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Comparative Study of Pasting Properties of High Fibre Plantain Based Flour Intended for Diabetic Food (Fufu)

C. C. Okafor and E. E. Ugwu

***Abstract*—**A comparative study on the feasibility of producing instant high fibre plantain flour for diabetic fufu by blending soy residence with different plantain (*Musa* spp) varieties (Horn, false Horn and French), all sieved at 60 mesh, mixed in ratio of 60:40 was analyzed for their passing properties using standard analytical method. Results show that $VIIIS_{60}$ had the highest peak viscosity (303.75 RVU), Trough value (182.08 RVU), final viscosity (284.50 RVU), and lowest in breakdown viscosity (79.58 RVU), set back value (88.17 RVU), peak time (4.36min), pasting temperature (81.18°C) and differed significantly ($p < 0.05$) from other samples. VIS_{60} had the lowest in peak viscosity (192.25 RVU), Trough value (112.67 RVU), final viscosity (211.92 RVU), but highest in breakdown viscosity (121.61 RVU), peak time (4.66min) pasting temperature (82.35°C), and differed significantly ($p < 0.05$), from other samples. $VIIS_{60}$ had the medium peak viscosity (236.67 RVU), Trough value (116.58 RVU), Break down viscosity (120:08 RVU), set back viscosity (167.92 RVU), peak time (4.39min), pasting temp (81.44°C) and differed significantly ($p < 0.05$) from other samples. High final viscosity and low set back values of the French variety with soy residue blended at 60 mesh particle size recommends this french variety and fibre composition as optimum for production of instant plantain soy residue flour blend for production of diabetic fufu.

***Keywords*—**Plantain, soy residue pasting properties particle size.

I. Introduction

PLANTAIN (*Musa* spp.) is fruit in the botanical sense but serves function as roots and tubers, when consumed unripened. It is a major starchy staple in the local food economies of sub-Saharan Africa, when consumed in large quantities, there by producing more than 25% of the carbohydrates and 10% of the daily calorie intake for more than 70 million people in the continent [1], plantain alone total accounts for nearly one quarter of the total world production of banana and plantain, while about 50% of this production is from Africa [2]. The bulk carbohydrate of unripe plantain is made up of starch and it is this bulk starch that gave plantain edged over other carbohydrate foods to be used as a diabetic food [3]. Plantain still contains non polysaccharides that are fibre, but this fibre is small in plantain, so there is need for additional source of fibre, in other to make plantain possible, for the production of high fibre food to be used by the diabetics. Diabetes Mellitus is a disease in which sugar concentrations is high in urine [4]. This is due to elevated level of sugar glucose in the body which is the main source of energy for cellular function in the body. It is a chronic disease conduction characterized by a blood glucose level in excess of 180mg per $100cm^3$ of blood [5]. This result is in the excretion of glucose in the urine as a result of disorder in the production or functioning of hormone insulin. Food needed for this group of people is a high fibre food which is high in fibre and low in calories. Plantain and fibre processing could offer means of adding value to the crop, while extending the shelf life, expanding the market, and facilitating transportation. Processing also improves product palatability, reduces cyanide content of soy residue product and facilities fortification with other food products. Ogazi [6] early reported on the profitability of plantain flour production where the top of the range of returns was estimated at 64%. Nutritional awareness has made people to seek for high fibre food which is the way out of this disease. As fibre has been credited for promoting increased excretion of bile acids, sterols and fats, the accumulation of this has been implicated in the etiology of certain ailments. The bulking effect of fibre in the diet, especially, effects on stool volume, softness, frequency and regularity of elimination are thought to be the results of high water binding capacity of fibre [7]. As a result, this new project was articulated to select the best plantain variety combination with the fibre source for the fufu production.

C. C. Okafor is with the Department of Food Technology, Institute of Management and Technology (I. M. T) Enugu, Enugu State, Nigeria (e-mail: kateschinyere@yahoo.com).
E. E. Ugwu is with the Department of Food Technology, Institute of Management and Technology (I. M. T) Enugu, Enugu State, Nigeria.

II. Materials and Methods

A. Materials

Three varieties of unripe plantain (Horn, false horn and French) cooled VI, VII and VIII respectively together with soy residue (S) were also investigated in this study. The above samples were obtained from the New Market, Enugu State, Nigeria, and the experimental station is Institute of Management and Technology, Enugu, located on latitude of 65000^0N and longitude 7500^0E of Enugu.

B. Methods

Flour was produced using the method describes by Adeniji et al [9] and Oluwole et al. [8]. Bunches were de-handed and individual fruits de-fingered from the hands. Five fingers of each of these three varieties (Horn, falsehorn and French) of plantain were washed separately, to remove dirt and latex which exuded from the cut surface of the crown and allowed to remain in water. These five fingers of each variety were then peeled, sliced into 3mm thick, manually with the aid of stainless steel kitchen knife, steam bleached at 800C for 5 minutes, then dried in Forced-Air moisture extraction plus 11 oven, Sayo Gallenkamp Plc, United Kingdom at 650C for 48 hours. Milling was carried out using a Retch Muhle, 2850 RPH Hammer Mill, resulting in flour with fine particle sizes, thus sieved with 60mm mesh sieve to get flour with 60mm particular size.

Again flour from soy residue was produced using the method described by Ihekonye and Ngoddy [10]. Soy bean was sorted, washed in clean pure water, boiled for 15 minutes at 100^0C, boiled water decanted, soaked in water for 24 hours, washed, wet milled with Retch Mutle, 2850 RPH Hammer mill, sieved with Muslim cloth, chaff collected as soy residue, defatted with hot water for 5 minutes, dried at 65^0C in forced-air moisture extraction plus 11 oven, for 48 hours, milled with Hammer mill and sieved with 60mm mesh sieve. The plantain flour and soy residue flour were blended in the ratio of 60:40 respectively for all the varieties of plantain and coded as VIS60, VIIS60 and VIIIS60 for samples as Horn soy residue, False horn soy residue and French/soy residue respectively.

The pasting properties of the flour was characterized by using Rapid Visco Analayser (RVA) model 3c, Newport Scientific PTV Ltd, Sydney) as described by Delcour et al., [11] and Sanni et al. [12]. 2.5 gram of sample was accurately weighed into a weighing vessel. 25ml of distilled water was dispensed into a new canister. Sample was transferred into the water surface of the canister, after which the paddle was placed into the canister. The blade was vigorously joggled up and down through the sample ten times or more until no flour lumps remained either on the water surface or on the paddle. The paddle was placed into the canister and both were inserted firmly into the paddle coupling, so that the paddle is properly centred. The measurement cycle was initiated by depressing the motor tower of the instrument. The test was then allowed to process and terminated automatically.

III. Statistical Analysis

Data were analyzed by using a statistical package for social science (SPSS 16) through two way analysis of variance (ANOVA) significance was accepted at 5% probability level.

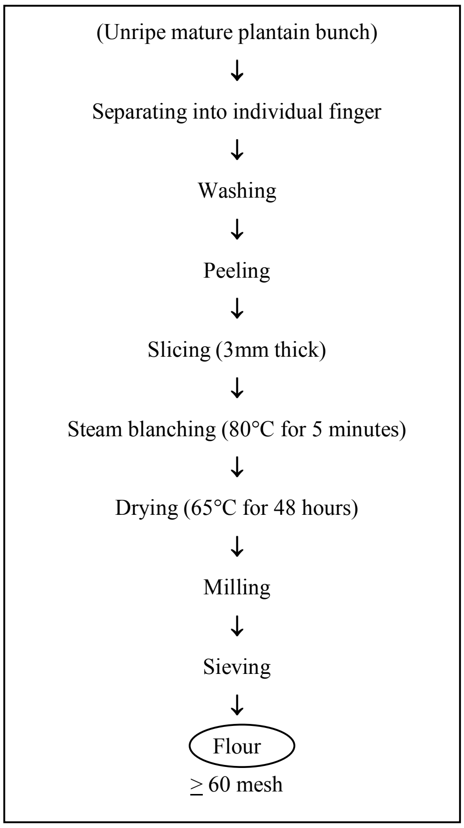

Fig. 1 Flow diagram of preparation of plantain flour

IV. Results

The pasting properties of flour form different plantain varieties mixed with soy residue in the ratio of 60:40 for the production of diabetic fufu is presented in Figs. 3 and 5. Fig. 5 shows that French soy residue ($VIIIS_{60}$) had the highest peak viscosity (303.75 RVU), Trough value (182.08 RVU) final viscosity (284.50 RVU), and lowest in breakdown value (79.58 RVU), set back value (88.17 RVU), pasting time (4.36min), pasting temp (18.8°C) and differed significantly ($p < 0.05$) from other variety. Fig. 3 shows that Horn soy residue (VIS_{60}) had the lowest in peak viscosity (192.25 RVU), trough value (112.67 RVU), final viscosity (211.92 RVU), pasting time (4.66min), pasting temp (82.35°C) and differed significantly ($p<0.05$) from other variety. While Fig. 4 (false Horn soy residue) $VIIS_{60,}$ had the intermediate value on peak viscosity (236.67 RVU), trough value (116.58 RVU), breakdown value (120.08 RVU), final viscosity (270.25 RVU), setback value (167.92 RVU), peak time (4.39min), pasting temperature (81.44°C) and differed significantly ($p<0.05$) from other variety.

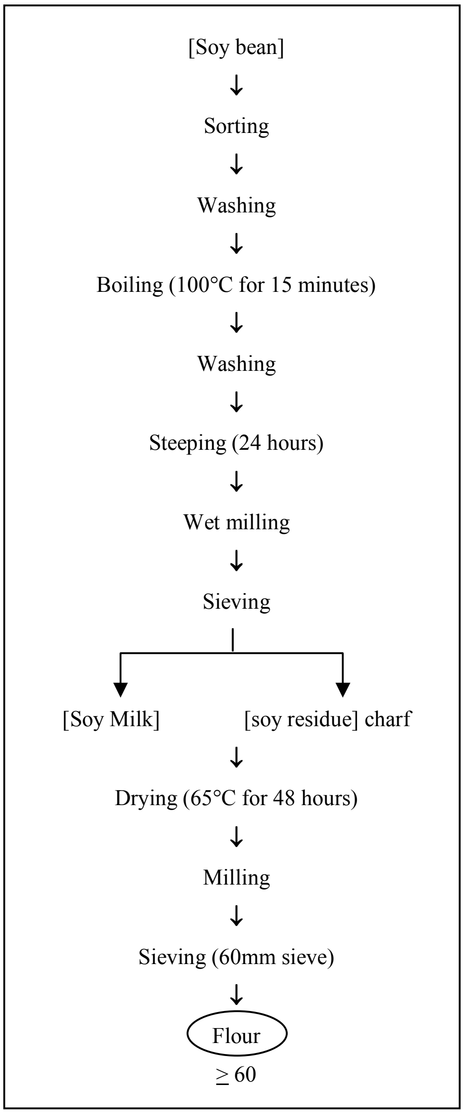

Fig. 2 Flow diagram of preparation of soy residue flour

V. Discussion

In flour production, pasting properties is an important index in determining where the flour can be best applied [13]. Viscosity of starch increases when heat is applied as a result of the swelling of the starch granules and their difficulty in moving fast one another. In pasting, the amount of water depends on the duration of cooking, starch content and the variety [14]. So in this work, the amount of water absorbed is being determined by the duration of cooking, the content of the mixed starch of plantain and soy residue and variety of plantain. The pasting properties of flour produced from plantain soy residue ranged from 192.25 - 303.75 RVU and are in consistent with those reported in starch and fibre derived from soybean as soy residue. From this work, it was observed that French soy residue VIIIS60 had high peak viscosity, which is an indication of strength of the paste to be formed, during processing in food application [15]. It corresponds to higher swelling capacity, and thickening power of the starch, [16]. This high value in peak viscosity is probability due to presence of interfering non-starch components, and also as a result of amylase activities in starch which have the tendency to cause changes in viscosity. Again, it may be due to varietal differences. A viscous paste is produced from starch when heated in the presence of water and this viscosity account for the application of starch in food industry.

Daramoha and Osanyinlusi [17] reported a much higher values of breakdown viscosity (115.42-487.9 RVU) in six verities of banana in Ekiti state compared to those found in these blend samples of different plantain varieties with soy residue. Products with low levels of break down viscosity have the tendency for better resistance to heating and shear-thinning. Moorthy et al. [18] postulated that the cohesiveness of starch is attributed to the break down viscosity of starch molecular during heating stirring. Starch may be predisposed to breakdown due to early gelatinisation because it undergoes a longer period of shear. Setback viscosity obtained in plantain flour is higher than the values obtained in *Disoscrea alata* [19]. Lower set back viscosity indicates higher potential for retrogradation in food products [20] and gives an idea about retrogradation tendency of starch. High setback value is associated with a cohesive paste and has been reported [21] to be significant in domestic products such as pounded yam, which requires high set back, high viscosity and high paste stability. French/soy residue flour may be widely accepted in any African countries in the production of diabetic fufu. Final viscosities of flour mixtures are important factor because it helps in determining the ability of the samples to form gel during processing [22]. It is an indication of whether the starch materials form a gel or a paste on cooling, and also indicates the strength of cooked paste [23]. It has been reported that starches with low pate stability or breakdown have very weak cross-linking within the granules. Pasting temperature is temperature at which first detectable viscosity is measured (when the stirred starch suspension begins to rise) and gives indication of minimum temperature to cook a given sample and it influences energy cost. There is need for a product to reach its pasting temperature in other to ensure swollen, gelatinisation and gel formation. French/soy residue (VIIIS60) has the shortest pasting time (4.36min), False horn/soy residue (VIIIS60) has pasting time (4.39min) and Horn/soy residue pasting time (4.66min). All these values are low indicating that they all have low cost implication.

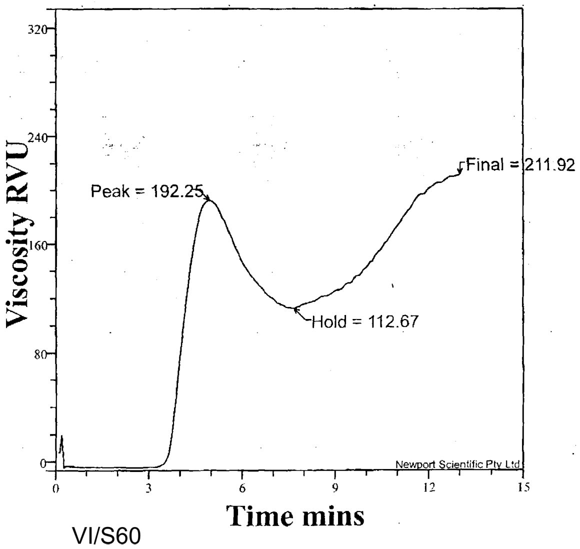

Fig. 3 VI/S60 (Horn plantain and soy residue flour blend sieved at 60 mesh sieve)

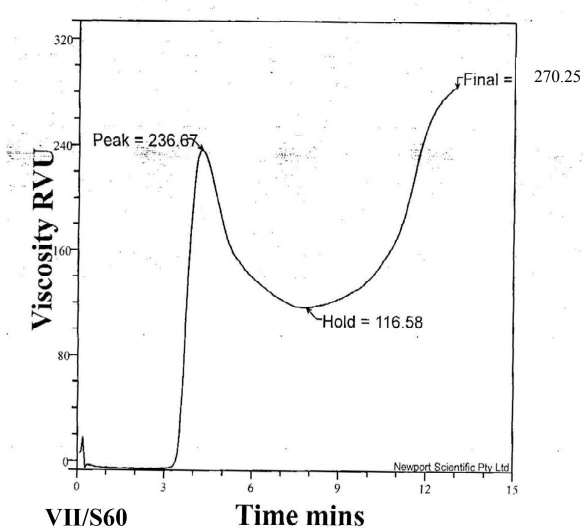

Fig. 4 VII/S60 (Falsehorn soy residue flour blend sieved with 60 mesh sieve)

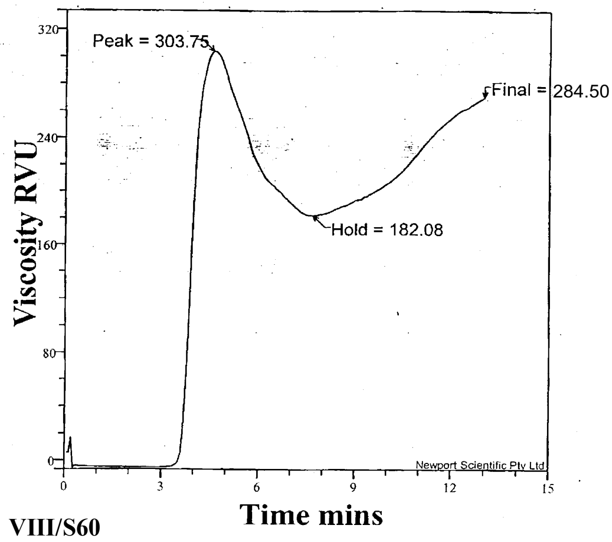

Fig. 5 VIII/S60 (French plantain and soy residue flour blend sieved at 60 mesh sieve)

VI. Conclusion

From the result, it is observed that there are differences in their pasting properties and that fufu could be formed from French/soy residue for the diabetics.

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