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Physico-chemical properties of plantain flour as affected by maturity time and drying methods

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ABSTRACT

Plantain (*Musa spp*.) is an important dietary source of carbohydrate in the humid tropical zones of Africa,Asia and South. Although there are reports on the physical, chemical and microbiological properties of plantain flour, little or no information is available on the effects of maturity time and drying method on the physicochemical properties of the flours. Thus, to promote and enhance the use of plantain flour, it is necessary to determine the physicochemical properties of the flour. Green Horn cultivar of fresh plantains was harvested at different periods of maturity from week 9 to 13 at Federal University of Technology Owerri University farm. The different batches were washed, peeled and cut into slices of 1cm thickness. The slices were dried using a solar dryer and sun drying. The dried samples were milled into flour and screened through a 100µm sieve. Results showed significant differences all the properties considered, but for the bulk density and oil absorption. Irrespective of the maturity time, Solar drying reduces the oil absorption, bulk density and wettability of Plantain flour. Solar dried plantain at 12th week of maturity gave the highest value of 1.8614, which is significantly different from others. Maturity time and different drying methods could be exploited for the development of multipurpose plantain flour.

INTRODUCTION

Plantain (*Musa spp*.) is an important dietary source of carbohydrate in the humid tropical zones of Africa, Asia and South America[12]. Plantain may be processed into many products at different stages of physiological maturity; unripe, ripe, overripe or in a number of ways such as frying, grilling, boiling and drying.

According to Demirel and Turhan[5], drying adds value to banana in addition to preservation. Moisture removal from plantain seems to be an appropriate and economical means of preservation, resulting in shelf stable and convenience products.

A reduction in moisture content potentially increases shelf life and hence prevents excessive post harvest loss and that drying is an alternative to a developing country like Nigeria where there is deterioration due to poor storage, weather conditions and processing facilities. Musa *et., al.*[11] argued that there is often a decrease in the quality of dried products because most conventional techniques use high temperature during the drying process. The process may introduce undesirable changes in appearance and will cause modification in texture, flavor and color as well. This is not in agreement with the increasing demand of consumers for the highest quality finished product.

Currently, unripe plantain flour is being processed into a thick paste product known as.amala., which is medically recommended for diabetic patient[1] The most commonly used drying method include sun drying, convectional air drying, vacuum drying and osmotic drying[9].

More specifically, drying method and processing conditions affect significantly the color, texture, nutritional content, density and porosity and sorption characteristics of the material. So the raw material may end up as a completely different product depending on the type of drying method and conditions applied[9,10] (Krokida and Maroulis, 2001a; Krokida and Maroulis, 2001b)

Therefore, this work is aimed at determining the effect of drying methods and the maturity time on the physicochemical properties of plantain flour

MATERIALS AND METHODS

Cultivars of fresh mature plantains were obtained from the FUTO Farms Limited. Harvesting was done at different periods of anthesis ranging from week 9 to 13. Unripe plantains at different stages of maturity stages 9th,10th, 11th,12th and 13th week) were cleaned, peeled and sliced to1cm thickness using a slicer. The slices were dried using a solar dryer and sun drying. The dried samples were milled into flour and screened through a 100μm sieve and packaged in hermetic glass containers and stored at room temperature for further use.

ANALYSIS OF PLANTAIN FLOUR

Determination of bulk density

The bulk density of a powder is the weight of the powder divided by the volume it occupies as determined by Falade & Omojola[7], normally expressed as kg/m3.

Water and oil absorption capacity determination

Water and oil absorption capacity was determined according to the method of Beuchat[4].

Swelling index determination

Swelling power and solubility of the plantain flours were determined according to the method of Svarovsky (1987)**.** 1 g of dried and milled sample was weighed into 100mLconical flask. Subsequently15ml of distilled water was added and it was shaken for 5 min at low speed using a vortexmixer. The sample was transferred into water bath and heated for 40 min at 80- 85°C with a constant stirring. The sample was then transferred into pre-weighed centrifuge tube and 7.5 ml of distilled water was added. It was centrifuged at 220rev/min for 20min. The supernatant was carefully decanted into a pre-weighed can and dried at 100°C to constant weight. The difference in weight of the evaporating dish was used to calculate starch solubility. The precipitate was weighed with the centrifuge tube. To calculate the swelling power, theweight of residue was divided by the original weight after solubility subtraction. Analysis was conducted in triplicate.

Determination of wettability of plantain flour

Wettability describes the capacity of the particles to absorb water on their surface, thus initializing reconstitution. About 3 g of dried plantain was placed around a pestle inside a funnel so that the pestle blocks the funnel opening. Then, the pestle was lifted to allow the power to flow through the stem into a beaker of water. As soon as all the powder has flowed into the beaker of water, a stop watch was started and the time(s) it took a sample of plantain powder to be completely wetted by water was determined.

Determination of pH

30g of plantain pulp juice was weighed which was obtained by blending 30 g of plantain with 90 ml of distilled water. The pH electrode was washed with distilled water. The electrode was placed in the filtrate. The electrode was allowed to stabilize for few moments. The pH value of the filtrate was taken after then[1].

Determination of gelling point

5g of the sample was dispersed in different chemicals in 250ml and made up to 500ml flour suspension. A thermometer was clamped on a retort stand with its bulb submerged in the system heated with a mantle. The heating and stirring is continued until the suspension begins to gel and the corresponding temperature was recorded.

RESULTS AND DISCUSSION

The Impact of Drying method and Maturity Time on the physicochemical Properties of Plantain Flour

Oil absorption

There were no significant differences as result of the drying method, except for the 11th week. However, the highest value of 3.148 was obtained for the solar

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dried plantain flour with 10th week of maturity while the least value of 2.71 was obtained for solar dried samples, at 11h week of maturity. According toFagbemi[6], good oil absorption capacity of flour samples suggest that they may be useful in food preparations that involve oil mixing like in bakery products, where oil is an important ingredient. The water/fat binding capacity of proteins is an index of its ability to absorb and retain oil, which in turn influences the texture and mouth feel of food products like ground meat formulations, doughnuts, pancakes, baked goods and soups.

TABLE 1 : Effect of drying method and maturity time on the oil absorption property of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	2.839^a	3.078^a	3.132^a	2.810^a	3.100^a
SOLAR DRYING	2.986^a	3.148^a	2.716^b	2.968^a	2.938^a

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

Swelling index

Swelling Index is regarded as quality criterion in some good formulations such as bakery products. It is an evidence of non-covalent bonding between molecules within starch granules and also a factor of the ratio of α-amylose and amylopectin ratios[13]. From the TABLE, swelling index increased as the maturity time increased. However, Sun dried flours had higher values. Sun drying had been observed to clearly play a role in obtaining starch with high swelling power and desirable organoleptic properties.

TABLE 2 : Effect of drying method and maturity time on the swelling index of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	1.66^b	1.735^b	2.1383^a	2.0167^a	2.3933^a
SOLAR DRYING	1.87^a	1.9283^a	2.275^a	2.0617^a	2.3267^a

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

Wettability

There were significant differences in the wettability factor for all the flour sample,as a result of the drying method, except for the ones with 10th week of maturity. However, the highest value of 265 was obtained for 13th week, solar dried plantain flour, while sun dried-11th week matured plantain produced the least value.

TABLE 3 : Effect of drying method and maturity time on the wettability of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	1.8055^a	1.297167^a	1.12^b	1.3477^a	2.3333^b
SOLAR DRYING	1.5971^b	1.222167^a	1.75a	0.5694^b	2.6528^a

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

Bulk density

The Bulk Density (g mL^{-1}) ranged from 0.6621 to 0.7728 g mL^{-1} with the Solar dried flour sample at 13 weeks of maturity, having the least value, while the solar dried samples with 10th week maturity had the highest value. There were no significant differences in all the maturity times, irrespective of the drying method applied.

TABLE 4 : Effect of drying method and maturity time on the bulk density of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	0.70953^a	0.7315^a	0.7186^a	0.709^a	0.7095^a
SOLAR DRYING	0.69595^a	0.7279^a	0.7268^a	0.7233^a	0.6621^a

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

Gelling point

The Gelling point ranged between 59.333 to 70.667 with sun dried flour with 10th week of maturity having the highest value and solar dried sample at 12th week maturity, having the least value. Variations in the gelation point may be attributed to the relative ratios of the different constituents proteins, carbohydrates and lips in the food sample[15]. The lower the gelling point, the better it serves as a good binder and provider of consistency in food preparations of semi solid beverages and the better the gelling ability of the flour[2].

Water absorption

The water absorption capacity ranged between 1.568 and 1.804%. Sun dried sample at the 10th week maturity had the highest value while the solar dried flour at the same maturity time gave the least value. The water absorption capacity is important in the formulation of ready to eat food s and high water absorption capacity may assure product cohesiveness (Houson and Ayenor, 2002). The difference depends on the amount and nature of the hydrophilic constituents (Ayele and Nip, 1994)

TABLE 5 : Effect of drying method and maturity time on the gelling point of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	64.3333 ^{b}	70.667 ^{a}	64.167 ^{a}	68.667 ^{a}	62.667 ^{b}
SOLAR DRYING	66.3333 ^{a}	65.667 ^{b}	65.333 ^{a}	59.333 ^{b}	65.333 ^{a}

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

TABLE 6 : Effect of drying method and maturity time on the water absorption property of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	1.7047 ^{b}	2.0346 ^{a}	1.6373 ^{a}	1.7971 ^{b}	1.6493 ^{a}
SOLAR DRYING	1.8047 ^{a}	1.6385 ^{b}	1.5683 ^{a}	1.8614 ^{a}	1.6185 ^{a}

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

pH

TABLE 7 shows that there were no significant difference in the Ph values for all the flour irrespective of the time of maturity and the drying method. However, Solar dried flour at the 13th week of maturity gave the highest value of 6.92, while sun dried flour at 10th week of maturity gave the least value of 6.06

TABLE 7 : Effect of drying method and maturity time on the ph of plantain flour

DRYING METHOD	MATURITY TIME				
	9th	10th	11th	12th	13th
SUN-DRYING	6.36 ^{b}	6.06 ^{b}	6.51 ^{b}	6.40 ^{b}	6.53 ^{b}
SOLAR DRYING	6.51 ^{a}	6.28 ^{a}	6.78 ^{a}	6.73 ^{a}	6.93 ^{a}

Each value represents mean of three replicates. Mean values having same superscript within column are not significantly different ($p < 0.05$)

CONCLUSION

The study revealed the physic-chemical property variations that exist in plantain flour, as a result of the maturity time and the drying method employed, during processing. Solar drying reduces the oil absorption, bulk density and wettability of Plantain flour. Swelling index increased as the maturity time increased. The pH increased as the maturity time increased, with solar drying, given higher ph values.

Higher water absorption property is feasible with less matured plantains. The usefulness of plantain flour could be enhanced by monitoring the maturity time of the plantain and applying the best drying method as required.

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