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AGE ASSESSMENT OF TWO CASSAVA CULTIVARS ON YIELD AND QUALITY OF GARI

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ABSTRACT

This study investigated the age effects of cassava roots on GARI yield and quality through the assessment of chemical analysis of two cassava varieties that were processed into gari, OKO IYAWO and TME 419; 12, 15, and 18 months of each of the cassava roots were selected. Chemical analyses done on the samples were: pH, total titratable acidity (TTA), total crude fiber (TCF), ash contents (AC), and moisture contents (MC). The results were pH of OKO IYAWO: 3.65, 4.00 and 3.75; pH of TME 419: 3.75, 4.00 and 4.21; TTA of OKO IYAWO: 0.85, 0.93 and 0.87; TTA of TME 419: 0.97, 0.95 and 0.84; TCF of OKO IYAWO: 2.77, 1.92 and 2.19; TCF of TME 419: 3.63, 1.82 and 1.62; AC of OKO IYAWO :1.30, 1.30 and 1.34; AC of TME 419: 1.24, 1.31 and 1.31; MC of OKO IYAWO: 3.7, 3.90 and 5.00; MC of TME 419: 5.5, 2.90 and 2.40. SI of OKO IYAWO: 2.80, 2.88 and 3.00; SI of TME 419: 3.00, 3.08 and 2.92 for 12, 15 and 18 months respectively. Finally, Gari yield values of OKO IYAWO cassava were 24%, 26% and 27% for the age of 12, 15 and 18 months respectively however, Gari yield of TME 419 cassava were 35%, 34% and 18% for the age of 12, 15 and 18 months respectively. The chemical analysis done were within the standard recommendation.

Keywords: Cassava age, gari quality, gari yield, cassava varieties, assessment, recommendation

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INTRODUCTION

Cassava is one of the most drought-tolerant crops and can be successfully grown on marginal soils, giving reasonable yields where many other crops do not thrive well FAO (2004). It is root is one of the major root tubers produced in the forest zones in Nigeria. Cassava is propagated by stem cutting and it is ready for harvesting after a period of eight months to one year, depending on the variety (Stephen, 1998). Nigeria is the world's largest producer of cassava with an estimated annual production of 54 million tons from an estimated area of 1.7 million hectares of land FAO (2013).

In Nigeria, similar to other West African countries, gari is the major form in which cassava is consumed similarly, higher or more than 70% of the cassava root is processed into gari in Nigeria Achinewhu *et al.* (1998). However, cassava roots spoil quickly after harvest due to its relatively high moisture and cyanide content therefore, in order to avoid this loss, it has to be processed into by-products or into dry forms that

can be stored for longer periods and to lower cyanide levels (Asiedu, 1989; Opara, 1999).
In fact, with the current food crisis in Nigeria, it is important to improve the yield and quality of *gari* products through the use of different cassava varieties and different age at which cassava roots are harvested. However, little knowledge was known about the effects of cassava varieties and different cassava ages on the yield and quality of *gari*. Therefore, the objective of this study was to determine whether age at harvest and varietal differences of selected cassava roots had any effect on the yield and quality of *gari* produced from these two varieties, a local variety of Oko iyawo and an improved cassava variety of TME 419.

MATERIALS AND METHODS

Fresh cassava tubers of the two cassava cultivars were used in this study, one is local variety of Oko iyawo and the other is an improved cassava variety of TME 419. The cuttings of local variety (Oko-iyawo) were sourced from local farmers and cuttings of an improved TME 419 cassava variety were obtained from the International Institute for Tropical Agriculture (IITA). The two cassava varieties were selected for their recognition among cassava growers in Nigeria. These cuttings were used to establish an experimental plot in Ogbomoso, Oyo State, Nigeria.

The two varieties, a local variety of Oko iyawo and an improved cassava variety of TME 419 were planted and harvested at maturity age of 12, 15 and 18 months, they were cleaned and sorted. To avoid waste, ten kilograms of newly harvested tubers with regular shapes of each of the two varieties at different ages were selected for this work. The method described by Achinewhu; *et al.* (1998) and Akingbala; *et al.* (2005) were adopted for the processing. The processing of cassava tubers into *gari* began on the day of harvest to avoid the rotten of the tubers. However, before cassava was processed into *gari*, they were carefully peeled neatly. They were washed, drained, and grated in a mechanized commercial grater. In order to know the loss from the tubers, the peeled cassava was weighed, and thereafter the final weight was removed from the initial weight. The grated pulp (mash) was loaded into jute bags and tied up with a thread. The mash was left to naturally fermentation for a period of 5 days at ambient temperature before pressing out the juice with a hydraulic press. The pressed-out mash (cake) was manually crushed and sieved with 1.50 mm mesh and fibers were removed before and roasting over a low fire. The roasted granules of *gari* were sieved through a cane mesh. The *gari* allowed to cool and weighed to determine the *gari* yield.

Physicochemical properties determination

The Physicochemical parameters determined were titratable acidity, crude fiber, pH, ash contents, and moisture contents using the standard methods described by Sanni *et al.* (2001). The methods of Montagnac *et al.* (2009) and Asiedu, 1989 were adopted in determining the pH and acidity of the products.

Percentage yield determination of gari

The yield of the samples was determined according to Sobowale *et al.* (2016), this was done to establish the basis for comparing the yield obtained in the two varieties at different age. The total amount of *gari* obtained, expressed as a percentage of the fresh cassava roots was calculated as follows;

$$\%\text{Yield} = \frac{\text{Mass of gari obtained}}{\text{Mass of cassava that produced the gari}} \times 100\% \quad \ldots\ldots (1)$$

Moisture contents

The moisture contents were calculated using the formula by Ndirika and Oyeleke (2006), different grams of dried samples of *gari* were weighed in a moisture dish and dried at 60^0 C for 6 hours. The moisture contents of *gari* were calculated by:

$$Mc\ (\text{wb})\% = \frac{Ww - Wd}{Ww} X\ 100 \quad \ldots. (2)$$

Where;
Ww is the weight of the wet sample (g),
Wd is the weight of the dried sample (g),
Mc is moisture content wet basis.

Swelling index (SI)

The Swelling index (SI) was determined using Sanni *et al.* (2001) method. The *gari* samples were dried at 60^0C for 6 hours. A 100 ml graduated measuring cylinder was filled with dried *gari* samples to a 25 ml level and filled to the 100 ml mark with distilled water. The top of the cylinder was tightly covered and the content

was mixed by inverting the cylinder. After 2 minutes, the cylinder was inverted again. The cylinder was then left to stand for 3 minutes (5 minutes total) and the final volume occupied was recorded.

$SI = \frac{Vf}{Vi}$ ….. (3)

Where,

SI = Swelling index

Vf = Final volume of sample in water;

$V\,i$ = Initial volume of sample in water.

Sensory evaluation of gari

The *gari* samples were subjected to sensory evaluation using 20 semi-skilled randomly selected panelists comprising males and females to eliminate contrast effect and positional bias. The panelists were asked to evaluate the *gari* samples in dry particulate form for color, sourness, taste, aroma, texture, and overall acceptability. The *gari* samples were also assessed in soaked form for color, taste, aroma, texture, soakability, and overall acceptability. Each panelist's score was reflected on a nine-point hedonic scale ranging from nine (like extremely) to one (dislike extremely) as described by Masen (1982). The results of the evaluation were then subjected to statistical analysis.

Statistical analysis

Data were subjected to statistical analysis of variance (ANOVA) using SPSS version 10.0. Means were separated using the Duncan Multiple Range Test (DMRT).

RESULTS

The percentage of gari yield were as indicated in Table 1; the analyzed physicochemical properties determination of gari were indicated in Table 2; gari swelling capacity were indicated in Table 3 and the results of sensory evaluation test on *gari* samples were as indicated in Table 4

Table 1: Percentage yield of *gari* samples of the two varieties at different age

Samples	Yield (%)
OKO IYAWO$_{12}$	24
TME 419$_{12}$	35
OKO IYAWO$_{15}$	26
TME 419$_{15}$	34
OKO IYAWO$_{18}$	27
TME 419$_{18}$	18

Subscripts used for various samples indicate the age of the tuber

Table 2: Physico-chemical properties determination of gari

Cassava varieties	Ages (Months)	Titratable acidity	Crude Fibre	pH	Ash contents	Moisture content (%)
OKO IYAWO	12	0.85	2.77	3.65	1.30	3.7
TME 419	12	0.97	2.63	3.75	1.24	5.5
OKO IYAWO15	15	0.93	1.92	4.00	1.30	3.9
TME 419	15	0.95	1.82	4.00	1.31	2.9
OKO IYAWO	18	0.87	2.19	3.75	1.34	5.0
TME 419	18	0.84	1.62	4.21	1.31	2.4

Table 3: Gari swelling capacity

Samples	Initial volume (ml)	Final volume (ml)	Swelling rate
OKO IYAWO$_{12}$	25	76	3.04
TME 419$_{12}$	25	74	2.96
OKO IYAWO$_{15}$	25	78	3.12
TME 419$_{15}$	25	75	3.00
OKO IYAWO$_{18}$	25	79	3.16
TME 419$_{18}$	25	75.5	3.02

Subscript used for various samples indicated the age of the tuber

Table 4: The results of the sensory evaluation test on *gari* samples

Samples	Taste	Colour	Sourness	Aroma	Texture	Overall acceptability
OKO IYAWO$_{12}$	2.0^{a}	2.4^{a}	2.3^{a}	2.1^{a}	2.6^{a}	2.6^{a}
TME 419$_{12}$	1.0^{b}	1.7^{b}	1.3^{b}	1.4^{b}	1.7^{b}	1.2^{b}
OKO IYAWO$_{15}$	2.5^{a}	2.4^{a}	2.4^{c}	2.8^{a}	2.3^{a}	2.4^{a}
TME 419$_{15}$	1.3^{b}	1.2^{b}	1.4^{b}	1.3^{b}	1.3^{b}	1.6^{b}
OKO IYAWO$_{18}$	2.6^{a}	2.2^{a}	2.1^{d}	2.6^{a}	2.6^{a}	2.2^{a}
TME 419$_{18}$	1.6^{b}	1.3^{b}	1.3^{b}	1.4^{b}	1.9^{b}	1.6^{b}

Subscript used for the samples indicated age of tubers. In each of the columns, the samples whose means are not followed by the same superscripts are significantly different (at $p<0.05$)

DISCUSSION

Gari yield

The yield of *gari* in this study was determined according to Sobowale *et al.* (2016). The *gari* obtained divided by the cassava roots that produced *gari* multiplied by 100. The yield of gari from the whole roots was necessary in revealing the cassava age that gives maximum yield of *gari* for each of the cassava varieties. Young cassava roots have most of their carbohydrates in the form of sugars and these might have been lost during processing, through fermentation and leaching (Akingbala *et al.* 2005; Ikujenlola and Opawale (2007). Over-aged cassava roots have more fibers than the younger cassava roots at harvest, hence, a lower quantity of *Gari* is produced. The percentage yield values of *gari* were in these order: 24, 26, and 27 for OKO IYAWO of 12, 15 and 18 months respectively, however, *gari* produced from TME 419 were 35, 34 and 18 for 12, 15 and 18 months respectively. Although, the usual life span of cassava is 15 months to 24 months depending on the varieties, climate and soil composition, but later tubers become fibrous and woody. However, some quick-growing varieties can be harvested between 6 to 7 months, so, they can be planted and harvested twice in a year. Meanwhile, some factors that may affect the yield of *gari* include cassava varieties, tuber age, and dry matter of the roots among others.

However, the high-yield *gari* was obtained from TME 419 of 12 months (35%), TME 419 of 15 months and OKO IYAWO of 18 months (27%) of the cassava tubers, though, less waste was generated from these varieties (Table 1), meanwhile, this may be due to a local variety of Oko iyawo which needs more age to matured and an improved cassava variety of TME 419 which needs few months to mature before harvest. However, the local variety signifies that the higher the age of the cassava plants on the farm at a certain period, the higher the tubers cake produced but, in an improved variety the higher the age of the cassava plants on the farm beyond a certain age, the lower the cake of the tubers produced. Meanwhile, six cassava cultivars studied in Rivers State in Nigeria gave *gari* yields in the range of 21 to 34% Akingbala *et al*. (2005), and these can be compared well in the yields obtained in the current study. This maybe correlated with Akingbala *et al*. (2005); Ikujenlola and Opawale (2007) that says young cassava plants may have most of their carbohydrates in the form of sugars and these might have lost through leaching and fermentation. Secondly, the values in these case were good which agreed with the report of Sanni *et al.* (2001) that says the yield of *gari* should not be less than 25% for maximum economic values for *gari* production. It can be deduced from both results that *gari* yield of cassava tubers of TME 419 of 12 months (35%), TME 419 15 months (34%), OKO IYAWO 18 months (27%) and OKO IYAWO 15 months (26%) (Table 1) will be profitable for *gari* producers.

Physicochemical properties determination

The Physico-chemical parameters determined were titratable acidity, crude fiber, pH, ash contents and moisture contents using the standard methods described by Sanni *et al.* (2001). The methods of Montagnac *et al.* (2009) and Asiedu (1989) were adopted in determining the pH and acidity of these *gari* products.

Total titratable acidity, expressed as the percent lactic acid of the samples ranged between 0.84

and 0.97 % (Table 2). This is probably due to the fact that titratable acidity is determined more on days of fermentation on the cassava mash Olayinka *et al*. (2016). Also, the roasting process during preparation may have caused most of the lactic acid and other organic acids contributing to the total acidity to evaporate. These results could be attributed to the low level of sugar in *gari*, because young cassava roots have most of their carbohydrates in the form of sugars and these might have been lost during processing, through fermentation and leaching (Akingbala et al. 2005; Ikujenlola and Opawale (2007). The codex standard of total acidity for *gari* is between 0.6 and 1.0%, expressed as percent lactic acid Codex Alimentarius Commission (1989).

The crude fibre content of the samples was in the range of 1.82 and 2.77%, however, Codex Alimentarius Commission (1989) gives a maximum of 2.0% for crude fibre. However, some of the *gari* samples had values above the codex standard. Studies conducted by Oduro (2000) on the quality of *gari* from some selected gari processing centers showed the crude fiber between 1.47 and 2.50%. The values reported in this study compared well with the mean values reported by Oduro (2000). The deviation from the expected trend might be a result of the difference in the cassava variety, however, crude fiber through its water absorption capacity has been found to aid bowel movement and aid digestion Abu et al. (2006) and therefore, it is significant in the diet.

The sample's pH ranged between the value of 3.65 and 4.21 (Table 2). pH depends on the extent of fermentation Ikujenlola and Opawale (2007). However, there was a significant ($p<0.05$) difference in the pH values obtained for all the *gari* samples (Table 2). The values ranged from 3.65 to 4.21. These were lesser than the range of values (4.42–5.98) reported by Sanni *et al.* (2005) for *gari*. The pH of *gari* is also a function of the extent of fermentation. The lower the pH, the better will be the keeping quality of *gari* samples. The ash content values ranged between 1.24 and 1.34% (Table 2). These values fall within the range of (1.40–1.82%) and (1.13- 1.31%) reported by Kure *et al.* (2012) and Olayinka *et al*. (2016) respectively. Ash content represents mineral contents in food. However, these gari will be a good source of minerals that are essential in many biochemical reactions of the body. The lowered ash content in all *gari* samples than the maximum of 2.75% specified by Codex Alimentarius Commission (1989), also signifies a lesser prospect of dust pollution and heavy metal during processing.

Moisture contents of the samples ranged between 2.4% – 5.5 % (Table 2). Roasting is one of the factors that affect the moisture content of *gari* during processing. Moisture contents of 9.54 - 11.57% were reported by Franklin *et al*. (2009) from their studies on *gari*. However, when comparing values obtained from this present study with the reported values, it was higher than the present study. The result was within specification. Lower moisture content is preferred for the suitability of *gari* for better storage, therefore, all gari samples processed are under the safe limit. Codex standards for *gari* (1989) gave a maximum value of 12.0% for moisture.

Swelling capacity is important in determining *gari* quality. The higher the swelling capacity, the greater its suitability for use in most West African dishes such as 'eba' and gari in dry particulate form which are typical delicacies of Nigerians. The swelling capacity of *gari* also indicates its starch content and the extent of concentration of starch, since it is the starch component of *gari* that enables it to swell. Good quality *gari* is expected to swell to three times its volume when placed in distilled water Oduro *et al*. (2000). The swelling index obtained values in this study ranged from (2.96 - 3.16) in Table 3. Even though OKO IYAWO of 12 months value was a little lower than 3, they compare well with values reported by other researchers Franklin *et al.* (2009). Harvesting age and varietal difference had no significant effect ($p > 0.05$) on the swelling capacity of the *gari* samples.

The *gari* samples when assessed in their dry particulate form are not significantly different (at $p<0.05$) in all the sensory attributes evaluated. All the *gari* samples were preferred in aroma, sourness, texture and color with preference ratings falling within the range of "like moderately" and "like extremely". Both OKO

IYAWO and TME 419 varieties *gari* irrespective of the age shared the highest mean score in overall acceptability and this corresponds to "like very much" on the hedonic scale of preference. When the *gari* samples were made into eba and evaluated, there were also no significant differences in all the sensory attributes.

CONCLUSION

The study has shown that the age at which some cassava roots were harvested can affect the yield and its suitability of *gari* production. There was a varietal effect on the yield and suitability of the two varieties that produced *gari*. It is concluded from the study that cassava tubers of 12 and 15 months of TME 419; Oko iyawo of 15 and 18 months were suitable for *gari* productions when compared to others in terms of yield but all the *gari* produced were suitable in term of physiochemical properties. This will give the grower of cassava tubers and *gari* processors the varieties that will give them maximum profit.

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Conflicts of Interest

The authors declare that they have no competing interests.

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