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Comparative Analysis on Pasting Characteristics of Yam and Cassava Starch

IKE, EBENEZER AMARACHUKWU[1], EWEAMA, ANN UCHECHI[2], MADU UDOCHUKWU, EMMANUEL[3]
[1, 2, 3]*Department of Food Science and Technology, Imo State Polytechnic Omuma, Oru East, Imo State.*

Abstract- Comparative analysis of pasting characteristics of yam and cassava starches was evaluated. The white yam variety (Dioscorearotundata) was processed peeling, washing, soaking in 1% sodium metabisulphate to inhibit enzymic browning, wet-milling, sieving, sedimentation of the starch, dewatering and sun-drying of the starch to obtain white starch. The cassava variety TME 419 were processed by peeling of the cassava tubers, washing, soaking in 1% sodium metabisulphate to inhibit enzymic browning, wet-milling, sieving, sedimentation of the cassava starch, dewatering and sun-drying of the starch to obtain white starch. The pasting properties of the samples evaluated were peak velocity, trough, breakdown velocity, final velocity, set back velocity, pasting time and pasting temperature using (AOAC, 2010).Peak velocity of the samples ranged from 7018.2 Rvu for cassava starch to 7622 Rvu for yam starch. Trough viscosity of the samples ranged from 2852Rvn for the sample Cassava starch flour to 3456Rvn for sample (yam starch).. Final velocity of the samples ranged from 3977Rvn for the sample cassava starch to 4377Rvn for the sample yam starch. The pasting properties peak velocity, trough, breakdown velocity, final velocity, set back, pasting time and pasting temperature revealed that yam starch sample had the highest value of pasting properties compared to white cassava starch(TME 419).From the study on the pasting properties sample YS (Yam starch) could be recommended due to its high values in the production of industrial products due to its high pasting properties.

Key words: Yam, Cassava Starch, Pasting Characteristics, Comparative Analysis

I. INTRODUCTION

Paste characteristics of starch from yam and cassava serves as quality attributes products obtainable from yam and cassava tuber starches (Adeyemi, 2018). Starch in the form of paste is obtained by physical or chemical treatment of native starch to make it useful for a particular application. Starch is used primarily in the food industry for its hydrocolloid properties, that is, the rheological characteristics it imparts to food products (Ihekoronye and Ngoddy, 1985). Starches can be obtained from white yam, tuber, potato, cereals and other tuberous crops (Norman and Hotchkiss, 2005). Starches are primarily of plant origin, and exhibit the following properties. Starch are not sweet, they are not readily soluble in cold water, starch forms pastes and gels in hot water. It provides reserve energy source to plants and supply energy to humans and also as a binder in pharmaceutical drugs (Egbeyemi, 2019). White cassava varieties TME 419 and TME 413 cassava tubers (*Manihot esculenta*) are extensively cultivated as annual crop in the tropical and subtropical regions for its edible starchy tuberous root, a major source of carbohydrates. Cassava is a major staple food in the developing countries providing a basic diet for over half a billion people (Fames, 2009). It is one of the most drought tolerant crops, capable of growing on marginal soils (Gabon, 2014). Nigeria is the world's largest producers of cassava, while Thailand is the largest exporter of dried cassava (Fames, 2009). Cassava generally is classified into yellow root cassava, sweet and bitter cassava. Bitter and sweet varieties of cassava contain anti nutritional factors and toxins, with the bitter varieties containing much larger amounts. It must be properly prepared before consumption, as improper preparation of cassava can leave enough residual cyanide to cause acute cyanide intoxication (Fames, 2009), goiters and even ataxia, partial paralysis or death (Tang, *et. al*, 2015).

Cassava roots are low in starch and contain small amount of calcium (16mg/100g), phosphorus (27mg/100g) and vitamin C (20. 6mg/100g) (Fames, 2009). However, they are poor in protein, vitamin A and other nutrients. The nutrition content of cassava depends on the specific plant part (root or leaves), geographic location, variety, age of the plant and environmental conditions. (FAOSTAT, 2011). The cassava root is composed on carbohydrates and is therefore mainly a source of energy. The starch content varies between 32 to 35% of the mass of fresh roots and 80 and 90% of the mass of dried roots. Amylopectin comprises 83% of the carbohydrate content of cassava roots, while amylase comprises 17% (Rawal and Kroll, 2003). Fiber content differs according to the variety and stage of development of the root. In fresh roots it is less than 1.7%, while it comprises 4% of cassava flour (Gil and Buitrago, 2002).

The protein content is trivial, between land 3% of dry matter and about 1.5 mg/100g of fresh mass (Bradbury and Holloway, 2010). Essential amino acids are present in low quantities, with the exception of arginine, glutamic acid and aspartic acid (Gil and Burtrago, 2002). The vitamin content of the root is low, except for vitamin C which is found at relatively high levels of between 15 to 45mg/100g per edible protein (Charles *et al*., 2004). The content of B vitamins of cassava roots is also found to be trivial (Giland, 2002).

Cassava is used as a source of food for man and animals. Cassava is used in production of ammonia. Cassava is used in production of industrial starch. Cassava is used production of flour. It is used in formulation of wheat commercial flour (Webeto *et al.,* 2006). Cassava is rich in carbohydrate, fat, beta-carotene pro-vitamin A. Cassava roots are very rich in starch and contain small amount of calcium (16mg/100g), phosphorus (27mg/100g) and vitamin C (20. 6mg/100g)(Fames, 2009).

Yams are tubers that are consumed due to its high carbohydrate content and used industrially in production of yam flour and starch for pharmaceutical industries (Scholar, 2023). Yams are cultivated mainly in the tropic and sub-tropic regions of the world, and over a wide ranges of environmental and soil conditions. It is tolerant of insect pests and diseases, and is very tolerant of drought and heat stress. The tuber is not a labour intensive crop and produces well on marginal soils. In many of the tuber growing regions of the world, however, the tuber does not achieve its yield potential, due primarily to disease and limited inputs such as fertilizer and irrigation (Adeleke, 2006).

In the tropical regions, white and yellow tubers are the most important root crop and, as a source of energy, the calorific value of tuber is high, compared to most starchy crops (Okigbo, 2016). The starch content of the fresh tuber root is about 30%, and gives the highest yield of starch per unit area of any crop known. The protein content is extremely low, however, and ranges between 1-3%. The tuber root contains a number of mineral elements inappreciable amounts that are useful in the human diet. The root contains significant amounts of iron, phosphorus and calcium, and is relatively rich in vitamin C.

White yam (*Dioscorea rotundata*) tuber is white in colour internally; yellow yam (*Dioscorea cayenensis*) tuber is yellow in colour. White yam (*Dioscorea rotundata)* is perennial plants with strongly marked annual cycle of growth. Typical *dioscorea* species produce annual stems, which climb by twining through the underground and trees. The leaves are borne on long petioles, usually simple and coordinate or acuminate. The flowers are small with male and female parts separated and usually sterile as a result of centuries of vegetative propagation (Coursey, 2008).

Hydrolysis of starch increases the quality of starch such as rheological and functional properties, thus increasing its use. It is also pertinent to know that when a suspension of starch granules in water is heated, the granules swell due to water uptake and gelatinize (Norman and Hotchkiss, 2005). Hydrolysis of starch yields dextrins, which are intermediate in chain length between starches and sugars and exhibits other properties that are beneficial to industrial food producers.

Starch has empirical formular of $C_6H_{10}0_5$ and is the storage polysaccharides in plants especially in seeds, tubers and fruits (Egbeyemi, 2019). It is the major energy source for many plants and has been extensively exploited by humans. It serves as a food source and more recently in a wide variety of non-food applications. Starch is found as long polymers composed of two structural classes: amylose and amylopectin. The basic repeating unit for both types of starch is D–glucose connected by glucosidic bonds (Egbeyemi, 2019) Amylose is essentially a linear polymer consisting of about 1000 to 2000 of (1-4) linked –D–glucopyranosyl units with a molecular weight of 250,000. Amylopectin is a highly branched polymer of D–glucopyranosyl units, primarily, linked by (1-4) bonds with branches of (1-6) linkages. On the average, branching in amylopectin occur every 25 to 27 glucose residues unlike glycogen which has one branch per 10 to 12 glucose units. Amylopectin has a ramified tree structure and has a very large molecular weight of about 50 – 500 million. Amylose constitutes 20 – 25% of starch while amylopectin accounts for 75 – 80% (Ihekoronye and Ngoddy, 1985).This work is aimed at carrying out a comparative analysis of paste characteristics of starch from yam and cassava starches.

II. MATERIALS AND METHODS

Sources of Materials

White yam (*Dioscorearotundata*)and White cassava TME 419 tubers was purchased from Orie Omuma Oru-East Local Government Area of Imo State. Other equipments to be used for processing of samples such as, stainless table knives, plates, weighing scales, water and Muslin cloth was sourced from the Department of Food Science and Technology, Imo State Polytechnic, Omuma

Production of starch from white yam tuber

Two kilogram (2kg) of fresh tubers white yam tuber was peeled, washed and then cut into small sizes of 2mm thickness. The sliced yams was soaked with sodium metabisulphite in sterile water (for 10mins) to prevent darkening and then milled into a fine paste using a attrition mill (Model Handel 326). The slurry was strained through a muslin cloth and the filtrate was left to settle. The supernatant was decanted at 12 h and 18h intervals and the starch slurry re-suspended in sterile water and dewatered. The starch cake was collected after 3 days and sun dried to obtain white yam starch. Flow chart of starch from white yam tuber is shown in figure 3.1 below.

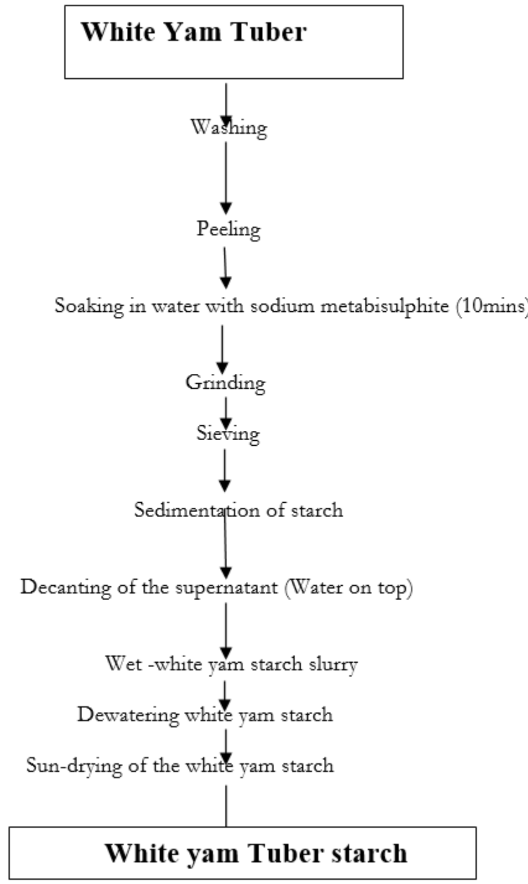

Figure 1: Flow chart for white yam starch production.

Production of starch from white Cassava variety (TME 419) tuber

One kilogram of fresh White Cassava variety (TME 419) tuber was peeled, washed and then cut into small sizes of 2mm thickness. The sliced cassava was soaked with sodium metabisulphite in sterile water (for 10mins) to prevent darkening and then milled into a fine paste using a attrition mill (Model Handel 326). The slurry was strained through a muslin cloth and the filtrate was left to settle. The supernatant was decanted at 12 h and 18h intervals and the starch slurry re-suspended in sterile water and dewatered. The starch cake was collected after 3 days and sun dried to obtain white cassava variety (TME 419) starch. Flow chart of starch from cassava variety (TME 419) is shown below.

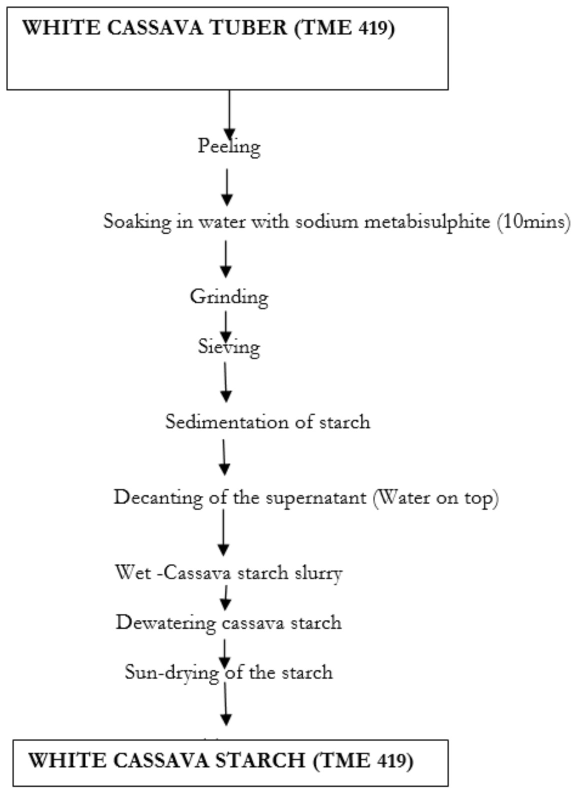

Figure 2: Flow chart for Cassava starch production.

III. SAMPLE ANALYSIS

Determination of paste characteristics of starch from the yam and cassava paste (AOAC, 2010) The paste characteristics of the starches was determined on an 20% slurry of the starch samples using a BrabenderVisco-amylograph (Viskograph-E, Brabender Instrument Inc., Duisburg, Germany) equipped with a 1000cmg sensitivity cartridge. The slurry was heated from 50 to 95 °C at a rate of 1.5 °C/min, held at this temperature for 15 min, cooled to 50 °C at a rate of 1.5 °C/min and held at this temperature for 15 min to determine pasting temperature, peak time, set back time, trough, breakdown viscosity, final velocity, pasting time and temperature.

Statistical Analysis
Data obtained from analysis was subjected to statistical analysis of variance (ANOVA) using SPSS version 21, with the mean values separated by Duncan's multiple range tests at 95% level of significance.

IV. RESULT AND DISCUSSION

Pasting characteristics of white yam tuber and cassava tuber starch.
Presented in Table 4.1 is pasting characteristics of yam and cassava starch. The pasting properties of the samples evaluated are peak velocity, trough, breakdown velocity, final velocity, set back velocity, pasting time and pasting temperature.

Peak velocity of the samples ranged from 7018.2 Rvu for cassava starch to 7622 Rvu for yam starch. Yam starch had the highest peak velocity. The high peak velocity of the sample (yam starch) indicates the ability of the sample to resist high frictional force during the flow of the sample. The high peak velocity is good a quality attribute of the yam starch.

Trough viscosity of the samples ranged from 2852Rvn for the sample Cassava starch flour to 3456Rvn for sample (yam starch). The trough velocities of the samples were significantly different at ($p \leq 0.05$). The high value of the yam starch in terms of trough velocity could be attributed to the sun drying method used. The trough velocity of a food sample is the minimum viscosity value in the constant temperature phase of RVA profile and measures the ability of paste to withstand breakdown during cooling.

Breakdown viscosity of the samples is an index of the stability of starch in a food material. Break down viscosity of the samples ranged from 3558Rvn for sample (cassava starch) to 4229 Rvn for sample yam starch.

Final velocity is the change in velocity after holding samples and it is the most commonly used parameter to define the quality of a particular starch or soup thickner. It is used as an indicator of the resistance of the paste to shear forces of the Ogbono samples (Adeyemi, 2018). Final velocity of the samples ranged from 3977Rvn for the sample cassava starch to 4377Rvn for the sample yam starch.

Set back value of the samples is a measure of recrystalization of gelatinizing flour (retrogradation) and is a function of amylose and amylopectin configuration. The lower set back value of cassava starch suggested that sample would be more stable to retrogradation. The set back of the samples ranged from 668Rvn for sample cassava starch to 988.20Rvn for the sample (yam starch). Set back value of a food sample is a measure of recrystalization of gelatinizing (retrogradation) and a function of amylose and amylopectin configuration. The lower set back value suggested that the sample would be more stable to retrogradation.

Pasting time of the samples ranged from 5.40 for sample (cassava starch) to 5.44 for the sample (yam starch).

Pasting time of a food sample gives an indication of the gelatinization time it takes for the starch present in a food material to form a paste. It is the time at which the first detectable increase in which viscosity is a measured and is an index characterized by initial change due to the swelling of starch. Pasting time has been reported to relate to water binding capacity of the starch in the food material and temperature of the water used. A higher pasting time implies low water binding capacity, low gelatinization and lower swelling property of starch due to low degree of association between starch granules in a food material. Pasting temperature of a food sample gives an indication of the gelatinization time during processing. It is the temperature at which the first detectable increase in which viscosity is a measured and is an index characterized by initial change due to the swelling of starch. Pasting temperature has been reported to relate to water binding capacity. A higher pasting temperature implies higher water binding capacity, higher gelatinization and lower swelling property of starch due to high degree of association between starch granules in the cassava and yam samples. Pasting temperature of the samples ranged from 70.20^{O}C for sample cassava starch to 74.20^{O}C for sample (Yam starch).

Table 1: Pasting characteristics of white yam and cassava tuber starch.

Samples	Peak velocity (Rvu)	Trough (Rvu)	Breakdown viscosity (Rvu)	Final Velocity (Rvu)	Set back (RuV)	Pasting Time(mins)	Pasting Temp(^{O}C)
CS	70.18^{b}+ 0.02	2852^{b} + 0.10	3558^{b}+0.12	3977^{b}+ 0.26	668^{b}+ 0.02	5.40^{a}+ 0.21	70.20^{b}+ 0.10
YS	7622^{a}+ 0.46	3456^{a}+ 0.46	4229^{a} + 0.42	4377^{a}+ 0.43	988.2^{a}+ 0.11	5.44^{a}+ 0.46	74.20^{a}+ 0.42
LSD	0.02634	0.4362	0.4266	0.0264	0.2434	0.6346	0.4334

Mean values having different superscripts along the same column are significantly different ($P \leq 0.05$).
Key
Sample CF = Cassava starch
Sample YS = Yam starch

V. CONCLUSION

The study on the comparative analysis of pasting characteristics from yam and cassava starches was evaluated. The pasting properties evaluated were peak velocity, trough, breakdown velocity, final velocity, set back, pasting time and pasting temperature revealed that yam starch had the highest value of pasting properties compared to white cassava starch(TME 419).

VI. RECOMMENDATION

From the study on the pasting properties sample YS (Yam starch) is recommended due to its high values on peak velocity, trough, break down velocity, final velocity, set back, pasting time and pasting temperature.

Yam starch could be diversified in the production of industrial products due to its high pasting properties.

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