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Selected Functional Properties, Proximate Composition of Flours and Sensory Characteristics of Cookies from Wheat and Millet-Pigeon Pea Flour Blends

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Abstract: Millet flour (MF) and pigeon pea flour (PPF) were produced and blended in the ratio of 65:35 to obtain millet-pigeon pea flour blend (MPF). Wheat flour (WF) and MPF were used in ratios of 100: 0, 90:10, 80:20, 70: 30 and 60: 40 to produce cookies. The flour were subjected to functional and proximate analysis, while the cookies made from the flour blends were subjected to sensory evaluation, to isolate the best ratio. Results obtained indicated that the functional properties of the flour ranged from 0.64 to 0.81 g/cm^2 bulk density, 0.47 to 1.10 ml/g, water absorption capacity, 16.70 to 48.25% swelling capacity and 6.03 to 6.40 pH; while the proximate composition ranged from 8.80 to 13.00% moisture, 8.76 to 16.64% protein, 1.30 to 3.00% fat, 1.25 to 1.80% ash, 0.80 to 2.5% 0 crude fibre, 67.86 to 78.60% carbohydrate. The functional properties of the flour showed some significant differences ($p<0.05$) when compared with wheat flour. All the cookies were acceptable to the panelists; however, the products produced from 80:20 ratio of wheat flour and millet-pigeon pea composite flour blend was selected as the best product.

Key words: Cookies, wheat, millet-pigeon pea, blend

INTRODUCTION

Functional properties are those characteristics that govern the behaviour of nutrients in food during processing, storage and preparation as they affect food quality and acceptability. The quality attributes of food products are generally affected by the functional properties of the flour (Lasekan and Akintola, 2002). They determine the application and use of food material for various food products. Biopolymers such as starch and protein contribute to the development of these characteristics (Akpapunam and Darbe, 1994).

Pigeon pea flour is a source of protein and millet though a carbohydrate source appears to be higher in protein than most cereals. Although its protein has a low lysine content; Frias *et al*. (2005) noted that ragi (finger millet) is adequate in all other essential amino acids. These flour proteins do not form gluten so they are sometimes useful to 'dilute' wheat flour thus making the dough less tough and easier to form sheets in baked products such as cookies.

Cookies are snack foods which are convenience foods that can be eaten in-between meals. An increasing proportion of the household food budget in Nigeria is spent on snack food items, in which convenience and quality are perceived as most important. Carbohydrate-based snacks such as cookies, doughnuts, potato chips and chin-chin have low nutritional value (Lasekan and Akintola, 2002). It is possible to improve the nutritional quality of such carbohydrate-based snacks by incorporating protein from plant sources into the formulations (Akpapunam and Darbe, 1994). Pigeon pea, a leguminous plant, is considered as one of the industrially under-utilized crops that have great potentials for becoming an industrial food raw material. It contains high levels of protein and important amino acids such as methionine, tryptophan and lysine that are lacking in cereals. Its combination with cereals such as millet will yield a snack with improved protein content (Duke, 1981). The objective of this study was to evaluate some functional and chemical properties of flours for cookies production and sensory attributes of the cookies made from wheat and millet-pigeon pea flour blends.

MATERIALS AND METHODS

Millet, pigeon pea, wheat flour and other baking ingredients were purchased from Ogige market in Nsukka, Enugu state, Nigeria.

Flour preparation: Millet was processed into flour according to the method of Jideani (2005). Two kilograms of the grains were cleaned by sorting and winnowing. The cleaned grains were dehulled using traditional method. Hulls were removed by winnowing and the weight of the dehulled grains noted. The dehulled grains were washed and dried at 50°C for 24 h in an oven (Fulton, Model NYC-101 oven). The grains were reduced to powder using a hammer mill (Driver model: De-Demark Super) and sieved through 4.25 μm sieve. The flow diagram for the preparation of millet flour is shown in Fig. 1. Pigeon pea (2 kg) was processed into flour using the dry method as described by Enwere (1998). The process is shown in Fig. 2.

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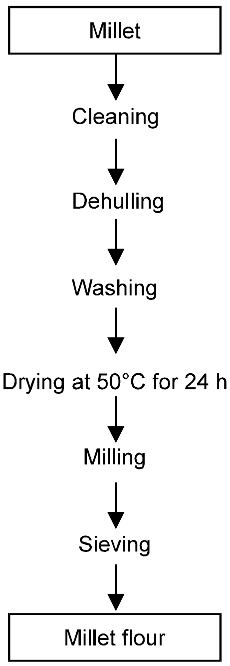

Fig. 1: Flow diagram for the processing of millet into flour (Jideani, 2005)

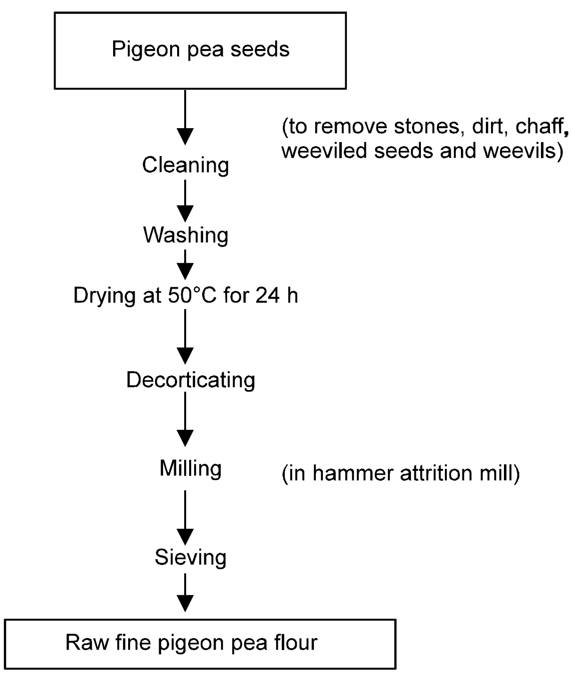

Fig. 2: Flow diagram for the processing of pigeon pea into flour (Enwere, 1998)

Sample preparation and cookies production: Millet flour (MF) and pigeon pea flour (PPF) were produced and blended in the ratio of 65:35 to obtain millet-pigeon pea flour blend (MPF). Wheat flour (WF) and MPF were used in ratios of 100:0, 90:10, 80:20, 70:30 and 60:40 to produce cookies. The cookies were prepared using the method described by Eneche (1999) with slight modifications. The flour (500 g), sugar (150 g), baking fat (190 g) and salt (5 g) were mixed together manually for 5 minutes to get a creamy dough. The baking powder (2.5 g) and vanilla (5 g) were then added. The measured amount of water (125 ml) was gradually added using continuous mixing until good textured, slightly firm dough was obtained. The dough was kneaded on a clean flat surface for four minutes. It was manually rolled into sheets and cut into shapes using the stamp cutting method. The cut dough pieces were transferred into fluid fat greased pans and baked in an oven (Carma, Model 1945XL, Terim Group Italy) at 180°C for 20 min, cooled and packaged for further analysis. Table 1 shows the formulation of the cookies samples and Fig. 3 shows the flow chart for production of cookies.

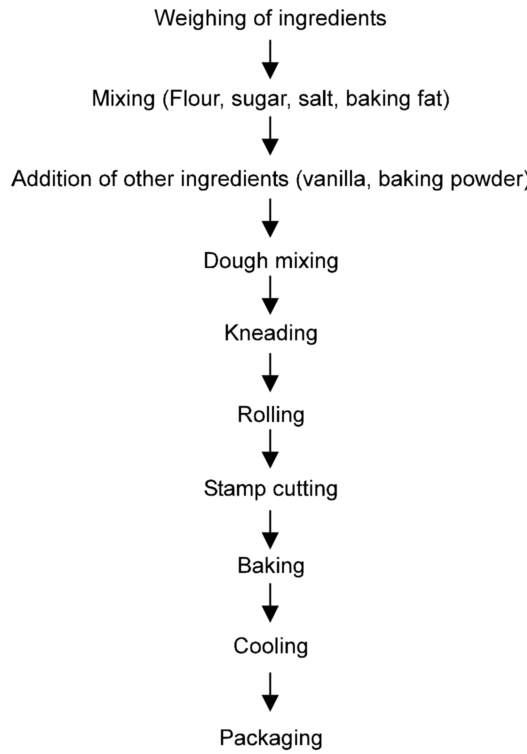

Fig. 3: Flow diagram for the production of cookies (Eneche, 1999)

Functional properties of flour

Bulk density: The Bulk Density of the flour sample was determined by the method of Okaka and Potter (1979).

Water absorption capacity (WAC): This was determined using the method of Lin *et al.* (1974) on 1g sample.

Swelling capacity: The method described by Ukpabi and Ndimele (1990) was used on 10 g sample.

Determination of pH: The pH of the flour samples was measured in a 10% (w/v) dispersion of the samples in distilled water. Each suspension was mixed thoroughly and a standard pH meter (Hanna meter model H196107) was used for pH determination.

Proximate analysis: Moisture, crude protein, fat, fibre and ash contents were determined using the method of AOAC (2010). Carbohydrate was determined by difference.

Sensory evaluation: Sensory evaluation of the cookies was conducted using twenty panel members. These panelists were familiar with quality attributes of cookies. The samples were coded and presented in identical containers. A nine point hedonic scale as described by Ihekoronye and Ngoddy (1985) was used. The scale ranged from like extremely (9) to dislike extremely. Each of the samples was rated for appearance, flavour, taste, texture and overall acceptability.

Statistical analysis of data: The experiment was laid out in a completely randomized design (CRD). Data were subjected to Analysis of Variance (ANOVA) using statistical package for social sciences (SPSS) version 17.0. Duncan's new multiple range test (DNMRT) was used to compare the treatment means. Statistical significance was accepted at $p \leq 0.05$ (Steel and Torre, 1980).

RESULTS AND DISCUSSION

The results of the functional properties of the flour are shown in Table 2.

The results of bulk density of the flour samples ranged from 0.64 to 0.81 g/cm^2. Wheat flour had the highest value. There was no significant (p>0.05) difference between millet flour (MF) and millet-pigeon pea flour (MPF) blend. The 0.64 and 0.65 g/cm^3 obtained for MF and MPF, respectively compared favourably with 0.62 g/cm^3 reported for yellow tiger nut flour (Oladele and Aina, 2009). The values obtained for PPF (0.71 g/cm^3) and WF (0.81 g/cm^3) compared favourably with 0.71 g/cm^3 reported for wheat flour (Akubor and Badifu, 2004). The lowest value (0.64 g/cm^3) was observed in millet flour (MF). This implied that MF would require more packaging space since the lesser the bulk density, the more packaging space is required (Agunbiade and Ojezele, 2010). The low bulk density observed show that these flours can be used for food formulation with less fear of retrogradation. Bulk density is a measure of heaviness of a flour sample (Oladele and Aina, 2009).

The results obtained for water absorption capacity (WAC) ranged from 0.47 to 1.10 ml/g. The lowest value was observed in WF. There was no significant (p>0.05) difference between the WAC of MF and WF as well as between that of PPF (1.10 ml/g) and MPF (0.93 ml/g). These values were comparable with 1.10 ml/g reported for pigeon pea flour processed by dry method (Tiwari *et al*., 2008). Water absorption capacity describes flour-water association ability under limited water supply (Singh, 2001). These results suggest that MF, PPF and MPF may find application in baked products such as cookies.

Table 1: Formulation of cookie samples

	Level of substitution	
Blends	Wheat flour (WF%)	Millet-pigeon pea flour (MPF%)
XP	100	0
XY	90	10
PS	80	20
ZY	70	30
WZ	60	40

The results obtained for swelling capacity of the flour samples ranged from 16.70 to 48.25% with the highest value observed in PPF. There was no significant (p>0.05) difference between MF and MPF samples, while there were significant (p<0.05) differences between PPF and WF. These results can be compared with results reported by Abulude *et al.* (2006). Swelling capacity is a function of the process conditions, nature of the material and type of treatment. Biopolymers such as starch and protein contribute to the development of these characteristics (Ayernor, 1976).

The results obtained for pH of the flour samples ranged from 6.03 to 6.40. It shows that there was no significant (p>0.05) difference between samples PPF and MPF as well as between samples WF, MF and MPF. Similar observations have been made by Ikpeme *et al.* (2010) for wheat and taro flour.

Proximate analysis: The results of the proximate analysis of the flour are shown in Table 3. There were significant (p<0.05) differences in all the measured parameters. The moisture content of the flour samples ranged from 7.35 to 13.00%. These values are below the minimum limit of moisture content for flour (Ihekoronye and Ngoddy, 1985). The values are therefore low enough for adequate shelf life stability if packaged in moisture-proof containers.

The ash contents of the flour samples ranged from 1.25 to 1.80%; which shows the presence of some minerals in the flour samples. The ash values for millet and pigeon pea flour compared favorably with 1.7% and 2.9% reported by Eneche (1999), respectively.

The protein content of the flour samples ranged from 8.76 to 16.64%. Significant (p<0.05) differences were observed among the samples. The variation in these results can be attributed to their original raw materials. The highest protein value was observed in pigeon pea flour. Mature pigeon pea seeds are noted to contain as

Table 2: Selected functional properties and pH of flour for production of cookies

Sample flour	Bulk density (g/cm^3)	Water absorption capacity (ml/g)	Swelling capacity (%)	pH
Millet	0.64±0.01^{c}	0.67±0.06^{b}	16.70±1.48^{c}	6.10±0.10^{b}
Pigeon pea	0.71±0.03^{b}	1.10±0.10^{a}	48.25±1.52^{a}	6.40±0.10^{a}
Millet-pigeon pea	0.65±0.02^{c}	0.93±0.12^{a}	17.50±2.50^{c}	6.20±0.20^{ab}
Wheat	0.81±0.01^{a}	0.47±0.15^{b}	28.95±2.63^{b}	6.03±0.06^{b}

Values are Means±S.D of duplicate determinations. Values in the same column with different superscripts were significantly ($p<0.05$) different

Table 3: Proximate composition of unblended flour from millet, pigeon pea and wheat

Sample code	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
Millet	8.80±0.04^{c}	8.76±0.08^{c}	3.00±0.03^{a}	1.25±0.10^{c}	0.80±0.14^{c}	77.39±0.40^{b}
PPF	9.50±0.10^{b}	16.64±1.85^{a}	1.30±0.01^{c}	1.30±0.00^{b}	1.15±0.04^{b}	67.86±1.82^{c}
*WF	13.00^{a}	10.50^{b}	2.60^{b}	1.80^{a}	2.50^{a}	78.60^{a}

*Enwere, 1998. Values are Means±S.D of duplicate determinations. Values in the same column with different superscripts were significantly ($p<0.05$) different. MF: Millet flour, PPF: Pigeon pea flour, WF: Wheat flour

Table 4: Sensory scores of cookies made from wheat and millet-pigeon pea flour blends

Sample code	Colour	Flavor	Taste	Texture	Overall acceptability
XP	8.50±0.69^{a}	7.95±1.32^{a}	8.45±0.95^{a}	8.05±0.89^{a}	8.30±0.98^{a}
XY	7.35±0.99^{b}	7.45±1.28^{a}	7.35±1.39^{b}	7.75±1.25^{ab}	7.80±1.32^{ab}
PS	7.70±0.99^{ab}	7.30±1.26^{ab}	7.25±1.41^{b}	7.60±0.94^{ab}	7.25±0.91^{bc}
ZY	7.85±1.27^{ab}	7.35±1.23^{ab}	6.95±1.70^{b}	7.70±1.30^{ab}	7.20±1.40^{bc}
WZ	6.20±1.96^{c}	6.40±2.23^{b}	6.80±1.70^{b}	7.00±1.59^{b}	6.70±1.66^{c}

Values are Mean±SD of scores of 20 panelists. Samples with different superscripts within the same column were significantly different ($p<0.05$). XP: Cookies made from 100%WF and 0%MPF, XY: Cookies made from 90% WF and 10% MPF, PS: Cookies made from 80% WF and 20% MPF, ZY: Cookies made from 70% WF and 30%MPF, WZ: Cookies made from 60% WF and 40% MPF

much as 22% (Duke, 1981) and 19.2% (Purseglove, 1991) protein. The protein content of millet flour was 8.7%. Millet grains are also known to contain appreciable quantity of protein of about 11% (Enwere, 1998). Flour proteins of pigeon pea and millet do not form gluten. Most cookies can be made from flour which has a gluten that is weak and extensible (Manley, 2000). These processed flour from pigeon pea and millet may sometimes be useful to 'dilute' wheat flour. This can help to make the dough less tough and easier to sheet. In addition, pigeon pea and millet flour can be major sources of high quality protein for dietary cookies.

The fat content of the flour samples were generally low, ranging from 1.3 to 3.0%. Significant ($p<0.05$) differences were observed among them. The fat value was highest in millet flour (3.0%), while 1.3% was observed in pigeon pea flour. These values for millet and pigeon pea flour compared favourably with Eneche's results of 4.8 and 1.4% respectively (Eneche, 1999). The higher fat content of millet flour can be attributed to the fact that millet is rich in germ which is rich in oil (Manley, 2000). Most legumes such as pigeon pea contain less than 3% fat (Ihekoronye and Ngoddy, 1985).

The crude fibre content of the flour samples ranged from 0.80 to 2.5% with the highest value observed in wheat flour. Fibre aids in lowering blood cholesterol level and slows down the process of absorption of glucose, thereby helping in keeping blood glucose level in control (Anderson *et al.*, 2009). It also ensures smooth bowel movements and thus helps in easy flushing out of waste products from the body, increase satiety and hence impacts some degree of weight management (Mickelson *et al.*, 1979).

There were significant ($p<0.05$) differences in the carbohydrate contents of the flour samples. Digestible carbohydrate contents of millet flour (77.39%) and pigeon pea flour (67.86%) compared favourably with 72.80% reported by Eneche (1999) and 64.4% reported by Oyenuga (1968). The high carbohydrate values of these flour can be attributed to the carbohydrate values of their raw materials which were not so much affected by processing.

Sensory evaluation of cookies made from wheat and millet-pigeon pea flour blends: The result of sensory evaluation of cookies made from millet-pigeon pea composite is shown in Table 4. It indicated that all the samples had appreciable ratings for colour, flavour, taste, texture and overall acceptability. However, the control sample (XP) made with 100% wheat flour had higher ratings in all the attributes than other samples. The degree of likeness for taste and overall acceptability decreased as the rate of substitution of millet-pigeon pea flour blend increased. Sample XY with 90% WF and 10% MPF compared favourably with the control sample in flavour, texture and overall acceptability. There was no significant ($p>0.05$) difference among samples XY, PS and ZY in all the evaluated attributes. Sample WZ had the lowest ratings, which could be attributed to its high (40%) MPF inclusion. The high mean scores observed for colour, flavor, taste, texture and overall acceptability indicated that all the cookies were of good sensory quality.

Conclusion: Results show that millet-pigeon pea and wheat composite flour blend could be used in the production of cookie products. Results of functional properties of the flour showed low bulk density (0.64 to 0.81 g/cm^2) and low water absorption capacity (0.47 to 1.10 ml/g). These indicate that the flour could find application in baked product such as cookies. The study also showed significant ($p<0.05$) differences in the proximate composition of the flour. Pigeon pea flour had the highest protein value (16.64%). It could be used to improve the nutrient density of cookies. All the cookies produced from these flour had high sensory ratings and were all acceptable. Since there were no significant ($p>0.05$) differences among samples with 10, 20 and 30% MPF in all the evaluated sensory attributes, cookies with 20% substitution was therefore selected as the best based on cost implication.

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