Drying and Reconstitution of Cassava Foo Foo

Opara C.C, Akangbou N.M, Evbuomwan B.O, Ogbodo M.N.

***Abstract*— The study of drying and reconstitution of cassava foo foo is aimed at determine if cassava foo foo can be dry and to measure the rate of drying; subsequently the dried product would be reconstituted to establish whether it will return to the original cassava foo foo properties. The experiment was performed in other to obtain the rate of drying and reconstitution using the principle of thin film (solar dryer) for drying process and application of hot and cold water for reconstitution process. The plots of drying and reconstitution rate with moisture content, moisture content with time and their rates with time were made showing the characteristics of cassava foo foo. Results showed reduction in moisture content in cassava foo foo from 54.36% to 13.56% during ten hours of drying. From the drying curves obtained, constant drying rate for cassava foo foo is 4.7 grams moisture per hour, is the falling rate period commenced at critical moisture of 36.37%.The changes were observed in colour (darkening in colour) harder texture, shrinkage, case hardenings and reduction in offensive odour of the cassava foo foo. Finally, cassava foo foo cannot be reconstituted due to breakage of the polymeric bond existing between the moisture of the cassava foo foo but can be used as cereals for breakfast.**

***Index Terms*— Cassava, Drying Foo Foo, Reconstitution.**

I. INTRODUCTION

Cassava (Manihot Esculenta Crantz) belongs to be the family Euphorbiaceease. It is a major carbohydrate staple consumed in various forms by humans. It forms a base for a wide variety of fermented foods in Africa, Asia and Latin America [1].Foo foo is a fermented wet paste made from cassava that is widely consumed in Eastern and South-Western Nigeria and other parts of West African Such as Sierra Leone [2]. It is ranked next to garri as an indigenous food of most Nigerians in the South. In Nigeria, it has commercial potential that has been reported to be increasing [3], in West Africa; foo foo is usually made from yams, sometimes combined plantains, in central Africa, foo foo often made from cassava tubers like Batonde manioc. The rural and urban demand for garri is higher than that of foo foo. Garri is the preferred product for higher income consumers because of the ease with which it is prepared for consumption. Several products are processed in Nigeria, in recent years consumer preferences for the various products have shown to be dynamic. Though the 1960s and early 1970s, cassava was consumed in the following forms, 15% as fresh roots; 5% as garri: 60% as foo foo; 10% as starch; and 10% as flour. By the early 1980s, the consumption of foo foo had declined to 14% of all cassava eaten, whilst consumption of garri rose to 65% according to a natural consumption survey by the federal Industrial Research [4]. Cassava tubers, when harvested, contain a high moisture content and when foo foo is produced from it, it also contain little moisture content; this moisture has to be removed in processing to foo foo flour or before preservation can be adequately ensured.[5].

It is considered that the consumer preference for foo foo has reduced due to its inherent undesirable characteristics of poor odour, short shelf life and tedious preparation [6]. Its preparation involves efficient dehydratum of pre-cooked cassava (manihotesculentacrantz) and cocoyam (xanthosomamaffiafa) or plantain (musa) or yam (DioscoraSpp) followed by milling and mixing with small proportion of cassava starch to improve the binding of the foo foo flour when reconstituted. Pounded foo foo is traditionally prepared by pounding boiled cassava roots together with cocoyam/plantain/yam pieces in a wooden using a pestle into a thick paste. It is therefore associated with lot of drudgery. Foo foo flour as a convenient staple is increasingly becoming very popular in West Africa [7].

Drying is the removal of moisture or water vapour from a food substance by means of thermal energy relative term and other bone-drying moisture content from an initial value to an acceptable final value [8]. Drying May required for several reasons. First and most often, water is removed from the cassava to extend its useful life [9]. The dried product is later reconstituted prior to use in order to produce a food closely resembling the fresh crops or they can be ground into flour [10]. Also cassava is sometimes dried so that a new product distinctly different from its original form can be produced [11]. Total cyanide content of cassava chips could be decrease by only 10-30 percent through fast air drying. Peeled cut pieces of roots gave a HCN concentration lower than 10mg/100g and loss was more effective than over drying [12].Drying may be in the sun or over a fire [13]. Drying lowers the moisture content which inhibits the growth of decay-causing organism. Drying also has the advantage of reducing of foodstuff to about 1/5 of the original while reconstitution increases the moisture content which helps in the growth of decay-causing organisms.

Reconstitution or rehydration is the restoration of a drying or dehydrated material in this case food product to its original edible condition by the simple addition of water, usually just prior to consumption or further processing. The objective is to obtain product that upon reconstitution will obtain adequate textural characteristics after a short time. The analytical model applied in drying process is extended for modelling of the reconstitution process [14].

II. MATERIALS AND METHOD

In this experiment, fresh bitter Cassava tubers were pealed, washed and soaked in a bucket with water to allow fermentation take place and a thermometer was inserted to note the temperature of the fermentation for three days, the temperature of the first, second and third day were 26^0C,37^0C

Opara C.C, Akangbou N.M, Evbuomwan B.O, Ogbodo M.N.*,* Department of Chemical Engineering University of Port Harcourt, Port Harcourt, Nigeria.

and 45^{0}C respectively before fermentation took place. The softened tubers were mashed with the hands and washed over a sieve placed on top a basin. The slurry obtained was allowed to settle. The clear liquid above the pulp was removed; further removed of liquid was accomplished by subjecting the pulp under high press. The fleshing fermented cassava pulp was dissolved completely in little quantity of water and poured in a pot placed on a 1000w electric stove. The mixture was stirred continuously for about 25 minutes, a thermometer was inserted in the cooking pot to note the temperature and time interval was also noted with the help of stopwatch. This cassava foo foo was then used for experiment.

A. *Drying Method:*

The dryer used in this experiment was solar dryer; the weight of the weighing pan was measured and noted with a triple beam balance. Thereafter, the cassava foo foo was prepared for drying using the principle of thin-film drying. The cassava foo foo was spread across each of the three the weighing pans with the required thickness placed at the edges and rolled over with damped rollers to give the required thickness of 1mm each. The three drying bins were transferred into the drying chamber of the dryer, and the whole system was mounted under the sun facing the direction of the sun's ray. An anemometer was mounted beside the dryer and the wind velocity was determined at one hair intervals. The wet bulb and dry bulb temperature were determined with a minimum and maximum thermometer. The collector temperature and drying air temperature were also determined at an interval of one hour. The weights of the three samples were constantly checked at one hour interval and recorded from which the drying rate and the moisture content were calculated. After solar drying of cassava foo foo was completed, perceptions were carried out by some individuals on the changes in physical property of the dried cassava foo foo. Changes were observed in colour (darkening in colour, harder texture, shrinkage, case hardenings and reduction in offensive odour of the cassava foo foo. The experiment is stopped when there is no more appreciable change in the weight of the sample with time.

III. RECONSTITUTION OF DRIED CASSAVA FOO FOO:

The bore-dry weights of the three samples were used for the reconstitution experiment using cold and hot water. The bore-dry cassava foo foo sample was grinded into powered form. The grinded cassava foo foo was then sieved using a 400 mesh size sieve. In the cold water experiment, 30ml (30g) of distilled water at 24^{0}C in temperature was poured in calibrated test tube, 20mm diameter and 2mm thick containing 3.7g of the sieved cassava foo foo sample.
Prior of this, the height in millitres of the calibrated test tube was recorded. After the water was poured; the change in height of the powered cassava as the water was being absorbed was recorded at four minutes interval. The change in height of the water was also recorded at same time interval. The results were recorded until a point where water was no longer absorbed. The water above was measured and decanted. This was repeated, using hot water at 100^{0}C. The experiment is stopped when there is no more appreciable change in the weight of the sample with time.

IV. RESULTS AND DISCUSSION

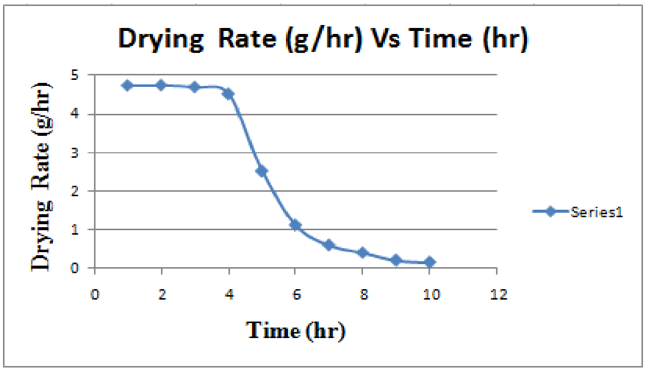

Figure: 1 Effect of drying rate of cassava foo foowith time.

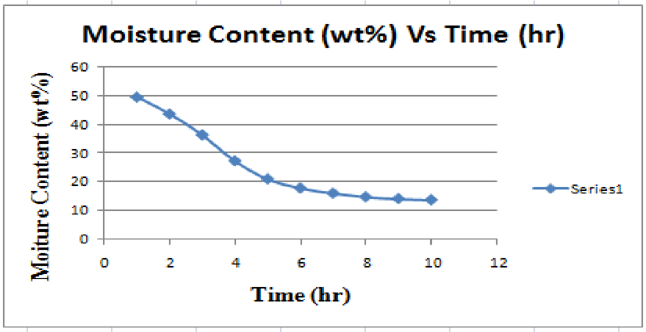

Figure 2: Effect of moisture content with time.

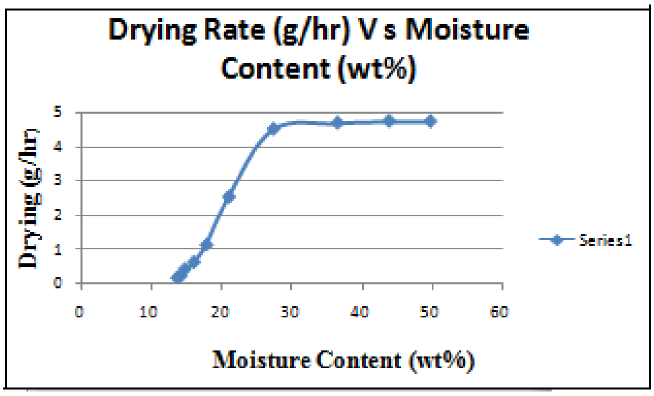

Figure 3: Effect of drying rate of cassava foo foo with moisture content.

RECONSTITUTION GRAPH FOR POWEDERED CASSAVA FOO FOO USING COLD WATER.

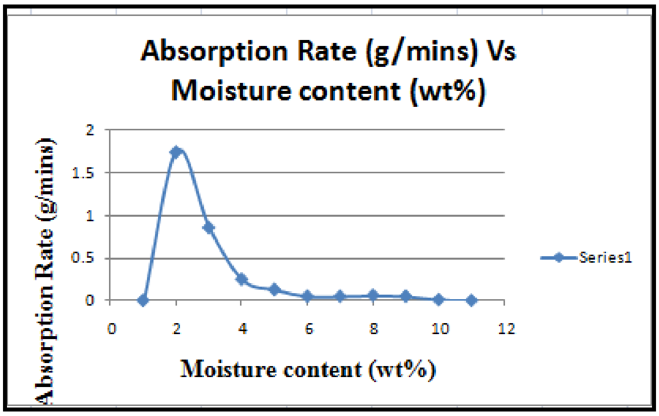

Figure 4: Effect of Absorption rate of cassava foo foo with moisture content.

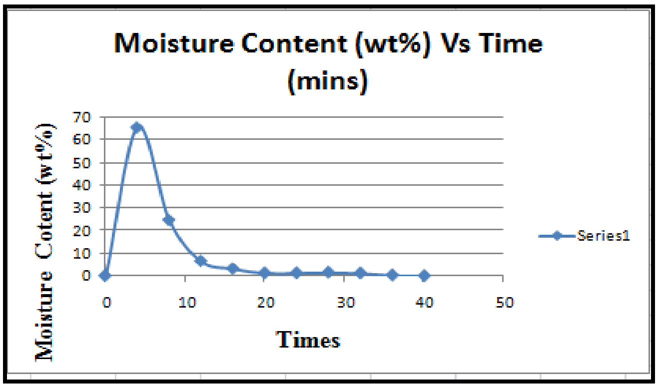

Figure 5: Effect of moisture content of cassava foo foo with time.

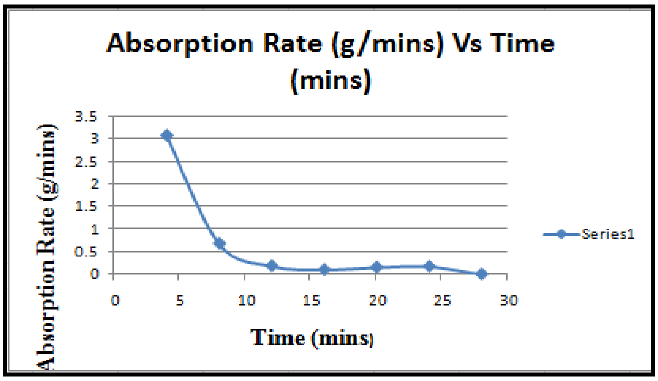

Figure 6: Effect of Absorption rate of cassava foo foo with time.

RECONSTITUTIONGRAPH FOR POWEDERED CASSAVA FOO FOO USING HOT WATERRECONSTITUTION GRAPH FOR POWEDERED CASSAVA FOO FOO USING COLD WATER.

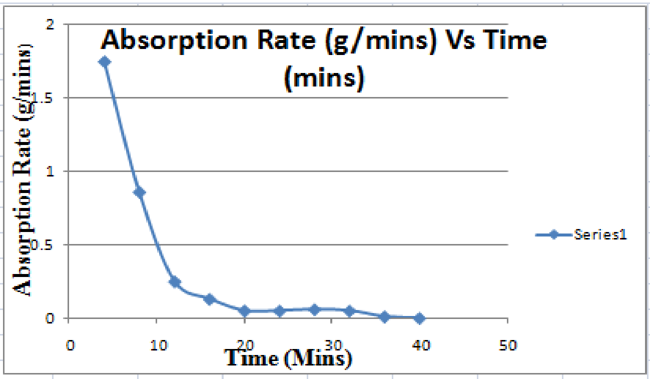

Figure 7: Effect of Absorption rate of cassava foo foo with time.

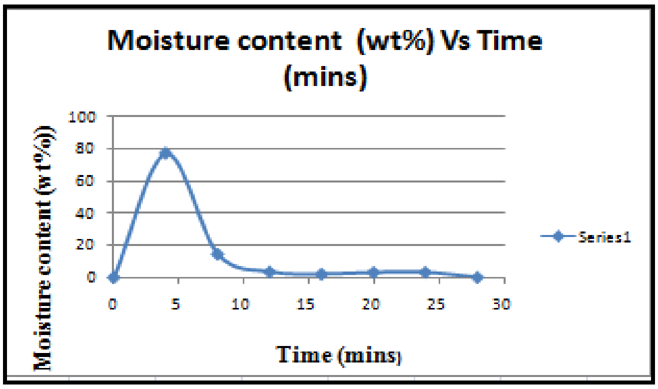

Figure 8: Effect of moisture content of cassava foo foo with time.

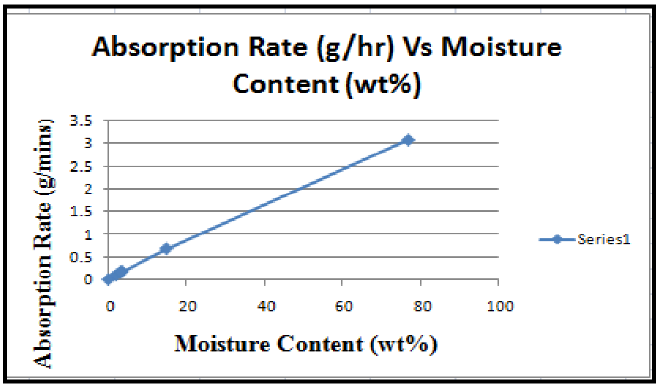

Figure 9: the effect of Absorption rate of cassava foo foo with moisture content.

V. DISCUSSION

Figure1: Effect of drying rate of cassava foo foo with time. From the graph it can be observed that the drying rate has a constant period at 4.7 with increase in time from 1-3 hours before the drying rate decreases with increase in time and become constant again with increase in time at time (9-10) indicating there is no further drying.

Figure 2: Effect of moisture constant with time. Drying of cassava foo foo with warm up period of 54.36% to 49.60% moisture content at time (0-1) hour and decrease with increase in time interval (0-10) hours. The moisture content concentration falls linearly over at time (1-6), time (5-8) show nonlinear drop of moisture content. The slope of the graph decreases in magnitude with increasing time and drying rate progressively diminishes. At time (5-9) represent falling rate periods. The slope of the curve has a discontinuity at time 9 hours. The equilibrium moisture content is reached at the time 9 hours after which the graph becomes flat indicating no further loss of moisture.

Figure 3: Effect of drying rate of cassava foo foo with moisture content. Increase in moisture content increases the drying rate. At moisture content of 49.60% to 54.36%, the rate of drying is constant at 4.7gram per hour.

Figure 4: Effect of Absorption rate of cassava foo foo with moisture content. From the graph, it can be observed that increase in moisture content decreases the absorption rate of cassava foo foo. The absorption rate of cassava foo foo reached its peak level at 1.75gram per minutes with moisture content of 65.42% after which the curve becomes flat indicating no further loss of moisture. Also the graph shows the reconstitution of dried cassava foo foo using cold water with constant rate period of absorption rate of (0.86-1.75)and linear increase in moisture content of 0%-65.42%.

Figure 5: Effect of Absorption rate of cassava foo foo with moisture content. From the graph, it can be observed that increase in time decreases the moisture of cassava foo foo. The moisture content of cassava foo foo reached its peak level at 65.42% with time at 4 hours after which the curve the becomes flat indicating no further loss of moisture. Also the graph shows the reconstitution of dried cassava foo foo using cold water with initial increase in moisture content of 65.42% with falling rate period (1.75-0.25) and it decreases linearly with increase in time (4-10) minutes.

Figure 6: Effect of Absorption rate of cassva foofoo with time. It can be observed that in the early hour there was a sharp rise in absorption rate of cassava foo foo and sudden later hour sloppy collapse. The increase in time decreases the absorption rate. Also the graph shows the reconstitution of dried cassava foo foo using cold water with initial reconstitution of 1.75 and constant rate period of (0.25-0.00) of absorption rate with time (12-40) minutes.

Figure 7: Effect of Absorption rate of cassava foo foo with time. It can be observed that in the early hour there was a sharp rise in absorption rate of cassava foo foo and sudden later hour sloppy collapse. The increase in time decreases the absorption rate. Also reconstitution of dried cassava foo foo using hot water with initial reconstitution of 3.8 with constant falling rate period of (3.08-0.68) and it decreases with constant rate period of (0.18-0.00) of absorption rate with time (12-28) minutes.

Figure 8: Effect of moisture content of cassava foo foo with time. From the graph, it can be observed that increase in time decreases the moisture content of cassava foo foo. The moisture content of cassava foo foo reached its peak level at 76.88% with time at 4 hours after which the curve becomes flat indicating no further loss of moisture. Also the graph shows the reconstitution of dried cassava foo foo using hot water with initial increase in moisture content of 76.88% with falling rate period (3.08-0.68) and it decreases linearly with increase in time (8-10) minutes.

Figure 9: Effect of absorption rate of cassava foo foo with moisture content. The graph shows the reconstitution of dried cassava foo foo using hot water. Increase in absorption rate of cassava foo foo increases the moisture content and absorption rate is linearly increase with moisture content at 0%-76.88%.

VI. Conclusion

From the plot of drying and reconstitution rate (rehydration) against moisture content and time, results showed reduction in moisture content of cassava foo foo from 54.36% to 13.56% during ten hours of drying. From the drying curves obtained, constant drying rate for cassava foo foo is 4.7grams moisture per hour and the falling rate period commenced at critical moisture of 36.37%. Changes were obtained in colour (darkening in colour), harder texture, shrinkage, case hardening, and deduction in offensive odour of cassava foo foo after solar drying. Increase in volume of the powdered cassava foo foo is greater in the hot water than cold water during reconstitution process. Cassava foo foo could not be reconstitution by either cold or hot water due to the breakage of its polymeric bonds as a result of the drying and grinding processes. Therefore the knowledge of the rate of drying and rate of reconstitution in this study can be used in the design of dryer that will minimize the deterioration in the eating quality and nutritive value of cassava foo foo in order to extend its shelf life.

REFERENCE

[1] .Alloys, N. and Ming Z.H. (2006): "Traditional cassava food in Burundi food" Review International, 22-1-27.

[2] Chiou, D. Langrish, T.A.G, Braham, R. (2008):"Partial Crystallization Behaviour during Spray drying".

[3] Da-Wen, S. (2007): "Computational Fluid Dynamics in Food Processing" CRC Press, Taylor and Francis Group. Page 251

[4] Federal Industrial Research (2005) cassava processing FIRO, Oshodi, Lagos, Nigeria.

[5] Lucas E.B. and Olayanju, T.M.A., (2003): "Effect of Moisture Content on some physical properties of Beni seed Accession". Journal of Applied Science and Technology. Volume 3, Number 1. Page 7-12.

[6] Okokon, F.B (2002): "Shrinkage and moisture loss of dried Melon Seed".

[7] Johnson PNT, Gallats, Oduro-Yeboah.C,Osei-Yaw .A and Westby .A. (2006):"Sensory properties of Instant Fufu flour from four high-yielding Ghanaian Cassava". Tropical Science, 46(1): 134-138.

[8] Itodo, I.N, Adewole, A.M, Edemeka, S.K. (2002): "Development of Active Solar Crop Dryer: Design Analysis and performance Evaluation". Nigerian Journal of Renewable Energy.10(1 &2).

[9] Taiwo K.A. (2006): "Utilization potentials of cassava in Nigeria". The Domestic and Industrial products. Food Review International, 22-42.

[10] Satori, E. (2000): "A Critical Review on equation employed for the calculation of the Evaporation rate from free water surfaces". Solar Energy 68 (1): pages 77-89.

[11] Abera, S. and Rakshit S.K. (2003):"Comparison of physiochemical and functional properties of cassava starch extracted from fresh roots and dried chips". Starch/starke, 55: 287-296

[12] Exell, R.H.B. (2001): "A Simple Solar Rice Dryer, Basic Design". Sun World 4, pages 186-191.

[13] McCabe, W.L, and Harriot, P. (2001): "Unit Operation of Chemical Engineering". Sixth Edition, McGraw-Hill,New York, pages 797-800.

[14] Crank, N. (2005): "Mathematics of Diffusion". Oxford Press, New Jersey.