Yield and Sensory Attributes of Gari from Dried Cassava Chips as Affected by Drying and Rehydration Conditions

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Abstract

The freshly harvested cassava (indigenous sweet variety of cassava locally referred to as *oko-iyawo*) tubers were washed, peeled manually and sliced into chips of uniform slices (length 4 – 5 cm, thickness 1.5 cm). Drying was done using different methods (sun, solar and cabinet at 60 °C). The dried chips were milled and rehydrated with water of different temperatures of 20, 30 and 40 °C. The *gari* produced were investigated for some quality parameters which include: percentage yield, proximate composition and sensory attributes. The yield value ranged from: 73.08 – 90.73 %. The results of sensory analysis showed that the control samples are highly rated but *gari* samples from cabinet-dried chips rehydrated with water at 40 °C were preferred in all the samples from dried cassava chips. High yield were observed in *gari* produced from dried cassava chips. Rehydration water temperature gave best results in all sample and higher acceptability of cabinet-dried chips rehydrated with water at 40 °C might be as a result of the fact that drying is done faster with cabinet dryer thereby retained the colour of the products making them appealing to the consumers.

Keywords: Drying, rehydration, yield, sensory attributes, *gari*

Introduction

Cassava (*Manihot esculenta* Crantz) is the world's fourth most important staple crop after rice, wheat and maize and is an important component in the diet of over one billion people[1.] It is also the third-largest source of carbohydrates for meals in the world[2, 3]. Cassava is the most important root crop in tropical countries which provides the major source of dietary calories for about 500 million people in many developing countries[4]. It is a major food crop in Nigeria and is essentially a carbohydrate food with low protein and fat. It plays an important role in alleviating the African food crisis because of its attributes such as efficient production of food energy, year-round availability, tolerance to extreme stress conditions, and suitability to the farming and food system in Africa[5].

Gari is a granulated and roasted cereal-like cassava food product which is convenient for consumption in urban environments because it is in a ready-to-eat form and it has an extended shelf life. It is preferred by urban consumers because it is a pre-cooked convenience food. It could be eaten with groundnut by soaking in cold water and adding sugar, or it could be prepared into dough (*eba*) with hot water and eaten with any form of soup. *Gari* is usually produced from fresh roots. Thus, when large quantities of cassava are harvested for the processing, the roots deteriorate, if not processed on time. Generally, irrespective of the quantity, the roots would deteriorate or turn woody if left for some time. Producing chips during glut period (when large quantity of cassava roots is harvested) can solve the problem of deterioration of roots as the chips can be used for further processing of cassava products like *gari*.

Chips are dried irregular slices of roots which vary in size but should not exceed 5 - 6 cm in length[6], so that they can be stored in silos. The products obtained from drying have longer shelf lives because the low moisture content thereby reduces enzymatic activity, chemical and biochemical reactions, and inhibits the growth of spoilage organisms. Another advantage of dried foods is that they take much less space than canned or frozen foods during transportation and storage thereby reducing cost. Meanwhile, the method of drying is one of the factors that affect the drying kinetics and quality of food products[7]. Different drying methods have been reported to significantly affect starch yield and quality of cassava[8]. Using cassava chips to produce *gari* has been established[9, 10, 11, 12] but rehydration condition (rehydration water temperature) has not been considered which is likely to affect the quality of *gari* in all its consumable forms combined with the effect of different drying methods. It is therefore important to study the effect of different drying and rehydration conditions on the acceptability of *gari* produced from cassava chips.

Materials and Methods

Materials

Cassava (*Manihot esculenta*) roots (local sweet variety also known as *oko-iyawo*) were obtained from LAUTECH (Ladoke Akintola University of Technology) Teaching and Research Farm, Ogbomoso, Nigeria.

Sample preparation

The freshly harvested cassava tubers were washed, peeled manually and sliced into chips of uniform slices (length 4 – 5 cm, thickness 1.5 cm) with a locally fabricated chipping machine. The method of Tunde-Akintunde *et al*.[13] was modified to dry cassava chips using sun, solar and cabinet (i.e. hot-air at 60 °C) drying. Dried cassava chips were coarse-milled and rehydrated to have cassava mash of about 67 % moisture content. This was done at different temperatures of 20, 30 and 40 °C. The amount of water added was calculated based on the mathematical expression[14]:

$$Q = \left\{\frac{(b-a)}{(100-b)}\right\} \times A$$

where, Q, a, b and A; are the quantity of water to be added (g) the initial moisture content of the sample (% wet basis); the moisture content of the sample at the point of interest (% wet basis) and the initial mass of the sample (g), respectively.

Production of Gari

The rehydrated mash was seeded with 5 % fresh cassava mash[15] and the method of Oluwole *et al*.[9] was utilized to produce *gari*. Seeding was done in order to induce fermentation in the rehydrated mash. The mash was stirred occasionally during fermentation for 72 h; the fermented mash was then be put into sack and pressed. The cake obtained after dewatering was weighed, broken up and sifted to remove the large lumps and roasted into gelatinized product (*gari*) using traditional method in shallow cast-iron pans. The *gari* was scooped out and cooled by spreading it in a large bowl prior to weighing and packaging.

Yield determination

The yield of the samples was determined according to Oluwole *et al.*[9]. This was done on two bases. Firstly the weight of *gari* obtained was divided with the weight of the chips used multiplied by 100. Secondly the weight of *gari* obtained was divided by the weight of the mash after seeding and multiplied by 100. The cassava mash was considered as the initial weight that is, after rehydration and seeding of cassava chips in this case. This was done to establish the basis for comparing the yield obtained with that of the control sample.

Sensory evaluation

The *gari* (in its various consumable forms which are unsoaked *gari*, soaked *gari* and reconstituted *gari* (*eba*) samples were subjected to sensory evaluation using 30 semi-skilled randomly selected judges[16]. This was based on colour, grainness/texture, taste, flavour 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[17].

Statistical Analysis

All experiments were conducted in triplicate. Data reported are averages of three determinations. Analysis of variance (ANOVA) was performed and differences in mean values were evaluated using Duncan's test at $p < 0.05$.

Results and Discussion

Yield

The yield of *gari* in this study was determined on two bases as shown in Table 1. Firstly, dried cassava chips were considered as the initial weight in the production of *gari*. This was done considering the fact that the dried chips stand as raw material for the production of *gari*. The yield value ranged from: 73.08 – 90.73 %. The high yield values obtained for *gari* using dried cassava chips as the basic raw material which might be due to coarse milling done to the chips. This would have eliminated the un-grated parts that would have obtained during grating of cassava if it were to produce from fresh roots which get lost to the waste during sieving before roasting. The results obtained in this study were found comparable to the range 68 -85% reported by Oluwole *et al*.[18].

Secondly, the values in the case of using mash as initial weight ranged from 25.03 to 33.35% which agreed with the report of Sanni[18] that the yield of *gari* should not be less than 25%

for maximum economic value for *gari* production. These values were found comparable to the values obtained for control sample which is 32.04. It can be deduced from both results (yield from chips and yield from mash) that producing *gari* from chips will give the processors more profit due to its high yield of *gari*.

Table 1: Percentage yield of *gari* produced cassava chips and mash

Sample	Dried chips	Mash
Sun_{20}	90.00	31.19
$Solar_{20}$	90.73	33.35
$Cabinet_{20}$	80.00	27.41
Sun_{30}	90.00	31.19
$Solar_{30}$	84.09	28.70
$Cabinet_{30}$	74.00	25.35
Sun_{40}	74.93	26.31
$Solar_{40}$	77.08	26.30
$Cabinet_{40}$	73.08	25.03
Control		32.04

Sun, solar and cabinet signify drying methods; subscripts 20, 30 and 40 signify rehydration water temperatures in (°C)

Sensory evaluation

The pictorial image of *gari* is as shown in Plate 1 and the attributes evaluated for sensory (colour, grainness/mouthfeel/texture, appearance, taste, flavour and overall acceptability) for both unsoaked, soaked and reconstituted (*eba*) *gari* are as presented in Tables 2, 3 and 4. The results of sensory evaluation for unsoaked *gari* were generally found significantly ($p \leq 0.05$) different in terms of colour, grainness, appearance, taste and flavour. *Gari* from cabinet-dried chips rehydrated with water at 40 °C was more preferred among *gari* produced from rehydrated chips in terms of overall acceptability.

The control sample was highly rated in all the sensory attributed (colour, mouthfeel, appearance, taste, flavour and overall acceptability) and significantly ($p \leq 0.05$) different from all the samples obtained from dried cassava chips. This was observed in all consumable forms (unsoaked, soaked and reconstituted *gari*) prepared. It was observed that both drying method and rehydration water temperature significantly affected the sensory attributes of *gari* from dried cassava chips in all forms. The unsoaked and soaked *gari* samples were found significantly different among each other in terms of mouthfeel, appearance, taste and flavour. But for reconstituted *gari* (*eba*), significant ($p \leq 0.05$) differences were observed in all attributes except for appearance. Meanwhile in all these attributes, the cabinet-dried samples at all temperatures of rehydration water were found more acceptable particularly at rehydration temperature of 40 °C. This was as result of the fact that drying is done faster with cabinet dryer thereby retained the colour of the products making them appealing to the consumers. However, in terms of overall acceptability, there was no significant difference among all the samples from dried cassava chips in soaked *gari* form. A slight significant difference was observed between solar and sun-dried samples.

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Plate 1: Samples of *gari* produced from dried cassava chips and control

Table 2: Sensory evaluation of unsoaked *gari* produced from dried cassava chips

Sample	Colour	Grainness	Appearance	Taste	Flavour	Overall Acceptability
Sun$_{20}$	5.6333^{b}	5.0667^{cd}	5.2667^{cde}	5.1667^{cd}	4.8000^{cd}	5.1667^{de}
Solar$_{20}$	5.6667^{b}	5.5667^{bcd}	4.9333^{de}	4.7333^{d}	4.5000^{d}	5.2333^{de}
Cabinet$_{20}$	5.5333^{b}	4.7333^{d}	4.9000^{de}	4.7000^{d}	4.8333^{cd}	5.0000^{e}
Sun$_{30}$	5.7000^{b}	5.5667^{bcd}	5.3667^{cde}	5.5000^{bcd}	5.4000^{bc}	5.4000^{cde}
Solar$_{30}$	5.4000^{b}	4.9667^{cd}	4.7667^{e}	5.1000^{cd}	4.5333^{d}	5.0000e
Cabinet$_{30}$	6.0667^{b}	5.8333^{bc}	5.9667^{bc}	5.8333^{bc}	5.7667^{b}	5.8667^{bcd}
Sun$_{40}$	6.1333^{b}	6.3667^{b}	6.3667^{b}	6.3000^{b}	5.9667^{b}	6.1333^{bc}
Solar$_{40}$	5.7667^{b}	5.9667^{b}	5.7000^{bcd}	5.1333^{cd}	5.4000^{bc}	6.0667^{bc}
Cabinet$_{40}$	6.1000^{b}	6.2333^{b}	6.3000^{b}	5.6667^{bc}	5.7333^{b}	6.4333^{b}
Control	8.6333^{a}	8.2333^{a}	8.3000^{a}	8.3333^{a}	7.9000^{a}	8.3667^{a}

Mean values (n=30) with different superscript(s) in the same column are significantly different at $p< 0.05$.
Sun, solar and cabinet signify drying methods; subscripts 20, 30 and 40 signify rehydration water temperatures in (°C)

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Table 3: Sensory evaluation of soaked *gari* produced from dried cassava chips

Sample	Colour	Mouthfeel	Appearance	Taste	Flavour	Overall Acceptability
Sun$_{20}$	6.3333^{bc}	5.9000^{b}	6.2000^{bc}	5.4333^{cd}	5.1667^{cde}	5.9333^{b}
Solar$_{20}$	6.0000^{c}	5.5000^{b}	5.7333^{bc}	5.0333^{d}	4.8667^{e}	5.7333^{b}
Cabinet$_{20}$	6.7000^{bc}	5.8667^{b}	6.0000^{bc}	5.5333^{cd}	5.0333^{de}	5.9000^{b}
Sun$_{30}$	6.6667^{bc}	5.9667^{b}	6.3667^{bc}	6.3000^{bc}	5.9000^{bc}	6.2667^{b}
Solar$_{30}$	6.3000^{bc}	5.6333^{b}	5.5667^{c}	5.5000^{cd}	5.2000^{cde}	5.8000^{b}
Cabinet$_{30}$	6.7000^{bc}	6.2667^{b}	6.5000^{b}	6.2000^{bc}	6.1667^{ab}	6.5000^{b}
Sun$_{40}$	6.7000^{bc}	6.2333^{b}	6.0333^{bc}	6.1333^{bc}	5.6333^{bcde}	6.4000^{b}
Solar$_{40}$	6.6333^{bc}	5.7667^{b}	5.6667^{c}	5.4000^{cd}	5.7333^{bcd}	6.1000^{b}
Cabinet$_{40}$	6.9000^{b}	5.5667^{b}	6.6000^{b}	6.5000^{ab}	6.2333^{ab}	6.4333^{b}
Control	7.9000^{a}	7.5667^{a}	7.9667^{a}	7.2667^{a}	6.7667^{a}	7.6667^{a}

Mean values (n=30) with different superscript(s) in the same column are significantly different at $p < 0.05$.

Sun, solar and cabinet signify drying methods; subscripts 20, 30 and 40 signify rehydration water temperatures in (°C)

Table 4: Sensory evaluation of reconstituted *gari* (*eba*) produced from dried cassava chips

Sample	Colour	Texture	Appearance	Taste	Flavour	Overall Acceptability
Sun$_{20}$	5.8333^{cde}	5.8000^{bc}	5.9333^{b}	5.7000^{cde}	5.4000^{bc}	5.8333^{cde}
Solar$_{20}$	5.0667^{e}	5.0667^{c}	4.6333^{c}	5.4333^{de}	4.9000^{c}	5.5333^{de}
Cabinet$_{20}$	6.7000^{b}	6.0000^{b}	6.3333^{b}	5.9000^{bcde}	5.6333^{bc}	6.1667^{bcde}
Sun$_{30}$	6.2333^{bcd}	6.2000^{b}	6.1667^{b}	5.6667^{cde}	5.5000^{bc}	6.1000^{bcde}
Solar$_{30}$	5.5333^{de}	5.7333^{bc}	5.5667^{b}	5.2667^{e}	4.8667^{c}	5.4333^{e}
Cabinet$_{30}$	6.2333^{bcd}	6.0000^{b}	6.2667^{b}	6.3667^{bc}	6.0000^{b}	6.3333^{bc}
Sun$_{40}$	5.7667^{cde}	5.8000^{bc}	5.7667^{b}	6.6000b	5.6667^{bc}	6.2667^{bcd}
Solar$_{40}$	6.2000^{bcd}	6.2000^{b}	5.8333^{b}	5.9000^{bcde}	5.8333^{b}	6.2000^{bcd}
Cabinet$_{40}$	6.5000^{bc}	6.0667^{b}	6.2333^{b}	6.2333^{bcd}	5.9000^{b}	6.6333^{b}
Control	8.3333^{a}	7.7000^{a}	8.0667^{a}	7.6000^{a}	7.2000^{a}	8.3000^{a}

Mean values (n=30) with different superscript(s) in the same column are significantly different at $p < 0.05$.

Sun, solar and cabinet signify drying methods; subscripts 20, 30 and 40 signify rehydration water temperatures in (°C)

Conclusion

Investigations were carried out on the effects of drying method and rehydration water temperature on yield and sensory properties of *gari*. High yield were observed in *gari* produced from dried cassava chips. The results of sensory analysis showed that the control samples are highly rated but *gari* samples from cabinet-dried chips rehydrated with water at 40 °C were preferred in all forms (unsoaked, soaked and reconstituted) of *gari* samples obtained from dried cassava chips.

References

1. FAO (1989). FAO Production Yearbook. Food and Agriculture Organization of the United Nations. Rome.

2. Phillips, T. P. (1984). An overview of cassava consumption and production. In Cassava Toxicity and Thyroid; Proceedings of a Workshop, Ottawa, 1982 (International Development Research Centre Monograph 207e), pp. 83 – 88 (F. Delange and R. Ahluwalia.Editors). Ottawa. Canada: International Development Research Centre.

3. Claude Fauquet and Denis Fargette, (1990). African Cassava Mosaic Virus: Etiology, Epidemiology and Control. *Plant Disease*, *74 (6): 404 – 411*.

4. Ceballos, H., Sanchez, T., Morante, N., Fregene, M., Dufour, D., Smith, A., Denyer, K., Perez, J., Calle, F., and Mestres, C. (2006). Discovery of an amylose –free starch mutant cassava (*Manihot esculenta* Crantz). *Journalof Agriculture and Food Chemistry*,55: 7469 – 7476.

5. IITA (1992). Cassava as Livestock Feed in Africa: Proceedings of the IITA/ILCA/University of Ibadan Workshop on the Potential Utilization of Cassava as Livestock Feed in Africa, edited by S. K. Hahn, ,Len Reynolds,G. N. Egbunike 14-18 November 1988, Ibadan, Nigeria

6. Cortis, S (1980). Solar Energy in the 80's. Proceeding of the Conference on Solar Energy. Pergamon press, London.

7. Methakhup, Siporn (2003). Effects of drying methods and conditions on drying kinetics and quality of Indian gooseberry flake. M Sc. Research Project Submitted to King Mongkut's University of Technology Thonburi.

8. Barimah, J., Ellis, W. O., Oldham, J. H., Safo-Kantanka, O. and Pawar, G. D. (1999). The effects of drying and varietal differences on the physicochemical properties of cassava starch. *Journal of the Ghana Science Association, 1 (3): 53 - 59.*

9. Oluwole, O. B. Olatunji, O. O. and Odunfa, S. A. (2008). Development and evaluation of a process technology for conversion of dried cassava chips into *gari*.*Journal of Industrial Research and Technology*, 2 (1): 21 – 30.

10. Ikujenlola, A. V. and Omosuli, S. V. (2009). Dehydrated cassava chips utilization in starch and *garri* production. Advanced Materials Research, 62-64: 203-207

11. Uvere, P. O. and Nwogu, N. A. (2011). Effect of rehydration and fermentation methods on the quality of *garri* produced from stored cassava chips. African Journal of Food Science, 5(13): 728-732.

12. Udoro E. O, Gbadamosi, O. S., Taiwo, K. A. and Akanbi, C. T. (2013). Effect of processing on the physico-chemical properties and yield of *gari* from dried chips. Journal of Food Processing and Technology, 4(8): 255. doi:10.4172/2157-7110.1000255.

13. Tunde-Akintunde, T. Y., Afolabi, T. J. and Akintunde, B. O. (2005). Influence of drying methods on drying of bell-pepper (*Capsicum annuum*). *Journal of Food Engineering, 68: 439 – 442*.

14. Hammonds, T. W., Aristee, G. D. and Wimbedlow, L. (1977).“Handbook of shea processing using a manually operated bridge press”. A Publication of National Resources Institute, Chathman, England.

15. Akinwande, B. A., Ngoddy, P. O., Olajide, J. O. and Fakolujo, A. D. (2013).Production and storage of cassava chips for reconversion into *gari*.*Innovative Systems Design and Engineering, 4(9): 68 - 72.*

16. Komolafe, E. A. and Arawande, J. O. (2010). Evaluation of the quantity and quality of *gari* produced from three cultivars of cassava. *Journal of Research in National Development*, 8 (1).

17. Masen, R. L. (1982). Sweet potato curing investigations. *Food Technology in Australia, 34: 574 - 576.*

18. Sanni, L.O. (1990). Hazard analysis of critical control points in the commercial production of high quality*gari*.*Nigerian Journal of Science*, 24.