EFFECT OF *GARIFICATION* (ROASTING) DURATION ON THE QUALITY CHARACTERISTICS OF CASSAVA GARI

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Abstract
The effect of different garification duration on the chemical, pasting, functional and sensory properties of cassava gari was studied. Sieved fermented cassava mash of equal quantity was roasted for 15minutes, 20 minutes, 25 minutes, 30 minutes and 35 minutes at constant roasting temperature of 95°C, the resulting cassava gari samples were subjected to chemical, pasting, functional and sensory analysis using standard methods. Increase in garification duration resulted in reduction in the moisture and hydrogen cyanide contents, and caused an increase in sugar content and pH. The moisture, protein, ash, fibre, sugar and hydrogen cyanide contents were in the range 7.96% - 17.89%; 1.89% - 2.23%; 1.03% - 1.64%; 1.16% - 1.97%; 2.21% - 5.05% and 14.08 mg/kg - 23.43 mg/kg respectively. Samples roasted for 25 minutes and 30 minutes had higher peak and final viscosities with lower breakdown viscosity, peak time and pasting temperature. Even though the percentage yield reduced with increase in garification duration, the swelling index and water absorption capacity of samples roasted for higher duration were however better. The ranges of the percentage yield, swelling index and water absorption capacity were: 53.57% - 75.00%; 1.20 - 3.10 and 4.00 ml/g - 7.60 ml/g respectively. In terms of all the sensory attributes examined samples roasted for 15 minutes and 20 minutes were poorly rated. There was no significant difference between the taste, colour, particle size and overall acceptability of samples roasted for 25 minutes, 30 minutes and 35 minutes. Optimum garification duration of 30minutes is recommended

Keywords: Cassava gari, garification duration, chemical properties, functional properties, pasting properties and sensory Properties.

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1. INTRODUCTION

Cassava (*Manihot esculenta crantz*) is a native of South America but was introduced to West Africa in the late 16th century where it is now an important staple in Nigeria, Ghana and some other African Countries (Aworh, 2008). The ability of the crop to survive during drought makes it one of the easiest crops that can be cultivated even when rainfall is not regular. It is reported that over 500million people around the world derive their daily carbohydrate intake from cassava (Udofia *et al.*, 2010). There are two major issues in the utilization of cassava; first, cassava root is highly perishable and cannot be stored in fresh form for more than 3 days after harvesting. Physiological deterioration of the root occurs in 2 -3 days after harvesting follow by microbial deterioration in 3 – 5 days (Akingbala *et al.*, 2005). Second, the root contain two cyanogenic glucosides, *linamarin* and *lotausralin* which on hydrolysis by enzyme release toxic hydrogen cyanide which pose health risk to human being. These two reasons usually necessitate the immediate consumption and processing of cassava roots after harvesting. Among many food products derived from cassava, *gari* is by far the most popular (Oluwole *et al.*, 2004).

Gari is creamy-white partially gelatinized roasted free flowing granular flour made from cassava roots (Sanni *et al*., 2008). To prepare gari fresh cassava roots are peeled, washed and grated; the resulting mash is put in a porous sack and allow to ferment for 3-5 days under heavy weight or screw press. After fermentation, the mash is dewatered with screw press, pulverized, sifted and roasted in iron pan to obtain *gari* (Agunbiade and Adanlawo, 2007). The roasting process which usually dextrinizes the starch and dries the granules is called *garification*. *Gari* is commonly consumed either as gelatinized dough (*eba*)

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served with sauces/soups or soak in cold water with sugar and roasted groundnut. It is a good source of energy and fibre, its cheapness, ease of storage and preparation for consumption have combined to make it an important food item in Nigeria.

Fermentation period and *garification* duration are two processing steps usually manipulated by most gari producers in order to save time and for economic gains at the detriment of the health of consumers. Inadequate fermentation and short garification duration may affect the quality characteristics of *gari* and result in high residual cyanide in the product which can cause consumers to suffer from acute toxicity and eventually death. Consumption of sub-lethal doses of cyanide from cassava products over long period of time can result in chronic cyanide toxicity that increases prevalence of goiter and cretinism in iodine-deficient areas (Aworh, 2008). Hence there is a need to assess the effect of different fermentation and garification duration on the quality characteristics and residual cyanide content of *gari* in order to be able to recommend optimum durations for the two processing steps. The effect of different fermentation period on the quality characteristics of *gari* has been studied (Ogueke *et al*., 2013; Owuamanam *et al.,* 2010; Agunbiade and Adanlawo, 2007), however there is dearth of information on the effect of garification duration of the quality characteristics of gari at constant mash quantity and garification temperature. This study therefore evaluates the effect of garification duration on the chemical, functional, pasting and sensory properties of *gari*.

2. MATERIAL AND METHODS

Production of *Gari*

Freshly harvested cassava root (local variety) obtained from a farm within the campus of Federal Polytechnic Ado-Ekiti was used in this study. The roots were peeled manually using stainless steel knife, washed in clean water and grated using a locally fabricated grating machine. The grated mash was put into a sack and the sack was tied with a string. The mash was left to ferment for four days (using natural microflora of the mash) at ambient temperature, after which the mash was dewatered with a screw press. The resulting cake was crushed manually and sieved using aluminum made mesh in order to remove fibre. Each sample of measured quantity (700g) of the granulated mash obtained was then roasted (garified) in iron pot with constant stirring (in order to ensure uniform temperature distribution) for 15 minutes, 20 minutes, 25 minutes, 30 minutes and 35 minutes at fixed garifying temperature of 95^{o}C. The *gari* samples produced were allowed to cool and then packaged in high density polyethylene bags which were then heat-sealed. The surface area and the volume of the iron pot used for garification were 2731.80 cm^{2} and 9891.00 cm^{3} respectively.

Analyses

Determination of Chemical Properties

The moisture, fat, protein, fibre and ash contents of the five *gari* samples were determined according to AOAC (2005) methods; carbohydrate content was determined by difference. The sugar content was determined by the phenol-sulphuric acid method of Dubois *et al.* (1956) while the residual cyanide content was determined using the method of Essier *et al*. (1993). The pH of previously homogenized suspension of 5g sample in 50ml distilled water was taken as the pH of the sample. The pH meter used (Starter 2100 Bench pH Meter) had been previously standardized with buffer solution of pH 4 and 9.

Determination of Functional Properties and Yield

Swelling index (cold water) was determined according to method described by Sanni *et al.* (2001). A 50ml measuring cylinder was filled with gari sample up to 10ml mark and then filled up to 50ml mark with distilled water. The mixture was inverted several times for 2 minutes after which it was allowed to stand for 5minutes before the volume of hydrated gari was read. Swelling index was obtained as the ratio of volume of hydrated *gari* to volume of dry gari. The method described by Sathe *et al.* (1982) was adopted for the determination of water absorption capacity; bulk density was determined by the fraction of the weight of *gari* samples over the volume of same in a graduated measuring cylinder as described by Onwuka (2005). The yield was calculated on the basis of the weight of sieved fermented cassava mash before garification

$$Yield = \frac{\text{Weight of gari}}{\text{Weight of fermented cassava mash}} \times 100$$

Determination of Pasting Properties

The pasting properties of the *gari* samples were determined using Rapid Visco Analyser (RVA) (Model Rva-3D). Slurry of 3g of the sample in 25ml of water was used while the 12 minute profile was adopted with sample heated from 50^{o}C to 95^{o}C and then cooled back to 50^{o}C

Determination of Sensory Properties

A twenty-man member panel (semi trained) consisting of staff and students of Federal Polytechnic Ado-Ekiti who are familiar with *gari* were selected for the sensory evaluation of the taste, colour, aroma, particle size and overall acceptability of the gari samples using a 9-point hedonic scale where 9 represents like extremely and 1 represents dislike extremely.

Statistical Analysis

The difference in the experimental data was tested for statistical significance P≤0.05 by Statistical Analysis of Variance (ANOVA) using SPSS 17.0 software package (Statistical Package for Social Scientist, Michigan, USA)

3. RESULTS AND DISCUSSION

Chemical Properties

The effect of different garification duration on some chemical properties of cassava *gari* is presented in Table1. There was significant difference in the moisture contents of the samples; there was reduction in the moisture content of *gari* as the duration of garification increased. Moisture content is a major determinant of the shelf stability of gari; high moisture content usually predisposes *gari* to problem of formation of lumps and mould growth within a very short period of storage. Even though low garification duration may result in higher yield, such sample will have a very poor storage potential.

FAO (1992) had recommended a moisture safe level of 12% - 13% for storage of cassava flour, while Ukpabi and Ndimele (1990) had reported that *gari* samples with moisture content of 13% - 16% can be successfully stored for up to 7 months without mould infestation. However only the *gari* samples roasted for 30mins and 35mins had moisture content that was below the stipulated standard of revised *gari* regulation of 10% by Standard Organisation of Nigeria/International Institute of Tropical Agriculture (SON/IITA) as reported by Sanni *et al.* (2005). This indicates that these two samples will have good storage potential and all things being equal will be fit for export.

The protein content of gari increased with increase in the duration of garification, this increase can be as a result of relative reduction in moisture content (concentration effect). It is generally known that other constituents of any biomaterial increase as the moisture is being reduced.

The range of protein content of the *gari* samples produced was comparable to 1.76% - 2.11% reported for cassava gari by Ogueke *et al*. (2013), There was fluctuation in the fat contents of the samples with sample roasted for 15 minutes having the highest while sample roasted for 25 minutes had the lowest, however the fat contents of all the samples were not significantly different. The ash contents of all the samples which were influenced by concentration effect were lower than 2.75% maximum level permitted for *gari* (Codex Standard 151-1989).

The fibre contents of the samples reduced significantly with increase in garification duration, this observation may be as a result of thermal degradation of fibrous materials, samples exposed to heat for a longer duration (35 minutes) had the lowest fibre content.

The fibre contents of the samples were below the regulatory standard of 2.0% (Codex Standard 151-1989, Sanni *et al*., 2005). Generally gari with low fibre content is considered to be of good quality (Almazan *et al.*, 1987) and it is preferred by most *gari* consumers.

There was no significant difference between the fibre contents of samples roasted for 30 minutes and 35 minutes, this suggest that roasting *gari* for these time durations will help reduce the fibre content. There was significant difference in the carbohydrate content of the samples, the high carbohydrate content makes *gari* to be a cheap source of energy. There was significant difference in the sugar contents of the samples, the gradual increase in the sugar content can be attributed to concentration effect and partial dextrinization of starch as garification duration increased.

The significant difference in the hydrogen cyanide contents of the samples indicates that garification play a major role in the reduction of cyanide content of *gari*. Aworh (2008) reported that processing of cassava roots into *gari* is the most effective means of reducing cyanide content to a safe level and that most of the cyanide in cassava tubers is eliminated during the peeling, pressing and frying operation.

The hydrogen cyanide contents of the samples reduced as the garification duration increased, this observation suggest that longer garification duration helps to reduce the residual cyanide in *gari* by way of vapourization. The cyanide content of *gari* roasted for 15mins was above the recommended standard of 20mg/kg by SON/IITA as reported by Sanni *et al*., (2005), this indicate that the usual habit of some *gari* producers to roast gari for few minutes and thereafter dry it partially in the open air in order to obtain maximum yield and good profit, will leave high residual cyanide in the product. This is particularly hazardous in communities where consumption of *gari* is very common as it can lead to problem of chronic cyanide toxicity.

The pH values reported for all the samples in this work were comparable to pH range (3.40 – 4.50) reported for cassava gari by Komolafe and Arawande (2010) and was within the recommended range of 3.50 – 4.50 for acid fermented products (Bainbridge *et al.*, 1996). The relatively high pH values for samples roasted for a longer period was as a result of vapourization of lactic acid and other volatile organic acids which reduce the acidity of the product. The assessment of pH is very important in *gari* and other flour samples as acid, in conjunction with sugar, often determines the taste of such product; taste is majorly a balance between acid and sugar contents. Acid particularly contribute to the sourness of gari which is preferable by some *gari* consumers.

Pasting Properties

The pasting properties of cassava *gari* samples are presented in Table 2. There was significant difference in the peak viscosity and final viscosity of the samples, sample roasted for 25 minutes had the highest peak and final viscosities followed by the sample roasted for 30 minutes. The peak and final viscosities reported for all the samples in this study were generally lower than 3611.04 cP (300.92 RVU) and 2931.00 cP (244.25 RVU) reported for cassava *gari* by Oluwamukomi and Jolayemi (2012) respectively.

Table 1: Effect of Garification Duration on the Chemical Properties of Cassava Gari

Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	Carbohydrate (%)	Sugar (%)	Hydrogen Cyanide (mg/kg	pH
G15	17.89±1.11[a]	1.89±0.90[c]	1.82±0.30[a]	1.03±0.05[d]	1.97±0.20[a]	75.40±1.50[c]	2.23±0.26[c]	23.43±1.60[a]	3.86±0.02[d]
G20	14.06±1.20[b]	2.04±0.10[bc]	1.76±0.50[a]	1.12±0.06[d]	1.79±0.11[a]	79.23±1.70[b]	2.21±0.30[c]	19.92±0.90[b]	3.96±0.06[c]
G25	12.67±0.90[b]	2.12±0.11[ab]	1.62±0.09[a]	1.21±0.02[c]	1.68±0.30[ab]	80.70±1.90[b]	3.67±0.52[b]	16.40±1.12[c]	4.15±0.05[b]
G30	8.25±1.00[c]	2.21±0.08[ab]	1.80±0.20[a]	1.48±0.10[b]	1.34±0.16[bc]	84.92±1.56[a]	4.59±0.31[ab]	14.15±1.00[d]	4.27±0.02[b]
G35	7.96±0.60[c]	2.23±0.10[a]	1.78±0.11[a]	1.64±0.09[a]	1.16±0.09[c]	85.23±1.12[a]	5.05±1.00[a]	14.08±1.01[d]	4.21±0.01[a]

Data represent means of three determinations ± standard deviation
Values with different superscript in the same column are significantly different ($P \leq .05$)

Table 2: Effect of Garification Duration on the Pasting Properties of Cassava Gari

Sample	Peak Viscosity (cP)	Trough (cP)	Breakdown Viscosity (cP)	Final Viscosity (cP)	Setback Viscosity (cP)	Peak Time (mins)	Pasting Temperature (°C)
G15	998.00±1.00[e]	886.00±0.25[e]	112.00±0.20[b]	1476.00±1.00[e]	590.00±0.50[e]	7.00±0.04[a]	94.40±1.00[a]
G20	1146.00±0.50[c]	1032.00±1.00[d]	114.00±0.00[a]	1902.00±0.00[c]	870.00±0.00[c]	6.93±0.01[b]	94.50±0.50[a]
G25	1932.00±1.10[a]	1889.00±0.00[a]	43.00±0.05[d]	2821.00±0.85[a]	932.00±0.65[b]	6.60±0.00[c]	89.65±0.18[c]
G30	1720.00±0.00[b]	1672.00±0.17[b]	48.00±0.00[c]	2781.00±0.52[b]	1109.00±1.00[a]	6.60±0.02[c]	88.75±0.00[c]
G35	1143.00±0.58[d]	1114.00±1.00[c]	29.00±0.40[e]	1817.00±1.00[d]	703.00±0.20[d]	6.33±0.00[d]	91.95±0.10[b]

Data represent means of three determinations ± standard deviation
Values with different superscript in the same column are significantly different ($P \leq .05$)

This difference may be as a result of variety of cassava used and different fermentation period. Peak viscosity reflects the maximum viscosity developed during or soon after the heating portion of the pasting test (Newport Scientific,1998) and it gives an indication of the viscous load to be encountered during mixing (Maziya-Dixon *et al.*, 2005). The increase in duration of garification tends to increase the degree of starch damage and the disruption of crystalline nature of the starch granules, this in turn increase the ability of starch granules to imbibe water, swell freely with high peak viscosity. This pattern of result for samples roasted for 25minutes and 30minutes corresponds with that obtained for their swelling index and water absorption capacity, this indicate the ability of the two samples to form sticky dough (*eba*). Gari is usually prepared for eating by stirring some quantity in hot water to form sticky dough (eba) which can be eaten with sauces or soups. Peak viscosity has been reported to be closely associated with the degree of starch damage and high starch damage results in high peak viscosity (Sanni *et al.,* 2008). The final viscosity is usually observed during the final step of pasting test, the increase in viscosity during this stage has been attributed to alignment of chains of amylose resulting in the formation of a gel structure (Sandhu *et al.,* 2007) The final viscosity indicates the ability of the starch-based food to form a viscous paste or gel after cooking and cooling (Adebowale *et al*., 2008) and it is useful in predicting and defining the final textural quality of starchy foods. Hence *gari* sample roasted for 15 minutes, 20 minutes and 35 minutes will form less sticky dough (eba) with poor mouldability while gari samples roasted for 25 minutes and 30 minutes will form sticky and mouldable dough (eba) which is preferable by most consumers. The mouldability of the dough which is influenced by the final viscosity is one of the factors that determine the consumer acceptability of *gari*. This pattern of result for peak and final viscosities reported in this study indicate that reducing or increasing the garification duration beyond certain critical range (25 -30minutes) will be to the detriment of the pasting properties.

The hold period of the pasting test during which sample is held at high temperature (95°C) with mechanical shear stress (rapid constant and continuous mixing) is usually accompanied by breakdown in viscosity (Newport Scientific, 1998). This is as a result of further disruption of starch granules resulting in the leaching out of amylose molecules into solution which align in the direction of the shear. The ability of a sample to withstand this breakdown in viscosity i.e. withstand heating and mechanical shear stress that is usually encountered during processing is measured by breakdown viscosity and it is an important factor for many processes especially those requiring stable paste and low retrogradation/syneresis. There was significant difference in the breakdown viscosities of the samples. The breakdown viscosity did not follow any particular pattern even though those of sample roasted for 25 minutes, 30 minutes and 35 minutes were much lower than the rest indicating their ability to resist shear thinning or breakdown in viscosity during heating. The result indicates that considerable longer duration of garification will produce gari of improved paste stability. It has been reported that the lower the breakdown viscosity, the higher the ability of the sample to withstand heating and shear stress during cooking and form stable paste (Adebowale *et al.,* 2005). The phase of the pasting curve after cooling of the sample to 50°C is known as setback region and it shows the tendency of starch to re-associate and retrograde; lower setback during the cooling of the paste indicates greater resistance to retrogradation (Sanni *et al.*, 2004). Also the setback value has implication on digestibility; low setback value indicate low retrogradation tendency and consequently improved paste/dough digestibility; this is because retrogradation is known to increase resistance of starchy foods to enzymatic hydrolysis. There was significant difference in the setback viscosity of the samples. The setback viscosity increased from 590.00 cP for sample roasted for 15 minutes and reached the maximum of 1109.00 cP for sample roasted for 30minutes after which it reduced to 703.00 cP for sample roasted for 35 minutes, this suggest that paste/dough made from sample roasted for 30 minutes may become firmer and stiffer after cooling.

The pasting temperature reported for *gari* samples in this study (88.75 °C – 94.50 °C) was higher than 80.85°C and 73.44°C reported for *gari* and tapioca by Oluwamukomi and Jolayemi (2012) and Arinola and Ogunbusola (2013) respectively. There was no significant difference in the pasting temperature of samples roasted for 25minutes and 30 minutes, however the pasting temperatures of the two samples were significantly different from that of other samples. Increase or decrease in garification duration above or below the range of 25 minutes – 30 minutes seems to increase the pasting temperature of *gari*. This suggests that optimum garification duration will result in a sample with low pasting temperature and consequently such sample will require less heat energy to form thick paste/dough. It has been reported that pasting temperature is a measure of the minimum temperature required to cook a given food sample and it also has implication on the energy cost of preparing food sample (Newport Scientific, 1998). Generally, the pasting temperature of all the samples was below the boiling point of water which indicates that they will readily form paste in hot water. The peak time of the samples reduced significantly as the garification duration increased even though the peak times of samples roasted for 25 minutes and 30 minutes were significantly the same. The time to attain peak viscosity is considerably lower than 4.53 minutes reported for tapioca by Arinola and Ogunbusola (2013) and 3.93 – 4.07 minutes reported for soy-melon enriched *gari* by Oluwamukomi and Jolayemi (2012). The high peak time may be as a result of relatively high fibre in *gari* when compared with tapioca and enriched gari. The combination of pasting temperature and time would determine the amount of energy required to cook the sample.

Functional Properties

The functional properties and yield of the various cassava *gari* samples are presented in Table 3. The swelling index of the samples, which depicts the ability of *gari* to imbibe water and swell, was affected significantly by the duration of garification. The swelling index of samples roasted for 25mins, 30mins and 35mins were significantly the same and were lower than 3.79 reported for cassava *gari* by Oluwamukomi and Jolayemi (2012) but agrees with 3.00 recommended by Almazan (1992). Swelling of *gari* is influenced by the starch content and the degree of gelatinization; samples roasted for longer period were properly gelatinized with disruption of intermolecular hydrogen bonds and crystalline nature of the starch granules, this enhance the ability of starch granules to imbibe water and swell. Swelling capacity has been shown to give a greater volume and more feeling of satiety per unit weight of gari to a consumer and a swelling index of at least 3.00 was recommended to be preferred by consumers (Almazan, 1992). From the foregoing it thus mean that roasting gari for short time which may be of undue advantage to gari producers will be of disadvantage to the consumers.

Table 3: Effect of Garification Duration on the Functional Properties and Yield of Cassava Gari

Sample	Swelling Index (v/v)	Water Absorption Capacity (ml/g)	Bulk Density (g/ml)	Yield* (%)
G15	1.20±0.10[c]	4.00±0.20[e]	0.57±0.02[b]	75.00±3.00[a]
G20	1.80±0.20[b]	5.40±0.00[d]	0.50±0.01[c]	71.43±2.30[a]
G25	3.00±0.10[a]	6.40±0.10[c]	0.62±0.02[a]	62.15±2.00[b]
G30	3.10±0.20[a]	7.60±0.20[a]	0.62±0.01[a]	57.14±2.00[c]
G35	3.00±0.10[a]	6.80±0.30[b]	0.58±0.01[b]	53.57±1.50[c]

** The yield is based on the weight of sieved fermented cassava mash*
Data represent means of three determinations ± standard deviation
Values with different superscript in the same column are significantly different ($P \leq .05$)

There was significant difference in the water absorption capacities of all the *gari* samples, the water absorption capacities of the samples with the exception of sample roasted for 15mins were higher than 4.68ml/g reported for cassava gari by Koubala *et al.* (2014). The water absorption capacity increased with increase in garification duration with sample roasted for 30 minutes having the highest, this may be as a result of gelatinization effect on the ability of the starch granules in *gari* to absorb water. Therefore proper garification will enhance the water absorption capacity of *gari*. The values of bulk density reported in this study were lower than 0.67 g/ml reported for cassava *gari* by Koubala *et al.* (2014). Bulk density has implication in the packaging and transportation of food materials (Arinola *et al.*, 2016); high bulk density products are known to exhibit better packaging property than those with low bulk density because higher quantity could be packaged in a given volume thus reducing storage space, packaging and transportation cost. Sample roasted for 25 minutes and 30 minutes had the highest bulk density and would therefore offer packaging and transportation advantages. The yields of samples roasted for 15 minutes and 20 minutes were significantly higher than that of other samples which is an indication of more profit, this explain the reason why some *gari* producers usually used short garification duration without due cognizance of the effect of such on the quality indices of gari. Karim *et al.* (2009), Akingbala *et al.* (2005) and Oluwole *et al.*, (2004) had reported a yield of 31.20%, 29.9% and 24.9% respectively based on the weight of fresh cassava roots as against the range of 53.57% - 75.00% reported in this study on the basis of sieved fermented cassava mash.

Sensory Properties

The effect of different garification duration on the sensory properties of cassava gari is presented in Table 4. The taste of the *gari* roasted for 25 minutes and above was preferred over and above the taste of samples roasted for lower duration as indicated in the ratings; even though the rating for the taste of sample roasted for 35 minutes was higher than that of samples roasted for 25 minutes and 30 minutes, the difference was however not significant. The same pattern of result was observed in the ratings for colour with samples roasted for 15 minutes and 20 minutes poorly rated. Generally the preference for colour of *gari* in Nigeria has been divided along the ethnic line, while the Yorubas in the southwestern part of Nigeria prefer creamy white colour, the Igbos in the southeastern part of the country prefer red gari to which plam oil has been added during garification and the Hausas in the northern part of the country seems to be indifferent to the colour of gari. So colour cannot be used even subjectively to determine *gari* that has been properly roasted especially in Nigeria. Aroma is a more sensitive index of quality, aroma of gari roasted for 15 minutes and 20 minutes was poorly rated whereas samples roasted for 30 minutes and 35 minutes had significantly better aroma than the rest. Aroma of *gari* is a combination of the aroma of the root, aroma developed during fermentation by the microflora of the mash and more importantly aroma that developed during the garification.

Table 4: Effect of Garification Duration on the Sensory Properties of Cassava Gari

Sample	Taste	Colour	Aroma	Particle size	Overall Acceptability
G15	3.25[b]	5.00[b]	3.70[c]	4.10[b]	4.05[b]
G20	4.10[b]	4.70 [b]	4.55[c]	3.05[b]	4.10[b]
G25	6.70 [a]	7.30[a]	6.30[b]	7.05[a]	6.95[a]
G30	7.45 [a]	6.60 [a]	6.95 [a]	6.25 [a]	7.35 [a]
G35	7.65[a]	6.60 [a]	7.00 [a]	6.50 [a]	7.45 [a]

Values with different superscript in the same column are significantly different ($P \leq .05$)

It was noticed that the unique aroma of gari becomes more perceivable as the garification duration increased which suggest that garification step contribute more to the aroma threshold of *gari* than any other factor. Consumers of gari generally prefer gari with fine particle size and this was reflected in the low ratings given to samples roasted for 15 minutes and 20 minutes. It was observed during garification that the particle size of *gari* was progressively smaller with increase in garification duration; this may be as a result of the effect of heat on the starch granules. These observations suggest that particle size and aroma may be sensorial parameters that can be used to subjectively determine *gari* that has been properly garified. In terms of overall acceptability, the rating increased significantly with increase in garification duration in agreement with increase in the ratings of taste, colour, aroma and particle size. However there was no significant difference in the overall acceptability of samples roasted for 25minutes, 30minutes and 35minutes.

4. CONCLUSIONS

This study has revealed that the chemical, pasting, functional and sensory properties of *gari* were significantly affected by garification duration. Generally *gari* roasted for duration above 25 minutes was better as reflected in virtually all the quality indices examined, however optimum garification duration of 30 minutes is recommended from this study. All samples roasted for duration lower than 25 minutes were poorly rated.

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