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Influence of Pretreatments and Storage Conditions of Taro (*Colocasia esculenta* (L.) Schott) on Functional Properties of its Flours

E. A. Baidoo [1], P.-N.T. Johnson [1] and A.S. Budu [2]

[1]Food Research Institute, P.O. Box M 20 Accra, Okponglo-Accra, Ghana
[2]Department of Nutrition and Food Science, University of Ghana, P.O. Box LG134, Legon- Accra, Ghana
Corresponding author: E.A. Baidoo, e-mail: kobinaelvis@yahoo.com

Abstract

Studies were conducted to evaluate the effect of pretreatment of taro prior to storage on functional properties of its flours. Taro tubers were pretreated in four ways: dipping in 2%w/v sodium chloride solution, 2%w/v sodium hypochlorite solution, 50% v/v ethanol and hot water blanching at 100°C and were either stored in a cold room (4-5°C) or ambient conditions (28±3°C) for three weeks. Flours were processed after treatment for assessment of swelling power, water binding capacity, peak viscosity and setback. These were repeated after the first, second and third weeks of storage. Flour processed from blanched taro showed the least swelling powers and the least peak viscosity and setback while flours from other treatments recorded comparable pasting properties. Taro stored in ambient conditions produced significantly high peak viscosity and setback values. Blanching may not be a substantive option for industrial application in taro post-harvest management because it may not achieve flours with very good dough characteristics.

Key words: Taro, storage, flours

Introduction

Taro (*Colocasia esculenta* (L.) Schott) is a major tuber crop cultivated in the tropical and subtropical regions of the world. Knowledge on taro post harvest technology is very limited. The crop has a high post harvest perishable rate and as such occupies a poor position on the food security profile (Njintang et al., 1997). A significant amount of research remains to be done on the functional characteristics of flours and native, as well as modified tropical starches if they are ever to become competitive with commercial starches such as corn, wheat, and potato (Satin, 1999). Aboubakar et al. (2007) also stated that before consideration is given to taro tubers as potential sources of starch to produce foods, it is necessary to characterize their chemical composition, physical, physicochemical, and functional properties.

Taro tubers are known to start rotting as early as two weeks after harvesting (Passam, 1982) and have been suggested as one of the major constraints in the production of taro (Minagri, 1999). The development of appropriate post-harvest storage techniques could therefore resolve some of the problems that affect the consumption and utilization of taro. Furthermore, with respect to its spoilage characteristics it would be feasible to carry out the pretreatment of harvested taro cormels before storage and is believed that it will go a long way in arresting spoilage due to rots.

Sajeev et al. (2004) found that after 20 days of storage, physiological loss in weight of taro cormels was maximum at ambient storage conditions followed by evaporative cooled room and refrigerated conditions. Malaki et al. (2003) also found that dipping taro in a 0.1% solution of sodium hypochlorite significantly reduced corm rot from 34.2% to 26.0%. Njintang (2003) initiated the study of some functional properties of Cameroonian taro flour while Mbofung et al. (2006) reported some functional properties of six varieties of Cameroonian taro flour. More recently, Njintang et al. (2007) investigated the relationship between the biochemical characteristics of taro flour and the colour of the paste made from it. Pretreatment of taro after harvest has the capacity to reduce the microbial load on the cormels from the soil and in effect increase the duration of storage between harvest and the onset of spoilage by rots. The objective of this work was therefore to study the effect of post-harvest pretreatments and storage on the functional and visco-elastic properties of flour produced from taro.

Materials and Methods

Freshly harvested taro (*Colocasia esculenta* L. Schott) cormels at 12 months maturity was obtained from a farm at Anyinam in the Eastern Region of Ghana. They were washed with tap water and transported the same day to the laboratory for analysis. The pretreatments were conducted for a period of two minutes each. These were blanched with hot water at 100°C, dipping in 2%w/v sodium chloride, dipping in 2%w/v sodium hypochlorite, dipping in 50%v/v ethanol and a control by dipping in distilled water. The pretreatments were based on modification of methods applied by Bikomo (1991), Bartz and Kelman (1986), Rickard (1983) and Malaki et al. (2003). The treated cormels were further divided into two sub-groups and kept in cardboard boxes and spread in a single layer leaving spaces between the cormels and stored in one of two storage conditions namely cold room (4-5°C) and tropical ambient temperature conditions (28±3°C). Thus, there were 10 treatments viz.,

T_1 - Cormels stored in cold room (control)

T_2 - Carmels stored in ambient conditions (control)

T_3 - Blanched carmels stored in cold room

T_4 - Blanched carmels stored in ambient conditions

T_5 - Carmels treated with 50% (v/v) ethanol and stored in cold room

T_6 - Carmels treated with 50% (v/v) ethanol and stored in ambient conditions

T_7 - Carmels treated with 2% (w/v) NaU and stored in cold room

T_8 - Carmels treated with 2% (w/v) NaU and stored in ambient conditions

T_9 - Carmels treated with 2% (w/v) NaOU and stored in cold room

T_{10} - Carmels treated with 2% (w/v) NaU and stored in ambient conditions

Samples were randomly selected from the two storage conditions for flour processing at harvest (week 0), and at the end of the first week of storage, at the end of 2nd week of storage and at the end of 3rd week of storage.

Cormels were selected for flour processing by the method described by Badrie and Mellowes, (1992). One and a half kilograms of taro was weighed, washed and peeled. The peeled cormels were weighed and cut into 2-5mm thick pieces using a food slicer (Fold-up electric Food Slicer model CFE 1954, Philips Atlantis). After weighing, the slices were dried in a mechanical dryer (Apex, Royce Ross Ltd.) at 54°C for 10 hours. The dried slices were weighed and milled using disc attrition mill. The flours were sieved with a 250 micron mesh and stored in air tight containers.

The swelling power of the flours produced was measured based on a modification of the method of Leach et al. (1959). One gram of sample was transferred into a weighed graduated 50 ml centrifuge tube. Distilled water was added to give a total volume of 40 ml. The suspension was stirred just sufficiently and uniformly avoiding excessive speed in order not to cause fragmentation of starch granules. The sample in the centrifuge tube was heated at 85°C in a thermostatically regulated temperature bath (Grant Instruments, England LTD) for 30 min with constant stirring. The tube was removed, wiped dry on the outside and cooled to room temperature. It was then centrifuged for 15 minutes at 2200 rpm in a Centrifuge (Mistral 3000i UK). The sediment paste was weighed and the swelling power was then calculated as follows:

$$\text{Swelling power} = \frac{\text{weight of sedimented paste}}{\text{weight of initial sample (dry basis - weight of sample which dissolves away)}}$$

The water binding capacity of flours produced were determined according to the method of Yamazaki (1953) as modified by Medcalf and Gilles (1965).

Pasting characteristics of the taro flour was determined

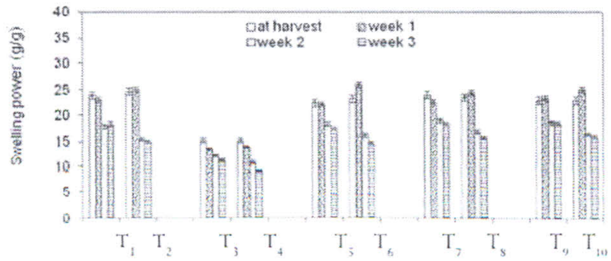

Fig. 1. Swelling power of taro flours produced from pre-treated taro stored in cold room (4-5°C) and ambient conditions (28±3°C).

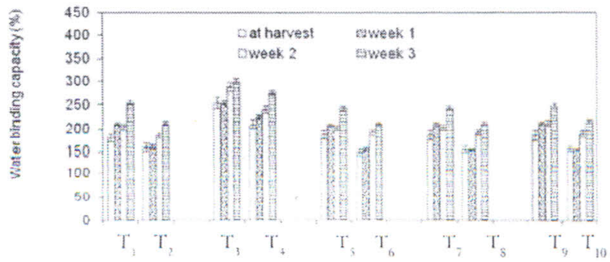

Fig. 2. Water binding capacity of taro flours produced from pre-treated taro stored in cold room (4-5°C) and ambient conditions (28±3°C).

using the Brabender viscograph E. (Ident. No. 802525 - Duisburg, Germany) according to a method described by (Mazurs et al. 1957). The parameters analysed were peak viscosity and setback.

All analyses were carried out in triplicate and data expressed as means with standard deviation. Analysis of variance was performed to calculate significant differences in treatment means. Duncan multiple range test was used to separate means using the Statistica for Windows statistical software (Statsoft Inc., 1999). Comparisons between sample treatments and correlation analysis were done with a probability $p<0.05$.

Results and Discussion

Functional properties of taro flour

The swelling power of taro flours processed from the cold room and ambient storage conditions are presented in Figure 1. The flour from the blanched sample showed significantly low swelling powers of 11.4 gg^{-1} and 9.5 gg^{-1} in the cold room and room storage conditions respectively while flours prepared from the other pretreatments showed significantly high swelling powers ranging from 23.9 gg^{-1} to 23.4 gg^{-1} for sodium chloride treatment in the cold room and room storage conditions respectively. During the blanching process, some of the starch grains in the taro might have gelatinized and swelled up and as a result, the flours processed from these cormels possess a reduced hydrophilic ability leading to the reduced hydration capacity of its flour and therefore showed low swelling powers. This result is in agreement with the findings of Tagodoe and Nip (1994) who found that the gelatinization of taro starch increased the density of the taro flour and therefore showed a reduced ability to absorb moisture. It could also be argued that the heat treatment in the blanching procedure reduced the amylose content of the taro leading to significant reduction in swelling power as observed by Sasaki and Matsuki (1988) who established a negative correlation between amylose content and swelling power of wheat starch. In addition to this point, there was a general reduction in swelling power of the flours with increasing time of storage of the cormels and is particularly between the second and third weeks of storage in the room storage conditions. Delay in processing of cassava into flours has been established to reduce swelling power of its flours (Ihedioh et. al. 2007). This may apply for taro flours processed from stored cormels as well. The effect from other treatments (sodium chloride, sodium hypochlorite, ethanol and control) showed comparable results and did not show any trend in both storage conditions. In bread making, flours with high water absorbing properties produces doughs that give a high yield of bread (Jeanne and Peckham, 1987) and as such taro flour processed from hot water blanching treatment will not produce high quality bakery products.

Water binding capacity (WBC) of taro flours ranged from 151.5% to 300.4% as shown in Figure 2. This result falls within the findings of Narkrugsa (1986) who established that taro flours bound with water 1 1/2 - 2 times of their weight in characterizing of WBC. Flours processed from the blanched cormels showed the highest significant WBC's in both storage conditions. Blanching may have caused a gelatinization of some starch granules in the taro and in turn caused the disruption of the internal structure of the granules (Wooton and Bamunuarachi, 1978). Additionally, *the* high water binding capacity in the blanched sample could also be attributed to loose association of the starch polymers in the native granule and low amylose content caused by the blanching process (Wooton and Bamunuarachi, 1978). The blanching process is also believed to have deformed some starch granules and thus leading to the high WBC'S recorded as established by Barimah et al. (1999) that amorphous starch has greater water binding capacity than crystalline starch. In other treatments most of the flours showed WBC's which were comparable and not statistically different from control results.

Pasting characteristics of taro flours

Taro flour processed from hot water blanching of taro and stored in cold room showed the least in peak viscosity (181.5 BU) and the least setback (57.6 BU) as shown in Figure 3 and Figure 4 respectively. The other treatments produced flours which generally gave comparable peak viscosities and were significantly different ($p < 0.05$) from that of the blanched treatment. This result agrees with reports which indicate that heat treatment of taro causes significant reduction in oxalate content due to leaching of soluble oxalate in taro (Aboubakar et al., 2008; Tattiyakul et al., 2007). The reduction in oxalates may

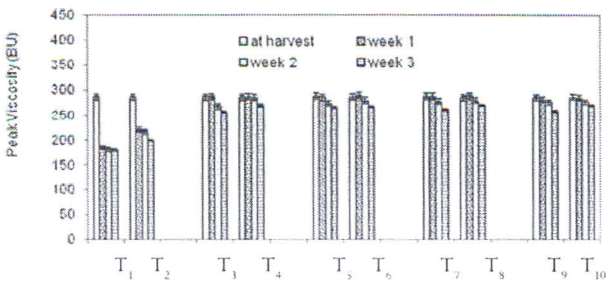

Fig. 3. Peak viscosity of taro flours produced from pre-treated taro stored in cold room (4-5°C) and ambient conditions (28±3°C).

have occurred due to the blanching process and in turn caused flours produced from them to possess low peak viscosity values as reported by Raja and Ramakrishna, (1990). Figures 3 and 4 also show that regardless of the kind of pretreatment on the taro cormels, the flours produced showed a general reduction in peak viscosities and setback with increasing time of storage in the two storage conditions. One of the reasons for this observed trend could be due to a reduction of amylose contents due to an increased amylolytic activity with time as reported by Ihedioh et al. 2007.

It is also observed in Figure 3 that flours processed from taro stored in ambient conditions produced higher peak viscosities and were significantly different at $p < 0.05$

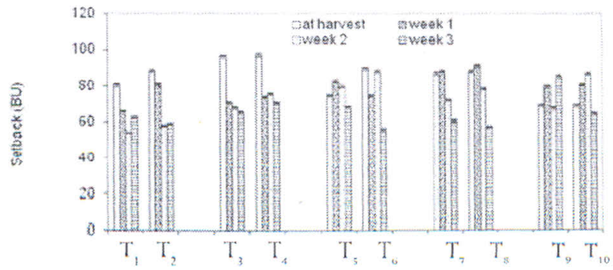

Fig. 4. Setback of taro flours produced from pre-treated taro stored in cold room (4-5°C) and ambient conditions (28±3°C).

than those processed from cold room storage. This is in agreement with Kaur et al. (2007) who reported that storing potatoes in temperature conditions between 4-8°C resulted in flours that had considerably lower amylose contents as against storage in temperatures between 16-20°C and this may be the case for taro stored under these conditions. The lowering of amylose content in taro stored in the cold room thus explains the lower peak viscosities and vice versa as reported by Ihedioh et al. 2007.

Conclusions

Of all the treatments used for taro in this study, blanching had the most effect on functional properties on the flours produced. Blanching of taro has a reducing ability on most functional properties of flour made from the taro. Therefore, blanching may not be a suitable treatment for taro especially if it is intended for subsequent processing of flour. Storage of taro in room temperature is more preferable as it produces higher pasting characteristics values in taro flours (peak viscosity and, setback) than those stored in the cold room. The storage of taro in ambient conditions therefore may be a better option as compared to cold room storage.

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