FUNCTIONAL AND RHEOLOGICAL PROPERTIES OF CASSAVA FLOUR PROCESSED BY ADAPTATION OF TRADITIONAL ‘ABACHA’ PROCESSING TECHNOLOGY.

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Abstract

Cassava flour was processed from dried ‘abacha’ slices made from fresh cassava root and dried cassava chips of four cassava varieties, 98/2101 NR87184, 97/4779 and 91/02324. The effect of the processing method and variety on the functional properties, pasting properties and sensory attributes of the ‘abacha’ flour were evaluated. The functional properties of ‘abacha’ flour showed bulk density range of 0.505-0.571 g/ml, water absorption capacity of 3.35-5.80 ml/g, the pasting properties of the flour showed peak viscosity range from 157.35 to 399.58RVU, trough 90.08-206.50 RVU, breakdown viscosity 67.23-193.09 RVU, final viscosity 123.58-300.41 RVU, setback 33.40-93.93 RVU, peak time 4.03-4.80 mins and pasting temperature of 51.60-79.20 °C. The sensory properties of the fufu prepared from the cassava flour showed that processing method and variety significantly (p<0.05) affected some of the sensory attributes.

Key words: cassava flour, dried ‘abacha’, pasting properties, water absorption, swelling capacity.

Introduction

Cassava (Manihot esculenta Cranz), variously called ‘manioc’, ‘tapioca’, ‘mandioca’, or ‘yucca’ is a perennial woody shrub of the family of Euphorbiaceae [1]. It is widely cultivated in the tropics and sub tropics for its edible starchy roots, which is a major source of carbohydrate [2]. Cassava provides about 40 % of all the calories consumed in Africa and ranks second only to cereal grain as chief source of energy in Nigeria diet [3]. There has been an increase in cassava production over the years. Its increase in Africa from 35.0 million tonnes to 40 million tonnes in 2002 was ascribed to Nigeria, which has increased its share from...
Nigeria is the current largest producer of cassava in the whole world producing 22% of the world’s 165.3 million tonnes per annum. This calls for increase in the utilization of cassava. One of the ways this can be achieved is by diversifying products obtained from cassava and also preventing the losses of both the produce and its products. Cassava roots are highly perishable and bulky, hence processing into more shelf stable and easy to transport food like dried ‘abacha’ minimizes such problems. Drying cassava into chips and later processing them into other products will also reduce post harvest losses. Chips have been successfully converted into gari.

Some cassava based foods such as wet ‘abacha’ and ‘akpu’ are not shelf stable. Wet ‘abacha’ slices are mostly consumed in the southern part of Nigeria were it is commonly called ‘abacha’ mmiri, mpataka, jigbo etc. It is prepared by peeling of cassava roots, washing, boiling, slicing, soaking, and washing to obtain the wet ‘abacha’ slices. It is eaten with coconut, palm kernel or groundnut. They are commonly hawked along the street and sold in the market. The spoilage of this product is high due to its moisture content. The spoilage is characterized by development of a sour taste, sliminess, discoloration, and the loss of structural integrity of the product. ‘Abacha’ can be dried and converted into other uses when needed.

Work has been done on the pasting properties of precooked and steeped cassava flour. They did not however consider the varietal and processing effect on the functional and pasting characteristics of cassava flour derived from dried ‘abacha’. The objective of this work therefore is to compare the functional, pasting and sensory properties of the flour produced from dried ‘abacha’ slices.

Materials and Methods

Source of Materials
Four cassava varieties, 98/210, NR86184, 47/4779 and 91/02324 harvested after 12 months of planting from Ebonyi State Agricultural Development Programme, Abakaliki were used in this work.

Production of ‘abacha’ flour from fresh cassava.
The freshly harvested cassava were manually peeled with stainless steel knife, washed and cut into chunks (7.0-8.0 cm). They were boiled in water for 20 mins. The cooked samples were cooled and thinly sliced (0.50-1.00 mm thickness) and soaked for 16 h. During the soaking, the water was routinely changed after 4 h. The slices were thoroughly washed to obtain fresh wet ‘abacha’ slices. The ‘abacha’ slices were sun dried on a flat surface covered with clean polyethylene material for five days. It was then milled using an attrition mill to obtain the ‘abacha’ flour.

Production of ‘abacha’ flour from dried cassava chips.
Freshly harvested cassava varieties were manually peeled with stainless steel knife, washed and cut into chunks (5-8 cm length). They were washed and spread on flat long fibre woven basket constructed.
from palm frond material. They were dried for 5 days. The dried cassava chips were used for production of wet ‘abacha’ slices. The dried chips were hydrated in potable water for 7 h to attain high moisture content. The hydrated chips were boiled in water for 75 mins. The cooked samples were cooled and thinly sliced (0.50-1.00mm thickness) with a sharp stainless steel knife. The sliced samples were soaked in water for 16 h and soaked water routinely changed after four hours. After soaking, the slices were thoroughly washed to obtain fresh wet ‘abacha’ slices. The wet ‘abacha’ slices were sun dried on a flat surface covered with clean polyethylene material for five days. It was then milled to obtain the ‘abacha’ flour.

Functional Properties.
Bulk density and Water absorption capacity were determined using the method described by Onwuka [9]. Swelling capacity was determined using the method employed by Sanni et al [10]. Least gelation capacity was determined using the method Kaur and Singh [11] used in their work.

Determination of pasting properties
Pasting characteristics were determined with a Rapid Visco Analyzer (RVA) (MODEL: RVA 3D+ Network Scientific, Australia) by adapting the method used by Sanni et al [12].

Sensory evaluation of the fufu (paste) made from the abacha flour.
The ‘abacha’ fufu was prepared by pouring boiled water into a plastic bowl; the flour was poured to cover the top of the water level. It was allowed to stand for about 2 mins before being mixed using a small wooden paddle to form a thick paste. A 20 semi-trained panelist were used to evaluate the sensory properties of the fufu. The samples were arranged randomly and presented to the panelists in a randomly coded plate. The ‘abacha’ fufu were assessed for taste, non-stickiness, mouldability, appearance and overall acceptability.

Statistical analysis
A completely randomized design (CRD) was employed in this work while analysis of variance (ANOVA) was used to analyse the data obtained according to Snedecor [13]. Means were separated using least significant difference [14].

Results and Discussions
The Functional Properties of the Samples
From the result (Table I), the bulk density (BD) of ‘abacha’ processed from dry cassava chips in all the varieties was higher (0.508-0.571 g/ml) than the ones (0.508-0.543 g/ml) made from fresh cassava tubers. Both variety and processing did not significantly (p>0.05) affect the BD of the samples. Different values of BD have been reported for cassava products. Abu et al [15] reported a range of 0.401-0.402 g/cm³ for gari, Ukpabi and Ndimele [16] 0.568-0.908 g/cm³ for gari in Eastern States of Nigeria. The bulk density of cassava fufu flour was reported to range from 0.63 g/ml to 0.77 g/ml [17]. The results in this work fall within these ranges. BD governs the fill weight of food materials; ‘abacha’ from dry cassava chips would give the characteristic...
quality of good filling weight when it is milled into flour. The Water Absorption Capacity (WAC) of the ‘abacha’ samples made from dry cassava chips (3.80-5.80 g/ml) was higher than 3.35-3.90 ml/g obtained from ‘abacha’ processed from fresh roots. Omodamiro et al [18] obtained a lower value (1.0-2.5 g/ml) for lafun. Etudaiye et al [17] reported that gelatinization of starch and swelling of crude fibre which may occur during heating, increase water absorption capacity. Increased WAC in food system enables bakers to manipulate functional properties of dough in bakery product [19, 20]. The high WAC of these ‘abacha’ flour samples can be useful in composite flour where it will increase the WAC if the complementing flour has low WAC. The swelling capacity of the ‘abacha’ made from 91/02324 and 98/2101 cassava varieties was significantly (p<0.05) affected by the processing method while others were not.

From the result (Table I) the swelling index (SI) of samples from fresh roots was significantly (p<0.05) higher than those from dry cassava in 91/02324 and 98/2101 varieties. Swelling capacity is an important functional property in food system especially in fufu. It has been reported that good quality gari should have a swelling capacity of 3.0-5.0 volume increase [21; 22]. The SI of all the ‘abacha’ samples was more than three times its initial volume comparable to the SI of good quality gari.

The least gelation capacity (LGC) of the ‘abacha’ flour is the minimum concentration needed to bring about gelation. From the result in Table II, the LGC range from 8 to 10%. Kaur and Singh [11] reported LGC for chickpea flour of 10-14 % which is higher than the result obtained here. Increase in heat treatment has been found to increase gelation capacity of cowpea [23]. The increase in the LGC end point had been attributed to pregelatinization and thermal degradation of starch [12]. This may explain why the flour made from dry chips had higher LGC.

Pasting characteristics of fufu from the samples.
The pasting characteristics of samples are presented in Table III. When the temperature of heated paste rises above gelatinization temperature, the starch granules begin to swell and viscosity increases on shearing. The temperature at the onset of rise in viscosity is referred to as pasting temperature [24]. It is the minimum temperature required to cook a given sample of food [25]. The pasting temperature of the samples which ranged from 51.60 °C to 79.20 °C gives an indication of the quantity of heat required to cook the flour [12]. From Table III, samples made from fresh roots of 98/2101 and 91/02324 cassava varieties had the highest and lowest value of pasting temperature, respectively. The pasting temperature of fufu made from ‘eberebe abacha’ derived from fresh 91/02324 did not differ significantly (P>0.05) from samples made from dry 91/02324 cassava variety. Both variety and processing method did not affect the pasting temperature of samples from 97/4779, 98/2101 and NR87184 significantly (p<0.05) Different pasting temperatures have been variously reported. Adebowale
et al [24] reported 83.80 °C for yam flour while 76.80 °C was reported for lafun [8]. Sanni et al [12] reported a pasting temperature of 64.0 °C for gari. It has been reported that high amylose content of starch increases the pasting temperature. This is because the presence of high amylose in a starchy food delays starch gelatinization and affects normal cooking properties. The low pasting temperature of the fufu samples made from fresh 91/02324 cassava varieties will require less heat energy input to cook the flour than other samples. This also implies that the cost of energy for reconstituting the flour into fufu would be low.

The final viscosity, which is the resistance of the paste to shear force during stirring [26], ranged from 123.58 to 300.41 RVU. The ‘abacha’ made from fresh 91/02324 cassava produced fufu with highest final viscosity while the ‘abacha’ made from dry chips of NR87184 produced fufu with lowest final viscosity. There were significant difference (P<0.05) in the value of the final viscosity of the samples. Sanni et al [12] reported a final viscosity of 202.58 RVU for gari, which is within the range obtained (Table III), while a higher value of 327.57 RVU was reported for lafun [8]. The variation in the final viscosity of the samples might be due to simple kinetic effect of cooling on viscosity and re-association of starch (especially amylose) molecules in the samples [25]. Final viscosity indicates the ability of a material to form viscous paste or gel after cooking and cooling [27]. Hence abacha prepared from fresh 91/02324 cassava has the ability to form sticky fufu while abacha made from dry NR87184 would produce less sticky fufu. The high final viscosity from fresh 91/02324 cassava makes it suitable for fufu as well as for thickening agent or for any food system where increase in viscosity is desirable.

At pasting temperature, large increase in viscosity is experienced. This is referred to as peak viscosity. Peak viscosity is the ability of starch to swell freely before their physical breakdown [28]. It ranged from 157.32 to 399.58 RVU with samples made from dry NR87184 cassava having the least value. The peak viscosity of the samples differed significantly (P<0.05) with each other, while ‘abacha’ made from fresh 91/02324 cassava variety produced fufu with the highest peak viscosity (399.58 RVU). High peak viscosity is an indication of high starch content [12] and is related to the water binding capacity of starch [24]. It is closely associated with the degree of starch damage. High starch damage results in high peak viscosity [12]. Based on these, samples made from 91/02324 with highest peak viscosity, indicating high water binding capacity of the starch granules, would be suitable for product that require high gel strength and elasticity while abacha prepared from dry NR87184 chips would be useful in products that require less gel strength and elasticity.

The measure of reduction in viscosity that occurred from peak viscosity to trough is referred to as breakdown viscosity. Breakdown viscosity of the samples ranged between 67.25 and 193.08 RVU. They differed significantly (p<0.05) from each other. Adebowale et al [24] however reported a lower value of 15.67 RVU for
yam. The breakdown viscosity is the measure of the stability of starch or the ease with which the swollen granules of starch can be disintegrated [24]. It is an important parameter in predicting the behaviour of food during processing. Higher breakdown viscosity values indicate lower ability of the sample to withstand heating and shear stress during cooking [24]. Hence the abacha from dry NR87184 cassava chips would produce fufu that will withstand more heat and shear stress during cooking because of its low (67.25 RVU) breakdown viscosity.

Starch paste re-associates upon cooling, a process referred to as setback or retrogradation [4]. It is the difference between final viscosity and hot paste viscosity [17]. The setback viscosity of the samples ranged from 34.00 to 93.92 RVU and falls within the range (53.5–315.35 RVU) reported for gari [12]. Etudaiye et al [29] reported a slightly lower range of 33–80.15 RVU for fufu from CMD resistant cassava. The setback viscosity of fufu samples from ‘abacha’ made from fresh 98/2101 cassava did not differ significantly (P>0.05) from the sample made from dry 97/4779 cassava. They however differed significantly (p<0.05) from other samples. The setback viscosity is an index of retrogradation [2]. The amylose content of starch has been reported to be responsible for retrogradation [13]. Sanni et al [30] reported that low setback value indicates higher resistance to retrogradation. Therefore sample made from 91/02324 with high setback viscosity (93.92 RVU) will retrograde faster than other samples when their flours are reconstituted to paste.

During the hold period of a typical pasting test, the sample is subjected to a period of constant heating at 95 °C and mechanical stress. This further disrupts starch granules and amylose molecules generally leach out into the solution and align in the direction of the shear [27]. The period is called hot paste viscosity or trough due to accompanying breakdown in viscosity [24]. The trough, which is the minimum viscosity in the constant temperature phase of the RVA profile, measures the ability of paste to withstand breakdown during cooling [24]. The ‘abacha’ made from fresh 91/02324 cassava produced fufu with the highest value of trough (206.30 RVU) and the ‘abacha’ sample from dry NR87184 had the least value (90.08 RVU). This implies that the samples made from fresh 91/02324 will have better keeping quality after cooking than other samples. There are significant difference (P<0.05) in the trough of the samples.

The peak time of the samples which is a measure of the cooking time, range from 4.00 to 4.80 mins. There are significant (P<0.05) differences in the peak time of the samples. The value obtained here is within the range of 4.07–5.42 mins reported by Etudaiye et al [29] for fufu made from CMD resistant cassava varieties. Adebowale et al [24] obtained slightly higher value (5.13–5.80 mins) for instant yam and breadfruit flour. From this result, fufu made from abacha produced from fresh 91/02324 cassava variety would cook faster than others, because of its low pasting time.
Sensory evaluation
Sensory evaluation is concerned with measuring the responses of consumers to products in terms of appearance, aroma, taste, colour, texture, after taste, etc without of label, pricing or other imagery [31]. Sensory qualities of food such as colour, and appearance have been used to determine the acceptability of products before they are priced. This is because consumers eat first with their eyes and use the appearance of the food to predict their quality [31].

Result of the sensory evaluation of the ‘abacha’ fufu is shown in Table IV. The processing method and variety significantly (p<0.05) affected some of the sensory attributes of the sample. The taste of ‘abacha’ fufu processed from dried chips was scored higher than ‘abacha’ fufu processed from fresh cassava except 91/02324. In non stickiness and mouldability, ‘abacha’ fufu made from fresh cassava were preferred by consumers than the one processed from dried chips in all the varieties. ‘Abacha’ fufu processed from fresh root of 97/4779 was the most preferred while abacha fufu processed from dried chips of 98/2101 was the least preferred in terms of the overall acceptability. For fufu processed from dried chips, NR87184 produced the most acceptable product.

Conclusion
The low bulk density and high water absorption capacity of the ‘abacha’ flour can be an advantage in composite food formulation where high water absorption capacity would improve the functionality of the complementing flours. The pasting property of some of the ‘abacha’ flour was similar to the pasting properties of gari. Therefore ‘abacha’ flour can be a possible substitute to gari.

Most of the ‘abacha’ fufu were all acceptable by the consumers. ‘Abacha’ processors can dry and mill leftover wet ‘abacha’ slices, and reconstitute them into fufu (dough similar to gari) so that the full potential of the product can be harnessed.
Fig. 1: Flowchart for the production of ‘abacha’ flour from fresh cassava roots
Cassava Root

Washing

Cutting into chunks (5-8cm length)

Sun Drying

Peeling

Dried cassava chips

Hydration of Chips (7 h)

Boiling (75mins)

Cooling (room temperature)

Slicing

Soaking

Washing

Fresh wet ‘abacha’ slices.

Drying

Milling

‘Abacha’ flour

Fig. 2: Flow chart for the production of fresh wet ‘abacha’ slices from dried chip
<table>
<thead>
<tr>
<th>Variety</th>
<th>Processing Method</th>
<th>Bulk density (g/ml)</th>
<th>Swelling WAC (ml/g)</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>98/2101</td>
<td>Fresh</td>
<td>0.505&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.90&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.55&lt;sup&gt;cd&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Dried</td>
<td>0.571&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.28&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>NR87184</td>
<td>Fresh</td>
<td>0.508&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.35&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.45&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Dried</td>
<td>0.516&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.45&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>97/4779</td>
<td>Fresh</td>
<td>0.543&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.60&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.73&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Dried</td>
<td>0.527&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.90&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.85&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>TME419</td>
<td>Fresh</td>
<td>0.508&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.75&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.18&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>Dried</td>
<td>0.508&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.80&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.90&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD</td>
<td></td>
<td></td>
<td>0.329</td>
<td>0.216</td>
</tr>
</tbody>
</table>

Values are means of duplicate.
Values with different superscript within a column are significantly (p<0.05) different.
WAC: Water Absorption Capacity.

**Table II: Effect of processing and variety on the gelation capacity of the ‘abacha’**

| Variety   | Processing Method | Concentration | Gelation
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>91/02324</td>
<td>FCR</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>97/4779</td>
<td>FCR</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>98/2101</td>
<td>FCR</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NR87184</td>
<td>FCR</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
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<td></td>
</tr>
</tbody>
</table>

---- = no gelation
### Table III: The pasting characteristics of ‘eberebe abacha’ derived from chips and fresh cassava roots.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Processing method</th>
<th>Peak viscosity (RVU)</th>
<th>Pasting Trough (RVU)</th>
<th>properties</th>
<th>Breakdown viscosity RVU</th>
<th>Final viscosity (RVU)</th>
<th>Setback Viscosity (RVU)</th>
<th>Pasting Time Temp. (min)</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>91/02324</td>
<td>FCR</td>
<td>399.58^a</td>
<td>206.50^a</td>
<td></td>
<td>193.09^a</td>
<td>300.41^a</td>
<td>93.93^a</td>
<td>4.03^b</td>
<td>51.60^b</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td>283.33^b</td>
<td>134.03^c</td>
<td>143.24^e</td>
<td>217.71^b</td>
<td>83.67^b</td>
<td>4.20^b</td>
<td>53.20^b</td>
<td></td>
</tr>
<tr>
<td>97/4779</td>
<td>FCR</td>
<td>225.77^a</td>
<td>133.16^d</td>
<td>92.58^g</td>
<td>194.17^d</td>
<td>60.67^d</td>
<td>4.72^a</td>
<td>75.99^a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td>276.80^c</td>
<td>95.75^a</td>
<td>134.75^e</td>
<td>131.41^g</td>
<td>35.67^d</td>
<td>4.20^b</td>
<td>75.93^a</td>
<td></td>
</tr>
<tr>
<td>98/2101</td>
<td>FCR</td>
<td>243.74^f</td>
<td>117.03^f</td>
<td>126.07^f</td>
<td>167.23^f</td>
<td>50.18^f</td>
<td>4.40^a</td>
<td>79.20^a</td>
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<tr>
<td></td>
<td>DCC</td>
<td>230.47^e</td>
<td>78.53^a</td>
<td>109.34^g</td>
<td>157.51^e</td>
<td>123.58^e</td>
<td>4.80^a</td>
<td>78.20^a</td>
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<tr>
<td>NR87184</td>
<td>FCR</td>
<td>266.67^d</td>
<td>137.09^b</td>
<td>129.53^e</td>
<td>201.74^c</td>
<td>64.66^c</td>
<td>4.61^abc</td>
<td>77.66^c</td>
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<tr>
<td></td>
<td>DCC</td>
<td>157.35^b</td>
<td>90.08^b</td>
<td>67.23^c</td>
<td>123.58^e</td>
<td>33.40^g</td>
<td>4.80^a</td>
<td>78.20^c</td>
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<td></td>
<td>LSD</td>
<td>4.451</td>
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<td>2.145</td>
<td>1.947</td>
<td>2.052</td>
<td>0.508</td>
<td>3.365</td>
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Values are mean of triplicates
Mean values with different superscript are significantly (p<0.05) different.
FCR = Flour made from fresh cassava root
DCC = Flour made from dried cassava chips.

### Table IV: Sensory properties of fufu made from ‘abacha’ flour.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Process. Method</th>
<th>Appearance</th>
<th>Taste</th>
<th>Stickness</th>
<th>Mouldability</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>91/02324</td>
<td>FCR</td>
<td>5.4^ab</td>
<td>6.2^a</td>
<td>7.0^a</td>
<td>6.4^a</td>
<td>6.3^ab</td>
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<tr>
<td></td>
<td>DCC</td>
<td>4.5^a</td>
<td>4.3^b</td>
<td>4.8^bc</td>
<td>4.1^bc</td>
<td>5.3^bc</td>
</tr>
<tr>
<td>97/4779</td>
<td>FCR</td>
<td>7.8^c</td>
<td>4.0^b</td>
<td>6.2^ab</td>
<td>7.1^a</td>
<td>7.8^a</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td>5.1^ab</td>
<td>6.8^a</td>
<td>5.6^ab</td>
<td>5.4^ab</td>
<td>4.7^bc</td>
</tr>
<tr>
<td>98/2101</td>
<td>FCR</td>
<td>6.4^bc</td>
<td>4.9^ab</td>
<td>5.5^ab</td>
<td>5.7^ab</td>
<td>6.2^ab</td>
</tr>
<tr>
<td></td>
<td>DCC</td>
<td>2.9^d</td>
<td>5.5^ab</td>
<td>3.7^c</td>
<td>3.6^c</td>
<td>4.3^c</td>
</tr>
<tr>
<td>NR87184</td>
<td>FCR</td>
<td>5.4^ab</td>
<td>5.5^ab</td>
<td>5.1^bc</td>
<td>4.8^bc</td>
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<td>DCC</td>
<td>5.8^ab</td>
<td>6.2^a</td>
<td>4.8^bc</td>
<td>4.6^bc</td>
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</tr>
<tr>
<td></td>
<td>LSD</td>
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<td>1.89</td>
<td>1.75</td>
<td>1.74</td>
<td>1.61</td>
</tr>
</tbody>
</table>

Values are mean of triplicates
Mean values with different superscript are significantly (p<0.05) different.
FCR = Flour made from fresh cassava root
DCC = Flour made from dried cassava chips.
References


