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Comparative Studies of Starch from Fresh and Dried Cassava Chips

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Abstract— *This work is on comparative studies of starch produced from fresh and dried cassava chips, starches produced from fresh and dried cassava chips were separately subjected to proximate, functional and pasting properties. The result of the pasting analysis revealed that when starches were heated in an aqueous environment both undergo changes known as gelatinization and pasting. Both samples may be suitable for products requiring high gel strength and elasticity. The result of proximate and functional properties also revealed that there was no significant difference in the parameters analyzed. Therefore dried cassava chip starch compared favorably well with fresh cassava chip starch.*

Keywords— *Proximate, functional, swelling capacity, pasting properties, bulk density.*

I. Introduction

Starch is one of the most abundant substances in nature; starch is produced from grain or root crops. It is mainly used as food, but it is also readily converted chemically, physically and biologically into many useful products. Starch is used for the production of diverse products such as in paper, textiles, adhesives, beverages, confectionery, drugs and building materials.

Starch is the predominant carbohydrate reserved found in plants. It is a major source of nutrient for human and animals and an important raw material for industry. Commercial starches are obtained from various botanical sources. Starch has unique functional properties but most of those used by diverse industries are modified before use, giving a wide range of useful product [1].

The application of starch is derived from its functional properties. An important functional property is pasting which is the development of high viscosity after heating of starch-water suspension. This property is exploited in different foods as well as non-food uses such as adhesives. Another important functional property is the capability to create gels. These properties are also used in different food and non-food application such as thermoplastics.

Starch is the major dietary component in the human populations. The recent consensus on healthy-eating habit favours an increase in the population of polymeric plant carbohydrates (including starch) in the daily diet [2]. However in our culture, the main purpose of starch utilization in foods remains more functional than nutritional. This biopolymer constitutes excellent raw materials to modify food texture and constituency.

Cassava is a root crop which is common to this region. It is one of the staple foods in Nigeria. One of the products of cassava is starch. Cassava starch is produced primarily by the wet milling of fresh cassava roots but in some countries such as Thailand it is produced from dry cassava chips. Starch is the main constituent of cassava; about 25% starch may be obtained from mature, good quality tubers. About 60% starch may be obtained from dry cassava chips and about 10% dry pulp may be obtained per 100kg of cassava roots [2].

When cassava roots are harvested, it needs to be processed immediately as the roots are highly perishable and enzymatic processes accelerate deterioration within 1-2 days [3]. This is a major setback in cassava processing so far there is no economically feasible technique of storing harvested cassava root for long period at large scale except in the form of dry chips. Compelled by this fact, starch factories are usually located close to the cultivation site to ensure supply of fresh roots. Seasonally the supply of fresh root to starch factories fluctuates. During peak harvest, supply exceeds the production capacity of the factories resulting in low prices and consequently reduced return to the growers. The idea of extracting starch from dry cassava chips is an attempt to solve this problem. The surplus root during peak harvest could be dried and stored; when supply of fresh root drops below demand the dry chip from storage could be used to produce the starch.

II. Materials and Method

A. Material

The cassava tubers used for this work were obtained from a farm in Ijabe, Osun State, Nigeria.

a. Methods

Production of Fresh Cassava Starch

Freshly harvested mature cassava tubers were sorted and graded; then washed to remove adhesive soil, the cleaned cassava tubers were then peeled and washed with clean water. The peeled cassava tubers were then passed through the process of grating and then mixed with water to form slurry. The slurry was filtered using muslin cloth. The starch obtained was allowed to settle and the supernatant decanted several times to prevent fermentation. The starch obtained was air dried at 30 ^{0}C for 48 hours. The dried starch was then milled to obtain a very fine particles size. It was then packed in cellophane bags for further analysis.

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Production of dry cassava chips starch

Mature cassava tubers were sorted and graded, and later washed to remove adhesive soil. Peeled and washed again. The peeled cassava tubers were cut into chips and then sun dried for 5 days. After sun drying, it was then soaked in fermented liquor for 6-12 hours. The soaked chips were grated and mixed with water and sieved. The starch was allowed to settle and supernatant decanted several times to prevent fermentation. The starch obtained was air dried at 30 ^{0}C for 48 hours. The dried sample was then milled to obtain a very fine particle size. The chip starch was then packed in cellophane bags for further analysis.

Chemical analysis

Moisture, ash, crude fibre and fat were determined by [4] and crude protein content by kjeldahl method. Carbohydrate content was determined by difference.

Water absorption capacity (WAC)

The WAC was determined by a combination of the [5] method and those of [6] and [7] A 2g sample was dispersed in 20ml of distilled water. The contents were mixed for 30s every 10 min using a glass rod and after mixing five times, centrifuged at 400g for 20min. the supernatant was carefully decanted, and then the contents of the tube were allowed to drain at a 45^0 angle for 10min and then weighed. Oil absorption was expressed as percentage increase of the sample weight.

Oil Absorption

Oil absorption capacity of the flour samples was determined by the centrifugal method elicited by [8] with slight modifications. One gram of sample was mixed with 10 ml of pure canola oil for 60 sec., the mixture was allowed to stand for 10min. at room temperature, centrifuged at 4000 g for 30 min and the oil that separated was carefully decanted and the tubes were allowed to drain at a 45^0 angle for 10 min and then weighed. Oil absorption was expressed as percentage increase of the sample weight.

Gelling concentration (GC)

The method of [9] was employed for the determination of gelling concentration. Sample suspension of 1,3,5,7,9,11,13,15,17, and 20% (w/v) were prepared in 5ml distilled water and the test tubes were heated in a boiling water bath for 1hr followed by rapid cooling under running cold tap water. The test tubes were further cooled for 2hrs at 4 ^{0}C. least gelling concentration was determined as that concentration when the sample from the inverted test tube did not fall down or slip'.

Swelling capacity (SC)

Swelling capacity was determined using the method elicited by [10] with slight modifications. Briefly, 3-5g samples were weighed into tared 50ml centrifuged tube. About 30ml distilled water was added and mixed gently. The slurry was heated in a water bath at 95 ^{0}C for 15 min. During heating; the slurry was stirred gently to prevent clumping of the starch. On completion of the 15 min, the tube containing the paste was centrifuged at 300 g for 10 min. The supernatant was decanted immediately after centrifuged. The tubes were dried at 50 ^{0}C for 30 min, cooled and then weighed (W_2). Centrifuged tubes containing sample alone were weighed prior to adding distilled water (W_1). Swelling capacity was calculated as follows:

Swelling capacity = (W_2 (g) – W_1 (g)/ Weight of sample (g)

Bulk density

Bulk density was determined by the method of [11]. A 10ml graduated cylinder, previously tared, was gently filled with the sample. The bottom of the cylinder was gently tapped on a laboratory bench several times until there was no further diminution of the sample per unit volume of sample (g/m).

pH

The pH was measured by making a 10% w/v suspension of the sample in distilled water. The suspension was mixed thoroughly in a Sorex blender and the pH was measured with a Hanna checker H meter (Model HI270).

III. Result and Discussion

From Table 1, the protein content obtained for fresh cassava starch is higher than that obtained for dried cassava chip starch; it is 3.66% and 3.32% respectively. These results are higher than that reported by [12]. The difference in the protein can be attributed to the processing method involve in the production of the starches. The ash content of fresh cassava and dried cassava chips are 1.43% and 1.482 respectively; these are slightly higher than the value reported by [13] which was 1.1%. Moisture content of 4.96% and 2.98% were obtained for fresh chi starch and dried cassava chip starch respectively. This result is lower when compared to 13% reported by [13]. Low moisture indicates higher shelf life of dried products. The lower the initial moisture content of a product to be stored, the better the storage stability of the product [14] The moisture content of the starches were below the 10% stipulated standard of the revised regulation of the standard organization of Nigeria. The difference observed when comparing the two starches produced may be due to the fact that the dried chips had been dried relatively before the liquor fermentation.

The crude fibre content of fresh cassava and dried cassava chips starches are 1.46% and 1.03% respectively. This implies that fresh cassava starch has the higher value. The fat content is 0.48% and 0.51% for fresh cassava starch and dried cassava chips starch respectively. These values are lower than 0.8% reported by [15] which is an indication that the fresh cassava and dried cassava chips starches and other product made from them may not be susceptible to quick rancidity due to the low fat content. The carbohydrate content of fresh cassava and dried cassava chips starches are 88.01% and 90.68% respectively. The two samples had very high carbohydrate content due to cassava being a major source of carbohydrate.

The result of the physicochemical and functional properties of the starch samples were shown in Table 2. The bulk density of the starches in g/ml were 2.56 and 0.19 for

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FCS and DCS respectively. The result of water absorption capacity of FCS and DCS is 69.95% and 72.08% respectively. The values are relatively the same. Similar result has been reported by [16] and [17] .Water absorption capacity is the ability of starch to absorb water and swell for improved constituency in food. It gives body to the food [18]. The absorption capacity of FCS and DCS are 1.49% and 1.37% respectively. This shows that as the cassava dries up, the oil absorption decreases after the extraction of starches. Fat absorption is an important property in food formulations because fat improves the flavor and mouth feel of foods [19].

The foam capacity of FCS is 5.73% and DCS is 3.05%. This implies that the FCS maintains high foaming capacity; similar results had been reported by [20]. It shows that high protein contents will give high foaming capacity. The emulsion capacity id FCS and DCS is 71.26% and 53.22%. This shows that as the cassava roots dried up, the emulsion capacity of the starch produce reduces, which compare relatively with the result reported by [21] for rice bran 4.97% and maize hull 38.10%.

The swelling capacity of FCS and DCS are 5.11% and 5.68% respectively. It shows that as the cassava root dries up for the production of starch, the swelling capacity of the starch increases. This result compared well with the result reported by [17]. Swelling power is an indication of the water absorption of the granules during heating. The gelation capacity of FCS is 1.27%, which shows that there were not much significant difference from the gelation of DCS of 1.42%. The pH values were 5.8% and 6.4% for FCS and DCS respectively, which is lightly different from 5.51 reported by [13] for starches. The aqueous solutions of both starches were acidic but FCS was more acidic (pH 5.8) than the DCS pH (6.4). The pH of the starch suspension is important since functional properties such as solubility, emulsifying activities and foaming properties are affected by pH. The gelation temperature of FCS and DCS is 2.33^{0} and 1.42^{0}, it implies that the temperature required for FCS to form gel is higher than that of DCS; this agreed will the result reported by [22].

IV. Figures and Tables

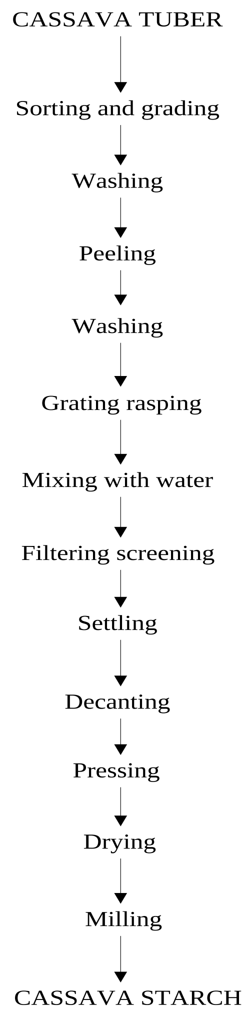

Fig. 1. Flow chart for the production of fresh cassava starch.

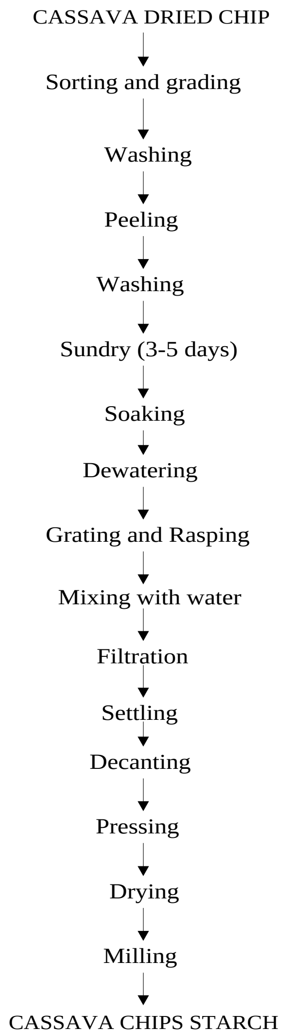

Fig. 2. Flow chart for the production of cassava chips starch.

TABLE I. Proximate composition of fresh cassava and dry cassava chip.

Sample	Protein %	Ash %	Moisture content %	Crude fibre %	Fat %	Carbohydrate%
Fresh cassava starch	3.66±0.10	1.43±0.20	4.96±0.11	1.46±0.40	0.48±0.02	88.01±0.50
Dry cassava chip starch	3.32±0.02	1.48±0.10	2.98±0.50	1.03±0.01	0.58±0.20	90.68±0.30

TABLE II. Physiochemical and functional properties.

Sample	Bulk density (g/mls)	WAC %	OAC %	Foam capacity %	Emulsion capacity %	Swelling capacity %	Gelation %	Gelation Temp ^{0}C	pH
FCS	2.56±0.10	69.95±0.20	1.49±0.20	5.72±0.50	71.26±0.30	5.11±0.11	1.27±0.20	2.33±0.30	5.8±0.30
CDS	0.19±0.11	72.08±0.10	1.37±0.40	3.05±0.10	53.22±0.20	5.68±0.40	1.42±0.10	1.42±0.20	6.4±0.20

Key: FCS-Fresh Cassava Starch, DCS – Dry Cassava Starch, WAC- Water Absorption Capacity, OAC- Oil Absorption Capacity

V. CONCLUSION

For all the parameters studied, it can be concluded that the starch obtained from dry cassava chips compares favourably well with the starch from fresh cassava tubers. It has an array of physiochemical, functional and proximate properties that can facilitate its use so many areas where the properties of the fresh cassava starch are accepted.

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