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Research Article

Proximate, Functional and Pasting Properties of Cooking Banana and Plantain Flour Blends

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Abstract

Cooking banana is an underutilized fruit with high post-harvest loss, high in fibre and important in the management of diabetes. Plantain on the other hand, is one of the widely grown fruit and cash crop in Nigeria. Both cooking banana and plantain flours were blended in the ratios of 100:0, 75:25, 50:50, 25:75, and 0:100 respectively and evaluated for proximate, functional and pasting properties. Proximate analysis of the flour blends revealed a significant ($p < 0.05$) increase in moisture (9.51 to 10.64%), fat (0.79 to 1.50%) and carbohydrate (80.99 to 82.47%) as inclusion of plantain flour increases while a significant ($p < 0.05$) increase in protein (3.28 to 5.47%), ash (2.37 to 2.75%), and crude fibre (0.80 to 2.17%) as inclusion of cooking banana increases. Results for functional properties revealed no significant differences in bulk density (0.70 to 0.71g/ml), water absorption capacity increases with increase in cooking banana flour in the blends (1.22 to 1.80g/g), oil absorption capacity ranged from 0.70g/g to 0.81g/g while the highest value was recorded for 50% plantain flour and 50% cooking banana flour. Results for pasting properties showed a significant increase in the peak viscosity (5614 to 6816.5 RVU), trough viscosity (4396.5 to 4666.5 RVU), breakdown viscosity (1218 to 2223 RVU), and final viscosity (6622 to 6676 RVU) with increase in cooking banana flour in the blends. On the other hand, a decrease in the setback viscosity (2005 to 2279.5 RVU), peak time (5.3 to 5.5 minutes) and pasting temperature (84.42 to 85.6°C) were observed with increase in cooking banana flour. This investigation proposes the utilization of the cooking banana and plantain flour blends in food application.

Keywords: Plantain; Cooking; Banana

Introduction

Cooking banana (*Musa acuminate*) is a banana cultivar in the genus Musa and is native to South Asia [1]. Cooking banana is a nutrient dense but neglected tropical food. Bananas and plantains belong to the same genus, Musa, in the family of *Musaceae* which contains 30-40 species [1]. The FAO and the International Institute of Tropical Agriculture (IITA), among other research centers, use the word "banana" to refer to Musa species that are sweeter and eaten raw and "plantain" to denote Musa species that are starchier and cooked before eating, while many researchers use "banana" to mean all Musa varieties, including plantains [2]. Cooking banana and plantain are horticulture commodities that are deteriorate in a short period of time. As a result, development of high yield, short time growth, diseases resistance banana varieties by agriculture institution has increased the volume of cooking banana over the years. The fruits contain minerals such as phosphorus, calcium and potassium [3,4]. reported that cooking bananas contain several vitamins including A, B and C, minerals particularly potassium but, low in protein and fat. It is cholesterol and gluten free but high in fiber content. These fruits are mainly transported to urban areas, where they would be eaten as fruit and vegetables. However, unavoidable delay in transport, poor post harvest technology and fluctuating market demand result in overripe and senescence of fruit prior to market delivery.

In Nigeria, there is a low inclination for cooking banana, despite its agronomical advantages, which necessitates its use in a composite flour. Moreover, there is high production for cooking banana than plantain due to its resistance to black sigatoka diseases, it is also cheaper compare to plantain [5], yet it is still underutilised in Nigeria and mainly used for house hold production of flour and fried chips. To ensure sustainable food consumption at the household level, during this time of food crisis, and their availability in Nigeria is an opportunity to achieve food security. It is critical to promote the use of underutilized food crops such as cooking bananas. Blending cooking banana flour with plantain flour, which is well known in most households will create awareness of cooking banana. In order to utilize cooking banana maximally, this research examines the blending of cooking banana flour and plantain flour at difference percentages and provides information on the proximate, functional and pasting properties of its flour blends with a view to establishing the full industrial potential in food applications.

Materials and Methods

Collection of samples

Freshly harvested, green matured plantain and cooking banana were obtained from Oje market in Ibadan, Oyo state, Nigeria. All chemicals used were of analytical grade and were obtained from chemical laboratory stores in Nigeria.

Processing of cooking banana flour.

The processing of the cooking banana into flour was carried out using the method of [6]. Unripe cooking banana was washed in tap water and peeled using hand pressure to obtain the pulp. The pulp was sliced and blanched at 100°C for 10 min. The blanched cooking banana was dried at 60°C for 24 hours in a hot-air fan oven, ground and sieved. The flour obtained was stored in an air-tight plastic container at room temperature (37°C) until used.

Processing of unripe plantain flour

The unripe plantains were cleaned, peeled, cut (2mm thickness) and blanched in hot water at 100°C for 10 min and dried in a cabinet dryer at 65°C for 24hrs. It was later milled and sieved to get the flour.

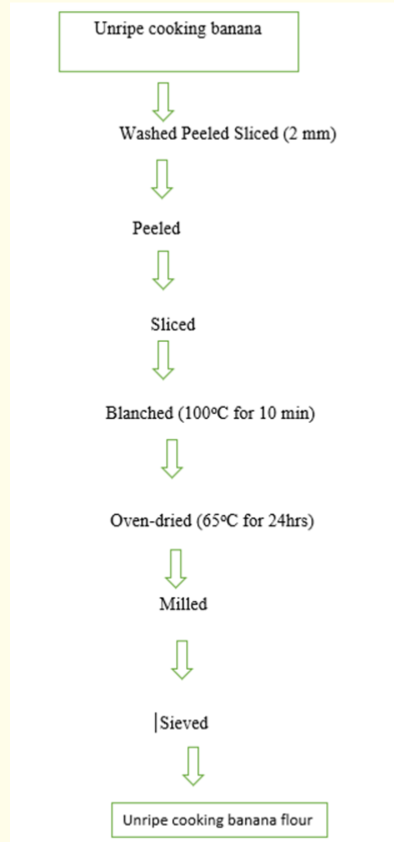

Figure 1: Flow diagram for the Production of cooking banana flour. Source: China., et al. (2020).

Sample formulation

Plantain and cooking banana flour blends were formulated at different proportion of 100:0, 75:25, 50:50, 25:75 and 0:100. The flour blends were mixed using a Nutri-Blender for 10 minutes in order to achieve uniform blending.

Proximate analysis

Proximate analysis (moisture, ash, protein, fat and crude fibre) of the cookies was determined using the method of the Association of Official Analytical Chemists [7] while total available carbohydrate was calculated by difference using the formula: 100% - (% Moisture + % Ash + % Crude protein + % Fat + % Crude fibre).

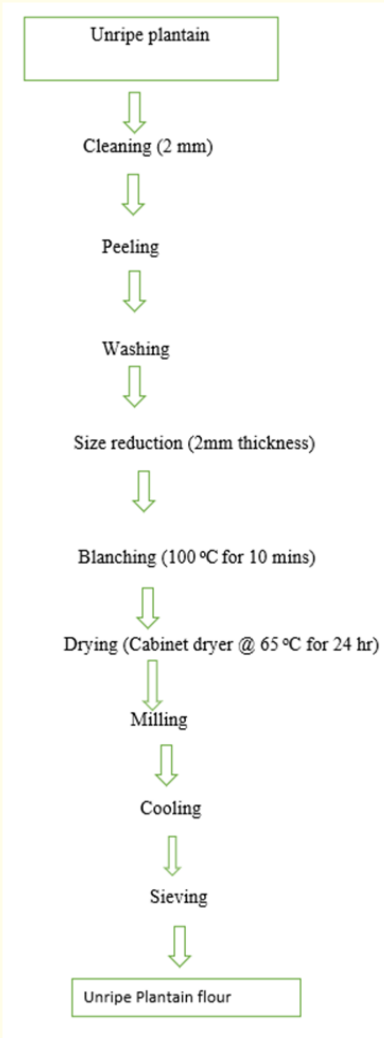

Figure 2: China., et al. (2020).

Functional properties of the flour blends

The oil and water absorption capacity of the flour blends was determined as described by [8]. Relative bulk density and least gelation concentration were determined by the method described by [9].

Pasting properties of the flour blends

The pasting properties of the samples were determined using the Rapid Visco Analyzer (RVA) also known as amylograph according to Newport Scientific, Narrabeen Australia as described by Ikegwu., *et al*. [10]. Thirty grams (30g) of the flour samples and 50 ml of distilled water were mixed in a paddle. The paddle was placed into a canister containing the samples and water. The samples were then inserted into the rapid viscous analyser. The analysis was carried out at a programmed heating and cooling cycle where the samples were held at 50ºC for 1 minute, heated at 95ºC for 3 to 8 minutes and held at 50ºC for 1 to 4 minutes. The pasting performance of the samples was automatically recorded on the graduated sheet of the instrument.

Results and Discussion

Proximate composition of plantain and cooking banana flour blends

The proximate composition of plantain and cooking banana flour blends is presented in table 1. The moisture content of the flour blends ranged from 9.51% to 10.64%. The trend of the moisture content result proved that plantain flour contributed to the moisture content in the blend, as the plantain flour is increasing in the blend the moisture content is increasing. Flour product with moisture content of less than 13% are stable from moisture dependent deterioration [11]. The crude protein of the flour blends ranged from 3.28% to 5.47%. The crude protein increase significantly as cooking banana flour is increasing in the blend. This signifies that cooking banana contains more of protein than the plantain.

The fat content of the flour blends ranged from 0.79% to 1.50%. The highest fat content was recorded for 100% plantain, while the lowest value was recorded for 100% cooking banana flour. All the blends had low fat content which indicate that both cooking banana and plantain are poor sources of fat which is in line with [12].

The fiber content of the flour blends ranged from 0.80% to 2.17%. 100% plantain flour had the lowest fiber content, while the highest value was recorded for 100% cooking banana flour**.** Fibre in food helps in burning of fat and boosting of the immune system. It could also provide bulk in the diet, enhance gastrointestinal function, prevent constipation and may reduce the incidence of metabolic diseases like maturity-onset diabetes mellitus and hypercholesterolemia [13].

The ash content of the flour blends ranged from 2.37% to 2.75%. The highest ash content was recorded for 100% cooking banana flour, while the lowest value was recorded for 100% plantain flour. As the cooking banana flour is increasing in the blends, ash content also increased. Ash content is a reflection of the mineral matter in a food sample.

The carbohydrate content of the flour blends ranged from 80.99% to 82.47%. All the blends are very high in carbohydrate with highest value from 50%PF:50%CBF and with no significant difference in the blends. The result recorded high carbohydrate contents for all the samples. This is an indication that both plantain and cooking banana are good sources of carbohydrate. The proximate composition of plantain and cooking banana flour blends is presented in table 1.

Sample	Moisture content (%)	CHO (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)
100%PF:0%CBF	10.64 ± 0.14^a	82.22 ± 0.12^a	3.28 ± 0.31^d	1.50 ± 0.40^a	0.80 ± 0.02^d	2.37 ± 0.07^c
75%PF:25%CBF	10.47 ± 0.14^b	82.18 ± 0.21^a	4.05 ± 0.15^c	0.91 ± 0.00^b	1.41 ± 0.16^c	2.40 ± 0.01^c
50%PF:50%CBF	9.51 ± 0.14^d	82.47 ± 0.12^a	4.71 ± 0.15^b	0.79 ± 0.01^c	2.01 ± 0.01^b	2.53 ± 0.00^b
25%PF:75%CBF	10.41 ± 0.14^b	81.30 ± 0.50^b	4.82 ± 0.00^b	0.96 ± 0.01^b	1.93 ± 0.07^b	2.51 ± 0.01^b
0%PF:100%CBF	10.01 ± 0.14^c	80.99 ± 0.36^c	5.47 ± 0.31^a	0.79 ± 0.01^c	2.17 ± 0.01^a	2.75 ± 0.00^a

Table 1

CHO: Carbohydrate; PF: Plantain Flour; CBF: Cooking Banana Flour

Note: Mean ± Standard deviation across a row with different superscription are significantly difference with a>b>c>d. Mean separation done with Duncan multiple range test.

Functional properties of plantain and cooking banana flour blends

The functional properties of plantain and cooking banana flour blends is presented in table 2.

The pH of the flour samples are within the range of 5.49 – 6.93 as shown in table 2. The pH values were significantly ($p < 0.05$) different from each flour blend, with 100% plantain flour having the highest pH value. High pH values for flour have been found to increase solubility due to increased hydrophilic character of the flour at these pH value [14]. Oil absorption capacity ranged from 0.70g/g to 0.81g/g. Lowest value was recorded for both 100% cooking banana flour and 100% plantain flour while highest value was recorded at 50% PF: 50% CBF. Good OAC of flour samples suggest that they may be useful in food preparations that involves oil mixing like in bakery products, where oil is important ingredient. The water/fat binding capacity of protein is an index of its ability to absorb and retain oil, which in turn influences the texture and mouth feel of food products like doughnut, pancakes, baked goods and soups. Oil absorption capacity is importance since oil acts as flavour retainer and increases the mouth feel of foods [15]. It has been reported that variations in the presence of non-polar side chains, which might bind the hydrocarbon side chains of oil among the flours, explain differences in the oil binding [16]. The result of the water absorption capacity (WAC) ranged between 1.22g/g and 1.80g/g and it showed that 100% cooking banana had the highest WAC while 50% PF: 50% CBF had the least value. The bulk density (BD) of the blends ranged between 0.70g/ml and 0.71g/ml and there were no significant ($p > 0.05$) difference amongst flour blends. Lower bulk density value for all the blends will be an advantage in the bulk storage and transportation of the flour.

Sample	Bulk density (g/ml)	Water absorption capacity (g/g)	Oil absorption capacity (g/g)	pH
100%PF:0%CBF	0.71 ± 0.01^a	1.34 ± 0.01^b	0.70 ± 0.01^b	6.93 ± 0.01^a
75%PF:25%CBF	0.71 ± 0.01^a	1.33 ± 0.01^b	0.72 ± 0.01^b	6.56 ± 0.01^b
50%PF:50%CBF	0.71 ± 0.01^a	1.22 ± 0.01^d	0.81 ± 0.01^d	6.19 ± 0.01^b
25%PF:75%CBF	0.70 ± 0.01^b	1.28 ± 0.01^c	0.77 ± 0.01^c	5.79 ± 0.01^c
0%PF:100%CBF	0.71 ± 0.01^a	1.80 ± 0.01^a	0.70 ± 0.01^a	5.49 ± 0.01^d

Table 2

PF: Plantain Flour; CBF: Cooking Banana Flour

NOTE: Mean ± Standard deviation across a row with different superscription are significantly difference with a>b>c>d. Mean separation done with Duncan multiple range test.

Pasting properties of plantain and cooking banana flour blends

The pasting properties of plantain and cooking banana flour blends were presented in table 3. The pasting properties of starch

Sample	Peak viscosity (RVA)	Trough (RVA)	Breakdown Viscosity (RVA)	Final Viscosity (RVA)	Setback (RVA)	Peak Time (mins)	Peak Temperature (0^c)
100%PF:0%CBF	5614	4396.5	1218	1218	2279.5	5.400	84.800
75%PF:25%CBF	5801	4418	1383	1383	2210	5.500	85.600
50%PF:50%CBF	6395.5	4603	1792.5	1792.5	2059	5.356	84.425
25%PF:75%CBF	6546.5	4666.5	1880	1880	2005	5.435	85.225
0%PF:100%CBF	6816.5	4593.5	2223	2223	2028.5	5.300	84.420

Table 3

are used in assessing the suitability of its application as functional ingredient in food and other industrial products [17]. Plantain flour and cooking flour form paste when reconstituted with hot water, hence its amylographic viscosities are important in assessing the suitability of its application as functional ingredient in food and other industrial products [17]. When starch or starch-based foods are heated in water beyond a critical temperature, the granules absorb a large amount of water and swell to many times their original size. Over a critical temperature, which is characteristic of a particular starch, the starch undergoes an irreversible process known as gelatinization [18]. When the temperature rises above the gelatinization temperature, the starch granules begin to swell and viscosity increases on shearing. The temperature at the onset of this rise in viscosity is referred to as the gelatinization or pasting temperature [18]. The pasting temperature of the flour blends ranged between 84.42 °C and 85.60 °C, there was slight significant difference in the blends. The pasting temperature is a measure of the minimum temperature required to cook a given food sample [19], it can have implications for the stability of other components in a formula and also indicate energy costs [20]. The peak time is a measure of the cooking time [19]. This ranged between 5.30 to 5.50 min for the flour blends, the lowest value was recorded for 100% cooking banana flour. Peak viscosity, which is the maximum viscosity, developed during or soon after the heating portion of the pasting test [20]. This ranged between 5614 to 6816.5 RVA, it is lower for the 100% plantain flour while the highest value was recorded for 100% cooking banana flour. Peak viscosity is often correlated with the final product quality. It also provides an indication of the viscous load likely to be encountered during mixing [21]. Higher swelling index is indicative of higher peak viscosity while higher solubility as a result of starch degradation or dextrinization results in reduced paste viscosity [21]. Trough due to the accompanied breakdown in viscosity is a period when the sample was subjected to a period of constant temperature (usually 95°C) and mechanical shear stress. It is the minimum viscosity value in the constant temperature phase of the RVA profile and measures the ability of paste to withstand breakdown during cooling [22]. Trough ranged between 4396.5 and 4666.5 RVA for all the blends. This period is often associated with a breakdown in viscosity [23]. It is an indication of breakdown or stability of the starch gel during cooking [23]. The lower the value the more stable is the starch gel. The breakdown is regarded as a measure of the degree of disintegration of granules or paste stability [24]. This ranged between 1218 and 2223, with highest value for 100% cooking banana flour and lowest value for 100% plantain flour. Setback or viscosity is a stage where retrogradation or reordering of starch molecules occurs. This ranged between 2005 and 2279.5 for all the blends, it is a tendency to become firmer with increasing resistance to enzymic attack. It also has effect on digestibility. Higher setback values are synonymous to reduced dough digestibility while lower setback during the cooling of the paste indicates lower tendency for retrogradation [25]. The final viscosity ranged between 6622 and 6676 for all the blends. The extent of increase in viscosity on cooling to 50°C reflects the retrogradation tendency [26].

Conclusion

The findings suggest that blending cooking banana and plantain flours could lead to innovative food ingredients in food applications, contributing to food security and nutritional enhancement. Future research should explore the sensory attributes and shelf-life of products made from these flour blends, as well as their potential role in gluten-free formulations, further broadening their applicability in the food industry. Overall, the integration of cooking banana flour in plantain flour blends presents a promising avenue for improving dietary options and promoting the utilization of underutilized cooking banana.

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