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The Effect of Drying Method and Maturity Time on the Functional Properties of Unripe Plantain Flour

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Abstract

The functional properties of solar and direct sundried green plantain *(Musa paradisiaca)* was investigated. The fingers were harvested weekly from 9th to 13th week. They were washed, peeled and cut into 1cm thickness. A distributed –type –natural circulation solar food dryer constructed with locally available materials was used to dry the slices as well as by direct sun drying. There were no significant difference as a result of the drying for the functional properties except for the 11th week for the oil absorption capacity which had the highest value of 3.148ml/g. No significance existed on the swelling index, pH, oil absorption whether by direct sun drying or solar dryer. The plantain flour samples had good functionalities and can used in food formulations.

Keywords: Plantain flour, direct sundrying, solar dryer and functional properties and maturity time.

1.0 Introduction

Drying is an ancient technique for preserving food. It involves the removal of moisture from food products so as to prevent the growth and reproduction of microorganism which can cause decay. The technique also minimizes many of the moisture mediated deteriorative reactions (Dincer 1996, 1998; Dincer and Dosi 1995; Akpinar *et al.,* 2003). To overcome the difficulties connected with open air sun drying, solar crop dryers have been developed and have proved to be beneficial for example; energy input is less, storage space is minimal, dried food are tasty, of high nutritional value and easy to prepare (Fagbemi, 1999).

Functional properties are defined as those characteristics that govern the behavior of food during processing, storage and preparation as they affect food quality and acceptability (Fagbemi, 1999). Some of these functional properties are water and oil absorption capacity, swelling index, gelling point, wettability and pH. Thus to promote the use of plantain flour it is necessary to study its functional properties. This present study is aimed at investigating the effect of direct sundrying and solar dryer on the functional properties of unripe plantain flour.

2.0 Methodology

2.1 Production of unripe plantain flour

Unripe plantain at different stages of maturity (9th to 13th week) were cleaned, peeled and sliced to 1cm thickness using a slicer. The slices were dried using a solar dryer and sun drying. The dried slices were milled into flour and screened through a 100µm sieve packaged in airtight containers and stored at room temperature for further use.

2.2 Drying of plantain slices

Two hundred and fifty grams of plantain slices were determined using the OHAUS triple beam balance of the 700/800 series which has a least count of 0.05g. The slices were left to dry in the drying chambers of the solar dryer and also on the sun directly. Drying lasted for three days.

Drying started each day at 9.00am and stopped at 5.00pm, a period of eight hours. The drying process was terminated when there was no detectable difference in mass between successive mass measurements (Mejeha, *et. al,* 2011).

2.3 Functional properties

2.3.1 Oil absorption capacity determination

This was determined according to the method of

Beuchat (1977). One gram of the flour samples was weighed into three dry centrifuge tubes. 10 ml of distilled water was added to three tubes and stirred manually. The mixture was allowed to stand for 30 minutes at room temperature then centrifuged for 30 minutes at 1,500 rpm. The oil absorption capacity was expressed as grams of oil absorbed per gram of flour sample.

2.3.2 Swelling index determination

One gram of the flour sample was weighed into a clean dry measuring cylinder. The volume occupied was recorded before 5ml of distilled water was added to the sample. This was left to stand undisturbed for an hour, after which the volume was recorded. The swelling index of the samples was given by:

$$Swelling\ Index = \frac{Volume\ occupied\ by\ sample\ after\ swelling}{Volume\ occupied\ before\ swelling}$$

2.3.3 pH determination

Thirty grams of plantain juice was weighed which was obtained by blending 30g of plantain slices with 90ml of distilled water, the electrode was placed in the filtrate. The pH of the filtrate was taken after the electrode was allowed to stabilize for few minutes.

2.3.4. Gelling point determination

Five grams of the sample was suspended in a beaker containing 20ml of water and heated while continuously stirring it. The temperature at which the suspension gelled was recorded as the gelatinization temperature.

2.2.5 Wettability

Wettability describes the capacity of the particles to absorb water on their surface, thus initializing reconstitution. The gap between the surface of 300ml water in the beaker and the tip of an inverted test tube was measured to be 10cm. 1g of the flour sample was released into the water and the time taken for the sample to get wet was recorded.

2.2.6 Statistical analysis

For the statistical analysis, Fishers LSD was used.

3.0 Results and Discussion

3.1 Oil absorption

Table 1 showed there were no significant differences as a result of the drying methods. The highest value of 3.148ml/g was obtained for the solar dried plantain flour with 10th week of maturity while the least value of 2.71ml/g was for solar dried sample at 11th week maturity. According to Fagbemi (1999), good oil absorption capacity of flour samples suggest that they are useful in food preparations that involve oil mixing like in baked products.

Table 1: Effect of drying method and maturity time on the oil absorption (ml/g) property of plantain flour.

Drying Method	Maturity Time (weeks)				
	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	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)

3.2 Swelling Index

Swelling index is regarded as quality criterion in formulations such as bakery products. From Table 2, 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 organolpetic properties (Ayele and Nip, 1994).

Table 2: Effect of drying method and maturity time on the swelling index (ml/ml) of plantain flours.

Drying Method	Maturity Time (weeks)				
	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]	2.2750[a]	2.0617[a]	2.3267[a]

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

3.3 pH

Table 3 shows that there were no significant difference in the pH values for all the flour irrespective of the time of maturity and 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 3: Effect of drying method and maturity time on the pH of plantain flours.

Drying Method	Maturity Time (weeks)				
	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)

Table 4: Effect of drying method and maturity time on the gelling point (°C) of plantain flours.

Drying Method	Maturity Time (weeks)				
	9th	10th	11th	12th	13th
Sun-drying	64.333[b]	70.667[a]	64.167[a]	68.667[a]	62.667[b]
Solar drying	66.333[a]	65.667[a]	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 5: Effect of drying method and maturity time on the wettability (min) of plantain flours.

Drying Method	Maturity Time (weeks)				
	9th	10th	11th	12th	13th
Sun-drying	1.81[a]	1.30[a]	1.12[b]	1.35[a]	2.33[b]
Solar drying	1.60[b]	1.22[a]	1.75[a]	0.57[a]	2.65[a]

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

3.4 Gelling point

The gelling point ranged from 59.33 to 70.66°C with sun dried flour at 10th week of maturity having the highest value (see Table 4). Variations in the gelation point can be contributed to the relative ratios of different protein and carbohydrates constituents (Okezie and Bello, 1988). The lower the gelling point the better it serves as a good binder in food preparations (Adeyemi and Umar, 1994).

3.5 Wettability

There were significant differences in the wettability factor for all the flour samples as a result of the drying method except for the ones with 10th week of maturity (see Table 5). However the highest value of 2.65min was obtained for 13th week, solar dried plantain flour, while sundried 11th week matured plantain produced the least value.

4.0 Summary and Conclusion

The study has demonstrated that whether by direct sundrying or solar dryer, unripe plantain flour has good functionalities. There were no significant difference as a result of the drying method, for oil absorption. However for wettability there were significant differences as a result of the drying method. Highest value was 2.65 minutes for 13th week solar dried plantain flour. Gelling point was highest for 10th week sundried sample. These functionalities will influence the texture and mouth feel of food products and so can be used in food formulations like pancakes, baked goods and soups.

References

Adeyemi, I.A and Umar, S.I (1994), "Effect of method of manufacture and quality characteristics of Kunun Zaki, a millet based beverages", Nigerian Food Journal **12,** 944-947.

Akpinar, E., Midilli and Bicer, Y. 2003, "Single layer drying behaviour of potato science in a convective cyclone dryer and mathematical modelling", Energy conversion and Management **44,** 1689-1705.

Ayele, T.and Nip, W.K. 1994, "Functional properties of raw and precooked taro (*Cococasia esculenta*) flours", Int.J of Food Sci and Technology **29,** 457-462.

Beuchat, L.R. 1997, "Functional and electrohoretic characteristics of succinylated peanut flour protein", J. Agric Fd chem **25,** 258-2611

Dincer, L, 1996, "Sun drying of sultana grapes", Drying Technology **14,** 1827-1838.

Dincer,L. 1998, "Moisture loss from wood products during drying part 1: moisture diffusionitives and moisture transfer coefficient" Energy sources **20,** 67-75.

Dincer, L and Dosi, S. 1995, "An analytical model for moisture diffusion in solid objects during drying", Drying Technology **13(1&2),** 435-436.

Fagbemi, T.N. 1999, "Effect of blanching and ripening on functional properties of plantain (*Musa* AAB) flour, Foods Human Nutrition **54,** 261-269.

Mejeha, 1.M., Amadi, J.O., Akujor, C.E and Uzomah, A. 2011"The drying characteristics of cassava and tatase in a three chamber solar food dryer" Advances in Science and Technology **5,** 89-94.

Okezie, B.O. and Bello, A.B. 1988, "Physicochemical and functional properties of winged bean flour and isolate compared with soy isolate", J. Food Sci **53,** 450-454.