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Effect of Drying Methods on Proximate Composition and Physico-chemical Properties of Cocoyam Flour

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ABSTRACT
Three drying methods (sun-, cabinet and oven-drying) were investigated on some quality attributes of flour produced from cocoyam, *Colocasia esculenta* Schott (taro). The proximate and physico-chemical compositions were determined to investigate the nutritional value and the characteristic properties of the cocoyam flour. It was observed that all parameters examined were affected by the drying methods as they varied in composition with the three differently processed flour samples (sun-, cabinet and oven-dried) except for carbohydrate that had no significant difference with the drying methods. The pasting property showed that all the three flour samples (sun, cabinet and oven dried methods) had no significant difference ($p \le 0.05$) in their pasting temperature while that of sun-dried cocoyam flour (sample A) had the least breakdown thereby retaining a good starch structure. The results of the experiment showed that the oven-dried cocoyam flour retained the highest values in protein (5.17%), ash (2.87%), crude fiber (2.97%) and carbohydrate (79.00%) than the sun and cabinet dried samples. The physico-chemical and pasting properties of sun dried sample is more acceptable as it has greater values in all its physico-chemical parameters tested for except for foam stability and least gelation concentration which have lower values than that of other samples (cabinet and oven dried), also sun dried flour had the least breakdown thereby retaining the best starch structure.

Key words: Cocoyam, flour, drying methods, physicochemical composition, nutritional values

INTRODUCTION
Roots and tubers belong to the class of foods that basically provide energy in the human diet in the form of carbohydrates and also provide some minerals and essential vitamins (Hahn, 1984). The terms (roots and tubers) refer to any growing plant that stores edible material in subterranean root, corm or tuber (Ugwu, 2009). Historically, very little attention has been paid to root crops by policy-makers and researchers as most of their efforts have been concentrated on cash crops or the more familiar grains. Root crops were regarded as food mainly for the poor and have played a very minor role in international trade. This misconception has lingered for so long because of the lack of appreciation of the number of people who depend on these root crops and the number of lives that have been saved during famine or disasters by root crops (FAO, 1990).

Root and tuber were critical components in the diet during the early evolution of mankind and the most important food crops of very ancient origin in the tropics and sub-tropics, associate with human existence survival and socio economic history (Asha and Nair, 2002). Roots and tubers used as food include yam, cassava, potatoes and cocoyam. They have high moisture content resulting in short storage life under ambient condition, of the solid nutrients content in these crops, carbohydrates predominates.

Cocoyam also known as taro is a tropical plant grown primarily as a vegetable food for its edible corm and secondarily as a leaf vegetable and it is believed to be one of the earliest cultivated plants (Purseglove, 1972). In its raw form, the plant is toxic due to the presence of calcium oxalate, although, the toxin is destroyed by cooking or can be removed by steeping taro roots in cold water overnight. Cocoyam being among the tuberous roots that are very well adapted to most agro-ecological zones in Nigeria, proper measures should be taken to utilize the crop to contribute to the enhancement of industrial growth. Yet despite the wide adaptability as well as nutritional and economic values of the crop, cocoyam has received minimal interest and attention by producers, consumers and even researchers. The potentials of the cocoyam for food security, income generation and nutritional enhancement in the households are grossly underutilized. Hence, there is a need to study the proximate composition, physico-chemical properties of cocoyam as it can be affected by various drying methods.

MATERIALS AND METHODS

Fresh corms of cocoyam (*Colocasia esculenta*) var. antiquorum were purchased from a local market called Ogbese, Ondo State, Nigeria.

Samples preparation: The cocoyam corms were peeled, washed, sliced into pieces of 3.5±0.2 mm thickness and soaked into 0.02% solution of sodium metabisulphite for 30 min to prevent oxidation browning. Batches of cocoyam slices were dried using cabinet drier and oven at 70°C and the other batch was sun dried as control. The dried samples were milled into fine flour using a milling machine, sieved and packaged in air-tight polyethylene bags labeled for analysis.

Determination of proximate composition of the flours: Moisture content of cocoyam flour was determined gravimetrically; ash, fibre, crude fat and protein contents of cocoyam flour were determined using official methods AOAC (1990). Carbohydrate content was also determined by difference described by AOAC (1990).

Determination of physico-chemical properties: Bulk and loose densities were determined by Narayara and Narasinga (1989). Bulk density was determined by placing 20 g of the sample into a weighed measuring cylinder and tapped gently to eliminate air spaces, the resulting volume was recorded and loose density was determined by placing 20 g of the sample into a measuring cylinder and the volume was recorded without tapping. Swelling capacity was determined by Leach *et al.* (1959) method while the procedure of Sathe *et al.* (1982) was used for water absorption capacity. The method described by Narayara and Narasinga (1989) was used for the determination of Foam Capacity (FC) and Foam Stability (FS). The Least Gelation Concentration (LGC) of the sample was determined using the method of Coffmann and Garciaj (1977).

The procedure of Kim *et al.* (1995) using the Rapid Visco Analyzer (RVA) model RVA-3D was used in determining the pasting properties.

RESULTS

Proximate composition: The results of moisture, protein, ash, crude fiber, crude fat and carbohydrate of cocoyam flours that were produced using sun, cabinet and oven drying methods in their percentage composition are as shown in Table 1. The protein content ranged between 4.93-5.17% and it was found to be highest in the oven-dried cocoyam flour sample while sundried sample had the lowest value; there was a slight difference between sun and cabinet-dried samples.

The fat content ranged between 0.50 and 0.57% with oven dried flour sample having the higher value; while the sun and cabinet- dried flour samples had the lower of the same values. The ash content which is the total mineral content, present in the samples ranged between 2.47 and 2.87% with oven dried flour having the highest value and sun dried sample having the lowest value.

The carbohydrate content ranged between 78.70 and 79.00%, with the oven dried flour sample having the highest value and cabinet dried sample, the lowest value.

Physico-chemical properties: The results of loose bulk density, packed bulk density, foam capacity, foam stability, swelling capacity, least gelation concentration and water absorption capacity of cocoyam flour samples produced from sun, cabinet and oven drying methods are shown in Table 2.

Pasting properties: The results of peak, trough, breakdown, final viscosity, set back, peak time and pasting temperature of the pasting characteristics of cocoyam flour that was produced using different drying methods (sun, cabinet and oven dried) are as shown in Table 3.

Table 1: Proximate composition of flour samples (%)

Sample	Moisture	Protein	Fat	Ash	Crude fiber	Carbohydrate
A	10.4700^{a}	4.9300^{b}	0.5000^{b}	2.4700^{b}	2.7000^{b}	78.9300^{a}
B	10.1300^{b}	5.0700^{ab}	0.5000^{b}	2.7700^{a}	2.8300^{ab}	78.7000^{a}
C	9.4300^{c}	5.1700^{a}	0.5700^{a}	2.8700^{a}	2.9700^{a}	79.0000^{a}
LSD	0.2579	0.1631	0.0666	0.1153	0.1489	00.4662

Means with the same letters along the same column are not significantly different at $p<0.05$

Table 2: Physico-chemical properties of flour samples

Sample	Loose density	Bulk density	Foaming capacity	Foam stability	Swelling capacity	Least gelation concentration	Water absorption capacity
A	0.6090^{a}	0.8892^{a}	15.67^{a}	50.00^{c}	1.50^{a}	6.00^{b}	130.30^{a}
B	0.6047^{b}	0.8463^{b}	6.83^{b}	60.47^{b}	1.30^{b}	8.00^{a}	125.40^{c}
C	0.6028^{b}	0.8309^{c}	6.00^{c}	66.57^{a}	1.30^{b}	8.00^{a}	127.50^{b}
LSD	0.0019	0.0032	0.7446	0.5957	0.0000	0.0000	0.0000

Means with the same letters along the same column are not significantly different at $p<0.05$; loose and bulk densities are in g mL^{-1} while other properties are in percentage (%)

Table 3: Pasting properties of flour samples

Sample	Peak (RVU)	Trough (RVU)	Break down (RVU)	Final viscosity (RVU)	Set back (RVU)	Peak time (min)	Pasting temp. (°C)
A	123.80^{b}	122.08^{b}	1.71^{b}	215.2100^{b}	93.13^{b}	6.7300^{a}	50.2300^{a}
B	185.59^{a}	169.25^{a}	16.34^{a}	279.1300^{a}	109.88^{a}	5.2500^{b}	50.2500^{a}
C	186.88^{a}	168.59^{a}	18.30^{a}	277.3400^{a}	108.75^{a}	5.2000^{b}	50.2000^{a}
LSD	8.2293	11.2350	7.2866	25.1620	14.1210	0.3077	0.3732

Means with the same letters along the same column are not significantly different at $p<0.05$. Sample, A: sundried cocoyam flour, B: Cabinet dried cocoyam flour, C: Oven dried cocoyam flour, LSD: Least significant difference

DISCUSSION

Proximate composition: The moisture content of the cocoyam flour samples ranged between 9.43-10.47% with sundried cocoyam flour having the highest value and oven dried the lowest. Analysis of variance shows that there was significant difference ($p<0.05$) between the three cocoyam flour samples.

The cabinet dried samples differed slightly from oven-dried samples. The variations in the protein values may be connected with denaturation of cocoyam protein associated with the various drying methods. Also maillard reaction could be responsible for losses of protein as this also depends on the intensity of heat and temperature. Generally, protein contents of all samples were relatively low because wheat, cassava and cocoyam are poor sources of protein (Oyenuga, 1992; Okaka and Isieh, 2002).

The lower fat contents observed in sun and cabinet dried samples could be associated with the oxidation of fat during the period of drying (McGill *et al.*, 1974). The low content of fat will enhance the storage life of the flour due to the lowered chance of rancid flavor development. The ash content which is the total mineral content, present in the samples ranged between 2.47 and 2.87% with oven dried flour having the highest value and sun dried sample having the lowest value. This result obtained is an indication of the presence of organic nutrients in the flour samples. There was no significant difference in cabinet and oven dried cocoyam flour samples.

Crude fiber measures the cellulose, hemicelluloses and lignin contents of food. The crude fiber composition is within the range of 2.70-2.97% with oven dried flour having the highest value and sun dried flour sample, the lowest value, analysis of variance showed that there was slight difference between cabinet dried sample and other flour samples.

The high content of carbohydrate observed may be attributed to the high content of carbohydrate in cocoyam. Enwere (1998) reported that, in all the solid nutrients in roots and tubers, carbohydrate predominates. Carbohydrate supplies quick source of metabolizable energy and assist in fat metabolism.

Physico-chemical properties: The loose density of the sun-dried cocoyam flour sample had the highest value of 0.6090 g mL^{-1} and oven-dried flour samples had the least value of 0.6028 g mL^{-1}. There is no significant difference between cabinet and oven dried cocoyam flour samples. The packed bulk density ranged between 0.8892 and 0.8309 g mL^{-1} with the sun-dried flour sample having the highest value while the oven dried flour sample had the lowest value. The difference between the loose and packed bulk densities of the samples was not significant, indicating that the volume of the samples during packaging will not decrease excessively during storage and distribution.

The foaming capacity of all starch samples can be rated as low since they do not contain considerable high amounts of protein, a good foaming agent (Ayele and Nip, 1994). The foam capacity of the flour samples ranged between 6.00 and 15.67% with sun-dried having the highest value and oven-dried the least. The foam stability ranged between 50.00 and 66.57%, with oven-dried flour having the highest value and sun-dried sample, the least value.

The swelling capacity ranged between 1.3-1.5%. Sun dried flour sample had the highest value; while cabinet and oven dried flours had lower values. Generally cocoyam samples shows good swelling index when compared to other root crops like cassava (Ojinaka *et al.*, 2009). This is because of the type of granules cocoyam starch has and its highly digestible nature. The starch grain of cocoyam is about one tenth of potato starch grain (Akomas *et al.*, 1987).

The Least Gelation Concentration (LGC) ranged between 6.0 and 8.0%, with cabinet and oven-dried flours having the higher values while sun-dried sample has the lowest value. Variations in LGC may be attributed to the relative ratios of different constituent proteins, carbohydrate and lipids in food samples (Sathe *et al.*, 1982). The lower the least gelation concentration, the better it serves as a good binder or provider of consistency in food preparations such as semi solid beverages and the better the gelling ability of the flour (Adeyemi and Umar, 1994).

The Water Absorption Capacity (WAC), ranged between 125.4-130.3%. Sun-dried samples had the highest value while cabinet dried sample the lowest value. The WAC is important in the development of ready to eat foods and a high absorption capacity may assure product cohesiveness (Houson and Ayenor, 2002). The difference depends on the amount and nature of hydrophilic constituents (Ayele and Nip, 1994).

Pasting properties: Pasting properties of flours are important indices in predicting the pasting behavior during and after cooking (Richard *et al.*, 1991). The pasting properties of cabinet and oven-dried cocoyam flour samples had no significant difference while a decrease was observed in sun-dried sample of all the pasting properties. However, there was no significant difference in pasting temperature of all the samples.

CONCLUSION

Acceptable cocoyam flour can be produced through different drying methods depending on intend utilization. The results of the experiment carried out on the cocoyam flour indicated that drying methods affect proximate composition and physico-chemical properties of flour by not only altering the biochemical composition but also the functional properties.

In terms of the best method of drying cocoyam corms with best nutritional and functional value keeping abilities, samples oven-dried at 70°C gave the best result, followed by cocoyam samples dried in cabinet driers.

The pasting temperature of the three samples also helps in determining the sample that possesses a good starch structure. The result of bulk density offers the product a packaging advantage and suitable in the preparation of high nutrient density weaning food. Cocoyam may serve as a good binder or provide consistency in food preparations.

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