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Influence of pre-treatments on dehydration characteristics and quality of dehydrated okra

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ABSTRACT

Okra fruits of cv. F152, either whole or sliced, were pre-treated with hot water blanching (100°C for 0.5 min.), sodium metabisulphite (0.2% $Na_2S_2O_5$ for 1 min.), microwave blanching (1 min.) and a control (without pre-treatment) and subjected to dehydration at two levels of temperature at 50° and 55°C. In general, drying time decreased with increase in temperature, but the quality was better maintained at lower temperature (50°C) in most of the treatments. Moisture content reduced at faster rate with time at a higher temperature in most treatments. Rehydration and dehydration ratio of sliced fruits with $Na_2S_2O_5$ (TS_3), microwave blanching (TS_4) and control were higher compared to dehydrated material at 55°C. With regard to retention of chlorophyll and ascorbic acid, 0.2% $Na_2S_2O_5$ (sliced) treatment at 50°C (TS_3) retained maximum ascorbic acid followed by microwave blanching of whole fruit at 50°C (TW_4) and control with sliced fruit at 50°C (TS_1). With regard to sensory attributes sliced fruits treated with 0.2% $Na_2S_2O_5$ treatment at 50°C showed the best result.

Key words: Dehydration, okra, ascorbic acid, chlorophyll, drying temperature.

INTRODUCTION

India is the largest producers of okra (*Abelmoschus esculentus* (L) Moench.) in the world. It contains carbohydrates, protein and vitamin C in large quantities and plays a vital role in human diet. Okra is very delicate and highly perishable crop and thus, has a very short storage life of two or three days under ambient condition. To enhance the shelf-life and prevent the wastage during peak season, preservation and processing of okra is necessary. Among them, dehydration is suited for developing countries. However, the mucilaginous substances and the immature diminutive seeds at the interior part of the fruit hinder the process of dehydration smoothly and develop poor colour, texture and dehydration characteristics. The considerable oxidation of ascorbic acid and degradation of chlorophyll associated with hot air-drying is reported to cause degraded colour (Shakuntala and Shadaksharaswamy, 8; Stone *et al.*, 11) and also nature of material (*i.e.*, size, whole or sliced okra, etc.) to be dehydrated appreciably affects the texture and quality of produce (Mulay *et al.*, 6; Stone *et al.*, 11). Thus, the present investigation was undertaken to standardize the size/ type of material (whole or sliced okra), dehydration temperature and pre-treatment for dehydration of okra.

MATERIALS AND METHODS

Tender okra fruits (5-6 cm) of hybrid cultivar F152, harvested from Mondouri Horticultural Research Station, BCKV, West Bengal, were used for the experiment. The fruits as a whole (TW) and sliced (TS) (3-4 mm thickness) were pre-treated with hot water blanching (100°C), hot water containing sodium metabisulphite (0.2% $Na_2S_2O_5$ for 1 min.), microwave blanching (1 min. at 90% power) and one of the lot was kept as control. The pre-treated samples were then subjected to dehydration at two levels of temperature, *i.e.*, 50° and 55°C. Thus, details of the treatment combination are as follows; TW1= control (50°C), TW2 = Hot water blanching (50°C), TW3 = 0.2% $Na_2S_2O_5$ (50°C), TW4 = Microwave blanching (50°C), TW5 = Control (55°C), TW6 = Hot water blanching (55°C), TW7 = 0.2% $Na_2S_2O_5$ (55°C), TW8 = Microwave blanching (55°C). TS1 = Control (50°C), TS2 = Hot water blanching (50°C), TS3 = 0.2% $Na_2S_2O_5$ (50°C), TS4 = Microwave blanching (50°C), TS5 = Control (55°C), TS6 = Hot water blanching (55°C), TS7 = 0.2% $Na_2S_2O_5$ (55°C), TS8 = Microwave blanching (55°C).

The pre-treatment and drying temperature was decided in this investigation based on earlier information by Stone *et al.* (11) and Shivhare *et al.* (10). A cabinet drier was used for drying purpose with a tray loading intensity of 4 kg/sq. m with air velocity of 4.7 m/ sec. During drying process the moisture removal pattern i.e., moisture content (% db), average moisture content (% db) and drying rate was observed periodically in order to study the drying characteristics of okra with respect to size (whole

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and slice), pre-drying treatments and temperature of drying. Average moisture content (% db) is the average of the two moisture content values at fixed time interval. After attaining almost constant moisture content of about 5% (db) the samples were unloaded and each sample of 15 g was packed in polyethylene bags (200 gauge) for further analysis. Dehydration ratio was determined in all the treatments after dehydration of okra. Rehydration ratio was computed according to the method described by Ranganna (7). The ascorbic acid content (mg/100 g as moisture free basis) was determined by 2, 6-dichlorophenol-indophenol dye and chlorophyll (mg/g as moisture free basis) was extracted with 80% acetone and measured by spectrophotometer method. Dehydrated sample was rehydrated for sensory evaluation on the basis of hedonic scale for colour and texture by a panel of 8 judges using 1-6 scale (Mulay *et al*., 6). The product with lowest score was judged best in sensory evaluation. Statistical analysis was done according to 2×4×2, factorial completely randomized design using standard statistical procedure.

RESULTS AND DISCUSSION

Dehydration curve indicated that time required to achieve a desired final moisture (about 5%) is influenced predominantly by the type of product (whole or sliced) and temperature of dehydration (Figs. 1 & 2). Higher temperature (55°C) resulted faster drying in sliced okra and it ranged from 6.5 h in TS_7 to 9 h in TS_8 as compared to whole okra both at 50°C (ranged from 10.5 h in TW_4 to 12.5 h in TW_1 and TW_2) and 55°C (ranged from 8 h in TW_2 to 11.5 h in TW_1). Similar pattern has been reported by Stone *et al.* (11). Sliced okra fruit dehydrated at 55°C gave the best result with regard to removal of moisture during dehydration than whole okra as reported by Shivhare *et al.* (10). The sliced fruits probably were better exposed to atmosphere resulting in easy exclusion of internal moisture at faster rate compared to whole fruit drying where the removal of internal moisture from the interior part of the fruit was difficult. Thus, sliced fruit took less time to attain the desired moisture level during drying. The non-linear moisture content-time relationship for most of the treatments was because of high moisture loss initially due to release of free moisture (Abhay *et al*., 1).

It appeared from drying rate vs average moisture content values (Figs. 3 & 4) that with the decrease in the average moisture content drying rate increased for a very short period and then decreased in all the treatments. The decrease in the drying rate with the average moisture content indicated that whole drying took place in the falling rate period and no constant rate period of drying was observed. It has been reported that almost all the drying of biological products takes

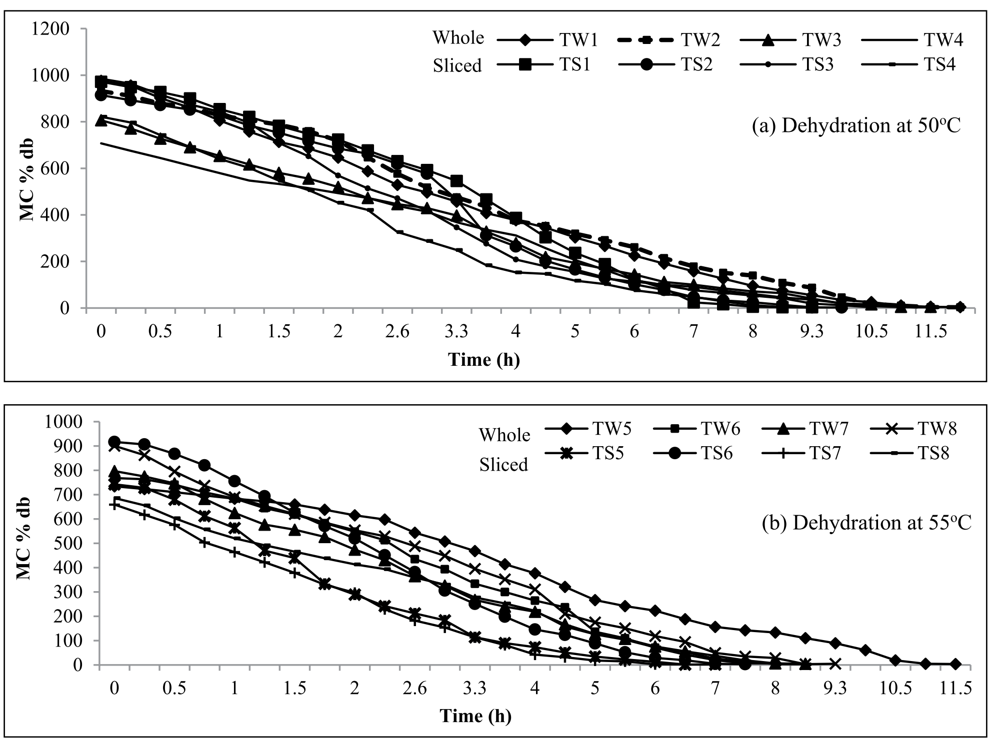

Fig. 1. Dehydration curve of okra fruits.

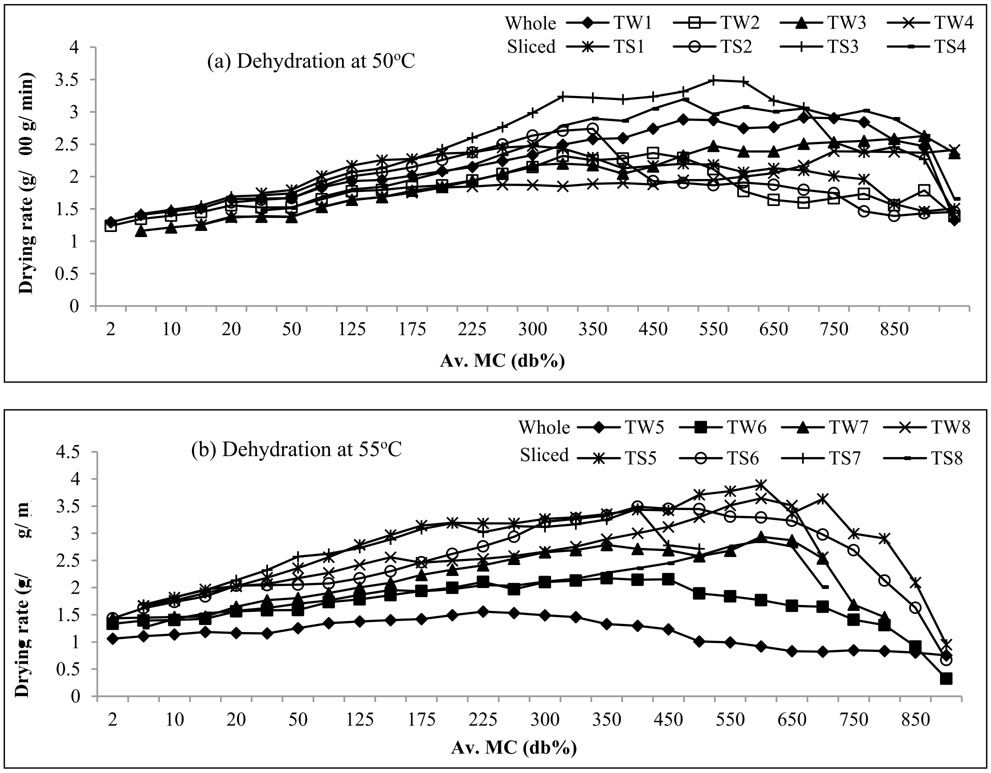

Fig. 2. Drying rate vs average moisture content curve of okra.

place in the falling rate period (Madamba *et al.*, 4), which is almost in agreement with our results.

Dehydration ratio and rehydration ratio is presented in bar diagram in Fig. 3. Dehydration ratio varied from 7.44 in TS_7 (*i.e.*, slice + $Na_2S_2O_5$ + drying at 55°C) to 10.52 in TS_3 (*i.e.*, slice + $Na_2S_2O_5$ + drying at 50°C). Other high dehydration ratio was observed 10.40 in TS_1 (*i.e.*, sliced + without treatment + drying at 50°C), 10.35 in TW_1 (*i.e.*, whole + without treatment + drying at 50°C), 10.02 in TW_2 (*i.e.*, whole + hot water blanching + drying at 50°C). Rehydration ratio of sliced fruits + drying at 50°C (TS_1 to TS_8) was higher (4.70 to 6.58) compared to sliced fruits + drying at 55°C, *i.e.*, TS_5 to TS_8 (4.04 to 4.79 rehydration ratio). Rehydration of whole fruits + drying at 50° and 55°C, *i.e.* TW_1 to TW_4 and TW_5 to TW_8 was much lower (2.16 to 2.27 and 1.73 to 2.13; resp). High rehydration ratio with $Na_2S_2O_5$ treatment + microwave drying has been recorded by Shams El-Din and Shouk (9) in sliced okra fruit. However, rehydration ratio decreases with increase in temperature of dehydration (Abhay *et al.*, 1). Dehydrated product sometimes did not recover their structural properties after rehydration as a result of structural damage during drying at higher temperature and the hysteresis phenomenon that takes place during rehydration (Magdalini and Zacharias, 5).

The interactions of treatment (Tr) × Type (Ty) × Temperature (Tm) were significant at 5% (Table 1). The interaction (Ty × Tr × Tm) effect showed that sliced fruit + $Na_2S_2O_5$ treatment at 50°C possessed maximum ascorbic acid (7.03 mg/100 g) followed by whole fruit + microwave blanching at 50°C (6.57 mg/100 g), whole fruit with no treatment (control) at 50°C and whole fruit + hot water blanching at 55°C (5.10 mg/100 g). However, the interactive effect of sliced fruit with $Na_2S_2O_5$ treatment at 50°C was at par with whole fruit treatment with microwave blanching at 50°C.

Further, whole fruit with microwave blanching at 50°C drying and sliced fruit with $Na_2S_2O_5$ treatment at 50°C drying was effective in retaining better ascorbic acid content. The higher drying temperature tends to hasten drying and in general rapid dehydration retained greater amount of ascorbic acid (Desrosier and Desrosier, 3). This is in contrary to present findings where lower dehydration temperature retained greater ascorbic acid. Shakuntala and Shadaksharaswamy (8) explained that ascorbic acid is unstable especially on exposure to heat and moisture. This is due to oxidation of ascorbic acid and it is converted into dehydro-ascorbic acid. In okra, SO_2 treatment before dehydration retained greater ascorbic acid content (Stone *et al.*, 11) due to inhibition of oxidative changes of ascorbic acid by SO_2 (Mulay *et al.*, 6).

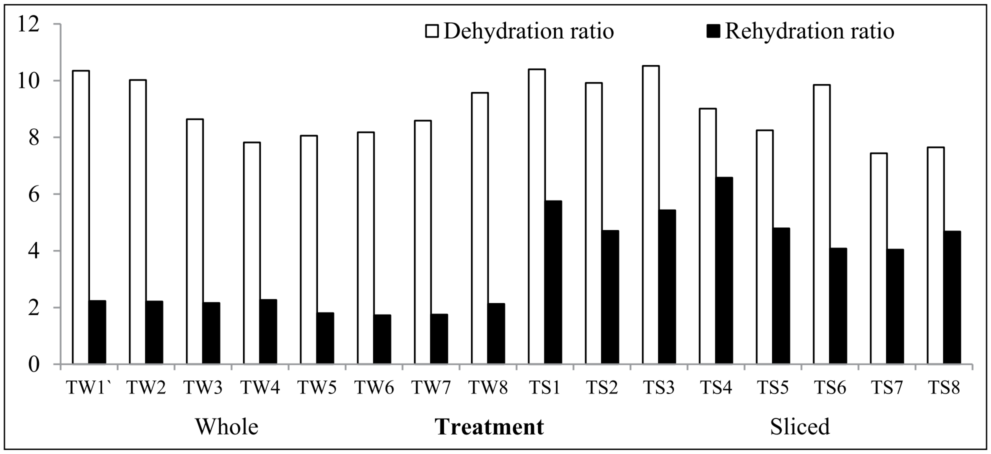

Fig. 3. Dehydration and rehydration of dehydrated okra.

The interaction of treatment, type and temperature (Tr × Ty × Tm) for total chlorophyll content is presented in Table 1. The sliced fruit with no treatment (control) and dehydration at 50°C recorded highest chlorophyll content (0.338 mg/g), followed by whole fruit with microwave balancing + dehydration at 55°C (0.331 mg/g), sliced fruit with $Na_2S_2O_5$ treatment + dehydration at 55°C and whole control fruits + dehydration at 50°C (0.248 mg/g). However, first and second interaction treatment and also the third and fourth interaction treatment are statistically at par.

High chlorophyll content in interaction treatment of whole fruits with microwave treatment at 55°C is because of greater retention of chlorophyll and carotenoids by microwave (Shams El-Din and Shouk, 9). In the present investigation different pre-treatment was less effective in the improvement of chlorophyll content whereas, control fruits possessed more chlorophyll. Bajaj *et al*. (2) in agreement to our findings also concluded that pre-treatment with chemicals like potassium metabisulphite resulted in considerable loss of chlorophyll.

Sensory evaluation as presented in Fig. 4 revealed that desirable colour and texture was obtained with TS_3 (0.2% $Na_2S_2O_5$ treatment), TS_4 (microwave blanching), TS_1 (control, sliced at 50°C), TS_5 (slice + control + 55°C) and TS_7 (0.2% $Na_2S_2O_5$ treatment at 55°C) treatments. Sensory scores for colour after dehydration showed outstanding fresh like in TS_3 and TS_4 with score 1 while TS_1, TS_5 and TS_7 showed bright

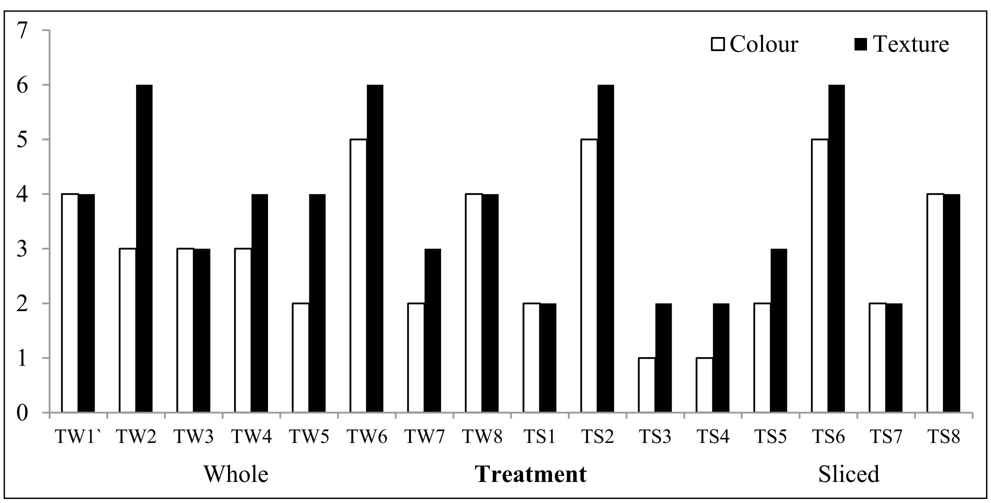

Fig. 4. Sensory score of rehydrated okra. TW1= control (50°C), TW2 = Hot water blanching (50°C), TW3 = 0.2% $Na_2S_2O_5$ (50°C), TW4 = Microwave blanching (50°C), TW5 = Control (55°C), TW6 = Hot water blanching (55°C), TW7 = 0.2% $Na_2S_2O_5$ (55°C), TW8 = Microwave blanching (55°C). TS1 = Control (50°C), TS2 = Hot water blanching (50°C), TS3 = 0.2% $Na_2S_2O_5$ (50°C), TS4 = Microwave blanching (50°C), TS5 = Control (55°C), TS6 = Hot water blanching (55°C), TS7 = 0.2% $Na_2S_2O_5$ (55°C), TS8 = Microwave blanching (55°C).

green colour free from blemishes (with score 2). Texture was also good in these treatments (scoring 2-3). However, sensory score of colour of whole fruits were not in accordance to chlorophyll content estimation, particularly of treatment TW_8 (whole + microwave blanching + 55°C) and TW_1 (whole + control + 50°C) because of the development of comparatively poor texture in whole fruits which virtually had a detrimental visual effect. Stone *et al.* (11) and Shams El-Din and Shouk (9) also revealed that general appearance and colour score of dehydrated okra samples treated with microwave was significantly better.

Thus, considering the dehydration characters and quality after dehydration it can be concluded that, TS_3 (sliced + 0.2% $Na_2S_2O_5$ + 50°C) and TS_4 (sliced + microwave blanching for 1 min + 50°C) were best treatment followed by TS_1 (sliced + control + 50°C), TS_7 (sliced + $Na_2S_2O_5$ + 55°C) and TS_5 (sliced + control + 55°C), because, these treatments took medium to less time for dehydration, drying rate and moisture reduction was medium to high. It also maintained high dehydration and rehydration ratio, retained better ascorbic acid content and sensory score with relation to colour and texture.

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