Effects of storage of fresh cassava in moist sawdust on the proximate chemical and functional properties of gari

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Abstract

Introduction. The research was carried out to evaluate the utilisation qualities of cassava roots stored in sawdust for *gari* production.

Materials and methods. A completely randomised design was used to investigate the effect of storage time on the results of processing *gari*. Fresh cassava roots were stored in sawdust for 12 weeks and *gari* which is a cassava product was produced every two weeks. The proximate composition, chemical composition and functional properties of the *gari* were determined.

Results and Discussion. Cassava major food product in Africa is *gari,* the latter covers about 70% of cassava use in human consumption. Cassava *Manihot esculenta Crantz* is a starchy root which is a highly perishable crop, it starts to deteriorate within two or three days after harvest if not stored or processed. This study investigates the quality of *gari* produced from stored cassava roots.

The results show that there were significant differences in the proximate composition of *gari* samples in terms of the ash content, moisture content, fat content, fibre, protein and carbohydrate ($p<0.05$). The pH, TTA, HCN values of the *gari* ranged from 3.9 to 4.89, 0.77 to 0.9%, and 0.25 to 0.33mg/kg respectively. Also, there were significant differences ($p<0.05$) in the bulk density, water absorption capacity and swelling index, which ranged between 7.79 and 8.169g/cm^3, 199.18 and 311.11ml/g, and 3.13 and 3.96, respectively.

Conclusion. Cassava roots stored for about 12 weeks will still produce a good quality *gari*.

Introduction

Gari is the most popular of the cassava products in Africa (Oluwole *et al.,* 2004). *Gari* is a creamy-white, granular flour with a slightly fermented flavor and a slightly sour taste made from fermented, gelatinized fresh cassava tubers (Sanni *et al.,* 2008). It is consumed as processed or reconstituted with hot water to give a dough-like paste called *Eba*.

Cassava is different from other major root crops in that its roots are not organs of dormancy, making the pre-process storage a main problem of its utilisation (Karim *et al.,* 2009). NSPRI (1995) reported that the shelf life of cassava can be extended to about 8-10 weeks, based on high visual acceptability of stored cassava root in transverse section.

However, storage and utilisation quality of cassava has not been established for that length of time except for Akingbala *et al.,* (2005) and Karim *et al.*, (2009) who only investigated the samples after 3 and 2weeks of storage respectively.

However, there is need for more studies to establish other limits and benefits of the recommended methods in terms of the functional, chemical, and physical properties of the stored cassava and its products.

Hence, the aim of this work is to evaluate the utilisation quality of cassava roots stored in sawdust for *gari* production.

Materials and methods

Storage of Cassava roots

12-months-old (var. TME 7), was harvested from Lasuju farm settlement in Asa LGA of Kwara State, Nigeria. The storage was done using the storage method described by Babarinsa and Oluwalana (2018), the root were arranged in layers and surrounded with moist sawdust so that no two tubers touched one another.

Gari production

15Kg of stored cassava was processed into *gari* for analysis every two (2) weeks. *Gari* was produced by the process described by Onyekwere *et al.* (2004). All the *gari* samples were prepared by one commercial *gari* processor, this is to avoid variability in processing. The cassava root of was peeled manually using sharp stainless steel knife. The peeled roots were washed and grated in a diesel powered grater. The grated meal was dewatered and was allowed to ferment for 72 hours. The pressed cake was broken and sieved with a wire mesh screen. The sieved pulp was *gari*fied using a wide shallow cast iron pot and stirred continuously over a low fire until well dried. It was then cooled, packaged, labeled and sealed.

Laboratory Analysis

The proximate analysis (moisture content, ash content, fat content, fibre, protein and carbohydrate) was carried out according to AOAC (2005). Estimation of hydrogen cyanide was done using silver-nitrate volumetric analysis described by Oboh *et al.*, (2002), while the pH and Total titratable acidity (TTA) as lactic acid was determined according to AOAC, (2005). Bulk density swelling index, water absorption Capacity of the sample was determined using the method described by AOAC (2005), Ukpabi and Ndimele (1990) and Ogungbenle *et al.* (2002) respectively.

Statistical analysis

A Completely Randomised Design was used to investigate the effect of storage time on the analytical determinations. Results from the analysis were subjected to analysis of variance ($p<0.05$). The Duncan (1955) multiple range test was then used to separate means. All analysis were in triplicate and Statistical analysis was done using SPSS 17.

Results and discussion

Moisture content

The moisture content of the *gari* was significantly affected by the processing rather than storage time ($p<0.05$), the values was generally low and were between 8.11 and 8.59% (Table 1). The moisture content of all the *gari* samples were below the 10% stipulated standard of the revised regulation of the Standard Organization of Nigeria and the export range of 6–10% (Sanni *et al.,* 2005).

Moisture is a significant parameter in cassava flour storage, high moisture greater than 12% allow for microbial growth. This is because moisture content and water activity of foods affect the progress of their chemical and microbiological spoilage reactions and thus low levels are favourable and give relatively longer shelf life. All the *gari* will be able to store for 7 months because their moisture contents were below the levels reported by Ukpabi and Ndimele (1990, who found that *gari* samples with a moisture content of < 16% but > 13% could be stored for 2-7 months without mould infestation. All the samples had good moisture levels and hence have the potential for better shelf life.

Ash content

The *gari* samples were significantly different ($P<0.05$), with the *gari* produced after Week 8 having the lowest value of 1.28% and Week 6 having the highest value of 3.34%. The values obtained in weeks 0, 2, 8 and 10 were comparable to the range of 1% to 2.84% dry weight reported by Aryee *et al*. (2006) and the range of values reported by Okolie *et al.* (2012) in their comparative study of different *gari* samples in Nigeria.

Ash content, which is a measure of the mineral element contents in the plant, is said to depend on the mineral contents of the soil. The slight differences in the ash content must have been due to processing. During processing, the dewatering of the grated cassava mash by pressing with a screw press may have resulted in loss of some minerals via the expressed water thereby reducing the ash content. The reduction may also be due to degradation of naturally occurring chemicals and loss due to spoilage (Ajala *et al.* 2012).

Fat content

All the *gari* had low fat content with the highest being 0.42%. There were significant differences ($p<0.05$) in the fat content amongst the studied *gari* samples. The *gari* samples were in line with those of 0.1% to 0.4% reported by Charles *et al*. (2005) and 0.65% reported by Padonou *et al*. (2005).

Fibre content

Fibre content of the *gari* samples were in the range of 2.82-2.92% (Table 1), which were significantly different between each other ($p>0.05$). Week 0 had the lowest with

2.82%, and Week 12 had the highest with 2.92%. The *gari* samples were comparable in fibre content to the range of 1.61 and 3.63% reported by Franklin *et al.,* (2009) and close to the result of the studies by Oduro *et al.,* (2000) on quality of *gari* from some selected *gari* processing centres in Ghana.

Protein content

The protein content of the *gari* investigated ranged from 0.78% to 0.98% (Table 1). There were significant differences amongst the studied samples and this may be attributed to storage time. This is in line with the protein content of cassava ranging between 1% and 3% on a dry matter basis, reported by Buitrago (1990). The increase in the protein content may likely be due to the presence of organisms that had been processed along with the cassava (Ajala *et al.,* 2012).

Carbohydrate content

The carbohydrate content of the *gari* samples were significantly different ($p<0.05$), having values ranging between 84.19-86.48% (Table 1). The values compared favorably with the values reported by Akingbala *et al*. (2005) and Karim *et al.,* (2009) and about the same value reported by Rose-Monde *et al.,* (2009). The high carbohydrate values obtained in this study suggest that cassava could be utilized as a reliable food and energy security crop (FAO, 2002).

pH

The storage time had significant ($p<0.05$) effect on the pH of the samples. The *gari* from Week 0 cassava root was more acidic, having pH of 3.90 while that of Week 10 was the lowest acidity with 4.89 (Table 1). Generally, there was decrease in the acidity as the storage time increases in the *gari* sample. The values agree with those of Oduro *et al.,* (2000) for the normally fermented cassava *gari* (pH 3.6 to 4.0), and Bainbridge *et al*., (1996) who reported pH of 3.5 – 4.5 for acid fermented product. The acidity of fermented cassava product has been found to be caused by the synthesis of lactates, acetates and some volatile organic acids (Oyewole and Odunfa, 1989) caused by microoganism such as C*ornebacterium manihot, Geotriucm candida, Lactobacillus spp*, which hydrolyze starch to this organic acids. The acid contributes to the desirable sourness of *gari* and is also an indication of the duration and effectiveness of the fermentation step in *gari* processing (Akingbala *et al.,* 2005).

Total titratable acidity

The titratable acidity of the *gari* was significantly affected by the storage time ($p<0.05$). The total titratable acidity expressed as percentage lactic acid of *gari* samples was between the range of 0.76-0.90% (Table 1). The total titratable acidity agrees with the Codex standard of total acidity for *gari* which is between 0.6 and 1.0%, expressed as percent lactic acid (Codex Alimentarius Commission, 1989) and the recommended standard of 0.6 – 1.2 for cassava-*gari* by Oduro *et al.,* (2000). Since changes in total titratable acidity is due to dissociation of the weak organic acids, mainly lactic and formic acids, Table 1 implies that the dissociation occurred and reached its optimum in the early week of storage, and subsequently there were poor or no dissociation. Fermentation is as a result of the lactic acid bacteria conversion of sugar content to organic acid (lactic acid) which consequently cause the increase in the total titratable acidity of the cassava mash (Akingbala *et al,*. 2005). The value ranged between 0.01- 0.16% with Week 0 having the highest and was significantly different from the rest of the weeks. The total titratable acidity which ranged from of 0.01-0.16 compares favourably with the report of Akingbala *et al.*, (2005) and Karim *et al.,* (2009).

HCN

There were significant differences ($p<0.05$) among the *gari* samples, with Week 4 having the lowest value and Week 12 having the highest value with a range value of 0.25-0.33 (Table 1). The *gari* samples range of 0.25-.33 and is far below the estimated lethal dose of 0.4-0.6 mg/kg reported for *gari* by Bokanga (1994).

Bulk density

Gari samples exhibited a decrease in bulk density value throughout the storage period and they differ significantly ($p<0.05$). The bulk density of *gari* produced from cassava roots ranged from 7.79 – 8.16 (Table 1). The bulk density conforms favourably with the findings of Olaleye *et al.* (2014) which values ranges from 0.70- 0.81 g/cm^3 and 0.61 - 0.77 g/cm^3 for *gari* produced from bitter and sweet cassava varieties respectively but higher than those reported by Achinewhu *et al.* (1998) for six different cassava cultivars whose relative bulk densities ranged between 0.15 and 0.30 g/cm^3. The bulk density is a reflection of the load the samples can carry if allowed to rest directly on one another. Bulk density is affected by moisture and reflects particle size distribution of the *gari* products (Olaleye *et al.,* 2014). Bulk density may also be attributed to high starch content in cassava which affect the mass and hence relative bulk density. According to Ukpabi and Ndimele (1990), good *gari* should have bulk density between 0.56 to 0.908 g/cm^3. High bulk density increases the rate of dispersion which is essential in the reconstitution of flours in hot water to produce dough.

Water Absorption Capacity

The Water absorption capacity of the *gari* was significantly affected by the storage time ($p<0.05$). Generally, the water absorption capacity reduces from 3.13 to 3.96ml/g as the storage time increases though Week 8 was the lowest (Table 1). Water absorption capacity is a very important property of all flours or starches used in food preparations. The observed differences in water absorption capacity of the *gari* products as suggested by Olaleye *et al.,* (2014) might be due to various factors such as particle size, amylose/amylopectin ratio and molecular structure. The larger the granular size, the greater the water absorption capacity while the higher the amylose levels, the lower the water binding capacity of starches (Akalu *et al.*, 1998). Processing factors such as fermentation have also been found to increase water absorption capacity. Since polar groups of carbohydrates (for starchy foods like *gari*) are chiefly responsible for the binding of water, it therefore follows that the *gari* starch contains polar (hydroxyl) groups which are able to interact with water through hydrogen bonding (Obadina *et al.*, 2008). It follows, therefore, that the higher the value of water absorption capacity, the greater the number of hydroxyl groups available to form hydrogen bonds with water (Obadina *et al.*, 2008).

Swelling Index

Generally, the swelling index increased with increasing storage time ranging from 3.13-3.96. The values compare favourably with the Codex Alimentarius standard of 3, while a range of 2.7 to 3.3 was reported by Oduro and Clarke, (1999) and 2.84±0.26 by Ajibola *et al.*, (1987) in the Nigerian market Swelling index is the ability of *gari* to swell and this is influenced by the quantity and type of amylose and amylopectin present (Bainbridge *et al.,* 1996) in the *gari*. Swelling index is very important because it indicates the degree of gelatinization of the *gari* sample and the rehydration characteristic. Swelling index reflects the extent of associative forces within the granules, thus, the higher the swelling index the lower the associative force (Sanni *et al*., 2001). According to Babarinsa (2011) a good quality *gari* should swell when soaked in water, to at least three times its dry volume because consumers demand *gari* with good swelling capability.

Table 1

Proximate, chemical and functional properties of the *gari* samples

Period of storage	MC (%)	ASH (%)	FAT (%)	CF (%)	CP (%)	CHO (%)
WEEK 0	$8.41\pm.09^{bc}$	$1.63\pm.05^{e}$	$0.42\pm.12^{a}$	$2.82\pm.06^{b}$	$0.78\pm.02^{d}$	$85.94\pm.33^{b}$
WEEK 2	$8.44\pm.03^{b}$	$2.38\pm.04^{c}$	$0.33\pm.02^{bc}$	$2.86\pm.01^{ab}$	$0.85\pm.05^{c}$	$85.13\pm.14^{c}$
WEEK 4	$8.37\pm.02^{c}$	$3.24\pm.02^{a}$	$0.23\pm.01^{d}$	$2.85\pm.05^{ab}$	$0.91\pm.01^{b}$	$84.41\pm.04^{e}$
WEEK 6	$8.39\pm.00^{bc}$	$3.34\pm.02^{a}$	$0.27\pm.01^{cd}$	$2.85\pm.01^{ab}$	$0.97\pm.02^{a}$	$84.19\pm.06^{e}$
WEEK 8	$8.19\pm.02^{d}$	$1.28\pm.05^{d}$	$0.39\pm.01^{ab}$	$2.82\pm.03^{b}$	$0.83\pm.02^{c}$	$86.48\pm.02^{a}$
WEEK 10	$8.59\pm.03^{a}$	$2.53\pm.02^{b}$	$0.29\pm.01^{cd}$	$2.86\pm.01^{ab}$	$0.98\pm.01^{a}$	$84.76\pm.03^{d}$
WEEK 12	$8.11\pm.01^{d}$	$3.24\pm.01^{a}$	$0.21\pm.01^{d}$	$2.92\pm.08^{a}$	$0.87\pm.01^{bc}$	$84.65\pm.05^{de}$

Period of storage	pH (%)	TTA (%)	HCN (mg/kg)	BD (g/cm^3)	WAC (ml/g)	SI
WEEK 0	$3.90\pm.02^{f}$	$0.77\pm.01^{a}$	$0.30\pm.01^{b}$	$8.16\pm.05^{a}$	311.11 ± 5.13^{a}	$3.14\pm.02^{a}$
WEEK 2	$4.32\pm.01^{b}$	$0.77\pm.01^{a}$	$0.30\pm.01^{b}$	$8.02\pm.01^{b}$	214.44 ± 1.76^{c}	$3.27\pm.01^{b}$
WEEK 4	$4.27\pm.01^{c}$	$0.80\pm.00^{a}$	$0.25\pm.00^{a}$	$8.03\pm.00^{b}$	220.81 ± 2.27^{b}	$3.21\pm.01^{b}$
WEEK 6	$4.26\pm.01^{c}$	$0.83\pm.01^{b}$	$0.26\pm.00^{a}$	$8.05\pm.01^{b}$	$212.65\pm.89^{cd}$	$3.15\pm.01^{a}$
WEEK 8	$4.19\pm.01^{d}$	$0.83\pm.03^{b}$	$0.32\pm.01^{ab}$	$7.79\pm.00^{d}$	$199.18\pm.17^{f}$	$3.13\pm.01^{a}$
WEEK 10	$4.89\pm.01^{a}$	$0.76\pm.01^{c}$	$0.26\pm.01^{a}$	$7.89\pm.00^{c}$	$204.97\pm.27^{e}$	$3.86\pm.05^{c}$
WEEK 12	$4.11\pm.01^{e}$	$0.90\pm.01^{a}$	$0.33\pm.00^{a}$	$7.90\pm.00^{c}$	$210.10\pm.01^{d}$	$3.96\pm.01^{c}$

Values are means of triplicates and standard deviation. Mean values having different superscripts within the same column are significantly different ($p < 0.05$).

KEY

MC = Moisture content ASH = Ash content
FAT = Fat contentCF = fibre
CP = Protein content CHO = Carbohydrate
TTA = Total Titratable Aciditity HCN = Hydrogen Cyanide
BD = Bulk density WAC = Water absorption capacity
SI = Swelling Index

Conclusion

The study has shown that stored cassava root can produce good quality of *Gari*. The chemical values obtained in terms of the total titratable acidity and pH of *gari* produced compared effectively with the *gari* of published recommended values. HCN content were reduced during storage. The proximate composition was also comparable to the Week 0 sample and published recommended values. The functional properties in term of the swelling index, water absorption capacity and bulk density of the stored cassava also compared favourable with that of Week 0 and published recommendations.

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