LAUTECH JOURNAL OF ENGINEERING AND TECHNOLOGY 4(2) 2007: 19 – 23

EFFECT OF DRYING METHOD ON SELECTED PROPERTIES OF CASSAVA FLOUR (*LAFUN*)

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ABSTRACT

Fermented cassava flour (Lafun) is one of the products obtained from cassava processing. Traditionally, sun-drying is one of its main processing steps, but it is ineffective for large-scale production. The effect of alternative drying methods to sun-drying, vis: solar and cabinet drying, on the quality of fermented cassava flour needs to be investigated.

Sun-drying, solar drying and cabinet drying methods were used to produce fermented cassava flour. The samples were analyzed for their proximate composition, cyanide content, physico-chemical and functional properties.

The moisture, bulk density and amylase contents of the sun-dried samples were higher while its protein and cyanide contents were lower than that of the other methods. Recorded functional properties of the fermented flours suggest that sun-dried samples cook faster than others and that the paste obtained from cooked sun-dried samples is firmer. However, values obtained from analysis of the different fermented cassava flours after drying were significantly different ($P \leq 0.05$)

Keywords: Cassava, lafun, fermentation, drying, proximate composition, functional properties

INTRODUCTION

Cassava as a food crop is one of the important food staples in the tropics and an estimated half billion people depend on it (IFAD/ FAO 2000). It is processed into various forms of food in Nigeria which include gari, lafun (fermented cassava flour), chips, 'fufu', 'pukuru', starch and cassava flour (Ketiku et al., 1978). Fermented cassava flour (lafun) is produced from washed and peeled cassava roots that are softened (retted) by soaking and fermentation in water (Oyewole and Odunfa, 1998). The roots are then dewatered, either manually or with a mechanical press, dried in the sun and milled into flour. The fermented cassava flour is used in the preparation of a stiff porridge locally called lafun, by stirring the flour into boiling water. It is eaten with a sauce or soup. The processing steps, especially the retting of cassava roots, help the removal of cyanogenic glucosides during the production of lafun (Bokanga, 1995). Soaking of cassava roots in water and subsequent sun drying was reported to remove about 85 to 100% of initial cyanogenic glucoside levels (Oke, 1994).

Fermented cassava flour is processed traditionally by sun-drying because its slower rate of drying results in higher reduction of cyanogenic glucosides (Gomez, 1984). This is because moisture is essential for the enzymatic hydrolysis of the glucosides and therefore the longer the presence of moisture, the more the hydrolysis of cyanogenic glucosides and the less the residual cyanogens in the final product. However, control and monitoring of the drying conditions in sun drying are difficult (Balagopalan et al., 1988). Other disadvantage of the sun-drying is that it results in long processing time, due to the low drying temperature of the sun and the climatic changes especially during the rainy season when cassava production is more abundant. Also, prolonged drying may induce some changes that could negatively affect some functional properties of the product (Shittu et al., 2001).

The problems encountered with sun-drying of dewatered cassava roots during processing of lafun have resulted in the search for other methods of drying. Research has been carried out on the use of solar and oven drying methods as alternative and efficient methods of drying used for other food stuffs (Ezeike et al., 1998; Karathanos and Belessiotis, 1997) but not much has been done in this respect on lafun flour production. The objective of this work was to study the effect of two other drying techniques on the proximate composition and some selected properties of the lafun flour.

MATERIALS AND METHODS

Fermented Cassava Flour Preparation

Fresh cassava roots were peeled and washed. The roots were divided into three portions of 5kg and each portion was soaked for three (3) days. After soaking and fermentation, the portions were dewatered using a screw press for about 30minutes. The portions were then broken into pieces before being dried by the three different drying methods i.e. sun, solar and cabinet dryer after which they were milled into flour.

Drying Methods

The dewatered bulk was broken into chunks after which sun drying was done by placing the dewatered chunks directly under the sun on a flat stony surface. The drying was done during year - 2004 dry season with an overall maximum daytime air temperature of about 38°C.

The solar drying was done by placing another portion of chunks in a direct cabinet type solar dryer used for drying agricultural products (Reuss, 1993). It consists of a solar collector and a drying chamber. The base of the dryer was lined with a reflective material while the collector base was painted black to absorb the heat efficiently. The top cover of the dryer was made of glass inclined to the horizontal to enhance incident solar radiation and air flow (Tunde-Akintunde et al., 2005). The mean temperature in the drying chamber was 46°C

A batch tray oven was used for the oven drying method (Tunde-Akintunde et al., 2005). Trays in the oven were filled thinly, while air was heated electrically with the temperature within the oven controlled at 60°C.

Drying was continued until the weight was constant in 3 consecutive readings. All the samples were subsequently milled using a hammer mill and sieved.

Proximate Analysis

Protein, moisture, fat, ash and crude fibre contents were determined using AOAC (1990) methods. Carbohydrate content was determined by difference. All analyses were performed in triplicates and the mean values were recorded.

Cyanogen Content

The cyanogen content was determined by weighing 30g of each sample into 250ml of cold 0.1M orthophosphoric acid. The mixture was homogenized by blending in a Waring blender followed by centrifugation at 4000rpm for 15mins. The cyanogen content of the supernatant was determined by colorimetric method as previously described by Esser et al. (1993).

Pasting Properties

The pasting properties of lafun samples were determined using a slurry at 8% (w/v) on dry basis for measurements in a Brabender Amylograph (Brabender OHG, Germany).

Physico-chemical Properties

The water absorption capacity (WAC), swelling power and solubility was determined by the method of Solsulski et al. (1982). The pH and titratable acidity (TTA) were determined using the method of Adeyemi and Beckley (1986). The bulk density was determined using the ASTM D1895B method.

Statistical Analysis

Statistical analysis was carried out using SAS software. Data were subjected to analysis of variance and Duncan's multiple range test was used for comparison of means and the significance was accepted at $P \leq 0.05$.

RESULTS AND DISCUSSION

The proximate composition of the samples is presented in Table 1. The mean temperature values for the three methods were 38, 46 and 60°C for sun, solar and cabinet drying, respectively. Table 1 indicates that the values obtained for the proximate analysis of the three drying methods are significantly different from one another ($P \leq 0.05$). The protein content for the samples dried using the cabinet dryer (1.04%) was higher than those obtained from sun and solar drying methods. However, the reverse was the case for the fat content, the fat content obtained from the cabinet dried sample (0.28%) was the lowest while that of the sun dried sample (0.33%) was the highest.. The higher value of protein for cabinet dried sample indicates enhanced nutritional status, thus, implying that the use of cabinet drying for the production of cassava flour will probably result in products of enhanced nutritional status.

The highest recorded moisture content of 10.89% was obtained in a sample that was sun dried while the least value of 10.02% was recorded in cabinet dried samples. This is expected since residual moisture content is a function of the drying temperature and lower residual moisture content occurs with higher drying temperature.

Cyanide Content

The cyanide content of the three drying methods is shown in Fig 1. The oven dried samples had higher total HCN (hydrogen cyanide) concentrations of 0.801 mg/100g than those obtained from solar and sun drying methods. This result indicates that sun drying is more effective in reducing HCN concentration than that of the other drying methods. This observation is similar to that of Cooke and Maduagwu (1978) as well as Mahungu et al. (1987). This is due to the fact that slower drying rate gives rise to loss of bound cyanide (Gomez, 1984) thus resulting in an inverse relationship between drying rate and cyanide loss as observed by Cooke and Maduagwu (1978). There were significant ($P \leq 0.05$) differences among the HCN values of the samples obtained from the three drying methods. However, the HCN values of the samples from the three drying methods were lower than that of 3mg HCN/100 g which was regarded by Akinrele et al. (1972) as being acceptable and that of 10mg HCN eq kg^{-1} dw safety limit of FAO / WHO. This implies that though drying using cabinet dryer gave a higher HCN value, it is still within the acceptable limit for food samples.

Physico-chemical Properties

The bulk density of the fermented cassava flour samples increased from 0.30 mg/m^3 for the cabinet dried sample to 0.58 mg/m^3 for the sun dried samples (Table 2). These values follow the same trend with the observations of Fasina and Sokhansaj (1993) and that of Shittu et al (2001) for alfalfa pellets and 'pukuru' (a fermented cassava product) respectively. The bulk density value obtained for the sun drying was significantly different ($P \leq 0.05$) from the values of the samples from the other two drying methods. The swelling power of the cabinet dried samples (10.35%) was the highest. This follows the same trend with the report of Shittu et al, (2001) that 'pukuru' flours obtained from kiln dried samples which used the highest drying temperature had lower values of swelling power. They reported that this was due to the fact that samples dried at lower temperature had higher percentage of damaged starch which enables them to absorb more water due to surface defects, thus exhibiting higher swelling characteristics. Table 2 shows that cabinet dried cassava flour samples had a higher percentage of starch which indicates a lower percentage of damaged starch, thus resulting in lower ability to absorb water as compared with the other two and hence lower swelling characteristics. Also drying of starch products at high temperatures may result in case hardening of starch granules thereby leading to reduced water adsorption (Oguntunde, 1987). This may also be responsible for the lower swelling characteristics of cassava flour dried using the cabinet dryer.

Sun dried fermented cassava flour samples had the lowest pH value of 4.08 while that of the other two increased with that of cabinet dried samples at 4.42 being the highest. This may be due to the fact that exposure of solar and oven dried samples to higher heating temperatures results in a reduction in the presence of volatile (organic) acids. Thus compared to the other drying methods, sun dried samples have a greater amount of residual volatile acids which is synonymous with a low value of pH.

Functional Properties

The amylographic viscosity is one of the most common variables used to estimate the functional properties of starch-based products (Ruales et al., 1993). The pasting properties of the three cassava flour samples are indicated in Table 3 and they are significantly different (at $P \leq 0.05$) from one another. The pasting temperature which is the temperature at which rapid swelling of starch granules takes place varied from 64 to 64.45^{0}C and the time to reach the peak viscosity increased from 3.78 to 3.94 minutes for sun, solar and cabinet dried samples, respectively. The viscosities increased generally with the exception of the final setback viscosity for the three samples, respectively. The samples obtained from sun drying took a shorter time (of 3.78minutes) to reach peak viscosity indicating that these samples were the most easily cooked. The ease of cooking is reported to depend on the rate of granule swelling and not on the swelling capacity (Zobel, 1984). The more accessible the internal matrix of the starch granule to water uptake due to surface defects which result from damaged starch granules, the faster the rate of swelling. These observations are contrary to the results of this study, this is because sun dried samples should have a lower percentage of damaged starch granules (since damaged starch granules arise from high temperature drying) and hence a slower rate of cooking. This indicates that other structural defects apart from damaged starch may have caused ease of cooking during sun drying.

The peak viscosity of the cabinet dried sample was the highest (548.942 BU) while that of sun dried sample was the lowest (456.33 BU). This is similar to the findings of Ruales et al. (1993) that higher starch degradation and reduced peak viscosity were obtained by drum drying quinoa seeds after precooking them at 60^{0}C. The peak viscosity of *pukuru* flour dried at high temperature of 70^{0}C and above was also higher than that obtained from sun drying which is the traditional method (Shittu et al., 2001).This may be due to the fact that at less severe heating and prolonged drying time in sun and solar drying methods, intrinsic amylase activity could have been favoured causing increased starch degradation. This may be explained by the fact that as Franco et al. (1995) demonstrated, amylase hydrolytic activity responsible for increased starch degradation can be sustained below 80^{0}C. Also the prolonged drying time in the two methods will result in a longer time for the amylase activity resulting in increased starch degradation which gives rise to a reduced peak viscosity. This is collaborates the fact that other changes (i.e. increased starch degradation) apart from damaged starch could be responsible for the ease of cooking of sun dried flours.

The set back viscosity of the lafun samples however, decreased from 112.25 BU for sun dried samples to 29.67 BU for oven dried samples. This parameter indicates the tendency of the dough to undergo retrogadation, a phenomenon which causes the dough to become firmer and increasingly resistant to enzyme attack (Ihekoronye and Ngoddy, 1985). This implication of this could be that when cooked, dough obtained from sun dried cassava flour becomes firmer than the dough obtained from other samples. This could have an effect on the digestibility of the dough since higher set back values may result in reduced dough digestibility (Shittu et al., 2001). This indicates that sun dried lafun will be easier to cook and may have firmer dough, but its dough digestibility may also be reduced.

CONCLUSION

This study shows that the three drying methods produce cassava flour that is safe for consumption based on national food standard specifications (Akinrele et al. (1972) and FAO / WHO). Oven drying can be used as an alternative to sun drying in the process of producing fermented cassava flour. Oven dried samples had a lower moisture content than other samples which gives it a longer shelf-life but it has a higher residual HCN value. A way in which oven-dried samples can be improved is to dry it at lower temperatures in the oven since lower drying temperature favors higher reduction in residual HCN in the final product. Also lower drying temperature can also help improve the swelling characteristics of oven dried samples. The use of oven-dried samples can help overcome the problem involved in the sun drying of the fermented cassava flour especially during the rainy season with its unpredictable climatic change which slows down the drying process.

Table 1: Proximate composition of cassava flour samples from the three different drying methods.

Drying method	Moisture content (%)	Protein content (%)	Fat content (%)	Ash content (%)	Starch content (%)
Sun	10.89a	0.99b	0.33a	1.28b	63.48c
Solar	10.54b	0.82c	0.30b	1.47a	64.21b
Cabinet	10.02c	1.04a	0.28c	1.03c	67.01a

- Means followed by different letters in the column are not significantly different ($p \leq 0.05$) from one another
- Results represent means of triplicate samples

Table 2: Physico-chemical properties of cassava flour samples from the three different drying methods.

Drying method	pH	TTA	WAC	Swelling power (%)	Bulk Density (mg/m^3)	Solubility (%)	Amylose (%)
Sun	4.08c	0.18c	97.45c	10.35a	0.58a	9.88c	20.45b
Solar	4.27b	0.35a	98.45b	10.33a	0.33b	10.03a	21.33a
Cabinet	4.42a	0.27b	99.02a	10.28b	0.30b	9.96b	21.52a

- Means followed by different letters in the column are not significantly different ($p \leq 0.05$) from one another
- Results represent means of triplicate samples

Table 3: Functional properties of cassava flour samples from three different drying methods.

Drying Method	Peak viscosity (BU)	Trough viscosity (BU)	Breakdown viscosity (BU)	Final viscosity (BU)	Setback viscosity (BU)	Time to reach peak viscosity, min	Pasting temperature, °C
Sun drying	456.33b	159.50b	268.08c	271.75a	112.25a	3.78c	64.00c
Solar drying	467.42b	153.17b	314.25b	82.83c	29.67c	4.79a	64.20b
Cabinet drying	548.92a	174.67a	371.5a	245.83b	71.17b	3.94b	64.45a

- Means followed by different letters in the column are not significantly different ($p \leq 0.05$) from one another
- Results represent means of triplicate samples

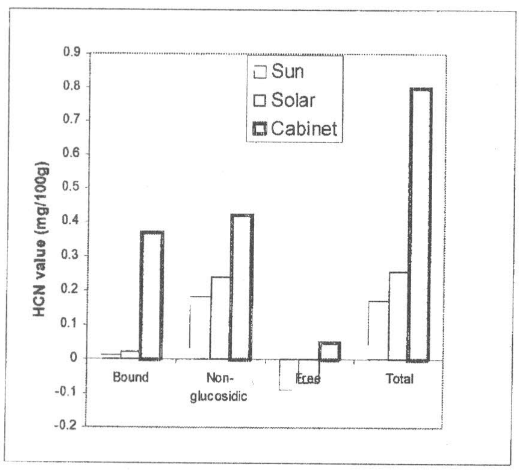

Fig 1: Hydrogen cyanide content

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LAUTECH JOURNAL OF ENGINEERING AND TECHNOLOGY 4(2) 2007: 24 – 27

EFFECT OF DEWATERING METHOD ON SELECTED PROPERTIES OF GARI

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ABSTRACT

Two of the most important steps in the 'gari' production process are the fermentation and dewatering steps during which the highest cyanide reduction occurs. 'Gari' samples were produced by dewatering the cassava mash during fermentation and after fermentation.

The samples were analyzed for their proximate composition, cyanide content and functional properties. The moisture content, bulk density and cyanide content of the sample from dewatering after fermentation were lower while the protein and ash contents were higher than that of the dewatering during fermentation method. Recorded functional properties suggest that the sample from dewatering after fermentation will take a longer time to cook and that the paste obtained from cooked 'gari' samples from the dewatering during fermentation method is firmer.

Keywords: Cassava, gari, dewatering during and after fermentation, functional properties, and fermentation.

INTRODUCTION

Cassava, a major root crop in the tropical world, serves as a primary calorie source for more than 500million people in Third World countries (IFAD, FAO; 2000). A major factor militating against the full use of cassava as food and feed is the crop's potential toxicity (Cock, 1985). This toxicity is due to the presence of cyanide in the tubers which is bound to a glucoside either as a linamarin or lataustralin (Cooke and Coursey, 1981). Consumption of high levels of Hydrogen Cyanide (HCN) from improperly processed cassava roots has been linked to many diseases such as endemic goiter and tropical ataxic neuropathy (TAN) among others.(Onabolu et al., 2002). Processing of cassava into products especially 'gari' hydrolyses the cyanogenic glycosides thus reducing the toxic content to safe levels of human consumption.

The processing steps involved in *gari* production include peeling, washing, grating, fermentation, dewatering, granulating, roasting, and cooling. Some of the bound cyanide is lost in the various steps. The ruptured cell walls during grinding result in the hydrolysis of cyanogenic glucosides by the enzyme linamarase due to contact with linamarin. During washing and fermentation, the cyanogenic glucosides are leached (Bokanga and Otoo, 1991). Reduction of HCN level in wet cassava of pulp of 72-77% was attributed to fermentation (Ngaba and Lee, 1979) while Achiwenhu and Eke (2002) reported a reduction of 81 to 87% due to fermentation and subsequent roasting. Bokanga and Otoo (1991) also reported that grinding and fermenting in water achieves the highest rate of detoxification of cassava roots resulting in a reduction of over 90% of the HCN level. Nambisan and Sudanresan (1985) observed that low rates of HCN reduction of less than 50% was observed for processes such as frying, steaming, drying, e.t.c. in which the integrity of plant cell is unaltered and enzyme linamarase is not released.

Thus the lactic acid fermentation process is one of the most important techniques in cassava processing (Odunfa, 1985). In some areas in the country, the cassava mash is dewatered continuously during fermentation while in some areas, dewatering is done after fermentation. The dewatering process is actually responsible for the quantity of liquid effluent from the cassava mash through which the free cyanide is leached. A study carried out by Onabolu et al. (2002) concluded that the method of dewatering cassava mash is an important processing factor that determines the quantity of residual cyanohydrins in gari. They observed that the highest cyanide reduction observed for both types of dewatering was recorded after 7 days of fermentation. Therefore, this study was carried out to determine the effect of the method of dewatering on selected properties of gari namely; proximate composition and functional properties of gari fermented for 7 days.

MATERIALS AND METHOD

Gari Preparation

Fresh cassava roots were peeled, washed and grated into mash using a traditional grater. Six portions of mash each weighing 5kg was put into a woven polyethylene sack with the open end tied. Heavy weights (15kg) were placed on three of the polyethylene sacks to dewater the mash continuously as the mash was fermenting. The other