ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 4, Issue 5, September 2015

Physio-Chemical and Organoleptic Properties of Gari from Cassava Roots Stored In Moist Medium for Fifteen Weeks

EJE, B. E., UGWU, K. C. and OKAFOR E. C.
Department of Agricultural and Bioresource Engineering,
Department of Agricultural Engineering Technology,
Enugu State University of Science and Technology.
Federal College of Agriculture, Ishiagu Ebonyi State

Abstract: ***The physio-chemical and organoleptic properties of gari sample from stored cassava roots were evaluated. Cassava roots of the cultivars, Tms 30572, Tms 4(2)1452 and Tms 50395 were stored for fifteen weeks in boxes with moist saw dust. The reference or control gari samples of the four cultivars were obtained from unstored cassava roots that were processed into gari, packaged, sealed and stored. Within the period of the root storage, ten kilogram of each cultivar were taken from storage every three weeks, processed into gari, packaged and stored. The temperature and relative humidity of the storage medium and the ambient were recorded daily. The results of the physio-chemical and organoleptic properties of the gari samples showed that up to twelve week of storage most of the gari samples qualities are good and acceptable. Again the moist saw dust maintained lower storage temperature and high relative humidity for the stored cassava roots. The analysis of variance (ANOVA) on the effect of gari through the color, taste, flavour and overall acceptance for storing cassava roots for the period of 15 weeks at 5% probability level were computed. There is a significant difference on gari colour, taste, flavor and overall acceptance but cannot make gari unconsumable, within 15 weeks of storage because hydrogen cynide content of gari obtained fell within the consumable dosage level.***

Keywords: **Physio-chemical, Organoleptic, Gari, Cassava Roots, Moist Medium.**

I. INTRODUCTION

Gari is a hydrated, granular grit with cream white colour or yellow, if palm oil is added to it. It is the most common processed food form of cassava in Nigeria and is one of the most important staple foods in the diet of Nigeria and West African people. Gari is consumed by more that 200 million people in the tropics either by soaking it in cold water with sugar or salt and taken with coconut, peanut, fish, beans porridge or soaked in hot water to form a paste eaten with any kind of soup. It can also be mixed with cooked beans and palm oil and eaten as in Togo [9].

In general, the determinants of a good quality gari are good starch content (draw ability) ranging from 81.8-90.8% (g/100g) low ash content 0.80-.4% (g/100g) [6], good flavour, taste, texture, attractive colour and free flowing uniform size grains. In addition good gari must swell 1.5-3 times its volume when soaked in cold water. According to sann [15], a good quality gari must have a shelf-life of at least three months and the moisture content in equilibrium with a relative humidity of less than 65% must be less than 12.1% (wb) [8]. Most importantly, an edible gari should contain low hydrogen cynide (HCN) content of not more than 50mg/kg, which is safe HCN level for human consumption [7].

Gari is processed from cassava roots, of which Nigeria is the largest world producer. During the dry season months in Nigeria (November – March) the supply of gari to the market drops and its price per measure rises. This is because cassava roots, being bulky, irregularly shaped and grows deep into the soil are difficult to harvest due to low soil moisture content. In an attempt to overcome the harvesting difficulty and deterioration, and extended the shelf life cassava roots had been stored with fungicides, wax emulsion, gamma radiation trench and in refrigerator, but these methods recorded high storage losses, and could not prolong the shelf-life of the roots. Again, the use of chemical is not encouraging because of their prohibitive cost, injurious side effects on consumers, and environmental pollution effects and micro-organisms resistance to chemical effects.

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 4, Issue 5, September 2015

Again, leaving the matured cassava roots in the soil is not economical due to bush fire, deterioration caused by rodents, bacterial and more importantly the economic value of the land is lowered.

Currently the only promising method of extending the shelf-life of harvested cassava roots is the storage in moist saw dust which is low-cost and affordable. This is because the moist saw dust has low volume of interstial air space of 30.7 litres, the ratio of volume of roots to preserving materials is 3.1 and has 1.65% moisture status in comparison with sand [1]. Adequate scientific knowledge and basic technologies on the storage of cassava roots in moist sawdust have been reported by many authors [4].

Some of these workers limited their storage evaluations of cassava root to physical appearance and cooking qualities [16] while others dwelled on bio-chemicals biophysical and organolephtic tests of the stored roots [4].

In another dimension [13], who had stored cassava roots for ten weeks in moist sawdust evaluated only the appearance and taste of gari samples from stored root. So far no attempt has been made in storing cassava roots in moist sawdust for a long period. Again information is scarce on the physio-chemical and organoleptic properties of gari from cassava roots of different cultivar stored for a long period.

Furthermore, no attempt has been made in evaluating the prevailing temperature and relative humidity of the moist sawdust during storage. The above are the objectives of this work. The information from this work will be of much use in the designing of cassava root storage structure and it will also help the gari processors, who may like to store cassava roots for processing during dry season.

II. MATERIALS AND METHODS

A. Cassava Root Storage and Preparation of Gari Samples

One year old of improved cassava roots of Tms 30572, Tms 4(2)1425, Tms 91934 and Tms 50395 were carefully harvested without damage, with 15cm stem length attached. The healthy roots were selected and stored in layers in moist sawdust of 80% moisture content (wb), in rectangular wooden boxes measuring 100cm by 60cm by 60cm by 40cm. In storing, the dry sawdust was placed at the bottom of the box, then cassava roots were placed on it and covered with a layer of moist sawdust. Then another layer of cassava roots were placed and covered with a layer of moist sawdust. This order was continued until the box was filled and covered with a lid. A provision was made at the centre of each box for installing the instruments for measuring the prevailing daily temperature and relative humidity. Each box contained only one variety and each variety was replicated three times. The boxes were placed in a ventilated room and the sawdust was moistened every two weeks with clean water.

To obtain a control or reference sample, ten kilogram of the freshly harvested unstored cassava roots of the four cultivars in use here were manually, peeled washed, grated, fermented and dewatered for two days. They were then sieved and fried manually at the temperature of 84 ± 1^{0}C [13] until thoroughly dry. On cooling, the gari samples were packed in thick polythene bags, mechanically sealed and inserted in the Hessian sacks and stored. This ensured the preservation of the moisture content and other qualities of the gari [8]. Every three weeks, starting from 3rd week of storage till the 15th week, ten kilogram of cassava roots were taken from each cultivar of the stored roots and processed into gari and stored as done with the control.

B. Bio-Chemical Tests

Chemically the gari samples including the references or control were evaluated. The hydrogen cynide content (HCN) was evaluated with the method of Ikediobi *et al* [12], the swelling capacity by the method of ASAE [2]. The moisture content was evaluated according to ASAE [2]. Each parameter was evaluated with three replication and the mean found.

C. Physical and Organoleptic Property Evaluation

The colour, taste, texture, flavour, draw ability and acceptability of all the gari samples were evaluated with multiple comparisons test [11] and compared with the control gari sample. A panel of ten trained gari consumers assessed the samples. Numerical scores of, 5 for no difference with reference or control sample, 9 for extremely better than reference sample and, 1 for extremely worse than reference sample were used for

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 4, Issue 5, September 2015

the panel rating [11]. The numerical scores were then subjected to analysis of variance and least significant difference at 95% level of probability was used to compare the mean properties of the sample for the storage period. For draw ability assessment, the gari samples were constituted into dough.

III. RESULTS AND DISCUSSION

A. Temperature and Relative Humidity Regime

The results of the temperature and relative humidity taken throughout the period of storage showed that the moist sawdust served as a good temperature stabilization medium for cassava root storage (Fig.1). While ambient temperature continued to fluctuate with a mean of 27 ± 2.2°C, the moist sawdust temperature remained at 26 ± 1°C. This situation discouraged the microbial deterioration and helped to maintain the cassava roots in a good condition without shrinkage. Again, the mean ambient relative humidity was 70±1%, while the moist sawdust maintained 91±1% relative humidity (Fig.1). These environmental situations favour the long storage period of cassava roots.

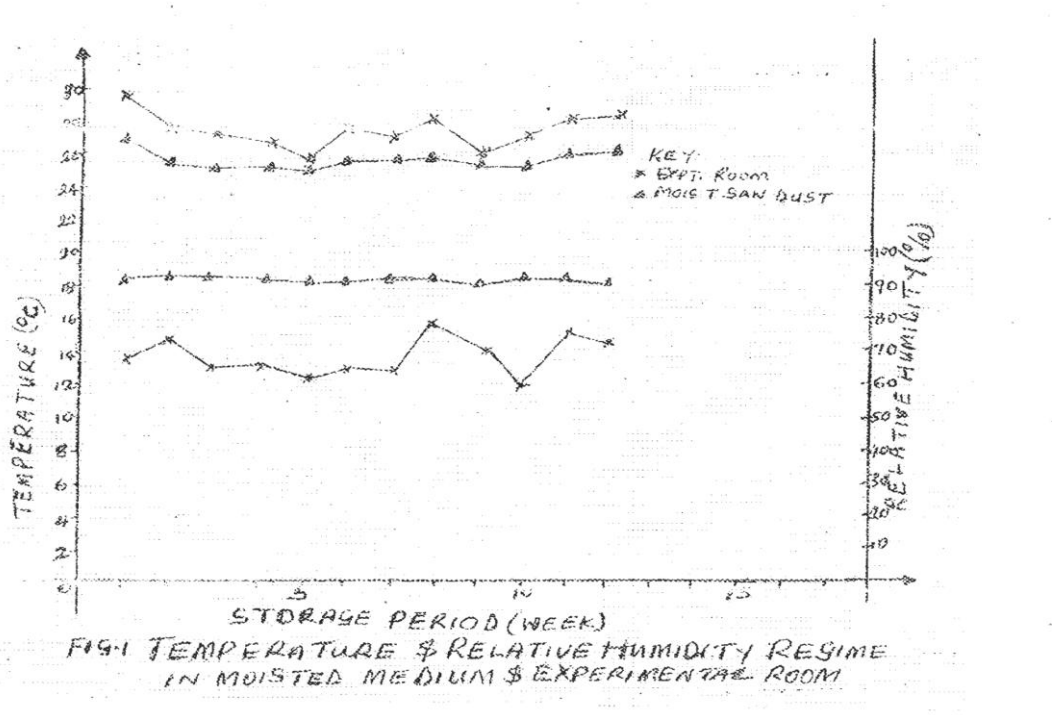

FIG.1 TEMPERATURE & RELATIVE HUMIDITY REGIME IN MOISTED MEDIUM & EXPERIMENTAL ROOM

B. Bio-Chemical Evaluation Results

Storage situations in moist saw dust did not encourage the significant increase in the hydrogen cynide content of cassava roots of the four cultivars (table 1). This result agreed with the report of Booth [4] when they assessed the HCN content of fresh cassava roots stored in mist saw dust. The slight increase in HNC content of some of the gari samples of the cultivars Tms 30572 and Tms 50395 were not significant and since all the gari samples HCN content values were below 50mg/kg, which is the recommended maximum level for human consumption, all the gari samples, up to 15th week of storage are consumable.

Table 1: Storage period on the Hydrogen Cynide content (mg/kg) of gari sampled

Storage Period	Cassava Cultivars			
(Week)	Tms 30272	Tms 50395	Tms 4(2)1425	Tms 91934
0	26.00	28.80	21.75	20.63
3	25.70	28.70	21.78	20.60
6	25.80	28.50	21.50	20.40
9	26.10	28.80	21.50	20.10
12	26.00	29.00	21.10	20.00
15	26.30	29.10	20.81	19.80

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 4, Issue 5, September 2015

Table 2: Storage Period on the swelling ability of the gari samples

Storage Period	Cassava Cultivars			
(Week)	Tms 30572	Tms 50395	Tms 4(2)1425	Tms 91934
0	2.00	1.80	2.10	2.00
3	2.10	2.10	2.90	2.40
6	2.40	1.85	2.00	1.90
9	2.30	1.85	2.10	1.90
12	2.00	1.90	2.00	1.90
15	2.30	1.95	1.90	1.90

The swelling ability of all the gari samples (table 2) for the whole period of storage was adequate since they were within the standard swelling capacity of 1.5 -3.0 times the initial volume [5]. The Tms 30572 and Tms 4(2) 1425 swelled more than the other cultivars. This can be attributed to the higher starch content of the gari sample particles which on absorbing water swelled and increased their sizes. The moisture contents of the gari samples of all the cultivars for the whole storage period were adequate and ranged from 8.0% to 12.0% (wb). Thus, these gari samples from stored roots can store for more than one year without quality changes.

C. Physical and Organoleptic Evaluation Results

Table 3: Cassava root storage period on the colour of gari samples

Storage Period	Cassava Cultivars			
(Week)	Tms 30572	Tms 50395	Tms 4(2)1425	Tms 91934
0	5.09	5.27	5.18	5.00
3	5.18	4.45	5.09	4.27
6	5.36	5.09	4.82	5.18
9	4.64	5.00	5.00	4.55
12	4.91	4.64	4.80	4.70
15	1.91	3.55	1.27	2.18

Table 4: Cassava root storage period on the taste of gari samples

Storage Period	Cassava Cultivars			
(Week)	Tms 30572	Tms 50395	Tms 4(2)1425	Tms 91934
0	4.73	5.37	5.73	4.64
3	4.27	4.55	5.64	4.45
6	4.27	5.00	4.64	4.55
9	4.00	4.36	5.27	4.45
12	3.86	4.55	3.55	3.82
15	3.85	3.80	2.18	2.73

Table 5: Storage period Cassava roots on the flavour of gari samples

Storage Period	Cassava Cultivars			
(Week)	Tms 30572	Tms 50395	Tms 4(2)1425	Tms 91934
0	5.27	4.82	5.27	5.00
3	4.55	4.18	6.00	4.73
6	5.18	5.09	5.64	4.73
9	4.36	4.00	5.27	4.00
12	5.00	4.55	4.18	2.73
15	3.18	3.95	2.45	2.55

Table 6: Storage period of cassava roots on the drawability of gari samples.

Storage Period	Cassava Cultivars			
(Week)	Tms 30572	Tms 50395	Tms 4(2)1425	Tms 91934
0	5.27	5.09	4.91	5.00
3	4.73	4.18	4.36	4.64
6	4.27	4.73	4.18	5.00
9	4.18	4.45	4.00	4.82
12	5.00	5.36	3.27	5.40
15	4.00	5.18	3.27	5.36

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 4, Issue 5, September 2015

Table 7: Storage period of cassava roots on the overall acceptance of gari samples

Storage Period	Cassava Cultivars			
(Week)	Tms 30572	Tms 50395	Tms 4(2)1425	Tms 91934
0	5.18	5.00	5.18	5.00
3	4.09	4.00	4.55	4.64
6	5.00	5.00	4.55	5.00
9	4.73	4.00	4.82	4.36
12	4.70	3.96	3.96	2.45
15	1.18	3.45	2.09	2.36

Table 8: ANOVA for the effect on gari Colour, taste, flavor and overall acceptance for storing cassava root for fifteen weeks.

Source of Variations	Sum of Squares	Degrees of Freedom	Mean Squares	Computed F
Treatments	0.613	3	0.204	0.0753
Blocks	63.11	5	12.62	
Error	40.65	15	2.71	
Total	104.37	23	-	

There were significant variations among the cultivars in the eating qualities of gari samples. The colour of all the gari samples remained acceptable up to the 12^{th} week of root storage (Table 3). Gari samples of the cultivar Tms 30572 and Tms 91934 had better appearance than the control gair samples in the 6^{th} week of storage. However at the 15^{th} week of root storage, the colour of the gari samples of all the cultivars differed significantly with the control samples. This colour change can be attributed to the initiation of physiologic changes in cassava roots. Thus, gari samples, from cassava root stored in most saw dust maintain good colors up to 12^{th} week of storage.

Again, for cultivars Tms 30572, Tms 59395 and Tms 91934, their gari sample taste were acceptable as the control sample for the whole storage period. Gari samples of Tms 4(2)1425 had taste significantly different from the control at the 12^{th} and 15^{th} week of storage.

Tables 4 and 5 showed the results of taste and favour obtained within 15 weeks of storage. Flavour arises from a subtle interaction of taste and aroma which impacts a pleasing or displeasing sensory experience to a consumer. Although gari colour evokes the initial response, it is the flavour that ultimately determines the gari acceptance or rejection by the consumer. This fact is confirmed by the similarity of tables 5 and 7. The flavour and taste of the gari samples of Tms 4(2)1425 and Tms 91934 varied much in the 12^{th} and 15^{th} week of root storage, making them to differ significantly with the control sample.

Table 6 presented the draw ability of the gari sample of all the cultivars. There is no significant difference among all the cultivar samples from 0 to 15^{th} week of storage. These results showed that there was no degradation in the starch content of the roots stored in moist saw dust as observed in sample swelling ability (table 2).

The analysis of variance shown above in table 8 was computed using 5% probability level. The critical (table) value of F is 3.29 and the computed value is 0.0753. Since $0.0753 < 3.29$, we conclude that, there is an effect on the colour, taste, flavor and overall acceptance of gari for the storage of cassava roots for the periods of 0 to 15 weeks. Henceforth, the effect cannot make gari inconsumable because the dosage level of hydrogen cynide content of gari obtained fell within the consumable dosage level. All the gari samples of all the cultivars were acceptable to the gari consumers but from 12^{th} to 15^{th} week the gari samples of many cultivars were not acceptable due to changes in physical and organoleptic properties resulting from stored tubers.

IV. CONCLUSION

The moist saw dust provided a good storage medium for cassava roots, resulting from its low and less fluctuating temperature of $26+1^{0}C$ and high relative humidity of 91+1%. These conditions ensured the good

ISSN: 2319-5967
ISO 9001:2008 Certified
International Journal of Engineering Science and Innovative Technology (IJESIT)
Volume 4, Issue 5, September 2015

storage of some cultivars of cassava root up to 12th week, and the gari processed from the roots were of good quality and were acceptable, physically, bio-chemically and organoleptically. The hydrogen cynide content of the gari obtained from all stored cassava roots fell within the consumable dosage level.

REFERENCES

[1] Aiyer, R.S, P.G., Nair and I. Prema (1978) No cost method for preserving fresh cassava roots. Cassava News. CAIT Cali Colombia, No 4, July/Dec.

[2] ASAE (1982) AMERICAN Society of Agricultural Engineers' Year Book Michigan, USA.

[3] Balagopal, C. and Padmaja, G. (1985). A simple technique to prolong the shell life of cassava National Symposium on Product Utilization of Tropical Tuber Crop. Trivandrum.

[4] Booth, Robert, H. (1977). Storage of Fresh Cassava: 11 sample storage techniques, Experimental Agric Vol. 13, 119-128.

[5] Ene, L.S.O. (1986). Annual Report National Root Crops Research Institute, Umudike, Nigeria. P.!5.

[6] Etejere, E.O. and Bhat, R. (1985), Traditional preparation and uses of cassava in Nigeria. Botany 39(2) 157 164.

[7] FAO (1972), Monograpy on cassava roots. Rome.

[8] Halliday, D. Qureshi, A H. and Broadbent, J. A. (1967), Investigation on the storage of gari Nig. Stored Prod. Res Institute Technical Report No. 16, 131-141.

[9] Igbeka, J.C., Jory, M and Griffon, D. (1992); Selective Mechanization for cassava processing p.45 – 50. in Agricultural Mechanization in Asia, Africa and Latin America. Vol. 23 No 1.

[10] Igram Jeans S. Humphries, J.R.O, (1992); Cassava storage; A Review; Tropical Sc. Vol 14(2) 131-148.

[11] Ihekoronye, A. I and Ngoddy, p.P Eds (1985). Integrated Food Science and Technology for the Tropics Macmillan Pub. London and Basinsstoke.

[12] Ikedibi, C.O. Onyia, G.O.C and Elunlah, C.E. (1980). A Rapid and Inexpensive enzymatic assay for total Cynide in cassava (manihot esculenta crantz,) and Cassava products. Agric Biol. Chem 44(12)2803-2809.

[13] Okafor, E.C and Onyekwere, P.S.N, (1992). An improved manual gari fryer for local Industry. Proc 4th Symposium, ISTRC – AB P.223-227.

[14] Richard, June E. and Coursey D.G. (1981). Cassava Storage Part 1: Storage of Fresh Cassava Roots. Tropical Science 23(1) 1-32.

[15] Sanni, M. Olayinka (1994). Gari Processing in Ibadan metropolis: Factors Controlling quality at the small-scale level. In Proc 9th Symposium of the Inter Sco for Tropical Root Crops 20-26 Oct., 1991. Accra, Ghana, P. 256-260.

[16] Wickham, A Lynda, D and Lawrence A. Wilson (1988). Quality changes during Long term storage of cassava roots in moist media Tropical Science, Vol. 28, 79-86.