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Pasting characteristics of plantain (*Balbisiana Hybrids*) and banana (*Musa acuminata*) starches

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ABSTRACT

The starch powdered samples were analyzed for their pasting characteristics using Rapid visco analyser (RVA). From the graph of viscosity versus time, the final viscosity of plantain starch (298.67Rvu) was higher than that of Banana starch (165.67Rvu). The higher viscosity recorded in plantain starch showed that there was re-association between the starch molecules which led to formation of gel and caused by not only simple kinetic effect of cooling but re-association of amylose. The hold period of plantain starch (141.75minutes) was higher than that of Banana starch (112.33minutes). The hold period is accomplished by a breakdown in viscosity. The breakdown of banana starch (29.42Rvu)was higher than that of protein (24.25Rvu). The high breakdown in viscosity of Banana starch will be of great usefulness industrially. The peak viscosity of plantain (116.00Rvu) was higher than that of Banana starch (141.75Rvu). The high peak viscosity in plantain showed that the starch formed a paste on cooling at pasting temperature of 94.5^{0}C.

Keywords: Plantain, Banana, Viscosity, hold period, breakdown, peak viscosity.

INTRODUCTION

Banana *(Musa acuminate)*
Bananas are cultivated in nearly all tropical regions of the world. Of particular importance to Africa is the East African Highland Banana (EAHB) which is a staple starchy food for 80 million people and important source of income. There are 120 EAHB varieties in Uganda alone that are not found anywhere else in the world.[1].

Plantain *(balbisiana* hybrids)
Plantain resemble banana but are longer in length, have a thicker skin, and contain more starch. They are also a major staple food in Africa, Latin America, and Asia. They are usually cooked and not eaten raw unless they are very ripe. Plantains are more important in the humid lowlands of West and Central Africa. One hundred or more different varieties of plantain grow deep in the African rainforest [1].

Production:
More than 100 million tons of banana and plantain were produced worldwide in 2007 according to FAO estimates. Banana are grown in nearly 130 countries. Uganda is the largest producer of banana and plantain in sub-Saharan

Africa (SSA), followed by Rwanda, Ghana, Nigeria, and Cameroon. Banana and plantain are cultivated in a wide variety of environments. Plants produce fruit year round, can produce for up to one hundred years and are suitable for intercropping. Vegetative propagation is necessary because they rarely produce seeds and those are not true to variety.[1]

Harvesting:
In 2007 more than 9.9 million hectares of banana and plantain were harvested worldwide. Where marketed across longer distances, post-harvest plantain losses are heavy due to poor handling and transport conditions and inadequate market access routes.

Importance:
Banana and plantain are important staple foods in many developing countries, especially in Africa. Of the numerous edible varieties, the EAHB accounts for 17% of the types of Musa grown worldwide, and plantain accounts for another 19%. They provide food security and income for small-scale farmers who represent the majority of producers. Only about 15% of the global banana and plantain production is involved in international trade; most production is consumed domestically. Banana starch, flour, and chips are processed banana products whose markets are yet to be fully developed. [1]

Consumption:
Africans annually consume 21 kg of banana and plantain per capita, but Ugandans consume 191 kg per year, or more than half of one kg per day. In fact, Ugandans use the same word for food as the name of the local banana dish *matooke*. Four African countries have the highest per capita consumption of banana/plantain in the world, with Uganda having the highest.

Nutritional Value and Uses:
Banana fruit is composed mainly of water (around 65 percent for banana and 75 percent for plantain) and carbohydrate (from 22 percent for banana and 32 percent for plantain).[2]. It contains several vitamins, including A, B, and C, and is very low in protein and fat but rich in minerals, particularly potassium (around 400 mg/100 g). It is cholesterol free, high in fiber, and low in sodium. Chemical composition varies not only among cultivars but also according to climatic and other conditions [2]

Ripe fruit is usually consumed fresh and eaten as a snack or dessert, in salads mixed with other fruit, and with breakfast cereal, but it also lends itself to more elaborate dishes ranging from ice cream to pie fillings.

Plantains, being starchier than bananas, can be eaten ripe or unripe, but many countries have developed commercial processes to provide a wide variety of products from both fruits (in several cases, green bananas can also be used): puree, flour, chips, crisps, flakes, dried, relishes or spreads, preserves, and even wine. Banana flour, both from green and ripe fruit, has a great industrial potential and, with sugar, powdered milk, minerals and vitamins, and artificial flavouring, is much used in baby foods. [2]

A plantain and soybean mixture, soyamusa, combining carbohydrates and proteins, has been recently developed in Nigeria to be used as a weaning food for toddlers. Bananas and plantains represent more than 25 percent of the food energy requirements of Africa [3].

Medicinal values:
The easy digestibility and nutritional content make ripe banana an excellent food, particularly suitable for young children and elderly people. In the green stage (and after liquefying) it is used in Brazil to treat dehydration in infants, as the tannins in the fruit tend to protect the lining of the intestinal tract against further loss of liquids. In general, the banana is appropriate for consumption when a low-fat, low-sodium, and/or cholesterol-free diet is required, making it particularly recommendable for people with cardiovascular and kidney problems, arthritis, gout, or gastrointestinal ulcers [2]. Both bananas and plantains contain complex carbohydrates capable of replacing glycogen and important vitamins, particularly B_6 and C, and minerals (potassium, calcium, magnesium, and iron). Ripe fruit has been used to treat asthma and bronchitis, and, as mentioned, in the control of diarrhoea. Boiled and mashed ripe fruit, especially when mixed with other appropriate plants, is also cited as a good remedy against constipation.[2]

A lot of research work has been done on the plantain and banana, but the pasting characteristic of them have not been investigated. Hence the objective of this experiment is to determine the pasting characteristics of plantain *(balbisiana* hybrids) and banana*(Musa acuminate)* starch flour in order to know if the pasting properties of the starch can be a determinant of textural quality in food product.

MATERIALS AND METHODS

The two samples were obtained from oja-oba (kings market) in Akure, Ondo state, they were Peeled, sun dried and grinded into powder for the extraction of their starch.

Starch Isolation:
The method of [4] was used for the isolation of starch from the sample flours .Each sample flour was extracted using soxhlet extractor with a mixture of Hexane, Trichloromethane and Methanol (1:2:1v/v/v) as solvent at reflux temperature. The crude starch was recovered when the defatted flour was steeped in water containing $HgCl_2$ (100ppm) for 16 hours at room temperature and macerated in a blender. The crude starch granules were separated by filtration through 150- 200mm mesh sieves and centrifuged at 5000 rpm for 10 minutes.

The crude starch granules were purified by treating with NaOH (0.1ml at room temperature) and 0.1M Nacl-toluene ,after each treatment the granules were sedimented by centrifugation and the sediment were washed thoroughly with water. The final sediment was further washed twice with methanol and air dried.

Rheological Analysis:
Pasting characteristics were determined with a Rapid Visco Analyze (RVA)[5]
This method was used as an alternative to Brabender Amylograph which was confirmed by[6]. 2.5g samples were weighed into a dried empty canister; 25ml of distilled water was dispensed into the canister containing the sample. The solution was mixed and the canister was well fitted into the RVA, as recommended. The slurry was heated from 50oc with 2 minutes holding time. The rate of heating and cooling were at a constant rate of 11.25^{o}C/minutes. Peak viscosity, trough, breakdown, final viscosity, setback, peak time and pasting temperature were read from the pasting profile with the aid of thermocline for windows software connected to a compute [5].

Fig 1. Diagram of Rapid visco analyser (RVA).

RESULTS AND DISCUSSION

From the table of results, the pasting temperature of plantain (94.50^{0}C) was lower than that of Banana (94.55^{0}C). The peak time taken to reach pasting temperature of Banana starch was 5.20m was lower than that of plantain starch (5.8). The pasting temperature of plantain which was lower than that of Banana indicated that lower temperature is needed for the sample to get cooked. The peak viscosity of plantain (166.00) was higher than that of Banana starch

(141.75). The peak viscosity is a measure of the ability of starch to form a paste on cooking. Peak viscosity occurs at equilibrium between granule swelling which increases viscosity and granule rupture and alignment, which cause its decrease. Viscosity rises only slowing and remained comparatively low. [1]. The high peak viscosity recorded in plantain (166.00) showed that the starch formed a paste on cooking having a pasting temperature of 94.50 ^{0}C.

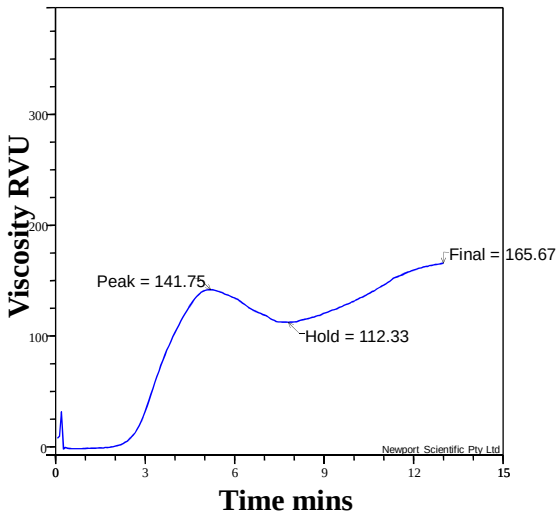
The hold period of plantain starch (141.75) was higher than that of Banana starch (112.33). The holding strength is the ability of the granules to remain undisrupted when the starch was subjected to a hold period of constant high temperature (95^{0}C for 2 minutes 30 seconds) and mechanical shear stress. This hold period is often accompanied by a breakdown in viscosity. The breakdown of Banana starch (29.42) was higher than that of plantain (24.25). It indicated the ability of the paste to breakdown during cooking. The ability of a starch to withstand this shear thinning or breakdown in viscosity (that is high breakdown value) is of high industrial significance in starches.[1] Thus the starch of Banana with high breakdown viscosity (29.42) will be of great usefulness industrially. The final viscosity of plantain starch (298.67Rvu) was higher than that of Banana starch (165.67Rvu).

On cooling of the starch there was re-association between the starch molecules and this occur to a greater or looser degree when there is sufficient concentration, it caused the formation of a gel and this was indicated by increase in viscosity called final viscosity.

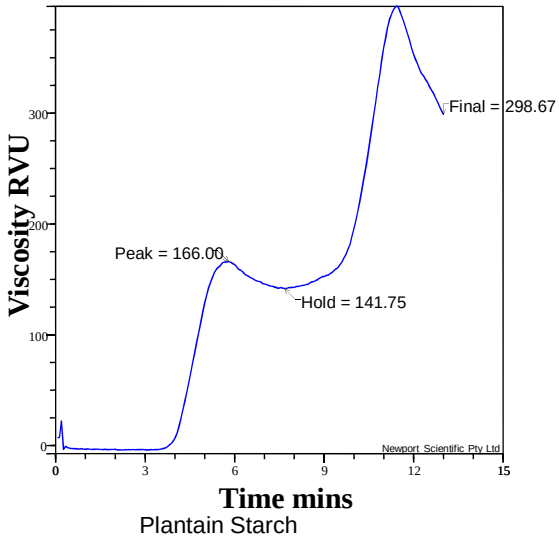
The higher viscosity recorded in plantain (298.67Rvu) showed that there was re-association between the starch molecules which resulted into the formation of a gel. This high value of final viscosity in plantain starch (298.67) was not only caused by simple kinetic effect of cooling but by re-association of amylose molecules [7]. Thus, final viscosity is an important parameter in predicting and defining the final textural quality of foods, [7]. [8] and [9] have reported the use of starches with high viscosity value in pharmaceutical companies especially, as tablet binders. Starches of plantain starch (298.67Rvu) can be found applicable in pharmaceutical industries.

The set back of Banana starch (53.33) was lower than that of plantain starch (156.92). This is the phase of the phase of the pasting curve after cooling of the starches (cooling to 50^{0}C) and this stage involve re-association, retro gradation of starch molecules. It indicated the tendency of the starch to associate and retrograde. The high set back of plantain (156.92) was associated with a cohesive paste while a low value of Banana starch (53.33) indicated that the paste was not cohesive [1].High setbacks value is useful for domestic products.

Graph of viscosity versus time of Banana and Plantain.



Banana stach



Pasting characteristics	Peak 1	Trough 1	Breakdown	Final Visc	Setback	Peak Time	Pasting Temp
Banana	**141.75**	**112.33**	**29.42**	**165.67**	**53.33**	**5.20**	**94.55**
Plantain	**166.00**	**141.75**	**24.25**	**298.67**	**156.92**	**5.80**	**94.50**

CONCLUSION

It can be inferred that the starch of Plantain can be very useful in the formulation of food component parts and as a stabilizers, tablet binders in pharmaceutical companies because of the high value of final viscosity.

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