Australian Journal of Basic and Applied Sciences, 6(5): 230-235, 2012
ISSN 1991-8178

Characteristics of Dried Mango Slices as Affected by Pre-Treatments and Drying Type

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Abstract: The characteristics of dried mango (fresh slices Seddik and Fajri Kalan cvs). were studied using two types of drying (normal drying oven at 58°C for 28 h or vacuum drying oven at 80°C for 4 h.), also to study the effect of pretreatment with Sodium metabisulfite 1% for 10 sec. then at 2% concentration for 5 min. or adding powder Sucrose 20 gm. (surfaces addition) per 150 gm. mango slices on physical characteristics (colour parameters changes as the total colour change (ΔE), chroma (colour saturation), hue angle, browning index (BI) were determined. L* and b* parameters, the dried slices weight, slices cut force and the net dried slices ratio). The chemical characteristics rehydration and drying rate of mango slices were also measured. The total colour changes under normal drying were less than that the vacuum drying. Browning index under vacuum drying for Seddik cv. was less than that of the Fajri Kalan cv. whereas the verses of normal drying. The vacuum dried slices weight was higher than normal drying that vacuum drying these results whereas in general were insignificant between the other treatments and cultivars. The dried slices ratio values of normal drying was lower than that vacuum drying treatment. The net dried slices ratio of Seddik cv. was higher than Fajri Kalan cv. The rehydration percentage of dried slices under normal drying was higher than that vacuum drying. The Sodium metabisulfite treatment of Seddik by normal drying gave the highest value. The rehydration percentage of Seddik was higher than the Fajri Kalan. The drying ratio rate of mango slices dried under vacuum was higher than that normal drying.

Key words: *Mangifera indica* L., normal drying oven, vacuum drying, colour change, sodium metabisulfite, sucrose

INTRODUCTION

The mango (*Mangifera indica* L.) is one of the most important tropical crops. Egypt is one of the major producer countries in Africa. In Egypt mango becomes one of the main fruit crops which ranks the second after citrus.

The fruitful area attained (209040 feddan) representing 14.8 % of the total planted area of fruit trees and the annual production reached about 450000 tons according to the statistical report of Agriculture Directorates of Governorates in 2009.

The great bulk consumes as a table fruits, however few amount of fresh fruit are exported primary to regional markets. A great demand on processed mango products have enormously increased through the last few years. Dried mango slices are the most preferable mango products.

Drying is one of the most widely used as a methods of food preservation. The objective of drying is to remove water to the level at which microbial spoilage and deterioration reactions are greatly minimized (Akpinar and Bicer, 2004). It also provides longer shelf-life, smaller space for storage and lighter weight for transportation (Ertekin and Yaldiz, 2004).

Colour is one of the most important appearance attribute of food materials, since it influences the consumer acceptability. Abnormal colours, especially those associated with deterioration in eating quality or with spoilage, cause the product to be rejected by the consumer (Avila and Silva, 1999; Mohamed et al, 2008), Therefore, approaches to improve the quality of dried fruits generally involve thermal, chemical and osmotic pre-treatments such as blanching, sulphitation and osmotic dehydration(Pott et al. 2005).

Sodium metabisulfite $Na_2S_2O_5$ is used as a preservative in foods such as baked goods, jams, wines, dried fruit and many sauces. Sodium metabisulfite is also used as an antibacterial agent and an antioxidant additive.

Beside the suppression of microbial growth, all pre-treatments aim at thermal or chemical inactivation of detrimental enzymes, chiefly of polyphenol oxidase (PPO), and at inhibition of the Maillard reaction (Wedzicha, Bellion, & German, 1994) by controlling pH, water activity, and reactive carbonyl compounds, respectively.(pott et al 2005).

The objectives of this study were to:

1- Investigate the drying process of mango fruit.

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2- Investigate the effect of drying by normal drying oven or vacuum drying oven on the dried period and the colour changes.
3- Investigate the influence of different sucrose and antioxidant additives as pre-treatments on mango slices and their physical characteristics after drying process.
4- Evaluate the suitability of mango cultivars for drying.

MATERIALS AND METHODS

This experiment was carried out at the Horticultural Crop Technology, NRC and Food Technology Research Institute (FTRI) ARC laboratories during the 2010 season.

2.1-Raw Material:

Fresh mangoes, cvs. "Seddik" and "Fajri Kalan" were harvested at the mature stage then ripened at 25±2ºC for four days (Pott et al, 2005). Similar and homogeny fresh fruits as soon as possible and at the same ripening stage were washed. The fruit firmness were measured by Penetrometer mod. FT 011(0-11 Lbs.) the values range were 1-3 Newton (N) where the Fajri Kalan cv. had more firmness value than the Seddik, and manually peeled using stainless steel knife and sliced using a manual food-slicer at 9 mm thickness. The fruit, flesh, seed and peel weight were determined. Flesh soluble solids contents were measured using digital Refractometer (ATAGO Pr-32), The means of SSC were 13.55 ºBrix and 12.55 ºBrix also the moisture content was 82.38% and 79% of Seddik and Fajri Kalan respectively.

The treatments were as follows:
1) Fresh mango slices (150 gm./ replicate) were immersed in sodium metabisulfite at 1% for 10 sec. then at 2% for 5 min. (Abdelgader and Ismail 2011).
2) Sucrose powder 20 gm. were spread on surface of 150 gm. mango slices/ replicate
3) Control
Then, samples were dried as the followed described

2.2- Drying Process:

Two types of oven dryers were used in this experiment. Vacuum drying oven Shellab Model:1410 Sheldon manufacturing, USA , Oil rotary vacuum pump ULvac Sinka Kiko co-, LTD G-25S and Normal drying oven Nahita Model 632/13. The drying process was at 80°C for 4 hours in the vacuum drying oven 15 inch Hg, and was at 58°C for 28 hours in normal drying oven according to the pre-experimental carried out to detect the best time with the lowest humidity content (ranged about 17%), which had the best colour retention during drying and measured the cut force of slices. (Mohamed et al, 2008; Shi et al, 2008 and Pott et al, 2005).

2.3-Measuring Parameters:

Colour Measurements:

Colour parameters were measured using a Minolta CR-400/410 Chroma-meter (Minolta, Japan). Hunter scale (L*, a*, b*) system was used. The Chroma meter was calibrated with a white standard tile with illuminant D65(Y=93.3, x= 0.3161 and y= 0.3328) equivalent to HL system: HL = 97.10, a = -0.17 and b= 1.80. Calibration were made at each experiment. The parameter L* represents the brightness of the colour, a* the hue range of the colours red (+) and green (-) and b*hue range of colours yellow (+) and blue (-).

The colour measurements were made on the surface of fresh sliced mango before and after drying and the average values were made for calculation and each treatment was representing by three replicates. Total colour change (ΔE), chroma (C), hue angle (h) and browning index (BI) were calculated using equations described by Maskan (2001):

$$\Delta E = ((L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2)^{1/2} \quad (1)$$

$$\text{Chroma} = (a2 + b2)^{1/2} \quad (2)$$

$$\text{Hue angle} = \tan^{-1}(b/a) \quad (3)$$

Where; subscript "$_0$" refers to the colour reading of fresh mango slices. Fresh mango was used as a reference and a larger ΔE denotes greater colour change from the reference material (Maskan, 2001).

$$BI = [100 (x - 0.31)] / 0.17 \quad (4)$$

Where:

$$x = (a + 1.75L)/ (5.645L + a - 3.012b) \quad (5)$$

(Mohamed et al, 2008 and Mohammadi et al, 2008).

2.4- Determination of Drying Rate and Drying Cut Force:

The drying rate (DR) (Kar & Gupta, 2003) was calculated using the equation

$$DR = \frac{M_0 - M_t}{t} \quad (6)$$

Where DR is overall drying rate (g water/g dry solid min^{-1}); M_0 is moisture content of mango slices at zero time (g water/g dry solid); and M_t is moisture content of mango slices at time t (g water/g dry solid) (Shi et al, 2008). Drying cut force of dried slices was measured by Shimpo digital force Gange Model: FGN-20.

Statistical Analysis:

Results were subjected to ANOVA and were evaluated by MSTAT program. The differences between means were compared using LSD test at 5% level.

RESULTS AND DISCUSSION

Physical Properties:

Colour parameters are showed in Fig. (1) where the total colour changes in the slices dried using normal drying oven were less than those dried under vacuum drying oven and this may be due to high temperature 80°C with vacuum. Both of cvs. the m. sulfite treatments showed the lowest values of colour changes whereas sugar treatments showed the higher values where the colour changes values under vacuum drying of all treatments in both cvs. were insignificant. The browning index with vacuum drying was lower than that normal drying. Browning index under vacuum drying of Seddik cv. was lower than Fajri kalan cv. whereas the verses is under normal drying, these results may be back to the decrease of reducing sugars due to the decrease of total sugars and increase of non-enzymatic browning (Abdelgader and Ismail 2011).

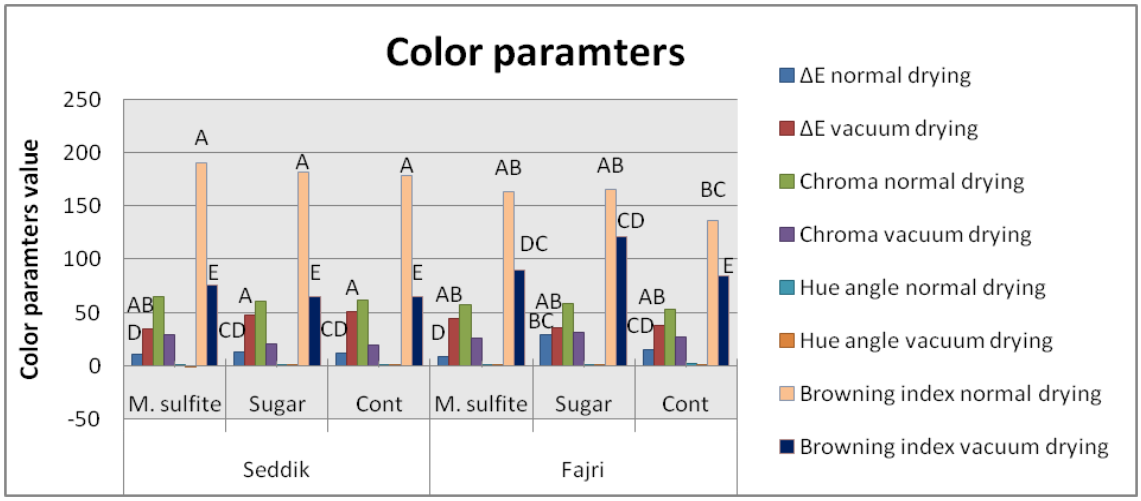

Fig. 1: Colour parameters changes of mango slices.

The weight of fruit, flesh and seed shows that the Fajri kalan fruit was larger than the Seddik . also the peel weight of Fajri kalan was significant higher than that of the Seddik, as in Fig. (2).

The slices weight dried under vacuum was higher than that normal drying whereas in general insignificant values existed between the other treatments and cultivars as in Fig (3).

The cut force values of slices dried using the normal drying type as in Fig (4) were significant higher than that under the vacuum one. The values showed no significant differences and no definite trend was observed between treatments and cultivars.

The net dried slices ratio under normal drying was lower than that under vacuum drying. The net dried slices ratio of the untreated Seddik cv. gave the highest value whereas the Fajri Kalan cv. sugar treated slices showed the significant highest value. The net dried slices ratio of Seddik cv. was higher than the Fajri Kalan cv. as in Fig(5). This may be due to the moisture percentage of Seddik which was higher than the Fajri Kalan 82.3 and 79 % respectively.

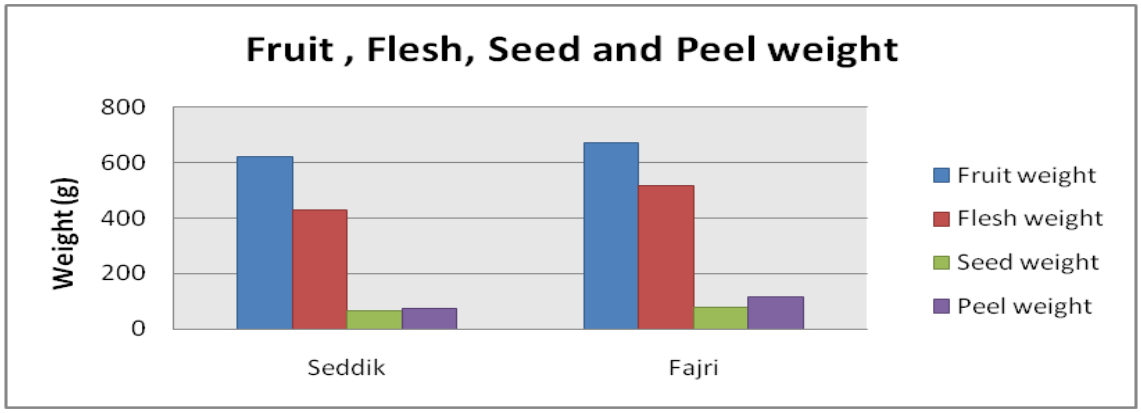

Fig. 2: Weight of fruit, flesh, seed and peel of Seddik and Fajri kalan cvs.

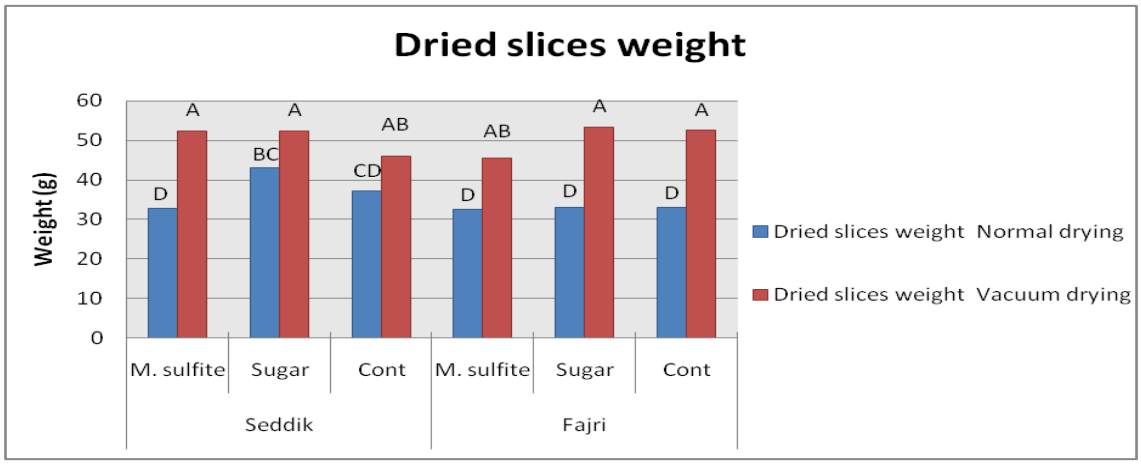

Fig. 3: Weight of dried mango slices.

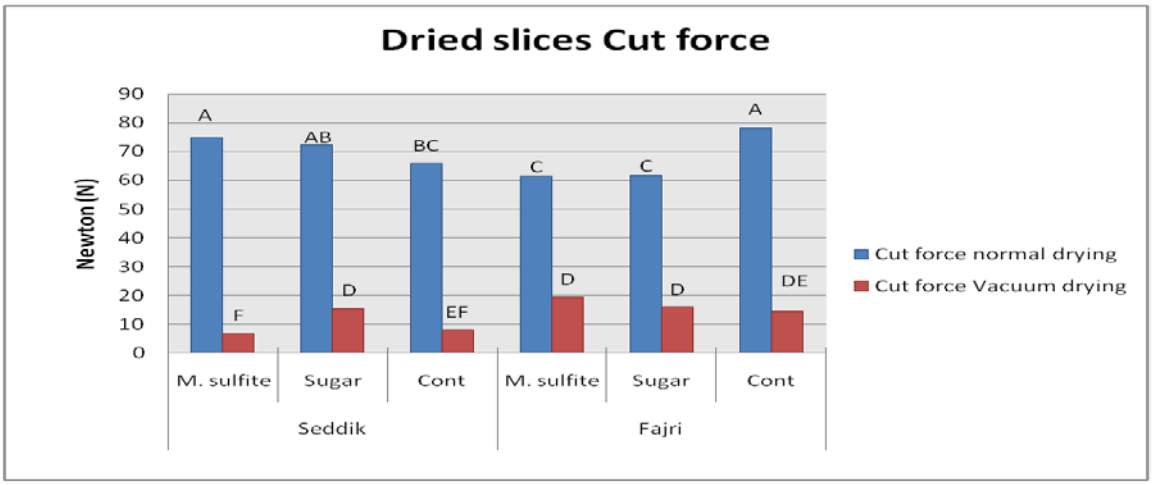

Fig. 4: The cut force of dried mango slices.

Chemical Parameters:

The rehydration percentage of slices dried using normal drying type was higher than that with vacuum drying. The Seddik slices received sodium metabisulphiite treatment under normal drying type showed the highest values, whereas those received sugar treatment under vacuum showed the highest value. Slices of the Fajri kalan cv. showed no significant differences. The rehydration percentage of Seddik was higher than Fajri kalan as in Fig. (6).

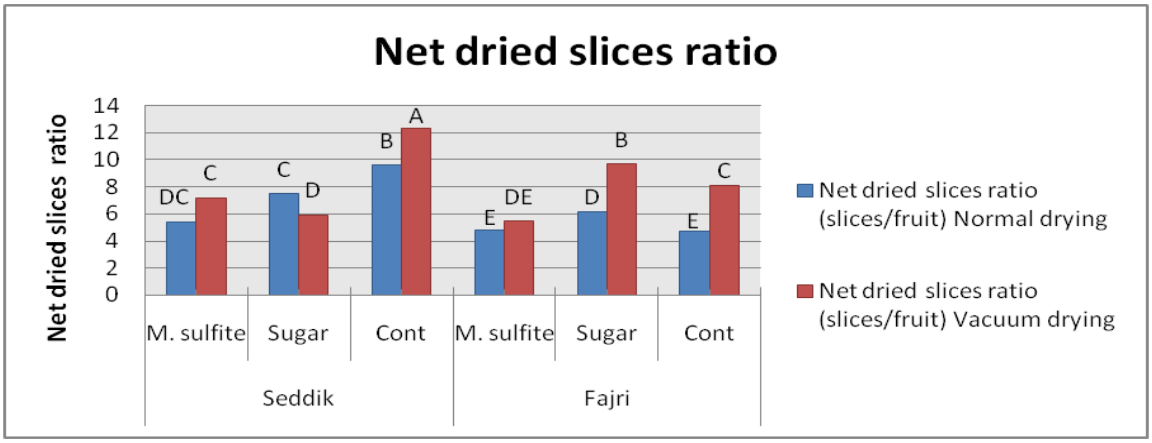

Fig. 5: Net dried slices ratio.

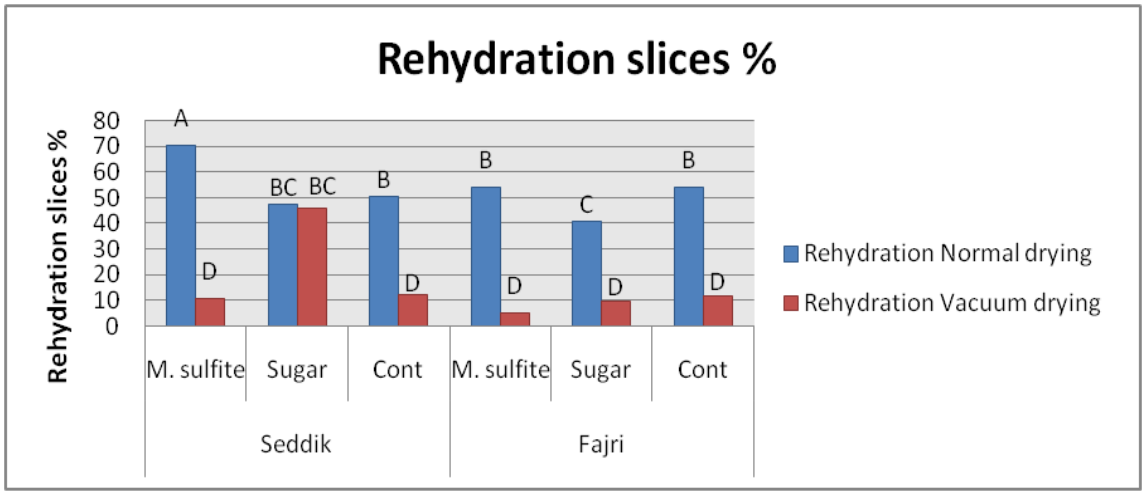

Fig. 6: The rehydration percentage of mango slices.

The dry rate of mango slices dried under vacuum drying was higher than that by normal drying as shown in Fig. (7). Most treatments dried under vacuum showed insignificant values where seddik slices received the sugar treatment showed the highest drying rate value.

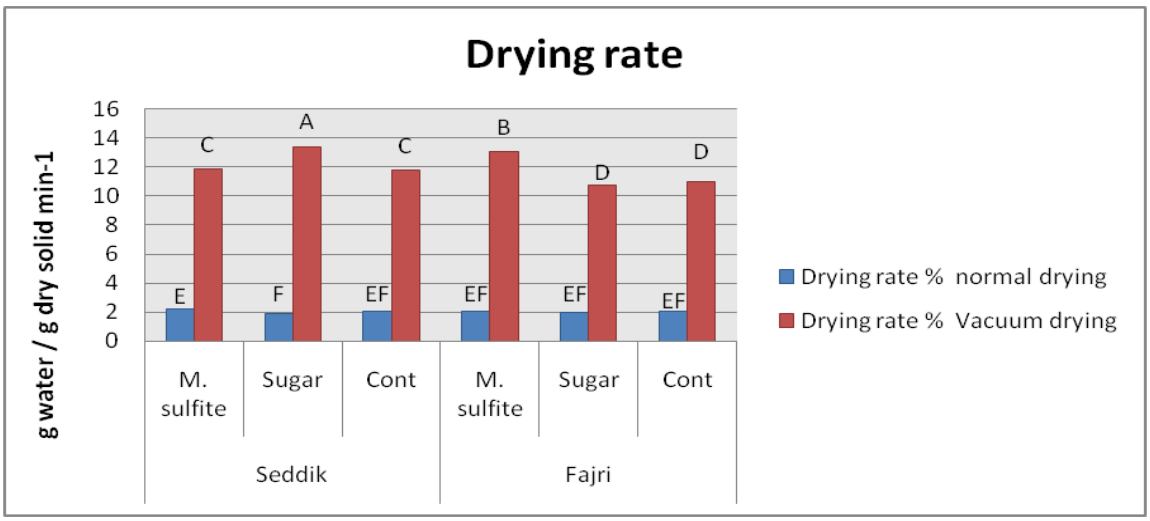

Fig. 7: Drying rate of mango slices.

4. Conclusion:

In conclusion, our results show that, drying process period, the rehydration and the cut force under vacuum were less than by normal drying. Using Sodium metabisulfite as an antioxidant was less colour changes than sucrose. Seddik cv. showed drying rate, rehydration and net dried slices ratio higher than Fajri Kalan.

In general, the surplus of the mango fruits especially of the varieties (Seddik and Fajri) being processed through the establishment of national industry projects. Conducting further research on the other mango varieties which had big size as Bullock's Heart and Zebda that have not been studied yet is also recommended

ACKNOWLEDGMENTS

The authors thank our colleague Mr. Moustafa Zohair for his technical help.

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