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The Production of Pawpaw Enriched Cookies: Functional, Physico-Chemical and Sensory characteristics

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ABSTRACT— ***The preservation of pawpaw pulp and its utilization as a constituent of cookie preparation was investigated by preparing blends of pawpaw/wheat flour with increasing level of pawpaw flour at 0, 25, 50, 75 and 100% addition in wheat. Control samples were 100% wheat flour and its cookie. The functional and some physico-chemical properties of the flours and their blends were determined. Also the cookies were evaluated for their proximate and physical properties. Sensory evaluation was also conducted on the cookies samples to determine their consumer acceptability. The data obtained showed an increased in water absorption, least gelation concentration and emulsifying capacity, a decrease in oil absorption, foaming capacity and bulk density as the level of pawpaw flour increases in the blends. The results of the physico-chemical analysis of flour blends shows increase in Vitamin C, titratable acidity, sugar and decrease in pH as the level of pawpaw flour increases in the blends. The proximate results showed an increase in ash content (1.56–3.35%), fiber (1.52–2.16%), and carbohydrate (67.15–73.85%) as the level of pawpaw flour increases, while there was a decrease in the fat (15−8.20%), protein (10.52−8.54%) and moisture (4.25−3.80%) content as the level of pawpaw flour increases, though there was no significant (p>0.05) difference between 100% wheat and up to 25% inclusion of pawpaw flour. The weight, height and volume decreased as the level of pawpaw flour increases. The diameter increases as pawpaw flour increases. Taste panel scores indicate that up to 50% addition of pawpaw flour was acceptable in cookie preparation. The study indicates that vitamin C enriched composite flour could be produced from wheat/pawpaw flour blend and also acceptable cookies could be produced from up to 50% inclusion of pawpaw flour in wheat flour.***

Keywords--- Pawpaw, Functional, Physico-chemical, Sensory properties, Acceptable cookies

1. INTRODUCTION

Fruits are mostly known and accepted as an excellent source of nutrients such as minerals and vitamins and also contain carbohydrates in form of soluble sugar, cellulose and starch [1]. Fruits form a vital portion of an adequate diet and also serve as food supplement and appetizer. The fruits seeds and leaves of many wild plants already form common ingredients in a variety of traditional native dishes for the rural populace in developing countries [2].

Economically, pawpaw (Carica papaya) is the most important fruit in the caricaceae family. The pulp of ripe pawpaw is usually consumed fresh in slices, in chunks as dessert and it can be processed and used in a variety of products such as jams and fruit juice. Pawpaw is a fruit which has high amount of vitamin C and minerals such as potassium, magnesium, iron and sodium [3]. Pawpaw fruit is also a source of essential amino acid and contains significant amounts of riboflavin, niacin, phosphorus and zinc. The amounts of these nutrients are greater than or the same as those found in bananas, apples or oranges [4]. Pawpaw is a seasonal fruit, and during its fruiting/ripening, the fruit is found in abundance and a larger percentage of it produced at a particular season is wasted. Due to its nutritive value, incorporation into wheat flour in baking could be beneficial.

Over the years, the demand for pastry product in Nigeria has being on the increase. As the demand for pastry product increase, the cost of ingredients and products also becomes very expensive [5]. This high cost is due to the fact that the principal ingredient in making pastries is wheat which is imported into the country because the prevailing climatic conditions and soil type in Nigeria do not support it local cultivation. Some fruits such as ripe bananas have been used together with wheat flour by some bakers to bake banana cakes and such products have been sold on commercial basis [6]. Its use has being limited solely to minimal processing in the form of packaged cut fruits or cut fruit blends which are sold by some food vendors. Ripe pawpaw also has a short shelf life of two to three days at room temperature [7]. Presently, there is little or no reported information on the use of processed pawpaw flour in conventional baked products.

Pawpaw could be processed into flour and used in similar manner other flours such as orange seed [8] and mango kernel [9, 10] are used. This will, however, depend on the knowledge of its chemical composition and functional properties. Quality attributes of developed food products are generally affected by the functional properties of the flour [11]. It was envisage that the incorporation of pawpaw flour into wheat flour in baking will improve the nutrient content of the baked product. The over dependence of 100% wheat flour in baking will also reduce. Pawpaw pulp could be preserved so as to make it available all year round and to incorporate it into wheat flour in the production of baked product (cookie) because of its nutritional and health benefits.

Cookies are consumed extensively all over the world as a snack food and on a large scale in developing countries where protein and caloric malnutrition are prevalent [12]. With the increased advocacy on the consumption of functional foods by World nutrition bodies due to different health problems related with food consumption[13]. The objectives of this work were to preserve pawpaw pulp and determine the functional and physicochemical properties of pawpaw flour and the blends of pawpaw/wheat as well as physical, proximate and sensory properties of cookies prepared from pawpaw/wheat flour.

2. MATERIALS AND METHOD

2.1 Source and preparation of raw materials

Pawpaw fruits were obtained from a farm in Okenya Igalamela/Odolu Local government area of Kogi State, Nigeria. Flour (wheat), margarine, baking powder, corn starch, sugar, egg, salt and milk were bought from Idah market. The study was undertaken in November, 2013 at the food processing laboratory, Federal Polytechnic, Idah, Kogi state- Nigeria.

Pawpaw fruits were washed and peeled. The seeds were removed and pulp sliced. The sliced pulps were grated to reduce the particle size. The grated pulp was blanched in hot water at a temperature of 95^{o}C for 5 minutes [14]. It was then cooled rapidly, spread thinly on a tray and sundry for 2 days to give a dried brittle texture and milled into flour with a milling machine. The flour obtained was sieved with an 80mm mesh sieve size to obtain a very fine particle size.

2.2 Blend formulation/ Cookie preparation

Blends of wheat and pawpaw flour containing 0, 25, 50, 75 and 100% pawpaw flour on replacement basis were prepared. The blends were thoroughly mixed in a food processor (Kenwood model km 201). Cookies were prepared according the formula of Nishibori and Kawakishi [15] as modified by Akpapunam and Darbe [16]. The basic formulation used was flour 49.5%, shortening 20%, sucrose 20%, baking powder 0.5% and beaten whole egg 10%.

2.3 Analytical methods

The bulk density, water absorption, oil absorption, emulsifies capacity, foaming capacity and gelation capacity of the flours and their blends were determined according to the method described by Okaka and Poter, [17]. The ascorbic acid, titratable acidity, pH and the total sugars were determined according to AACC [18]. The proximate analysis to determine how much of major or macro components which include Moisture , Ash , Fiber ,Fat , Protein and carbohydrate were determined according to standard methods AOAC, [19] . Physical properties such as weight, height, volume, diameter and density were determined for all the cookies according the method described by Onwka, [20].

Sensory evaluation was conducted by 20 trained panelists made up of ten final year students and ten staff of Department of Food Science and Technology, Federal Polytechnic, Idah who were familiar with cookies. The panelists were trained in ten sessions until the panelists' were familiar with the range of characteristic intensities required for the study. The panelists were provided with clean tap water to rinse their mouth after tasting each sample. Assessment was by 5 point hedonic scale for colour, taste, flavour, texture and general acceptability.

2.4 Statistical analysis

Data were analyzed using analysis of variance. Means were separated by the least significant difference (LSD) test. Significance was accepted at $P < 0.05$ [21].

3. RESULTS AND DISCUSSION

3.1 Functional properties of the flours and their blends

The results for the functional properties of the various blends of pawpaw/wheat flour are shown in Table 1. The water absorption capacity of 92.80% for pawpaw flour was significantly higher ($p<0.05$) than 68.80% for wheat flour. The water absorption capacity increases as the percentage pawpaw flour incorporation increases. Pawpaw flour may have contained more hydrophilic constituents than wheat flour, which gave rise to higher water absorption capacity (WAC). The lower moisture content of pawpaw flour also enhanced its WAC. Water absorption of flour is dependent mainly on the amount and nature of the hydrophilic constituents and to some extent on pH and nature of the protein [22]. Water absorption characteristic represents the ability of the product to associate with water under conditions when water is limiting such as doughs and pastes. The results of this study suggest that pawpaw flour would be useful in foods such as bakery products which require hydration to improve handling characteristics.

The oil absorption capacity decreases as the percentage pawpaw flour increases. It ranged from 73.70 − 61.50%. Whole Pawpaw flour had lower (61.50%) oil absorption capacity (OAC) than whole wheat flour (73.70%). The OAC of pawpaw flour was higher than 49% reported for orange seed flour [8] and lower than 70% for cola *milinii [23]*. The lower oil OAC suggested little or absence of polar amino acids in pawpaw flour [24]. Oil absorption capacity is attributed mainly to the physical entrapment of oils. It is an indication of the rate at which protein binds to fat in food formulations [23]. OAC is useful in formulation of foods such as sausages [25].

The emulsify capacity increases while the foaming decreases as the percentage pawpaw flour increases. These increase of emulsify capacity and decrease of foam capacity could be associated with the starch and protein content respectively of the pawpaw flour. There were significant ($p<0.05$) differences among the blends in emulsify and foaming capacity from the control sample (100% wheat flour). The least gelation capacity increases as the percentage pawpaw flour increases in the blends. It ranged from 10-12.01%. It shows no significant difference between the control sample and the 25% inclusion of pawpaw flour, but significantly different for other samples. The least gelation concentration varies for different flours. Sathe *et al.*, [24] associated the variations in the gelling properties of different flours different ratios of components that make up the flours. Interaction among these components play a significant role in functional properties as it affects gelation.

The bulk density decreases as the percentage pawpaw flour increases but it shows no significant difference between the control samples and up to the incorporation of 75% pawpaw flour. Bulk density is a function of particle size, particle size being inversely proportional to bulk density [26]. The differences in the particle size of the flours may be the cause of variations in bulk density of the blends. Bulk density is an indication of the porosity of a product which influences package design and could be used in determining the type of packaging material required, material handling and application in wet processing in the food industry [11]. Bulk density is also important in infant feeding where less bulk is desirable. The low bulk density of the flours with increasing level of pawpaw would an advantage in the use of the flour for preparation of complementary foods.

Table 1: Functional Properties of Pawpaw/Wheat Flour Blends

Samples	Parameter (%)					
Wheat: pawpaw	WAC	OAC	EC	FC	LGC	BD (g/cm^3)
100: 0	68.80d	73.70a	75.70d	15.40a	10.00c	0.76a
75 : 25	81.10c	68.80b	84.80c	7.70b	10.52c	0.74a
50 : 50	88.50b	63.00d	95.20b	3.80c	11.10b	0.70a
25 : 75	91.00a	65.50c	97.10a	2.30d	11.55a	0.64a
0 :100	92.80a	61.50e	98.10a	1.20d	12.01a	0.52b
LSD 0.05	1.94	1.37	1.93	1.49	0.55	0.19

Reading within a column with same letter are not significantly ($p<0.05$) different. WAC = Water absorption capacity, OAC = Oil absorption capacity, EC = Emulsify Capacity, FC = Foam Capacity, LGC = Least Gelation Concentration, BD = Bulk Density

3.2 Physico-chemical properties of the flours and their blends

The results for the physicochemical properties of pawpaw/wheat flour blends are shown in Table 2. The results shows that there was no significant ($p>0.05$) difference between the control sample (100% wheat) and the other sample incorporated with pawpaw flour at different level. The Ascorbic acid content increases as the percentage of pawpaw inclusion increases. The value ranged from 1.76–4.13% for the pawpaw incorporated flour and 0.16% for 100% wheat flour. The results show that there was significant difference between the samples. This increasing trend of Ascorbic acid could be linked to the high amount of vitamin C content in pawpaw fruit [27].

The titratable acidity content of the samples increases as the percentage pawpaw increases. It ranged from 2.21–3.45% for 100% wheat flour to 100% pawpaw flour. The pH value also decreases as the percentage pawpaw increases. The addition of up to 25% pawpaw flour shows no significant (p>0.05) difference from the control sample (100% wheat flour) in terms of pH. The pH value ranged from 4.50–5.60 for 100% pawpaw and 25% pawpaw flour, and 5.87 for the control sample. The rise in titratable acidity and decrease in pH indicates that the acid concentrations in the flour blends are appreciating. The sugar content shows a progressive increase with increased percentage of pawpaw flour inclusion. It ranged from 5.10% for 25% inclusion to 6.80 % for 100% inclusion while the control sample had 4.52^{o}brix. This increase is associated with the high sugar content of pawpaw fruit. The increase in pH value could be associated with the high acid content of partially ripe pawpaw fruit [27].

Table 2: Physico-chemical Properties of Pawpaw/Wheat Flour Blends

Samples	Parameter			
Wheat: Pawpaw	AA. (Mg/100g)	TA. (%)	pH	TS. (Mg/100g)
100: 0	0.16e	2.21b	5.60a	5.10c
50: 50	2.54c	3.21a	5.01b	5.50c
25 : 75	3.37b	3.31a	4.85b	6.12b
0 : 100	4.13a	3.45a	4.50b	6.80a
LSD 0.05	0.39	0.46	0.46	0.58

Readings within a column with same letter are not significantly (P<0.05) different. AA = Ascorbic Acid. TA = Titratable Acidity. TS = Total Sugar

3.3 Proximate composition of the cookies

The results for the proximate composition of pawpaw/wheat cookie are shown in Table 3. The values shows that the moisture content of the cookies ranged from 3.80 – 4.25% with 100% pawpaw flour having the least (p<0.05) amount of moisture compared to 100% wheat flour with the highest moisture content of (4.25%). The inclusion of up to 50% pawpaw flour into wheat flour in cookie preparation shows no significant difference (p>0.05) from 100% wheat flour though the percentage moisture content decreases as the percentage of pawpaw flour increases . The trend of moisture decrease could be related to the decreased protein content with increased in percentage pawpaw flour .This is because the functional property such as water absorption of food is mainly attributed to its protein [25].The proximate composition shows that the incorporation of 25% - 100% pawpaw flour into wheat flour contained significant (p<0.05) high amount of mineral ash (1.83–2.16%) compared to 100% wheat with 1.52%. Crude fiber for the pawpaw incorporated flour ranged between 2.01–3.45% compared to whole wheat with 1.56%. The protein content decreases from between (10.01 – 8.54%) as the percentage incorporation of pawpaw flour increases from 25 – 100% incorporation into wheat flour. Up to 25% incorporation of pawpaw flour into wheat flour shows no significant (p>0.05) difference of protein content from 100% wheat. Also the fat content decreases as the percentage of pawpaw flour increases from 25% pawpaw flour having 12.00% to 100% pawpaw flour with 8.20% compared to 100% wheat flour of 15.00% fat. These protein and fat percent decrease is associated with the low protein and fat content of pawpaw fruit [27]. Pawpaw based cookie (100% pawpaw) contain significantly higher (p<0.05) amount of carbohydrate (73.85%) compared to 67.15% for 100% wheat. The percentage carbohydrate increases as the percentage pawpaw flour increases showing a significant difference in carbohydrate in all the samples. The high amount of carbohydrate is associated with the high amount of carbohydrate content of pawpaw fruit.

Table 3: Proximate Composition of Cookies Samples from Wheat/pawpaw flour blends

Samples	Parameter (%)					
Wheat: pawpaw	Moisture	Ash	Fiber	Protein	Fat	Carbohydrate
100: 0	4.25a	1.52c	1.56c	10.52a	15.00a	67.15d
75 : 25	4.12a	1.83b	2.01b	10.01a	12.00a	70.03c
50 : 50	4.02a	1.94a	2.42b	9.53b	11.40b	70.69b
25 : 25	3.89b	2.11a	3.02a	9.02b	9.80c	72.16b
0 : 100	3.80b	2.16a	3.45a	8.54c	8.20d	73.85a
LSD 0.05	0.26	0.31	0.54	0.54	0.99	0.98

Values within a column with same letter are not significantly different (p<0.05)

3.4 Physical characteristics of the cookies

The results of physical characteristics are shown in Table 4. The cookie weight shows no significant (p>0.05) difference among the control sample (100% wheat flour) and cookie at 25% level of pawpaw flour incorporation. The addition of pawpaw flour decrease the weight of the cookie prepared as the percentage pawpaw increases from (5.4g for 100% pawpaw to 7.8% for 100% wheat). The decrease in height and volume of the cookie as the percentage pawpaw flour increases, shows a significant difference between the samples at various percentage of pawpaw incorporation and the control sample (100% wheat flour) in terms of volume but the 25% incorporation of pawpaw flour shows no significant difference from the control in terms of height. The height ranged from 0.5cm on average for pawpaw flour to 0.9cm for 100% wheat flour. The volume ranged from between 7ml for 100% pawpaw flour to 10ml for 100% wheat flour. Though there was slight decrease in diameter just as the percentage pawpaw flour increases, there was significant difference between the various cookies incorporated with pawpaw flour and the control sample but not from between the other samples themselves. The mean diameter for the control cookies (2.90cm) is lower than all other cookies which ranged from (3.10−3.30cm). All the pawpaw containing cookies were statistically similar with respect to diameter. It has been suggested that cookie spread (diameter and height) is affected by the competition of ingredients for available water [28]. There was no significant (p>0.05) difference in cookie density for all the samples and the control (100% wheat), generally, densities decreases as the percentage pawpaw flour increases. The density ranged from between 0.75g/cm^3 to 0.81g/cm^3.

Table 4: Mean Physical Properties of Cookies Produced from Pawpaw/Wheat Flour Blends.

Samples	Parameter				
	Weigh (g)	Height (cm)	Volume (cm^3)	Diameter (cm)	Density (g/cm^3)
Wheat: pawpaw					
100 : 0	7.80a	0.90a	10.00a	2.90a	0.80a
75 : 25	7.30a	0.80a	9.00b	3.30a	0.80a
50 : 50	6.40b	0.60b	8.00c	3.20a	0.78a
25 : 75	6.00b	0.60b	8.00c	3.10a	0.75a
0 : 100	5.40c	0.50b	7.00d	3.10a	0.77a
LSD 0.05	0.01	0.61	0.25	0.60	0.24

Mean within a column with same letter are not significantly (p<0.05) different.

3.5 Sensory properties of the cookies

The sensory scores of cookie samples are shown in Table 5. The sensory results shows that there was no significant ($p>0.05$) difference in the sensory scores for 100% wheat cookie and cookie produced from the incorporation of 25% pawpaw flour in wheat flour in all the sensory attributes. The cookie from 100% pawpaw flour was rated lowest in all sensory attributes evaluated. Cookie produced from up to the 50% incorporation of pawpaw flour (50:50) shows no significant difference ($p>0.05$) in terms of taste, flavour and general acceptability with the 100% cookie produced from wheat flour (control sample). However, sensory quality scores for colour and texture differed significantly at 50% level of pawpaw flour. All the sensory attributes showed progressive decrease in preference with increasing level of pawpaw flour in the blends. At 75% level of pawpaw flour, sensory scores decreased significantly ($p<0.05$). This suggests that sensory quality will be adversely affected at pawpaw flour substitution levels higher than 50% in cookie preparation. This is in agreement with Akpapunam and Darbe [15], who reported decrease colour and texture ratings at higher levels of maize/bambara groundnut cookies.

Table 5: Mean sensory scores for cookies from pawpaw/wheat flour blends

Sample	Parameter				
Wheat: pawpaw	Colour	Taste	Flavour	Texture	General Acceptability
100: 0	4.60a	4.10a	4.25a	4.35a	4.40a
75 : 25	4.20a	4.10a	3.90a	3.65a	3.95a
50 : 50	3.80b	3.50a	3.50a	3.35b	3.65a
25 : 75	3.10b	3.00b	3.35b	2.85b	3.05b
0 : 100	2.70c	2.95b	2.95b	2.35c	2.55b
LSD 0.05	0.75	0.95	0.83	0.83	0.91

Means followed by the same letter in column are not significantly different at ($p<0.05$). Each sensory attribute was rated on 5 – point hedonic scale (5 = like extremely, 1 = dislike extremely).

4. CONCLUSION

The study reveals that composite flour with enhanced vitamin c and functional properties could be produced from wheat/pawpaw flour blend and also consumer acceptable cookies could be produced from up to 50% inclusion of pawpaw flour in wheat flour.

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