



*Bayero Journal of Pure and Applied Sciences*, 12(1): 651 - 656  
ISSN 2006 – 6996

## EFFECT OF RIPENING AND PRETREATMENT ON THE PHYSICAL, PASTING AND SENSORY PROPERTIES OF CARDABA BANANA (*Musa ABB*) FLOUR

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### ABSTRACT

*This study investigated the effect of ripening and processing on the physical, pasting and sensory properties of Cardaba banana flour. Three stages of ripening including 1 (green mature), 3 (more green than yellow) and 4 (more yellow than green) were selected for this study. The pulps were first pretreated using blanching and sulphiting while the control was not pretreated; before being dried and milled to produce flour. The flours were thereafter analysed for colour changes, pH, total titratable acidity, pasting properties and sensory attributes. The results showed that the lightness (L) values of the flours reduced with ripening from 87.67-77.77%, while the redness (a\*) (1.57-4.06) and yellowness (b\*) (9.07-15.03) increased with ripening. Blanching however decreased the L values while sulphiting increased it. The redness (as indicated by a\*) and yellowness (indicated by b\*) of the flours were not significantly affected by pre-treatment. The pH (4.88-5.50) reduced while the total titratable acidity (0.127-0.223 g/l) increased with ripening. Blanching and sulphiting reduced the pH of the flours. Variations were observed in the pasting properties of the flours; pasting temperature (83.11-86.0 °C), peak viscosity (1388.0-3367.33 RVU), set back viscosity (290.0-1642.33 RVU), final viscosity (1763.33-3948.0 RVU) and breakdown viscosity (221.33-1608.0 RVU) all decreased with ripening. Sensory attributes of the flour revealed that the sensory qualities of the dumplings from stage 1 blanched flour were rated best amongst the other samples.*

**Keywords:** Post-harvest, cardaba, pre-treatment, flour, ripening

### INTRODUCTION

Banana fruit can be utilized at all stages of ripening, hence it is a multipurpose crop. There are several benefits that can be derived from whole banana flour processing, including economy, time and nutrient (Adeniji *et al.*, 2007). During ripening, the colour of banana usually changes from dark green to bright yellow due to the degradation of chlorophyll structure, which gradually unmasks the carotenoid pigments present in the fruit (Robinson, 1996). A change in peel colour often reflects changes in pulp colour (Wainwright and Hughes, 1989). Whole flour development from cooking bananas is usually aimed at improving the economic importance of the crops (Izonfuo and Omuoru, 1988). More recently, banana flour has been incorporated into a lot of foods due to the high content of resistant starch, dietary fibre and non-starch polysaccharides (Happi Emaga *et al.*,

2008). Some of these products include baby foods, pastries, desserts, sorbets and cream products (Ng *et al.*, 2014). The production of flour will therefore, encourage enhanced utilization of cooking banana. This research was carried out in order to determine the effect of ripening and pre-treatment on some quality attributes of Cardaba banana (*Musa ABB*) flour.

### MATERIALS AND METHODS

#### Acquisition and Ripening of Bananas

Mature green Cardaba banana fruits (Stage 1) were obtained from Ilara-mokin market in Akure, Ondo State, Nigeria. The fruits were allowed to ripen naturally at room temperature of 25±2 °C to Stage 3 (more green than yellow) and Stage 4 (more yellow than green) ripeness. Ripening was monitored using the Banana Colour chart as described by Soltani *et al.* (2010).

### **Experimental Design**

The experiment was a 3x3 factorial in a Completely Randomized Design. The factors were ripeness (green mature, more green than yellow and more yellow than green) and pre-treatments (blanched, sulphited and untreated).

### **Production of Cardaba Banana Flour**

The method of Arisa *et al.* (2013) was used to produce the flours. The banana fruits bunch were cut into individual fruits and were defingered and weighed. The fruits were washed, peeled and cut to (approximately) 2 mm thick using a stainless steel knife. Blanching was carried out on some samples by placing the sliced fruits in hot water at 100 °C for 5 min. They were drained and subsequently dried in a hot air oven at 60 °C for 24 h. The dried Cardaba banana slices were milled using an attrition mill. Sodium metabisulphite (Na<sub>2</sub>S<sub>2</sub>O<sub>2</sub>) was prepared by dissolving 1g of the salt in a litre of water. The slices were soaked in the solution for 15 min, drained and dried at 60 °C for 24 h using a hot air oven. This served as the sulphited sample. The untreated Cardaba banana flour served as the control. Slices of peeled Cardaba banana were washed and placed directly into the oven and dried at 60 °C for 24 h. It was milled using an attrition mill and sieved.

### **Determination of Physical Properties of Cardaba Banana Flour**

The pH was determined using a digital pH meter at 27 °C. pH is the standard measure of how acidic or alkaline the flour is. It is measured on a scale of 0-14. pH of 7 is neutral, < 7 is acidic and > 7 is alkaline. The total titratable acidity of the flour was determined by dissolving a known weight of sample in distilled water and then titrated against 0.1 m NaOH using phenolphthalein as indicator (Srivastava and Sajeev, 2003). It is a measure of the total acid present in a solution. The colour of the flour was measured according to the method described by Rocha and Morais (2003), with a hand held tri stimulus reflectance colour meter. The colour was recorded using a CIE-L\*a\*b\* uniform colour space (-Lab), where L\* indicates lightness, a\* indicates chromaticity on a green (-) to red (+) axis, and b\* chromaticity on a blue (-) to yellow (+) axis.

### **Determination of Pasting Properties of Cardaba Banana Flour**

Pasting properties of the flour was determined using Rapid Visco Analyser (RVA) Model 3C, Newport Scientific PTY Ltd., Sydney) as described by Delcour *et al.* (2000) and Sanni *et*

*al.*, (2004). Five grams (5 g) of the sample was accurately weighed into a weighing vessel. Twenty five milliliters (25ml) of distilled water was dispensed into a new test canister. Sample was transferred onto the water surface in the canister, after which the paddle was placed into the canister. The blade was vigorously joggled up and down through the sample ten times or more until no flour lumps remained either on the water surface or on the paddle. The paddle was placed into the canister and both inserted firmly into the paddle coupling so that the paddle is properly centred. The measurement cycle was initiated by depressing the motor tower of the instrument. The test was allowed to proceed and terminate automatically (IITA, 2001).

### **Sensory Evaluation of Cardaba Banana Dumplings**

Dumpling (cooked paste) was prepared with each of the flour by stirring the flour in boiling water at water to flour ratio of 1:4 (v/w) at 100 °C for 5 min. The products were evaluated for taste, appearance, aroma, texture, mouldability and overall acceptability by a panel of ten members using a 9-point hedonic scale. The rating of the samples ranged from 1 (Dislike extremely) to 9 (Like extremely) (Ihekoronye and Ngoddy, 1985).

## **RESULTS AND DISCUSSION**

### **Effect of ripening and pre-treatment on the physical properties of the flour**

The colour, pH and total titratable acidity of the untreated, blanched and sulphited Cardaba banana flour as affected by ripening is presented in Table 1. Colour is an important quality during ripening of bananas, it changes from green to yellow thus reflecting different extents of starch hydrolysis and sugar synthesis in the fruits (Salvador and Fiszman, 2007). There were significant differences in the L\* (lightness) values of the samples as ripening progressed, the values reduced with ripening. This could be attributed to the changes in the colour of banana usually from dark green to bright yellow due to the degradation of chlorophyll during ripening (Wainwright and Hughes, 1989). Sulphiting increased the L\* values of the flours across all stages. This could be due to the fact that sodium metabisulphite was used in the preparation of the flours which also serves as an anti-browning agent (Morris *et al.*, 2006). Blanching however reduced the lightness properties of the flours except for stage 4 flour. This could be as a result of the high temperatures involved in blanching leading to browning reaction in the pulp and hence the flour.

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The redness (as indicated by a\*) and yellowness (as indicated by b\*) values increased with ripening. The colour of banana indicates the extent of ripening. Seymour *et al.* (1987) attributed this to reduction in total carotenoid content in the peel during the early stage of ripening followed by carotenoid biosynthesis at the yellow-green to yellow-ripe stage. However,

blanching and sulphiting had significant effect on the a\* and b\* values.

The pH reduced with ripening, implying an increase in the degree of acidity. Generally, banana pulp shows increase in acidity during ripening due to the accumulation of organic acids especially malic acid (Seymour, 1993).

**Table 1: Effect of Ripening and Pre-treatment on the Physical Properties of Cardaba Banana Flour**

Sample	Colour			pH	TTA (g/l)
	L*	a*	b*		
1U	85.35±.84 <sup>c</sup>	1.72±.12 <sup>f</sup>	12.65±.03 <sup>f</sup>	5.25±.04 <sup>b</sup>	0.172 <sup>d</sup> ±.002
1B	83.47±.15 <sup>d</sup>	1.86±.01 <sup>e</sup>	16.48±.02 <sup>b</sup>	5.05±.04 <sup>e</sup>	0.127 <sup>e</sup> ±.001
1S	86.53±.04 <sup>b</sup>	1.86±.01 <sup>e</sup>	9.07±.02 <sup>i</sup>	5.50±.03 <sup>a</sup>	0.183 <sup>cd</sup> ±.005
3U	85.59±.17 <sup>c</sup>	1.57±.01 <sup>g</sup>	13.95±.02 <sup>e</sup>	5.13±.02 <sup>c</sup>	0.187 <sup>c</sup> ±.001
3B	82.81±.30 <sup>de</sup>	2.53±.01 <sup>d</sup>	11.45±.15 <sup>g</sup>	5.07±.02 <sup>ed</sup>	0.176 <sup>d</sup> ±.003
3S	87.67±.14 <sup>a</sup>	1.54±.01 <sup>g</sup>	10.93±.01 <sup>h</sup>	5.12±.01 <sup>cd</sup>	0.195 <sup>b</sup> ±.003
4U	77.77±.86 <sup>f</sup>	4.06±.04 <sup>a</sup>	17.96±.03 <sup>a</sup>	4.96±.02 <sup>f</sup>	0.221 <sup>a</sup> ±.000
4B	82.64±.07 <sup>e</sup>	2.84±.00 <sup>c</sup>	15.70±.01 <sup>c</sup>	4.88±.01 <sup>g</sup>	0.202 <sup>b</sup> ±.001
4S	82.28±.25 <sup>e</sup>	3.14±.10 <sup>b</sup>	15.03±.13 <sup>d</sup>	4.90±.01 <sup>g</sup>	0.223 <sup>a</sup> ±.002

Each value is a mean of triplicate determination. Values in the same column with same letters are not significantly different ( $p < 0.05$ ). **L\***=Lightness, **a\***=redness, **b\***=yellowness, TTA-Total Titratable Acidity; **1, 3, 4** (1-Stage 1 (green mature), 3-Stage 3 (more green than yellow), 4 (Stage 4 (more yellow than green)); **U, B, S** (Untreated (Control), Blanched, Sulphited)

Similar pH values ranging from 4.18-5.77 have been reported by Ayo-Omogie *et al.* (2010) in the effect of ripening on the pH of Cardaba banana flours. Blanching reduced the pH values of the flours across all ripening. This could be attributed to possible leaching of minerals, acids and water-soluble vitamins into the blanching water (Morris *et al.*, 2006). The sulphited samples of the stage 1 and 3 flours had higher pH values as compared to the flours from the blanched and untreated fruit.

Mean values shows that total titratable acidity increased with ripening. This confirms the earlier findings of Tapre and Jain (2012) that total titratable acidity gradually increases till fully ripe stage. Blanching and sulphiting however had a significant effect on the TTA of the flours. Blanching decreased, while sulphiting increased the TTA of the flours irrespective of the ripening stage.

### Pasting Properties of Cardaba Banana Flour as Affected by Ripening and Pre-treatment

There are certain variations that occur upon heating a starch-water system. These may include swelling, increased viscosity, translucency, solubility, and loss of anisotropy (Emire *et al.*, 2006). These variations are referred to as gelatinization. The gelatinization temperatures reduced with ripening (Table 2) in stage 1 and in stage 4 untreated flour. Higher pasting temperatures imply higher cooking times required to reach gelatinization. The peak viscosity is defined as the maximum viscosity that occurs prior to the initiation of sample cooling. The peak viscosities were affected by ripening; it reduced in stage 3 and subsequently increased in stage 4. Blanching and sulphiting increased the peak viscosities of flours from stages 1 and 3, except for stage 4 where blanching reduced the peak viscosity. This implies high water-binding potentials of the flour. Ripening had no significant effect on the peak viscosities of the flours. The viscosity achieved after cooling to 50 °C represents the setback or viscosity of a cooked paste.

**Table 2: Pasting Properties of Cardaba Banana Flour as Affected by Ripening and Pre-treatment**

Samples	1U	1B	1S	3U	3B	3S	4U	4B	4S
<b>PV (rvu)</b>	1911.66±19.35 <sup>d</sup>	2122.0±19.0 <sup>cd</sup>	3272.33±26.75 <sup>b</sup>	1553.11±13.2 <sup>f</sup>	1694.0±10.1 <sup>e</sup>	2434.0±1.14 <sup>c</sup>	1612.33±11.5 <sup>ef</sup>	1388.0±38.0 <sup>g</sup>	3367.33±19.24 <sup>a</sup>
<b>BDV(rvu)</b>	555.33±86.50 <sup>e</sup>	221.33±13.50 <sup>g</sup>	967.0±37.0 <sup>c</sup>	556.13±11.12 <sup>e</sup>	798.0±8.22 <sup>d</sup>	1608.0±11.13 <sup>a</sup>	501.0±52.0 <sup>f</sup>	222.0±4.0 <sup>g</sup>	1333.33±93.5 <sup>b</sup>
<b>FV (rvu)</b>	2269.0±25.10 <sup>c</sup>	3014.0±10.0 <sup>b</sup>	3948.0±39.40 <sup>a</sup>	2231.21±14.19 <sup>c</sup>	1985.0±2.96 <sup>d</sup>	2132.1±16.18 <sup>c</sup>	1763.33±7.5 <sup>d</sup>	1973.33±69.50 <sup>d</sup>	3026.33±15.95 <sup>b</sup>
<b>SV(rvu)</b>	913.0±14.40 <sup>d</sup>	1113.66±4.50 <sup>b</sup>	1642.33±16.35 <sup>a</sup>	748.26±18.11 <sup>ef</sup>	290.0±2.11 <sup>h</sup>	498.12±12.12 <sup>g</sup>	652.0±56.0 <sup>f</sup>	807.33±35.50 <sup>e</sup>	985.0±61.0 <sup>c</sup>
<b>PT(°C)</b>	84.42±.42 <sup>c</sup>	83.92±.77 <sup>d</sup>	84.82±.02 <sup>c</sup>	83.11±.08 <sup>d</sup>	85.35±.06 <sup>b</sup>	83.25±.02 <sup>d</sup>	83.55±1.25 <sup>d</sup>	86.0±.40 <sup>a</sup>	83.15±.05 <sup>d</sup>

Each value is a mean of triplicate determination. Values in the same column with same letters are not significantly different ( $p < 0.05$ ) PV-Peak viscosity, BDV-Breakdown Viscosity, FV-Final Viscosity, SV-Setback Viscosity, PT-Pasting Temperature (°C), rvu- Rapid Visco Units; **1, 3, 4** (Stage 1 (green mature), Stage 3 (more green than yellow), Stage 4 (more yellow than green); **U, B, S** (Untreated (control), Blanched, Sulphited)

It is a stage where retrogradation or reordering of starch molecules occurs (Ihekoronye and Ngoddy, 1985). Ripening reduced the setback values of the flours.

The setback value in the untreated flour were significantly different ( $P < 0.05$ ) from the sulphited and blanched samples. Shittu *et al.* (2001) reported that higher setback values are similar to reduced digestibility. The final viscosities of the flours were significantly high. Ripening significantly affected the final viscosities. It reduced the final viscosities of the flours, Blanching and sulphiting however, increased the final viscosities significantly. Breakdown viscosity (BDV) is the measure of the tendency of swollen starch granules to rupture when held at high temperatures and continuous shearing (Patindol *et al.*, 2005); this indicates stability of the starch during heating. Sulphiting increased the breakdown viscosities while blanching decreased it. This implies that the sulphited Cardaba banana could be useful in bakery products where high temperatures are required.

**Sensory characteristics of Cardaba banana dumplings as affected by ripening and pre-treatment**

Table 3 shows the results of the sensory characteristics of the dumplings produced from Cardaba banana flour. They were evaluated for taste, colour, aroma, mouldability, appearance and overall acceptability. There were significant differences in the appearance of the dumplings. The panelists preferred the colour of the dumplings from the stage 1 blanched flour (8.8). The preference of the panelists may be attributed to the possible benefits of blanching in enhancing the colour of foods. The flours from stages 1 and 3 moulded better than that from stage 4 especially in the blanched samples. The starch content of stages 1 and 3 flours are higher than that of stage 4 and as such have high gelation property that could contribute to the mouldability of the dumplings. Panelists disliked the taste and moulding attributes of the dumplings from stage 4. This reduced tendency to mould may be due to the presence of sugars in the ripened flour as sugar inhibits the water absorption capacity of these flours. The sensory qualities of the dumplings from stage 1 blanched flour were rated best amongst the other samples.

**Table 3: Sensory Properties of Cardaba Banana Dumplings**

Sample	Appearance	Mouldability	Aroma	Taste	Overall Acceptability
1U	6.9±0.09 <sup>bc</sup>	7.1±1.5 <sup>b</sup>	6.6±0.5 <sup>c</sup>	7.1±1.2 <sup>b</sup>	7.1±0.9 <sup>b</sup>
1B	8.8±1.2 <sup>a</sup>	8.0±1.4 <sup>a</sup>	8.2±1.5 <sup>a</sup>	8.9±0.7 <sup>a</sup>	8.8±1.1 <sup>a</sup>
1S	7.2±1.2 <sup>b</sup>	7.2±0.9 <sup>b</sup>	7.2±1.5 <sup>b</sup>	7.0±0.9 <sup>b</sup>	7.6±0.7 <sup>b</sup>
3U	5.7±1.5 <sup>d</sup>	6.2±1.1 <sup>c</sup>	6.3±1.3 <sup>c</sup>	6.4±1.8 <sup>c</sup>	6.5±1.5 <sup>c</sup>
3B	6.6±2.9 <sup>c</sup>	7.3±1.6 <sup>b</sup>	7.6±1.2 <sup>b</sup>	6.4±2.2 <sup>c</sup>	7.3±2.4 <sup>b</sup>
3S	5.7±2.7 <sup>d</sup>	4.9±2.3 <sup>d</sup>	5.1±2.2 <sup>d</sup>	5.8±1.9 <sup>d</sup>	5.4±2.4 <sup>d</sup>
4U	6.5±1.5 <sup>c</sup>	4.5±0.9 <sup>d</sup>	7.5±1.6 <sup>b</sup>	4.2±1.7 <sup>e</sup>	4.0±1.9 <sup>e</sup>
4B	4.3±1.1 <sup>e</sup>	4.6±1.9 <sup>d</sup>	6.3±1.2 <sup>c</sup>	4.3±1.4 <sup>e</sup>	5.0±1.3 <sup>d</sup>
4S	5.8±1.3 <sup>d</sup>	4.4±1.3 <sup>d</sup>	5.5±1.4 <sup>d</sup>	5.6±1.8 <sup>d</sup>	6.3±1.2 <sup>c</sup>

Each value is a mean of triplicate determination. Values in the same column with same letters are not significantly different ( $p < 0.05$ ). **1, 3, 4** (1-Stage 1 (green mature), 3-Stage 3 (more green than yellow), 4 (Stage 4 (more yellow than green)); **U, B, S** (Untreated (Control), Blanched, Sulphited)

### CONCLUSION

Cardaba banana flour can be produced from the fruit at different ripening stages and pretreatment methods. The treatments however, had significant effects on the quality of the flour. Ripening could be attributed to color, pH and acidity changes. The pasting and sensory properties of flour is

significantly affected by both the ripening and pretreatment methods. However, the physical, pasting and sensory properties of the flours obtained clearly showed that Cardaba banana flour could be useful in preparation of different kinds of food.

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