

Full Length Research Paper

Investigation on modification of cassava starch using active components of ginger roots (*Zingiber officinale* Roscoe)

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Effects of ginger grates at concentrations of 1, 5 and 20 g per 150 g of cassava starch suspension in 200 ml of water at room temperature were investigated in order to evaluate the potentials of active components of the ginger in modifying pasting and some physicochemical properties of the starch. Pasting properties of the ginger modified cassava starch showed high peak viscosities (487.58 - 420.25 RVU) compared to low peak viscosity (392.33 RVU) of the native starch. The modified starch was characterized with low set back viscosities (64.14 - 57.05 RVU) in relation to native starch with high set back viscosity (66.58 RVU). Similarly, the ginger modified starch was characterized with low gelatinization time (3.45 - 3.36 min) compared to the native starch with high gelatinization time (3.5 min). Ginger modified starch showed high swelling power (12.9 - 9.5) and solubility indices (11.3 - 15.6%) compared to native starch with low swelling power (8.9) and solubility index (3.1%). Therefore active components of ginger root can be used as natural modifying agents for cassava starch.

Key words: Cassava starch, ginger root, modification, pasting properties.

INTRODUCTION

Native starches, irrespective of their source, are undesirable for many applications (Wang et al., 1993) because of their inability to withstand processing conditions such as extreme temperature, diverse pH, high shear rate and freeze-thaw variation. In order to improve on desirable functional properties, native starches are often modified. Modified starches have wide applications as binders, fillers, emulsion stabilizers, consistency modifiers and adhesives.

Nigeria is the world largest producer of cassava and cassava is the most economic source of starch in the country. Therefore, it is prudent that cassava starch should be focus for modification. Starch modification can be broadly grouped into four classes namely: physical, chemical, enzymic and biological modifications (James and West, 1997). Among these modification methods, chemical means is the most frequently used process.

There are legislative restrictions on the use of new synthetic chemicals for modifying starch while the use of higher concentrations of existing ones are banned (James and West, 1997). The prohibition is for consumer and worker safety, environmental concern and economic reasons. As a result, prudence dictates that attention should be shifted towards using active components of natural products especially those that man has been eaten for thousands of years to modify starch. Active components in Ginger root are examples of such natural products. Consequently, the objectives of this investigation were: (1) Preparation of modified cassava starch at room temperature using ginger grates. (2) Determination of pasting properties of the ginger modified starch.

MATERIALS AND METHODS

Raw materials

Cassava roots of clone TME 30572, aged thirteen months at harvest were obtained from Igbira farm in the premises of Federal Polytechnic, Ado-Ekiti, Nigeria. The roots were improved variety

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(low cyanide and high yield). Ginger was purchased from local market in Ado-Ekiti.

Cassava native starch was produced according to classical method described by Osunsami (1987).



Figure 1. Flow chart for the preparation of ginger modified cassava starch.

Preparation of ginger modified cassava starch

Ginger root was cleaned and peeled using knife. The peeled roots were grated. Ginger grates were mixed with starch-water suspension and stirred periodically for 30 min at room temperature. Ginger grates were sieved out and starch milk obtained was washed and the water removed using suction pump. The starch obtained was dried using air oven and milled to obtain ginger modified starch (Figure 1).

Methods of analysis

Proximate composition of samples were determined according to the methods of AOAC (1980) with analytical codex number 14.062, 14.064, 14.066 and 14.067 for moisture, total ash, total crude fibre, crude fat and total crude protein, respectively. Carbohydrate was obtained by difference. All results were the average of duplicate analyses.

Determination of pasting properties

Starch treated with ginger was characterized using Rapid Visco Analyser (RVA) as described by Delcour et al. (2000). 5 g of accu-

rately weighed treated starch was added into water to obtain a ratio 1:2 (w/w). The treated starch heated from 28°C to 150°C at 4°C/min and all experiments were carried out in triplicate. The RVA-3d was operated with 250 g of 9.9% treated starch in water suspension. The temperature profile included a 2 min isothermal step at 50°C, linear temperature increases to 95°C in 7 min, a holding step (8 min at 95°C), a cooling step (7 min) with a linear temperature decrease to 50°C and a final isothermal step at 50°C. Duplicate measurement always agreed within 5 rapid visco units over the whole profile. Viscosities of technological importance were identified and values determined.

Determination of swelling power

This was determined in accordance with the method described by Leach et al. (1959) with modification for small samples. A sample of 0.1 g was weighed into a weighed test tube into which 10 ml of distilled water added and heated in a water bath at temperature of 60°C for 30 min. This was continually shaken within the heating period. At the end, the test-tube was centrifuge at 1000 x g for 15min in order to facilitate the removal of the supernatant, which was carefully decanted and the weight of the starch paste taken. Swelling power was calculated as follows:

$$\text{Swelling power} = \frac{\text{Weight of starch paste}}{\text{Weight of dry starch sample}}$$

Determination of solubility index

Solubility index was evaluated by weighing 1 g of starch in 20 ml of distilled water in a test tube. This was subjected to heating in water bath at a temperature of 60°C for 30 min because there was no appreciable solubility at ambient temperature. At the end of heating, it was subjected to centrifugation at 1200 x g for 20 min and 10 ml of the supernatant was decanted and dried to constant weight and the solubility was expressed as the percent by weight of dissolved starch from a heated solution (Kainuma et al., 1967).

RESULTS AND DISCUSSION

Proximate composition

Proximate composition of the native cassava starch was: fat, 0.08%; protein, 0.57%; ash, 0.50%; moisture, 11.9%; and carbohydrate, 85.95%. These findings are in agreement with the earlier report of Agboola et al. (1990).

Pasting properties

Pasting spectral and pasting values of technological importance of ginger modified and native cassava starches as extrapolated from pasting curves are presented in Figure 2 and Table 1, respectively. Generally, starch treated with ginger grate showed high peak viscosities (489.58 - 420.25 RVU) compared to low viscosity (392.33 RVU) of the native starch. Ginger modi-

Table 1. Pasting characteristics of native cassava starch and ginger-modified cassava starch.

Sample	Peak viscosity (RVU)	Final viscosity (RVU)	Set back viscosity (RVU)	Peak time (min)	Pasting temp (°C)
A*	392.33	217.58	66.58	3.55	63.90
B	434.83	240.08	59.08	3.36	64.90
C	487.58	257.25	57.50	3.42	65.20
D	424.50	217.58	60.83	3.45	64.90
E	420.25	217.75	64.17	3.45	65.05

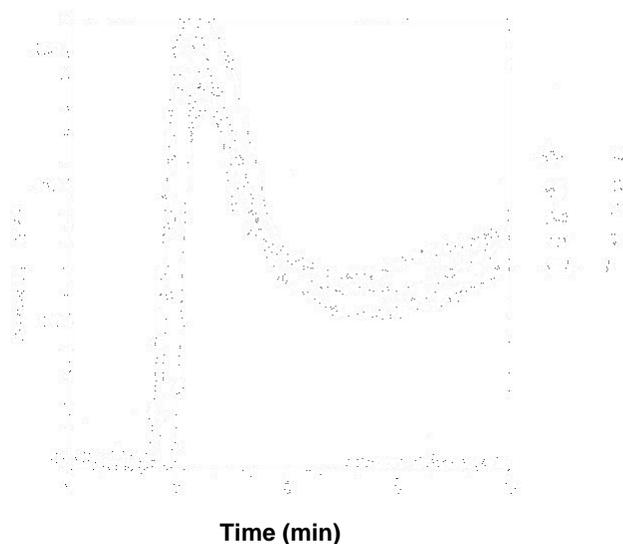


Figure 2. Rapid visco-analysis of native cassava starch (A) and cassava starch modified with 1, 5, 10 and 20 g of ginger (B, C, D and E).

- A. Native cassava starch.
- B. Cassava starch modified with 1 g of ginger.
- C. Cassava starch modified with 5 g of ginger.
- D. Cassava starch modified with 10 g of ginger.
- E. Cassava starch modified with 20 g of ginger.

Table 2. Some physical characteristics of native cassava starch and ginger-modified cassava starch.

Sample	Solubility (%)	Swelling power
A*	3.1	8.9
B	12.7	9.5
C	15.6	10.5
D	14.2	10.7
E	11.3	12.9

*Native cassava starch (A) and cassava starch modified with 1, 5, 10 and 20 g of ginger (B, C, D and E).

fied starch with 5 g concentration has the highest peak viscosity (487.58 RVU) which implied the sample with highest water-binding potential. High peak viscosities of

ginger modified cassava starches in comparisons to the native starch suggest cross linkage of starch molecules by active components of the ginger root. Cross-linked starch is more resistant to loss of viscosity at low pH values than are other kinds of starch. This resistance makes it a useful bodying agent for acid fruit fillings in which the pH is often adjusted to a range of 3 - 4 (Stauffer, 1990).

Native cassava starch has high set back viscosity (66.58 RVU) compared to ginger modified starch with low range of set back viscosities (57.50 - 64.17 RVU). Product of modification effected by 5 g of grate showed lowest set back viscosity (57.50 RVU) from the peak. This reflects the stability of the cooked paste against retrogradation (Mazurs et al., 1957). The high but stable viscosities of ginger modified starch suggest that it can be used in products such as pie-filling where good thickening and stabilities are required. The peak viscosity time of ginger modified starch ranged from 3.36 to 3.45 min as against 3.55 min for the native starch. Cooking time has energy- cost implication. Ginger modified cassava starches were characterized with high gelatinization temperature range (64.90 – 65.20°C) in relation to low gelatinization temperature (63.90°C) of the native starch (Table 1). Starch that has been modified to cook at higher temperature can be useful in canning process where gelatinization at elevated temperature will facilitate quick heat penetration while the canned content remains fluid especially in the early heating stages. This property, allow sterilization to occur in a shortened time without significant loss in organoleptic and nutritional qualities of the product.

Solubility index

Solubility of ginger modified and native starch is shown in Table 2. The ginger modified starches were insoluble in water at room temperature and as a result, solubility was determined at a temperature of 60°C. The solubility in percentage of the ginger modified starch were higher than that of the native starch (Table 2) with cassava starch modified using 5 g of ginger grate having the highest solubility index of 15.6%. High solubility of the modified starch signifies improve digestibility.

Swelling power

Similarly, swelling power (12.9 - 9.5) of ginger modified starch was higher than that of the native starch with 8.9 swelling power. The swelling power increases as the quantity of ginger added increases. Swelling power is a measure of hydration capacity, because the determination is a weight measure of swollen starch granules and their occluded water. Food eating quality is often connected with retention of water in the swollen starch granules (Rickard et al., 1992).

Both pasting and physical properties examined indicate that the nature of modification effected by active components of ginger is cross-linking. This could be due to the bi-functional entities containing an activated double bond as well as hydroxyl/methoxy phenyl residues (Stauffer, 1990) present in active ginger components such as gingerol, dehydroginger-dione and shogaol (Kikuzaki and Nakatani, 1993).

Conclusions

Active components of ginger could be used to modify cassava starch at room temperature by the slurry method. The different quantities of ginger grates used affect the extent of modification. Modification under the conditions employed in this study gave starch with high but stable viscosity. In addition, the modified starches were characterized with high swelling power, which influence texture, a determining factor in consumer acceptance of some foods and improved solubility that depicts enhanced digestibility. As a result the modified starch can be applied where such properties are desired.

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