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The Effect of Some Processing Variables on Desorption Characteristics of Fermented Cassava Mash for Cassava Flour Production

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Abstract In the cassava flour production, the time required for drying to save moisture content is of great interest in the flour production mill. The production of cassava flour involves fermentation, dewatering, size reduction and drying. The effect of processing condition such as fermentation duration (3 and 5 days), dewatering pressure (5 and 10MPa), drying temperature (50 and 80^{0}C) and size reduction (Hammer mill and retting in water) on drying time and final moisture content of cassava were investigated using a 2^4 factorial design. The result of the experiments shows that an increase in drying temperature reduces the final moisture content and the drying time. It was found that only drying temperature had high significant effect on final moisture content and drying time of fermented cassava flour. A change in temperature from 50^{0}C to 80^{0}C decrease the drying time by about 50% and final moisture content by about 3.8% on the average in the range of factors considered. About four hours was used to dry the mash to safe moisture of about 10% (d.b). Although, the effect of drying temperature was more significant on the time of drying but also, it was found that size reduction method and fermentation period also have noticeable effect on the time of drying. From the curve, the entire drying process occurred in the range of falling rate period. Since the final moisture content and the drying time is an important tools in production of fermented flour, the results of this work will be of great importance to flour miller and cassava flour processors in determine the correct production process to archive the desire result.

Keywords: Cassava flour, final moisture, drying time, size reduction, fermentation period, dewatering pressure, drying temperature

Introduction

Cassava (*Manihot esculenta*) is an important food crop grown in the tropics for it roots and young leaves. The root has rapidly risen to prominence

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as cash crop and as one of cheapest sources of calories for food use (Thampan, 1979; White, 1998). It is available all year round, providing household food security and offering an affordable source of calories for small scale farmers (RADA, 2004). This tropical crop is said to have originated from Brazil in South America and it is cultivated mostly in the poorest country of the world until recently when some developed countries are showing interest.

Cassava roots are traditionally processed in many ways varying from region to region. The tuber contains about 15% peel and 85% flesh (Olorunfemi *et al.*, 2007). In India, Srilanka, South America and Philippines, it is eaten after cutting into small pieces and cooked in water (Padmaja, 1995). In Nigeria roots are traditionally processed into some fermented products, like *Fufu, Lafun, Gari, and pupuru.* The root is rich in vitamin C (35 mg per100 g fresh weight) and contains traces of niacin, thaiamine, riboflavin and vitamin A (Bradbury and Egan, 1992). The consumption of cassava has been associated with several kinds of pathological disorders due to the presence of the cyanogenic glycosides, linamarin and lotranstrtine which on hydrolysis release hydrocyanic acid (HCN). Linamarin, a cyanogenic glycoside is found in both the leaves and roots of the plant (Bradbury and Egan, 1992; FAO, 2006). However, the consumption of cassava by man or animal can be safe if it is adequately processed (Onwueme and Sinha, 1991). The three unit operations used for the removal of cyanogens from cassava in Latin America, Africa and Asia which had been verified by research as effective method are size reduction, drying and fermentation (Olusegun, 1994; FAO, 2004).

The technology of processing cassava into instant flour by industry is now being developed to replace the unhygienic flour produced traditionally. In traditional cassava flour production, the roots are peeled, soaked, grated, or diced then left for 3 to 5 days to ferment before dewatered and sun dried for 3 to 5 days. The current increase in demand for cassava flour for food, feed and industrial raw materials necessitate an industrial production of more hygienic flour. Since the final moisture content and the drying time is an essential industrial tools in the management of production of cassava flour, this study will therefore provide some necessary data for the production of fermented cassava flour.

Materials and methods

Sampling technique

Freshly harvested cassava tubers were bought from Igbara-Oke Central Market in Ifedore Local Government of Ondo State, Nigeria. The cassava was harvested after fifteen month of planting.

Experimental procedure

The cassava roots were manually peeled and washed twice to ensure dirt was completely removed. The peeled cassava roots were then subjected to size reduction, fermentation, dewatering and drying. Two methods of size reduction were applied on the fresh cassava; reduction by mechanical means using Hammer mill that was fabricated at Obafemi Awolowo University and renting in water. The fermentation periods selected after literature review were 3 days and 5 days. The fermentation was done at the room temperature of $30^oC \pm 2^oC$.

Removal of water by pressing as an aid to the dehydration was done using a laboratory hydraulic press fabricated at the Department of Agricultural Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria. Pressure of 5MPa and 10MPa were selected after a preliminary investigation consideration. Drying of samples at selected temperature of 50^oC and 80^oC were done in the shelves of a Galenkamp moisture extraction oven. The drying of the fermented cassava granules was done using a thin layer of about 200g of fermented cassava crumbles spread on stainless steel trays and placed in the shelves of the oven. Equilibrium moisture content was assumed to be reached when there was no further loss in weight after three consecutive interval readings.

The moisture content on dry basis at any time t is given by:

$$X_{T/(d)} = [(W_T - W_2)/W_2]100$$

Where;

X_T =moisture content at any time t

X_d =moisture content on dry basis

W_2 =final weight of sample after drying

W_T =weight of sample at any time t

Experimental design

Some processing variables that are considered during the processing of fermented cassava root were drying temperature, size reduction, dewatering pressure and fermentation time. These variables have been reported to be a good hydrocyanic acid reduction method (White *et al.*, 1998). In order to determine the effects and interaction effect of these factors on the desorption characteristics of dried fermented cassava flour, a 2^4 factorial experiment was designed to investigate the effect of the processing variables selected, viz; drying temperature (50^oC and 80^oC); dewatering pressure (5MPa and 10MPa); size reduction methods (hammer mill and renting in water) and fermentation period (3 and 5 days).

Results and discussions

The drying curves for the various combinations of processing conditions are shown in Figs 1 to 4. The time required to reduce the moisture content to a save moisture level was found to depend on the combination of various processing variables. It was observed that the drying time reduced with increase in temperature (Table 1). Cassava having about 64% initial moisture content was dried to a range of final moisture content below 10%. Drying was carried out between 3hours and 4hours, depending on the drying temperature. There were no constant rates drying under any of the test condition. These results agrees with the report of several researches carried out on desorption investigation on some biomaterials (Giri and Prasad, 2007; Zaki *et.al*., 2005; Nurul *et al*., 2007; Ndukwu, 2009). The results show that higher drying rates were obtained with higher temperature. It was clearly seen from the figures that drying rates were higher when the moisture content is high and decreased with decreasing moisture content. As the value of dielectric constant and less factors of material are directly proportional to moisture content, obviously, the material absorbs more heat and heating is faster at high moisture content. The moisture content decreased as the drying time increased and the drying rate decreased as the drying time increased. This result agrees with the findings of Nwabanne (2009) and Ademiliyu *et. al*., (2006). An increase in drying temperature from 50^oC to 80^oC decrease the final moisture content by about 3.8%, and drying time by about 50% .The relationship between the drying time and moisture content of cassava flour dried at 50^oC and fermented in water for 3days is closely observing a constant rate drying while the relationship was polynomial for the cassava flour dried at 80^o C and fermented for 5days (Figure 1). The drying temperature seems to be the major factor as the drying curve for each temperature of 80^oC and 50^oC shows similar shape for each drying temperature not minding the other combinations of process (Figures 1- 4). Effect of size reduction was more pronounced on time of drying than on the final moisture content. When the size reduction method was changed from renting in water to hammer milling before fermentation the final moisture content changed from 6.37 to 8.87% db while the time of drying changed from 210 minutes to 360 minutes. This may be due to differences in sizes of the mash after reduction.

Although dewatering pressure has little effect on final moisture content but reduce the time of drying by about 9% when the pressure increased from 5MPa to 10MPa.

The results of these experiments were statistically analyzed using Yates algorithm. The four, three and two none significant interaction effect were pull together to test the significant of the main effect and significant effect. The drying temperature and dewatering pressure was found to be significant on the final moisture content at $p<0.01$ probability, while the fermentation was significant ($p<0.05$). All the processing factors investigated were found to be significant on the drying time although at different level of probability. Drying temperature was found to be significant ($p<0.01$), dewatering pressure ($p<0.1$) while the size reduction and the fermentation period was significant ($p<0.05$) on the drying time. Dewatering pressure and drying temperature have an inverse relationship with drying time and final moisture content i.e the higher the dewatering pressure or drying temperature or both the lesser the drying time and the final moisture content. It was found that the interaction effect of drying temperature and size reduction, dewatering pressure and drying temperature are significant at $p< 0.1$ probability while the interaction effect of size reduction and fermentation time on drying time was also found to be statistically significant ($p< 0.01$).

Table 1. The result of the experiment on effect of processing factors on final moisture content and drying time of dried fermented cassava granules

Sample	Temp (oc)	Size Redu.	Fermentation Days	Pressure (MPa)	Final Moisture	Drying Time (miniutes)
1	50	R.water	3	5	6.37	210
2	80	R.water	3	5	2.14	210
3	50	H.mill	3	5	8.87	360
4	80	H.mill	3	5	8.90	290
5	50	R.water	5	5	7.30	300
6	80	R.water	5	5	2.94	180
7	50	H.mill	5	5	5.25	270
8	80	H.mill	5	5	3.25	180
9	50	R.water	3	10	6.58	333
10	80	R.water	3	10	2.34	270
11	50	H.mill	3	10	6.90	360
12	80	Hmill	3	10	2.63	210
13	50	R.mill	5	10	5.87	330
14	80	R.water	5	10	2.14	340
15	50	H.mill	5	10	3.99	270
16	80	H.mill	5	10	2.28	210

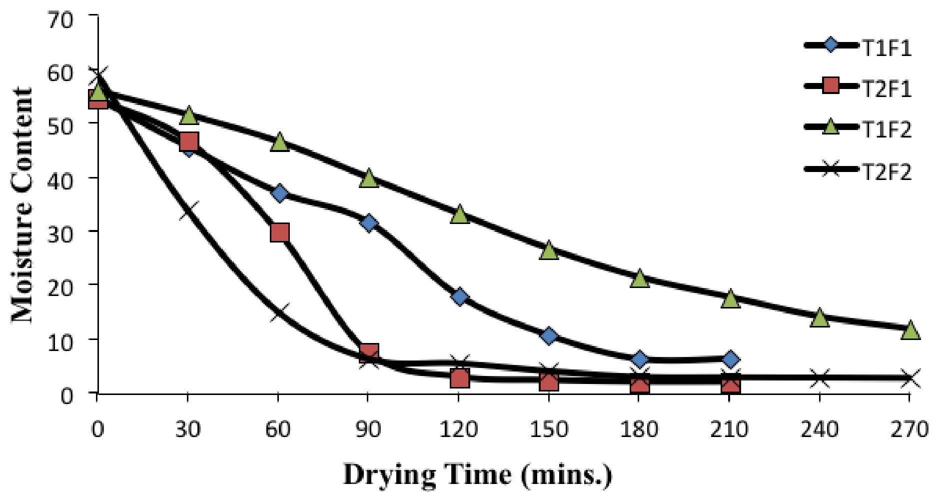

Fig. 1. Effect of drying temperature and fermentation period on desorption characteristics of Fermented cassava mash, fermented in water and dewatered at 5MPa (T_1=50^o C; T_2=80^0 C; F_1=3days; F_2=5days)

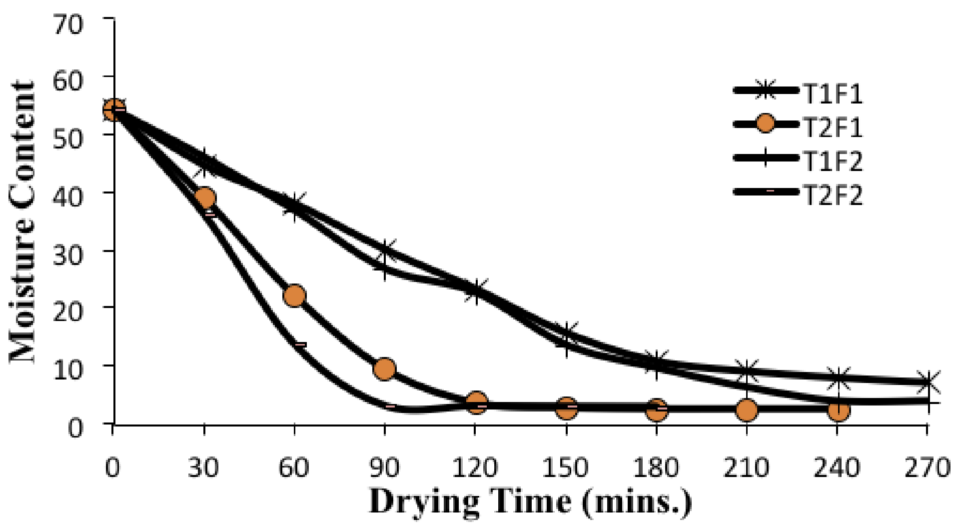

Fig. 2. Effect of drying temperature and fermentation period on desorption characteristics of Fermented cassava mash, fermented in water and dewatered at 10MPa (T_1=50^o C; T_2=80^o C; F_1=3days; F_2=5days)

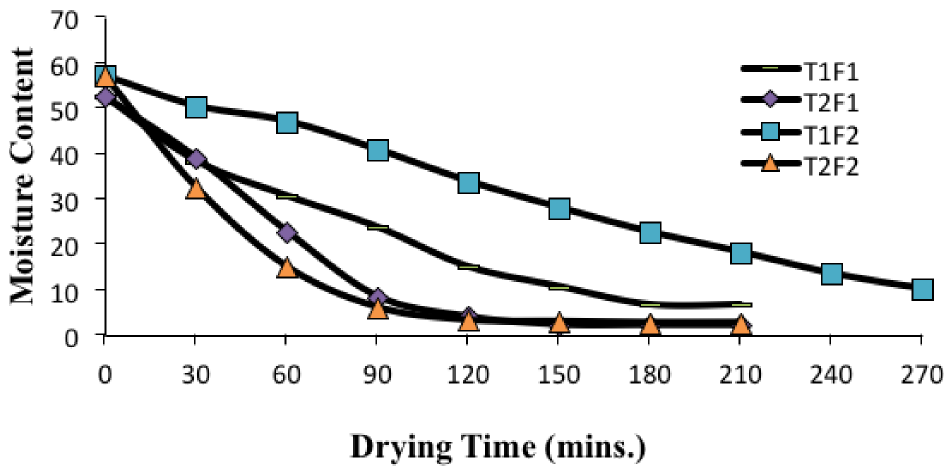

Fig. 3. Effect of drying temperature and fermentation period on desorption characteristics of Fermented cassava mash hammer milled before fermentation and dewatered at 5MPa (T_1=50^o C; T_2=80^o C; F_1=3days; F_2=5days)

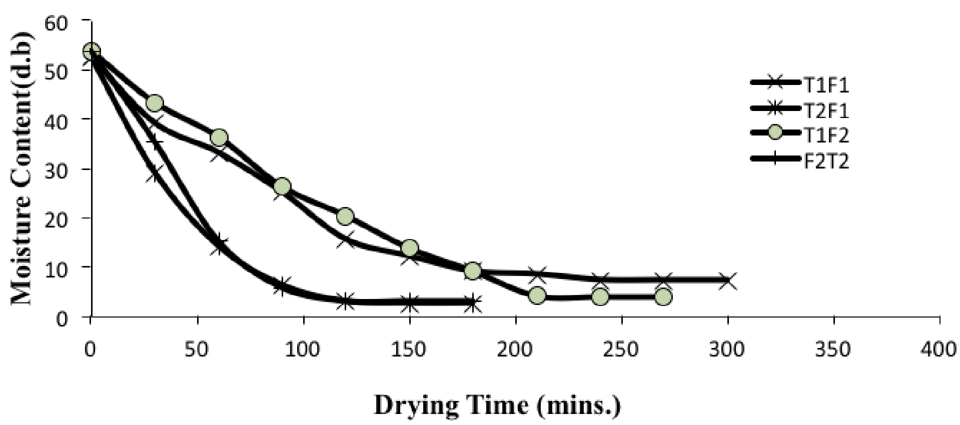

Fig. 4. Effect of drying temperature and fermentation period on desorption characteristics of Fermented cassava mash hammer milled before fermentation and dewatered at 10MPa (T_1=50^o C; T_2=80^o C; F_1=3days; F_2=5days)

Conclusion

The results of these experiments on the drying characteristics of fermented cassava flour has shown that the fermented cassava flour could be dried to save moisture of less than 10% d.b between 3 and 6 hours depending on the drying temperature. Also the investigation has shown that processing variables investigated are significant on drying time and final moisture contents.

It is therefore suggested from the results of this experiment that in the design of an automated cassava drying machine, effect of various processing methods should be taking into consideration.

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