Intercultivar Differences in Quality and Postharvest Life of Pomegranates Influenced by Partial Drying

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Abstract. Eleven pomegranate (Punica granatum L.) cultivars were first evaluated, dried for 9 days at 20°C and 47% relative humidity (RH), 30°C and 33% RH, and 40°C and 25% RH before storage at 20 ± 2°C and 47% RH. ‘Taifi-A’ was given the highest scores for sensory evaluation. ‘Kab El-Jameel’ contained significantly more edible portion and more juice, and had lower pH and higher acidity than any other cultivar. The highest vitamin C content was found in ‘Taifi-A’, ‘Red Balady’, and ‘Mellasi’. Drying at 40°C and 25% RH seriously damaged the pomegranates. ‘De-Jativa’, ‘Molar’, ‘Succary’, and ‘Taifi-R’ softened on the 4th day of drying and were more sensitive to drying conditions than the others. Drying at 30°C and 33% RH and at 20°C and 47% RH did not appear to have visually deleterious effects on the internal portion of the fruit, but the edible portion was slightly inferior to that of fresh (refrigerated) fruits, particularly those dried at 30°C and 33% RH. The juices of most dried fruits had higher pH, acidity, and total soluble solids content, but less vitamin C than fresh fruits. Fruits dried at 30°C and 33% RH or 20°C and 47% RH remained acceptable at 20 ± 2°C and 47% RH for up to 3 months or more, depending on the cultivar. Fungal decay (Aspergillus niger. Tiesh. and some Penicillium spp. were found) appeared only in fruits previously dried at 20°C and 47% RH. Partial drying of pomegranates maybe useful for processed juice products.

Pomegranate fruits are mainly consumed fresh and as juice that can be used in beverages and for flavoring and coloring drinks, jam, jelly, and grenadine (Chace et al., 1930; Ewaïdah, 1987; Hodgson, 1917; LaRue, 1969). ‘Taifi’ pomegranate is the most popular cultivar in Saudi Arabia, particularly in the South West region (Naser, 1983). However, some Egyptian and Spanish cultivars were introduced to the Riyadh region (Shaheen, 1985). The fresh fruits are only available from the middle of September until the beginning of November. Refrigeration has been recommended for storage and transport of pomegranates (Kader et al., 1984; Lutz and Hardenburg, 1977; Mukarjee, 1958; Piantastico et al., 1975). However, the high cost of refrigeration and disorders (mainly fungal growth and chilling injury symptoms) associated with fruit during refrigerated storage (Ben-Arie and Or, 1986; Elyatem and Kader, 1984) justify the search for an alternative method of preservation. Partial drying of pomegranate has not been commercially adopted, even though it was a normal practice of farmers and villagers in the past.

The objectives of this study were to evaluate postharvest quality of 11 pomegranate cultivars and to attempt to determine the effect of drying on their sensory, physical, and chemical properties.

Materials and Methods

Fruits. Fruits of all cultivars (Table 1) except ‘Taifi-A’ were obtained from 6- to 9-year-old trees grown at the Agricultural Experimental Station, College of Agriculture, King Saud Univ., Riyadh, during the 1989 harvest season. ‘Taifi-A’ fruits were harvested from a farm in Abha province in the southern region of Saudi Arabia and transported by air on the same day. The fruits were sorted for size and shape uniformity, and defective ones were eliminated. The fruits were then washed with tap water, dried with paper tissue, and held at 5°C and 90% RH until the next morning. Some fresh fruits from each cultivar were used for quality evaluation.

Table 1. Intercultivar differences’ in fruit weight, percent edible portion, and percent juice.

| Cultivar      | Range  | Mean   | Edible portion | Juice |
|---------------|--------|--------|----------------|-------|
| Taifi-A       | 99-206 | 160 f  | 67.6 bc        | 52.3 b|
| Taifi-R       | 232-264| 245 b-e| 59.1 de        | 43.0 cd|
| El-Madina     | 191-277| 230 c-f| 55.3 de        | 36.6 e|
| Kab El-Jameel | 312-364| 305 ab | 77.2 a         | 57.0 a|
| Red Balady    | 220-299| 266 a-d| 61.2 cd        | 43.0 cd|
| Mellasi       | 253-428| 325 a  | 61.6 ed        | 42.0 d|
| De-Jativa     | 163-295| 219 cef | 57.8 de      | 43.5 cd|
| Molar         | 156-198| 173 ef | 61.7 cd        | 42.5 d|
| Manfaloti     | 305-379| 323 a  | 72.4 ab        | 47.4 c|
| Banati        | 232-332| 293 abc| 58.7 de        | 41.1 de|
| Succary       | 133-205| 167 f  | 54.2 e         | 41.2 de|

Means separation in columns by Duncan’s multiple range test, P = 0.05.

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Table 2. Sensory evaluation of pomegranate fruits of different cultivars. Means of 20 judges ± SE.

| Cultivar      | Color   | Flavor  | Mouth feel | Overall acceptability |
|---------------|---------|---------|------------|-----------------------|
| Taifi-A       | 8.8 ± 0.40 a | 7.5 ± 0.5 a | 7.9 ± 0.3 a | 8.6 ± 0.2 a |
| Taifi-R       | 2.4 ± 0.3 g  | 6.9 ± 0.4 ab | 6.9 ± 0.4 ab | 6.0 ± 0.4 b |
| El-Madina     | 2.8 ± 0.3 fg | 4.4 ± 0.5 de | 3.6 ± 0.5 f  | 4.7 ± 0.5 cd |
| Khab El-Jameel | 7.4 ± 0.3 bc | 3.6 ± 0.3 ef | 5.1 ± 0.5 cd | 5.4 ± 0.4 bc |
| Red Balady    | 7.8 ± 0.2 b  | 3.2 ± 0.5 e  | 3.7 ± 0.5 ef | 4.2 ± 0.5 d  |
| Mellasi       | 4.6 ± 0.3 d  | 4.7 ± 0.3 de | 4.9 ± 0.3 de | 5.0 ± 0.3 bcd|
| De-Jative     | 3.7 ± 0.4 e  | 6.2 ± 0.4 bc | 7.5 ± 0.4 ab | 6.0 ± 0.5 b  |
| Molar         | 3.6 ± 0.3 ef | 6.3 ± 0.4 b  | 6.3 ± 0.6 bc | 6.0 ± 0.4 b  |
| Manfaloti     | 6.5 ± 0.4 e  | 5.0 ± 0.4 d  | 4.8 ± 0.5 de | 5.5 ± 0.4 bc |
| Banati        | 4.0 ± 0.3 de | 4.6 ± 0.3 de | 4.9 ± 0.4 def| 4.7 ± 0.4 cd |
| Succary       | 3.4 ± 0.2 ef | 5.0 ± 0.4 cd | 5.4 ± 0.5 cd | 5.3 ± 0.3 bcd|

Means separation in columns by Duncan’s multiple range test, P = 0.05.

Table 3. Effect of drying conditions on weight loss of pomegranates under various temperature/relative humidity conditions [vapor pressure difference (kPa)].

| Cultivar      | 20C, 47% RH | 30C, 33% RH | 40C, 25% RH |
|---------------|-------------|-------------|-------------|
| Wt loss (%)   | (1.2)       | (2.9)       | (5.5)       |
| Taifi-A       | 9.3 e       | 12.3 f      | 24.0 e      |
| Taifi-R       | 14.7 d      | 19.6 de     | 29.6 cd     |
| El-Madina     | 17.3 bc     | 21.8 c      | 25.5 e      |
| Kab El-Jameel | 14.8 d      | 19.5 d      | 28.4 d      |
| Red Balady    | 17.6 b      | 18.8 e      | 30.3 c      |
| Mellasi       | 14.3 d      | 19.9 de     | 24.7 e      |
| De-Jativa     | 18.3 b      | 22.7 C      | 37.6 b      |
| Molar         | 21.3 a      | 24.3 b      | 40.2 a      |
| Manfaloti     | 18.2 b      | 20.2 d      | 25.8 e      |
| Banati        | 15.9 cd     | 22.1 c      | 25.2 e      |
| Succary       | 20.1 a      | 27.4 a      | 39.6 a      |

Means separation in columns by Duncan’s multiple range test, P = 0.05.

Table 4. Percentage of discarded pomegranates after drying for 9 days at different drying conditions.

| Cultivar      | Drying temp (°C)/relative humidity (%) | Vapor pressure difference (kPa) |
|---------------|----------------------------------------|---------------------------------|
|               | 20/47 (1.2)                           | 30/33 (2.9)                     | 40/25 (5.5)                     |
| Taifi-A       | 0.5 cd                                 | 3.0 d                           | 68 b                            |
| Taifi-R       | 1.0 cd                                 | 9.0 bc                          | 89 a                            |
| El-Madina     | 0.0 d                                  | 3.0 d                           | 67 b                            |
| Khab El-Jameel| 0.0 d                                  | 0.5 d                           | 59 d                            |
| Red Balady    | 2.0 bc                                 | 4.5 cd                          | 63 b                            |
| Mellasi       | 0.0 d                                  | 2.5 d                           | 55 b                            |
| De-Jativa     | 4.0 a                                  | 18.0 a                          | 95 a                            |
| Molar         | 3.5 ab                                 | 16.0 a                          | 88 a                            |
| Manfaloti     | 0.0 d                                  | 2.0 d                           | 57 b                            |
| Banati        | 0.0 d                                  | 1.5 d                           | 67 b                            |
| Succary       | 1.5 cd                                 | 13.5 ab                         | 92 a                            |

Means separation in columns by Duncan’s multiple range test, P = 0.05.

Table 5. Compressive strength and strain as measurements of fresh (cold-stored) and dried pomegranate fruits texture.

| Cultivar      | Fresh      | Dried [°C/% RH (VPD)] |
|---------------|------------|----------------------|
|               | 20/47 (1.2) | 30/33 (2.9)         | 40/25 (5.5)         |
| Taifi-A       | 2.0 bc     | 3.5 a                | 1.2 f               |
| Taifi-R       | 1.9 bc     | 2.3 cd               | 2.8 ed              |
| El-Madina     | 1.8 bcd    | 1.5 c                | 2.2 e               |
| Kab El-Jameel | 2.0 bc     | 2.0 d                | 2.1 e               |
| Red Balady    | 1.5 de     | 2.5 c                | 2.9 e               |
| Mellasi       | 2.2 ab     | 2.0 d                | 2.4 de              |
| De-Jativa     | 1.9 bc     | 1.6 c                | 2.2 e               |
| Molar         | 1.4 e      | 2.0 d                | 1.6 f               |
| Manfaloti     | 1.7 cde    | 1.8 de               | 4.9 a               |
| Banati        | 2.4 a      | 1.6 e                | 3.5 b               |
| Succary       | 1.7 cde    | 3.0 b                | 2.1 c               |

Compressive strength (kg·cm⁻²)

| Cultivar      | Compressive strain (%) |
|---------------|------------------------|
| Taifi-A       | 331 c                  | 168 f                 |
| Taifi-R       | 319 ed                 | 124 g                 | 372 c                |
| El-Madina     | 337 c                  | 347 bcd               | 302 b                |
| Kab El-Jameel | 268 c                  | 232 f                 |
| Red Balady    | 277 de                 | 308 de                |
| Mellasi       | 321 cd                 | 276 ef                |
| De-Jativa     | 449 a                  | 440 a                 |
| Molar         | 331 c                  | 398 ab                |
| Manfaloti     | 300 cde                | 237 f                 |
| Banati        | 319 cd                 | 259 cd                |
| Succary       | 400 b                  | 346 ed                |

Means (of five fruits) separation in columns by Duncan’s multiple range test, P = 0.05.

Each factor was graded on a 10-point scale (1 = poor, 10 = best).

Texture. After removal of the calyx, five fruits per cultivar were compressed on their equator by use of an Instron Universal Testing Machine (Model 1197, Buckinghamshire, England) with compression plate diameter of 100 mm. Crosshead speed was 5 mm-min⁻¹ and the accuracy was ± 1 g. Total compressive distance, initial height, contact area, and the force necessary to cause cracking of the fruit were recorded. Both compressive strength (kilograms per square centimeter) and compressive strain (percent) were calculated.

Drying of pomegranates. The fruits of each cultivar were divided into three groups. One group was left to dry for 9 days at room temperature (~20C) and 47% RH. The second and third groups were dried for 9 days at 30C and 33% RH or at 40C and 25% RH, using drying ovens. The dried fruits were then

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Table 6. Number of panel members whose score differed for refrigerated and fruit dried for 9 days under several drying conditions [T = temperature (C), RH = relative humidity (%), VPD = vapor pressure difference (kPa)].

| Cultivar         | T 20 | T 30 | T 40 | RH 47 | RH 33 | RH 25 | VPD 1.2 | VPD 2.9 | VPD 5.5 | Flavor T 20 | Flavor T 30 | Flavor T 40 | Overall acceptability T 20 | Overall acceptability T 30 | Overall acceptability T 40 |
|------------------|------|------|------|-------|-------|-------|---------|---------|---------|-----------|-----------|-----------|---------------------------|---------------------------|---------------------------|
|                  |      |      |      |       |       |       |         |         |         |            |            |            |                           |                           |                           |
| Taifi-A          | 0.5  | ab   | 2.0  | cd    | 19.5 | a     | 1.5     | b       | 1.5     | b         | 19.5 a    | 2.0 b      | 1.0 cd     | 20.0 a                    |                           |                           |
| Taifi-R          | 0.0  | b    | 4.0  | c     | 20.0 | a     | 2.0     | b       | 2.5     | b         | 17.0 ab   | 2.5 b      | 3.5 bc      | 19.0 a                    |                           |                           |
| El-Madina        | 0.5  | ab   | 2.5  | cd    | 19.0 | a     | 1.5     | b       | 1.0     | b         | 14.5 bc   | 0.5 b      | 0.0 b       | 17.5 a                    |                           |                           |
| Khab El-Jameel   | 1.0  | a    | 3.0  | cd    | 20.0 | a     | 1.0     | b       | 2.0     | b         | 18.5 ab   | 1.0 b      | 3.0 c       | 18.0 a                    |                           |                           |
| Red Balady       | 0.0  | b    | 2.0  | cd    | 20.0 | a     | 1.5     | b       | 0.5     | b         | 16.5 ab   | 2.0 b      | 1.5 cd      | 19.5 a                    |                           |                           |
| Mellasi          | 0.5  | ab   | 0.0  | d     | 20.0 | a     | 2.0     | b       | 1.0     | b         | 15.0 ab   | 3.5 b      | 2.0 cd      | 18.0 a                    |                           |                           |
| De-Jativa        | 2.0  | a    | 7.5  | ab    | 19.5 | a     | 8.0     | a       | 11.0    | a         | 19.5 a    | 8.5 a      | 10.5 a      | 20.0 a                    |                           |                           |
| Molar            | 1.5  | b    | 8.5  | a     | 19.5 | a     | 9.0     | a       | 9.5     | a         | 18.5 ab   | 10.0 a     | 11.0 a      | 19.0 a                    |                           |                           |
| Manfaloti        | 0.0  | b    | 0.0  | d     | 19.0 | a     | 0.5     | b       | 0.5     | b         | 19.0 a    | 0.5 b      | 1.5 cd      | 20.0 a                    |                           |                           |
| Banati           | 0.0  | b    | 0.0  | d     | 18.0 | a     | 1.0     | b       | 2.5     | b         | 11.0 c    | 1.0 b      | 1.5 cd      | 18.5 a                    |                           |                           |
| Succary          | 0.5  | ab   | 5.0  | bc    | 20.0 | a     | 2.0     | b       | 1.0     | b         | 11.0 c    | 3.5 b      | 6.0 b       | 17.0 a                    |                           |                           |

*Means separation in columns by Duncan's multiple range test, P = 0.05.

Table 7. Chemical characteristics of pomegranate juice extracted from fresh fruits (F) or from fruits dried (D) at 30°C and 33% RH (2.9 kPa vapor pressure difference).

| Cultivar       | pH | TSS (%) | Acidity (%) | Vitamin C (mg/100 ml) | Total sugar (%) |
|----------------|----|---------|-------------|-----------------------|-----------------|
| Taifi-A        | 3.5 | cde     | 16.3 a      | 0.5 cde              | 2.2 a           |
| D              | 3.7 |         | 17.0        | 0.6                   | 0.5             |
| Taifi-R        | 4.1 | abc     | 15.4 abc    | 0.3 de               | 0.9 d           |
| D              | 4.2 |         | 16.8        | 0.4                   | 0.2             |
| El-Madina      | 3.8 | a-e     | 16.0 ab     | 0.5 cd               | 0.7             |
| D              | 3.8 |         | 16.8        | 0.6                   | 0.2             |
| Khab El-Jameel | 3.3 | e       | 16.0 ab     | 1.4 a                | 1.6 cd          |
| D              | 3.8 |         | 17.0        | 1.6                   | 0.5             |
| Red Balady     | 3.4 | de      | 14.1 d      | 1.3 a                | 2.1 a           |
| D              | 3.5 |         | 14.5        | 1.3                   | 0.2             |
| Mellasi        | 3.6 | b-e     | 15.3 bc     | 0.9 b                | 2.2 a           |
| D              | 3.8 |         | 17.6        | 1.1                   | 0.2             |
| De-Jativa      | 4.2 | ab      | 14.2 d      | 0.3 de               | 0.3 c           |
| D              | 4.5 |         | 17.2        | 0.4                   | 0.4             |
| Molar          | 4.0 | a-d     | 15.9 ab     | 0.5 c                | 0.3 e           |
| D              | 3.6 |         | 16.2        | 0.6                   | 0.2             |
| Manfaloti      | 3.5 | cde     | 15.8 abc    | 1.0 b                | 1.4 c           |
| D              | 3.6 |         | 17.0        | 1.2                   | 0.2             |
| Banati         | 3.6 | b-e     | 15.2 bc     | 0.8 b                | 1.7 b           |
| D              | 3.6 |         | 15.6        | 1.3                   | 0.6             |
| Succary        | 4.3 | a       | 14.9 cd     | 0.2 e                | 0.4 e           |
| D              | 3.8 |         | 16.8        | 0.5                   | 0.4             |

Table 8. Shelf life* and proportion of decayed fruit* following drying for 9 days under the conditions indicated.

| Cultivar       | Shelf life (days) | Decayed fruit (%) | Shelf life (days) | Decayed fruit (%) | Shelf life (days) | Decayed fruit (%) |
|----------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Taifi-A        | 84                | 23.7              | 84                | 26.3              | 5                 | 58.3              |
| Taifi-R        | 49                | 39.1              | 42                | 53.5              | 0                 | 100               |
| El-Madina      | 91                | 22.8              | 119               | 23.5              | 5                 | 36.6              |
| Khab El-Jameel | 98                | 32.5              | 126               | 26.3              | 5                 | 51.8              |
| Red Balady     | 91                | 21.9              | 119               | 20.1              | 5                 | 41.1              |
| Mellasi        | 112               | 18.7              | 126               | 17.5              | 5                 | 45.8              |
| De-Jativa      | 42                | 49.3              | 14                | 65.6              | 0                 | 100               |
| Molar          | 49                | 43.8              | 14                | 58.7              | 0                 | 100               |
| Manfaloti      | 84                | 22.8              | 126               | 16.2              | 5                 | 35.6              |
| Banati         | 98                | 26.1              | 126               | 20.7              | 5                 | 41.1              |
| Succary        | 35                | 39.4              | 14                | 49.6              | 0                 | 100               |

*Days until the dried pomegranates deteriorated to a general acceptability score of 3 or lower.

*Decay percentage at the end of indicated storage period.

Storage of dried fruits. Dried fruits were stored at room temperature (20 ± 2°C), and the extent of shelf life of each cultivar was determined based on general acceptability on a 9-point hedonic scale, (1-3 = unacceptable; 4-6 = acceptable; 7-9 = excellent). Visual evaluation of quality was made every 5 days, transferred to room temperature where the first group had been kept. The following determinations were carried out during and/or after drying: 1) Ten identified fruits from each group and for each cultivar were weighed daily during drying for 9 days. 2) External and internal symptoms on dried fruits were observed. Decayed fruits were discarded, and their cumulative percentages were calculated until the end of the drying period. 3) The compressive strength and compressive strain of dried fruits were measured as noted for the fresh fruits. 4) The same sensory evaluation panel used for evaluating the pomegranate cultivars was asked to detect attributable differences between fresh (cold-stored) and dried pomegranates. 5) The extracted juice of dried fruits was analyzed for pH, TSS, titratable acidity, vitamin C, and reducing or nonreducing and total sugars (AOAC, 1980).
Results

Evaluation of fresh fruits. The color of fresh fruits varied among cultivars from yellow (‘Taifi-R’, ‘De-Jativa’, ‘Molar’, ‘Succary’), to greenish white (‘Mellasi’, ‘Banati’), to green (‘El-Madina’, ‘Kab El-Jameel’, ‘Manfalotii’), to bright red (‘Mellasi’, ‘Banati’), to dark red (‘Red Balady’, ‘Manfalotii’, ‘Mellasi’, and ‘Kab El-Jameel’ weighed, on average, >300 g, while ‘Taifi-A’, ‘Molar’, and ‘Succary’ weighed < 200 g (Table 1). ‘Kab El-Jameel’, followed by ‘Manfalotii’, contained more edible portion and more juice than the other cultivars. ‘Taifi-A’ was given the highest sensory scores (Table 2). The other cultivars either lacked the attractive red pigmentation or the sweet taste, or they had a grainy mouth feel.

Weight loss and decay during drying. The pomegranate fruits gradually lost weight during drying under the various conditions (Table 3). Weight loss increased with increasing vapor pressure difference (higher temperatures, lower relative humidity). The drying pattern varied among cultivars, but most of the water was lost from the peel tissue rather than from the pulp (data not shown). Drying at 40C and 25% RH severely damaged the fruits (Table 4), particularly those of ‘Taifi-R’, De-Jativa’, ‘Molar’, and ‘Succary’, which softened on the 4th day of drying. The most prevalent types of damage other than softening were browning and superficial discoloration of the husk, mold-infected “scaled area”, and dripping leakage of juice. The fruits were much less affected by drying at 30C and 33% RH, and almost no fruits were discarded during drying at 20C and 47% RH.

External and internal appearance of dried fruit. Upon drying, particularly at 40C, the rind lost its natural color, shriveled, and became hard and dark. The dried fruits shrunk toward the center and were irregular in shape. Internal symptoms of drying at 40C included splits, voids, and browning of the arils and white segments separating the arils. However, drying at 30 or 20C did not have any visually deleterious effect on the internal portion of the fruit.

Compressibilities of dried fruit. Two measures of compression were determined: 1) compressive strength (kg-cm-2) = force/contact area; 2) compressive strain (%) = total compressive distance/initial fruit height.

The compressive strength reflects the force required to crack the fruit, while compressive strain represents the deformation of the fruit until it cracks. The force necessary to cause cracking was generally higher for dried than for fresh fruit (Table 5), although the results were not always consistent. Drying resulted in harder rind that resisted cracking and in an irregular shape that altered the size of the contact area between the compression plate and the equator of the fruit. This change may explain the difference in compressive strength between fresh and dried fruits. Drying caused a decrease in compressive strain of most fruits dried at 30C and 33% RH, or at 40C and 25% RH (Table 5). Dried fruits had lost most of their natural elasticity during drying and were less tolerant to compression; consequently, shorter compressive distance was obtained. However, ‘Taifi-R’, ‘De-Jativa’, and ‘Succary’ dried at 40C showed significantly (P < 0.05) longer total compressive distance (data not shown) and, consequently, higher compressive strain percentages, which is a symptom of softening of fruits during and after drying.

Sensory evaluation of dried fruit. Drying at 20C and 47% RH or at 30C and 33% RH did not appear to have any deleterious effect on fruit quality (Table 6). However, a few panelists gave higher scores to refrigerated fruits than to fruits dried at 30C and 33% RH, while most gave the lowest scores to fruits dried at 40C and 25% RH on the basis of their color, flavor, and overall acceptability. The effects of drying at 20C and 47% RH or at 30C and 33% RH on sensory properties varied among cultivars; ‘De-Jativa’ and ‘Molar’ consistently were judged different from the refrigerated fruit (Table 6). Fruit dried at 40C and 25% RH almost always was judged different from refrigerated fruit.

Chemical composition of fresh and dried fruits. ‘Khab El-Jameel’ had the lowest pH and the highest-acidity, while ‘Succary’ had the highest pH (Table 7). Vitamin C content was highest and about equal in ‘Taifi-A’, ‘Red Balady’, and ‘Mellasi’. TSS ranged from 14.1% to 16.3%, while total sugar content ranged from 11.4% to 15.2%. However, nonreducing sugars (1.9%) were found only in ‘Banati’.

After drying for 9 days at 30C and 33% RH, most fruits had generally higher pH, TSS, and acidity but a lower vitamin C content than refrigerated fruits (Table 7). Drying had no consistent effect on total sugar content, and the reason for the inconsistency is unknown.

Drying at 20C and 47% RH did not affect the chemical composition of the fruits (data not shown). The fruits dried at 40C and 25% RH were damaged by drying and, therefore, their juice was not analyzed. The interaction for TSS, vitamin C, and total sugars between cultivar and treatment was significant (P < 0.05) but not for pH and acidity.

Shelf life of dried fruits and their quality during storage. Fruits dried at 40C and then kept at 20 ± 2C and 47% RH had a very short (≤5 days) shelf life (Table 8). However, those dried at 20 or 30C remained acceptable for 14 to 126 days, depending on cultivar and drying conditions. Cultivars (De-Jativa, Molar, Succary, Taifi-R) that had been rapidly damaged by drying (Table 4), had a shorter shelf life (<49 days) than the others.

Fruits initially dried at 20C and 47% RH showed some fungal decay during subsequent storage under the same conditions. The decay started as a soft area around the calyx and progressed as a mass of blackened arils inside the fruit. Aspergillus niger and some Penicillium spp., mainly Penicillium expansum Lk. ex Thorn. were identified (Raper and Fennel, 1965; Raper et al., 1968).

Discussion

The evaluation of fresh fruits showed the panelists’ preference toward ‘Taifi-A’ over the other cultivars, including ‘Taifi-R’. This result would be expected since ‘Taifi-A’ is the most popular cultivar in Saudi Arabia. ‘Taifi-A’ and ‘Taifi-R’ are grown in two completely different climatic regions, and the edible portion of ‘Taifi-A’ is a very attractive red, while that of ‘Taifi-R’ lacked this attribute. The mean fruit weight and edible portion of the fresh fruits are important from the economic standpoint whether the fruits are to be consumed fresh or used for juice extraction. Data presented here on ‘Taifi’ pomegranate are consistent with earlier studies (Ewaidah, 1987).

Weight loss during drying increased with temperature increase and relative humidity decrease. Elyatem and Kader (1984)
found the weight loss of pomegranates during storage to be largely due to water loss; weight loss due to respiration represented only ≈ 9% to 26% of the total, depending on temperature. Weight loss of pomegranate fruits during storage at various temperatures was also reported by others (Al-Mughribi and Bacha, 1986; Heikal et al., 1984). The change in color of the fruit caused by drying can reduce the marketability, while toughness of the rind can increase the durability during shipping and handling.

Drying at 30°C and 33% RH or at 20°C and 47% RH produced a brown, leathery, tough rind, but the edible portion remained acceptable and no internal changes were observed. However, the edible portion of fruits dried at 40°C browned and had a poor flavor. The browning of plant tissues may be due to either enzymatic or nonenzymatic and both were investigated by Ben Arie and Or (1986) in ‘Wonderful’ pomegranate. They suggested that discoloration was a result of enzymatic oxidation.

The increase in pH, TSS, and acidity and the decrease in vitamin C upon drying of pomegranate cultivars are in agreement with the findings of other workers (Al-Mughribi and Bucha, 1986; Elyatem and Kader, 1984; Heikal et al., 1984).

The shelf life of dried pomegranates varied among cultivars, depending on drying conditions. Fruits dried at 30°C and 33% RH or at 20°C and 47% RH had better keeping quality ( >3 months) than those dried at 40°C and 25% RH, which deteriorated rapidly. Al-Mughribi and Bucha (1986) reported that 21.46%, 13.72%, and 24.82% of fruit were decayed for ‘Manfaloti’, ‘Mellasi’, and ‘Khab El-Jameel’, respectively, after storage for 10 weeks at room temperature (20 to 30°C). Elyatem and Kader (1984) discarded ‘Wonderful’ pomegranate fruits after 6, 4, and 1 weeks of storage at 10, 20, or 30°C, respectively, because of decay. However, unlike in this study they had not treated the fruits with postharvest fungicides.

Partial drying of pomegranates can be a successful method of preservation if drying conditions are properly chosen and carefully controlled. The results of this study suggest that drying temperature should not exceed 30°C to minimize the deleterious effect on quality. Partially dried pomegranates can have slightly inferior eating quality than those refrigerated, but they might find some applications in the manufacture of jams, jellies, and other products.

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