**ABSTRACT**

Ogi, a popular breakfast cereal and weaning food in West Africa was produced from maize, acha and sorghum. Ogi was produced from the three cereals and the gruels obtained were subjected to fermentation. The total starch content and alpha amylase activity during the period of fermentation of the ogi slurries were evaluated using standard methods. Total starch content was determined at 0, 12, 24, 36 and 48 h and α-amylase activity was also determined at 10 °C, 20 °C, 30 °C, 40 °C at 0, 12, 24, 36 and 48 h. The outcome of the research showed that α-amylase activity increased with increase in temperature and was highest in maize (1.507 – 4.458 E. U) while acha ogi (0.497 – 3.219 E. U) had the lowest α-amylase activity. The starch content decreased with increase in time of fermentation time and was highest in maize ogi while acha ogi had the lowest. This shows that the higher the temperature of fermentation and longer fermentation time can increase the breakdown of starch by α-amylase in ogi slurry. The result of the Principal component analysis (PCA) showed distinct similarity in maize and acha. Agglomerative hierarchical clustering grouped acha into two groups (groups one and two) but grouped all maize and sorghum ogi samples together into group three. Due to the low starch content and low α-amylase activity observed in acha, it could be utilized in the production of gluten-free ogi with low glycemic index especially for vulnerable groups.

**Keywords:** alpha-amylase, starch, fermentation, maize, sorghum, acha, ogi, PCA, hierarchy, clustering, relationship

**INTRODUCTION**

Ogi is a smooth, free flowing thin porridge obtained from wet milled, fermented maize and sorghum in the southern part of Nigeria. It serves as a major weaning food for infants, a breakfast meal for both children and adults in West Africa (Abioye and Aka, 2015; Ukeyima et al., 2019). Ogi can be produced from cereals such as maize, sorghum, millet and recently acha. The choice of grain depends on preference and ethnicity (Oyenhen and Ikenebomeh, 2007). Presently, researchers are studying how resistant starches can reduce the glycermic and insulin response (Deepa et al., 2010; Jideani and Jideani, 2011). The in-vitro starch digestibility and glycemic property of acha and maize porridge has been investigated. The in-vitro digestibility and glycemic property of maize and acha showed the digestible starches (DS) in maize and acha were 43.7 and 41.4 (Jideani and Podgorski, 2009). Acha also contains resistant starches which has been shown to be promising in the management or prevention of certain diseases or health conditions (Deepa et al., 2010; Jideani and Jideani, 2011). Fermentation improves absorption of nutrient, especially from agricultural produce, by enzymatic splitting of cellulose, hemicellulose, and related polymers that are not digestible by humans into simpler sugars and sugar derivatives (Parker, 2018; Malomo et al., 2019). Most of these enzymes are naturally present in cereal grains but at low levels (Malomo et al., 2019). α-Amylases are hydrolytic enzymes which specifically break the α-1, 4-glucosidic bonds in starch. Possible sources of α-amylase in plants, animals and microbes have been reported (Aiyer, 2005; Asante et al., 2013). The effect of controlled fermentation of ogi has been reported (Oyenhen and Ikenebomeh, 2007). The volatile compounds and associated microbes during fermentation of ogi slurry from maize have been identified by Balogun et al. (2020). There are several articles on the use of acha but there is a dearth of information on the effect of fermentation on α-amylase activity and starch during fermentation of ogi from acha, sorghum and maize, hence this study.

**RESULTS AND DISCUSSION**

Determination of α-amylase activity of ogi samples

Alpha amylase activity of the fermenting ogi samples were determined as described by Malomo et al. (2019). Each ogi sample (5 g) was weighed at 0, 12, 18, 24, 36 and 48 h of fermentation and homogenised in 50 ml of 0.2 M sodium acetate buffer (pH 4.0). The homogenate was transferred into a conical flask and was mechanically shaken at 150 rpm for 10 min at room temperature in a Gallenkamp orbit shaker (3597 C2-2, England). The suspensions were transferred to centrifuge tubes and centrifuged at 5000 rpm for 30 min in centrifuge (Bosch Model No TDL-5, Germany) and the supernatant was used as crude enzyme for enzyme assay. The substrate for assay was 0.5 ml of 0.5 % soluble starch, buffered with 0.2 ml of 0.2 M sodium acetate (pH 5.6). Crude enzyme extract (0.3 ml) was added to the mixture, mixed and incubated at 40 °C for 30 min in Gallenkamp water bath (HH-86, England). The reaction was terminated by the addition of 2 ml of 3, 5-Dinitrosalicylic acid (DNSA) and boiled for 5 min in the water bath. The mixture was cooled under running water and 7 ml of distilled water was added. Blank that consisted of 0.3 ml distilled water, 0.5 ml of 0.5 % soluble starch and 0.2 ml of buffer was treated in similar way. The absorbance of the resultant solution was read at 540 nm in UV Spectrophotometer (Spectrulab 752S, YMI206PHB2, China). Reducing sugar in the samples was estimated from a standard curve of known concentrations of maltose (0-1000 µg/ml). One unit of α-amylase was defined as the amount of enzyme required to produce 1 microgram of reducing sugar equivalents per minute measured as maltose from soluble starch under the experimental conditions. 1 enzyme unit (E.U.) =1 µg of maltose produced/min

Extraction and estimation of starch from ogi samples

Modified method of Kiran and Sandeep (2016) was used for determination of starch by using anthrone method. Ogi samples (5 g) was homogenized in 80% ethanol to remove sugars present in the samples. Residue was retained after centrifugation at 5000 X g for 15 min. The starch was extracted by 52% perchloric acid at 0 °C for 20 min. One millilitre (1 ml) of extract from each sample was taken into test tubes and 4 ml of anthrone was added. The tubes were kept for boiling for 5 min. The colour intensity was measured at 620 nm in spectrophotometer (Spectrulab 752S, YMI206PHB2, China). Starch concentration was calculated from standard curve of known concentration glucose (0 – 10000µg).

**CONCLUSION**

Alpha amylase activity during fermentation of ogi samples

The α-amylase activity increased with increase in temperature (Fig. 1-4). It was generally higher in ogi samples produced from maize (1.507- 4.458 E. U) than

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**KEYWORDS:** alpha-amylase, starch, fermentation, maize, sorghum, acha, ogi, PCA, hierarchy, clustering, relationship
sorghum (1.070 – 3.019 E. U) and lowest in ogi produced from acha (0.497 – 3.219E. U) throughout the period of fermentation. It was within the range of 0.497 – 3.281 E. U at 10 °C, 0.643 – 3.453 E. U at 20 °C, 0.931 – 3.531 at 30 °C and 1.875 – 4.458 E. U at 40 °C. Acha was reported to have lower α-amylase activity during fermentation of the ogi slurries and relatively evoke low sugar on consumption, an advantage for diabetics (Malomo et al., 2019). Amylolysis susceptibility of maize starch is higher, because of the presence of surface pores and channels that facilitate enzymatic diffusion (Zhang et al. 2006).

**Figure 1** Alpha amylase activity of ogi samples at 10 °C

**Figure 2** Alpha amylase activity of ogi samples at 20 °C

**Figure 3** Alpha amylase activity of ogi samples at 30 °C

**Figure 4** Alpha amylase activity of ogi samples at 40 °C

**Total starch content of ogi samples**

Ogi samples produced from maize had the highest starch content while (61.20 – 71.55 %) and lowest in acha ogi samples (33.31 – 51.86 %) (Table 1). There was significant difference (p < 0.05) in the starch content of all the cereals from 0 – 36 h of fermentation but there was no significant difference (p > 0.05) between ogi from maize and sorghum ogi at 48 h of fermentation. Starch is the main constituent of maize kernels, about 72–73% of the total weight (Paraginskia et al. 2014). Acha (68 %) is reported to have lower starch content than sorghum (73.8 %) (Balogou et al., 2013).
Table 1 Changes in total starch content of *ogi* samples

<table>
<thead>
<tr>
<th>Sample</th>
<th>Fermentation time (h)</th>
<th>0</th>
<th>12</th>
<th>24</th>
<th>36</th>
<th>48</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>51.86±1.200</td>
<td>51.32±1.11</td>
<td>47.06±2.01</td>
<td>42.47±1.78</td>
<td>33.31±0.70</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>71.55±1.00</td>
<td>69.16±0.08</td>
<td>68.45±0.65</td>
<td>66.58±1.03</td>
<td>61.20±1.50</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>73.23±0.56</td>
<td>72.96±0.74</td>
<td>72.11±1.02</td>
<td>70.99±0.98</td>
<td>60.00±0.02</td>
<td></td>
</tr>
</tbody>
</table>

Keys: A- *Ogi* from Acha; M- *Ogi* from Maize; S- *Ogi* from Sorghum

The principal component analysis (PCA) was used to determine the relationship between temperature and α-amylase. Also, to evaluate the effect of α-amylase on starch during fermentation of *ogi* produced from maize, acha and sorghum. The principal components were grouped into five components and PC 1 and PC 2 best represent the samples.

Starch (TS) had positive correlation (Fig. 4) with all the variables but had strongest correlation with α-amylase activity at 10 °C (0.616) and reduced to 0.544 at 40 °C. This showed that as the temperature increased, the starch production decreased. The temperature at 10 °C had strongest positive correlation at 20 °C (0.969) and also reduced progressively to 0.658 at 40 °C.

The relationship between the samples are shown in Fig. 6. All acha samples were grouped separately on the negative side of PCA 1 except A0 at the negative side of PCA 2. Maize *ogi* fermented for 0 to 36 h were represented on the positive axis of PCA 1 and M48 on the positive side of PCA 2. Sorghum was represented on the positive axis of PCA 2 at 0 – 24 h and on the positive side of PCA 1 from 36 to 48 h. This showed that there is similarity in the pattern of α-amylase activity in both maize and sorghum *ogi* during fermentation.
CONCLUSION

The α-amylase activity generally decreased with increase in temperature. It was highest in maize ogi and lowest in acha ogi. Total starch content was also highest in maize ogi and lowest in acha ogi. PCA showed more similarity in maize ogi and sorghum ogi than acha ogi. The AHC grouped ogi produced from acha in different and grouped acha ogi separately. It is therefore suggested that ogi with low glycemic index could be produced from this rich non-glutenous cereal “acha”.

REFERENCES


