Effect of Chemical Modifications on Pasting Properties of Cocoyam Starch (Xanthosoma Sagittifollium)

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Abstract
The present study investigated the effect of chemical modifications on pasting properties of starch isolated from Cocoyam chemically modified to produce oxidized starch. The objective of chemical modification was to tailor and improve the native properties of Cocoyam starch so that it could be used in wide variety of food products. The chemicals used for oxidation is sodium hypochlorite (NaOCl). The pasting characteristics of native and modified (oxidized) cocoyam were analyzed using Rapid Visco Analyser (RVA). The peak viscosity of native cocoyam (304.7^{0}C) was reduced after oxidation (290.5^{0}C). The trough of native cocoyam (164.9Bu) was increased after oxidation (176.0Bu). The pasting value of native Cocoyam (4.52mins) reduced after Oxidation (4.50mins). The setback value for the native cocoyam (88.42) was reduced after oxidation (87.92).The pasting temperature of native cocoyam (79.65^{0}C) was significantly reduced after oxidation(78.35^{0}C). The FT-IR showed that the native cocoyam showed hydroxyl peak around 3492.24cm^{-1}. On oxidation, the FT-IR spectrum showed a new peak around 1641.48cm^{-1} for carbonyl group.
Keywords: cocoyam modified , native starches, pasting properties, RVA, Ft-Ir, carbonyl group.

Introduction

Cocoyam is an important source of carbohydrate in Tropical Africa. In Nigeria, the corms are usually eaten boiled, mashed or sometimes pounded, frequently mixed with other staples,such as yam or plantain. The source of Cocoyam varies all over the world and it depends on the tradition and prevalent climatic conditions. The high carbohydrate content of cocoyam and its wide availability makes it very good source of starch for both domestic and industrial uses in Nigeria and Tropical Africa. Applications of starch in food systems are primarily governed by gelation,gelatinization,pasting,solubility swelling, colour and digestibility (Adebowale and Lawal, 2002b).Depending on the end use, one or more of the above particularly detrimental properties are often subjected to suitable chemical modifications through degradation,substitution,or crossbonding (Wang and Wang, 2001). Cocoyam is a tropical starchy tuberous root crop. There are many varieties of cocoyam but the most common are the soft variety used mainly as soup thickeners and the yam-like variety that can be boiled in a short time and eaten with pepper sauce.The soft variety is used mainly as a thickener in some Nigerian soup recipes which include: Bitter leaf which is a very traditional soup recipe, native to the eastern part of Nigeria.

Starch is a white, granular, organic chemical that is produced by all green plants. Starch is a soft, white, tasteless powder that is insoluble in cold water, alcohol, or other solvents. The basic chemical formula of the starch molecule is $(C_6 H_{10} O_5)_n$ where n is the number of molecules. starch is manufactured in green leaves of plants from excess glucose produced during photosynthesis and serves the plant as a reserve supply. Starch is stored in chloroplast in the form of granules and in such organs as the roots of the cassava plant, the tuber of the potato, to stem pith of sago and the seeds of corn, wheat and rice from where most commercial starch are made (smith, 2001). When required, starch is broken down, in the presence of certain enzymes and water, into its constituent monomer glucose units, which diffuse from the cell to nourish the plant tissues. In humans and other animals, starch is broken down into its constituent sugar molecules, which then supply energy to the tissues (Revedin *et al.,* 2010). Starch is a mixture of two polysaccharides (glucans) the smaller of the two, amylose, is essentially a linear polymer composed of α-D-anhydroxyglucopyranose units linked (1 – 4). The larger is amylopection which contains α (1 – 4) linkages and α (1 – 6) branch points starch is a major storage component of most economically important crops like cereals, legumes and tubers (e.g. corn, oat, lentil, yam, etc) Vasanthan, (2001). It is one of the most abundant renewable raw materials (third only to cellulose and vegetable oil) and can easily be recovered from plant organs (Brown and Poon, 2005). It is also relatively inexpensive and can readily be converted through chemical, physical and biological means into useful products of industrial importance (Madigan, 2011).

Starch is used for both food and non-food application for example, starch is used as binders, fillers, disintegrants and lubricants in tablet formulations (Odeku and Itiola, 2007). It is also used as flocculants in the purification of water and in waste water treatment (Marton, 2003). It can also be applied in the production of supper-adsorbent products, called super slurper that are used in making disposable nappies and diapers, incontinent pads, bandages, hospital bed pads and sanitary napkins (Madigan, 2011). Also starch is used as fillers in bioplastics, in textiles, cosmetics, agrochemcials, construction, etc (Rocher, 2003; Madigan, 2011).

At present, the world's major sources of starch are edible such as wheat, rice, maize, yam, cassava and potato (Vande *et al;* 2002). There are numerous alternatives currently being explored for commercial quantification of starch for the production of industrial and pharmaceutical products (Madigan, 2011). The sources include many seeds and some other parts of plants usually considered as non-edible though researchers have shown that they contain starch and could be a good source of starch of commercial quantity (John, 2010).

Materials and Methods.

Starch Isolation

The washed Cocoyam were cut into small tubes and homogenized in warring blender for about two minutes at the speed setting available. The resultant slurry was packed into a muslin cloth and lowered into distilled water inside a bucket. The cloth was held at the ends and the contents were continuously squeezed to expel the starch into the water. The starch was allowed to settle overnight and the supernatant decanted off. Further rinsing of the starch with water, setting of the starch granules and decantation of the supernatant removed soluble impurities. This process was repeated till the supernatant was clear. The wet starch was spread on trays and allowed to air dry till the following day.

Starch modification

The extracted starch was chemically modified by oxidation method. The method of forssel *et al.,* (1995) was employed with modifications for oxidation of cocoyam starch. Slurry of starch was prepared by dispersing 100g of starch in 500ml of distilled water. The pH was adjusted to 9.5 with 2M NaOH. Ten grams of NaOCl was added to the slurry over a period of 30 mins, while maintaining a pH range 9.0 – 9.5, with constant stirring at 30^{+}-2^{0}C. The reaction proceeded for 10 mins after addition of NaOCl. After the reaction, the pH was adjusted to 7 with H_2SO_4 and the oxidize starch was filtered, washed four times with distilled water and air-dried for 48 hrs.

Infrared Spectroscopic Analysis

FT-IR spectra of the native cocoyam and oxidized cocoyam starch were obtained using shimadzu Model FTIR – 8201PC. The infrared spectral analysis was done to determine the functional groups responsible for the oxidation.

Pasting properties

Pasting characteristics like pasting temperature, time to reach peak viscosity, peak viscosity, setback viscosity of native and modified Cocoyam starches were determined with a Rapid Visco Analyzer (RVA). (Model RVA 3D+, Network Scientific, Australia); the flour (2.5g) sample were weighed into a dried empty canister; 25ml of distilled water was dispensed into the canister containing the sample. The solution was thoroughly mixed and the canister was well filled into the RVA as recommended. The slurry was heated from 50^{0}C to 95^{0}C with a holding time of 2 minutes followed by cooling to 50^{0}C with 2mins holding time. The rate of heating and cooling were at constant rate of 11.25^{0}C/mins. 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 computer (Newport Scientific, 1998).

Results

Table 1.1 : FT-IR data of native and oxidized Cocoyam starch.

Type of starch	Frequency (cm^{-1})	Type of bond
Native Cocoyam	3492.24	O-H (Hydroxyl)
Oxidized Cocoyam	1641.48	C=O (Carbonyl)

Table 1.2 : Pasting properties of native and oxidized starches from cocoyam.

Type of starch	Peak (BU)	Trough (BU)	Break down(BU)	Final viscosity(BU)	Set back (BU)	Peak time(mins)	Pasting temperature (o^{C})
Native	304.67	164.92	139.75	253.33	88.42	4.52	79.65
Oxidized	290.50	176.00	114.50	263.92	87.92	4.50	78.35

Fig : 1.1 FT-IR analysis result of native cocoyam starch.

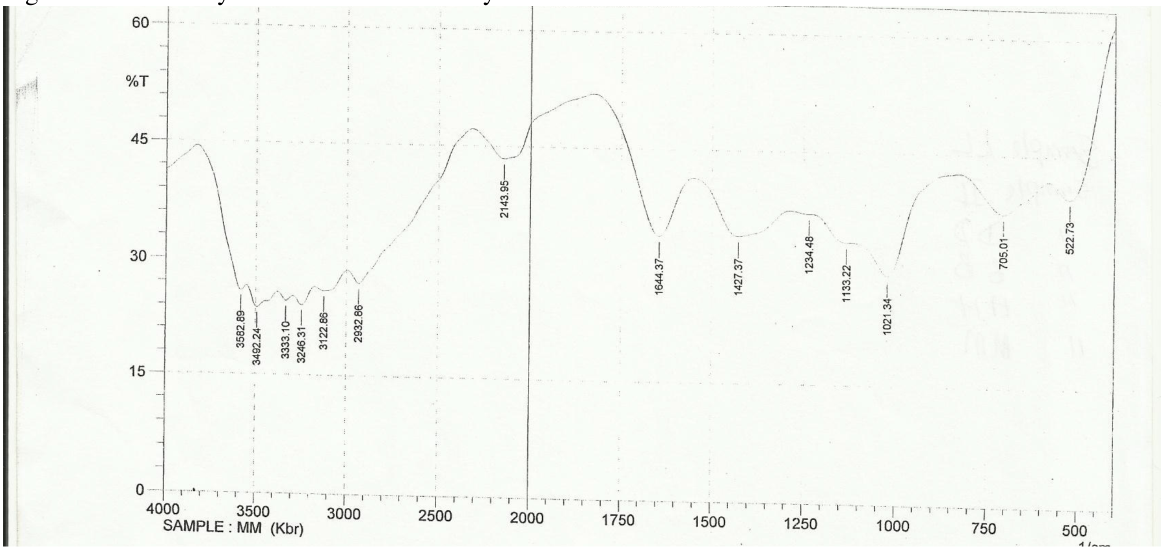
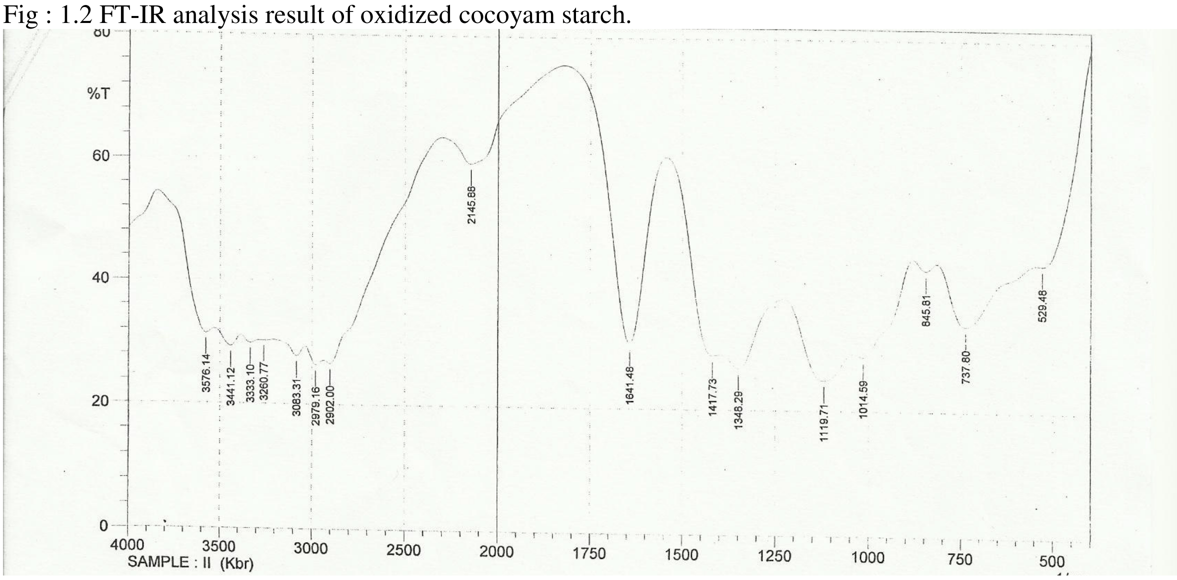


Fig : 1.2 FT-IR analysis result of oxidized cocoyam starch.



DISCUSSION

FT-IR spectra

The FT-IR data of native and oxidized Cocoyam are shown in table 1.1.The native cocoyam showed hydroxyl peak around 3492.24cm. On oxidation, the FT-IR spectrum showed a new peak around 1641.48cm for carbonyl group.

Pasting properties

The pasting characteristic of native and modified Cocoyam were analyzed using Rapid Visco Analyser (RVA). The peak viscosity of oxidized cocoyam (290.5^{0}C) and cocoyam (157.3^{0}C) was lower than that of native cocoyam (304.7^{0}C) this result agrees with the previous reports (Potze and Heimslry,1963; Hebeish et al.,1989; Adebowale *et al.,* 2002). The observed decrease could be attributed to the partial cleavage of the glucosidic linkages due to extensive oxidation. The partially degraded network was not resistant to shear, hence could not maintain the integrity of the starch granule which therefore resulted in lower viscosity. The trough of native cocoyam (164.9Bu) decreased after increased after oxidation (176.0Bu). The result indicated that the oxidized Cocoyam have the ability to withstand breakdown during cooling than the native. The setback value for the native cocoyam (88.42) was reduced after oxidation (87.92), according to Deman (1976), staling of bread is a function of retrogradation (setback) that is association of the linear amylose molecules. Cocoyam when modified (oxidized) can be used as a thickening agent or as stabilizer (Sanderson, 1981). The acetylated Cocoyam (4.58mins) has the highest pasting time (4.58mins) followed by The pasting time of native Cocoyam

(4.52mins) reduced after Oxidation. (4.50mins) which suggest that deformation of the starch granules occurs easily in oxidized Cocoyam.

Conclusion

The modified starch which has better functional properties than the native starch showed that the modified starch is a good candidate in starch processing and pharmaceutical industries. Also it could be used in food formulation.

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