The Dehydration of the Green Herb, Shado Beni: Blanching Treatments, Drying Behaviour and Organoleptic Properties

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The effects of blanching treatments prior to drying on the drying behaviour of the herb, shado beni (Eryngium foetidum L.) at 55°C was investigated. The blanching treatments studied were: steam, water and alkali (magnesium carbonate). The cellular structure of the herb was unaffected by steam blanching and this pre-treatment had no effect on the drying rate. Water and alkali blanching increased drying rates. For such herbs, shrinkage (linear) occurred during blanching. Drying rate constants were 1.895 h^{-1} for water blanched shado beni (shrinkage of 5.2%) and 2.144 h^{-1} for alkali blanched shado beni (shrinkage of 26.3%) as opposed to 1.397 h^{-1} for unblanched shado beni. Water blanched shado beni was highly favoured by a consumer panel as this pre-treatment was judged best for colour, aroma and flavour.

1. Introduction

Shado beni (*Eryngium foetidum* L.) also called "bhandhanya" in Trinidad and Tobago or "culantro" or "cilantro" in Latin America, is a pungently scented green herb. It is widely used in Trinidad and Tobago as a seasoning/flavouring agent for meats and in appetizers such as "chutneys", "amchars" and "kuchelars". The herb also has culinary uses in Guyana and Latin America [1].

Shado beni has considerable export market potential to Europe and North America. The fresh herb however wilts rapidly under ambient tropical conditions and must be air freighted immediately after harvest. In an attempt to develop a dehydrated product with quality attributes similar to fresh shado beni, Maharaj and Sankat [2] investigated the effects of blanching methods and drying conditions on the quality (colour and essential oil content) of the shado beni dried under natural and forced convection conditions. Blanching in water or alkali (magnesium carbonate) minimised loss of the green colour typical of the fresh shado beni while oil yield, irrespective of blanching treatments was higher under forced convection drying. The organoleptic characteristics of the dried herb were not reported. Sankat and Maharaj [3] also investigated the drying behaviour of the shado beni at 35 - 65°C under natural convection conditions and in solar dryers. Drying at all temperatures occurred in the falling rate period.

The objectives of this study were:

(i) To determine the effect of prior blanching in steam, water and magnesium carbonate on the drying behaviour of shado beni at 55°C under forced convection drying conditions and

(ii) To evaluate the organoleptic characteristics of the dried herb.

2.0 Materials and Methods

2.1 Drying Characteristics

Pre-treatments prior to drying the uncut herb were:

(i) Blanching in steam (96°C/6 min),

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(ii) Blanching in near boiling water (100°C/ 10 s) and

(iii) Blanching in hot water (100°C) containing magnesium carbonate (0.09%/10 s).

These procedures were fully outlined by Maharaj and Sankat [2]. Unblanched shado beni served as the control. Shado beni (257 g per treatment) was placed in a circular wire-meshed basket of radius 0.125 m (bed depth approximately 0.025 m) and dried to near constant weight at 55°C in a forced convection drying apparatus previously described by Sankat et. al., [4]. For fresh shado beni, because of the rapid shrinkage of the herb, the bed depth was reduced from 0.09 m to approximately 0.03 m after only 15 min of drying. Heated air was passed upwards through a cylindrical glass-drying chamber containing the perforated basket into which the herb was placed. The basket was suspended from the underhook of a laboratory balance (Sartorius Gmb H, Model 1216MP, Germany). Air flow through the basket containing the herb was 1.6 m/s. The weight of the suspended basket was determined at 15-min intervals for the first hour of drying, followed by half-hour intervals for the next two hours of drying. Beyond this time, weighing intervals increased to one hour and drying was allowed to proceed until there was virtually no change in weight with time. As the bed was very porous, it was assumed that the drying air conditions surrounding the crop were unlikely to change with bed depth, in a forced convection situation. Hence, thin layer drying conditions were assumed.

2.2 Histological Evaluation

Shado beni (fresh and blanched) were cut into 10 mm^2 pieces and fixed in a 1:1:1 ratio of formalin : acetic acid : alcohol. The leaves were then dehydrated in an ethanol/tertiary butylalcohol series, infiltrated with and embedded in parafilm wax and sectioned transversely at 15 μm. The sections were mounted on glass slides stained in iron haematoxylin and examined under a Zeiss Photomat III microscope (Zeiss Company, Germany).

2.3 Organoleptic Evaluation

2.3.1 Drying Procedure

The effects of the pre-drying treatments and drying at 55°C under forced convection on the sensory characteristics of the shado beni were investigated. Previous studies by Maharaj and Sankat [2] showed that pre-drying treatments of water blanching and magnesium carbonate blanching gave the most acceptable products based on an objective evaluation of colour. Approximately 600 g of water blanched and magnesium carbonate blanched shado beni were dried for 3.5 h to a moisture content of approximately 10% wet basis.

2.3.2 Method of Preparation

For evaluation of the colour and aroma of the herb, 25 g of dried shado beni were ground using a Straub Model 4E Grinding Mill (the Straub Company, Croydon, P.A., USA). For evaluation of flavour, the dried shado beni was used in the preparation of an appetizer popularly called "mango chow" in Trinidad and Tobago. Mangoes of the Julie variety (mature green) were sliced to a thickness of 1 cm using a Hobart Food Processor (Model 1612ER, Hobart Corporation, Ohio, USA) and manually cut into cubes (approximately 1 cm x 1 cm x 1 cm). The fresh, finely chopped shado beni (87.5 g) and sodium chloride (5.25 g) were added to 350 g of the fruit. The appetizer prepared from the water blanched, dried shado beni was made in a similar manner using 7.49 g of the dried herb (equivalent to 87.5 g fresh shado beni).

2.3.3 Sensory Analysis

A semi-trained panel of 18 members comprising of individuals who were familiar with similar, sensory evaluations was used to evaluate the quality attributes of colour, aroma, taste and overall acceptability of fresh and dried shado beni. Panelists were asked to compare the quality attributes of colour and aroma of the ground herb with a reference (fresh shado beni). To compare for taste only, the herb was used in the preparation of the appetizer previously described. For each quality attribute evaluated, the direction (i.e., the quality change) and magnitude of the difference from the reference, if detected, were determined. Panelists were also asked to rank the samples according to their preference and the ranking data statistically analysed by the Kendall Coefficient of Concordance test [5]. For evaluation of the herb's flavour, 15 g samples of the mango chow were placed in polystyrene containers. For determination of the herb's colour and aroma, 15 g of fresh shado beni, 1.29 g of water blanched and 1.23 g of the alkali blanched herb (equivalent to 15 g of fresh shado beni) were placed in 50 ml beakers and covered with parafilm. The order of presentation was randomised for each panelist with each order of presentation triplicated.

3. Results and Discussion

3.1 Drying Characteristics

Figures 1 and **2** show the drying curves and the drying rate curves respectively of blanched and unblanched shado beni at 55°C. The drying rate curves (**Figure 2**) show a progressive decline in the drying rate with decreasing moisture content. Fitting the logarithmic form of the drying equation,

$$(M - M_e)/(M_o - M_e) = Ae^{-Kt}$$

$$\text{i.e. } \ln[(M - M_e)/(M_o - M_e)] = \ln A - Kt \text{ [6]}$$

to the drying data yielded fits through linear regression analyses with $0.966 \leq R^2 \leq 0.998$. In the above equation, M_o, M_e and M are the initial, equilibrium and the variable moisture content respectively, K is the drying constant and t is the drying time. The drying equation used is the simplified form (single term) of the solution to the diffusion equation and for a semi-infinite slab of half thickness a, the drying constant K_1 is directly related to the moisture diffusivity D by $K = \pi^2 D / 4a^2$. A is related to the shape of the material being dried and for a slab $A = 8/\pi^2$. This is the theoretical approach to the development of the drying equation [6]. Frequently a semi-theoretical approach is used which assumes A = 1 [7]. It is also noted that the drying rate curves can be broken into distinct falling rate periods, e.g., 1st falling rate period, 2nd falling rate period, etc., with drying equations fitted to each period [8]. For simplicity, and as good fits were obtained, single falling rate equations were considered only in this study.

For shado beni drying, near equilibrium occurred after 5 h and 4 h of drying for water and magnesium carbonate blanched herbs respectively with corresponding equilibrium moisture contents of 2.9 and 3.0% d.b. For the steam blanched and unblanched herbs, this was established after 6 h with respective equilibrium moisture contents of 6.4% and 4.1% d.b. These equilibrium moisture contents were used as M_e in the drying equation.

A summary of linear regression models fitted to the drying data is shown in **Table 1**. P* (probability of null hypothesis of the slope = 0) was ≤ 0.001 for all treatments investigated, indicating that the drying behaviour of blanched and unblanched shado beni can be characterised by single falling rate periods of drying as reflected by the good, linear fits in **Figure 3**. It has been reported that drying of steam blanched and unblanched basil, also a herb, at 35 - 60°C occurred in the falling rate period [9].

Figure 2 shows that the drying rate of steam blanched shado beni was less than the drying rates of the other treatments and the control. This was an unexpected result. The drying rate constants, obtained from the slopes of **Figure 3** also reflected this small, negative effect of steam blanching on the drying rate, i.e., 1.338 h^{-1} for steam blanched shado beni compared to 1.396 h^{-1} for unblanched shado beni. Apart from a slight enlargement of cells (increase by 20 μm) possibly due to expansion of the cell wall upon contact with steam, histological studies revealed no significant structural disruption of the herb during steam blanching (**Plate 2**). Thus, it is not surprising that the drying rate of the steam treated shado beni was no better than that of the unblanched herb. Saravacos and Charm [10] also found that steam blanching of potato had no significant effect on the drying rate when compared to the unblanched vegetable dried at 66°C.

In contrast, blanching of shado beni in water or magnesium carbonate resulted in appreciable shrinkage of cells and thus drying rates were higher. Drying rate constants were 2.144 h^{-1} for alkali blanched shado beni and 1.895 h^{-1} for water blanched shado beni (1.396 h^{-1} for the unblanched

TABLE 1: *Summary of Linear Regression Models fitted In* $[(M - M_e)/(M_o - M_e)] = \ln A - Kt$ [6] *for Shado Beni dried at 55°C*

Treatment	Estimated Slope (K)	Standard Error of Slope (K)	Degree of Freedom	t	P*	R^2
Steam blanched	1.3383	0.0836	9	16.01	≤ 0.001	0.966
Water blanched	1.8945	0.0885	8	21.40	≤ 0.001	0.983
$MgCO_3$ blanched	2.1439	0.1152	7	18.61	≤ 0.001	0.977
Unblanched (control)	1.3964	0.0191	9	73.10	≤ 0.001	0.998

P* denotes the probability of null hypothesis [Slope (K) = 0]
t denotes slope (K)/standard error of slope (K)
R^2 denotes coefficient of determination

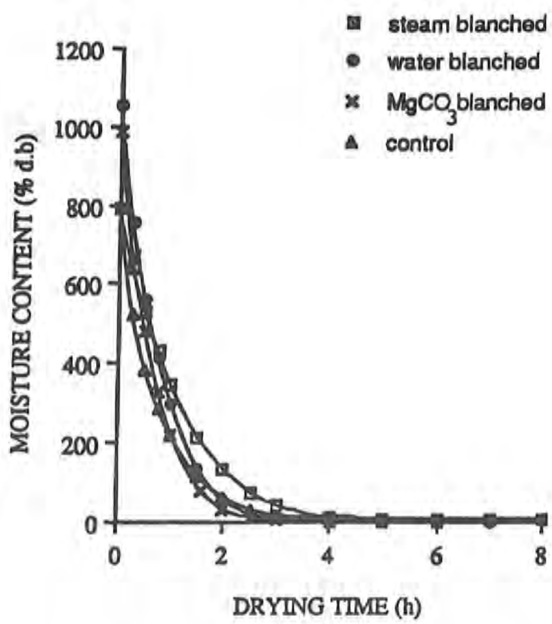

FIGURE 1: *Drying Curves for Blanched and Unblanched Shado Beni dried at 55°C under forced Convection*

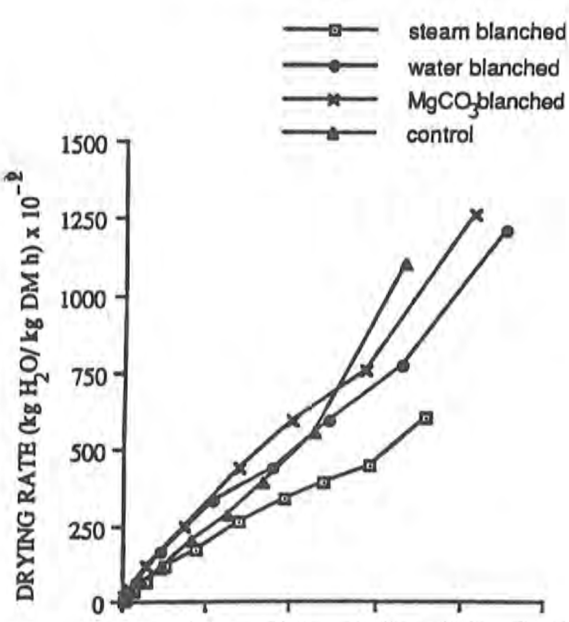

FIGURE 2: *Drying Rate Curves for Blanched and Unblanched Shado Beni dried at 55°C under forced Convection*

herb). The most prominent change observed for magnesium carbonate blanched shado beni was the plasmolysed appearance of the cells (**Plate 1**). Protoplasts had shrunken away from the walls of the cells with the resulting development of spaces between protoplasts and cell walls. There was also shrinkage of the cells with minimum wall destruction, and obliteration of the air spaces among the cells of the spongy mesophyll resulting in a reduction of the thickness of the leaves (% shrinkage of 26.3). Unlike alkali blanching, plasmolysis was not observed for the water blanched herb (**Plate 2**). However, the cells particularly those of the palisade parenchyma underwent some degree of shrinkage (5.2%) and as a result the drying rate constant for such herbs was lower, i.e., 1.895 h^{-1} (2.144 h^{-1} for magnesium carbonate blanched herb). Shrinkage was based upon the change in the linear diameter of the cells or the thickness of the leaves.

3.2 Organoleptic Evaluation

Mean rank scores for quality attributes of colour, aroma and flavour of fresh and dried shado beni are shown in **Table 2**. Shado beni blanched in magnesium carbonate (alkali) prior to drying at 55°C was the least acceptable (highest rank scores) for all the quality attributes examined. The mean rank score for the colour of this herb was 2.44 compared to 1.58 ($P \leq 0.05$) for fresh shado beni. Such herbs were rated as

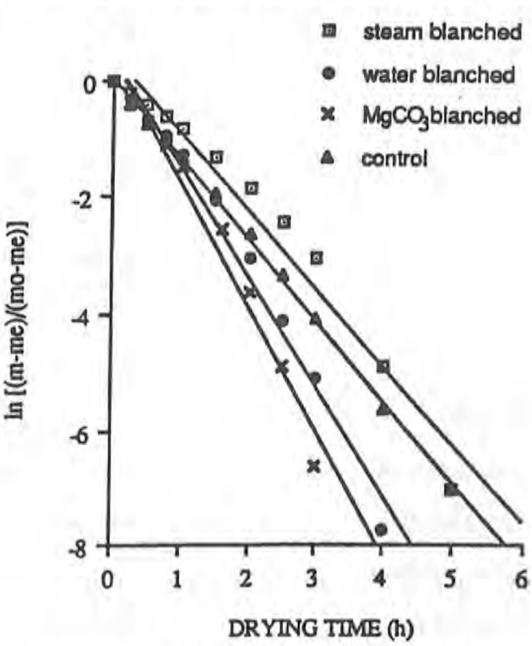

FIGURE 3: *Plots of the Logarithmic of Moisture Ratio vs. Time for Blanched and Unblanched Shado Beni dried at 55°C under forced Convection*

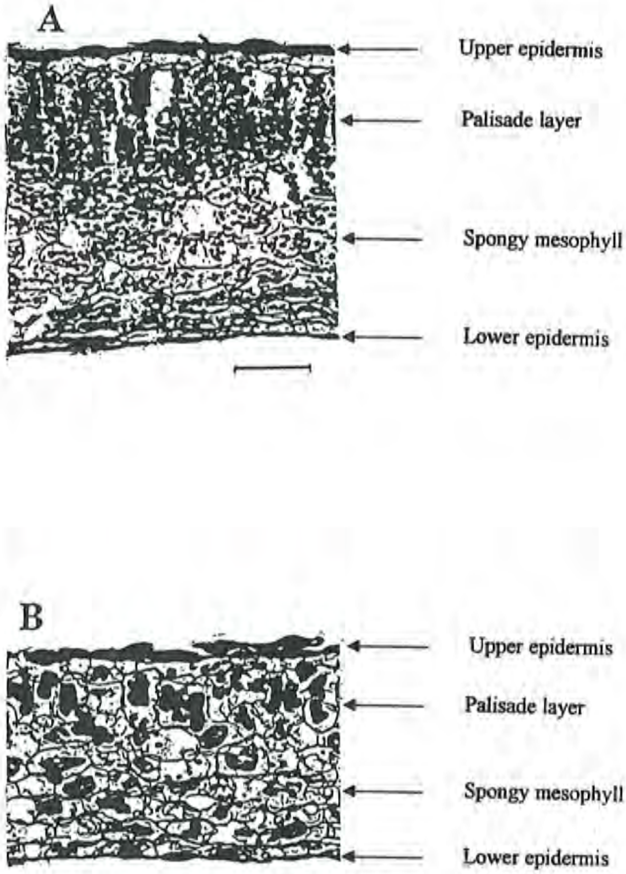

PLATE 1: *Transverse Sections (T.S) of Fresh (A) and Alkali Blanched (B) Shado Beni (1 bar = 50 μ m)*

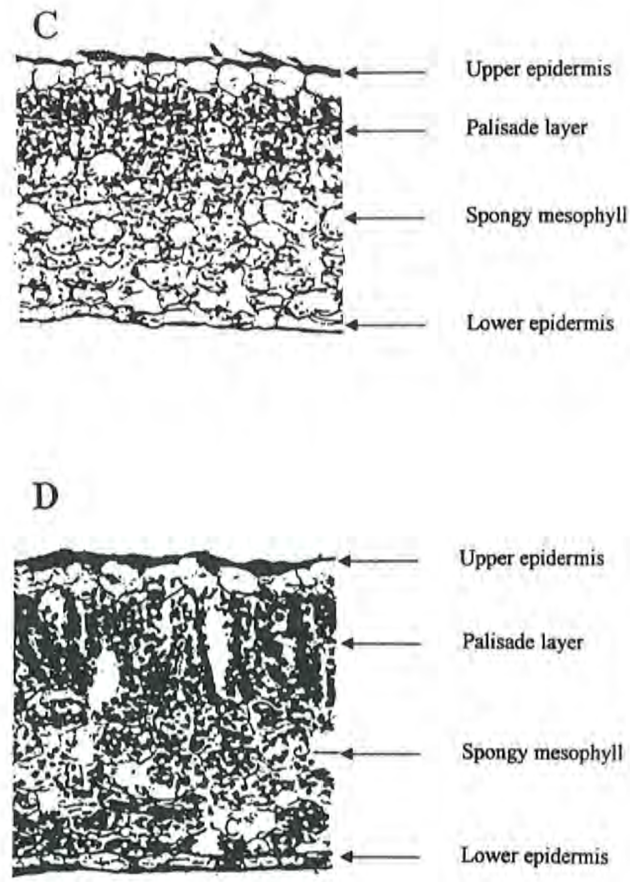

PLATE 2: *Transverse Sections (T.S) of Water (C) and Steam Blanched (D) Shado Beni (1 bar = 50 μ m)*

less green than fresh shado beni by 50% of the panelists. The mean colour score of water blanched dried shado beni on the other hand was lower (more acceptable), differing from the fresh herb by only 0.39 units (**Table 2**). Such herbs were rated as dark green by 61% of the panelists with slight to moderate differences from the fresh herb. The aroma scores of both alkali and water blanched dried shado beni were higher ($P \leq 0.001$) compared to fresh shado beni (**Table 2**) with the majority of the panelists (> 72%) indicating a loss in pungency during the blanching and/or drying processes. For flavour, alkali blanched shado beni was rated as inferior to fresh shado beni by 61% of the panelists. The mean rank score of such treated herbs was 2.56 compared to a low 1.47 for fresh shado beni ($P \leq 0.01$). The water blanched dried herb, with a lower mean rank value, i.e., 1.97 was rated as comparable to fresh shado beni by 28% of the panelists and superior to the fresh herb by 17%. The amount of difference from fresh shado beni was none (28%), slight (39%), moderate (16%) and large (17%). Such herbs were more acceptable than the alkali blanched, dried shado beni with 83% of the panelists indicating a willingness to purchase if commercially available, as opposed to only 56% for the alkali blanched dried herb. It must be noted that previous studies [3] had shown that drying the fresh, green herb, shado beni at 35 - 65°C (without any pre-treatments) resulted in an inferior product. Water blanching is therefore an attractive process, prior to dehydration.

TABLE 2: *Organoleptic Evaluation (Mean Rank Values) of Fresh and Dried Shado Beni*

Quality Factor	Mean Rank Values Alkali Blanched	Water Blanched	Fresh	w
Colour	2.44	1.97	1.58	0.194*
Aroma	2.64	2.19	1.17	0.587***
Flavour	2.56	1.97	1.47	0.347**

w denotes Kendall's coefficient of concordance
* denotes $P \leq 0.05$
** denotes $P \leq 0.01$
*** denotes $P \leq 0.001$

4. Conclusions

Drying of the shado beni (blanched and unblanched) under forced convection and at 55°C occurred via single falling rate, diffusion controlled periods of drying. The drying rate of the herb was influenced by cellular changes which occurred during the blanching process. Steam blanching of shado beni did not improve the drying rate as the drying rate constant was somewhat lower compared to that of the unblanched herb. There was no overall tissue deformation with steam blanching. Water and magnesium carbonate (0.09%) blanching pre-treatments on the other hand, resulted in the shrinkage of cells and consequently, the rates of moisture removal from such herbs were higher. Compared to the alkali- treated herb, water blanched, dried shado beni was more acceptable with respect to flavour, colour and odour. The results indicate the potential for the development of a dehydrated product, which can be used as an alternative to the fresh shado beni.

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References

[1] Morean, F. (1988). "Shado Beni - A Popular Caribbean Seasoning Herb and Folk Medicine". F. Morean. Trinidad.

[2] Maharaj, V. and Sankat, C.K. (1996). "Quality Changes of the Green, Culinary Herb, Shado Beni *(Eryngium foetidum Linn.)* during Dehydration". West Indian Journal of Engineering. Vol. 19. pp. 1-9.

[3] Sankat, C.K. and Maharaj, V. (1994). "Drying of the Green Herb (*Eryngium foetidum* L.) in Natural Convection Cabinet and Solars Dryers". ASEAN Food Journal, Vol. 9. pp. 17-23.

[4] Sankat, C.K., McGaw, D.R. and Bailey, A.M.H. (1992). "Factors influencing the Drying Behaviour of Copra". Drying '92 - Part B. Elsevier Science Publishers, Amsterdam. pp. 1436-1445.

[5] Siegel, S. (1956). "Nonparametric Statistics for the Behavioural Sciences". McGraw-Hill Company. New York. pp. 229-239.

[6] Henderson, S.M. and Perry, R.L. (1976). "Agricultural Process Engineering". AVI Publishing Company. Inc. Connecticut. pp. 302-339.

[7] Brooker, D.B., Bakker-Arkema, F.W. and Hall, G.W. (1974). "Drying Cereal Grains". AVI Publishing Company. Inc. Connecticut. pp. 189-191.

[8] Sankat, C.K., Castaigne, F. and Maharaj, R. (1996). "The Air Drying Behaviour of Fresh and Osmotically Dehydrated Banana Slices". Int. Journal of Food Science and Technology. Vol. 31. pp. 123-135.

[9] Rocha, T., Lebert, A. and Marty-Audouin, C. (1993). "Effects of Pre-treatments and Drying Conditions on Drying Rate and Colour Retention of Basil (*Ocimum basilum*)". Lebensmittel-Wissenschaft und-Technologie. Vol. 26. pp. 456-463.

[10] Saravacos, G.D. and Charm, S.E. (1962). "A Study of the Mechanism of Fruit and Vegetable Dehydration". Food Technology.