turned on a floured table and rolled out. The dough was kneaded gently and double turned and left for 5 min to rest after which it was rolled out and cut into different shapes (triangles, squares, rectangles and cubes) and allowed to rest for 5 min. The vegetable oil was poured into a pot and heated to a temperature of about 170 ^{0}C. The cut dough was added and deep fried until golden brown in colour. The Chin chin was carefully scooped from the oil into a perforated basket for the oil to drain and allowed to cool to room temperature before packaging in polyethylene bags for further studies.

Proximate analysis

The methods described by AOAC (2005) were employed to determine the protein, moisture, crude fibre, fat, ash and carbohydrate content of the samples and the analysis was done in triplicates.

Mineral analysis

The mineral contents of the **C**hin chin samples were determined using the AOAC (2005) method. The samples were dry ashed, the ash was dissolved with 20 ml of dilute hydrochloric acid, filtered with Whatman No. 4, the filtrate was made up to 100 ml using deionized water in a graduated cylinder. Calcium, magnesium and iron were determined in 10 ml aliquots of the filtrates using atomic absorption spectrophotometer (Perkin-Elmer 410021, USA) and phosphorus was assayed colorimetrically using varadomolybdate method of AOAC (2005). Potassium content and sodium content were determined with a flame photometer (Jenway PFP7, UK).

Phytochemical analysis

Flavonoid determination

The flavonoid content was determined by the method described by Boham and Kocipai (1994). Five grams of the ground sample was weighed in a 250 ml titration flask and 100 ml of 80 % aqueous methanol was added at room temperature and shaken for 4 h in an electric shaker. The entire solution was filtered through Whatman N0. 1 filter paper and again this process was repeated. The filtrate as a whole was later transferred into a crucible and evaporated to dryness over a water bath and reweighed.

Saponin determination

The saponin content was determined using the spectrophotometric method described by Brunner (1984). Two grams of the ground sample was taken and 100 ml of isobutyl alcohol was added. To ensure uniform mixing, it was put in the laboratory shaker for 5 h. The mixture was filtered into 100 ml beaker containing 20 ml 40% saturated solution of $MgCO_3$. This was filtered again with Whatman No. 1 filter paper to get a clean colourless solution. In a 50 ml volumetric flask, 1 ml of the colourless solution and 2 ml of 5% $FeCl_3$ solution were added together and made up to the mark with distilled water and allowed to stand for 30 min for colour development. Absorbance was measured against the blank at 380 nm.

Alkaloid determination

The alkaloid content was determined with the alkaline precipitation gravimetric method described by Harborne (1998). Five grams of the sample was dispersed in 100 ml of 10% acetic acid in ethanol solution. The mixture was well shaken and allowed to stand for 4 h at room temperature and shaken every 30 min. At the end of this period, the mixture was filtered through Whatman No. 42 filter paper. The filtrate (extract) was concentrated by evaporation to a quarter of its original volume. The extract was treated with drop-wise addition of concentrated NH_3 solution to precipitate the alkaloid. The dilution was done until the NH_3 was in excess. The alkaloid precipitate was removed by filtration using weighed Whatman No. 42 filter paper. The paper was dried at 60 ^{0}C and re-weighed after cooling in a desiccator and the weight of alkaloid was calculated.

Tannin determination

The tannin content was determined with the method described by Makkar and Goodchild (1996). Two hundred and fifty milligram of the sample (after the pigments and fat have been removed with diethyl ether containing 1% acetic acid) was taken into 10 ml of 70% aqueous acetone for extraction for 2 h at 30 ^{0}C using a water-bath. The total polyphenols (as tannin) was determined using Folin Ciocalteau reagent and 2.5 ml Na_2CO_3 solution. Absorbance was measured at 725 nm. The total polyphenols (as tannin) was calculated using the standard curve.

Sensory evaluation of Chin chin

The sensory evaluation of the wheat flour supplemented with combined sprouted/fermented pigeon pea flour Chin chin was done using 20 staff and students of Michael Okpara University of Agriculture, Umudike. The panelists were asked to evaluate the Chin chin samples on the basis of the 9-point Hedonic scale described by Iwe (2010), ranging from 1 (extremely dislike) to 9 (like extremely) and 5 (neither like nor dislike). The Chin chin samples were evaluated for appearance, taste, flavor, crispiness and overall acceptability.

Statistical analysis

All data obtained were statistically analyzed with one-way analysis of variance (ANOVA) to determine significant difference at 5% level of acceptance using SPSS version 17. All data were expressed as mean $\pm$ standard deviation of triplicate values.

Results and Discussion

Proximate composition of Chin chin prepared from blends of wheat and combined sprouted/fermented pigeon pea flour

Table 1 shows the proximate composition of Chin chin prepared from blends of wheat flour and combined sprouted/fermented pigeon pea flour. There were no significant differences ($p>0.05$) in the moisture contents of the Chin chin samples which ranged from 5.00% - 5.01%. The low moisture contents recorded for the samples are advantageous for storage stability and enhanced shelf life of the products since low moisture content does not permit the growth of pathogenic microorganisms. There were significant differences ($p<0.05$) in the protein content of the Chin chin samples which ranged from 15.60% - 34.10%. The 100% wheat flour (control sample) had the lowest protein content (15.60%). The protein content of the Chin chin samples recorded significant ($p<0.05$) increment with increased inclusion of combined sprouted/fermented pigeon pea flour into wheat flour. This result is expected because pigeon pea is high in protein. The increased protein can also be attributed to the combined sprouting and fermentation treatment of pigeon pea since sprouting and fermentation improves protein content through synthesis of proteins by the hydrolyzing enzymes and fermenting microorganisms during sprouting and fermentation respectively. Arukwe (2021) also reported increased protein content for blends of wheat flour supplemented with combined sprouted/fermented pigeon pea flour. The high protein content of the composite test samples could be due to synergistic effect of the supplementation. Hotz and Gibson (2007) opined that when legumes are used to supplement cereals, they provide a protein quality comparable or higher than that of animal protein. The higher protein of the composite samples showed that they are superior to the control sample. High protein in Chin chin will improve the nutrient intake of the consumers who are mostly children, thereby alleviating protein-calorie malnutrition. There were significant variations ($p<0.05$) in the fat content of the Chin chin samples which ranged

between 2.85% to 5.65%. The low fat content recorded for the samples was expected because legumes and cereals store energy in form of starch rather than fat. The low fat values are advantageous for enhanced shelf life of the products since high fat content increases the chances of rancidity. This result corroborates the report of Arukwe *et al*. (2021) on the low fat content of cookies from blends of wheat, sorghum and African yam bean flours. There were significant differences ($p<0.05$) in the fibre contents of the samples which ranged between 1.01% and 5.50%. The least crude fibre content was recorded for the 100% wheat sample. The crude fibre content increased with increased inclusion of combined sprouted/fermented pigeon pea flour to wheat flour. This implies that pigeon pea is a good source of fibre because the value obtained for fibre content is within the range (>3g dietary fibre/100g food) recommended by Nutritional Claims for Dietary Fibre Foods (Official Journal of European Commission, 2012). This result is in agreement with the report of Arukwe (2021) on the increased fibre content due to supplementation of combined processed pigeon pea flour to wheat flour. Nwanekezi *et al*. (2017) opined that the increased fibre content of combined sprouted/fermented pigeon pea could be as a result of the depletion of carbohydrate and fat of the flour due to sprouting and fermentation thereby increasing the ratio of crude fibre. Fibre in the diet is beneficial because it reduces cholesterol level, risk of coronary heart diseases, colon cancer, breast cancer, hypertension, and increases glucose tolerance and insulin sensitivity (Hassan and Umar, 2004). The ash content varied among the samples and ranged from 1.00% to 4.98%. The lowest value for ash content (1.00%) was recorded for the control sample (100% wheat flour). The ash content recorded significant increments ($p<0.05$) with increase in the ratio of addition of combined sprouted/fermented pigeon pea flour to wheat flour. This result suggests that the composite samples are good sources of minerals (Reebe *et al*., 2000). Minerals are very important nutrients needed by man in trace quantities for maintaining good health (Aletor and Omodara, 1994). There were significant differences ($p<0.05$) in the carbohydrate content of the samples which ranged between 44.79% and 74.55%. The highest carbohydrate content was recorded for the 100% wheat flour and the values reduced as the level of inclusion of combined sprouted/fermented pigeon pea flour to wheat flour increased. This is expected since pigeon pea is lower in carbohydrate content than wheat. Arukwe (2021) had similar results in the study involving wheat flour supplemented with combined processed pigeon pea flour.

Mineral composition of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flour

Minerals are constituents of skeletal tissues, cofactors to enzymes, carrier proteins, protein hormones and electrolytes in body fluids and cells (Okoye, 1992). The result of the mineral content of Chin chin prepared from wheat flour supplemented with combined sprouted/fermented pigeon pea flour is shown in Table 2. There were significant differences ($p<0.05$) in the calcium content of the samples. The calcium content of the 100% wheat flour Chin chin was the lowest (111.12mg/100g) whereas those with combined sprouted/fermented pigeon pea flour supplementation had higher calcium content. The result showed that the calcium content of the samples increased as the proportion of combined sprouted/fermented pigeon pea flour increased. This is in consonance with the report that pigeon pea is a rich source of calcium (Okpala and Chinyelu, 2011; Nwanekezi *et al*., 2017). Calcium in the diet is necessary for preventing bone diseases, maintaining nerve transmission and muscle contraction, as well as mediation in vascular contraction and vasodilation (Itankar *et al*., 2016). There were significant differences ($p<0.05$) in the potassium content of the Chin chin samples prepared from wheat and combined sprouted/fermented pigeon pea flours. The potassium content ranged between 168.20mg/100g and 256.43mg/100g, with 100% wheat flour sample (control) recording the lowest value. There were significant ($p<0.05$) increase in the potassium content of the samples with increase in the addition of the combined sprouted/fermented pigeon pea flour to wheat flour. Potassium was observed to be the bountiful mineral in the Chin chin samples studied. This corroborates the report of Olaofe and Sanni (1988) that potassium is the plentiful mineral in the agricultural crops of Nigeria. Potassium is necessary for maintaining fluid and electrolyte balance and integrity of the cells in the human body. There were significant differences ($p<0.05$) in the magnesium, phosphorus, iron and sodium contents of the Chin chin samples produced from blends of wheat and combined sprouted/fermented pigeon pea flours and they followed the same trend of increase with increased level of inclusion of combined sprouted/fermented pigeon pea flour to wheat flour. The magnesium content ranged from 74.25mg/100g to 148.01mg/100g, phosphorus 64.33mg/100g to 120.21mg/100g, iron 20.10mg/100g to 21.25mg/100g and sodium 11.15mg/100g to 15.02mg/100g. It was observed that sodium was the scarce mineral in the Chin chin samples. This is an advantage since low level of sodium in the diet decreases blood pressure, stroke and cardiovascular diseases (Strazzullo *et al*., 2009). Foods that are rich in iron are important in curbing the prevalence of iron deficiency which causes anaemia. Magnesium activates enzyme systems and maintains the electrical potential in nerves (Shills and Young, 1992). Also, magnesium, calcium and potassium rich foods help to reduce blood pressure in people with hypertension (Houston *et al*., 2008). Phosphorus in the diet is necessary in carbohydrate metabolism (FNB, 1997). This result indicates that the use of the blends of wheat and combined sprouted/fermented pigeon pea composite flours in Chin chin production enhanced the mineral content. Nwanekezi *et al*., (2017) noted that the increased mineral content due to the inclusion of combined sprouted/fermented pigeon pea flour to wheat flour could be attributed to synthesis of minerals by

increased activities of enzymes and microorganisms during the sprouting and fermentation process.

Phytochemical composition of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flour

Table 3 shows the result of the phytochemical content of Chin chin prepared from blends of wheat and combined sprouted/fermented pigeon pea flours. There were significant differences ($p<0.05$) in the flavonoid, saponin, alkaloid and tannin contents of the samples with values ranging between 0.53 – 0.81mg/100g, 0.41 – 0.55mg/100g, 0.22 – 0.38mg/100g and 0.30 – 0.45mg/100g respectively. The control sample (100% wheat flour) recorded the lowest values and these continued to increase with increased addition of combined sprouted /fermented pigeon pea flour to wheat flour. The inclusion of the combined processed composite flour conferred some benefits on the Chin chin samples because of the phytochemicals content, which are desirable for human health. Flavonoids are important because they are anti-allergic, anti-carcinogenic, antiviral and antioxidants (Close and McArthur, 2002; Okwu, 2005). This implies that eating of Chin chin prepared from the blends will confer these benefits to the consumers. Saponins are water-soluble glycosides with a bitter taste which reduce the uptake of cholesterol and prevent cardiovascular diseases (Esenwah and Ikenebomeh, 2008). Alkaloids are plant substances with therapeutic properties such as analgesic, antispasmodic, antibacterial among others (Stray, 1998). Tannins are water soluble phenolic compounds located in the seed coat which quickens wound and burns healing in man (Singh, 1988; Farquar, 1996). This result suggests that regular consumption of Chin chin prepared from these blends will confer these benefits to the people.

Sensory properties of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flour

The sensory properties of Chin chin prepared from blends of wheat and combined sprouted/fermented pigeon pea flours are presented in Table 4. There were significant differences ($p<0.05$) in appearance, flavor, taste, crispiness and overall acceptability of the Chin chin samples. The 100% wheat flour Chin chin (100:0) which served as control recorded the highest values for all the parameters analyzed and therefore rated the best by the panelists than the test Chin chin samples with 5% - 30% combined sprouted/fermented pigeon pea flour supplementation. Furthermore, all the Chin chin samples were accepted by the panelists judging from the sensory scores. However, among all the Chin chin supplemented with combined sprouted/fermented pigeon pea flour, sample with 95% wheat flour and 5% combined sprouted/fermented pigeon pea flour was more accepted than the others in all the parameters assessed.

Conclusion

Chin chin of acceptable sensory properties were produced from wheat flour supplemented with combined sprouted/fermented pigeon pea flour. This study has shown that Chin chin containing combined sprouted/fermented pigeon pea flour have great potential in improving the protein and micronutrient intake of the consumers, and can also serve as a nutraceutical for the prevention and management of diseases. This study will promote the utilization of this legume in bakery products enrichment resulting to increased cultivation of the crop.

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Table 1: Proximate composition of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flours

Samples	Moisture (%)	Protein (%)	Fat(%)	Crude fibre(%)	Ash(%)	Carbohydrate(%)
100:0	5.01±0.02^{a}	15.60±0.01^{g}	2.85±0.0^{g}	1.01±0.01^{g}	1.00±0.0^{g}	74.53±0.01^{a}
95:5	5.0±0.0^{a}	17.00±0.02^{f}	3.50±0.01^{f}	1.62±0.02^{f}	1.82±0.01^{f}	69.06±0.02^{b}
90:10	5.01±0.01^{a}	23.12±0.0^{e}	3.92±0.02^{e}	3.00±0.0^{e}	2.30±0.01^{e}	62.65±0.01^{c}
85:15	5.0±0.01^{a}	25.73±0.01^{d}	4.35±0.01^{d}	3.85±0.01^{d}	2.75±0.01^{d}	58.32±0.0^{d}
80:20	5.01±0.01^{a}	28.25±0.02^{c}	4.80±0.01^{c}	4.40±0.01^{c}	3.50±0.02^{c}	54.04±0.02^{e}
75:25	5.0±0.01^{a}	31.00±0.01^{b}	5.20±0.02^{b}	4.95±0.01^{b}	4.22±0.01^{b}	49.63±0.01^{f}
70:30	5.0±0.02^{a}	34.10±0.0^{a}	5.65±0.01^{a}	5.50±0.02^{a}	4.98±0.0^{a}	44.79±0.01^{g}

Values are means ± standard deviations. Means with different letter within a column are significantly different (p<0.05). Key: 100:0 = 100% wheat flour, 95:5 = 95% wheat flour and 5% combined processed pigeon pea flour, 90:10 = 90% wheat flour and 10% combined processed pigeon pea flour, 85:15 = 85% wheat flour and 15% combined processed pigeon pea flour, 80:20 = 80% wheat flour and 20% combined processed pigeon pea flour, 75:25 = 75% wheat flour and 25% combined processed pigeon pea flour, 70:30 = 70% wheat flour and 30% c ombined processed pigeon pea flour

Table 2: Mineral composition of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flours

Samples	Calcium (mg/100g)	Potassium (mg/100g)	Magnesium (mg/100g)	Phosphorus (mg/100g)	Iron (mg/100g)	Sodium (mg/100g)
100:0	111.12±0.0^{g}	168.20±0.0^{g}	74.25±0.1^{g}	64.33±0.0^{g}	20.10±0.02^{g}	11.15±0.0^{g}
95:5	121.25±0.02^{f}	175.42±0.01^{f}	85.40±0.0^{f}	72.58±0.1^{f}	20.35±0.0^{f}	11.70±0.0^{f}
90:10	124.40±0.0^{e}	188.60±0.01^{e}	92.48±0.0^{e}	78.12±0.02^{e}	20.50±0.1^{e}	12.20±0.1^{e}
85:15	131.65±0.0^{d}	215.87±0.0^{d}	104.62±0.0^{d}	85.15±0.0^{d}	20.72±0.0^{d}	12.92±0.02^{d}
80:20	146.88±0.0^{c}	226.05±0.0^{c}	122.75±0.0^{c}	96.01±0.1^{c}	20.90±0.0^{c}	13.50±0.1^{c}
75:25	152.10±0.0^{b}	240.20±0.0^{b}	136.86±0.1^{b}	105.15±0.0^{b}	21.10±0.1^{b}	14.10±0.02^{b}
70:30	165.30±0.1^{a}	256.43±0.01^{a}	148.01±0.0^{a}	120.21±0.0^{a}	21.25±0.02^{a}	15.02±0.1^{a}

Table 3: Phytochemical composition of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flours

Samples	Flavonoid (mg/100g)	Saponin (mg/100g)	Alkaloid (mg/100g)	Tannin (mg/100g)
100:0	0.53±0.1^{g}	0.41±0.1^{g}	0.22±0.0^{g}	0.30±0.1^{g}
95:5	0.55±0.0^{f}	0.43±0.1^{f}	0.25±0.0^{f}	0.32±0.1^{f}
90:10	0.59±0.0^{e}	0.45±0.0^{e}	0.27±0.1^{e}	0.35±0.0^{e}
85:15	0.67±0.1^{d}	0.48±0.1^{d}	0.31±0.1^{d}	0.37±0.0^{d}
80:20	0.74±0.0^{c}	0.50±0.1^{c}	0.33±0.0^{c}	0.40±0.1^{c}
75:25	0.78±0.1^{b}	0.52±0.0^{b}	0.35±0.1^{b}	0.42±0.1^{b}
70:30	0.81±0.0^{a}	0.55±0.1^{a}	0.38±0.1^{a}	0.45±0.0^{a}

Table 4: Sensory properties of Chin chin prepared from blends of wheat and combined Sprouted/fermented pigeon pea flours

Samples	Appearance	Flavour	Taste	Crispiness	Overall Acceptability
100:0	7.5±0.0^{a}	7.3±0.0^{a}	7.8±0.1^{a}	7.6±0.0^{a}	7.5±0.02^{a}
95:5	7.1±0.02^{b}	7.3±0.01^{a}	7.5±0.0^{b}	7.4±0.1^{b}	7.3±0.0^{b}
90:10	7.1±0.0^{b}	7.0±0.01^{b}	7.1±0.0^{c}	7.0±0.02^{c}	7.0±0.1^{c}
85:15	6.5±0.0^{c}	6.8±0.0^{c}	6.5±0.0^{d}	6.5±0.0^{d}	6.5±0.0^{d}
80:20	6.3±0.0^{d}	6.5±0.0^{d}	6.5±0.0^{d}	6.5±0.1^{d}	6.3±0.0^{e}
75:25	6.0±0.0^{e}	6.0±0.0^{e}	6.0±0.1^{e}	6.0±0.0^{e}	6.0±0.1^{f}
70:30	5.8±0.1^{f}	5.5±0.01^{f}	5.5±0.0^{f}	5.0±0.0^{f}	5.5±0.02^{g}