Effect of Different Drying Methods and Pre-Treatments on Quality Characteristics of Mango Slices

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ABSTRACT

Fresh mango slices, Keitt (Mangifera indica L.) was used to study the effect of different drying methods and pre-treatments on quality characteristics of Mango slices. Two types of drying (oven and microwave). Also, several pre-treatments such as dipping in 0.5% sodium metabisulfite solution for 2 min, or 1% ascorbic acid + 1% citric acid solution (1:1) for 2 min. Moreover, coating with powdered sucrose 20g (surface addition) per 100 g mango slices were used. Chemical composition, Vitamin C, total carotenoids, color parameters, drying rates%, rehydration ratio % and organoleptic evaluation were determined. Results indicated that raw fresh mango flesh had (3.12, 1.00, 2.62, 4.91 and 88.35 % protein, fat, ash, fibers and carbohydrates (on dry wet. Basis); respectively. Results also reveal that raw fresh mango flesh exhibited 92.75 and 7.04 mg/100 g vitamin C and total carotenoids (as β-carotene); respectively. Dipping pre-treatments with sodium metabisulfite caused significant (P≤ 0.05) reduction in % loss of vitamin C and % loss of total carotenoids during drying process with different rates from 24.29 to 71.88 % and from 46.50 to 91.28 %; respectively. Results also indicate that different dried pre-treated samples contained lower values of saturation and Hue angle than found in fresh samples. All samples treated with sodium metabisulfite had the lowest values of total color changes (ΔE) compared with control samples and other treated samples. In addition, sodium metabisulfite treatments lowered the values of browning index compared with control and other samples. Samples dried with microwave oven had higher values of drying rate % than the other groups. In contrast, sodium metabisulfite treatments gave the highest values of rehydration in all groups. Results of sensory evaluation showed, that dried mango slices sample pre-treated with sugar, then soaked in solution contained 1% ascorbic acid+1% citric acid (1:1) for 2 min (AC) and dried by microwave had the highest total score for all sensory characteristics under investigation. Higher scores for taste, texture, chewiness, aroma and overall acceptability were noticed per-treatments samples in samples as compared to control samples. In conclusion, Mango slices samples pre-treated with Sodium metabisulfite solution 0.5% for 2 min had the lowest percentage of vitamin C and total carotenoids loss and the lowest values for total color changes (ΔE) and gave the highest values of rehydration ratio for all groups under the different conditions of drying methods followed by samples pretreated by ascorbic + citric acids treatments.

Key words: Mango slices, Drying, Sodium metabisulfite, Total carotenoids, Vitamin C, Microwave oven

Introduction

Mango (Mangifera indica L.) is considered to be a good source of carbohydrates; vitamin C and very rich source of pro-vitamin A. During fruits maturity, the contents of moisture, minerals and most vitamins increase. The vitamins are partially destroyed during processing (Kendall and Sofos, 2012). Due to high concentrations of sugar, the dried fruits have high energy values however, the contents of Proteins and fats are very low. Different varieties vary greatly in vitamin C content (Fowomola, 2010). Maximum β-carotene contents of dried mango slices from cvs. ‘Chok Anan’ and ‘Kaew’ corresponded to retinol equivalents of 333–383 and 483–905 per 100 g of edible portion (on dry weight basis), meeting daily mean requirements of vitamin A for adults according to FAO/WHO. Egypt is one of the major producer countries in Africa for mangoes. In Egypt mango becomes one of the main fruit crops which ranks the second after citrus. Mangoes are usually sliced before drying to improve the efficiency of the drying process. Drying is one of the most widely used as a method of
food preservation. Dry objective is to reduce water content which minimize microbial spoilage and deterioration reactions (Akpinar and Bicer, 2004). Which provides longer shelf-life, reduces the storage space and lightweight for transportation (Ertekin and Yaldiz, 2004). One of the most important appearance character that influences the acceptability of food materials is color. Several factor caused degradation of vitamin C such as temperature and water activity… Etc. Drying of fruits and vegetables results in losses of vitamin C cause the product to be rejected by the consumer (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 Na2S2O5 is used as a preservative in foods such as baked goods, jams, wines, dried fruit and many sauces. 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, and German, 1994) by controlling pH, water activity, and reactive carbonyl compounds, respectively (pott et al., 2005). Beside traditional sun drying by direct solar radiation, solar dryers and conventional overflow dryers are presently used in small-scale enterprises to reduce the water activity. Drying air temperature ranges between 50 and 60 ºC, drying air temperature and drying time were shown to be the primary factors influencing product color and water activity (Pott et al., 2005). Currently hot air drying is the most widely used method in post-harvest technology of agricultural products. Using this method is considered more uniform, hygienic and attractively colored dried product can be produced rapidly (Wankhane et al., 2013). The rehydration capacity and color characteristics are considered as the most important quality parameters for the dehydrated products. The rehydration capacity is used to express ability of the dried material to absorb water. The largest part of the dehydrated products must be rehydrated during their final use. Rehydration is a process performed in order to obtain an adequate restitution of raw material properties when dried material is in contact with water (Taiwo et al., 2002). The color measurements can be used in an indirect way to estimate color change of foods, since it is simpler and faster than chemical analysis (Maskan, 2001). There are other parameters derived from: Hunter L*, a*, b* scale; the total color difference (ΔE), the saturation index that indicates color saturation and is proportional to its intensity. The Hue angle is another parameter frequently used to characterize color in food products (Lozano and Ibarz 1997). Mangoes can be classified as provitamin A-rich fruits. The fruits have to be cut manually and are commonly pre-dried osmotically in sugar solution with added preservatives. While slicing, the loss of fruit flesh located around the seed or flesh which is already too soft to cut properly usually reaches 30%, while losses caused by peeling are about 20%, additionally. Sliced mangoes are commonly dried in tray dryers with air temperatures of 60 ºC or less. To reduce the power requirement of the fan, these dryers are operated in over-flow mode.

The objective of this study were to investigate the effect of different drying methods (oven and microwave) on mango slices with various pre-treatments such as dipping in sodium metabisulphate, citric acid, ascorbic acid solutions and powdered sucrose coating. The experiments determine color parameters, vitamin C, total carotenoids, rehydration ratio and sensory characteristics of different dried mango slices.

Materials and methods

This study was carried out at the Food Science and Technology Department, National Research Centre during the 2016 season.

Materials:

Fresh ripe var. Keitt (Mangifera indica L.) mangoes were purchased from local market, Giza. The fruits were then washed manually, peeled using stainless steel knife and sliced using a manual food slicer at 9 mm thickness.

The treatments were classified to five groups as follows:

1. Oven group which was divided to three parts:
   1.1. Control sample dried at 60°C for 6 hours.
1.2. Immersion in 0.5% sodium metabisulfite solution for 2 min and dried as part 1.1.
1.3. Immersion in solution contained 1% ascorbic acid + 1% citric acid (1:1) for 2 min. (AC) and dried as part 1.1.

2. Microwave group which was divided to three parts:
2.1 Control sample dried by microwave (Goldstar, Egypt) at power level 2 for 36 min.
2.2 Immersion in 0.5% sodium metabisulfite solution at for 2 min and dried as part 2.1.
2.3 Immersion in solution contained 1% ascorbic acid + 1% citric acid (1:1) for 2 min (AC) and dried as part 2.1.

3. Sugar and microwave group which was divided to three parts:
3.1. Control sample was coated with powdered sugar (powder sucrose 20g/100g mango slices) for 24 hours and dried by microwave at power level 2 for 40 min.
3.2. Coated with powdered sugar then soaked in sodium metabisulfite solution at 0.5% for 2 min. and dried as part 3.1.
3.3. Coated with powdered sugar then soaked in solution contained 1% ascorbic acid+1% citric acid (1:1) for 2 min (AC) and dried as part 3.1.

4. Sugar oven group which was divided to three parts:
4.1. Control sample was coated with 20% sugar for 24 hours and dried in oven at 60°C for 6 hours.
4.2. Coated with 20% sugar then immersed in sodium metabisulfite solution at 0.5% for 2 min and dried as part 4.1.
4.3. Coated with 20% sugar then immersed in solution 1% ascorbic acid+1% citric acid (1:1) for 2 min. (AC) and dried as part 4.1.

5. Oven and microwave group which was divided to three parts:
5.1. Control sample was dried in oven at 60°C for one hour followed by microwave at power level 2 for 25 min.
5.2. Immersion in sodium metabisulfite solution at 0.5% for 2 min and dried as part 5.1.
5.3. Immersion in solution 1% ascorbic acid+1% citric acid (1:1) for 2 min (AC) and dried as part 5.1.

All chemicals used in this study were analytical grade purchased from Sigma-Aldrich (St Louis, MO, USA) and W.W. Grianger, Inc. (Lake Forest, IL, USA).

Chemical composition (moisture, protein, fat, fiber and ash) of mango fruit flesh was determined according to AOAC, (2005) and total carbohydrates were calculated by difference.

Vitamin C and total carotenoids determinations

Vitamin C determined in flesh before drying, and then in control and pre-treated mango samples after drying to determine the extent of vitamin C degradation in dried samples. Determination of vitamin C was done according to titration method as described in AOAC (2005). For total carotenoids, samples were extracted with hexane: acetone (7:3) solution and after phase transfer, the absorbance was red at 450 nm using a spectrophotometer (T80+ UV/VIS Spectrometer PG instruments ltd. Germany) (Davis et al., 2007). Total carotenoids were determined as β-carotene equivalent using a standard curve prepared with pure β-carotene (0.5-2.5 µg/ml).

Color Measurements:

The color of different samples measured using a spectro-colorimeter (tristimulus color machine) with CIE lab color scale (Hunter, Lab Scan XE, Reston VA.) calibrated with a white standard tile of Hunter Lab color standard (LXNO. 16379): X= 77.26, Y= 81.94 and Z= 88.14 (L =92.71; a = -0.89; b = -0.18). Using Hunter-scotfield’s equation (Hunter, 1975). Color change (ΔE) was calculated from a, b and L parameters, using Hunter-Scotfield’s equation (Hunter, 1975) as follows:

\[ ΔE = (Δa^2 + Δb^2 + ΔL^2)^{1/2} \]
Where \( a = a_a - a_0 \), \( b = b_b - b_0 \) and \( L = L_L - L_0 \). Subscript “O” indicates color of control. The Hue angle \((t^1_g b/a)\) and saturation index \((\sqrt{a^2 + b^2})\) were calculated.

**Determination of browning index**

Samples were diluted to 11.2°Brix with distilled water. The absorbance was determined on a Unicam UV-VIS (UV 2) spectrophotometer in 10 mm cells against water at 420 nm (Ashoor and Zent, 1984; Baxter, 1995 and Toribio and Lozano, 1984).

**Determination of Drying Rate**

The drying rate (DR) was calculated by Kar and Gupta, (2003) using the equation according to Shi et al. (2008):

\[
DR = \frac{M_0 - M_t}{t} \times 100
\]

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).

**Rehydration ratio**

Rehydration ratio was determined according to the official method of AOAC (2005), 5g of dried sample was soaked for 60 min in 50 ml distilled water, filtered through filter paper and then the filtrates were weighed (two measurements for each sample). The rehydration ratio \((R/R)\) was used to express ability of the dried material to absorb water. It was determined by the following equation:

\[
Rehydration ratio (R/R) = \frac{W_2}{W_1} \times 100
\]

Where: \( W_2 \) = weight of drained material, g  
\( W_1 \) = weight of dried material, g.

**Organoleptic evaluation:**

Taste, texture, chewiness, aroma and overall acceptability were evaluated as described by Meligaard et al. (1991). The organoleptic scores involved 10 grades for each sensory property for different mango slices samples as affected by different drying treatments.

**Statistical analysis:**

Results were expressed as Means and Standard Deviation (M±SD) from triplicate determinations. Data were subjected to one-way analysis of variance (ANOVA) to compare the effect of drying methods and pre-treatments on quality characters of mango slices. Significant differences were defined as \( p < 0.05 \), according to Richard and Gouri, (1987).

**Results and Discussion**

**Proximate chemical composition of mango flesh**

Table (1) shows proximate chemical composition of mango flesh on wet weight and dry weight basis. The analysis showed that moisture was the highest components (82.07%) followed by
carbohydrates (15.84%) while, fiber, protein, ash and fat contents represented minor components which were 0.88, 0.56, 0.47 and 0.18% respectively. The results on dry weight basis indicated that, carbohydrates and fiber content were 88.35 and 4.91% respectively and the content of protein 3.12% was higher than fat and ash contents (1 and 2.62%) respectively. Nixwell et al., (2013) reported that mango cultivar Keitt contained 2.8, 0.2, 2, 1.8 and 85.7% for protein, fat, ash, fiber and carbohydrates content at moisture level 7.8%. Our results are in agreements with those obtained by Nixwell et al. (2013) and Guiamba (2016).

Table 1: proximate chemical composition of mango flesh on wet weight and dry weight basis.

<table>
<thead>
<tr>
<th>Components</th>
<th>% on wet weight basis</th>
<th>% on dry weight basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>82.07±0.76</td>
<td>88.35</td>
</tr>
<tr>
<td>Protein</td>
<td>0.56±0.11</td>
<td>3.12</td>
</tr>
<tr>
<td>Fat</td>
<td>0.18±0.09</td>
<td>1</td>
</tr>
<tr>
<td>Ash</td>
<td>0.47±0.12</td>
<td>2.62</td>
</tr>
<tr>
<td>Fibers</td>
<td>0.88±0.16</td>
<td>4.91</td>
</tr>
<tr>
<td>Carbohydrates*</td>
<td>15.84</td>
<td>88.35</td>
</tr>
<tr>
<td>vitamin C mg/100g</td>
<td>16.62</td>
<td>92.75</td>
</tr>
<tr>
<td>Total carotenoids (as β-carotene) mg/100g</td>
<td>1.27</td>
<td>7.04</td>
</tr>
</tbody>
</table>

*Calculated by difference

From the same Table, fresh mango flesh contained 92.75 mg/100g (dry weight basis) vitamin C and 7.04 mg/100g (dry weight basis) total carotenoids as β-carotene. About (50 to 80) % of the total existing carotenoids is β-carotene Mercadante and Rodriguez Amaya (1998). The β-carotene and vitamin C contents found in this study are in the same range reported by other authors in fresh mango flesh of different cultivars (Pott et al., 2003, Vásquez-Caicedo et al., 2005, Manthey and Perkins-Veazie, 2009 and Guiamba, 2016).

Loss percentage of Vitamin C in dried mango slices:

Effect of different pre-treatments and drying methods on % vitamin C loss of dried mango slices is given in Fig. (1), from which the loss percentage was ranged from (24.29 -71.88%). High loss percentage for vitamin C content was present in control sample of group 1 where, sample 2.2 of group 2 had low loss percentage. Pre-treatments of samples with sodium metabisulfite solution 0.5% for 2 min. caused reduction in vitamin C loss percentage in all groups under investigation. The best results were observed in samples 2.2 dried by microwave at power 2 for 36 min (24.29%), samples pre-treated as 5.2 and dried by oven at 60°C for 1hr. followed by microwave at power 2 for 25 min (30.17%) and sample pre-treated as 3.2 and dried by microwave at power 2 for 40°C (32.53%)

Loss of Vitamin C %

![Fig.1: % vitamin C loss of different dried pre-treated mango slices](image-url)
Mango slices samples pre-treated with immersion in solution 1% ascorbic acid and 1% citric acid (1:1) for 2 min. dried as 1.3, 2.3, 3.3, 4.3 and 5.3 had moderate values for vitamin C loss percentage. It was ranged from 37.86-65.45% where drying as 1.1 and 2.2 gave the highest and lowest loss percentage respectively. Sugar addition in groups 3 and 4 showed that, drying type and time (oven or microwave) was responsible for the decreased or increased loss percentage of vitamin C for mango slices with similar pre-treatments. Similar previous studies mentioned the protective action of sodium metabisulphate on vitamin C Karim (2005). These results are consistent with finding with Marfil et al. (2008) who stated that, the vitamin C degradation rates were depend on samples treatments before drying and drying temperature. In addition, he reported that, vitamin C is better retained in sample treated by sodium metabisulphate than in lemon juice treated samples. Masamba et al. (2013) reported that, the rate of vitamin C degradation was higher in the mango pieces control samples than the sodium metabisulphate and samples treated with lemon juice.

Loss percentage of total carotenoids in dried mango slices

Fig. (2) showed the loss percentage for total carotenoids as β-carotene of different dried pre-treated mango slices. Results indicated that, high values for total carotenoids loss% were found in dried mango slices by microwave at level 2 for 36 min (group 2) as compared with (group 1) results which samples treated with similar pre-treatments and dried in oven at 60°C for 6 hours. The loss percentages values were ranged from 62.40 to 79.03% for group 1 and from 78.63 to 83.42% for group 2. These results may be due to different dry methods including oven or microwave drying and the time used in drying (6 hours in oven and 36 min. in microwave).

Fig. 2: Total carotenoids loss% as β-carotene of different dried pre-treated mango slices

The sugar pre-treatment of dried samples was responsible to increased % loss of total carotenoids as β-carotene when samples dried in oven at 60°C for 6 hours (group 4). Drying by microwave for samples pre-treated with sugar for 40 min. tend to values of β-carotene loss percentage varied from 68.97 to 85.39 % which lower than that occurred in group 4 results. Group 5 dried for 1 h then oven at 60°C then microwave at power 2 for 40 min. contained lowest loss percentage of β-carotene among the other groups. As a general observation, pre-treated with sodium metabisulfite caused a reduction in % loss of total carotenoids in all groups. This result may be due to the action of sodium metabisulfite as a color preservative in dried fruits (Omayma and Nagy, 2012). The loss percentage of β-carotene in all groups was ranged from 46.50-91.28% where, these results may due to
the action of temperatures on carotenoids compounds, caused a degradation in the initial β-carotene content of different pre-treatment groups of mango slices which decreased their content of β-carotene and increased loss percentages according to drying and pretreatments conditions.

These results are in agreement with those reported by Ndawula et al. (2004) and Sogi et al., (2015).

**Color parameters changes of dried mango slices**

Fig. (3) Showed color parameters of different dried pre-treated mango slices. Saturation index and Hue angle values of fresh mango slices were 72.08 and 80.14 respectively (results not presented in Fig. (3)). Different dried pre-treated samples contained lower values of saturation index and hue angle than found in fresh samples. Samples 1.2, 2.2, 3.2, 4.2 and 5.2 had the lowest values of saturation index and Hue angle in their groups. The saturation index value indicates the degree of color and is proportional to strength of the color. Similar findings reported by Akoy (2014) who investigated the effect of drying temperatures (60, 70 and 80°C) on quality attributes of mango slices. All samples treated with sodium metabisulfite had the lowest values of total color changes (ΔE) compared with control samples and samples immersed in 1% ascorbic acid +1% citric acid (1:1) solution for 2 min. in all groups. Total color changes (ΔE) values for all groups 2, 3and 5 were higher than that those found in groups 1 and 4 which drying was carried out by oven. Browning index (BI), which represents the purity of brown color and is reported as important parameters in processes where, enzymatic and non-enzymatic browning taking place Palou et al. (1999). Also sodium metabisulfite treatments lowered the values of browning index for different dried pre-treated samples compared with control samples and ascorbic + citric acids treatment. The last results may be due to the effect of sulfite on thermal or chemical inactivation of enzymes, chiefly of polyphenol oxidase (PPO), and inhibition of the Millard reaction (Wedzicha et al., 1994). Latapi and Barret (2005) who concluded in their study that dipping tomatoes in 6% or 8% sodium metabisulfite for 5 min. before drying established the best color. Similar results were reported by Mozumder et al. (2012) who found out that potassium metabisulfite and calcium chloride treated tomatoes before drying showed better color than the other samples. These results are in agreement with those reported by Omayma and Nagy, (2012). They stated that, values of color parameters for Seddik and Fajri treated by sodium metabisulfite at 1% for 10 sec. then at 2% for 5 min. were the lowest.

![Image of color parameters changes of different dried pre-treated mango slices](image-url)
Drying rate of dried mango slices:

The effect of different pre-treatments and drying methods on drying rate of mango slices samples is shown in Fig. (4). Drying rate results for different samples had significant differences between all dried mango slices groups even inside samples of the same group except oven group and the treatment 3.2 and 3.3 "in sugar and microwave group". Microwave group had higher values than the other groups. Different dried mango slices for sugar and microwave group had 178.13, 181.34 and 181.38% which were higher than the values of drying rate obtained from results of group 1, 4 and 5 but lower than the obtained from microwave group. Results of group 5 approximately four times equal to groups 1 and 3. The obtained results were different due to different pre-treatments and drying methods used.

Microwave drying for samples of groups 2 or 3 was responsible for the highest results of drying rate and may be due to the short time used for drying (36-40 min.) for groups 2 and 3, respectively and coating with powdered sugar for 24 hr. before drying of group 3. These results are in agreement with those obtained by Omayma and Nagy (2012). They stated that, mango slices immersed in sodium metabisulphate solution at 1% for 10 sec., then at 2% for 5 min. or spreading sucrose powder on surface dried under vacuum had higher drying rate than normal oven during.

Rehydration ratio of dried mango slices

Results for rehydration ratio (R/R) for different pre-treatments and dried mango slices samples are presented in Fig. (5). It was observed that sodium metabisulfite treatments gave the highest values of rehydration ratio in all groups. Ascorbic and citric acids treatments caused increasing in rehydration ratio values for all dried mango slices samples as compared with control samples. Groups one, two and five had higher rehydration ratio values than found in other groups, these results may be due to drying by oven (group 1), microwave (group 2) and group 5 dried initially in oven for 1hr. followed by microwave at power 2 for 25 min. without and additional pre-treatment. Addition of sugar to samples (groups 3 and 4) and drying by oven or microwave lowered the values of rehydration ratio when compared with groups one and two (oven and microwave, respectively). These results are in good agreement with those reported by Omayma and Nagy (2012). They stated that, the rehydration percentage of pre-treated dried mango slices (Seddik and Kalan) under normal drying was higher than that vacuum drying.
Sensory evaluation of dried mango slices

Data presented in Table (2) showed that the sensory evaluation of mango slices treated by different pre-treatments and drying methods. Treated samples by several pre-treatments and dried by oven or microwave for different times improved all sensory characteristics of different samples except chewiness of samples 2.2 and 2.3. Results indicated that, dried mango slices sample treated as 3.3 had the highest total score (41.3) for all sensory characteristics while, dried sample 5.1 (control) had the lowest total score (29.1) the highest scores for taste, texture, chewiness, aroma and overall acceptability were noticed in samples 3.2 (8.5), 3.3 (8.6), 3.3 (8.5), 4.3 (8.2) and 4.2 (8.4) respectively.

There was no significant differences were found between dried samples treated as 1.1 and 2.1 regarding taste. The same last result was present taste between two dried samples treated as 2.2 and 2.3 also, the same trend was observed between three dried samples treated as 3.2, 4.2 and 4.3 and between samples treated as 2.1, 5.2 and 5.3. No significant differences were detected regarding texture between samples 4.2 and 4.3 also, between samples 1.2 and 5.2 or between samples 1.3, 2.1 (control of group 2), 2.3 and 5.1 (control of group 5) moreover, from the same table between samples 3.1(control of group 3) and 5.3, between samples 2.1(control of group 2) and 4.1 (control of group 4), between samples 2.2, 2.3 and 5.2 and between samples 3.2, 4.2 and 4.3 no significant differences were noticed for chewiness. Between samples 1.2, 1.3 and 2.1, between samples 2.3, 3.1, 3.2, 3.3 and 4.2, between samples 2.2 and 4.1 and between samples 5.2 and 5.3, there was no significant differences for aroma. On the other hand, between samples 1.2 and 5.3 and between samples 3.1, 3.2, 3.3, 4.2 and 4.3 no significant differences were found regarding to overall acceptability. These results are in agreements with those reported by Abano (2010) and Mozumder et al. (2012).
Table 2: Sensory evaluation of mango slices treated by different pre-treatments and drying methods.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Oven group (1)</th>
<th>Microwave group (2)</th>
<th>Sugar + microwave group (3)</th>
<th>LSD &gt;0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samples code</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>2.1</td>
</tr>
<tr>
<td>Taste</td>
<td>5.8±0.63</td>
<td>6.5±0.53</td>
<td>6.6±0.52</td>
<td>6.3±0.48</td>
</tr>
<tr>
<td>Texture</td>
<td>6.0±0.94</td>
<td>6.8±0.91</td>
<td>6.5±1.08</td>
<td>6.5±0.84</td>
</tr>
<tr>
<td>Chewiness</td>
<td>5.7±0.67</td>
<td>6.3±0.94</td>
<td>6.5±0.70</td>
<td>6.9±1.1</td>
</tr>
<tr>
<td>Aroma</td>
<td>6.1±0.87</td>
<td>6.4±0.69</td>
<td>6.6±0.69</td>
<td>7.4±0.69</td>
</tr>
<tr>
<td>Overall</td>
<td>5.9±0.73</td>
<td>6.2±0.63</td>
<td>6.1±0.65</td>
<td>7.1±0.73</td>
</tr>
<tr>
<td>acceptability</td>
<td></td>
<td></td>
<td></td>
<td>7.2±0.91</td>
</tr>
<tr>
<td>Total</td>
<td>29.5</td>
<td>32.2</td>
<td>32.3</td>
<td>33.1</td>
</tr>
</tbody>
</table>

Table 2: Cont.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Sugar + oven group (4)</th>
<th>Oven (1 hr) + microwave group (5)</th>
<th>LSD &gt;0.05</th>
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</thead>
<tbody>
<tr>
<td>Samples code</td>
<td>4.1</td>
<td>4.2</td>
<td>4.3</td>
</tr>
<tr>
<td>Taste</td>
<td>7.3±0.48</td>
<td>8.4±0.69</td>
<td>8.5±0.70</td>
</tr>
<tr>
<td>Texture</td>
<td>7.3±0.82</td>
<td>8.3±0.67</td>
<td>8.2±0.42</td>
</tr>
<tr>
<td>Chewiness</td>
<td>6.9±0.73</td>
<td>7.9±0.78</td>
<td>7.9±0.99</td>
</tr>
<tr>
<td>Aroma</td>
<td>7.4±0.84</td>
<td>8.1±0.73</td>
<td>8.2±0.91</td>
</tr>
<tr>
<td>Overall</td>
<td>7.8±0.42</td>
<td>8.4±0.69</td>
<td>8.2±0.78</td>
</tr>
<tr>
<td>acceptability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36.7</td>
<td>41.1</td>
<td>41</td>
</tr>
</tbody>
</table>

*Means with the same letters in the same row is not significantly different (p ≤ 0.05).
*LSD: Least Significant Difference

Conclusion

Different dried pre-treated samples contained lower values of saturation index and Hue angle than found in fresh samples. Mango slices samples pre-treated with Sodium metabisulfite solution 0.5% for 2 min had the lowest percentage of vitamin C loss and total carotenoids and the lowest values for total color changes (ΔE) and gave the highest values of rehydration ratio for all groups under the different conditions of drying methods followed by samples pretreated by ascorbic + citric acids treatments. Drying rate % of dried mango slices was high in samples of microwave group and sugar microwave group for their pre-treatments. All different pre-treatment for mango slices dried by oven or microwave under different times improved all sensory characteristics.
References


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