

Effect of different drying modes and cassava varieties on the quality of its chips

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ABSTRACT

The effect of drying height and cassava variety on the quality and drying characteristics of cassava chips were investigated. The varieties used were TMS 30572, NR 8083 and local best. The samples were sun-dried at the loading rate of 7kg/m^2 , at 0, 0.5m, 1.0m and 1.5m heights on a flat palm frond basket. The microbial load of the chips dried on the above heights was investigated. The hydrogen cyanide (HCN) content of the dried samples from the varieties was analyzed while the particle size distribution of the milled samples was evaluated. The chips were also assessed for colour. Data obtained from the analysis showed that chips from different cassava varieties contain non-lethal level of HCN that range from 5.35 to 7.6 mg HCN /100g. However statistical differences in the HCN values ($p < 0.05$) were observed. The mould count of the samples ranged 1×10^1 cfu /g- 1×10^2 cfu/g which is below the innocuous value of 1×10^5 cfu/g. The fineness moduli of flours from different cassava varieties which ranged 4.52-4.87 were significantly different ($p < 0.05$). The result also shows that as the drying height increased, the drying time of the chips decreased, however the colour of the dried chips from different varieties were significantly different ($p < 0.05$) after drying. The particle size distribution of the milled samples - uniformity index measurement shows that the varieties used in this work produced more coarse (9) than mediums (1-2) sized particles after milling twice.

Keywords: drying height, cassava chips, milling, uniformity index, mould infestation.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a drought tolerant crop [4] and a staple food crop in many developing countries. About 200 million people depend on it as a major source of carbohydrate [1]. It also is a major source of raw materials for other industries where it is used in animal feed, starch, glucose syrup, dextrose syrup, and fructose syrup and alcohol production.

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In most of these productions, chipping and drying are intermediate processes [2].

The cassava roots is highly perishable because it undergoes rapid physiological changes resulting to quality deterioration if left unprocessed after 48 hours of harvest [16]. This tends to thwart the efforts of many African countries to attain self-sufficiency in food production. Irregular and inadequate supply of raw cassava is major setback to industrial processing of cassava based

products [17,16]. Fresh cassava tubers are bulky and transportation to urban markets is difficult and expensive. It has been proposed that drying fresh tubers into chips will enhance the shelf-life of the product, facilitate transportation and handling, reduce cyanide content to innocuous levels, diversify the food uses and provide industries with low cost raw materials [5]. Oluwole and Adeyemo [16] stressed that drying will also ensure steady production and availability of dried chips throughout the year for local and export markets. Ngoddy and Onuoha [12] reported many factors that affect the rate of drying and quality of cassava chips. These among others include the physical properties of the drying environment and the characteristics of the drying equipment. The extent to which these factors affect the rate of drying and quality of dried chips are not well documented for various cassava varieties.

Cassava like other food crops is traditionally sun-dried at different heights –on the floor, fences, raised racks and on top of low buildings. The effect of these drying heights on the quality of chips has not been fully researched. Investigating this would help the local processor to know the quality implications of the various heights they use for drying.

Dried chips are generally milled before use in food production this makes for easy mixing or blending. The quality of milled products are usually measured by the finess modulus and uniformity index [20]. Since there are many high yielding cassava varieties now, it is necessary to study their drying and milling characteristics. Based on the foregoing, the objective of this work is to investigate the effect of different drying heights and variety on the drying and milling quality of cassava chips

MATERIALS AND METHODS

Three cassava varieties used for this work, NR 8083, TMS 30572 and local best, which were 18 months old after planting, were harvested from Faculty of Agriculture experimental farm, Ebonyi State University, Abakaliki

Preparation of samples

Fifteen (15) kg of NR 8083 tubers were manually peeled, washed, and chopped into circular chips of 5mm thick.

Drying of samples

Four portions of 2.5 kg each were spread on flat palm frond basket (1.037 m x 0.33 m) at a loading rate of 7 kg/m². The samples were placed on 0 m, 0.5 m, 1.0 m and 1.5 m heights and sun dried for two days (28th -29th Nov.) with an average daily temperature of 36± 1 °C and relative humidity of 57 ± 1 %. The samples were dried between 10am to 5pm each day.

Three varieties of cassava TMS 30572, NR 8083 and Local best were processed as above and were sun dried on 1.0 m height and loaded at 7 kg/m² on flat palm frond basket

Daily temperature and relative humidity readings were taken using mercury in glass thermometer and hydrometer respectively throughout the drying period. The moisture content of the fresh and dried chips were determined

Determination of the drying characteristics

As drying progressed, weight changes were taken at 1hr intervals using a top loading Metler weighing balance (Model PB602, Metler Toledo, Switzerland). The drying chips were manually turned 2-3 times before the weight loss was determined. Drying was continued until constant weight was achieved.

ANALYSIS OF THE SAMPLES

Determination of moisture content

The hot oven method [3] was adopted. Washed, dried petri dishes were cooled in a desiccator and their weights were determined. Ten (10) g of cassava chip samples were weighed into the petri dishes. The samples were dried in a hot air oven (Mido /2/SS/F: A. J. Patterson Scientific Ltd) at 105 °C. They were removed, cooled and weighed; the process was repeated until a constant weight was attained. The moisture content was calculated as percentage loss of the original weight.

Determination of drying time

The drying time was evaluated using procedure described by Odogola [15]. Using the graph of moisture content of the samples against time, the final moisture content is located. From this point, a line is drawn horizontally until it meets the curve; a vertical line is drawn from the point of intersection to drying time axis to locate the total drying time.

Determination of mould count.

The mould count was carried out according to the method of Frazier [9]. Eight (8) g of potato dextrose agar was weighed and dissolved in 250 ml of water in conical flask and covered with cotton wool and foil. NaCl (0.10 g) was weighed and dissolved in 100ml of water in a beaker. Nine (9) ml of diluents each was pipetted into eight small bottles. The prepared medium and the diluent and the pipette were autoclaved at 121 °C for 15 mins. The medium was cooled down after autoclaving. Ten (10) g of each ground sample were inoculated into their respective diluents in small bottles. One (1) ml of inoculum was pipetted into petri dishes. About 2 ml of nutrient agar was added into the petri dishes and covered. The medium and the inoculum were mixed thoroughly. The plates were

allowed to solidify on the bench and incubated in inverted position. After 48hrs, the growth was observed and the spores and colonies of the mould counted.

Determination of HCN

The hydrogen cyanide was determined using the methods of Cooke [6].

The milling quality of the dried chips

The milling characteristics were evaluated as follows: 1.0 kg of each dried sample was milled twice into flour using (No. 1A Premier) attrition mill. The particle size distribution of the milled samples, which was used for calculating the uniformity index and fineness modulus, was determined by the method adopted by Ukpabi and Dafe [19].

Determination of particle size and uniformity index (UI)

About 250 g of milled sample was placed on the uppermost sieve in a stack of six different sieves with aperture size of 2.0mm, 0.85mm, 0.435mm, 0.25mm, 0.18mm, and 0.15mm respectively. It was covered and vibrated for 5 minutes and the percentage fraction retained in each sieve was determined. The uniformity index (U.I) was calculated using the following formulae.

$$U.I(\text{coarse}) = \frac{\% \text{ retained in the first upper 2 sieves}}{10}$$

$$U.I(\text{medium}) = \frac{\% \text{ retained in the three middle sieves}}{10}$$

$$U.I(\text{fine}) = \frac{\% \text{ retained in the two lower sieves}}{10}$$

The values were rounded up to the nearest whole number.

Sensory evaluation

Cassava chips were evaluated for colour using 9- point Hedonic scale with 9 being Liked extremely while 1 was Disliked extremely

[10]. Twenty panelists drawn from students of the Faculty of Agriculture, Ebonyi State University were used. The samples were coded with 3-digit random numbers. The order of presentation of the samples was randomized for each panelist.

Data analysis

All the data were analysed using ANOVA. Least significant difference (LSD) was used to determine differences between means at $p < 0.05$ [14].

RESULTS AND DISCUSSION

Effect of drying height on the drying characteristics of cassava chips

The result in Fig 1 shows that the drying height affected the drying pattern of the cassava chips. From the curves, there was no observable constant rate period. Only the falling rate existed during the drying process. There was a very steep drying gradient at the beginning of drying, which later gradually reduced to near zero at the end of drying. Further drying after this did not show any observable loss in moisture. Odogola [15] made similar observation, when he compared solar and open sun drying of cassava chips in Uganda. Ngoddy and Onuoha [12] observed that the absence of constant rate drying shows that internal diffusion was the dominant mechanism of moisture loss. Similarly in this study, the loss of moisture from the cassava chips was probably dominated by internal diffusion mechanism

The sample dried on 1.5 m height lost moisture faster than other samples in the first 1.5 hours of drying. Thereafter the sample dried on 1.0 m height lost moisture faster than others until 2.5 hour. From 2.5 hours of drying the sample dried on 1.5 m height lost moisture faster than others. This is due to the fact that movement of air on the samples spread on raised flat palm frond basket through the holes

in the basket from the bottom and movement of air over it while it was restricted to only horizontal movement over the samples spread on the ground. It was observed that drying time decreased significantly with increase in drying height ($r = 0.93$, $p < 0.05$).

Effect of variety on drying characteristics of chips

Fig 2 shows the drying characteristics of three cassava varieties. From the results, variety affected the drying pattern of cassava chips.

There was no constant rate phase and all the samples lost moisture at the same rate within the hour of drying. After this, TMS 3052 dried faster than all other samples. The difference in the drying pattern may be due to the difference in the composition of the samples.

Fig 3 shows the effect of variety on the drying time of cassava chips. The drying time of NR8083 (13hrs) significantly ($p < 0.05$) differed from other samples. The drying time of TMS30572 (9hrs) and local best (10hrs) did not however differ significantly ($p > 0.05$) from each other. They generally dried faster than NR8083 variety. This could be due to the fact that NR8083 probably contained more bound water, which is generally difficult to remove during drying [7].

Effect of drying height on mould infestation of chips

The results in Fig 4 show that cassava chips dried on the floor (0m) had mould count of 1×10^2 cfu/g. This was higher than the mould count of the chips dried on the heights of 0.5 m, 1.0 m and 1.5 m that were 4×10^1 cfu, 2×10^1 cfu /g and 1×10^1 cfu /g respectively. Mould contamination has been a major problem in sun-dried products and its quality can be drastically reduced by dust particles [8]. Oyewusi [18] reported that total mould count of 1×10^5 cfu /g as being the innocuous range in cassava products. From this, the mould

count of the samples dried on different heights was below the innocuous range. For the production good quality cassava chips, drying on 1.5 m or 1 m heights is recommended.

Effect of variety on HCN of cassava chips

The hydrogen cyanide (HCN) content of the dried chip samples (Table 1) was within the acceptable range of 5-10mg HCN /100g reported safe for human consumption by NIS [13]. However, these values were significantly different ($p < 0.05$) among the varieties. The HCN level in chips made from Local best was low compared with that in TMS 30574 and NR 8084 respectively.

Effect of variety on the particle size distribution of cassava flour

Milled products are desired to be of only one homogenous size. They however come out in some distribution of sizes. The uniformity index and fineness modulus are used to describe the distribution of sizes and mean particle size in milled products, which are indices of quality of products [20]. Table 1 also shows that the distribution of particle sizes in the samples vary greatly with the variety of cassava. The fineness modulus of flour sample made from different cassava varieties was significantly different ($p < 0.05$) from each other. The local best had the highest value of 4.87 while the TMS 30572 had the least (4.52). This was probably because TMS 30572 after the drying became softer which resulted in greater particle size reduction. Based on this, TMS 30572 would be suitable for food formulation where flour with small particle size is required. Other samples may require further milling, which implies increase in milling energy and cost.

Table 1: Hydrogen cyanide content and particles size distribution of flour from different cassava varieties

Variety	HCN g HCN/100g)		Particles Size Distribution		
	Before Drying	After drying	Fineness Modulu	Uniformity Index (UI)	
				Coarse	medium: fine
Local Best	14.40	5.37 ^a	4.87 ^a	9	1: 0
TMS 30572	16.51	6.91 ^b	4.52 ^b	8	2: 0
NR8083	18.45	7.61 ^c	4.83 ^c	9	1: 0

Values are means of triplicates. Means with different letters in same column are significantly different ($p < 0.05$)

The samples from other cassava varieties produced more coarse flour than medium particles sizes (Table 1).

Effect of drying height and variety on the colour of the chips

The colour of the chips before and after drying did not show any difference significantly ($p > 0.05$) (Table II). The judges preferred the colour of chips from Local best and NR 8083 and there was no significant difference ($p > 0.05$) between them. They were however different from TMS 30572. The colour changes are caused by enzymes *polyphenyloxidase* [11]. Oluwole and Adeyemo [16] stated that for cassava chips to be desirable, its colour must be sparkling white or creamy. Result in Table II shows that colour of samples dried on different heights did not differ significantly ($p > 0.05$) from each other. The cassava chips from NR8083 could be dried on any height without affecting its degree of whiteness.

Table II: The Effect of heights and variety on the colour of dried chips

Sample type	Colour of samples	
	Before drying	After drying
Sample height (m)	0.0	6.00 ^a
	0.5	6.35 ^a
	1.0	7.05 ^a
	1.5	5.65 ^a
LSD	3.075	
Variety		
Local best	8.4 ^a	5.8 ^a
TMS 30572	8.0 ^a	4.0 ^b
NR8083	8.5 ^a	5.9 ^a
LSD	0.95	1.40

Values in the same column with different letters are significantly different ($p < 0.05$)

CONCLUSION

From this work, it was observed that drying time decreased as the drying height increased. Chip dried on different heights had tolerable level of microbial load. Increasing drying height also led to increase in the drying rate of the cassava chips irrespective of the variety used. The colour of the chips dried on different heights did not differ significantly whereas the colour of chips from different varieties varied significantly from each other ($p < 0.05$). Generally the HCN of the samples were below the tolerable level.

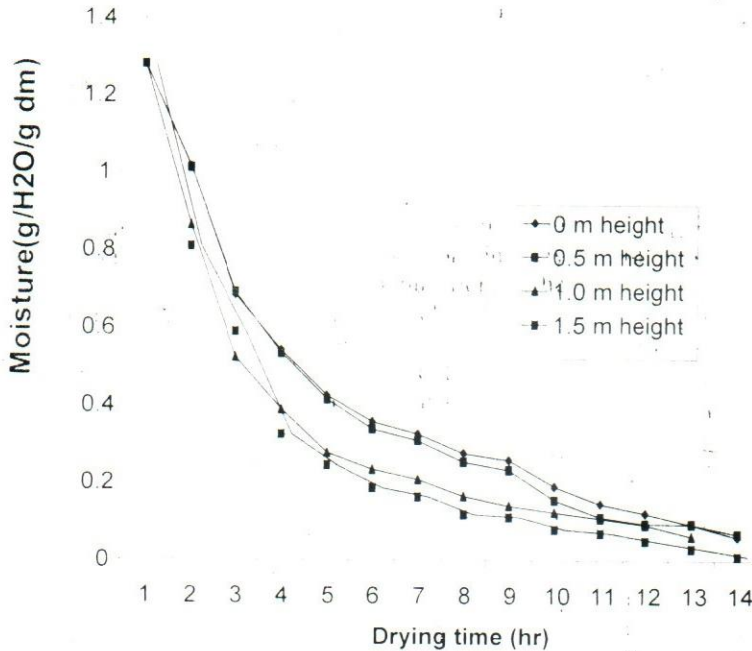


Fig 1 Drying Curves of cassava Samples Dried on Different Heights

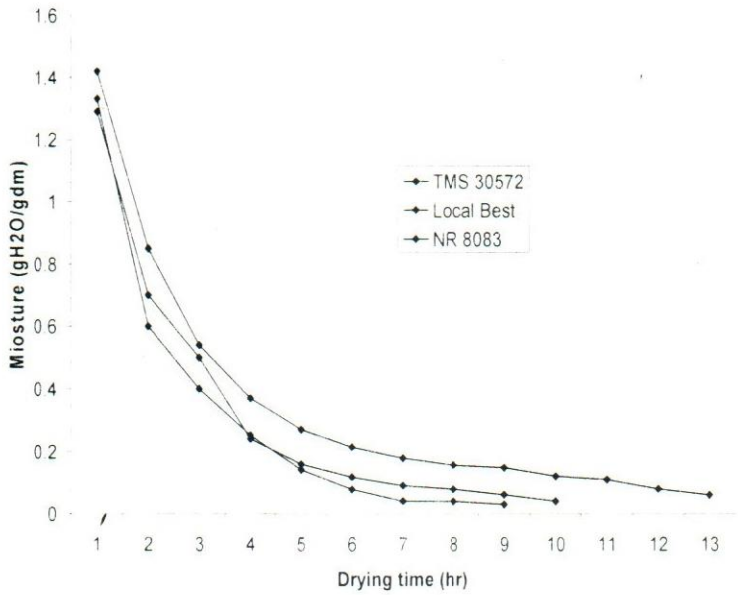


Fig. 2: Drying curves of samples from different cassava varieties

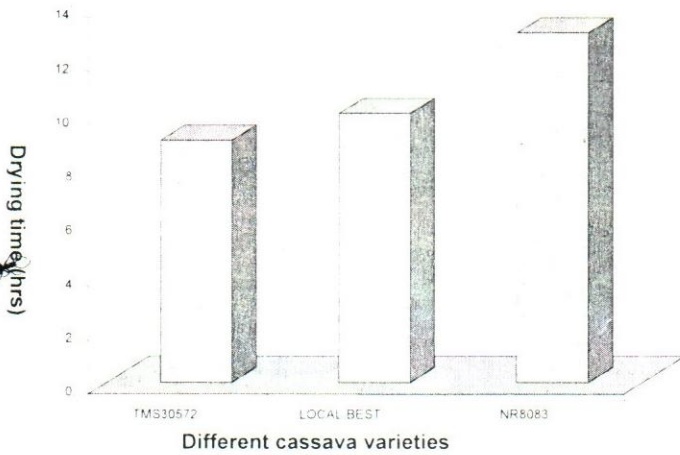


Fig 3 Drying time of the cassava varieties

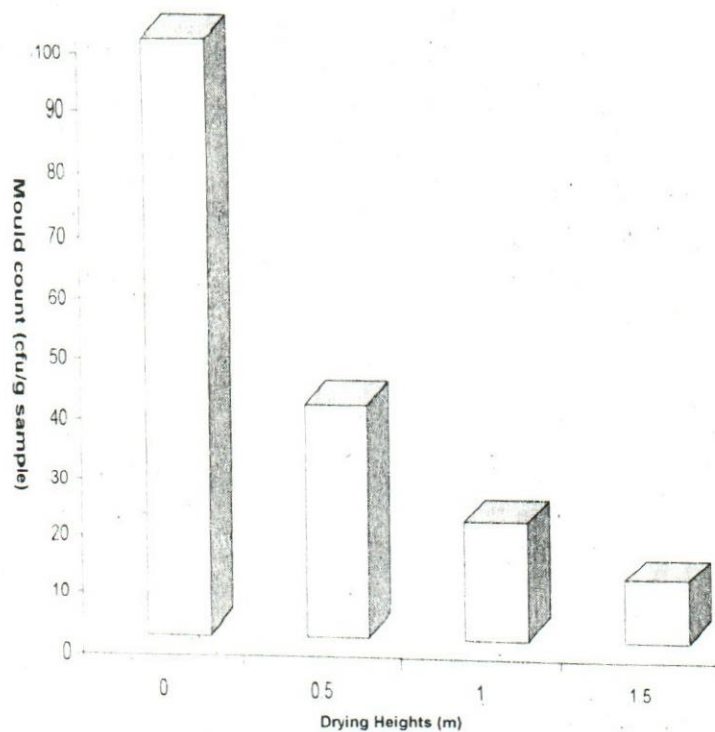


Fig 4 Effect of Drying Height on the Mould count of NR8083

REFERENCES

1. Adesuyi, S. A. (1977). Storage of roots and tubers. *Nigerian Food Journal* 1: 86-90.
2. Ajibola, O.O. Faborode, M. O. T. K. and Okpe, B.S. (1994) Development of cassava chipping machine. *Int. society for tropical root crops (ISRC)*, Netherlands
3. A. O. A. C. (1990) Official Methods of Analysis (15th edition) Association of Official Analytical Chemist. Washington D.C. Vol 2, pp 142-202
4. Ashley, J. (1999) Food Crop and Drought, Macmillan Education Ltd London in association with CTA (Technical centre for Agricultural and rural Co-operative), Lome pp.32 -35.
5. CAR (1979) Cassava annual report, Centro Internacional De Agricultural, Cail Colombia 5: 26-28
6. Cooke, R.D. (1978). An enzymatic assay for total cyanide content of cassava. *Journal of Science of Food and Agriculture* 29: 345-352
7. Ekwu, F. C (2004) Basic calculation in Food Engineering. Cheston Agency, 120 Agbani Road Enugu Nigeria, p 73
8. Ejiofor, M. A. N. (1997) Production of safe, odourless fufu. *Nigerian Food Journal* 4: 22-25
9. Fraizer, W.C. (1992) *Food Microbiology*, 2nd ed., MC Graw Hill Publishing Company New Delhi pp. 438-450
10. IFT (1981) Sensory evaluation guide for testing food and beverages products by the sensory evaluation division of the Institute of Food Technologists *Food Technology*, pp 57-59

11. Intermediate Technology Group (ITD) (1989) Root crop processing: Food cycle technology source book. United Nations Development Fund for women pp.151-152.
12. Ngoddy, P. O. and Onuoha, C. C. (1985) Selected problems in yam processing. In *Advances in Yam Research* edited by Osuji, G. O. and Pub. by Biochemical Society of Nig and ASUTECH Enugu, Nigeria. pp 295- 318
13. Nigerian Industrial Standard, NIS (1988) Standard for gari. Standard Organisation of Nigeria. Federal Ministry of Industry, Lagos.
14. Obi, I.U. (2002) Statistical methods of detecting differences between treatment means and research methodology issues in laboratory and field experiments. 2nd SNAAP Press Nig Ltd Nsukka Nigeria
15. Odogola, W. R. (1999) Comparative study of solar and open sun drying of cassava chips in Uganda. ISTRC, Netherlands pp. 274-277
16. Oluwole, O.B and Adeyemo, F.S. (2001) Report of commercial production of cassava chips. Federal Institute of Industrial Research Oshodi (FIIRO) Lagos .1-2
17. Onwueme, I. C. (1978) *Tropical Tuber Crops* John Wiley and Sons Ltd, Chichester pp. 124-130
18. Oyewusi, F.A. (2001) Report on Industrial Cassava Starch production. Federal Institute of Industrial Research Oshodi, Lagos
19. Ukpabi, U.J and Dafe, M. (1997) Quality evaluation of gari from major production areas of Mid – western States of Nigeria. *Nigeria Food Journal*. 4: 51-55
20. Zibokere, D.S. (1992) Performance evaluation of a bur mill in maize grain comminution. *Nigeria Food Journal*. 10: 83-92