Functional, Pasting and Sensory Properties of Chinchin Produced from Wheat- Tigernut Pomace Blends

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Abstract: This study was carried out to investigate the effects of tigernut pomace (TP) substitution with wheat flour on functional, pasting and sensory properties of wheat-tigernut pomace blends for Chinchin. Yellow variety of tigernut was sorted and washed with tap water and was soaked inside the water for eight hours, the soaked nuts was wet milled to obtain the tigernut co-products which was pressed inside the muslin cloth to obtain the extract which is tigernut pomace and dried in a cabinet dryer at 60°C for 72hrs. The tigernut pomace was blended with wheat flour at different ratios (98:2, 96:4, 94:6, 92:8 and 90:10) of wheat: tigernut pomace, while 100% wheat flour served as controls. The blends were analyzed for functional properties; pasting properties while the chinchin produced from the blends were analyzed for sensory properties. Data obtained were subjected to analysis of variance (ANOVA) and significant means were separated using Duncan multiple range test. Bulk density, water holding capacity, swelling power and solubility index of the blends ranged from 0.70 to 0.75g/ml, 1.38 to 4.05g/g, 4.06 to 4.47g/g, and 2.45 to 13.7% respectively. Range of values for peak, trough, breakdown, final viscosity, setback, peak time, and pasting temperature were 113.6-135.9RVU, 76.7-90.2RVU, 36.0-45.8RVU, 170-183.7RVU, 91.0-93.6RVU, 5.07-6.03min and 88.4-90.0RVU respectively The sensory properties of the chinchin from the blend of wheat and pomace powder were all acceptable base on the degree of their substitution. The findings show that blends had a significant effect on the functional properties. However, wheat flour can be incorporated into tigernut pomace up to 10% level without affecting its overall acceptability.

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1. Introduction

The search for lesser known crops, many of which are potentially valuable as human and animal foods has been intensified to maintain a balance between population growth and agricultural productivity, particularly in the tropical and sub-tropical areas of the world (Okafor *et al.,* 2003).

Curbing the menace of malnutrition in Africa is a major concern of food producers, consumers and processors alike. The situation demands an urgent solution which should be based on the use of locally available crops. Exploring the underutilized crops, some of which has been reported to be rich in nutrient and high density with the purpose of enriching the existing food could be a viable means to tackling malnutrition. Tigernut (*Cyperus esculentus* L) is an underutilized crop which belongs to the division Magnoliophyta, Class-liliopsida, order-cyperales and family-cyperaceae and was found to be a cosmopolitan perennial crop of the same genus as the papyrus plant. Other names of the plant are earth almond as well as yellow nut grass (Odoemelan, 2003; Belewu and Belewu, 2007). In Nigeria, it is known as Aya in Hausa, Ofio in Yoruba and Akiausa in Igbo where three varieties (black, brown and yellow) are cultivated. Among these, only two varieties yellow and brown are readily available in the market. Tigernut has been demonstrated to be a rich source of good quality oil (Dubois, 2007; Yeboah, 2011) and contain a moderate amount of protein (Oladele and Aina, 2007). It is a source of some useful minerals such as potassium, phosphorus and calcium (Bixquert-Jimenez, 2003) as well as vitamin E and C (Balewu and Belewu, 2007). In addition, tigernut has been demonstrated to contain higher essential amino acids than those proposed in the protein standard by the FAO/WHO (1985) for satisfying adult needs (Bosch *et al.,* 2005) It has been reported to be high in dietary fibre content (Joy-Toran and Farre-Rovira, 2003) which could be effective in treatment and prevention of many diseases including colon cancer (Adejuyitan, 2009), coronary heart disease (Chukwuma *et al.,* 2010), obesity, diabetes, gastrointestinal disorders (Anderson et al., 2009) and losing weight (Borges *et al.,* 2008).

Chin-chin is a fried snack popular in Nigeria and West Africa. It is sweet, hard, donut-like baked or fried dough of wheat flour. Chin-chin may also contain cowpeas. Many people bake it with ground nutmeg for flavour. It is usually kneaded and cut into small squares of one square inch or to about a quarter of an inch thick before frying. This can be served as a side dish and make no ideal savoury snack with drinks at parties or simply in between meals (Akbor, 2004; Mepba *et al.,* 2007).

Recent application of tigernut has been concentrated on tigernut flour for bread making (Ade-omowaye *et al.,* 2008), tigernut milk (Udeozor, 2012), biscuit (Zahra and Ahmed, 2014). However, there is dearth of information on the use of tigernut pomace as composite flour from wheat and yellow variety of tigernut for the production of chinchin. The nutritional content of wheat is low in fibre due to the various processes the whole wheat might have undergone. Tigernut seeds are cheap and readily available but grossly underutilized and need more attention because of its nutritional qualities such as high fibre. Therefore, the inclusion of tigernut pomace would serve as a source of fibre supplement for the production of chinchin. This study is therefore aimed to produce flour blends from wheat and tigernut and determine its functional, pasting and sensory properties of chinchin produced from wheat-tigernut pomace blends.

2. Materials and Methods

2.1 Materials

The materials used for this study include wheat flour, tigernut (yellow variety), Ingredients such as sugar, margarine, baking powder, egg, milk and vegetable oil were purchased from Osiele market in Abeokuta, Ogun State.

2.2 Preparation of Tigernut pomace

The method described by Sanchez-zapata *et al.* (2012) for preparation of tigernut pomace was adopted. Yellow tigernut (*Cyperus esculentus*) was sorted to remove unwanted materials like stones, pebbles and other foreign materials before washing with tap water. It was soaked inside the water for eight hours, the soaked nuts was wet milled using laboratory hammer mill (Fritsch, D-55743, Idar-oberstein-Germany). The tigernut co-products were pressed inside the muslin cloth to obtain the extract which is tigernut pomace. The tigernut pomace was dried in the cabinet at 60^0C for 72hours. The tigernut pomace was packed and sealed in polyethylene bags until further analysis.

2.3 Blends formulation

Different composite flour samples were prepared by combining 100%, 98%, 96%, 94%, 92%, 90% wheat flour with 0%, 2%, 4%, 6%, 8% and 10% tigernut pomace respectively.

2.4 Preparation of Chinchin

The method described by Ajani *et al.* (2012) was adopted. The wheat-tigernut pomace, sugar, butter, egg, baking powder, water and milk were mixed together at appropriate rate in a large bowl to make fairly stiff dough. The stiff dough was rolled tightly to 1cm thickness on a board and cut into cubes. Cut dough was fried in a deep hot vegetable oil until golden brown. The fried chinchin was removed and drain off excess oil before serving.

2.5 Functional properties of wheat-tigernut pomace blends

2.5.1 Determination of Bulk density

Bulk density was determined using the method described by Wang and Kinsella, (1976). Ten grams of sample were weighed into 50ml graduated measuring cylinder. The sample was packed by gently tapping the cylinder on the bench top. The volume of the sample was recorded.

$$\text{Bulk density}\left(\frac{\text{g}}{\text{ml}}\right) = \frac{\text{Weight of sample}}{\text{Volume of sample after tapping}}$$

2.5.2 Determination of Water holding capacity

The water holding capacity of samples was determined using the method described by Adeyemi and Idowu, (1990). Five grams of sample was weighed into a centrifuge tube and 15ml of water was added to soak the flour and the slurry was centrifuged at 2000rpm for 20minutes. The supernant was decanted immediately after centrifuging and the sample was reweighed. The difference in weight was divided by the weight of flour to obtain the apparent water holding capacity. The above procedure was repeated for fresh sample of flour. The difference in weight after centrifuging was then used to calculate the true water holding capacity.

2.5.3 Determination of swelling power and solubility index

The swelling power and solubility index was determined using the method described by Takashi and Seibel, (1988). One grams of flour was weighed into a 50ml centrifuge tube. 50ml of distilled water was added and mixed gently. The slurry was heated in a water bath at 90^0C for 15 minutes. During heating the slurry was stirred gently to prevent clumping of the flour. On completion, the tube containing the paste was centrifuged at 3,000rpm for 10 minutes using a centrifuge machine. The supernatant was decanted immediately after centrifuging. The weight of the sediment was taken and recorded. The moisture content of sediment gel was thereafter determined to get dry matter content of the gel.

$$\text{Swelling power} == \frac{\text{Weight of wet mass sediment}}{\text{Weight of dry matter in the gel}}$$

$$\text{Solubility index (\%)} = \frac{\text{Weight of dry solids after drying}}{\text{Weight of sample}} \times 100$$

2.5.4 Pasting properties of wheat-tigernut pomace blends

Pasting characteristics were determined with a Rapid Visco Analyzer (RVA) (RVA TECMASTER, perten instrument-2122833, Australia). Three grams of sample were weighed into a dried empty canister, and then 25ml of distilled water was dispensed into the canister containing the sample. The suspension was thoroughly mixed properly so that no lumps were obtained and the canister was fitted into the rapid visco analyzer. A paddle was then placed into the canister and the test proceeded immediately automatically plotting the characteristic curve. Parameters estimated were peak viscosity, setback viscosity, final viscosity, trough, breakdown viscosity, pasting temperature and time to reach peak viscosity.

2.6 Sensory properties of chinchin

The method described by Iwe, (2000) was used. The sensory panel consisted of fifty consumers of chinchin who were asked to score the chinchin using a 9-point hedonic scale based on their degree of likeness where 9= like extremely; 5= neither like nor dislike; 1= dislike extremely. Chinchin attributes evaluated were: Appearance, texture, aroma, colour, crispness and overall acceptability.

2.7 Statistical Analysis

Data obtained were subjected to statistical analysis. Means, Analysis of variance (ANOVA) were determined using SPSS Version 21.0 and the differences between the mean values were evaluated at $p \leq 0.05$ using Duncan's multiple range test.

3 Results and Discussion

3.1 Functional properties of wheat-tigernut pomace composite blends

Table 1 present the functional properties of wheat-tigernut pomace blends. The functional properties are those parameters that determine the application and end use of food materials for various food products. The bulk density of the wheat-tigernut pomace composite flour ranged from 0.70 to 0.75g/ml. wheat flour (100%) has the lowest bulk density while wheat flour substituted at 8% had the highest bulk density. The bulk density is generally affected by particle size and the density of flour or flour blend and it is very important in determining the packaging requirement, raw materials handling and application in wet processing in food industry (Adebowale *et al.,* 2008; Ajanaku *et al.,* 2012). The bulk density obtained in this study was higher than the values of 0.57-0.64g/ml reported by Ade-omowaye *et al.* (2008) on brown variety of tigernut flour. The water holding capacity of the blends ranges from 1.3 to 4.11g/g. Significant differences ($p<0.05$) were observed in the blends of the water holding capacity. Wheat flour (100%) had the lowest water holding capacity and wheat flour substituted with tigernut pomace at 8% had the highest water holding capacity. Water holding capacity is the ability to hold its own and added water during the application of centrifugation and heating. The water holding capacity was comparatively higher in the composite flour blends. This can be attributed to the high amount of fibre present in the tigernut pomace. According to Lakshmi *et al.* (2014) Starch and fibre content of the composite flour blends can cause a subsequent increase in water holding capacity and moisture retention.

The swelling power ranged from 4.06-4.47. There was a significant differences ($p<0.05$) in the swelling power of the blends, 100% wheat flour substituted had the least swelling power while wheat flour substituted with tigernut pomace at 10% had the highest swelling power. The result obtained in this study is lower to than the values of 8.9 and 12.9 reported by Daramola and Osanyinlusi, (2006) for native and ginger modified starches respectively. Moorthy and Ramanujan, (1986) reported that the swelling power of flour granule is an indication of the extent of associative forces within the granules. Swelling capacity can also be related to the water absorption index of the starch-based flour during heating. The solubility index had a high value which ranged from 2.45 to 13.7%. Significant difference ($p<0.05$) was observed in the value of solubility index. 100% wheat flour had the lowest solubility index while wheat flour substituted with tigernut pomace at 10% had the highest solubility index.

Table 1: Functional properties of the wheat-tigernut pomace blends

WF:TP	BD (g/ml)	WHC (g/g)	SP (g/g)	SI (%)
100:0	0.70 ± 0.00^{a}	1.38 ± 0.78^{a}	4.06 ± 0.04^{c}	2.45 ± 0.01^{d}
98:2	0.71 ± 0.03^{b}	3.42 ± 0.92^{d}	4.10 ± 0.09^{b}	3.79 ± 0.01^{b}
96:4	0.73 ± 0.03^{c}	3.64 ± 0.78^{e}	4.16 ± 0.17^{f}	5.38 ± 0.04^{a}
94:6	0.71 ± 0.01^{b}	3.89 ± 0.07^{c}	4.19 ± 0.18^{e}	6.61 ± 0.09^{c}
92:8	0.75 ± 0.00^{e}	4.11 ± 0.92^{b}	4.19 ± 0.18^{d}	9.18 ± 0.16^{e}
90:10	0.74 ± 0.03^{d}	4.05 ± 0.07^{a}	4.47 ± 0.29^{a}	13.7 ± 0.22^{f}

Mean values with different superscripts within the same column are significantly different ($p<0.05$)

WF: Wheat flour, TP: Tigernut pomace, BD: Bulk density, WHC: Water holding capacity, SP: Swelling power, SI: Solubility index

3.2 Pasting properties of wheat-tigernut pomace blends

Table 2 shows the pasting properties of wheat-tigernut pomace blends. The pasting property is one of the most important properties that influence quality and aesthetic consideration in the food industry since they affect texture and digestibility as well as the end use of starch based food commodities (Onweluzo and Nnamuchi, 2009). Peak viscosity is an index of the ability of starch-based food to swell freely before their physical breakdown (Sanni *et al.,* 2006; Adebowale *et al.,* 2008). There was decrease in the values of this property as proportion of tigernut pomace increases. The value ranged from 113.6-135.9RVU. There was significant differences ($p<0.05$) in peak viscosity of the composite flour. High peak viscosity indicates high starch content and this could explain why 100% wheat flour sample had highest peak viscosity. Trough is the minimum viscosity value in the constant temperature phase of the RVA pasting profile and it measures the ability of the paste to withstand breakdown during cooling. This property also decreases with increase in tigernut pomace substitution except wheat flour substituted with tigernut pomace at 6%. The value of trough viscosity ranges from 76.7-90.2 RVU with wheat flour (100%) having the highest and wheat flour substituted with tigernut pomace at 10% having the lowest trough viscosity. Break down viscosity measures the ability of paste to withstand breakdown during cooling. There were no significant differences ($p>0.05$) in the breakdown viscosity as the substitution of tigernut pomace increases. The break down viscosity ranges from 36.0- 45.8 RVU. Wheat flour substituted with tigernut pomace at 2% had the highest break down viscosity and wheat flour substituted with tigernut pomace at 10% had the lowest break down viscosity. The higher the value, the greater the ability of the starches to withstand breakdown. The final viscosity is a measure of stability of the granules, the value ranged from 170-183.7 RVU. Final viscosity is commonly used to define the quality of particular starch-based flour, since it indicates the ability to viscous paste after cooling or gel after cooking and cooling as well as the resistance of the paste to shear force during stirring (Adeyemi and Idowu, 1990). The decrease in the final viscosity might be due to the sample kinetic effect of cooling on viscosity and the re-association of starch molecules in the samples (Nwokeke *et al.,* 2013).

Setback viscosity ranged from 91.0-93.6RVU. Significant differences ($p>0.05$) were not observed in the setback viscosity of wheat-tigernut pomace composite flour. The higher the setback, the lower the retrogradation of the flour paste during cooling and the lower the staling rate of the product made from the flour (Adeyemi and Idowu). Peak time which is a measure of the cooking time ranged between 5.07-6.03 minutes with 100% wheat flour having the highest value of 6.03 minutes suggesting more processing time and wheat flour substituted with tigernut pomace at 2% having the lowest peak time of 5.07 minutes. There were significant difference ($p<0.05$) in the peak time among the blends. The pasting temperature ranged between 88.4^0C and 90.0^0C. It was observed that there was significant differences ($p<0.05$) in pasting temperature among all the samples. Wheat flour substituted with tigernut pomace at 10% recorded the highest pasting temperature which indicates the presence of starch that is highly resistant to swelling during cooking time. The pasting temperature provides an indication of minimum temperature required for cooking the samples, the pasting temperature obtained for the composite flours were quite close.

Table 2: Pasting properties of wheat-tigernut pomace blends

WF:TP	Peak (RVU)	Trough (RVU)	Breakdown (RVU)	Final Viscosity (RVU)	Setback (RVU)	Peak time (min)	Pasting temp (^{0}C)
100:0	135.9 ± 1.98^a	90.2 ± 0.21^b	45.8 ± 1.77^a	183.7 ± 2.53^b	93.6 ± 5.44^a	6.03 ± 0.14^b	88.4 ± 1.70^b
98:2	130.0 ± 6.40^b	82.2 ± 3.50^b	47.7 ± 2.90^a	174.6 ± 6.68^b	93.0 ± 3.11^a	5.07 ± 0.05^a	88.6 ± 1.20^b
96:4	126.6 ± 0.00^b	81.2 ± 0.00^b	44.9 ± 0.00^a	175.7 ± 0.00^b	94.5 ± 0.00^a	5.87 ± 0.00^b	88.8 ± 0.00^b
94:6	125.8 ± 0.71^c	84.6 ± 1.10^c	42.3 ± 1.77^a	176.7 ± 2.61^c	93.1 ± 1.66^a	5.90 ± 0.00^b	88.8 ± 0.34^a
92:8	116.8 ± 4.00^a	77.1 ± 3.20^a	40.0 ± 0.71^a	170.9 ± 3.30^a	91.0 ± 0.00^a	5.80 ± 0.10^a	88.9 ± 1.20^a
90:10	113.6 ± 2.01^b	76.7 ± 1.20^a	36.0 ± 1.77^a	170.0 ± 0.50^b	93.0 ± 3.11^a	5.83 ± 0.50^a	90.0 ± 0.00^b

Mean values with different superscripts within the same column are significantly different ($p <0.05$)

WF: Wheat flour, TP: Tigernut pomace

3.3 Sensory properties of chinchin prepared from wheat-tigernut pomace blends

Table 3 shows the sensory properties of chinchin prepared from wheat-tigernut pomace blends. The appearance of the chinchin shows that substitution level at 10% of tigernut pomace recorded least appearance score while substitution at 100% wheat flour (control) had the highest appearance score as statistically shown. The texture of the chinchin from the blends of wheat-tigernut pomace ranged from 5.30-8.36. Chinchin prepared from 100% wheat flour had the highest score for texture while chinchin prepared from 10% substitution of tigernut pomace had the lowest score for texture. Significant ($p<0.05$) difference was observed in the aroma and colour sample of the chinchin prepared from wheat-tigernut pomace blends. The Aroma and colour of chinchin ranged from 6.14 to 7.28 and 6.23 to 7.40 respectively. Chinchin prepared from 100% wheat flour has the highest score for aroma and colour as compared with the aroma and colour of chinchin prepared at 4% and 6% substitution of tigernut pomace respectively The crispness of the chinchin ranged from 6.30-7.70 with chinchin prepared from 100% wheat flour having the highest crispness while chinchin prepared from 4% substitution of tigernut pomace have the lowest crispness. The overall acceptability ranges from 6.38-7.80. The sample with 100% wheat flour was most preferred while 10% substitution of tigernut pomace was least preferred by the panelist. Based on all the substitution for chinchin, addition of tigernut pomace was accepted. So addition of tigernut pomace up to 10% could be acceptable for chinchin production. It was observed generally, that there was a decrease in the overall acceptability of wheat and tigernut pomace chinchin; this could be due to the known popularity of the panelists with chinchin prepared from wheat flour.

Table 3: Mean score for sensory properties of chinchin from wheat-tigernut pomace blends

WF:TP	Appearance	Texture	Aroma	Colour	Crispness	Overall acceptability
100:0	8.64 ± 0.91^{a}	8.36 ± 0.80^{d}	7.28 ± 1.13^{c}	7.40 ± 0.71^{c}	7.70 ± 0.97^{b}	7.80 ± 0.90^{c}
98:2	7.04 ± 1.31^{c}	7.28 ± 1.06^{bc}	6.34 ± 1.13^{abc}	7.32 ± 0.97^{b}	6.60 ± 1.14^{a}	7.22 ± 0.95^{ab}
96:4	6.82 ± 1.29^{b}	6.94 ± 0.92^{c}	6.14 ± 0.96^{ab}	6.63 ± 1.11^{ab}	6.30 ± 0.94^{c}	7.09 ± 1.10^{a}
94:6	6.66 ± 1.22^{a}	6.63 ± 0.95^{b}	6.24 ± 1.18^{a}	6.23 ± 1.03^{a}	6.65 ± 1.35^{a}	6.53 ± 1.06^{b}
92:8	6.23 ± 1.28^{a}	6.42 ± 1.54^{b}	6.66 ± 1.38^{bc}	6.30 ± 1.31^{a}	6.54 ± 1.88^{a}	6.52 ± 1.82^{a}
90:10	6.16 ± 13.2^{ab}	5.30 ± 1.55^{a}	6.32 ± 1.54^{abc}	6.42 ± 1.46^{ab}	6.50 ± 1.62^{a}	6.38 ± 1.57^{a}

Mean values with different superscripts within the same column are significantly different ($p <0.05$).
WF- Wheat flour, TP- Tigernut pomace

4. Conclusion

The study investigated the potentials of tigernut pomace in the production of chinchin. Blending of wheat flour with tigernut pomace had significant effect on the functional properties of the flour blends. However, wheat flour can be incorporated into tigernut pomace up to 10% level without affecting its overall acceptability. Hence blends from wheat-tigernut pomace can be used for production of other baked and fried product with improved functional properties.

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