Influence of Pre-treatments on Quality of Dehydrated Ripe Banana (*Musa acuminata* cv. *Embul)*

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ABSTRACT

A study was undertaken to examine the influence of different pre-treatments on drying rate and quality of ripe banana. The effects of pre-treatments such as blanching, chilling, freezing and combination treatments on the quality of bananas (*Musa acuminata* cv. *Embul)* were investigated. The banana fruits were dehydrated at 40ºC in a heat pump dehumidifier dryer at the air velocity of 3.0 m/s until the final moisture content of approximately 20% of dry weight basis was achieved. The drying rates of all treatments were high initially when the moisture content was highest then decreased rapidly. The blanched samples had the highest moisture content whereas the frozen fruit samples resulted in the shortest drying time compared to other treatments. The overall drying rate of banana after application of freezing was found to be significantly ($P<0.05$) faster than those of freezing not involved. The level of total sugars, vitamin C and pH were significantly higher in the blanching process followed by the combined blanching and freezing. The vitamin C content of the blanched sample was 41.7 mg/100g which was significantly highest among the treatments. The results of the sensory evaluation revealed that the preference rating of colour of the blanched fruits was found to be significantly higher than that of blanching was not involved. Combined blanched and frozen bananas before drying improved their overall acceptability as a result of inactivating the enzymes responsible for browning. Therefore, combined blanching and freezing could be used as a pre-treatment to produce high quality dried banana where the banana fruits are produced in surplus annually.

Keywords: Bananas, chemical composition, dehydration, sensory evaluation

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INTRODUCTION

Banana (*Musa acuminata*) is the most widely cultivated and consumed fruit in the tropical and sub tropical regions of the world where they constitute a major staple food crop for millions of people. It is an alternative perennial fruit crop for farmers due to its high economic gains throughout the year. When considering the production, it is the second important crop in the world. However, banana being a delicate highly perishable fruit, the production is subjected to serious postharvest problems including premature ripening, losses due to diseases, mechanical damages such as bruising, poor quality due to inappropriate ripening environments and losses in different markets due to its limited shelf life (Deka and Choudhury, 2006).

The postharvest losses of banana account about 35-40% in Sri Lanka. A large quantity of unmarketable surplus is available in the banana growing areas and very few processed products are marketed in Sri Lanka. Processing of banana into diverse products with longer shelf life such as fruit powder, chips, puree and beverages has been proposed as a way of absorbing seasonal surpluses and thus increasing and stabilizing farmers' income (Balasooriya *et al.*, 2006). Postharvest losses of banana could be substantially reduced if suitable processing methods are available to local small-scale processors to undertake onsite processing of banana. Small-scale processors using simple technology and equipment could produce dehydrated banana in the form of dried banana fruit. Unmarketable small-sized fruits and surface-blemished fruits could be utilized to produce dried banana chips. There is a potential to use banana chips powder in drinks, desserts, baby foods, sweets and other products (Deka and Choudhury, 2006).

Pre-treatments such as chilling, freezing, blanching, osmotic dehydration and combination treatments have been investigated in order to improve the drying efficiency and product quality of fruits (Sankat *et al.,* 1996). Hot water blanching increased the drying rate of products such as sugar beet, carrot, mangoes and chillies (Mate *et al.,* 1998). Freezing the products before drying also increased the drying efficiency in green beans and carrots (Eshtiaghi *et al.,* 1994). The objectives of this study were to determine the effects of different pre-treatments on the drying efficiency of banana and to assess the physico-chemical and organoleptic qualities of the dehydrated banana chips.

MATERIALS AND METHODS

Fully matured unripe bananas (cv. Embul) were obtained from a wholesale market and the fruits were separated carefully with a knife. The fruits were ripened in a humidity control cabinet at 20±0.5°C and the relative humidity of 85-90% until they attained the edible ripe stage with the peel colour of yellow. The ripe fruits were cut into round slices of 5 mm thickness and randomly divided into 6 groups for treatments. Approximately 1 kg of banana slices for each treatment was dipped into 1000 ppm potassium metabisulphite and 0.5% citric acid to prevent the discolouration and off-flavour development (Nelsen and Tressler, 1980). The ripe banana slices were treated before drying as follows;

Untreated or Control

Bananas were weighed and loaded directly onto drying trays without any pre-treatment.

Blanched

Fruits were blanched in boiling water for 3 min and cooled completely with tap water in a bath for 3 min to remove excess heat from the material, then drained on a stainless steel mesh.

Chilled

Bananas were held in cold room at 0°C for 24 h. The chilled fruits were taken and left at room temperature for 3 h before being dried.

Frozen

Bananas were frozen at -20°C for overnight (12 h) and thawed at room temperature for 3 h before drying.

Combined Blanched and Frozen

Bananas were blanched, frozen and thawed as described earlier.

Combined Blanched and Chilled

Bananas were blanched and chilled as described in the previous treatments.

Treated bananas slices from each of the treatments were placed in perforated stainless steel trays and dried in a heat pump dehumidifier dryer at a temperature of 40ºC using an air velocity of 3.0 m/s with the co-current drying method. Weight of the trays and the product were recorded every hour during drying using an electronic balance until the final moisture content of approximately 20% dry weight basis was attained. Initial moisture content of all the samples was determined using the standard vacuum method at a temperature of 70ºC for 24 h. Drying rates were calculated based on the weight of water removed per unit time per kg throughout the drying process. Overall drying rate was calculated and defined as the ratio of total mass to water removed (kg) per unit mass of banana divided by total drying time (hour).

The powder was obtained by grinding the dried material in a blender for 3 min and stored in glass airtight containers. The chemical characteristics of the dried banana powder were assessed using standard AOAC methods (2000). The ascorbic acid content was determined using sodium salt of 2, 6-dichlorophenol indophenol dye. Measurement of total acidity was conducted using a standard 1% phenolphthelene solution, titrated against

0.1 N NaOH and the result was expressed as percentage of citric acid in the sample and the pH was measured using a pH meter (Model-Beckman SS-3) with a glass electrode. The total sugar content was estimated by Lane and Eynon method using Fehling's solutions. Three replicates were carried out for each parameter. The organoleptic quality of dried banana slices from each treatment was evaluated by 20 members of trained sensory evaluation panel. The dehydrated bananas slices were numbered using three digit random numbers and codes were changed for each session. The evaluation was held either 10 am for the morning session or at 2 pm for the afternoon session. Panelists were asked to rate them for colour, texture, flavour, taste and overall acceptability using a nine-point hedonic scale in which 1 is denoted as "dislike extremely" and 9 denoted as "like extremely".

Data were subjected to analysis of variance and the mean differences of physico-chemical characteristics were determined by the Duncan's multiple range test at 5% significant level. Descriptive statistics was done on sensory attributes and the means were compared using the Tukey's test ($P<0.05$).

RESULTS AND DISCUSSION

Drying Rate

Drying rates of all treatments were high initially when the moisture content was highest, then decreased rapidly until all were losing moisture at a similar rate after about 5 h of drying (Figure 1). This was due to free moisture near the surface of the product being removed early in the process. The initial drying rate was fastest for the blanched treatment but the rate dropped quickly to be slower than that of the two treatments involved freezing. The high initial drying rate probably occurred because the blanched samples gained moisture during the blanching and cooling process that was manifested as an increase in the initial moisture content.

The initial moisture content of the blanched samples was significantly ($P<0.05$) higher than the other samples. The samples frozen only had the lowest moisture content as a result of cell rupture during freezing which led to water loss during thawing. The initial drying rate of banana after blanching and freezing was slower than that of the banana which had only been blanched because of a reduction in available free water caused by drip loss observed during thawing after freezing (Cano *et al.*, 1996). The initial drying rate of chilled samples was similar to that of untreated bananas and both of these drying rates were less than that of other three treatments (Figure 1). This indicates that these two treatments have no effect on the cell structure of the material being dried. The blanched treatment did not significantly ($P>0.05$) result in reduce the drying time compared with the control however, this was greater when the fruits were treated with a combination of blanching and freezing as the drying rate of this treatment was significantly faster when compared with that of control (Table 1). The overall drying rates of banana dried after the application of freezing was significantly higher than those treatments where freezing was not involved. This indicates in order to increase the drying rate, bananas need to be frozen as part of any pre-treatments. The higher drying rate and faster drying time of frozen samples was because freezing causes disruption which allows moisture to be removed more easily.

Chemical Composition of Dehydrated Banana

The values of the chemical indices in dried banana (Table 2) were influenced by the different pre-treatments applied to fruits before drying. The level of total sugars, vitamin C and pH were significantly ($P<0.05$) increased by the blanching process. A tendency of decreasing content of total acids was observed in the combined blanched and frozen treatment. These results were reflected in the sensory evaluation parameters as leaching losses of acidity. Freezing caused deterioration in the texture of fruits accompanied by decrease in the content of vitamin C while an even higher level of the vitamin C was recorded in banana after blanching. The losses of vitamin C are due to the activity of enzymes particularly in an oxygen environment. Inactivating or disrupting oxidative enzymes resulted in better retention of vitamin C in banana. In the present work, a fairly pronounced increase in total sugars was recorded irrespective of the applied pre-treatments. Horti *et al.* (1999) observed a significant increase in the content of total sugars in relation to the blanching time and temperatures of the treatments. Ponting (1993) reported that pre-treatments such as blanching and freezing prior to drying were beneficial to quality of the product.

Sensory Evaluation

The results of sensory analysis of banana from all of the dried samples are presented in Table 3. The preference rating for colour of the blanched samples was significantly higher compared to all other treatments. This product had an attractive yellow colour. There were no significant ($P>0.05$) differences between the colour rating of control and the frozen samples or between the chilled and frozen samples. The highest texture score was observed in the control fruits while the lowest score was noted in the blanched only samples. The texture of the samples which had been blanched and frozen was more preferred to chilled or frozen treatments. The score for flavour was highest in the blanched and frozen fruits and lowest in the blanched samples. The preference rate for flavour of the samples that had been frozen was significantly higher than that of chilled only samples. Differences are probably owing to retention of banana flavour compounds during freezing pre-treatment. The taste of the samples which had been frozen only was less preferred to combined blanched and frozen treatments. The overall acceptance score for the bananas from the combined blanched and frozen treatment was significantly higher than that of other treatments except for control fruits. Blanching and freezing of bananas before drying improved their overall acceptability as a result of inactivating the enzymes responsible for browning reactions (Turhan and Sahbaz, 1988) and reduction in available free water caused by drip loss during thawing after freezing (Cano *et al*., 1996).

CONCLUSIONS

Surplus unmarketable banana fruits can be reduced, if these fruits are dehydrated and processed into banana chips and powder. The banana powder could be used for the production of jam, soft drinks, alcoholic beverages, baby foods, vinegar and other confectionary items. The results of this study revealed that pre-treatments such as combined blanching and freezing significantly ($P<0.05$) increased the drying rate and therefore decreased the drying time of bananas. This could provide a major means of reducing processing cost through increased drying efficiency. Drying of frozen bananas without thawing could reduce the amount of thaw-exudates, thereby improving the product quality. Based on the results, the combined blanching and freezing could be applied as a pre-treatment to produce high quality banana chips in the areas where the banana fruits are produced in surplus annually. Extending the production and sale of banana chips in the super markets will enable the consumers to purchase the good quality products with the extended shelf life and quality.

Table 1: Moisture content, drying rate and drying time for banana dried at 40°C after the application of pre-treatments

Treatments	Moisture Content (% db)	Drying Rate (kg kg^{-1} h^{-1})	Drying Time (h)
Control	20.7 b	0.086 c	9.1 a
Blanched	24.4 a	0.084 c	8.7 ab
Chilled	21.4 b	0.081 c	8.6 b
Frozen	19.2 c	0.121 a	6.9 d
Blanched and Frozen	18.0 d	0.132 a	7.9 c
Blanched and chilled	23.6 a	0.099 b	8.0 c

Values followed by the same letter in the same column did not significantly differ at 5% significant level.

Table 2: The levels of chemical indices of the dehydrated banana following application of pre-treatments

Treatments	Total acidity (% citric acid)	pH	Vitamin C (mg/100g)	Total Sugars (mg/100g)
Control	0.74 a	4.01 d	34.4 c	75.7 c
Blanched	0.59 c	4.37 a	41.7 a	83.6 a
Chilled	0.69 b	4.12 c	34.1 c	77.2 b
Frozen	0.68 b	4.19 b	32.8 c	78.2 b
Blanched and frozen	0.60 c	4.22 b	39.1 b	80.2 b
Blanched and chilled	0.67 b	4.20 b	38.0 b	79.0 b

Values are means of four replicates.
Values followed by the same letter in the same column did not significantly differ at 5% probability level.

Table 3: Sensory qualities of banana dried in a dehumidifier at 40°C after the application of pre-treatments

Treatments	Colour	Texture	Flavour	Taste	Overall Acceptability
Control	7.0 b	8.1 a	7.7 b	8.0 a	7.9 ab
Blanched	8.2 a	7.4 c	7.6 b	8.1 a	7.7 b
Chilled	6.7 b	7.6 b	7.7 b	7.6 b	7.4 c
Frozen	6.9 b	7.6 b	8.0 a	7.2 c	7.3 c
Blanched and frozen	8.1 a	8.0 a	8.1 a	7.9 a	8.2 a
Blanched and chilled	8.0 a	7.8 ab	8.0 a	7.2 c	7.4 c

Nine point hedonic scale, 1 – Dislike extremely 9 – Like extremely
Values followed by the same letter in the same column did not significantly differ at 5% probability level.

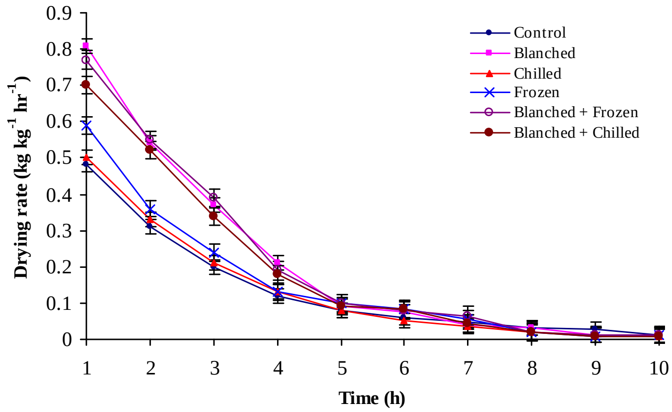

Figure 1: Drying rates of Bananas at 40°C in the heat pump dehumidifier after application of pre-treatments

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