QUALITY EVALUATION OF gari PRODUCED FROM PROVITAMIN A CASSAVA (Manihot esculenta) ENRICHED WITH AFRICAN YAM BEAN (Sphenostylis stenocarpa)

Olatunde SJ1*, Owoola GO1, Ajiboye TS1 and GO Babarinde1

Sogo James Olatunde

*Corresponding author email: sjolatunde@lautech.edu.ng

1Department of Food Science, Ladoke Akintola University of Technology, Ogbomosho, Nigeria

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ABSTRACT

Provitamin A cassava (PVAC), a biofortified yellow cassava, has great potential to alleviate vitamin A deficiency in sub-Saharan Africa. Blending PVAC with an underutilized legume, African Yam Bean (AYB), in gari production will go a long way in reducing protein and vitamin A malnutrition problems in sub-Saharan Africa where gari is a staple food. Gari was produced from PVAC mash substituted with varying proportions (0, 7.5, 15, 23 and 30%) of AYB using simplex lattice design expert (version 16.0). The gari samples were evaluated for their nutritional composition, physicochemical properties and anti-nutritional factors. Sensory attributes of the products were evaluated using a 7-point hedonic scale. Moisture contents of all the gari samples were below 5% indicating safe level for prolonged storage. Substituting PVAC with AYB at varying proportions resulted in 14.4-23.7%, 16.3-23.5%, 19.8-20.3% and 18.3–21.8% reduction in fiber content. Production of gari from blends of PVAC and AYB significantly (p<0.05) increased pH level and reduced total titratable acidity of the gari samples. Gari produced from 92.5% PVAC and 7.5% AYB mash had the least value of 1.20 mg/kg HCN, and 100 % cassava gari had the highest value (5.0 mg/kg) of HCN. The swelling capacity decreased with increase in the substitution level of AYB in the mixture. The results of syneresis of the samples followed a similar trend with that of swelling capacity. Water absorption capacity and reconstitution index showed increase with increase in the level of AYB inclusion. The anti-nutritional factor of the gari sample ranged from 1.95 to 5.65% for trypsin inhibitor, 4.53-31.02 mg/100g for total phenols, and 2.56-5.33 mg/100g for alkaloids. Gari produced from 100% PVAC was the most preferred in terms of colour, texture, aroma and appearance while gari substituted with 7.5% AYB was best preferred in terms of taste. Significant difference (p<0.05) was recorded for the overall acceptability attribute of 100% PVAC gari (control sample) which was best rated by the panelists. It was concluded that a substitution of 7.5% AYB into PVAC mash gave the gari with the best overall quality acceptability. These findings indicated the potential of AYB in gari processing to curb vitamin A deficiency among the vulnerable group.

Key words: Gari, Vitamin A Deficiency, Provitamin A cassava, African yam bean
INTRODUCTION

Cassava (Manihot esculenta Cranz), is an important commodity in sub-Saharan Africa, after cereals and grain legumes, which constitute either staple or subsidiary food for about a fifth of the world’s population [1]. In the tropics, cassava is an important food crop and is a major carbohydrate source. Cassava is grown in all the agro-ecological zones of Nigeria. It is a staple food for over a million people of the West African population [2, 3]. However, apart from the fact that fresh cassava has limited storage life because of its high moisture content, cassava roots are known to be low in micronutrients such as vitamin A, iron, and zinc. Micronutrient deficiencies threaten the lives of millions of poor households and those located in remote rural areas of sub-Saharan Africa [4]. Considering the important roles of cassava in the diets of Nigerians, cassava varieties biofortified with provitamin A were recently developed in order to complement government efforts to check vitamin A deficiency (VAD) and malnutrition in the country [5]. These varieties are yellow in colour owing to their high beta-carotene (provitamin A) content; hence they are called provitamin A cassava (PVAC). It is strongly believed that PVAC varieties being introduced to farmers would be an effective tool in combating VAD among the less privileged [5]. Cassava can be transformed into various products such as ‘gari’, ‘fufu’, ‘lafun’ and many other West African traditional dishes [3,6].

Gari (a roasted fermented cassava meal) is the most popular cassava product consumed in West Africa and the most important food product in the diet of millions of Ghanaians and Nigerians [3]. It is a staple food that falls within the purchasing power of all categories of people in a society irrespective of their income [5]. Cassava and its products are low in protein and deficient in essential amino acids and therefore, have poor qualitative and quantitative protein content [7]. The nutrient deficiency of gari suggests the need to explore alternative sources to enrich the product in a way that will be affordable to the low-income earners in developing countries [8]. Continual dependence on cassava as the only raw material for gari production could lead to malnutrition. Great success has been recorded in the use of sweet potato for gari production [7]. In Nigeria, there have been several attempts at overcoming the nutritional deficiency of cassava-based diets by fortifying with soybean, which has high protein content of good quality. The continuous utilization of soybean for other industrial applications has led to an increase in price of soybeans, which cannot be afforded by all. Exploration of other alternative sources such as African Yam Bean (Sphenostylis stenocarpa) could be of great advantage considering the ever-increasing market for gari both at home and abroad. It, therefore, becomes imperative to search for cheaper and good quality protein sources that are readily available.

African Yam Bean (AYB) is a leguminous crop of tropical African origin which is grown for both its edible seeds and tubers. African yam bean is one of Africa's under-utilized plant species with potential to broaden man's food base. It forms small tuberous roots that contain more protein than sweet potatoes, potatoes or cassava roots [9]. Due to the high cost of animal protein in developing countries, legumes are of great importance to the low socio-economic population as a cheap source of protein. Nutritionally, AYB seed contains 62.6% carbohydrates, 21-29% protein and 2.5% fat.
The aim of this research, therefore, was to evaluate the quality attributes of *gari* produced from blends of PVAC and AYB.

**MATERIALS AND METHODS**

**Materials**

Fresh PVAC tubers were procured from the Teaching and Research farm of Ladoke Akintola University of Technology, Ogbomoso, while AYB seeds were purchased from Saki, South Western Nigeria. The PVAC tubers and AYB seeds were manually cleaned to remove adhering soil and other extraneous materials before processing. All reagents that were used in this study were of analytical grade.

**Sample Preparation**

The method of Sanni [10] was adopted with slight modifications for processing of *gari* products. African yam bean seeds were soaked in 0.1% potassium metabisulphite for 20 min to prevent browning and were pressed for 24 h before adding to cassava mash already pressed for 48 h. Provitamin A cassava was mixed with varying proportion of AYB (0, 7.5, 15, 23 and 30%) as generated by simplex lattice design (version 6.0) of mixture design. The mixture of PVAC-AYB mashes were fermented further for another 24 h before subsequent processing into *gari*. The dried granules of PVAC-AYB *gari* were packed into polyethylene bags and heat-sealed before keeping in a plastic container with cover until needed for analyses.

**Chemical Analysis**

The chemical analyses of the *gari* products were carried out to determine the following: moisture content, ash content, crude fibre, crude protein, crude fat, carbohydrate (by difference), pH, total titratable acidity (TTA), beta-carotene content and total hydrogen cyanide according to the methods of AOAC [11].

**Physical and Physico-Chemical Properties**

The bulk density was determined using the method of Cooke [12]. Swelling capacity for the samples was determined according to the method adopted by Sanni [10]. Syneresis, Reconstitution index and water absorption capacity were determined according to the procedure described by Iwuoha [13].

**Sensory Evaluation**

Sensory evaluation was conducted to determine consumer preferences and acceptability of the samples, using a 7-point hedonic scale for the degree of likeness. In scaling, 7 represents “like extremely”, midpoint 4 represents “neither like nor dislike” and one represents “dislike extremely”. The quality parameters assessed included: colour, texture, taste, aroma, appearance and overall acceptability. Fifty (50) untrained panelists who were regular *gari* consumers were selected randomly and used for the sensory evaluation. Samples were coded and randomly presented in clean ceramic plates all at the same time and were assessed in dried form.
Statistical analysis
All treatments were replicated twice for reproducibility and analysis was done in duplicate. The statistical analysis of the data was done with Statistical Package for Social Science (SPSS, version 20). Statistically significant differences (p< 0.05) in all data were determined by analysis of variance while least significant difference was used to separate the means.

RESULTS AND DISCUSSION

Proximate Composition of the Gari Samples
The results of the proximate composition of the gari samples are presented in Table 1. The values for the moisture content ranged from 2.47-4.61% with 100% cassava gari having the highest value (4.61%). Moisture content decreased generally as the level of substitution with AYB increased. All the gari samples generally had low moisture contents within the range of values reported for gari by Airadion et al. [14]. Good quality gari should be well-dried and thus of low moisture (less than 14%) content for good storability [15]. A little enhancement in the ash content (1.22 – 2.01%) in AYB containing gari samples was observed compared to gari from 100% PVAC (control). This observation is in line with the findings of Oluwamukomi and Adeyemi [16] who reported 1.18% ash content for cassava gari. The highest value of crude protein obtained for the samples were 4.66% (AYB enriched gari) while the least was 3.23% (control). This is expected as AYB is fairly rich in protein [17]. According to Oluwamukomi and Adeyemi [17], the crude protein content of gari is in the range of 2.33 to 2.55% which contradicts the value (1.04 to 1.40%) reported by other researchers [18]. Generally, gari should contain 0.7 to 1.2% protein [19]. The protein contents in this study are higher than the ones reported by previous researchers. Production of gari from blend of PVAC substituted with AYB will be an added advantage by increasing gari’s protein contents when compared with conventional gari.

The maximum value for crude fibre was 2.06 for 100% cassava gari while the minimum value was 1.73% for 92.5% PVAC - 7.5% AYB mash (Table 1). There was significant difference (p<0.05) between PVAC gari and those substituted with AYB mash, which could be due to differences in the initial fibre content of the fresh samples. There was significant reduction in the values with substitution of cassava with AYB in the gari products. This range falls below the value (6.13%) reported for gari from 100% cassava by Oluwamukomi and Adeyemi [17], which could be associated with varietal differences in the materials used. However, the range of values observed in this study agrees with those reported for gari produced from 100% cassava by Airadion et al. [15].

The range of values for crude fat falls between 1.08% and 2.69% with 100% PVAC having the highest value and those substituted with 15% AYB mash having the least value. These values were generally lower than those reported for pure cassava gari by some authors, which could be as a result of varietal differences [17]. Gari is not a rich source of fat except when fried with palm oil for colour enhancement. Carbohydrate content of the control sample was not significantly different from those substituted with
AYB mashes except for samples containing 15% AYB, which could be due to its relatively high crude fibre content because carbohydrate was determined by difference.

Cyanide content, pH and total titratable acidity of the samples
There was significant reduction in the cyanide level of gari produced with AYB (Table 2). Gari from PVAC had 5.00 mg/kg while those containing AYB ranged between 1.20 mg/kg and 4.57 mg/kg. These relatively low cyanide levels could be attributed to cassava processing which involves grating, fermentation and roasting that have been reported to lower total cyanide in fresh peeled roots [20]. Furthermore, AYB has a low level of hydrocyanic acid contributing significantly to reducing the residual cyanide content in gari produced from PVAC-AYB mashes. The values obtained are lower than the recommended maximum safe level of 20 mg/kg [17, 21]. The gari products can be considered adequate and safe for human consumption in regard to cyanide poisoning, because the values obtained for all gari samples were below the maximum safe level.

The pH value increased from 4.20 (control) to 4.35 (7.5% AYB) and the acidity (TTA) correspondingly decreased from 1.16% (control) to 0.06% (30% AYB). The pH values of gari fall within the recommended range of 3.5 – 4.5 for acid fermented products [20] while the TTA fall within the recommended standard of 0.6 – 1.2 for cassava-gari [2]. The values of TTA recorded in all the gari samples with AYB were in agreement with Nigerian Industrial Standard [19] (recommendation of less than 1.00% TTA for gari samples). A range of 0.77 and 1.62% TTA was reported by FAO [22] for cassava gari samples. The Codex standard of total acidity for gari is between 0.6 and 1.0%, expressed as percent lactic acid [23]. The gari samples had values within the codex standard. This further corroborates the potential of AYB in gari making.

Physical and Physicochemical Properties of the Gari Samples
Water absorption capacity values increased with increase in the level of AYB in the gari samples (Table 3). The highest value (474.64%) was observed in the samples with 15% AYB inclusion while the lowest was recorded in 100% PVAC gari. Water holding property is a term commonly used to describe the ability of a matrix of molecules, usually macromolecules, to entrap large amounts of water in a manner such that exudation is prevented [24]. Water absorbed is usually reported as weight increase in relation to the original dry weight of the sample. It is known to be related to the degree of dryness and porosity. As observed by FAO [23], a product which restricts access of water into the starch granules, can delay gelatinization. Water absorption capacity has been reported to increase with increasing level of protein content [25].

The swelling capacity of the samples ranged from 529.9% (control) to 456.1% (30% AYB inclusion gari). The control sample had the highest swelling capacity of 529.9%, followed by gari produced from cassava mash substituted with 7.5% AYB mash with swelling capacity value of 517.9%, while the gari produced from 30% AYB mash had the least swelling capacity of 456.1%. However, the values were lower when compared with PVAC - gari (517.9%). The observed reduction in the swelling capacity with increasing AYB substitution is in line with the findings of Henry et al. [26] who also reported a reduction in the swelling capacity of gari with enrichment. Swelling capacity is the ability of gari to swell which is influenced by the quantity and type of
Amylose and amylopectin present in the gari. Swelling capacity is an important quality parameter as it indicates the degree of gelatinization of the gari sample.

Reconstitution index follows the same trend with water absorption capacity as the value increased from 6.60 for control to 12.48 in 30% AYB substituted gari. The higher values recorded in gari samples containing varying levels of AYB might not be unconnected to the low-fat content in AYB and cassava, the different starch properties and carbohydrate levels in the samples.

The values of syneresis decreased generally with control (PVAC gari) having the highest value (34.65%) and gari containing 30% AYB had the lowest value (20.54%). All gari samples containing AYB had reduced tendency to syneresis as compared with PVAC gari. This observation suggests that substitution of cassava mash with AYB mash showed an enhancement of the syneresis tendency of PVAC gari. This corroborates the findings of Ibarra et al. [27] who reported reduced syneresis for soy protein-cassava starch. Researchers have attributed high syneresis tendency to variation in setting time, nature and the ratio of the amylose to amylopectin of each starch.

The antinutrients of the samples are presented in Table 2. The trypsin inhibitor activity (TIA) of the protein isolates were reduced after extraction from the AYB seeds and lower than those obtained from the flour. The current findings are in agreement with those that recorded a noticeable decrease in trypsin inhibitor in dry heated cowpea meal. Among antinutrients, trypsin inhibitor has received core attention and reported to cause growth depression, poor feed efficiency and inhibition of digestive enzymes.

**Sensory attributes of gari produced from PVAC and AYB**

The mean sensory scores of gari samples are summarised in Table 5. The result showed that gari produced from 100% PVAC was the most preferred in terms of colour, texture and appearance, which is similar to a report Olatunde et al. [28] in which gari from 100% cassava had the best sensory ratings than those produced from PVAC. However, 7.5% AYB inclusion gari was best preferred in terms of taste. The panelists rated the colour of the control sample better than the rest, followed by the gari from PVAC mash substituted with 7.5% AYB, while the gari produced from cassava mash substituted with 23% AYB was least rated. The texture of gari produced from 100% PVAC had the best rating, while the gari from cassava mash substituted with 23% AYB was least preferred by the panelists. Statistical analysis of the data showed that all the gari samples containing AYB at varying proportions had texture attributes different from the PVAC gari. The panelists preferred the aroma of gari produced from 100% PVAC, while the gari from PVAC mash substituted with 23% AYB was least preferred. The panelists preferred the appearance of gari produced from 100% PVAC to the rest, while the gari produced from PVAC mash substituted with 23% AYB had the lowest score. Control sample was best preferred in terms of overall acceptability, followed by the gari produced from 7.5% AYB inclusion, while the gari from cassava mash substituted with 23% AYB had the least rating. Statistical analysis of the data indicated that the gari produced from 7.5% AYB inclusion had overall acceptability attribute similar to that of the 100% PVAC, which was best rated by the panelists.
CONCLUSION

The addition of AYB to PVAC mash in *gari* enrichment yielded products (0, 7.5, 15, 23 and 30% substitution levels) that had better nutritional and sensory characteristics than the unfortified. The commercial production of the *gari* enriched with AYB may also be embarked on to further add to the variety of *gari* available to the populace to solve the problem of malnutrition.
Table 1: Nutritional Composition of *gari* produced from PVAC and AYB blends

<table>
<thead>
<tr>
<th>Sample %</th>
<th>Moisture %</th>
<th>Ash %</th>
<th>CHO %</th>
<th>Crude Protein %</th>
<th>Crude lipids %</th>
<th>Crude fiber %</th>
<th>Calorific value mg/100g</th>
<th>B carotene mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>R100</td>
<td>4.61&lt;sup&gt;a&lt;/sup&gt; ± 0.81</td>
<td>1.56&lt;sup&gt;ab&lt;/sup&gt; ± 0.08</td>
<td>85.84&lt;sup&gt;ab&lt;/sup&gt; ± 0.94</td>
<td>3.23&lt;sup&gt;b&lt;/sup&gt; ± 0.34</td>
<td>2.69&lt;sup&gt;a&lt;/sup&gt; ± 0.22</td>
<td>2.06&lt;sup&gt;a&lt;/sup&gt; ± 0.02</td>
<td>1589.0&lt;sup&gt;a&lt;/sup&gt; ± 4.23</td>
<td>0.11&lt;sup&gt;d&lt;/sup&gt; ± 0.00</td>
</tr>
<tr>
<td>R150</td>
<td>4.20&lt;sup&gt;a&lt;/sup&gt; ± 1.04</td>
<td>2.01&lt;sup&gt;a&lt;/sup&gt; ± 0.12</td>
<td>83.46&lt;sup&gt;b&lt;/sup&gt; ± 2.49</td>
<td>4.66&lt;sup&gt;b&lt;/sup&gt; ± 0.05</td>
<td>3.96&lt;sup&gt;a&lt;/sup&gt; ± 3.39</td>
<td>1.73&lt;sup&gt;a&lt;/sup&gt; ± 0.04</td>
<td>1620.7&lt;sup&gt;a&lt;/sup&gt; ± 87.17</td>
<td>0.16&lt;sup&gt;a&lt;/sup&gt; ± 0.00</td>
</tr>
<tr>
<td>R300</td>
<td>2.47&lt;sup&gt;a&lt;/sup&gt; ± 0.66</td>
<td>1.93&lt;sup&gt;a&lt;/sup&gt; ± 0.49</td>
<td>88.97&lt;sup&gt;a&lt;/sup&gt; ± 1.26</td>
<td>3.61&lt;sup&gt;ab&lt;/sup&gt; ± 0.16</td>
<td>1.08&lt;sup&gt;a&lt;/sup&gt; ± 0.77</td>
<td>1.95&lt;sup&gt;a&lt;/sup&gt; ± 0.16</td>
<td>1586.7&lt;sup&gt;a&lt;/sup&gt; ± 10.49</td>
<td>0.14&lt;sup&gt;c&lt;/sup&gt; ± 0.00</td>
</tr>
<tr>
<td>R460</td>
<td>3.37&lt;sup&gt;a&lt;/sup&gt; ± 1.45</td>
<td>1.22&lt;sup&gt;b&lt;/sup&gt; ± 0.00</td>
<td>86.94&lt;sup&gt;ab&lt;/sup&gt; ± 2.40</td>
<td>4.66&lt;sup&gt;b&lt;/sup&gt; ± 0.01</td>
<td>2.06&lt;sup&gt;a&lt;/sup&gt; ± 0.96</td>
<td>1.75&lt;sup&gt;a&lt;/sup&gt; ± 0.01</td>
<td>1607.6&lt;sup&gt;a&lt;/sup&gt; ± 4.11</td>
<td>0.15&lt;sup&gt;ab&lt;/sup&gt; ± 0.00</td>
</tr>
<tr>
<td>R600</td>
<td>3.36&lt;sup&gt;a&lt;/sup&gt; ± 0.07</td>
<td>1.76&lt;sup&gt;ab&lt;/sup&gt; ± 0.01</td>
<td>87.27&lt;sup&gt;ab&lt;/sup&gt; ± 0.40</td>
<td>3.68&lt;sup&gt;ab&lt;/sup&gt; ± 0.47</td>
<td>1.99&lt;sup&gt;a&lt;/sup&gt; ± 0.28</td>
<td>1.95&lt;sup&gt;a&lt;/sup&gt; ± 0.13</td>
<td>1593.7&lt;sup&gt;a&lt;/sup&gt; ± 11.66</td>
<td>0.15&lt;sup&gt;b&lt;/sup&gt; ± 0.00</td>
</tr>
</tbody>
</table>

Mean values along the same column with different superscripts are significantly different (p<0.05)

Key:
R100 = 100% provitamin A cassava
R150 = 92.5% provitamin A cassava - 7.5% AYB mash
R300 = 85% provitamin A cassava - 15% AYB mash
R460 = 77% provitamin A cassava - 3% AYB mash
R600 = 70% provitamin A cassava - 30% AYB mash
### Table 2: Chemical Composition of *gari* produced from blends of provitamin A cassava and AYB

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>HCN (mg/kg)</th>
<th>pH</th>
<th>TTA(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R100</td>
<td>5.00(^{a})</td>
<td>4.20(^{b})</td>
<td>1.16(^{a})</td>
</tr>
<tr>
<td>R150</td>
<td>1.20(^{b})</td>
<td>4.35(^{a})</td>
<td>0.27(^{b})</td>
</tr>
<tr>
<td>R300</td>
<td>4.57(^{a})</td>
<td>4.20(^{b})</td>
<td>0.23(^{b})</td>
</tr>
<tr>
<td>R460</td>
<td>4.23(^{a})</td>
<td>4.30(^{a})</td>
<td>0.18(^{d})</td>
</tr>
<tr>
<td>R600</td>
<td>4.37(^{a})</td>
<td>4.20(^{b})</td>
<td>0.06(^{d})</td>
</tr>
</tbody>
</table>

Mean values along the same column with different superscripts are significantly different \((p<0.05)\)

**Key:**
- Sample R100 = 100% provitamin A cassava
- Sample R150 = 92.5% provitamin A cassava - 7.5% AYB mash
- Sample R300 = 85% provitamin A cassava - 15% AYB mash
- Sample R460 = 77% provitamin A cassava - 23% AYB mash
- Sample R600 = 70% provitamin A cassava - 30% AYB mash

### Table 3: Physicochemical properties of *gari* produced from blends provitamin A cassava and AYB

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>WAC %</th>
<th>Swelling %</th>
<th>Reconstitution index</th>
<th>Syneresis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R100</td>
<td>436.99(^{b})±16.22</td>
<td>529.92(^{a})±20.83</td>
<td>6.60(^{d})±0.77</td>
<td>34.65(^{a})±0.49</td>
</tr>
<tr>
<td>R150</td>
<td>462.56(^{ab})±18.86</td>
<td>517.90(^{a})±17.87</td>
<td>8.19(^{c})±0.20</td>
<td>30.41(^{b})±0.20</td>
</tr>
<tr>
<td>R300</td>
<td>474.64(^{a})±10.76</td>
<td>510.87(^{a})±4.39</td>
<td>10.92(^{b})±0.11</td>
<td>25.00(^{c})±0.00</td>
</tr>
<tr>
<td>R460</td>
<td>441.63(^{ab})±0.46</td>
<td>456.60(^{b})±3.70</td>
<td>10.47(^{b})±0.55</td>
<td>24.08(^{d})±0.01</td>
</tr>
<tr>
<td>R600</td>
<td>431.82(^{b})±9.42</td>
<td>456.14(^{b})±1.87</td>
<td>12.48(^{a})±0.04</td>
<td>20.54(^{c})±0.14</td>
</tr>
</tbody>
</table>

Mean values along the same column with different superscripts are significantly different \((p<0.05)\)

**Key:**
- Sample R100 = 100% provitamin A cassava
- Sample R150 = 92.5% provitamin A cassava - 7.5% AYB mash
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- Sample R460 = 77% provitamin A cassava - 23% AYB mash
- Sample R600 = 70% provitamin A cassava - 30% AYB mash
Table 4: Anti nutritional factor of *gari* produced from blends provitamin A cassava and AYB

<table>
<thead>
<tr>
<th>Samples</th>
<th>Trypsin inhibitor %</th>
<th>Phenolic mg/100g</th>
<th>Alkaloids mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td>R100</td>
<td>1.95±0.02</td>
<td>4.53±0.01</td>
<td>2.56±0.00</td>
</tr>
<tr>
<td>R150</td>
<td>5.65±0.03</td>
<td>12.28±0.10</td>
<td>4.16±0.00</td>
</tr>
<tr>
<td>R300</td>
<td>5.45±0.66</td>
<td>17.88±0.20</td>
<td>5.33±0.00</td>
</tr>
<tr>
<td>R460</td>
<td>3.09±0.25</td>
<td>23.87±0.00</td>
<td>3.98±0.00</td>
</tr>
<tr>
<td>R600</td>
<td>3.31±0.00</td>
<td>31.02±0.51</td>
<td>5.13±0.01</td>
</tr>
</tbody>
</table>

Key:
R100 = 100% provitamin A cassava
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R600 = 70% provitamin A cassava - 30% AYB mash

Table 5: Sensory evaluation of *gari* produced from blends provitamin A cassava and African yam bean

<table>
<thead>
<tr>
<th>Sample</th>
<th>Color</th>
<th>Taste</th>
<th>Texture</th>
<th>Aroma</th>
<th>Appearance</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>R100</td>
<td>7.73±1.11</td>
<td>7.43±1.43</td>
<td>7.37±1.59</td>
<td>7.27±1.31</td>
<td>7.33±1.47</td>
<td>7.73±1.04</td>
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<tr>
<td>R150</td>
<td>7.07±1.11</td>
<td>7.47±1.01</td>
<td>6.90±1.30</td>
<td>7.13±0.86</td>
<td>6.60±1.38</td>
<td>7.20±1.19</td>
</tr>
<tr>
<td>R300</td>
<td>6.43±1.38</td>
<td>6.67±1.27</td>
<td>6.17±1.78</td>
<td>6.10±1.60</td>
<td>5.80±1.73</td>
<td>6.30±1.34</td>
</tr>
<tr>
<td>R460</td>
<td>5.93±1.08</td>
<td>5.77±1.76</td>
<td>5.93±1.46</td>
<td>6.10±1.30</td>
<td>5.27±1.28</td>
<td>6.07±1.17</td>
</tr>
<tr>
<td>R600</td>
<td>6.47±0.97</td>
<td>6.50±1.33</td>
<td>6.83±1.34</td>
<td>6.97±1.45</td>
<td>6.70±1.26</td>
<td>6.73±1.26</td>
</tr>
</tbody>
</table>

Key:
Sample R100 = 100% provitamin A cassava
Sample R150 = 92.5% provitamin A cassava - 7.5% AYB mash
Sample R300 = 85% provitamin A cassava - 15% AYB mash
Sample R460 = 77% provitamin A cassava - 23% AYB mash
Sample R600 = 70% provitamin A cassava - 30% AYB mash
REFERENCES


18 Komolafe EA and JO Arawande. Evaluation of the quantity and quality of *gari* produced from the cultivars of cassava. JORIND. 2010: 8 (1).


