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Effect of Processing Methods on the Functional Properties of Cocoyam Flour

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Abstract

Cocoyam tubers were processed using two different sizes which are slice and chip. Two different processing methods were also carried out that soaking for eighteen (18) hours and non-soaking. The cocoyam was chipped using NCAM chipping machine and NCAM peeling tools was used slice the tubers for sliced cocoyam. The cocoyam slice and chip was both dried using NCAM Cabinet dryer and milled. Analysis was carried out on the milled production to know the effect of the processing methods (soaked for 18 hours, soaked, chipped and sliced) on the functional properties of the flour. The results obtained for water absorption capacity for samples A-D are 0.83, 0.63, 0.72 and 0.71, Foaming capacity are 9.62, 13.46, 15.38 and 11.54, Viscosity are 1.802, 1.41, 1.52 and 1.57, Bulk density are 0.7, 0.67, 0.69 and 0.72, and Gelatinization temperature are 81.5, 82.2, 83.2 and 84.7°C. The result shows that sample C has the highest Foaming capacity and viscosity, while sample A has the highest Water absorption capacity and sample D has the highest Bulk density and gelatinization temperature. Sample D has the highest Viscosity, Gelatinization temperature and bulk density which make it easy for paste reduction and the ability to form gel which is also involved in pasty property. Therefore the best processing method is soaking for eighteen (18) hours before drying and milling.

Keywords

Functional Property, Chipped, Sliced, Processing Methods

1. Introduction

Cocoyam varieties (Xanthosoma sagittifolium) called tannia and (Colocasia esculenta) called taro are important staple food crop grown extensively in south-eastern Nigeria. [1] stated that cocoyam is a member of Araceae family and in the group of monocot plant and constitute one of the six most important root and tuber crops worldwide [2]. Although, they are less important than other tropical root crops such as yam, cassava and sweet potato, they are still a major staple in some parts of the tropics and sub-tropics [3]. Nigeria is the world's largest producer of cocoyam, accounting for about 37% of total world output [4] with the annual production of cocoyam in Nigeria estimated at 26.587 million tones [4]. In the Eastern part of Nigeria, it serves as staple food and is used as a thickener in food preparations especially the varieties *Colocasia esculenta* and *Xanthosoma cultivar*. Cocoyam is rich in digestive starch, good quality protein, vitamin C, thiamine, riboflavin, niacin and high scores of protein and essential amino acids [5], [6]. [18] emphasized that cocoyam can be processed into cocoyam flour, chips and poi a processed form of taro which is popular in Hawaiian and Polynesian. The author further stated that cocoyam flour is highly digestible and therefore suitable for feeding invalids, for making confectionaries and baby food.

Cocoyam is used in a range of indigenous foods and it post-harvest losses are high due to mechanical damage of corms during harvest and microbial attacks on such damaged corms during storage. However, chemical effects of raphides crystals of calcium oxalate and other components produce irritation when raw corm tissue is ingested resulting in several levels of discomfort. With appropriate processing method, cocoyam could be a rich source of starch for food and industrial applications and corms have potential for new product development. Stabilizing cocoyam tuber and adding value could greatly improve its utilization in cocoyam producing countries as reported [7]

Cocoyam like other root crops deteriorate few weeks after harvesting due to inadequate post-harvest technologies and this makes the crop scarce and expensive when it is not in season. Processing of cocoyam into flour extends the shelf life of the commodity thereby making it available for use all year round. Processing of food commodities into flour involves drying of the food commodity in order to reduce the moisture content to a minimal level where the food material will be shelf stable

Drying is the oldest method of preserving food. [17] define drying as a mass transfer process consisting of the removal of moisture from a solid, semi-solid or a liquid. It is also a method of food preservation that works by removing water from the food, which inhibits deterioration [8]. Food can be dried in several ways for example by the sun if the air is hot and dry enough, in an oven if the climate is humid and in solar system if the climate is hot to about 30-40°C [8]. Sun (open air) drying uses heat from the sun and natural movement of the air and expose the food material to environmental factors such as dust, bacterial growth and excessive respiration. Drying involves use of equipment (dryer). There are different types of mechanical dryers which include solar dryer, cabinet dryer, flash dryer. Crop drying is one of the methods, such as sun, oven and solar drying that are used to preserve some perishable food crops as reported by [9].

[16] observed that drying temperature influence colour and flour gelatinization of cocoyam flour. Conversion of corm tubers into flour reduces water content and this could contribute markedly to resolving post-harvest storage problems.

Research on the use of different processing treatment application for the production of cocoyam flour has been minimal. There is therefore need to evaluate the effects of processing treatment on cocoyam in the production of cocoyam flour.

2. Materials and Methods

The cocoyam tubers were sourced from Akoda market, Ede North Local Government of Osun state for the drying process. The drying process makes use of NCAM cabinet dryer.

Cocoyam tubers were manually peeled using the kitchen knives and NCAM peeling tools, washed. They were divided into two portions, some were soaked in water for 18 hours before chipping using NCAM chipping machine, and the other portion was chipped using the NCAM chipping machine without soaking. The cocoyam tubers which were supposed to be sliced were sliced using NCAM peeling tool and also divided into two portions, half was soaked for eighteen (18) hours and the other portion was not soaked. The samples were fed into NCAM Cabinet dryer and dried at 60°C for 24 hours. The dried samples were then wrapped in air tight packaging material ready for further analysis. Analysis was carried out using the method by [18].

2.1. Determination of Water Absorption Capacity

1g of sample was weighed using an analytical balance and poured into a centrifuge tube. 10ml of water was added into the centrifuge tube containing the sample. The tube was placed in the centrifuge and rotated at 3000rpm at 30°C for 30minutes. The tube was removed from the centrifuge, and the water decanted from the sample into a measuring cylinder, and the volume was recorded.

The absorbed water may be converted to weight (in grams) by multiplying by the density of oil (0.894 g/ml) and water (1 g/ml).

$$\text{Absorbed water} = \text{total water} - \text{free water}. \tag{1}$$

2.2. Determination of Foam Capacity

2g of the sample was weighed using analytical weighing balance and then transferred to a 100ml measuring cylinder. 50ml of distilled water was added. The suspension was mixed and properly shaken to form foam and the volume of foam after 30sec was recorded.

The foam capacity (FC) was expressed as a percentage increase in volume. The foam volume was recorded 1hour after whipping to determine the foam stability of the initial foam volume.

The percentage foam capacity was calculated as;

$$\%FC = \frac{V2 - V1}{V1} X100 \tag{2}$$

Where V_1 =volume before homogenization

V_2 = volume after homogenization,

FC= foam capacity

2.3. Bulk Density

The gravimetric method was used. A weighed sample (10 g) was put in a calibrated 10 ml measuring cylinder. Then the bottom of the cylinder was tapped repeatedly onto a firm pad on a laboratory bench until a constant volume was observed. The packed volume was recorded. The bulk density is calculated as the ratio of the sample weight to the volume occupied by the sample after tapping.

$$Bulkdensity(g/ml) = \frac{Weightofsample(g)}{Volumeofsample(ml)} \tag{3}$$

2.4. Gelatinization Point

10 g of flour sample was suspended in distilled water in a 250 ml beaker and made up to 100 ml flour suspension. The aqueous suspension was heated in a boiling water bath, with continuous stirring using a magnetic stirrer. A thermometer

was then clamped on a retort stand with its bulb submerged in the suspension. The heating and stirring continued until the suspension began to gel and corresponding temperature was recorded 30 secs after gelatinization was visually noticed.

2.5. Statistical Analysis

The data obtained from the study were subjected to analysis of variance (ANOVA) procedure of [20].

3. Result

Table 1. *Functional Properties of Cocoyam Flour.*

SAMPLE	BULK DENSITY (g/cm^3)	GELATINIZATION TEMP (°C)	VISCOSITY (P)	WATER ABSORPTION CAPACITY (g/ml)	FOAM CAPACITY (%)
A	0.7^{ab}	81.5^{d}	1.802^{a}	0.83^{a}	9.62^{d}
B	0.67^{b}	82.2^{c}	1.41^{d}	0.63^{c}	13.46^{b}
C	0.69^{ab}	83.2^{b}	1.52^{b}	0.72^{b}	15.38^{a}
D	0.72^{a}	84.7^{a}	1.57^{b}	0.71^{b}	11.54^{c}

Means with similar alphabets across the row are not significant different at $P<0.05$
A: Chipped Non-soaked
B: Sliced Non-soaked
C: Sliced Soaked
D: Chipped Soaked

4. Discussion

The results obtained from the analysis are shown in table 1. The water absorption capacity as shown in table 1 shows that sample A has the highest water absorption capacity compared to the other samples. There was no significant difference in samples C and D while there was a significant differences between samples A and B at P> 0.05 significant level. Drying increases the absorption capacity of flour [10]. [11] also stated that water absorption capacity is important in bulking and consistency of products as well as baking applications. The water absorption capacity is important in the development of ready to eat foods and a high absorption capacity may assure product cohesiveness [12]. Water absorption capacity of flours is influenced by the degree of disintegration of native starch granules which Suggests that undamaged starches have low potential absorption capacities. The water absorption capacity of flour enables the processor to add more water during food preparation thereby enhancing profitability; and also improving handling characteristics, which maintains the freshness of bread, cakes and sausage. The high water absorption of colocasia species favours their use as a soup thickener [21].

Sample D has the highest bulk density compare to samples A, B and C. There is significant difference between samples B and D, while there is no significant difference between samples A and C at P> 0.05 significant level. According to [10], drying decreases the bulk density of flour. Bulk density gives an indication of the relative volume of packaging material required. It is a measure of heaviness of solid samples, which is important for determining packaging requirements, material handling and application in the food industry [24].

Bulk density and porosity are affected by the particle size of flour and play important roles during mixing (as in dough formation), sorting, packaging as well as transportation of particulate foods [21]. [21] states that bulk density and porosity are influenced by the geometry, size and surface properties of a given material. Generally, higher bulk density is desirable for greater ease of dispersibility and reduction of paste thickness [14]. Low bulk density of flour are good physical attributes when determining transportation and storability since the products could be easily transported and distributed to required locations [15]. Sample D also has the highest gelatinization temperature which shows it has a high ability to form gel. This indicated higher stability of Colocasia spp flours crystals upon heating. Gelling temperature is the temperature at which a food solution forms an observable thicker consistency when heat is applied [22]. The relatively high gelling temperature of the flour samples could be due to the presence of other components in cocoyam flours such as proteins and lipids that would obstruct the swelling of granules and thus increase the amount of heat required to reach the final swelling. According to [21], gelling temperature might be associated with the relative ratio of amylase and amylopectin in flour. The implication of the result is that lesser amount of energy will be spent on cooking the food.

Sample C has the highest foaming capacity this shows that the protein has a high ability to bind with fat there forming batter or dough. Foam capacity and stability show the level of adsorbed air on the air-liquid interface during whipping or bubbling, and its ability to form a cohesive viscoelastic film by way of intermolecular interactions [23]. It is also related to the amount of solubilized protein, and the amount of polar and non-polar lipids in a sample [23].

5. Conclusion

The result obtained shows that Sample D has the highest Viscosity, Gelatinization temperature and bulk density which make it easy for paste reduction and the ability to form gel which is also involved in pasty property. Therefore the best processing method is soaking for eighteen (18) hours before drying and milling.

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