Responses of pomegranates to ethylene treatment and storage temperature

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Fully ripe fruit can be safely stored for long periods if not over-chilled

Almost all the commercial production of pomegranates in the United States is in California. The fruit is large, deep purple-red in color, and glossy in appearance, and the edible portion, the pulp around each seed (aril), is eaten fresh or used in making juice, jelly, grenadine, and wine.

Harvesting of the most widely grown cultivar of pomegranate, *Punica granatum* 'Wonderful', usually begins in the middle of September and continues until mid-October. Currently used indices of minimum maturity are titratable acidity (less than 1.85 percent acid content) and intensity of red color of the juice.

Pomegranates may be stored for several weeks to extend their marketing season, but very little information is available on their postharvest physiology and optimum storage conditions. Our objectives were to investigate responses of pomegranates to ethylene treatments and to storage temperature and duration.

During the 1979 to 1981 seasons, we obtained fruits of the 'Wonderful' cultivar from a packinghouse in Lindsay, California. We used medium-size (about 230-gram) fruits in all experiments except when investigating the relationship between fruit size and composition. Respiration and ethylene production were measured on five individual fruits (replicates) per treatment. Studies of weight loss, compositional changes, and chilling injury used three replicates of five fruits each per treatment. Quality evaluations included external skin color as well as color, soluble solids content, pH, and titratable acidity of the juice extracted from the arils.

Fruit characteristics

Within each season, titratable acidity decreased and soluble solids content, pH, and red color intensity of the juice increased with fruit maturation and ripening. For example, fruits picked in early October had an average soluble solids content of 18.1 percent and a titratable acidity of 1.58 percent, whereas those harvested in mid-September averaged 17 and 1.8 percent, respectively. There was no consistent relationship between the extent of red coloration of the skin and fruit composition.

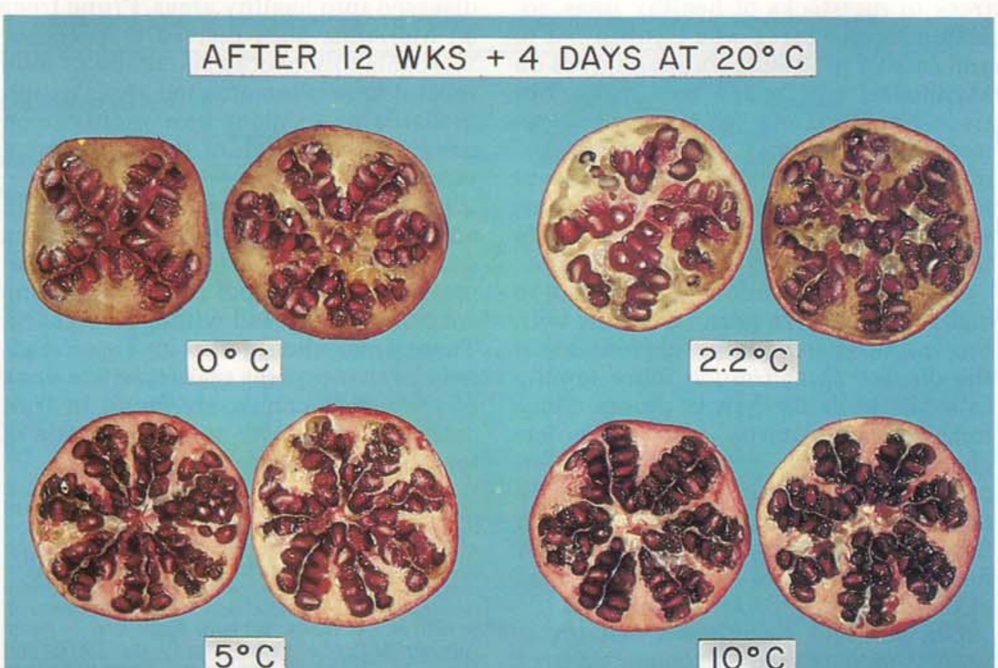
Differences in soluble solids, juice color, percent edible portion, and percent extractable juice were small among fruits of various sizes. Large fruits (more than 250 grams) were generally lower in titratable acidity than smaller fruits.

Pomegranate fruits had a relatively low respiration rate, which declined with time after harvest (fig 1). At temperatures between 0° and 10°C (32° and 50°F), the respiration rate remained below 8 milliliters carbon dioxide per kilogram-hour during storage for up to three months. Pomegranates produced only trace amounts of ethylene (less than 0.2 microliter per kilogram-hour) while being held at 20°C (68°F) for two weeks (fig. 2). Based on these respiration and ethylene-production patterns, the pomegranate can be classified as a nonclimateric fruit, that is, one that exhibits no dramatic changes in postharvest composition or physiology.

Responses to ethylene

Exposure of pomegranates to 1, 10, or 100 ppm ethylene for up to 13 days at 20°C stimulated their respiration rate; the degree of stimulation was proportional to the ethylene concentration (fig. 1). Subjecting pomegranates to 100 ppm ethylene for 2 days temporarily increased their respiration and ethylene production rates, which then declined to near the levels of control fruits after 3 days in air (fig. 2). This response occurred again when the fruits were exposed to a second 2-day ethylene treatment after 7 days in storage.

None of the ethylene treatments had a significant effect on skin color, juice color, soluble solids, pH, or titratable acidity of the fruits. These results indicate that pomegranates do not ripen once removed from the tree and should be picked when fully ripe to ensure the best eating quality for the consumer. Also, there is no value in treating har-



Chilling injury occurred in pomegranates stored at 0° - 5°C (32° - 41°F) for 12 weeks before transfer to 20°C (68°F) for four days. No symptoms developed in fruits kept at 10°C. (D. Edwards photo)

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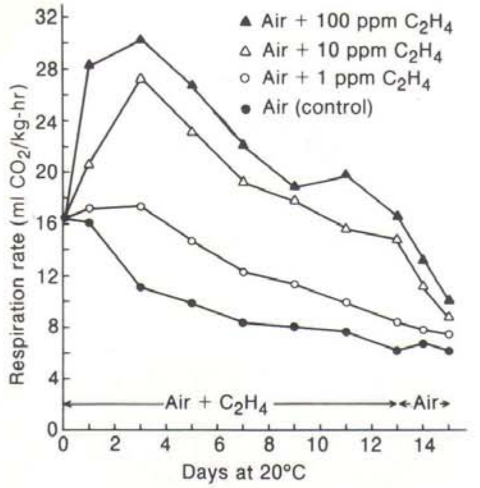

Fig. 1 The relatively low respiration rate of pomegranates after harvest was stimulated by exposure to ethylene in proportion to the ethylene concentration.

vested pomegranates with ethylene.

Storage conditions

Weight loss from pomegranates increased with storage temperature and duration (see table) but remained low when the fruits were kept in jars ventilated with humidified air (about 95 percent relative humidity). Fruits stored at the same temperatures but at lower relative humidities lost much more of their weight. Shriveling became noticeable on fruits that lost 5 percent or more of their weight. Although the skin appears tough, it has numerous minute openings that permit free movement of water vapor and make pomegranates highly susceptible to water loss under conditions of high vapor pressure difference.

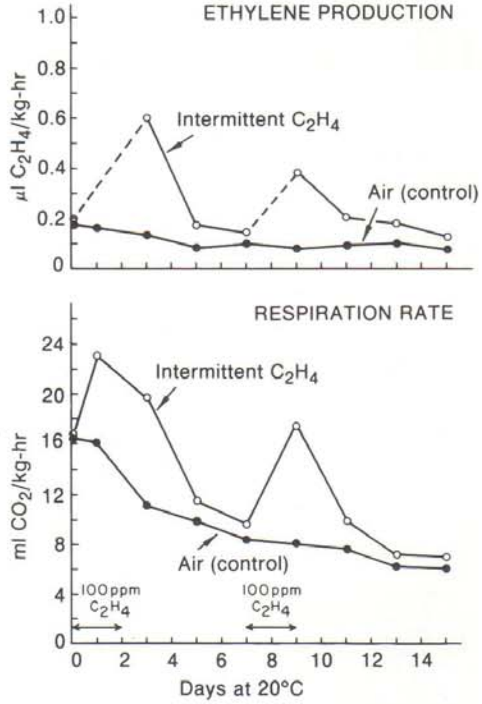

Fig. 2 Subjecting pomegranates to 100 ppm ethylene for two days temporarily increased their respiration and ethylene production rates.

During storage at all temperatures, soluble solids and titratable acidity decreased and pH increased in fruits as compared with their composition at harvest. After 4, 8, 12, and 16 weeks, differences in composition among fruits stored at 0°, 2.2°, 5°, and 10°C (32°, 36°, 41°, and 50°F) were generally small. No significant temperature effects on changes in skin or juice color were found during storage for up to 8 weeks. Subsequently, fruits stored at 5° and 10°C maintained their red skin color better than those kept at lower temperatures.

No chilling injury or decay was visible in pomegranates kept for 4 weeks at any of the temperatures. After 8 weeks, fruits kept at temperatures below 5°C showed symptoms of chilling injury, which became more noticeable after transfer to 20°C for 3 or 4 days. External symptoms included brown discoloration of the skin and increased susceptibility to decay. Internal symptoms were a pale color of the arils and brown discoloration of the white segments separating the arils. On a few of the fruits stored at 5°C for 8 weeks, the white tissues were only slightly discolored. After 12 weeks of storage, fruits held at 0°, 2.2°, and 5°C developed chilling injury, but those kept at 10°C did not.

The incidence and severity of chilling injury varied from season to season but generally increased with lower temperatures and with storage duration. Chilled fruits were more susceptible to surface molds, whereas the decay on fruits kept at 10°C was limited to the blossom end.

From the data presented here as well as data from five other experiments, it is clear that pomegranates are susceptible to chilling injury but it takes more than one month of storage at temperatures below 5°C (41°F) for the disorder to appear. Fruits can be safely stored at 5°C for up to two months, but for longer storage, 10°C (50°F) appears to be the minimum safe temperature. The problem limiting storage at 10°C is decay incidence, which depends on the extent of preharvest infection with pathogens and the relative effectiveness of preharvest disease control procedures.

Conclusions

Pomegranates do not ripen off the tree and should be picked when fully ripe to ensure their best flavor. Ethylene treatments do not influence external color, juice color, or composition of pomegranates. Maintenance of a relative humidity near 95 percent minimizes weight loss during storage.

Pomegranates are susceptible to chilling injury if stored longer than one month at temperatures between their freezing point (−3°C, or 26.6°F) and 5°C (41°F). The minimum safe temperature for storage for up to two months is 5°C. Longer storage should be at 10°C (50°F) to avoid chilling injury.

Effects of storage temperature and duration on pomegranates picked October 5, 1981

Storage treatment						Chilling injury‡				
						External		Internal		
Duration	Temp.	Weight loss	SSC*	pH	TA†	Fruits Score	affected	Fruits Score	affected	Decay
Weeks	*°C(°F)*	%	%		%		%		%	%
Initial	--	0	18.7	3.09	1.58	1.0	0	1.0	0	0
4	0 (32)	0.8	18.7	3.24	1.33	1.0	0	1.0	0	0
	2.2 (36)	0.8	18.4	3.20	1.29	1.0	0	1.0	0	0
	5 (41)	0.8	18.5	3.18	1.43	1.0	0	1.0	0	0
	10 (50)	0.9	18.7	3.08	1.35	1.0	0	1.0	0	0
8	0 (32)	0.9	18.3	3.25	1.44	2.3	73.3	2.9	60.0	0
	2.2 (36)	1.0	18.2	3.26	1.39	1.4	26.7	2.5	60.0	0
	5 (41)	1.1	18.4	3.36	1.20	1.0	0	1.1	6.7	0
	10 (50)	1.2	18.1	3.36	1.18	1.0	0	1.0	0	0
12	0 (32)	0.9	18.2	3.29	1.27	2.9	80.0	2.9	80.0	26.7
	2.2 (36)	1.1	18.0	3.38	1.09	2.1	66.7	3.9	100.0	13.3
	5 (41)	1.2	18.1	3.42	1.06	1.3	33.3	1.8	40.0	13.3
	10 (50)	1.4	18.0	3.32	1.08	1.2	20.0	1.0	0	6.7
16	0 (32)	1.0	—§	—	—	3.3	93.3	3.3	100.0	60.0
	2.2 (36)	1.3	17.8	3.42	1.16	2.4	60.0	4.2	93.3	60.0
	5 (41)	1.5	17.6	3.39	1.24	1.5	33.3	2.1	40.0	26.7
	10 (50)	1.9	17.4	3.36	1.11	1.3	40.0	1.1	6.7	20.0

* SSC = soluble solids content.
† TA = titratable acidity.
‡ Evaluations were made after four days at 20°C (68°F) following the storage treatment using the following scoring system: 1 = none, 2 = slight, 3 = moderate, 4 = severe, and 5 = extreme injury.
§ No analysis was made, because fruits were too badly affected by chilling injury and decay.

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