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Director's Note

While it is technically still winter, here in California spring is in the air! Trees are blooming and while we are all hoping for more rain and snow, we are also enjoying the pleasant weather. If it is still winter where you are, you may want to consider enrolling in the Fruit Ripening & Ethylene Management Workshop March 31-April 1 on the UC Davis campus.

I am preparing to participate in the Global Forum for Innovators in Agriculture in Abu Dhabi next month. I will be offering a workshop for participants, **Cooling Produce is Key to Marketing Success**, and also will look forward to learning about some new innovations of interest to the produce industry. I will be sure to share them here after the conference.



*Interim Director,
Beth Mitcham*

Postharvest Education at UC Davis



Fruit Ripening & Ethylene Management Workshop March 31-April 1

This workshop focuses on how to increase profits by reducing losses at the receiving end, and delivering ready-to-eat, delicious fruits and fruit-vegetables to the consumer. Topics will include ripening facilities and equipment, maturity and quality relationships, biology of ethylene production, sensory quality, temperature management, retail handling, and phythological disorders. Learn from experts from the produce industry and the University of California and University of Florida. Demonstrations of how to measure produce physical and sensory quality and environmental conditions will be included. Join us to experience the flavor benefits of ripe fruit! Please visit the [website](#) for more information.

[**Enroll Here!**](#)



Postharvest Technology of Horticultural Crops Short Course beginning June 15
March Madness has arrived at UC Davis! Receive 10% off your registration fee until March 31!

This course is a one or two-week intensive study of the current technologies used to handle fruits, nuts, vegetables and ornamentals, along with an overview of the underlying biology. It is designed for quality control personnel in the produce industry, along with research, extension, business and government professionals interested in postharvest handling of horticultural crops. Week two is an optional tour of produce operations in California, including harvesting, packing, cooling and transportation. Please visit the [website](#) for more information.

[Enroll Here!](#)

On Our Website

Stay up-to-date with the Postharvest Technology Center by joining our [LinkedIn Group](#).



New Publications on our Website

Stefan Petrasch, Steven J. Knapp, Jan A.L. Van Kan and Barbara Blanco-Ulate. [Grey mould of strawberry, a devastating disease caused by the ubiquitous necrotrophic fungal pathogen Botrytis cinerea](#). Molecular Plant Pathology (2019). D OI: 10.1111/mp.p.12794.

Cassandro V.T. do Amarante, Joao Paulo G. Silveira, Cristiano A. Steffens, Sergio T. de Freitas, Elizabeth J. Mitcham, Aquidauana Miquelotoa. [Post-bloom and preharvest treatment of 'Braeburn' apple trees with prohexadione-calcium and GA4+7 affects vegetative growth and postharvest incidence of calcium-related physiological disorders and decay in the fruit](#). Scientia Horticulturae 261 (2020) 108919.

Postharvest Opportunities



Summer Intern United Fresh Produce Association Food Safety Team

Consider applying for a summer internship at the United Fresh Produce Association, the national trade association for the fresh produce industry, located three blocks from the White House. Get a glimpse into how federal food safety policy is developed, how foodborne illness outbreaks are handled, and how science and education promote the implementation of risk-based preventive approaches by the industry. Job posting - <https://www.unitedfresh.org/content/uploads/2020/02/food-safety-intern-2-10-20.pdf>

For more information:

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Research Highlights

Berry, E. D., Wells, J. E., Durso, L. M., Friesen, K. M., Bono, J. L., & Suslow, T. V. (2019). Occurrence of *Escherichia coli* O157:H7 in pest flies captured in leafy greens plots grown near a beef cattle feedlot. *Journal of Food Protection*, 82(8), 1300–1307. <https://doi.org/10.4315/0362-028X.JFP-18-601>

The authors investigated the occurrence of E. coli O157:H7-positive flies in leafy greens planted up to 180 meters (197 yards) from a cattle feedlot and assessed their relative risk to transmit this pathogen to leafy greens. Among the different flies that were trapped and tested, carriage rates for most of the flies ranged from 2.23 to 2.9%, but stable flies had a lower carriage rate (0.11%). E.coli carriage rates did not differ by distance from the feedlot (0-180 meters). Further research is needed to determine risk for leafy greens contamination by pest flies.

Polari, J. J., Zhang, L., Ferguson, L., Maness, N. O., & Wang, S. C. (2019). Impact of microclimate on fatty acids and volatile terpenes in “Kerman” and “Golden Hills” pistachio (*Pistacia vera*) kernels. *Journal of Food Science*. https://onlinelibrary.wiley.com/doi/abs/10.1111/1750-3841.14654?casa_token=q4q-phwMGoAAAAA:xiNGmWYdd4gDwWTqWb-B9ficq6_iiuZNTjXNwNTntZm2VpoD_We9htUcTb-Y3luk4-W5fchwz6SAdjz0

The authors monitored changes in moisture, fat content, fatty acid composition and volatile terpenes during kernel development in pistachio nuts grown in two California locations. Harvest time affected fat content in Kerman pistachio kernels, where the values increased drastically from late July to early August, then remained constant. The results showed that microclimate affects biosynthesis of fatty acids and terpenes in pistachio kernels, the main compounds responsible for pistachio nutritional and sensory quality.

Amir, R., Borochoy-Neori, H., Tian, L., & Holland, D. (2019). The biodiversity of different traits of pomegranate fruit peels from a broad collection of diverse cultivars. *Scientia horticulturae*, 246, 842-848. <https://www.sciencedirect.com/science/article/pii/S0304423818307246>

Pomegranate peels are a rich source of bioactive compounds, but peel traits differ between cultivars. The peels contain high levels of hydrolysable tannins that contribute to the health-promoting activities of pomegranate, and are usually extracted into the pomegranate juice. The hydrolysable tannins are also related to peel quality during prolonged storage of fresh pomegranate. The study showed that both genetic and environmental conditions contribute to the different desired traits.

Postharvest Calendar

- March 9-10, 2020. [Global Forum for Innovations in Agriculture Abu Dhabi 2020](#), Abu Dhabi, UAE
- March 31-April 1, 2020. [Fruit Ripening & Ethylene Management Workshop](#). Davis, CA
- June 15-26, 2020. [Postharvest Technology of Horticultural Crops Short Course](#). Davis, CA
- September 22-24, 2020. [Fresh-cut Products: Maintaining Safety and Quality Workshop](#). Davis, CA
- November 9-13, 2020. [9th ISHS International Postharvest Symposium](#). Rotorua, New Zealand

Ask the Produce Docs



Q. We are a national retail chain interested in the proper postharvest handling of nuts. Nuts are usually held in our distribution centers (DCs) for about 3-4 weeks, but we do not have a consistent temperature zone established as a best practice. In some DCs, the nuts are stored at low temperature (34-37F; 1-3C) while in others they are stored with the dry grocery items at 65-80F (18-27C). At the store level, the nuts are displayed in non-refrigerated area. Do you have any specific temperature information to help me?

A. Since nuts are increasing in popularity, I reviewed the published literature to ensure the most accurate information. Three sources of information are cited below, but a

more extensive reference list on nuts is available at <http://ucanr.edu/datastoreFiles/234-2753.pdf>.

Important factors for nut quality include drying to low moisture content and packaging in moisture proof bags. Since nuts in shells are often handled loose, temperature will be important to maintain quality and shelf-life as summarized in **Table 1**.

These shelf-life estimates take into account information on quality and food safety changes at different temperatures. The main quality concerns are rancidity (oxidation of lipids leading to off-flavors), darkening (related to initial drying temperature and subsequent storage conditions), mold growth (moisture and temperature dependent), brittleness (moisture content too low), insect infestation, and stale flavor (held too long under the given storage conditions). The main food safety concerns for nuts are aflatoxins produced by fungi and human pathogenic bacteria (*Salmonella* sp., *Listeria monocytogenes*); both food safety aspects are affected by the moisture content and temperature of the nut. Some nuts, especially peanuts, may cause allergic reactions in some people.

The moisture content of common nuts in refrigerated storage should be near the following percentages: almonds 6%, Brazil nuts 7%, cashew nuts 8%, coconut 20%, hazelnuts 15%, macadamia nuts 15%, pecans 5%, peanuts 7%, pistachio nuts 7% and walnuts 5%. The optimum relative humidity of storage varies from 55-70% depending on the moisture content of the nuts, and packaging in moisture-proof containers is recommended to maintain quality. The higher the temperature, the more critical is relative humidity and moisture content. Coconuts and chestnuts have high moisture contents and should be considered more as 'fresh fruits'.

Nuts in the shell have about 25-50% longer shelf-life than the nutmeats alone; this percentage can vary considerably depending on the particular nut and whether the packaging provides a moisture barrier and/or a low oxygen concentration. Pieces of nutmeats have about half the shelf-life of the intact nutmeats. Some roasted nuts have a shelf-life about one fourth that of the raw nutmeats.

In general the optimal storage temperature is 0-10C with relative humidity at 55-70%, depending upon the original moisture content of the nut.

Table 1. Shelf-life of raw nuts (in shell or intact nutmeats) stored at different temperatures. Estimates are derived from general published information and the specific references cited. If the nutmeats are packaged, it is assumed that relative humidity is controlled but that oxygen concentrations are not substantially different from air. It is also assumed the nuts were dried adequately before storage.

Nut	Type	Estimated Shelf-life in months					References
		-10°C (-14°F)	0°C (32°F)	10°C (50°F)	20°C (68°F)	30°C (86°F)	
Almond	Nutmeat		10	8	4		Labavitch, 2004; Cornacchia et al., 2012
	In shell		20	16	6		
Brasil nut	Nutmeat		6				WFLO, 2008
	In shell		12				

Cashew	Nutmeat		12		6		Soares et al., 2012; WFLO, 2008
Chestnut	In shell	Do not freeze	3	0.5	0.25		Kader, 2003; Panagou et al., 2006
Coconut	In shell, no husk		2	0.5			TIS, undated; Siripanich et al., 2011
	In green husk		2	1	0.5	0.25	Maciel et al., 1992; Siripanich et al., 2011
Hazelnut	Nutmeat		24	12			Maness, 2004
	In shell		24	12			WFLO, 2008
Macadamia	Nutmeat	24	12	12	5	0.75	Cavaletto, 2004; Wall, 2013
Peanut	Nutmeat	24	12	9	4		WFLO, 2008; Maness, 2004; Calhoun, 2013
	In shell		12	9	6		Maness, 2004; Orloff, 2009
Pecan	Nutmeat	18	10		3		Maness, 2004
	In shell	24	18	9	4		WFLO, 2008; Maness, 2004
Pine Nut	Nutmeat						
Pistachio	Nutmeat		10	3	1	0.25	Arena et al., 2013; Kader & Thompson, 2002
	In shell, split		12				Maskan et al., 1999
Walnut	Nutmeat		12		3		Mexis et al., 2009; Kader and Thompson, 2002
	In shell		12		4		McNeil, 2013
Average*		22.5	13.5	10	4	0.5	

*The average excludes high moisture chestnuts and coconuts

Kader, A.A. and J.F. Thompson. 2002. Postharvest handling systems: Tree nuts. Ch 32, pp 399-406. In: Kader, A.A. (ed.), Postharvest Technology of Horticultural Crops. Univ. California Publication 3311.

Kader, A.A., E.J. Mitcham and C. Crisosto. 1998. Dried fruits and nuts: Recommendations for maintaining postharvest quality. <http://postharvest.ucdavis.edu/PFfruits/DriedFruitsNuts/>.

Harris, L.J. (ed.) 2013. Improving the safety and quality of nuts. Woodhead Publishing Series in Food Sciences, Tech. and Nutrition Number 250, Woodhead Publishing, Cambridge, UK. 405 pp.

Marita Cantwell

Postharvest Questions. If you have a postharvest question you'd like answered, please send it to postharvest@ucdavis.edu, and we'll see if one of our specialists can help.

Archived Items. Link to a data store of all our previous "Ask the Produce Docs" questions, or link to [archived copies](#) of our monthly e-newsletter as PDF documents.

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