INFLUENCE OF DRYING METHODS ON PHYSICO-CHEMICAL, CHEMICAL AND PASTING PROPERTIES OF CHIPS OF DIFFERENT CASSAVA VARIETIES

Ogunlakin G. O.*, Tunde-Akintunde T. Y., Oke M. O.

1Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Abstract

Cassava (Manihot esculenta Crantz), one of the major carbohydrate sources in developing countries is highly perishable and needs to be processed promptly. Processing it into chips will make it available for further processing into other cassava products like gari. Studies were carried out to investigate the effects of drying methods on physico-chemical and pasting properties on cassava chips of four varieties [two indigenous-odongbo and oko-iyawo; two improved-arubielu (TMS 30572) and ege-funfun (TMS 23576)] of cassava. The drying methods include sun, solar and cabinet (60 °C) drying. The swelling capacity of the samples has the range 1.20 - 2.0% and the titratable acidity (0.100 – 0.173%) values obtained show that the products are of high quality. Results of analyses for physico-chemical and pasting properties indicated significant differences (p<0.05) among the varieties and drying conditions. Also there was great reduction of the level of hydrocyanic acid (HCN) thereby making the chips safe to produce food for consumption. The results obtained also establish the fact that though all the drying methods can be adopted to dry chips for the production of other cassava products but sun drying method gave the best results for both physico-chemical and pasting properties. This process technology gives relief to the farmers to safeguard investment losses during glut period.

Keywords: Drying methods, cassava chips, physico-chemical, pasting, varieties.

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1. INTRODUCTION

Cassava (Manihot esculenta Crantz) is the most important root crop in tropical countries which provides the major source of dietary calories for about 500 million people in many developing countries (Aguado et al., 1999). The edible part of fresh cassava root contains 32 – 35% carbohydrate, 2 – 3% protein, 65 – 80% moisture, 0.1% fat, 1.0% fibre and 0.70 – 2.50% ash (Oluwole et al., 2004). Cassava tubers deteriorate rapidly after harvesting due to high moisture content (65 – 80%) and this deterioration is caused by physiological changes and mechanical damage during harvesting, transportation and handling (Oyewole, 2002; Oyewole and Asagbra, 2003). Also, the bulky nature of cassava makes its transportation from rural areas difficult and expensive (Ukwuru and Egbonu, 2013). These rapid post-harvest deterioration and bulkiness of cassava roots place serious constraints on their distribution and use especially where there are delays in marketing and on the holding of buffer stock for large-scale processing; hence, there is the need for its immediate processing. The main reasons for processing cassava roots are to increase shelf-life and facilitate transportation. Processing the tubers into a product with low moisture content makes it more durable and stable, and with less volume, which makes transportation easier (IITA, 1990; Ugwu, 1996). Also, cassava is traded internationally in some processed form like chips (FAO, 2005). Processing provides a variety of products which are convenient to cook, prepare and consume. Chips are the most common form in which dried cassava roots are produced, stored and marketed by most exporting countries (IITA, 2005). Cassava chips are made directly from fresh roots by peeling and sun drying or hot-air drying the roots (Hahn, 1989). Drying as a unit operation has been reported to significantly affect the quality of
dried food products (Tunde-Akintunde and Afon, 2009). Thus the most important unit operation in the production of cassava chips is drying as it can have a greater influence on the product quality. Different drying methods (sun, solar, and hot air) have been reported to significantly affect the quality of food products (Barimah et al., 1999; Bechoff et al., 2009). It is therefore important to study the effect of different drying methods on the quality of cassava chips.

Therefore this work aimed at studying the effects of different drying methods (sun, solar and cabinet drying) on some quality parameters of chips of different varieties of cassava.

2. MATERIALS AND METHODS

Materials

Four varieties (two indigenous- odongbo and oko-iyawo; two improved- arubielu (TMS 30572) and ege-junjun (TMS 23576) of cassava (Manihot esculenta) were harvested after 12 months from Ladoke Akintola University of Technology Teaching and Research Farm, Ogbomoso, Nigeria. The study was conducted in Owodunni Food Processing Laboratory, Department of Food Science and Engineering, Ladoke Akintola University of Technology Teaching and Research Farm, Ogbomoso, Nigeria.

Preparation of cassava chips

Each variety of cassava was washed, peeled manually and sliced into chips of uniform slices (length 4 – 5 cm, thickness 1.5 cm). A locally fabricated chipping machine was used for uniform drying. Drying was done using different methods (sun, solar and cabinet at 60 °C).

Drying of the cassava chips

The method of Tunde-Akintunde et al. (2005) was modified to dry cassava chips using sun, solar and cabinet (i.e. hot-air) drying.

Sun drying

The sun drying was done by placing the chips under direct sunlight in the dry season. The products was spread evenly on black nylon and placed under the sun and the chips were turned periodically during drying for proper heat and mass transfer. This was done for three days in the month of February until the moisture reached about 9 percent. The drying temperatures were monitored daily which was between 30 and 40 °C until the drying was complete.

Solar drying

The dryer base was lined with a reflective material with the trays fixed in the drying chamber while the collector base was painted black. This was done for three days in the month of February until the moisture reached about 9 percent. The drying temperatures were monitored daily which was between 35 and 45 °C until the drying was complete.

Cabinet (hot-air) drying

A batch tray drier was used for the hot-air drying method. The perforated trays were filled with one layer of wet cassava chips. There was a gap of 10 cm between the trays to allow for adequate air movement. The air in the dryer was heated using an electrical burner and the drying was done at a drying temperature of 60 °C (Tunde-Akintunde and Afon, 2009) until the moisture reached about 9 percent.

Physico-chemical and chemical properties determination

The swelling capacity was determined by using the method of Sathe and Salunkhe (1981), water absorption capacity and solubility index were determined using the method of Malomo et al. (2012), loose and bulk densities were determined according to Balami et al. (2004). The pH was determined using a pH meter (Oyewole and Odunfa, 1989), total titrable acidity (TTA) was determined as described by Owuamanam et al. (2010), hydrogen cyanide content was determined by using A.O.A.C (2005) and amylose and amylopectin contents were determined using the method of Juliano (1971).

Determination of pasting properties

The pasting profile of cassava chips was studied using a Rapid Visco-Analyzer...
(RVA) (Newport Scientific, 1998) with the aid of a thermocline for windows version 1.1 software (1996). The parameters that were measured (RVA units) are: peak viscosity, holding strength, breakdown, cold paste (final) viscosity, setback, peak time and pasting temperature.

**Statistical analysis**

All experiments were done in three replicates and the means of determinations were presented in tables. The statistical significance of difference were evaluated by one-way analysis of variance (ANOVA) at the 5% significance level by means of comparing the effect of different varieties of cassava as well as the different drying methods on chip samples.

**3. RESULTS AND DISCUSSION**

**Physico-chemical and chemical properties of dried cassava chips**

The physico-chemical properties of cassava chips of different varieties dried with different drying methods are as shown in Table 1. The swelling capacity of a food material is the measure of the ability of flour/starch to absorb water and swell. The values obtained ranged between 1.20 (in both cabinet-dried odongbo and solar-dried oko-iyawo) and 2.00 in solar-dried odongbo variety. The ANOVA shows that the values significantly ($p<0.05$) differ among the varieties. In terms of drying methods, the significant ($p<0.05$) difference was observed in all drying methods used to dry odongbo, oko-iyawo and ege-funfun samples but no significant difference was observed in the values obtained in arubielu variety. This value range agreed with the finding on Ajala *et al.* (2012) who reported 1.10 to 1.31 for dried cassava chips using tunnel dryer.

The water solubility index ranged from 11.43% in sun-dried ege-funfun to 14.23% in cabinet-dried oko-iyawo sample. Water solubility index values were significantly different ($p<0.05$) for both the drying methods and varieties considered. This property reflects the extent of starch degradation (Diosady *et al.*, 1985). The values of water solubility index obtained in this study are generally low which indicates the starch of the chips is of the least starch degradation. The values obtained are similar to those obtained by Eriksson *et al.* (2014) who reported similar range (12.27 – 20.77%) of water solubility index in their study on three varieties of cassava.

Water absorption capacity ranged from 140.00% for solar-dried arubielu variety to 200.00% for cabinet-dried ege-funfun chips. The higher value obtained for cabinet-dried samples might be due to higher temperature and shorter used to dry the samples. The values were significantly different ($p<0.05$) for both varieties and the drying methods. Water absorption capacity measures the volume occupied by the starch after swelling in excess water which indicates the integrity of the starch in aqueous dispersion. It has been reported to be dependent on the starch of the chips (Ajala *et al.*, 2012). Water absorption capacity is important in the development of ready to eat foods and a high absorption capacity may assure product cohesiveness (Housen and Ayenor, 2002). The high values of water absorption capacity obtained in all samples could be attributed to the loose association of starch polymer, amylose and amylopectin in the native granules (Biliarderis *et al.*, 1993). Therefore, the values obtained in this study show that all the samples could be used for the production of ready to eat foods such as snacks inclusion in breakfast cereals.

Loose density of the sample was found to be within the range of 0.30 - 0.39 g/cm$^3$ with solar-dried ege-funfun having the lowest value and sun-dried oko-iyawo, the highest. Bulk density ranged from 0.50 g/cm$^3$ in solar-dried ege-funfun sample and 0.59 g/cm$^3$ in sun-dried oko-iyawo with the mean value of 0.54 g/cm$^3$. The values are significantly different ($p<0.05$) for both the varieties and drying methods. The values obtained were comparable to the values reported by Ajala *et al.* (2012) which ranged from 0.35 - 0.55 g/cm$^3$ for dried cassava chips. They were found lower than the...
values reported by Sanni et al. (2005) for cassava flour. Bulk density has been reported as an important parameter that determines the suitability of the chips for case of packaging and transportation of particulate foods (Shittu et al., 2005). Lower values of bulk density of cassava chips obtained from this study imply the enhancement of material handling in terms of packaging and transportation. Also, it has been reported lower bulk density is desirable in infant food preparation (Nelson-Quartey et al., 2007).

The pH of the samples ranged from 5.90 (solar-dried odongbo) to 7.90 (sun-dried arubielu) and the mean value was 6.96. The pH of flour/chips is an important parameter in determining its quality. This range falls between the range (6 - 7) given by CSIR-FRI (2009) for high quality cassava chips. There were significant differences ($p<0.05$) in the values obtained. It was also observed that the chips produced from the sun-drying method gave the highest pH value considering each variety of the four varieties examined; this might be as a result of a reduction in the cyanide content.

The titratable acidity of the dried cassava chips ranged from 0.10% in cabinet-dried odongbo variety to 0.17 in sun-dried ege-funfun sample. The titratable acidity values were significantly different from each other with exception of solar and cabinet drying samples that were slightly significant. The results showed that the products obtained are of high quality because CSIR-FRI (2009) specifies a lower acidity (i.e $<0.25\%$) for high quality cassava chips.

The cyanide content of the samples ranged between 0.00 in sun-dried oko-iyawo sample and 0.05 mg/100 g in solar-dried ege-funfun. The range of values obtained is below the safe level of 10 mg HCN equivalents/1 kg flour (10 ppm) recommended by Food and Agriculture Organisation/World Health Organisation (FAO/WHO, 1991). The values obtained were significantly different ($p<0.05$) for both varieties and the drying methods except in sample B (oko-iyawo) that showed very slight significant difference between sun drying and other two methods. It was observed from the values obtained that sun drying method eliminated more cyanide content and this could be due to the fact that there was prolong contact time between linamarin and the enzyme linamarase which ultimately catalyzed the hydrolytic breakdown (Bandna, 2012).

The amylose and amyllopectin contents of dried cassava chips were found to be within the ranges 22.067 - 25.533% and 74.467 - 77.933% respectively. The lowest value of amylose was found in cabinet-dried odongbo variety and the solar-dried ege-funfun variety had the highest value. The solar-dried ege-funfun sample had the lowest amyllopectin content while cabinet-dried odongbo sample had the highest value. There were significant differences ($p<0.05$) in amylose content among the varieties studied. The amylose portion of the starch affects its swelling and hot-paste viscosities. Shimelis and Rakshit (2005) stated that as the amylose content increases, the swelling tends to be restricted and the viscosity of the hot paste viscosity stabilizes. Moreover, high amylose contents are desired in starches that are to be used for the manufacture of extrudates (Lii and Chang, 1981). Nuwamanya et al. (2009) observed a range of 18.8 – 25% of amylose in cassava starch obtained from both the parents and progenies. A range of 15.9 – 22.4% of amylose was reported by Albert et al. (2005) for five cultivars of cassava starches.
### Table 1: Physicochemical and chemical properties of cassava chips produced from different varieties and drying methods

<table>
<thead>
<tr>
<th>Sample</th>
<th>SC (%)</th>
<th>SI (%)</th>
<th>WAC (g/cm³)</th>
<th>LD (g/cm³)</th>
<th>BD (g/cm³)</th>
<th>pH</th>
<th>TTA (%)</th>
<th>HCN (mg/100 g)</th>
<th>Amylose (%)</th>
<th>Amylopectin (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A\textsubscript{o}</td>
<td>1.500d</td>
<td>12.600f</td>
<td>160.000d</td>
<td>0.364</td>
<td>0.553d</td>
<td>6.900f</td>
<td>0.130c</td>
<td>0.020e</td>
<td>22.667h</td>
<td>76.333d</td>
</tr>
<tr>
<td>A\textsubscript{s}</td>
<td>2.000a</td>
<td>13.167d</td>
<td>180.000c</td>
<td>0.371d</td>
<td>0.560c</td>
<td>5.900k</td>
<td>0.113de</td>
<td>0.037bc</td>
<td>24.133d</td>
<td>75.867e</td>
</tr>
<tr>
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<td>1.200f</td>
<td>12.800ef</td>
<td>180.000c</td>
<td>0.377b</td>
<td>0.557cd</td>
<td>6.333i</td>
<td>0.117d</td>
<td>0.027de</td>
<td>22.067j</td>
<td>77.933a</td>
</tr>
<tr>
<td>B\textsubscript{o}</td>
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<td>13.133d</td>
<td>180.000c</td>
<td>0.386a</td>
<td>0.585a</td>
<td>7.467e</td>
<td>0.110def</td>
<td>0.000g</td>
<td>24.567b</td>
<td>75.333f</td>
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<td>B\textsubscript{s}</td>
<td>1.200f</td>
<td>13.800b</td>
<td>160.000d</td>
<td>0.353g</td>
<td>0.554d</td>
<td>6.000j</td>
<td>0.103fg</td>
<td>0.007fg</td>
<td>22.733gh</td>
<td>77.267c</td>
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<tr>
<td>B\textsubscript{a}</td>
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<td>14.233a</td>
<td>180.000c</td>
<td>0.344h</td>
<td>0.520f</td>
<td>6.400h</td>
<td>0.100g</td>
<td>0.003fg</td>
<td>22.333i</td>
<td>77.667b</td>
</tr>
<tr>
<td>C\textsubscript{o}</td>
<td>1.300e</td>
<td>12.067g</td>
<td>186.670bc</td>
<td>0.344h</td>
<td>0.518f</td>
<td>7.900a</td>
<td>0.150b</td>
<td>0.010f</td>
<td>24.300c</td>
<td>75.700c</td>
</tr>
<tr>
<td>C\textsubscript{s}</td>
<td>1.300e</td>
<td>13.533c</td>
<td>140.000e</td>
<td>0.378c</td>
<td>0.566b</td>
<td>6.800g</td>
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<td>22.833g</td>
<td>77.167b</td>
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<tr>
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<td>1.300e</td>
<td>13.000de</td>
<td>190.000b</td>
<td>0.356f</td>
<td>0.525e</td>
<td>7.767b</td>
<td>0.107efg</td>
<td>0.030cd</td>
<td>22.800g</td>
<td>77.200b</td>
</tr>
<tr>
<td>D\textsubscript{o}</td>
<td>1.600b</td>
<td>11.433h</td>
<td>180.000c</td>
<td>0.316j</td>
<td>0.512g</td>
<td>7.700c</td>
<td>0.173a</td>
<td>0.037bc</td>
<td>23.167f</td>
<td>76.833c</td>
</tr>
<tr>
<td>D\textsubscript{s}</td>
<td>1.500c</td>
<td>11.933g</td>
<td>180.000c</td>
<td>0.303k</td>
<td>0.505h</td>
<td>6.767g</td>
<td>0.150b</td>
<td>0.047a</td>
<td>25.533a</td>
<td>74.467g</td>
</tr>
<tr>
<td>D\textsubscript{a}</td>
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<td>12.133g</td>
<td>200.000a</td>
<td>0.335i</td>
<td>0.528e</td>
<td>7.600d</td>
<td>0.130c</td>
<td>0.043ab</td>
<td>23.367e</td>
<td>76.633d</td>
</tr>
</tbody>
</table>

Mean values (n=3) with different alphabet (s) in the same column are significantly different at p<0.05.

A: odongbo; B: oko-iyano; C: arubiela (TMS 30572); D: ege-funfun (TMS 23576) and subscripts su, so and ca represent sun, solar and cabinet drying methods respectively.

SC: Swelling capacity; SI: Solubility Index; WAC: Water Absorption Capacity; LD: Densest Density; BD: Bulk Density; TTA: Titratable Acidity; HCN: Cyanide content

### Table 2: Pasting properties of cassava chips of different varieties and drying methods

<table>
<thead>
<tr>
<th>Sample</th>
<th>Peak viscosity (RVU)</th>
<th>Trough (RVU)</th>
<th>Breakdown (RVU)</th>
<th>Final viscosity (RVU)</th>
<th>Setback (RVU)</th>
<th>Peak time (RVU)</th>
<th>Pasting temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A\textsubscript{o}</td>
<td>251.850c</td>
<td>220.110b</td>
<td>31.735i</td>
<td>309.220c</td>
<td>89.115e</td>
<td>5.105i</td>
<td>84.225a</td>
</tr>
<tr>
<td>A\textsubscript{s}</td>
<td>235.900d</td>
<td>108.560i</td>
<td>127.340a</td>
<td>183.410h</td>
<td>74.845f</td>
<td>5.550d</td>
<td>79.665j</td>
</tr>
<tr>
<td>A\textsubscript{a}</td>
<td>169.440h</td>
<td>109.090h</td>
<td>60.345e</td>
<td>230.640f</td>
<td>121.540c</td>
<td>5.210h</td>
<td>82.665d</td>
</tr>
<tr>
<td>B\textsubscript{o}</td>
<td>197.420d</td>
<td>158.950d</td>
<td>38.450i</td>
<td>249.300d</td>
<td>94.350d</td>
<td>5.110i</td>
<td>83.365c</td>
</tr>
<tr>
<td>B\textsubscript{s}</td>
<td>191.180d</td>
<td>156.020e</td>
<td>35.150k</td>
<td>224.340g</td>
<td>62.165h</td>
<td>5.285g</td>
<td>82.025g</td>
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<tr>
<td>B\textsubscript{a}</td>
<td>135.060f</td>
<td>98.000j</td>
<td>37.055j</td>
<td>160.160i</td>
<td>68.315g</td>
<td>5.610c</td>
<td>83.335c</td>
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<tr>
<td>C\textsubscript{o}</td>
<td>278.620b</td>
<td>199.860c</td>
<td>78.760b</td>
<td>391.600b</td>
<td>191.740a</td>
<td>5.365f</td>
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<td>124.160g</td>
<td>73.185c</td>
<td>157.940j</td>
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<td>133.510j</td>
<td>85.055k</td>
<td>48.455g</td>
<td>145.280k</td>
<td>60.220h</td>
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<tr>
<td>D\textsubscript{o}</td>
<td>301.090a</td>
<td>240.340a</td>
<td>60.750d</td>
<td>413.860d</td>
<td>173.520b</td>
<td>5.190b</td>
<td>82.430e</td>
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<tr>
<td>D\textsubscript{s}</td>
<td>194.260f</td>
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<td>45.490h</td>
<td>237.560e</td>
<td>55.715i</td>
<td>6.135b</td>
<td>82.345f</td>
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<tr>
<td>D\textsubscript{a}</td>
<td>119.660</td>
<td>70.940j</td>
<td>48.730f</td>
<td>126.520l</td>
<td>88.780e</td>
<td>5.340f</td>
<td>81.765h</td>
</tr>
</tbody>
</table>

Mean values (n=3) with different alphabet (s) in the same column are significantly different at p<0.05.

A: odongbo; B: oko-iyano; C: arubiela (TMS 30572); D: ege-funfun (TMS 23576) and subscripts su, so and ca represent sun, solar and cabinet drying methods respectively.

### Pasting Properties of Dried Cassava Chips

The pasting properties are important indices to predict the pasting behaviour during and after cooking of starch-based products (Richard et al., 1991). The values of pasting properties obtained for cassava chips of different varieties dried with sun, solar and cabinet drying methods are as shown in Table 2. The peak viscosity which is the maximum viscosity obtained immediately after the heating portion ranged from 119.660 to 301.090 RVU with the cabinet-dried and sun-dried ege-funfun (TMS 23567) having the lowest and highest values respectively. There was significant (p<0.05) difference in the values obtained which might be due to the variation in the amylose contents of the chips since Ogununde (1987) gave a report that the associative binding of the amylose fraction is responsible for the structure and the pasting characteristic of starch granule (Ikegwu et al., 2009).

Trough is the ability of paste to withstand breakdown during cooling and the results obtained ranged from 70.940 to 240.340 RVU in cabinet and sun-dried ege-funfun.
samples respectively. The breakdown viscosity which is an index of the stability of starch ranged from 31.735 (sun-dried odongbo chips) to 127.340 RVU (solar-dried odongbo chips). There are significant ($p<0.05$) differences for both trough and breakdown viscosities in terms of drying methods and varieties considered. The rate of breakdown of starch-based food depends on the nature of the material, temperature and the degree of mixing and the shear applied to the mixture (Maxiya-Dixon et al., 2004). The high value of breakdown viscosity indicates the inability of the sample to withstand heating and shearing stress during cooking (Adebowale et al., 2008). This indicates that all the samples except solar-dried odongbo sample might be able to withstand heating and shear stress during cooking because of their low breakdown values.

The final viscosity of cassava chips gave the range of 145.280 - 413.860 RVU with the cabinet-dried arubielu having the lowest and sun-dried ege-funfun had the highest value. The results obtained are significantly ($p<0.05$) different from each other for both drying methods and varieties considered. Final viscosity is the ability of sample to form various paste/gel after cooking/cooling and it is the most commonly used characteristic to determine the quality of a particular starch-based product (Osungbaro et al., 2010). The variation in the values of final viscosity obtained might be due to the kinetic effect of cooling on viscosity and re-association of the starch molecules in the chips (Bentil, 2011). It was observed from the results obtained that sun dried samples gave the highest values of final viscosity in all the varieties considered. There is an indication that sun-dried chips will be more stable after cooling due to their high values of final viscosity.

The results of setback of cassava chips of different varieties dried with different drying methods ranged from 33.780 to 191.740 RVU. The highest value was obtained in sun-dried arubielu, the lowest in solar dried arubielu and the values were significantly ($p<0.05$) different except for sun-dried odongbo and solar-dried ege-funfun samples were not different significantly. Setback viscosity is an ability to retrograde on cooling. Osungbaro et al. (2010) gave 45 – 81.75 RVU in composite cassava-sorghum flour meals. Lower value of setback will give higher resistance to retrogradation during cooling (Sanni et al., 2005). It was observed that all solar-dried samples were found low in setback values in all the varieties considered. This implies that solar-dried chips would give highest resistance to retrogradation during cooling. There are significant ($p<0.05$) differences in both peak time and pasting temperature values. Peak time ranged from 5.105 (sun-dried odongbo) to 6.220 (cabinet-dried arubielu) minutes. Low values obtained for peak time in all the samples indicates that there would early gelatinization as it has reported by Ahmed et al. (2005) that low pasting time favours early gelatinization. Pasting temperature ranged between 79.665 and 84.225 °C for solar-dried odongbo and sun-dried odongbo samples respectively. Pasting temperature gave an indication of the minimum temperature required to cook the sample. It shows that solar-dried odongbo sample will cook faster which will save time and cost compared to other samples. The value range obtained was significantly higher than the range (69 – 78 °C) reported by Sefa-Dedeh et al. (2004) on maize. The higher pasting temperature may call for continuous stirring when cooking any product produced from these chips to avoid scorching because higher temperatures are likely to induced scorching before a paste is well-cooked.

4. CONCLUSION

Significant effects among the varieties and drying methods were observed in all the properties determined but variety was found to have a more significant effect on the chemical and physico-chemical properties while drying method was found to have a more significant effect than that of the
variety on pasting properties of cassava chips. The values of swelling capacity, water absorption capacity and bulk density obtained indicated that the chips are of high quality which can be used for further processes in the production of other cassava products of high quality. Based on the findings, it is therefore recommended oko-iyawo- a local variety and arubielu (TMS 30572)- an improved variety of cassava for the production of cassava chips. Also, cabinet drying method can be adopted.

5. REFERENCES


