Comparative Studies on the Pasting Properties of Starches of Corms and Cormels of Two Cocoyam (*Colocasia esculenta*) Cultivars

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Abstract

The starches of the corms and cormels of both white and red varieties of cocoyam (*Colocasia esculenta*) were extracted and evaluated for pasting parameters, which were gelatinization temperature, paste viscosity, final viscosity, retrogradation, pasting time, paste stability and paste clarity. The results obtained showed that the values of gelatinization temperature, final viscosity, pasting time and retrogradation of the corms of both white and red cocoyam varieties were higher than those of the starches of the corresponding cormels. However, an opposite trend was observed for the values of paste viscosity and stability of the starch samples. The values of paste viscosity for all the samples were observed to be higher than those of final viscosity of the same samples. The peak value of paste viscosity (523.00RVU) was obtained in the cormels of white cocoyam (*Colocasia esculenta*) followed by that of the corms of red cocoyam (472.58RVU). The values of gelatinization temperature of the starch samples range from 76.95 to 83.70^{0}C, indicating the lowest and highest values of gelatinization temperature obtained in the cormels of red cocoyam and corms of red cocoyam respectively. The studies also suggest that an inverse relationship may exist between retrogradation and paste stability. The results obtained showed that the higher the value of retrogradation of a starch sample, the lower its value of paste stability and vice versa. The peak value of paste stability (255.08RVU) was obtained in the cormels of white cocoyam and the least (163.67RVU) in the corms of red cocoyam. The graphical plots of %transmittance against refrigeration hours for the starch samples gave straight lines except for the starch of the corms of red cocoyam that deviated a bit. This indicated that the more the refrigeration hour the clearer the pastes of the samples. The highest value of paste clarity (0.26) after the third day was obtained in the starch of white cocoyam corms.

Keywords: Starch, paste, gelatinization temperature, viscosity, retrogradation, stability, clarity.

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Introduction

Cocoyam (*Colocasia esculenta*), an herbaceous bush of 1-2 m high that is built by leaves originating from a starchy corm, is an ancient tuber of the Araceae family [1, 2], which originated from South-East Asia, possibly, India [3, 4], where it has been cultivated for more than 2000 years. It has both red and white varieties.

Tuber processing is aimed at obtaining products that are stable in terms of longitivity, nutrition and palatability. Previous research reports have shown that consistent palatability problems (bitter and astringent taste and scratchiness in mouth and throat) associated with cocoyam have hindered the realization of its potential [5, 6, 7, 8]. The causes of these anti-nutritional and off-taste problems have been identified as calcium oxalate crystals (raphides) and other acidic and proteinaceous principles [8]. An extensive review of the role of oxalate in nutrition including the possibility of oxalaurea and kidney stones has been reported [9].

Cocoyam (*Colocasia esculenta)* can be processed into several food and feeds products and industrial inputs, similar to that of potatoes in Western world. The processes include boiling, roasting, frying in oil, pasting, milling and conversion into ‘fufu’, soup thickeners, flour for baking, chips, beverages powder, porridge and specialty food for gastro-intestinal disorders [3, 8, 10].

However, studies aimed at eliminating these limitations in cocoyam and its products have included those on baking [11, 12], peeling, grating, cooking, anaerobic fermentation and soaking in water [3].

The flour of cocoyam has been evaluated for proximate composition and the values of its crude fibre, ash content and carbohydrate by difference are found to be higher than those of wheat flour [13]. In addition, its gelatinization temperature falls between 68^0C and 72^0C while the related starch of yam is between 71.7^0C and 80.3^0C [14]. The observed difference is an indication of the rate at which each resultant flour could lose birefringence characteristics of its starch fraction [15]. Possibly, gelatinization temperature is a measure of the temperature level at which the carbohydrate fraction of food system affects its thickening power, that is, water binding capacity is most effective from about such temperature. The staling of bread has been ascribed to retrogradation, which gives the bread its elastic and tender crumb structure [15].

Materials and Methods

Sample Preparation

The corms and cormels of both white and red cocoyam varieties (*Colocasia esculenta)* were purchased at Araromi Market, Oranmiyan Local Government, Ile-Ife, Osun State, Nigeria. They were washed with water, peeled, sliced, grated into pulp and sieved with muslin cloth to extract the starch milk. The filtrate (starch milk) was allowed to settle and then decanted. The resulting starch cake was sun-dried, milled and sieved into fine particle size of 150μm before packaging it in polythene film.

Methodology

Rapid Visco Analyser (RVA) Model 3-D (Newport Scientific) was used to determine the gelatinization temperature, paste viscosity, final viscosity, pasting time, paste stability and retrogradation of each sample [16] and paste clarity was determined using Perera and Hoover's method [17].

Results and Discussion

Table 1 shows the result of gelatinization temperature (^{0}C), paste viscosity (RVU), final viscosity (RVU), pasting time (mins), retrogradation (RVU) and paste stability (RVU) of the samples namely: starches of white cocoyam corms (WCCM), white cocoyam cormels (WCCL), red cocoyam corms (RCCM) and red cocoyam cormels (RCCL). The highest value of gelatinization temperature is obtained in RCCM (83.70^{0}C) while the lowest in RCCL (76.95^{0}C). In the same vein, WCCM exhibits higher value of gelatinization temperature than that of WCCL. High gelatinization temperature suggests high proportion of amylose chains in the starch with the view that high thermal energy is required to dissociate the crystallite [18].

The values of paste viscosity of WCCL (523.00 RVU) and RCCL (472.58 RVU) are higher than that of the corresponding WCCM (437.58RVU) and RCCM (383.92 RVU) respectively. However, in addition to the lower values of final viscosity than paste viscosity for the corresponding samples, an opposite trend is obtained for final viscosity in that WCCM and RCCM have higher values of final viscosity than WCCL and RCCL respectively. These differences may be as a result of set in of retrogradation, which is accompanied by fall in viscosity [10, 19]. Adequate knowledge on viscosity is a tool of importance in characterizing and selecting starch for food uses [20].

The pasting time of the starch samples is highest in RCCM (5.02mins), which is the sample with the highest gelatinization temperature while the lowest value of pasting time is obtained in WCCL (3.97mins). In addition, the trend obtained for the starch samples is that the values of pasting time of WCCM and RCCM are correspondingly higher than those of WCCL and RCCL.

The value of retrogradation of the starch of WCCM (72.67RVU) is the highest among others, giving the starches of WCCL (23.17RVU), RCCL (38.75RVU) and RCCM (65.42RVU) low tendency of retrograding. Staling of bread, cake not risen well, cream separated, running paste and glues have been reported as a function of retrogradation [15, 19].

The values of paste stability of WCCL (255.08RVU) and RCCL (251.17RVU) are higher than those of WCCM (172.83RVU) and RCCM (163.67RVU) respectively, which is the opposite trend of the values of retrogradation obtained for the starch samples. This may suggest a relationship between paste stability and retrogradation, which implies that paste stability is inversely proportional to retrogradation; the lower the stability, the higher its susceptibility to retrogradation.

Figure 1 shows the plots of various values of %transmittance against time. The plots for all the samples are straight lines except in RCCM, which deviates a bit. This is indicative of the fact that paste clarity increases with increase in refrigeration time. At the end of the third day of refrigeration, starch paste of WCCM is found to possess the highest %transmittance.

Conclusion

This study has revealed that the values of gelatinization temperature, viscosity and retrogradation of WCCM and RCCM are greater than those of WCCL and RCCL respectively whereas an opposite trend is observed for the values of their stability. The starch of corms of red cocoyam variety exhibits appreciably high crude protein and carbohydrate by difference, which could make it a suitable supplement to cereals in baby food formulas. As high thickness, that is, viscosity is an index of formulation in pharmaceuticals [20], starches of the corms and cormels of red and white cocoyam varieties could be used as tablet binder (or filler) as well as in the production of ointments owing to their high values of viscosity. The starches of corms and cormels of both white and red cocoyam can be used in frozen foods owing to their low values of retrogradation to impart textural and freeze-thaw stability, thus prolonging the shelf-life of the food product. Appreciably low values of retrogradation of the cormels of white and red cocoyam varieties could place them as better raw material in bakery than the corms of white and red cocoyam varieties.

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Table 1: Result of Rapid Visco Analysis (RVA) of the Starch Samples

Sample	Gel. Temp. (^{0}C)	Paste Viscosity (RVU)	Final Viscosity (RVU)	Pasting Time (Mins)	Retrogra-dation (RVU)	Stability (RVU)
WCCM	81.35	437.58	337.42	4.63	72.67	172.83

WCCL	78.95	523.00	290.25	3.97	23.17	255.08
RCCM	83.70	383.92	285.67	5.02	65.42	163.67
RCCL	76.95	472.58	260.17	4.04	38.75	251.17

WCCM-Starch of corms of white cocoyam

WCCL-Starch of cormels of white cocoyam

RCCM-Starch of corms of red cocoyam

RCCL-Starch of cormels of red cocoyam

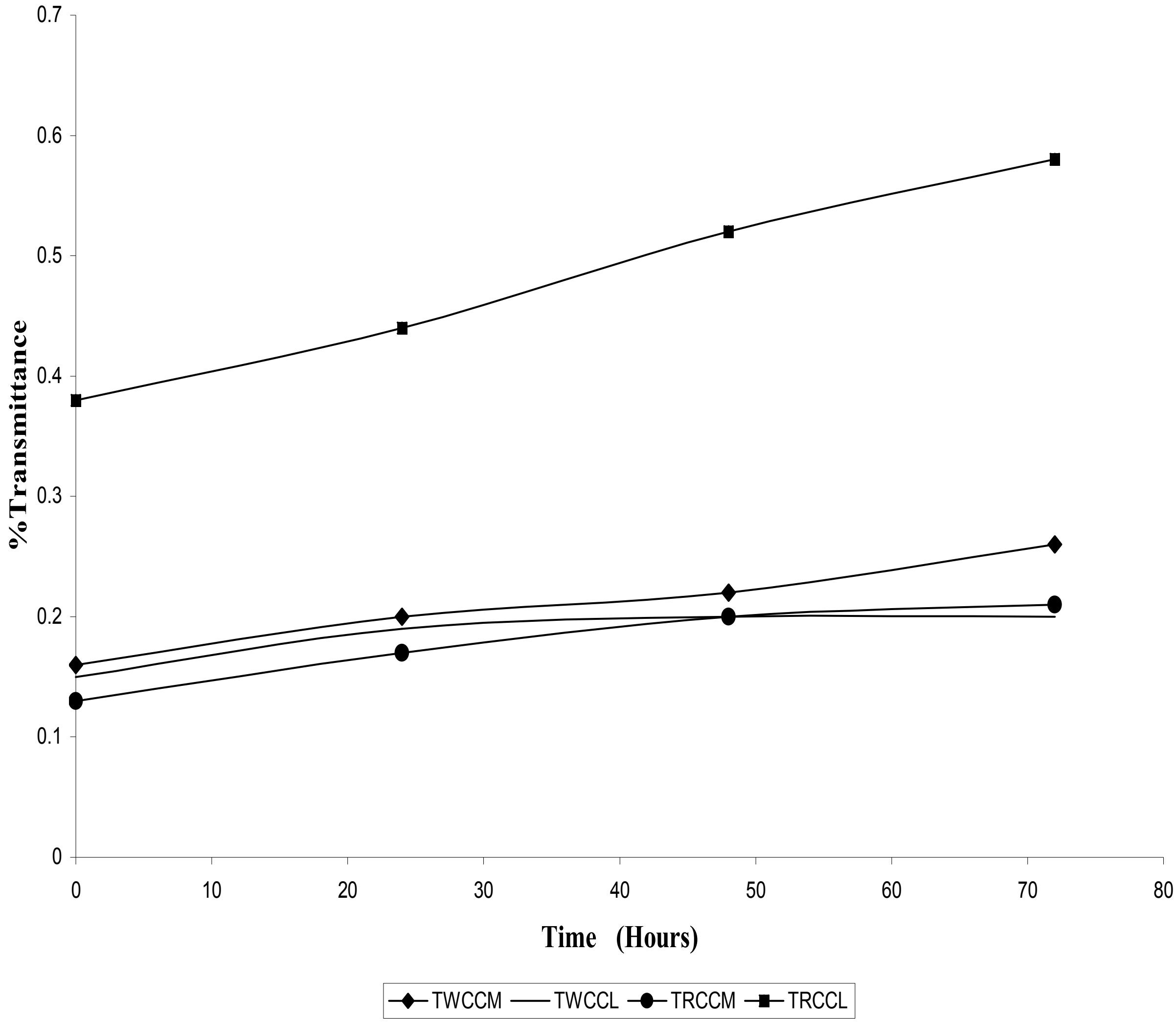

Figure 1: Variation of %Transmittance with Time