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Gari Yield and Chemical Composition of Cassava Roots Stored Using Traditional Methods

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Abstract: Cassava has gained increased industrial, economic and nutritional importance over the years, because of the multifarious uses of the starch-rich roots. Several storage methods have been proposed for cassava roots due to the physiological deterioration that sets in 2-3 days after harvesting, followed by microbial deterioration 3-5 days thereafter. Nigeria is the largest producer of cassava in the world; with 80% of the production from rural farmers who cannot practice modern storage methods. Furthermore, gari (a major fermented product of cassava root) is an important component of cassava production in Africa. It is therefore imperative to quantify the effects of traditional storage methods being practiced by the farmers on the yield of gari and the chemical composition of cassava roots. Four traditional storage methods (polyethylene bags, jute bags, trench and plastic storage boxes containing sawdust) were used to store fresh cassava roots for 14 days. The roots were evaluated at 7 day intervals for moisture, ash, crude fibre, carbohydrate, pH, TTA, cyanogenic potentials and yield of gari. The result revealed a varied impact of the storage methods on the chemical composition of the root over the holding period. The moisture, carbohydrate, cyanogenic potentials and yield of gari reduced while the ash and crude fibre increased as the holding period increases. The moisture content reduced significantly from 66.52% to 60.15, 61.97, 63.26, and 64.17% for samples stored in polyethylene bag, jutebag, trench and storage box respectively. The sample stored in the plastic storage box had the highest gari yield of 29.9 and 24.2% after 7 and 14 days of storage respectively. While the gari yield from the roots stored in trench and jute bags were 22.8 and 23.4% respectively, after 14 days storage. This was significantly lower than the yield obtained for fresh roots of 31.2%. It could therefore be deduced from the study that storage of fresh cassava roots could be done for a maximum of 7 days using plastic storage boxes and trench containing wet sawdust for gari production.

Key words: Post-harvest, cassava processing, plastic storage boxes

INTRODUCTION

Cassava (*Manihot esculenta crantz*) is one of the most important food crops grown in the tropics (Hahn, 1989; FAO, 1990; Phillips *et al*., 2004) and a significant source of calories for more than 500 million people world-wide (FAO, 2000; Mroso, 2003). The production of cassava for human consumption has been estimated to be 65% of cassava products, while 25% is for industrial use, mostly as starch (6%) or animal feed (19%) and 10% lost as waste (Fish and Trimm, 1993; Oluwole *et al*., 2004; Maziya-Dixon *et al*., 2007). The production have significantly improved with Nigeria as the largest producer and gari is the most consumed and traded of all the food products from cassava roots in Nigeria (FOS, 1970; Westby and Twiddy, 1992; Okafor *et al*., 1998) and in many other countries in West Africa (Oduro *et al*., 2000). It is creamy-white, partially gelatinized roasted free flowing granular flour (Sanni *et al*., 2008). It is wide consumption is attributed to its relatively long shelf life compared to other food products from cassava, as well as its ease of preparation for eating (Sanni *et al*., 2008). The pre-process storage is the main problem of cassava utilization on an industrial scale. Physiological deterioration occurs in cassava roots 2-3 days after harvesting, followed by microbial deterioration 3-5 days thereafter (Rickard and Coursey, 1981; Rickard, 1985; Akingbala *et al*., 2005). This deterioration is either primary deterioration, which is characterized by the discoloration of roots or microbial deterioration. The starch also undergoes structural changes (Plumbley and Rickard, 1991). Economically, the roots discoloration is more important than the microbial deterioration because it reduces the economic value of the roots and most especially for production of gari and fufu.

Several modern storage methods have been developed to control the deterioration like refrigeration, freezing, waxing and chemical protection. While the traditional methods include leaving roots in the soil after maturity, burial of freshly harvested roots, storing in trench etc. However, most of the modern methods may not be economically viable for storing of cassava roots prior to processing to major products like gari and fufu. It is therefore important to consistently evaluate the appropriateness of some traditional storage methods for cassava roots meant for gari production. The study was therefore conducted to evaluate the chemical composition and yield of gari from cassava roots stored using four traditional methods.

MATERIALS AND METHODS

Ninety-nine kilogram (99 kg) of a mature cassava cultivar, TMS 55752 roots was obtained from a local farm in Ogun state, Nigeria. Ten kilogram of the fresh roots was processed into gari using traditional method (Odunfa, 1998). The remaining 80 kg were stored in the four storage methods of polyethylene bags, jute bags, trench and plastic storage box. The polyethylene bags was of 0.208 mm thickness, the trench was of 0.5m long, 0.5 m wide and 0.5 m deep while the plastic storage box was of 90 cm high and 60 cm wide. The roots were carefully arranged into the storage medium. In between the layers of the roots stored in the trench and plastic storage box were raffia palm and wet sawdust. The samples were at ambient temperature of 30±2°C.

Chemical analysis: The moisture, crude fibre and pH were determined as described by AOAC (1992) method while the Titrable Acidity (TTA) as lactic acid was determined as described by Lees (1975). The method by Essers *et al.* (1993) was employed for cyanide analysis.

Production of gari: The traditional method of processing cassava roots to gari as described by Hahn (1989) and Odunfa (1998) was employed. The roots were carefully peeled (manually) and the pulp was later washed thoroughly to remove dirt. The washed pulp was grated into mash and put into sack to ferment for four days at ambient temperature. After which the fermented mash was pressed with a screw to express out the juice. The cake was crushed manually on the fiber sieve before roasting over a low fire. The gari was allowed to cool and weighed before packaging to determine the gari yield. The yield was calculated as the percentage of the weight of the unpeeled fresh root on a dry matter basis.

Statistical analysis: All analytical determinations were done in triplicates. Data were subjected to statistical analysis of variance (ANOVA) using SPSS version 10.0. Means were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1965).

RESULTS AND DISCUSSION

The results of moisture, ash, crude fibre and carbohydrate content of the cassava roots are presented in Table 1. The results showed that the moisture content of the roots ranged between 60.15 and 66.52% over 14 days storage period. The moisture content of the fresh root was 66.52%, which compares favourably with the report of Akingbala *et al.* (2005) and Karim (1995). The moisture content decreased with increase in storage period for roots stored in polyethylene and jute bags 60.14 and 61.97% respectively. While the roots stored in the trench and plastic storage box reduced to 63.86 and 64.17% respectively. There was significant difference ($p \leq 0.05$) between the moisture contents of the roots stored over the 14 days storage period, though the difference was slight for the roots stored in trench and plastic storage boxes. The high reduction in moisture content of the roots stored in polyethylene and jute bags may be attributed to the respiration and transpiration processes. These also occurred in the roots stored in the trench and plastic storage boxes, however the environmental condition created by the wet saw dust used in between layers of roots stored in plastic storage box and trench respectively might had protected the roots from deleterious moisture loss. Furthermore, as reported by Karim (1995) and Akingbala *et al.* (2005) other factors like starch hydrolysis and equilibrium of roots and atmospheric moisture might have affected the moisture content of the roots.

The ash and crude fibre content also increased with increase in the storage period as shown in Table 1. While the carbohydrate content decreased with increase in the storage period. The carbohydrate content of the roots at the end of 14 days storage period was 27.43 and 28.69% for trench and plastic storage box respectively with no significant difference ($p \leq 0.05$) between the values obtained at 7 days. These values compared favorably with the values reported by Akingbala *et al.* (2005). According to Wheatly (1984) and Rickard (1985) during vascular streaking fiber content of the roots may increase due to condensed tannins from leucoanthocyanidins and cathechin.

While, the slight increase in root pH may be attributed to the hydrolysis of starch to sugar under anaerobic condition (Karim, 1995; Akingbala *et al.*, 1989). This was observed in the roots stored in polyethylene and jute bags. The values of the pH and TTA (Table 2) reduced also with increase in storage period with slight and no significant difference ($p \leq 0.05$) between the values for pH and TTA respectively. While the cyanogenic potential of the roots reduced with increase in storage period for all the storage methods. This is however expected with the reduction in carbohydrate, pH and moisture content of the roots. The HCN value of the roots at the end of 14 days storage were 0.106, 0.109, 0.068 and 0.070 g/kg for polyethylene, jute bag, plastic storage box and trench respectively.

The yield of gari from fresh and stored cassava roots is presented in Table 2. Apparently the yield reduced significantly ($p \leq 0.05$) with increase in storage period. The lowest value of 20.9% was obtained as the gari yield, for the roots stored in polyethylene bag at the end of 14 days storage, while 24.2% was as the gari yield, for the roots stored in plastic storage box. However, the yield of gari from fresh cassava roots was 31.2%. This supports the report that for maximum economic value of

Table 1: Moisture, ash, crude fibre and carbohydrate content of fresh and stored cassava roots

Storage Days	Moisture% P	Moisture% J	Moisture% T	Moisture% S	Ash% P	Ash% J	Ash% T	Ash% S
0	66.52a	66.52a	66.52a	66.52a	1.01c	1.01c	1.01c	1.01b
7	61.81b	64.18b	64.19b	65.08ab	1.22b	1.08b	1.11b	1.05b
14	60.15c	61.97c	63.86b	64.17b	1.61a	1.31a	1.22a	1.13a

Storage Days	Crude fibre% P	Crude fibre% J	Crude fibre% T	Crude fibre% S	Carbohydrate% P	Carbohydrate% J	Carbohydrate% T	Carbohydrate% S
0	1.02b	1.02c	1.02c	1.02c	30.15a	30.15a	30.15a	30.15a
7	1.18b	1.18b	1.16b	1.13b	27.71b	29.45b	28.61b	29.65b
14	1.71a	1.36a	1.41a	1.38a	25.74c	27.63c	27.43c	28.69c

P-Polyethylene bag, J-Jute bag, T-Trench, S-Plastic Storage box. Mean value having the same letter within the row is not significantly different at ($p \leq 0.05$). Means of three replicates

Table 2: pH, total titrable acidity and cyanogenic content of fresh and stored cassava roots.

Storage Days	pH P	pH J	pH T	pH S	Total Titrable acidity g/kg P	Total Titrable acidity g/kg J	Total Titrable acidity g/kg T	Total Titrable acidity g/kg S
0	6.7c	6.7c	6.7c	6.7c	0.004a	0.004a	0.004a	0.004a
7	7.1b	7.2b	7.0b	6.9b	0.003a	0.003a	0.003a	0.003a
14	7.3a	7.4a	7.2a	7.1a	0.002a	0.002a	0.002a	0.003a

Storage Days	HCN g/kg P	HCN g/kg J	HCN g/kg T	HCN g/kg S	Yield of Gari % P	Yield of Gari % J	Yield of Gari % T	Yield of Gari % S
0	0.132a	0.132a	0.132a	0.132a	31.2a	31.2a	31.2a	31.2a
7	0.110b	0.115b	0.104b	0.092b	25.8b	28.8b	28.5b	29.6b
14	0.106c	0.109c	0.068c	0.070c	20.9c	23.4c	22.8c	24.2c

P-Polyethylene bag, J-Jute bag, T-Trench, S-Plastic Storage box. Mean value having the same letter within the row is not significantly different at ($p \leq 0.05$). Means of three replicates

cassava roots for gari production, the yield of gari should not be less than 25% (Sanni, 1990). Therefore, the polyethylene bag could only support storage of cassava roots meant for gari production, for less than 7 days. The reduction in the yield of gari with increasing storage period may be associated to difficulty of peeling due to moisture loss and greater loss of pulp as peel. Therefore, it could be derived from the research results that cassava roots meant for gari production can only be kept in polyethylene bag for less than 7 days, while jute bags and trench could protect cassava roots for up to 7 days and the plastic storage box fairly up to 14 days.

Conclusion: Storage of cassava roots could be done using the traditional methods of trench with wet raffia leaves and plastic storage box with wet sawdust for a maximum of 7 days. The yield of gari from the roots stored in these methods also justified their efficiency.

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