



Ideal pretreatments and drying temperature on physico-chemical properties and bioactive compounds of dehydrated taro wafers

Chowdhury S Kumar*, G., Mondal, S., Kavya D., Mani A, Chakraborty I and Mitra S

Department of Post Harvest Technology, Bidhan Chandra Kriahi Viswavidyalaya, Mohanpur 741252, India

ABSTRACT

This study investigated the effect of various pre-treatments on the physicochemical properties of dried wafers prepared from taro cultivars, commonly grown in wasteland areas. Various pretreatments like blanching with water at 80°C and steam for 4 minutes, and immersion in a 0.1% citric acid solution were applied, followed by drying at 50°C and 60°C, respectively in a cabinet dryer. All pretreated dehydrated slices exhibited moisture levels below (10%), which is satisfactory for prolonged storage. The best rehydration ratio (2.72) and the lowest reducing sugar (2.29%) were observed in the samples pretreated with hot water-blanching and dried at 60°C. On the other hand, the highest ascorbic acid and total phenol were found in the untreated (control) sample. As pretreatments before drying affect physical parameters of dried taro chips, the best pretreatment should be used to produce high-quality end products. Wafers that were treated with hot water blanching produced better results compared to the untreated (control) because water blanched helps with colour improvement and reduction of reduced sugar level. The sensory analysis of the fried wafers revealed that the hot water blanched sample received the highest overall acceptability score (8.14) on the 9-point hedonic scale, which was substantially higher in comparison to the control sample.

Key words: Pre-treatments, physico-chemical properties, bio-active compounds, sensory quality.

INTRODUCTION

Taro (*Colocasia esculenta* var. *esculenta*), is a tropical root crop, is primarily cultivated for its edible leaves and underground corms. Its corms are rich sources in carbohydrates and low in fat and protein. They also provide essential minerals, including magnesium, calcium, and potassium (Kaushal *et al.*, 10). The area coverage, production, and productivity of taro have steadily increased over time. In 2021, the cultivated area expanded to 1,793,703 hectares, with a production reaching 12,396,248.5 tons and major contributing countries were Africa, followed by Asia, Oceania, and America (Ferdaus *et al.*, 7). Owing to their elevated moisture content, taro tubers have a limited shelf life. Post-harvest storage losses in taro have been observed to exceed 60% within 5 to 6 months (Agbor-Egbe and Richard, 2). To prevent significant losses, it is crucial to process them into non-perishable forms through various food processing techniques (Aboubakar *et al.*, 1). One potential way to store corms and prevent further losses is by dehydrated the product, which lowers moisture levels and halts microbial growth. Drying is a traditional method of food conservation that extends shelf life, reduces weight for easier transportation, and saves storage area (Calín-Sánchez *et al.*, 6). This method enhances food stability by considerable

reducing water content and microbiological activity, as well as minimizing physical and chemical alterations with in storage (Hatamipour *et al.*, 9). Sun drying is the most common and cost-effective drying method for food products due to its low expenses. However, the lengthy dehydration is not ideal for commercial purposes and poses risks of decay since the products are open to the atmosphere. To enhance product quality, conventional drying technique should be exchanged with modern dryers like freeze dryers and hot air dryers. Hot air drying is much faster, ensuring uniformity and hygiene, making it essential for industrial scale (Xia *et al.*, 21), while freeze drying, though effective, is substantially more expensive.

In recent times, consumer demand for pre-processed foods has been increasing steadily. Dehydrated taro wafers, often considered a pre-processed alternative to potato chips, have gained wide popularity, in urban communities. Consumer demand for lean fat and fat-free products has led the food industry to discovered fried products with minimum oil content, maintaining their desirable taste and texture. Blanching is commonly used to deactivate enzymes and ensure consistent quality in products prior drying and frying. This process also helps to minimize fat absorption to some extent by promoting the gelatinization of surface starch. furthermore, pre-drying products before frying has led to a considerably reduced oil content in a food items.

*Corresponding author email: my.subhadip45@gmail.com

These crops play a crucial role in generating income, promoting eco-friendly growth, and ensuring food security for households, particularly in developing and underdeveloped countries. They provide a source of livelihood for local populations by reducing post-harvest losses and producing value-added taro-based products. It is essential to promote effective post-harvest management and agro-processing techniques for taro. These practices help maximize the benefits of crop production by reducing losses while maintaining product quality and nutritional value. Developing value-added products that are well-accepted by consumers can stimulate the growth of rural-based agro-processing industries. Unfortunately, there is a significant gap in research regarding the industrial use of taro as a source of components for processed food products. The current study focuses on the post-harvest utilization of bunda taro by processing it into dehydrated wafers. The objective will be to investigate the effects of various pretreatments, such as blanching, citric acid, and pre-drying temperature, on dehydrated taro wafers.

MATERIALS AND METHODS

Freshly harvested *Colocasia esculenta* var *esculenta* cv 'BCB-3' were collected from AICRP on tuber crop at Kalyani centre. The experiment was conducted at the Post Harvest Technology Laboratory for Horticultural Crops at BCKV Mohanpur, West Bengal, over two consecutive seasons in 2022 and 2023. The entire sample was stored at ambient condition at $26 \pm 3^\circ\text{C}$ and 92% relative humidity for 24 hours prior to experiment. To maintain consistency in the physical traits of the corm.

The dasheen taro wafers were subjected to a series of pretreatment protocols, the specifics of which are delineated. Dasheen taro slices were divided into four groups; the first group was blanched with water at 80°C for 4 minutes (HWB), the blanching process was performed with a sample to solution ratio of 1:5, using muslin cloth. After blanching, the sample was immediately submerged in cold water and then placed on a paper towel to remove any excess moisture before drying. In the second group, steam blanching (SB) was performed in a closed water bath by placing a single layer of taro slices on a perforated tray above boiling water for 4 minutes. The third group was soaked in a 0.1% citric acid (CA) solution for 4 minutes; there is no pretreatment in the fourth group. The samples were subsequently placed in a preheated cabinet dryer.

The pretreated dasheen taro slices were arranged in a monolayer on trays and evenly distributed in a perforated basket. Each sample

weighed 100 g. The cabinet dryer was preheated to a stable temperature of 50°C and 60°C . After loading the sample into the dryer, weight loss was measured at 15-minute intervals during the drying procedure. The dehydration process was deemed complete when the sample reached equilibrium moisture content, indicated by three consecutive consistent moisture content readings, and no additional moisture could be removed at the specified drying temperature.

Rehydration ratio of the dried dasheen taro slices were rehydrated with distilled water. Afterward, the slices were drained, gently blotted with tissue paper, and weighed (Ahamad *et al.*, 4). Moisture content of dehydrated wafers was determined by digital moisture analyzer meter manufactured by Citizon. The total and reducing sugar amount was measured by copper reduction method and the results were expressed as a percentage (Ahamad *et al.*, 5). This method involves the reduction of copper ions, which is proportional to the sugar content in the sample. Ascorbic acid was analyzed using the titration method by Ahamad *et al.* (3). A 10 g sample was mixed with 100 mL of 3% HPO_3 , filtered, and titrated with a dye solution.

$$\text{Ascorbic acid (mg/100 g)} = \frac{\text{Titrate} \times \text{dye factor} \times \text{Volume made up} \times 100}{\text{Volume of filtrate taken} \times \text{Weight of sample}}$$

Total phenol content was evaluated using the methods by (Ranganna (16),

$$\text{Total phenol (mg GAE/g)} = \frac{\text{O.D.} \times \text{Standard curve factor} \times \text{Volume up} \times \text{Dilution}}{\text{Aliquot taken} \times \text{Weight of sample}}$$

The sensory evaluation of the fry wafers, based on attributes like colour, taste, crispiness, and overall acceptability, was conducted by trained judges who utilized a 9-point hedonic scale for scoring. This scale is commonly used to assess the level of preference or acceptability of the product, with higher scores indicating greater satisfaction.

All recorded data were obtained from five repetitions, and the average values along with the standard deviation (SD) were calculated. The data related to the physicochemical characteristics were statistically analyzed using a Completely Randomized Design (CRD) with the OPSTAT software (Sharon *et al.*, 18).

RESULTS AND DISCUSSION

Rehydration ratios are commonly applied to assess the quality of dehydrated products. The highest rehydration ratios (3.48 and 3.71) were recorded, which was treated with HWB, while the minimum rehydration ratios were found in control wafers (2.72 and 2.85) dried at 50°C and 60°C , respectively (Table 1). A higher rehydration ratio (RR) indicates a higher-quality product due to

Table 1: The response of rehydration ratio, moisture content (%) and reducing sugar (%) of taro chips towards pretreatment and mode of drying.

Treatment	Rehydration ratio		Moisture content (%)		Reducing sugar (%)	
	50°C	60°C	50°C	60°C	50°C	60°C
SB	3.32 ± 0.11	3.59 ± 0.11	9.10 ± 0.29	8.41 ± 0.27	1.74 ± 0.06	1.86 ± 0.06
HWB	3.48 ± 0.04	3.71 ± 0.04	9.00 ± 0.10	8.12 ± 0.09	1.37 ± 0.02	1.46 ± 0.02
Citric	3.16 ± 0.12	3.33 ± 0.13	9.29 ± 0.36	8.51 ± 0.33	2.08 ± 0.08	2.24 ± 0.09
Control	2.72 ± 0.09	2.85 ± 0.09	9.27 ± 0.30	8.41 ± 0.27	2.29 ± 0.07	2.64 ± 0.08
LSD (<0.05)	0.18	0.19	0.53	0.48	0.12	0.13

regaining its original shape, and they reflect the physicochemical changes that occur throughout the drying process (Górnicki *et al.*, 8). Blanched wafers had the maximum rehydration ratio contrast to those treated with citric acid solution and control sample. This phenomenon can be attributed to the removed air from vegetable tissues, reduced minute quantities of water, and also enhanced cell softness and permeability (Wang *et al.*, 20).

Moisture level is very crucial for storage of dried foods. The maximum values of moisture (9.27% and 8.51%) were found in those pretreated with citric acid and dried at 50°C and 60°C, respectively (Table 1). The minimum value was found in (9.00%) and (8.12%) treated with HWB and dried at 50°C and 60°C, respectively. Comparative analysis revealed that dehydrated samples at 60°C exhibited lower moisture value than those dried at 50°C. According to Nilnakara *et al.* (14) this outcome is primarily due to the temperature -induced decrease in air relative humidity, which consequently augments the driving force of mass transfer and enhances moisture diffusivity. Maintain a moisture level below 15% in dehydrated samples effectively prevent microbial growth and facilitates extended storage life.

The Maillard reaction within reducing sugars and free amino acid during food processing has deleterious consequences. Lowering Reducing sugars can minimize this reaction, retained food colour. The highest reducing sugar (2.29%) at 50°C and (2.64%) at 60°C was recorded in control dried (Table 1), while the least value was found in pretreated with HWB (1.37%) and (1.46%). This phenomenon can be the result of the blanching of softened cells to leach out water-soluble substances and also recorded HWB more leaching compared to SB it may be due to WB more contact with water compared to stem blanching. Consistent with our finding, Quarcoo and Wireko, (15) noted that SB resulted in better retention of soluble compounds contrast hot water blanching.

The control dehydrated wafers exhibited a higher level of total sugar (3.37% and 3.57%)

compared to other pre-treated dehydrated wafers (Fig. 2). Specifically, HWB (2.22 and 2.35%) and SB (2.62 and 2.75%) dried at 50°C and 60°C, respectively. The reduction in sugar level is chiefly contributable to the depletion of soluble sugar during blanching process (Li *et al.*, 13). Higher dehydration temperatures promote the breakdown of polysaccharides, such as starch, into simpler sugars, including monosaccharides and disaccharides, which contribute to the overall sugar levels.

After dehydration, the ascorbic acid quantity in dasheen taro wafers exhibited considerable variation (Fig. 1). The maximum vitamin C was noticed in the untreated samples (17.55 mg/100 g and 15.69 mg/100 g) dried at 50°C and 60°C, respectively. Whereas least value was found in HWB treated wafers (10.00 mg/100 g and 8.48 mg/100 g). Thermal degradation and leaching out are the main reasons for the lower value of obtaining blanching-treated chips. Additionally, a small loss of vitamin C occurred during citric acid (CA) treatment, likely due to its water-soluble nature, which did not provide protection during the drying process. A comparable finding was revealed by Sun *et al.* (19) in the investigation on tuber dehydration.

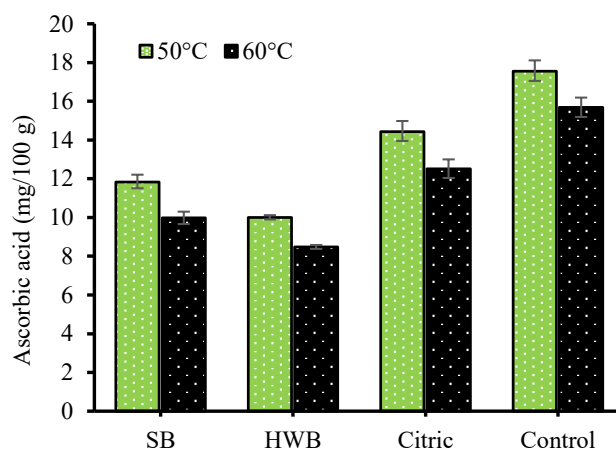


Fig. 1. The effect of drying temperatures and pretreatments (steam blanching (SB), hot water blanching (HWB) and citric acid) on ascorbic acid of dried slices.

Table 2: Effect of different pretreatment on sensory score of fried taro slices.

Treatment	Colour		Taste		Crispiness		Overall acceptability	
	55°C	60°C	55°C	60°C	55°C	60°C	55°C	60°C
SB	6.82	6.91	7.72	7.91	6.71	6.92	6.81	7.05
HWB	7.61	7.83	7.81	8.02	6.84	7.01	7.82	8.14
Citric	6.71	6.92	7.64	7.91	6.63	6.94	7.71	7.91
Control	5.44	5.86	6.96	7.18	5.91	6.12	6.69	6.96

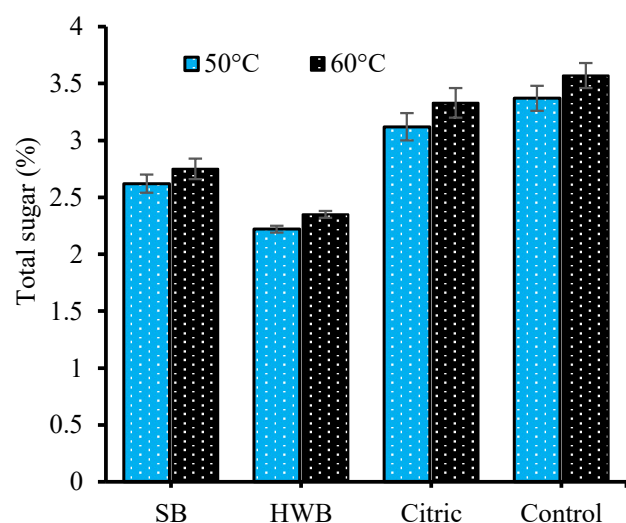


Fig. 2. The effect of drying temperatures and pretreatments (steam blanching (SB), hot water blanching (HWB) and citric acid) on total sugar.

The maximum amount of total phenol was recorded in untreated chips (144.64 mg/100 g) dried at 50°C (Fig. 3). The lowest value was observed in HWB (90.31 mg/100g) dried at 60°C. Water blanching results in greater phenol leaching compared to steam blanching and citric acid treatment at different temperatures. It mainly due to the high solubility of phenolic substances in water. There are conflicting results. Lavelli *et al.* (12) observed that higher temperatures could increase the release of bound polyphenols by breaking down cell wall phenolic compounds, but our result was supported by Kuyu *et al.* (11) they said that thermal processing adversely affected polyphenol stability.

The impact of various pre-treatments on sensory qualities has also been evaluated. The treated with HWB and drying at 60°C secured the highest mark for colour (7.83), crispiness (7.01), taste (8.02) and acceptability (8.14) relative to the other dehydrated wafers (Table 2). followed by stem blanching and citric acid-treated slices. It is suggested that blanching helps to leach out sugars and phenolic compounds, which are responsible for

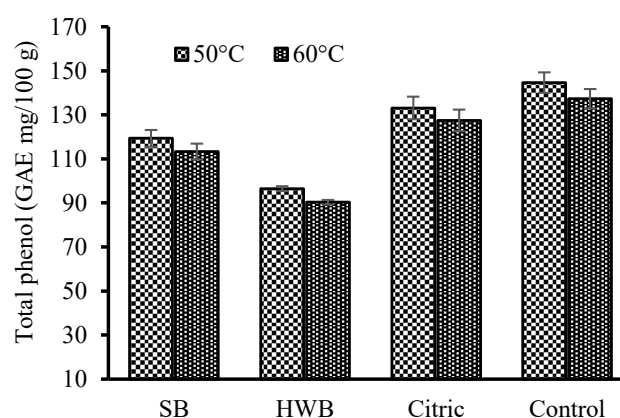


Fig. 3. The effect of drying temperatures and pretreatments (steam blanching (SB), hot water blanching (HWB) and citric acid) on total phenol.

browning in dehydrated bunda taro slices due to the Maillard reaction. As a result, the control sample had a lower colour score. The color appearance of food is the first quality characteristic assessed by consumers, and it plays a crucial role in influencing product acceptance, even before tasting (Santis *et al.*, 17).

Considering the substantial losses of taro in India during the peak season due to inadequate post-harvest management, we analyzed the outcomes of water blanching, steam blanching, and citric acid pretreatment, followed by drying at different temperatures, on the quality traits of dehydrated dasheen taro wafers. The results showed that nutrient losses were higher in samples dried at higher temperatures. The water-blanching samples exhibited the highest rehydration ratio and overall acceptability, while the lowest rehydration ratio and the highest levels of phenols and ascorbic acid, were found in the control samples. The study concluded that optimal quality dehydrated dasheen taro wafers were achieved through water blanching and drying at 60°C.

AUTHOR'S CONTRIBUTION

The Conceptualization of research (SM, IC, AM); Designing of the experiments (SM, SC, GK);

Contribution of experimental materials (SM, SC, KD); Execution of the experiments and data collection (SC, KD); Analysis of data and interpretation (SM, SC); Preparation of the manuscript (SM, SC).

DECLARATION

The authors declare that they do not have any conflict of interest.

ACKNOWLEDGEMENT

The authors would like to acknowledge the BCKV, and AICRP on Tuber crops, Mohanpur for providing resources and facilities.

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(Received : February, 2025; Revised : September, 2025;
Accepted : March, 2026)