Full Length Research Paper

Effect of processing on the quality of flour, abacha slices and its flour derived from cassava (*Manihot esculenta* Crantz) TMS 97/4779

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This study was undertaken to evaluate the effect of processing methods on the quality of abacha slices. Abacha slices were produced from cassava (TMS 97/4779) roots by four different methods. The abacha processing methods investigated were of different peeling, boiling, slicing and soaking methods. Also, raw cassava flour, which was peeled, sliced and dried (PSD) was produced. The sensory properties and yield of abacha, the chemical and physical properties of the flour from the dried abacha and raw cassava flour were determined. The sensory properties of the fresh abacha were evaluated which showed that boiled, peeled and sliced sample (BPS) was most preferred. The yield of the abacha ranged from 29.17-39.13%. Significant differences (p<0.05) were observed in the proximate composition of the samples. The processing methods significantly affected the swelling index and water absorption capacity of the abacha flour. PSD sample showed the highest value in swelling index and water absorption capacity. The cyanide content, which ranged from 4.20-7.20 mg/kg, was below the recommended safety level of 10 mg/kg HCN. The processing methods significantly (p<0.05) affected the pasting properties of the abacha flour except peak viscosity and peak time.

Key words: Cassava, peeling, boiling, slicing, soaking, hydrogen cyanide.

INTRODUCTION

Abacha is a snacks or main meal in the eastern states of Nigeria. It is a shredded or sliced dry or wet product, obtained by shredding or slicing boiled cassava roots, soaking the shreds for 8-24 h in cold water and washing to remove the scum that causes sliminess. It may then be dried. Preliminary work carried out on the effect of variety on consumer acceptability of abacha slices, showed that slices made from TMS 97/4779 were most preferred. And also, ascertained that texture is the main attribute in determining the acceptability of sliced abacha. The most common method (traditional) employed in the processing of abacha is peeling, size reducing into chunks, boiling, slicing and soaking. However, alternative methods include boiling the root before peeling, boiling of the peeled root before slicing and different peeling method. There is need to understand the effect of the different

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processing methods on the quality of abacha product. The effects of these alternative processing methods on the chemical, physical (functional and rheological) and sensory properties of the product is the focus of this investigation.

MATERIALS AND METHODS

Source of sample

Roots of bitter cassava variety (Manihot esculenta Crantz), 97/4779, were harvested 14 months after planting, from a farm at the Ebonyi State Agricultural Development Programme, Abakaliki.

Preparation of abacha slices samples

Four kilograms each of the cassava roots was used to produce abacha slices, using different sequence of treatments as follows:

**Traditional method: Peeled, sliced and boiled abacha slices (PSB)**

Four kilograms (4 kg) of the root was washed with cold tap water and manually peeled with stainless steel knives. The peeled root was thinly sliced (0.5 mm thick), boiled (PSB) in 3 L tap water for 45 min using stainless cooking pot, cooled and washed once to reduce the scum which causes sliminess before steeping in 5 L cold tap water at room temperature (28±2°C) for 16 h. The steep water was changed at 4 h intervals for 16 h before final washing.

**Alternative method 1: Peeled, boiled, sliced and soaked abacha (PBS)**

Another 4.0 kg of the roots was peeled manually, washed with cold tap water, boiled in 3 L tap water for 45 min, cooled and sliced (0.5 mm). The sliced sample (PBS) was steeped in 5 L tap water for 16 h and washed as in PSB.

**Alternative method 2: Peeled, boiled, sliced and soaked abacha (CBS)**

Four kilograms of the root was washed and the papery brown peel (cork) removed. It was boiled in 3 L tap water for 45 min, cooled, sliced (CBS), steeped in 5 L cold tap water for 16 h and washed as above.

**Alternative method 3: Boiled, peeled and sliced abacha slices BPS**

Another portion (4.0 kg) of the cassava roots was washed and boiled without peeling in 3 L tap water for 45 min, cooled and peeled with a stainless steel knife. It was then sliced (BPS) steeped in 5 L tap water for 45 min and washed in tap water as in PSB above.

**Peeled, sliced and dried chips PSD**

The roots were peeled, washed, sliced and sun dried (35-40°C). All the abacha samples were sun dried for 72 h to get dried abacha slices which was packaged in a polyethylene bag and put in an air tight plastic container for analysis.

Analyses

**Yield of abacha**

This was determined by using the expression.

\[
\text{Yield} (\%) = \frac{\text{Weight of abacha after washing}}{\text{Weight of cassava used}} \times 100
\]

Where, weight after washing was determined after draining.

**Determination of chemical properties of wet or dried abacha**

The moisture, ash and crude fibre, contents were determined by standard methods of the AOAC (1990). Fat content was determined by the continuous solvent extraction method using the soxhlet apparatus. Crude protein was determined by the Kjeldahl method (Kirk and Sawyer, 1998) in which the N content was determined and multiplied by the factor, 6.25. Carbohydrate content was calculated by difference.

The energy content of the samples was determined from the result of the proximate analysis by multiplying with the relevant factors: 17, 17 and 37 which are the conversion factor for carbohydrate, protein and fat, respectively.

The hydrogen cyanide (HCN) content was determined by the alkaline picrate method of Bradbury et al. (1999), where pH was determined by the method of Matil (1971). The method of Kirk and Sawyer (1998) was used to determine the titratable acidity.

**Determination of physical properties**

The method described by Okaka et al. (1997) was used to determine bulk density. Swelling capacity was determined following the procedure of Ukpabi and Ndimele (1990), while the water absorption capacity was determined using the method of Lin et al. (1994). A rapid visco analyzer (RVA) (Model RVA 3d+ Network Scientific, Australia) was used to determine the pasting characteristics according to the procedure adopted by Omodamiro et al. (2007).

**Statistical design and analysis**

All data obtained were subjected to analysis of variance (ANOVA) using completely randomized design (CRD). Means were separated using Fisher’s least significant design (FLSD) at p<0.05 (Steel and Torrie, 1980).

**RESULTS AND DISCUSSIONS**

**Sensory properties**

The sensory properties of abacha samples (Table 1) showed that consumers preferred the boiled, peeled and sliced (BPS) followed by peeled, sliced and boiled (PSB)
Table 1. The sensory properties of the *abacha* samples.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Appearance</th>
<th>Texture</th>
<th>Taste</th>
<th>General acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBS</td>
<td>2.90(^{b})</td>
<td>4.80(^{c})</td>
<td>4.15(^{b})</td>
<td>3.80(^{c})</td>
</tr>
<tr>
<td>PBS</td>
<td>7.00(^{a})</td>
<td>6.10(^{b})</td>
<td>6.70(^{c})</td>
<td>7.00(^{b})</td>
</tr>
<tr>
<td>PSB</td>
<td>7.05(^{a})</td>
<td>6.60(^{a})</td>
<td>7.35(^{a})</td>
<td>7.05(^{b})</td>
</tr>
<tr>
<td>BPS</td>
<td>7.55(^{a})</td>
<td>7.15(^{a})</td>
<td>7.43(^{a})</td>
<td>7.85(^{a})</td>
</tr>
<tr>
<td>LSD</td>
<td>0.718</td>
<td>0.746</td>
<td>0.612</td>
<td>0.796</td>
</tr>
</tbody>
</table>

Values in the same column with different superscript are significantly (p<0.05) different. PSB = Peeled, sliced and boiled; PBS = peeled, boiled and sliced sample; CBS = only papery brown layer peeled, boiled and sliced sample; BPS = boiled, peeled and sliced sample.

The appearance, texture and the taste of the *abacha* influenced the general acceptability of the *abacha*. This is so because BPS that had the highest score for appearance (7.55), texture (7.15) and taste (7.43) scored the highest for general acceptability, while CBS that had the least score for appearance (2.90), texture (4.80) and taste (4.15), scored least.

**Yield**

The yield of the *abacha* samples ranged from 29.17 to 39.13\% (Figure 1). Boiled, peeled and sliced (BPS) sample had the highest yield of 39.13\%, while the peeled, sliced and boiled (PSB) sample had the least value (29.17\%). This is probably due to high loss of materials during peeling and slicing in addition to losses sustained from disintegration of *abacha* slices during boiling. The BPS sample had the highest yield of *abacha* slices because during boiling, the cementing material between the peel and the edible fleshy portion breaks down,
Table 2. Effect of processing on the proximate composition of the abacha slices.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture (g/100 g)</th>
<th>Fibre (g/100 g)</th>
<th>Ash (g/100 g)</th>
<th>Protein (g/100 g)</th>
<th>Fat (g/100 g)</th>
<th>Carbohydrate (g/100 g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB</td>
<td>8.82</td>
<td>2.68</td>
<td>2.35</td>
<td>2.53</td>
<td>1.55</td>
<td>81.03</td>
</tr>
<tr>
<td>PBS</td>
<td>9.23</td>
<td>2.86</td>
<td>2.28</td>
<td>2.48</td>
<td>1.48</td>
<td>81.68</td>
</tr>
<tr>
<td>CBS</td>
<td>9.62</td>
<td>2.64</td>
<td>2.33</td>
<td>1.59</td>
<td>1.33</td>
<td>82.48</td>
</tr>
<tr>
<td>BPS</td>
<td>9.43</td>
<td>2.56</td>
<td>2.38</td>
<td>2.33</td>
<td>1.71</td>
<td>81.60</td>
</tr>
<tr>
<td>PSD</td>
<td>9.23</td>
<td>2.56</td>
<td>2.38</td>
<td>2.33</td>
<td>1.71</td>
<td>81.60</td>
</tr>
<tr>
<td>LSD</td>
<td>0.075</td>
<td>0.0158</td>
<td>0.322</td>
<td>0.051</td>
<td>0.0775</td>
<td>0.016</td>
</tr>
</tbody>
</table>

Data are means of 3 replications. Values in the same column with different superscripts are significantly different (p<0.05). PSB = Peeled, sliced and boiled; PBS = peeled, boiled and sliced ‘abacha’; CBS = only papery brown layer peeled, boiled and sliced ‘abacha’; BPS = boiled, peeled and sliced ‘abacha’; PSD = peeled, sliced and dried ‘abacha’.

Proximate composition

The proximate composition of the abacha samples are presented in Table 2. The moisture content of the dried abacha slices ranged from 8.82 to 9.86 g/100 g. The moisture content of the abacha processed from alternative methods was significantly lower than the moisture content of abacha processed from traditional method. The lower moisture content is advantageous as it will help in the storing of the abacha flour. PBS sample had the least value (8.82 g/100 g). Okechukwu and Okoye (2010) reported a similar moisture range (7.72-10.83 g/100 g) for abacha samples. With this range of moisture content, the abacha slices will be stored well provided it is kept in an airtight container. There was significant (p<0.05) differences between the moisture content of samples, which may be attributed to differences in processing methods such as peeling, slicing and boiling, peeling, peeling and slicing etc, applied.

The protein (Nx6.25) content ranged between 1.29 and 2.53 g/100 g. The protein content of PSB (traditional method) was higher than the protein content of abacha processed using the alternative methods. The low protein range is similar to the low range usually quoted in literature (Oke, 1968; Oyenuga, 1968) for cassava. Statistical results showed significant differences (p<0.05) in the protein content of some of the samples.

The ash content of the samples ranged from 1.33 to 1.77g/100 g. PSD had the highest value of 1.77 g/100 g, indicating that boiling and soaking reduces the fat content of cassava. The lower fat content would enhance the keeping quality of the abacha since oxidative rancidity would be reduced. The fat content of the samples obtained in this study is higher than the 1.15% for cassava products (Oluwolọ et al., 2004). The differences could probably be attributed to the processing method employed during sample preparation or to differences in the variety of the cassava used. There were significant differences (p<0.05) in the fat content of the samples except for PSD and peeled, boiled and sliced (PBS) samples, which had similar values.

The crude fibre content ranged from 2.56 to 2.86 g/100. CBS that had only the brown papery peel removed had the highest crude fibre content of 2.86 g/100 g. This could imply that the cortex (corky layer which was not removed) has higher fibre content than the inner tissue. PSD sample had the least (2.56 g/100 g). The crude fibre of the abacha (2.56-2.86 g/100 g) was within the range of 2.0 to 5.0 g/100 g as reported by the NIS (1998) for cassava products. It is significantly lower than the value of fibre in raw cassava flour (3.52 g/100 g) and may be attributed to the different processing method, age and varietal differences (Njoku and Banigo, 2006). With the high fibre content, consumers of abacha processed in these forms may not suffer from gastro and circulatory disease epidemiologically linked to low dietary fibre intake (Okaka et al., 2002). The samples differed significantly (p<0.05) in their fibre content.

The ash content ranged from 2.28 to 2.47 g/100 g. The PBS sample had the highest of 2.47 g/100 g, indicating that leaching of organic matter during boiling of the root probably occurred to a greater extent than the mineral content, leading to higher concentration of minerals in the sample. This was followed by PSD sample (2.35 g/100 g), while sample CBS had the lowest ash content (2.24 g/100 g). The ash content of samples differed significantly (p<0.05) from each other and may be due to...
Table 3. The TTA and pH of abacha slices from 97/4779.

<table>
<thead>
<tr>
<th>Sample</th>
<th>TTA (%)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBS</td>
<td>0.22ab</td>
<td>6.78a</td>
</tr>
<tr>
<td>PBS</td>
<td>0.18b</td>
<td>6.38c</td>
</tr>
<tr>
<td>PSB</td>
<td>0.21ab</td>
<td>6.55b</td>
</tr>
<tr>
<td>BPS</td>
<td>0.26b</td>
<td>6.25d</td>
</tr>
<tr>
<td>PSD</td>
<td>0.20a</td>
<td>6.74a</td>
</tr>
<tr>
<td>LSD</td>
<td>0.051</td>
<td>0.051</td>
</tr>
</tbody>
</table>

ND = Not determined. Data are means of 3 replications. Values in the same column with different superscripts are significantly different (p<0.05). PSB = Peeled, sliced and boiled; PBS = peeled, boiled and sliced sample; CBS = only papery brown layer peeled, boiled and sliced sample; BPS = boiled, peeled and sliced sample; PSD = peeled, sliced and dried sample.

Table 4. The hydrogen cyanide content of the samples.

<table>
<thead>
<tr>
<th>Samples</th>
<th>Fresh cassava (mg/kg)</th>
<th>Wet samples (mg/kg)</th>
<th>Reduction (%)</th>
<th>Dried samples (mg/kg)</th>
<th>Total reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBS</td>
<td>6.78</td>
<td>84.04</td>
<td>4.60</td>
<td>89.18</td>
<td>42.50</td>
</tr>
<tr>
<td>PBS</td>
<td>6.17</td>
<td>85.48</td>
<td>4.50</td>
<td>89.41</td>
<td>42.50</td>
</tr>
<tr>
<td>PSB</td>
<td>42.50</td>
<td>6.72</td>
<td>84.19</td>
<td>4.50</td>
<td>89.41</td>
</tr>
<tr>
<td>BPS</td>
<td>42.50</td>
<td>6.25</td>
<td>85.29</td>
<td>4.20</td>
<td>90.11</td>
</tr>
<tr>
<td>PSD</td>
<td>42.50</td>
<td>ND</td>
<td>7.20</td>
<td>83.06</td>
<td></td>
</tr>
</tbody>
</table>

0.135 0.0256

ND = Not determined. Data are means of 3 replications. PSB = Peeled, sliced and boiled; PBS = Peeled, boiled and sliced sample; PPBS (CBS)= only papery brown layer peeled, boiled and sliced sample; BPS = boiled, peeled and sliced sample; PSD = peeled, sliced and dried sample.

differences in the processing methods employed.

The carbohydrate content of the samples ranged from 81.03 to 82.98 g/100 g. The carbohydrate content of the abacha from the alternative methods (PBS- 82.98 g/100 g, CBS - 81.69 g/100 g and BPS- 82.48 g/100 g) was higher than the carbohydrate content of abacha processed from traditional method (81.03 g/100g). The range of 81.03-82.98 g/100 g is slightly lower than the value of 84.22-86.99 g/100 g obtained for pre-gelled and raw cassava flour (Njoku and Banigo, 2006). The values were significantly different (p<0.05) from each other and may be attributed to differences in the processing methods.

pH, total titratable acidity (TTA) and hydrogen cyanide (HCN) content

The pH and TTA content of the abacha samples are presented in Table 3. The TTA of the samples ranged between 0.18 and 0.26%. The sample from boiled, peeled and sliced cassava had the highest value of 0.26%, while that from peeled, boiled and sliced cassava had the least (0.18%). There were significant differences (p<0.05) in the total titratable acidity of samples BPS, PSD and PBS, while BPS did not differ from PSB and CBS. High TTA is expected to lower the pH of a cassava product due to increase in acidity.

The pH of the abacha samples ranged from 6.25 to 6.78. The high pH may be due to the fact that the samples were not fermented. The sample from CBS had the highest pH, while the sample from BPS cassava root had the least pH of 6.25. The pH of the abacha samples differed significantly (p<0.05) from each other except samples from CBS and PSD, which were statistically the same.

The hydrogen cyanide content of the samples are presented in Table 4. The hydrogen cyanide content of
Table 5. Functional properties.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Energy (J)</th>
<th>Swelling index</th>
<th>Water absorption capacity (%)</th>
<th>Starch (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSB</td>
<td>753.93</td>
<td>8.12</td>
<td>76.33</td>
<td>70.46</td>
</tr>
<tr>
<td>PBS</td>
<td>767.09</td>
<td>7.48</td>
<td>73.55</td>
<td>69.25</td>
</tr>
<tr>
<td>CBS</td>
<td>759.35</td>
<td>8.45</td>
<td>74.17</td>
<td>69.15</td>
</tr>
<tr>
<td>BPS</td>
<td>762.41</td>
<td>7.24</td>
<td>68.50</td>
<td>69.05</td>
</tr>
<tr>
<td>PSD</td>
<td>758.98</td>
<td>9.05</td>
<td>95.44</td>
<td>69.84</td>
</tr>
<tr>
<td>LSD</td>
<td>0.544</td>
<td>0.051</td>
<td>0.0485</td>
<td>0.051</td>
</tr>
</tbody>
</table>

ND = Not determined. Data are means of 3 replications. Values in the same column with different superscripts are significantly different (p<0.05). PSB = Peeled, sliced and boiled; PBS = Peeled, boiled and sliced sample; CBS = only papery brown layer peeled, boiled and sliced sample; BPS = boiled, peeled and sliced sample; PSD = peeled, sliced and dried sample.

The range (4.20-7.20 mg/kg) of HCN for both the fresh and dry samples of the product (Table 4) were below the recommended safety level of 10 mg/kg HCN reported by World Health Organization (Adindu et al., 2003). Therefore the methods of processing of abacha used in this study adequately detoxified the cassava.

Functional properties

The functional properties of flour derived from sliced abacha samples are presented in Table 5. The peeled sliced and dried samples had the highest swelling index and water absorption capacity of 9.05 and 95.44%, respectively, while the abacha from boiled, peeled and sliced cassava had the least values of 7.24 and 68.50%, respectively. The high water binding capacity of the PSD samples may be attributed to a high proportion of undegraded starch granules (Soni et al., 1985; IITA, 2003) or to a lack of association of the starch polymers in the native granules. Increase in water absorption capacity in food systems enables bakers to manipulate the functional properties of dough in baked products (Omodamiro et al., 2007). This implies that PDS sample can confer good functionality when used as composite flour in confectionery products. Processing significantly (p<0.05) affected the swelling indices and the water absorption capacities of the samples.

Starch in the peeled, sliced and dried (PSD) samples ranged from 6.17 to 6.87 mg HCN/kg, while the dry samples ranged between 4.20 and 7.2 mg HCN/kg. The wet samples had a higher HCN than the dried samples. The lower HCN value of dry abacha slices was due to the volatile nature of the compound, which was easily lost during drying. For the dried samples, the peeled, sliced and dried sample had the highest HCN content (7.20 mg/kg) with the least percentage reduction of HCN, 83.06%. This is because only drying was employed during processing which is one of the least effective method in detoxification of cassava. Statistically significant differences (p<0.05) were observed in the HCN content of the fresh sliced abacha samples. For the abacha samples, CBS had the least percentage reduction of HCN for both wet and dry abacha slices. This could be because of the cortex that was not removed, which contains higher proportions of HCN (Ihekoronye and Ngoddy, 1985).

The pasting properties of the flour derived from samples are presented in Table 6. Peak viscosity of the abacha samples ranged from 100.83 to 109.00 RVU (rapid visco-analyser unit). The peeled, sliced and dried (PSD) sample had the highest peak viscosity (181.00 RVU) at a temperature of 64°C in 8.99 min. The peak viscosity of the abacha samples was significantly lower than the PSD sample, with the peeled, boiled and sliced (PBS) sample having the least peak viscosity (100.00 RVU) at 63.90°C in 9 min. The higher peak viscosity of PSD indicates that
boiling and soaking reduced the peak viscosity of cassava flour and also shows that PSD should have the best starch content (Osungbaro, 1990). The relatively high peak viscosity exhibited by flours from PSD samples is an indication that the flour may be suitable for products requiring high gel strength and elasticity. The peak viscosity of PSD was significantly (p<0.05) different from the peak viscosity of all the abacha samples, which did not differ (p>0.05) from each other.

The setback viscosity of the PBS sample was the highest (107.00 RVU), while PSD had the lowest value of 53.43 RVU. The high setback viscosity of PBS indicates higher potential for retrogradation in food products (Olapade et al., 2004; Otegbayo et al., 2006) as it is a measure of gel stability. The setback viscosity of samples differed significantly (p<0.05) from each other.

The pasting temperature of the abacha flour samples ranged from 63.90 to 64.80°C. Flour from PBS had the highest value of 64.80°C, while that from PBS had the lowest (63.90°C) indicating low heat stability. Increase in viscosity would therefore be detected first in PBS. Pasting temperatures obtained in this study (for abacha flour) is similar to the value reported by Sanni et al. (2005) for gari, but Omodamiro et al. (2007) reported slightly higher pasting temperatures (69-80°C) for fufu and starch processed from different cassava genotypes. Differences in the reported values may be due to the processing methods used, varietal differences and the nature of the starch involved. A higher pasting temperature implies higher water binding capacity, higher gelatinization time and lower swelling property of starch due to a high degree of association between starch granules (Numfor et al., 1996). Flour from abacha of BPS would therefore have lower swelling properties as observed (Table 4). There were significant differences (p<0.05) in pasting temperature of the samples.

The trough (holding strength) ranged from 54.58 to 93.73 RVU. The peeled, sliced and dried (PSD) sample had the highest value (93.73 RVU) indicating that the granules would be less prone to rupture during pasting and its cooked paste would be more stable than the paste of other samples (Adebowale et al., 2008). The peeled, boiled and sliced (PBS) sample had the lowest value (54.58 RVU). There were significant differences (p<0.05) in the holding strength of the samples.

Breakdown viscosity ranged from 22.44 to 87.72 RVU. The lowest breakdown viscosity of PSB implies that it probably had very weak cross-linking within the granules (Oduro et al., 2005), which may result from much rupture of the starch granules. The abacha processing method significantly (p<0.05) affected the value of breakdown viscosity of the samples.

The peak time of samples ranged from 4.17 to 9.01 min. The PSD sample had the lowest value (4.17 min), while the flour from CBS had the highest (9.01). This shows that the peeled, sliced and dried (PSD) sample attained peak viscosity in the shortest time and will gel faster than others. This implies that less energy would be used during its thermal processing. Processing methods did not significantly (p>0.05) affect the peak time of the abacha samples but PSD sample significantly (p>0.05) differed from the abacha samples.

Conclusions

From the result in this study, the following conclusions are made. Boiling, peeling before slicing cassava roots (BPS) produced abacha with highest (39.13%) yield. The high fibre content of the samples (2.56-2.86 g/100 g) would make consumers of abacha processed following the methods adopted in this study not to suffer gastro and circulatory disease epidemiologically linked to low fibre

### Table 6. Effect of processing on the pasting properties of flour derived from abacha slices from 97/4779.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Peak viscosity (RVU)</th>
<th>Trough viscosity (RVU)</th>
<th>Breakdown viscosity (RVU)</th>
<th>Setback viscosity (RVU)</th>
<th>Final viscosity (RVU)</th>
<th>Pasting time (min)</th>
<th>Pasting temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBS</td>
<td>117.92a</td>
<td>81.02c</td>
<td>36.90e</td>
<td>94.44c</td>
<td>175.40c</td>
<td>9.01a</td>
<td>64.20c</td>
</tr>
<tr>
<td>PBS</td>
<td>100.83a</td>
<td>54.58b</td>
<td>46.25b</td>
<td>107.00b</td>
<td>161.58b</td>
<td>9.00a</td>
<td>63.90b</td>
</tr>
<tr>
<td>PSB</td>
<td>110.52a</td>
<td>87.08a</td>
<td>22.44a</td>
<td>81.50a</td>
<td>168.52a</td>
<td>8.99a</td>
<td>64.00a</td>
</tr>
<tr>
<td>BPS</td>
<td>109.33a</td>
<td>74.92d</td>
<td>34.41d</td>
<td>96.56d</td>
<td>171.00d</td>
<td>8.98a</td>
<td>64.80d</td>
</tr>
<tr>
<td>PSD</td>
<td>181.00b</td>
<td>93.73g</td>
<td>87.27g</td>
<td>53.43g</td>
<td>152.13g</td>
<td>4.17b</td>
<td>64.01g</td>
</tr>
<tr>
<td>LSD</td>
<td>26.763</td>
<td>0.05</td>
<td>0.055</td>
<td>0.05</td>
<td>0.0613</td>
<td>0.055</td>
<td>0.0613</td>
</tr>
</tbody>
</table>

RVU = Rapid visco analyser Units. Values are means of 3 replications. Values in the same column with different superscripts are significantly different (p<0.05). PSB = Peeled, sliced and boiled; PBS = Peeled, boiled and sliced sample; CBS = only papery brown layer peeled, boiled and sliced sample; BPS = boiled, peeled and sliced sample; PSD = peeled, sliced and dried sample.
intake. HCN (6.17-7.20 mg HCN/kg) of the samples were within the safe range for human consumption. The PSD sample, which had high peak viscosity would be suitable for products that require high gel strength and elasticity. Flour made from *abacha* processed from peeled, boiled and sliced cassava roots would be stable in foods, while higher retrogradation would be experienced when flour from PBS is used in food manufacture.

Consumers preferred *abacha* slices that were boiled, peeled and sliced in all sensory attributes, while they did not like the one made by peeling only the brown papery peel of cassava root. Therefore, *abacha* slices from TMS 97/4779 should be processed by boiling, peeling and slicing before soaking and washing.

### Conflict of Interests

The authors did not declare any conflict of interests.

### REFERENCES


