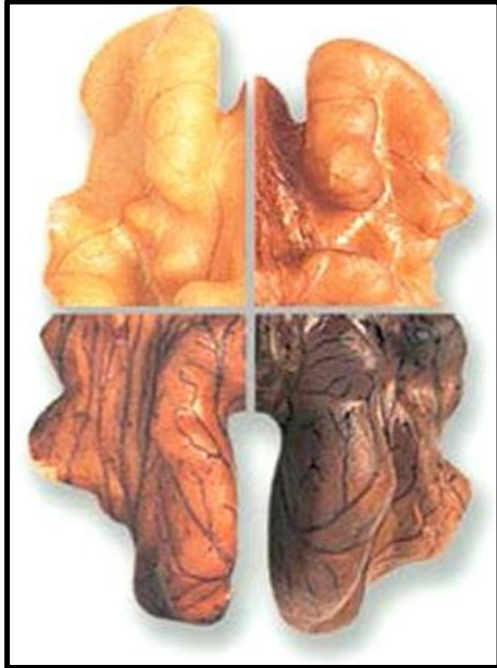


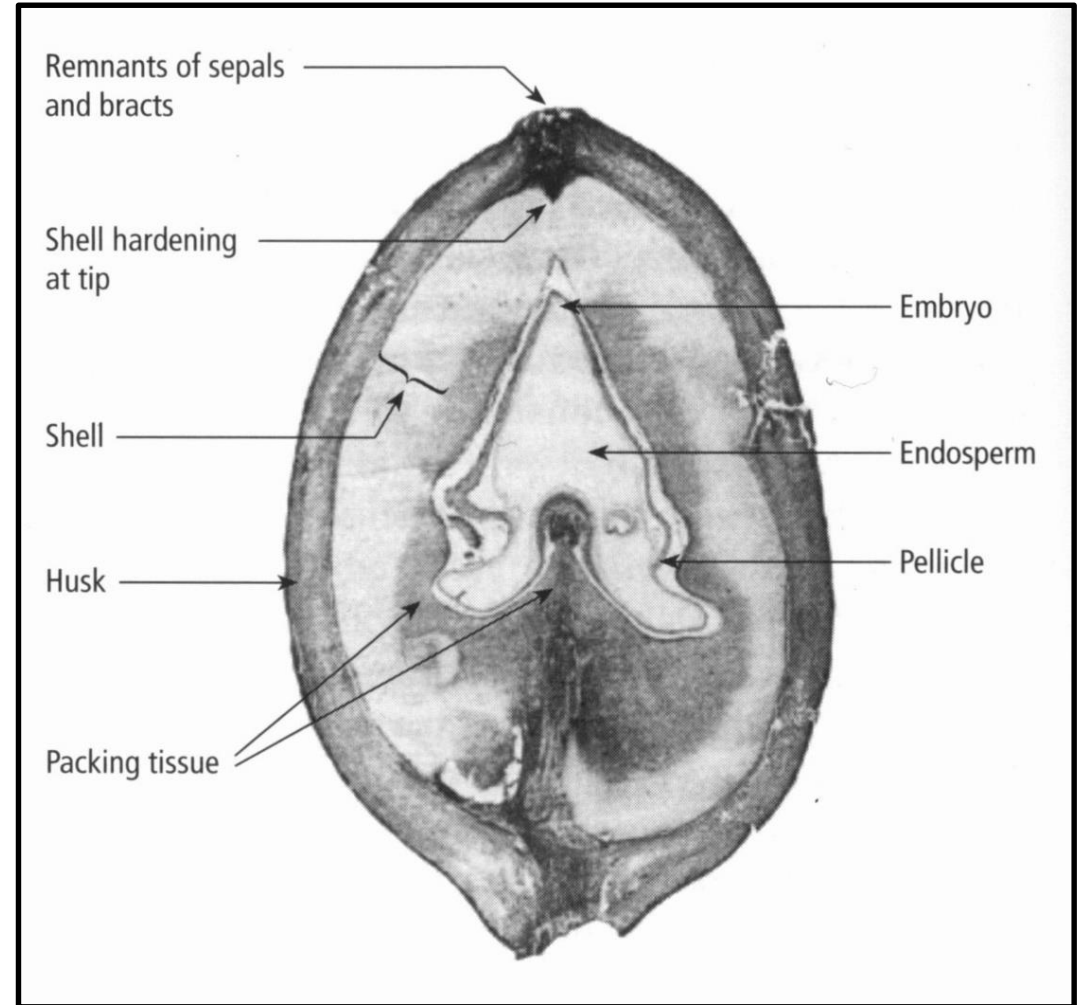
# Maintaining Walnut Kernel Color Quality during Postharvest Handling



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- Abhaya Dandekar
- Irwin R. Donis-Gonzalez
- Selina Wang
- Bruce Lampinen

# Walnut Components and Implications



# Fatty acids composition of nuts influences their storage potential

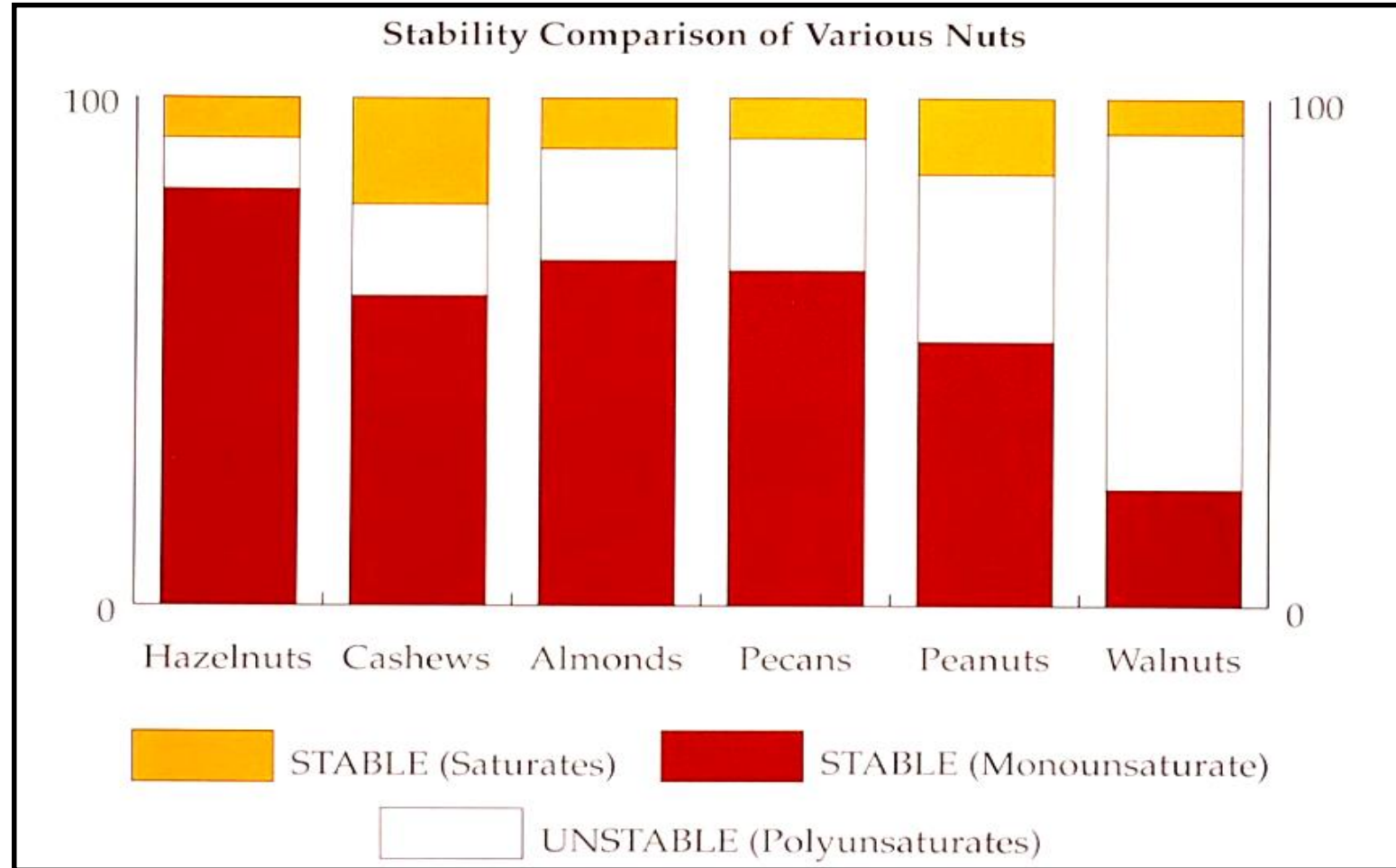
Walnuts 10-30% >>> 8% moisture content.

Walnuts contained 17% protein and 67% lipids (fatty acids) on a dry weight basis.

Fatty acids, polyunsaturated fatty acids (PUFAs).

Linolenic acid is an Omega-3 fatty acid, therefore beneficial for our health. However, it also contributes to the potential for rancid flavor development.

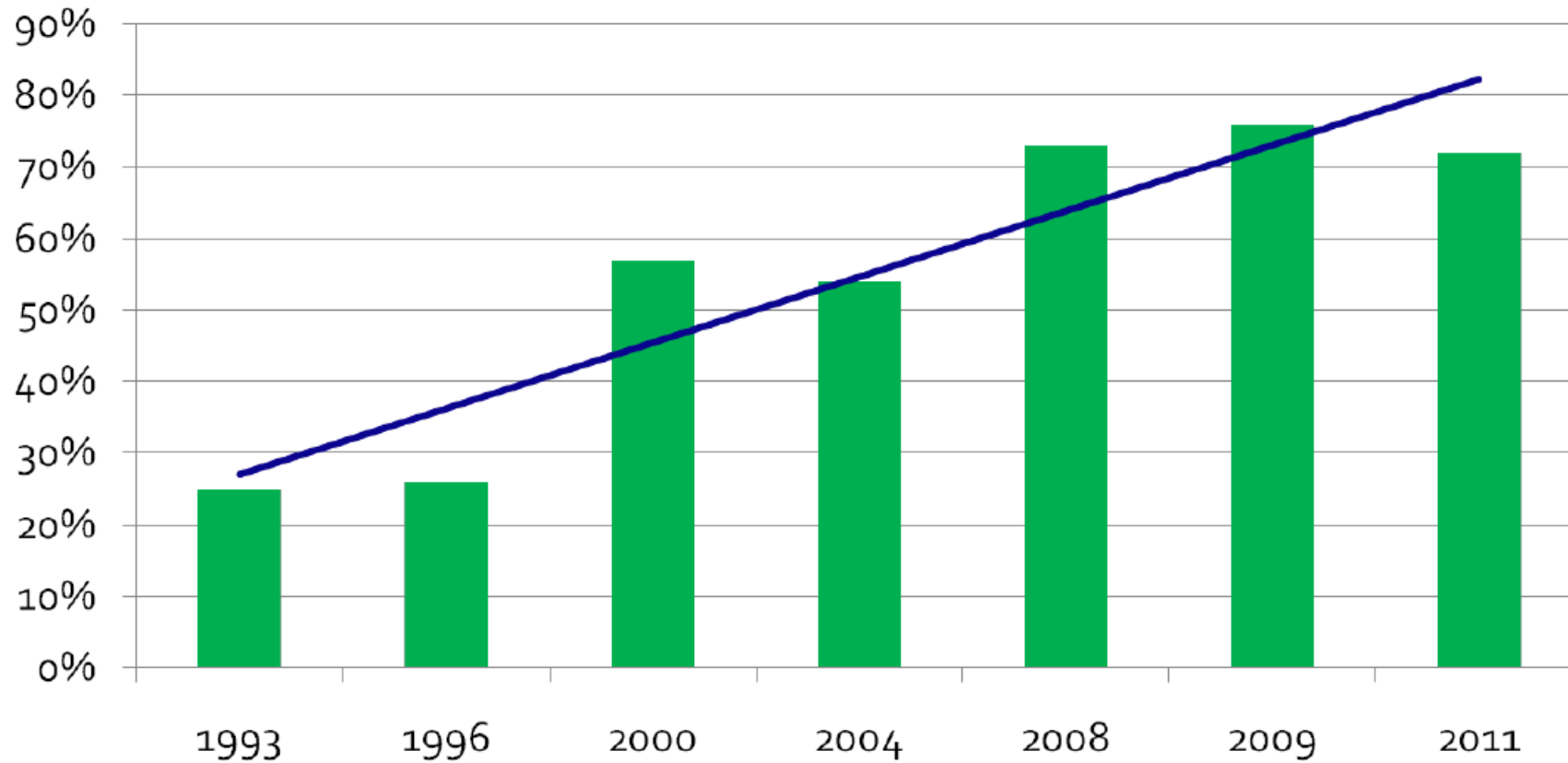
Phenolics (antioxidants), beneficial for our health, but potentially involved in kernel browning.



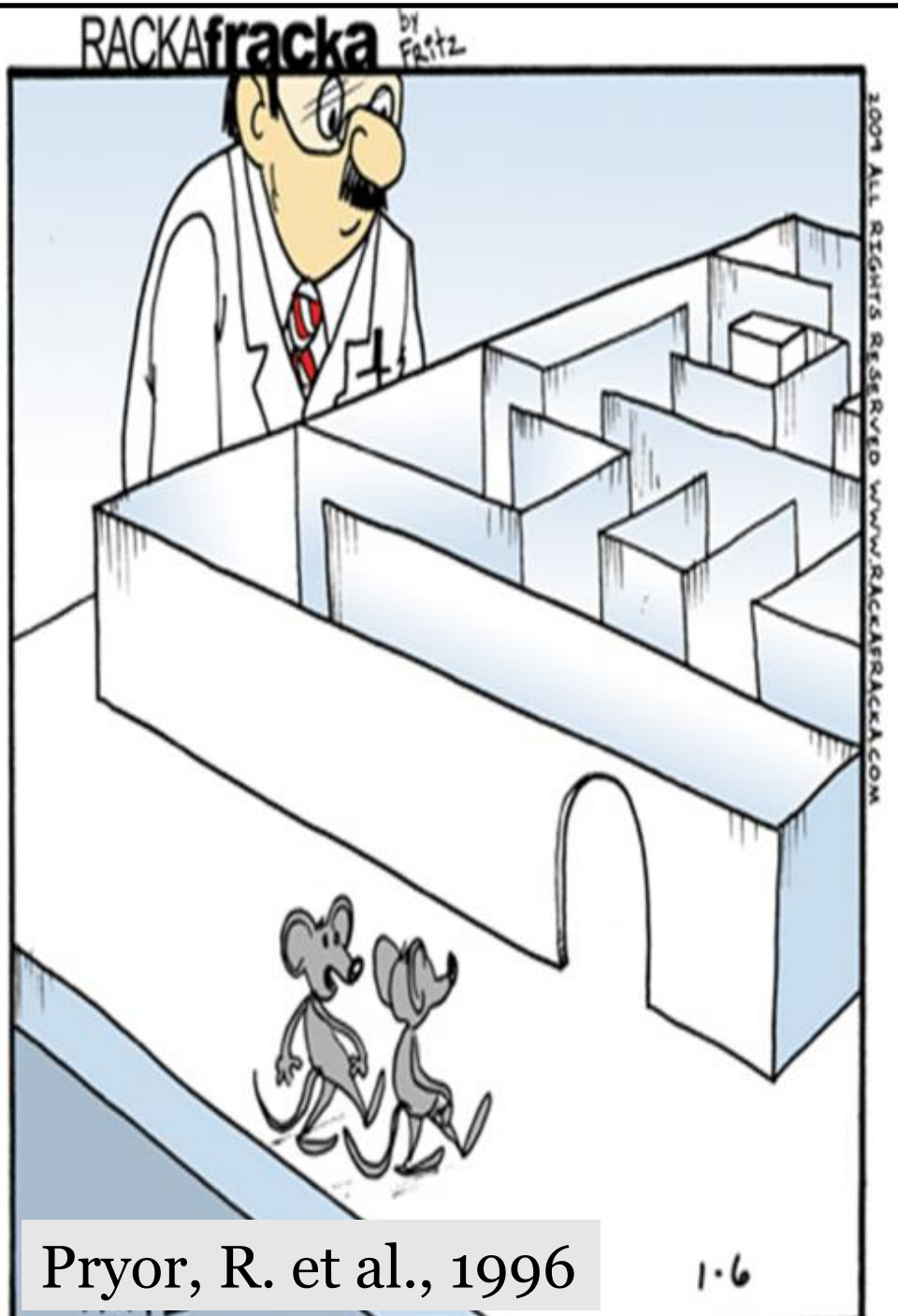
Tocopherols

# CONSUMER PERCEPTIONS

**% of Consumers Using More Walnuts Because They Are Healthy/Good For You/Nutritious**

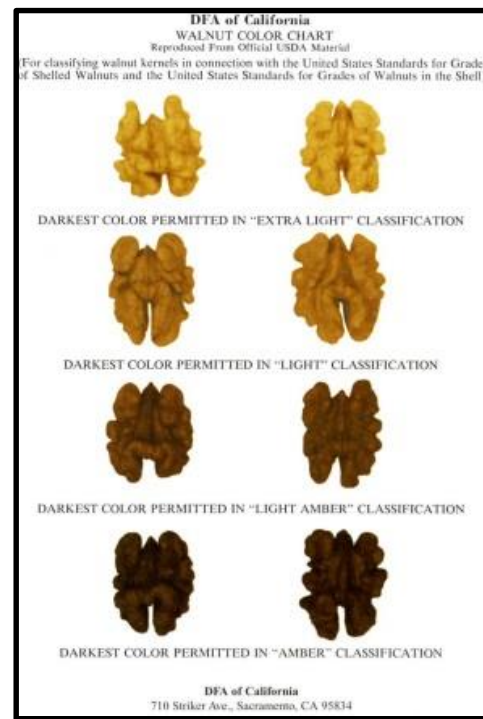


Phenolics



# Kernel Color Measurements

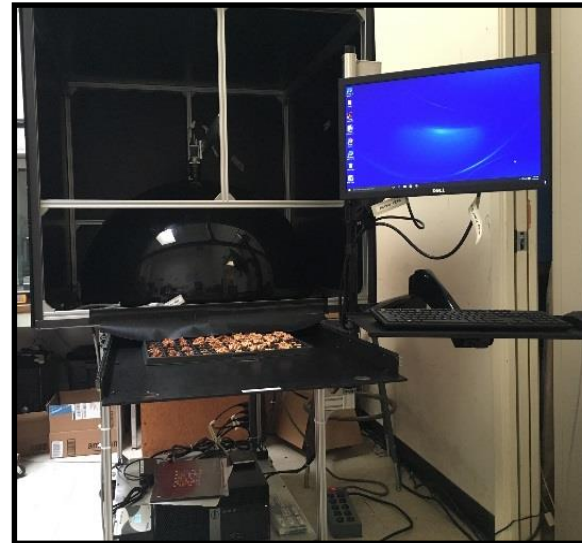
- DFA of California guidelines
  - 1-4 scores
  - Method is subjective
- Minolta Colorimeter
  - Measures color quantitatively, using  $L^*$ , Hue, Chroma.
  - Objective, limited
- Walnut Computer Vision System.
  - Percentage of high-quality color kernels.



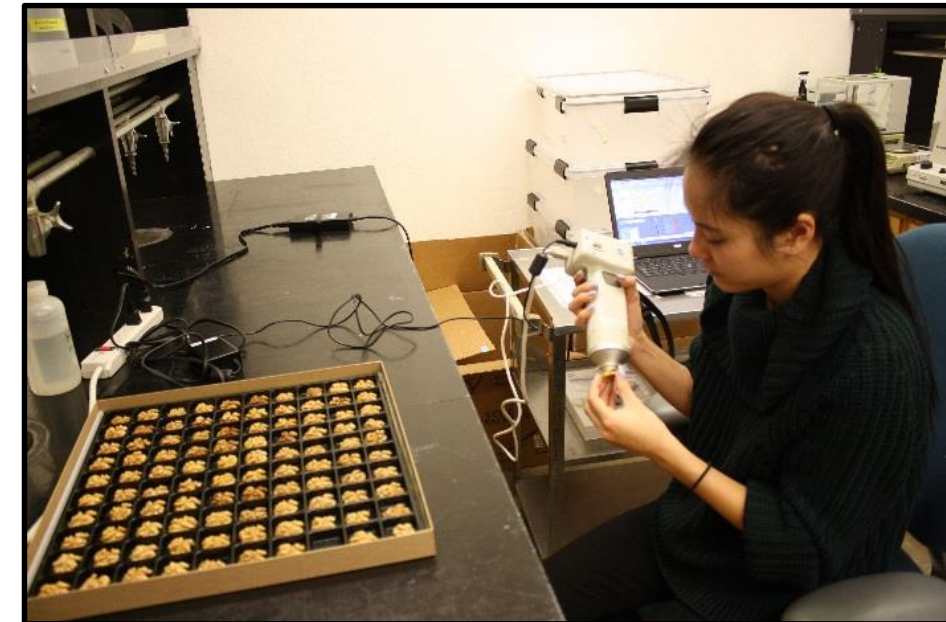
DFA Guidelines



Comparing walnut kernels to the color guidelines.



Computer Vision System (CVS)



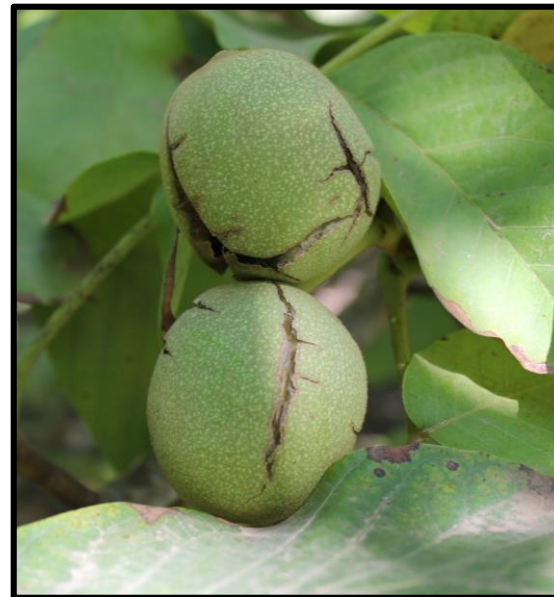
Minolta Colorimeter



## Walnut Maturity Studies



**PTB STAGE: M-1**



**M-2**



**M-3**

**Packing tissue brown (PTB) date: at stages M-2 (Hull split) and M-3 (Onset of hull bloom)**

# Impact of Maturity on ‘Chandler’ walnut kernel browning at harvest



|                | 2016-2017                                 | 2017-2018                    |
|----------------|---|------------------------------|
| Maturity       | Extra light and light <sup>z</sup><br>(%) | Extra light and light<br>(%) |
| M-2            | 98  | 97                           |
| M-3            | 94  | 91                           |
| <i>P-value</i> | <i>0.1111</i>                             | <i>0.1290</i>                |

<sup>z</sup> Extra light and light percentage is the percentage of light-colored kernels



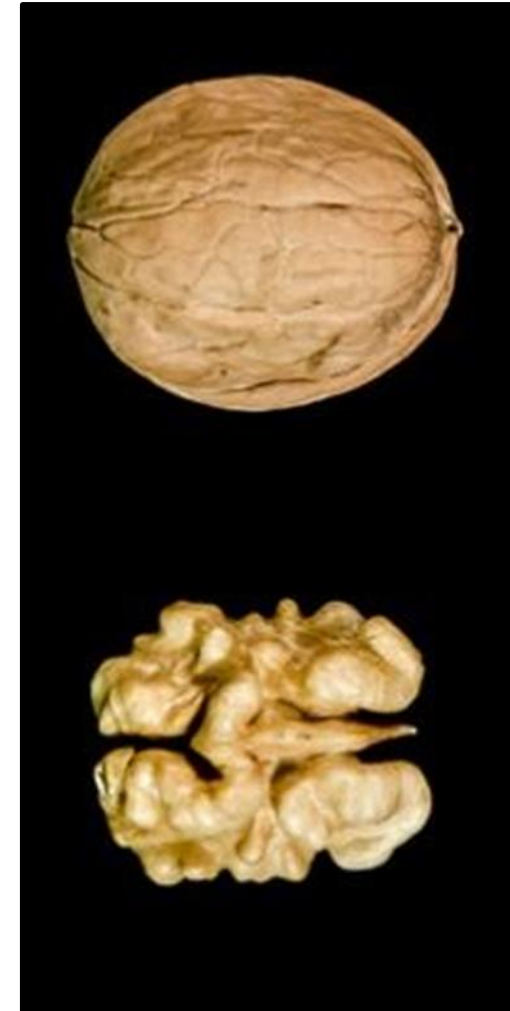
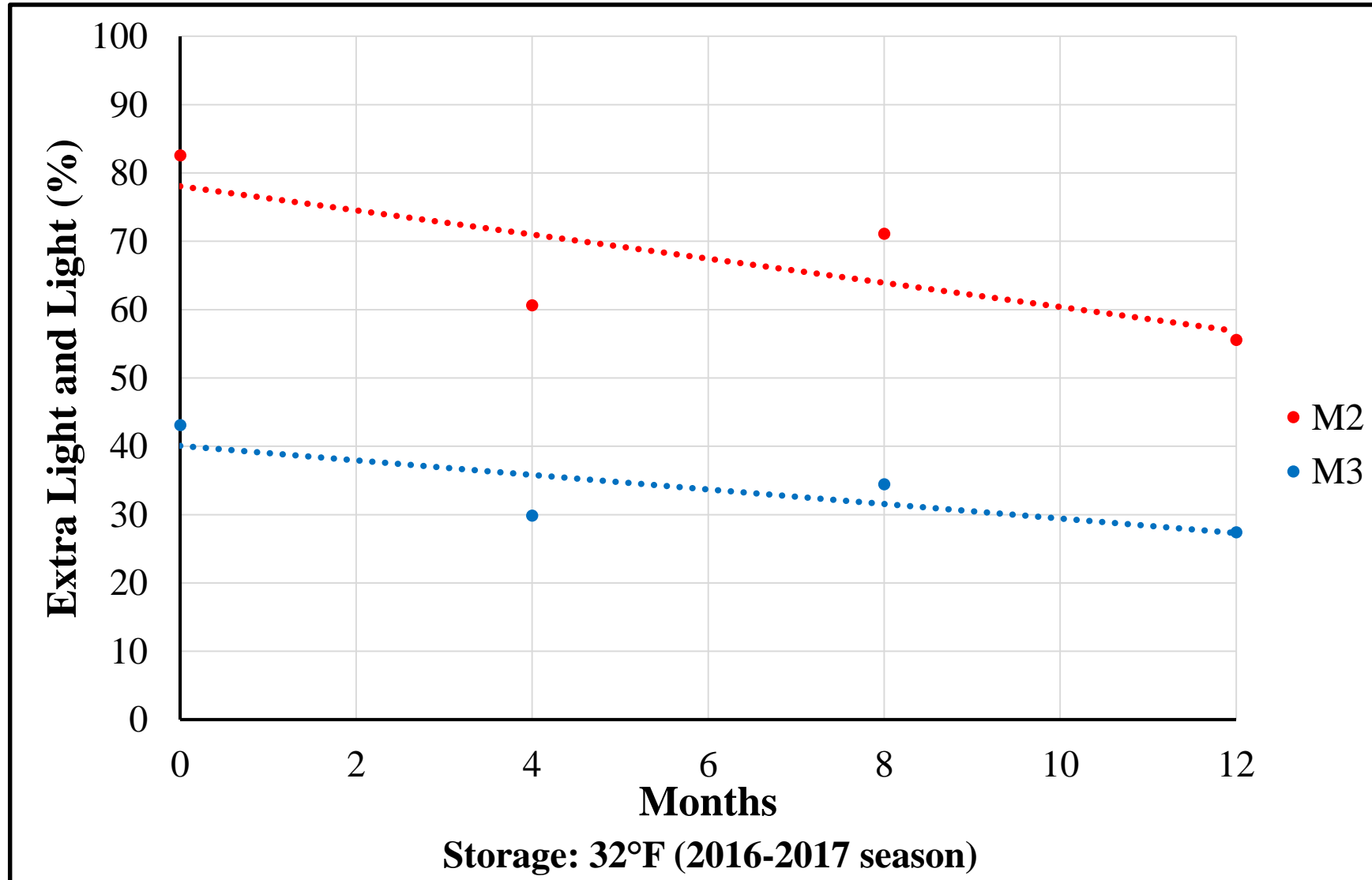
# Impact of Maturity on ‘Howard’ walnut kernel browning at harvest



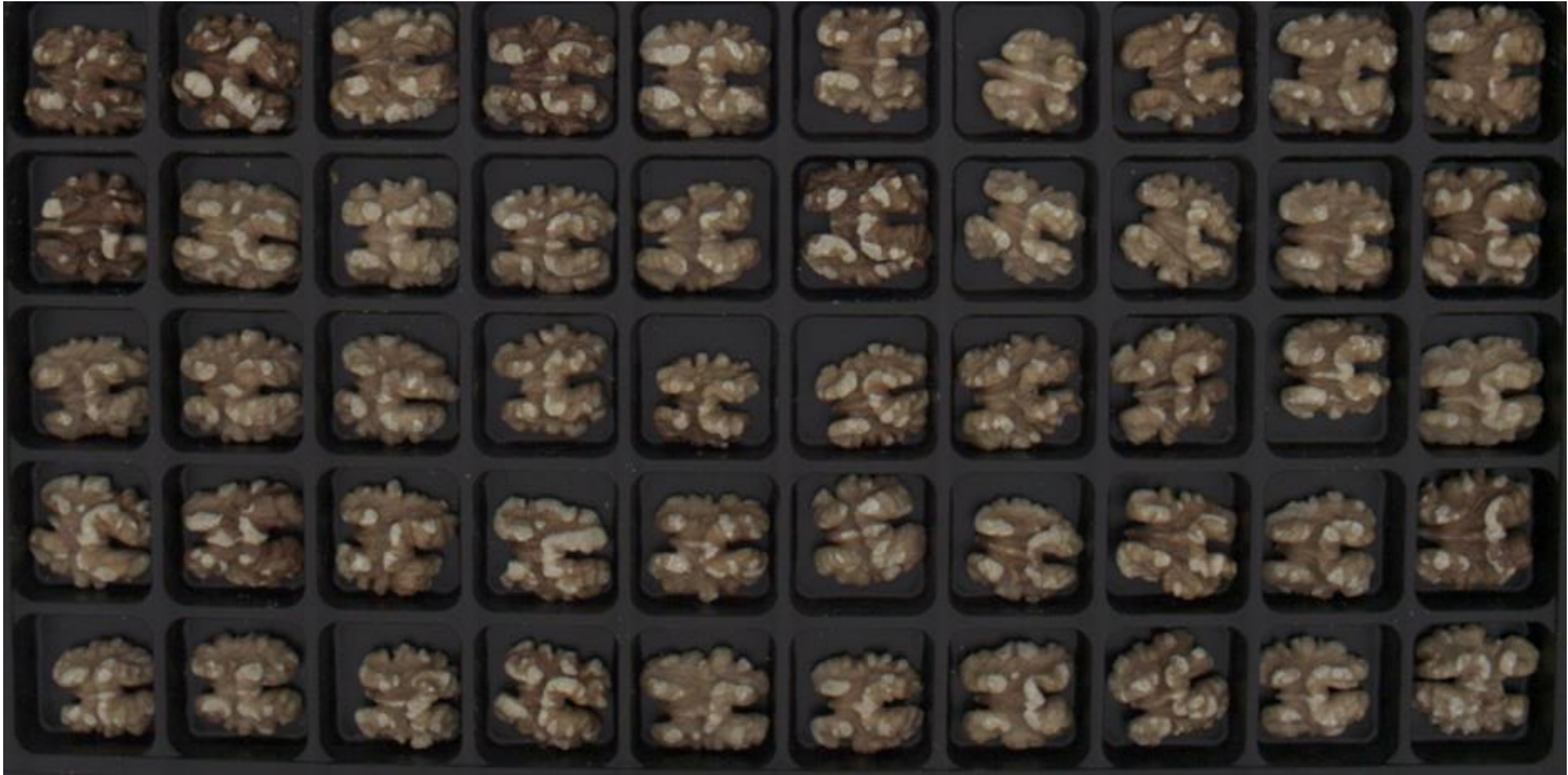
|                | 2016-2017                                 | 2017-2018                    |
|----------------|---|------------------------------|
| Maturity       | Extra light and light <sup>z</sup><br>(%) | Extra light and light<br>(%) |
| M-2            | 87  | 88                           |
| M-3            | 54  | 60                           |
| <i>P-value</i> | <i>&lt;0.0001</i>                         | <i>&lt;0.0001</i>            |

<sup>z</sup> Extra light and light percentage is the percentage of light-colored kernels

# Impact of Maturity (M2 and M3) on the percentage of high-quality color (extra light and light) 'Howard' kernels



# Why are our walnut lots-treatments responses erratic?



Samples were scanned and the acquired images were used to determine the percentage of the outermost region of the dorsal side damaged by using the software ImageJ

# How Much Energy is Needed to Crack a Nut?



Are We  
Nuts?



**Chandler**

**Howard**

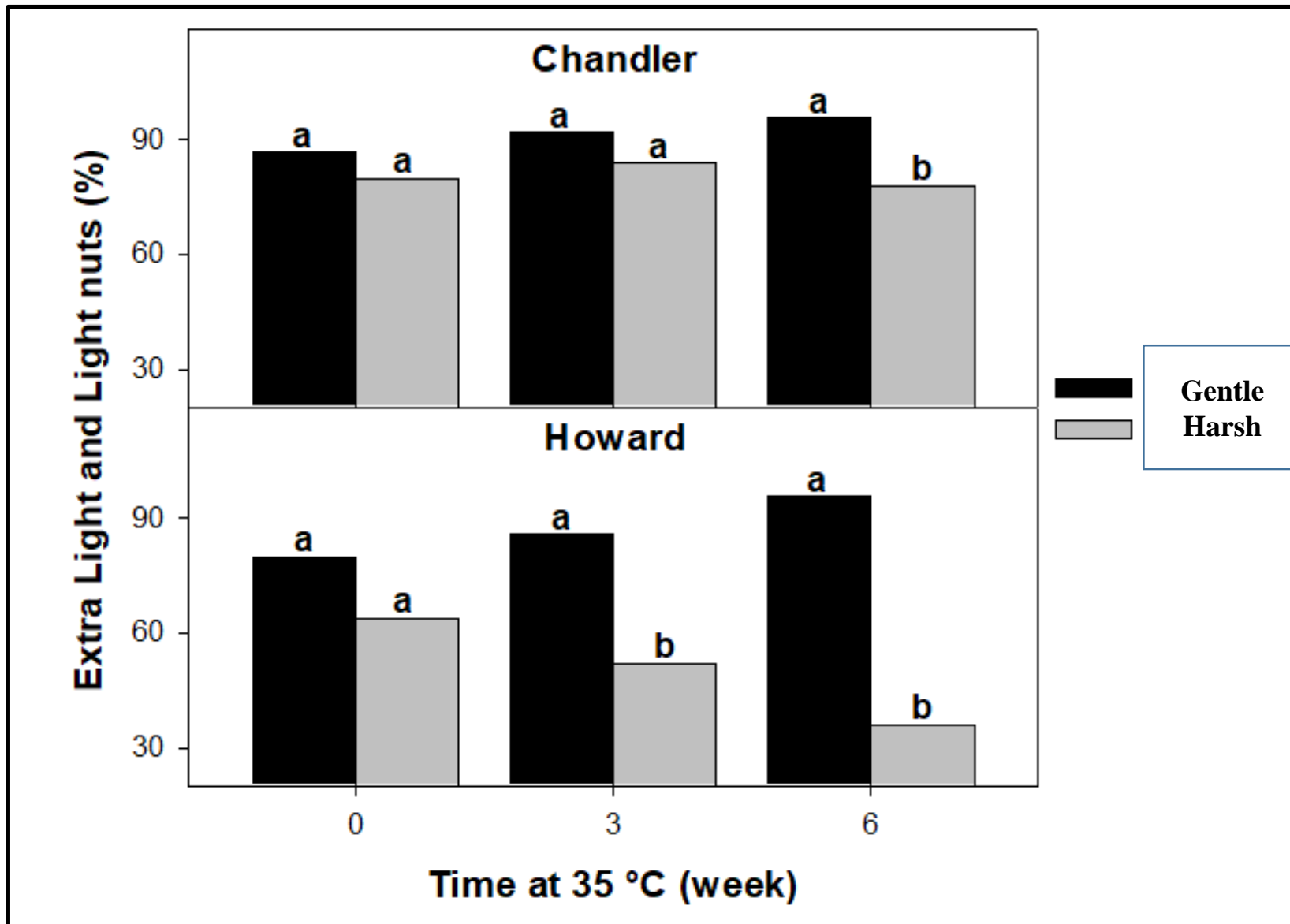
**Gentle**



**Harsh**



# Percentage Extra light and Light walnut kernels subjected to gentle (*GS*) or harsh shelling (*HS*) during warm display for 6 weeks at 95°F and 60% RH



On the harsh shelled treated, there were 15% and 55% less kernels in the high-quality color category for 'Chandler' and 'Howard', respectively measured after 6 weeks at 95°F and 60% RH.

Different letters indicate differences between treatments at each storage-sampling date based on a Tukey test at a level of significance of  $\alpha = 0.05$ .

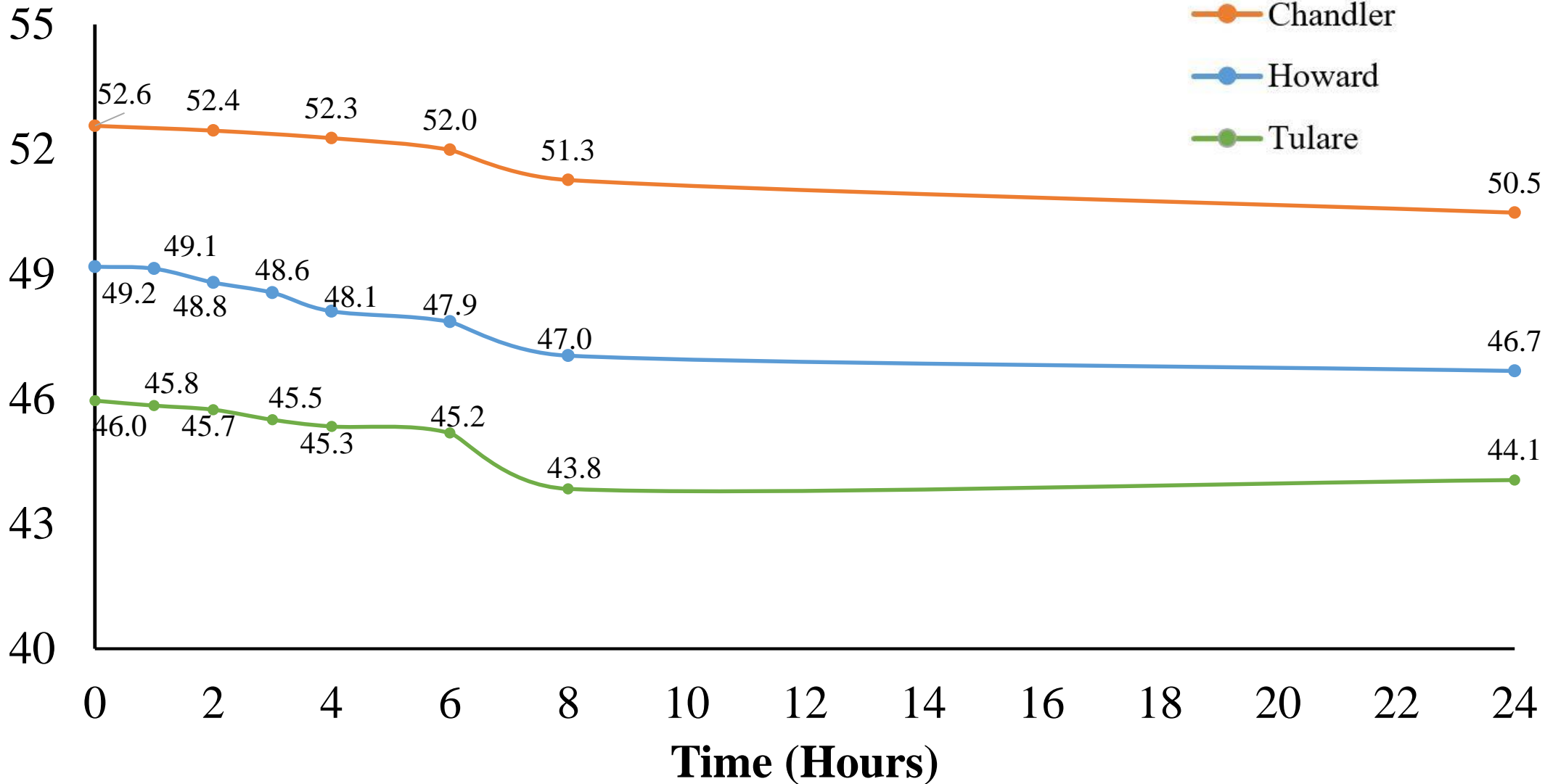
# Kernel Color Changes at 70°F

White

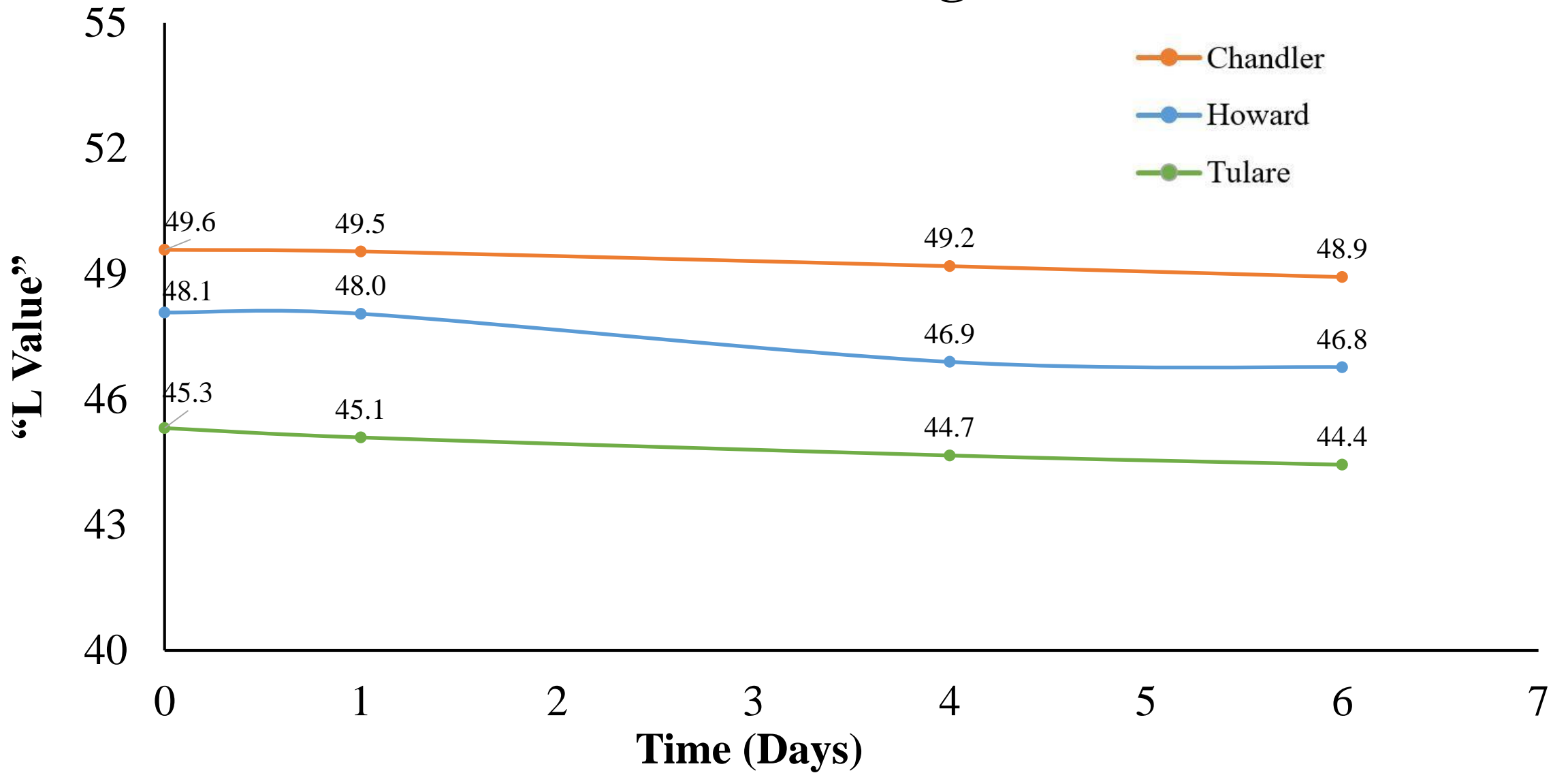
“L Value”

Dark

- Chandler
- Howard
- Tulare

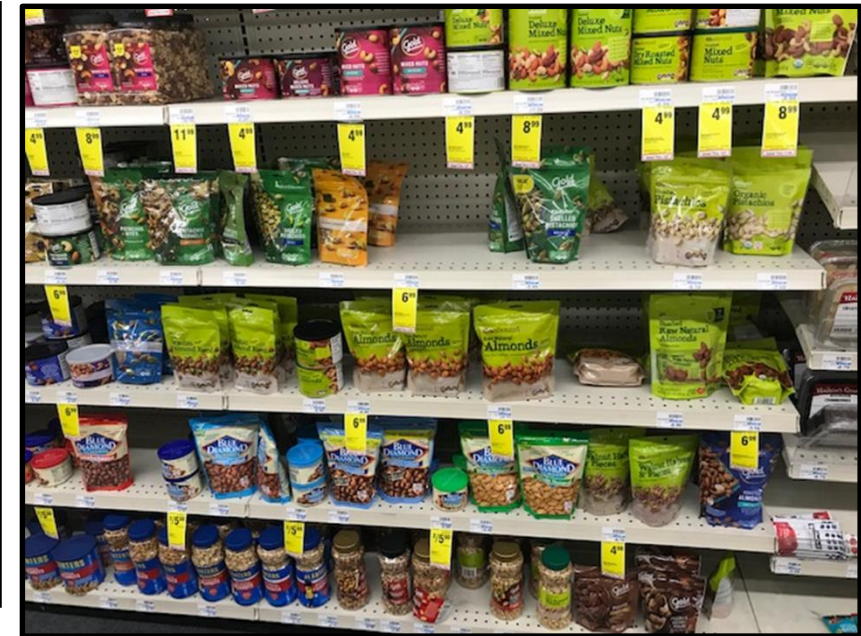


# Kernel Color Changes at 45°F





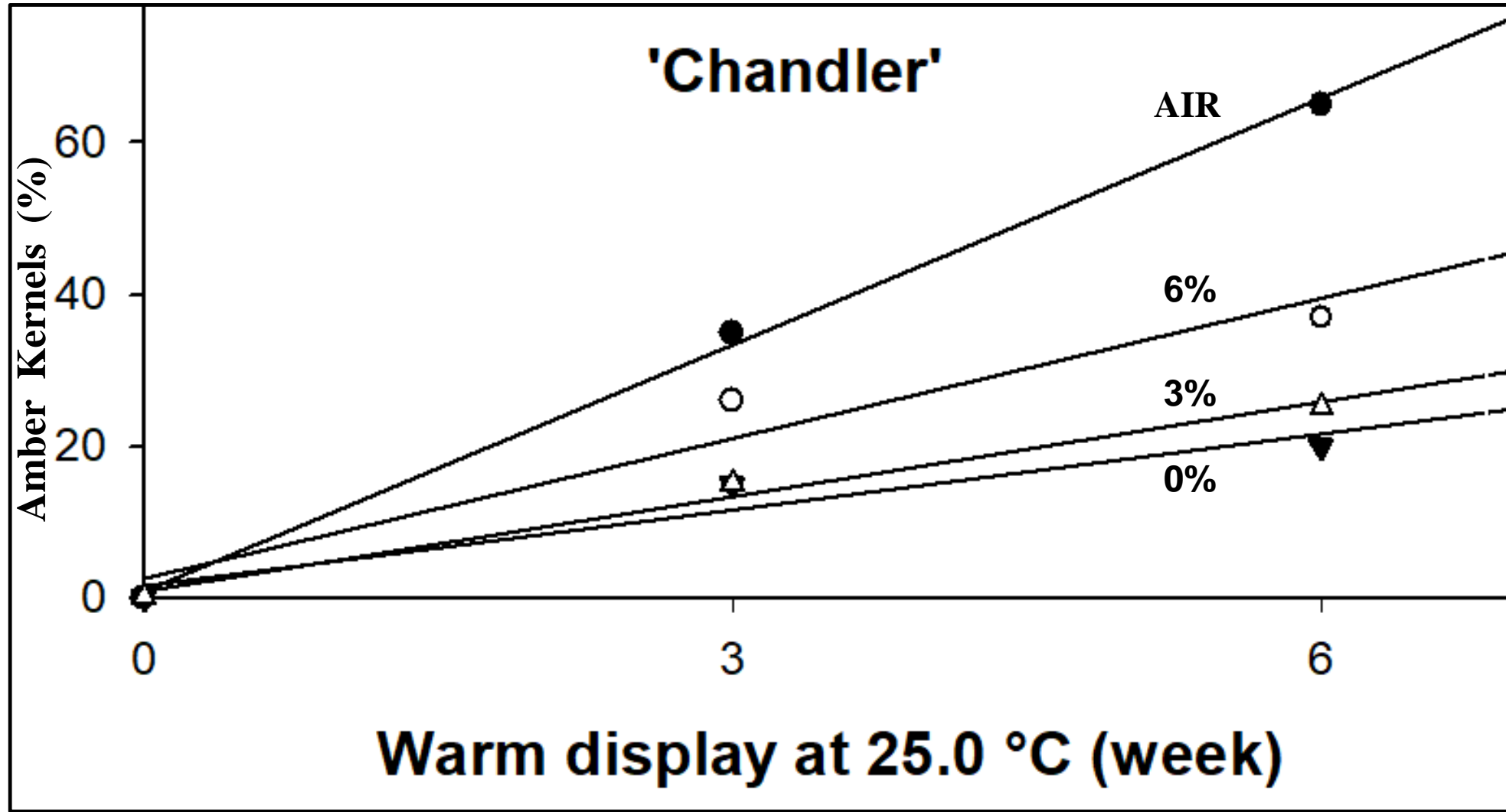
# Does low Oxygen reduce kernel losses due to amber color during warm handling and retail display of commercial kernels?



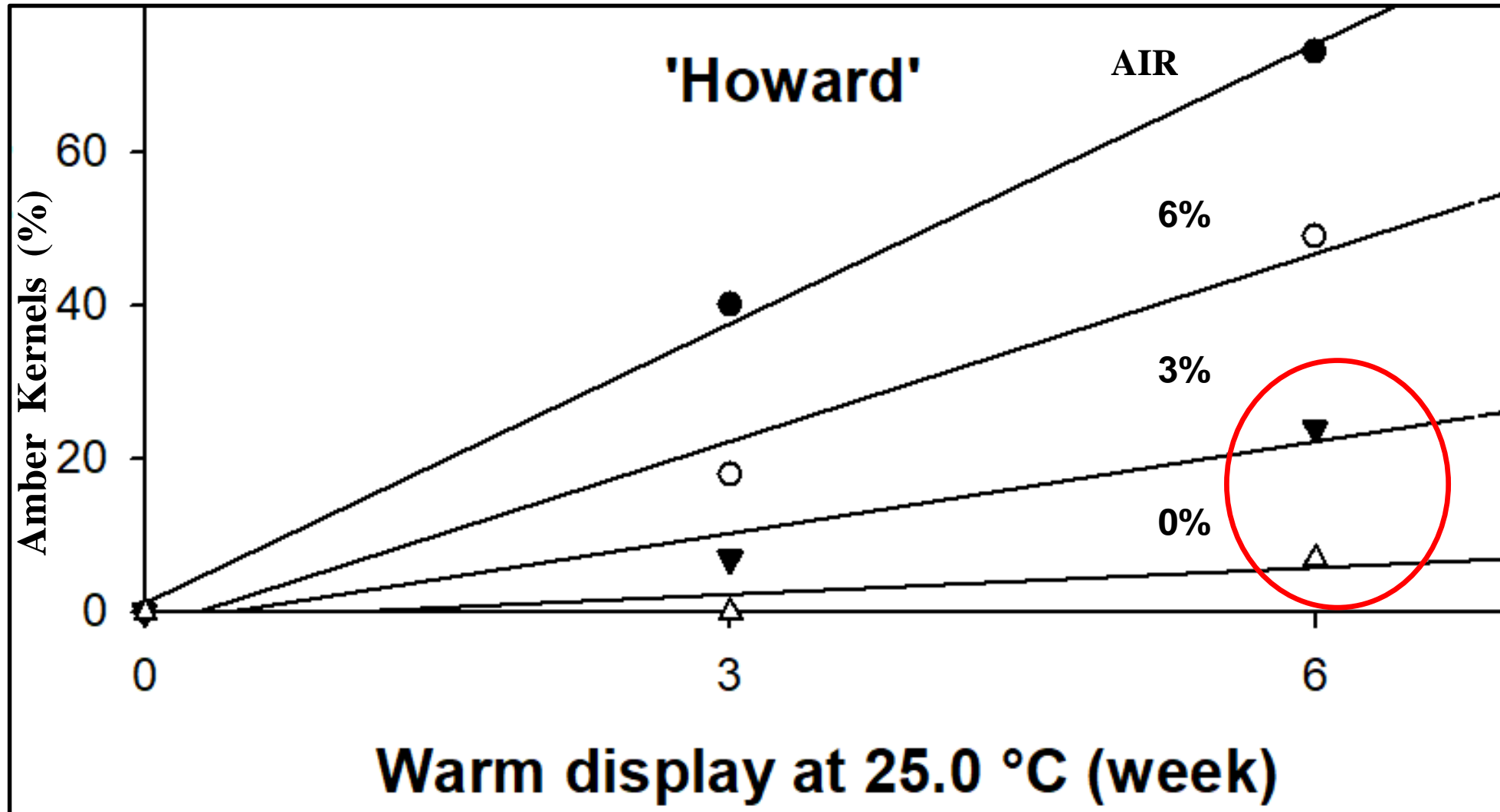
WARM

Kernels of 'Chandler', 'Howard', 'Tulare', and 'Vina' were harvested and stored at 41°F, 77°F, and 95°F. 0, 3, and 6% Oxygen balanced with Nitrogen or Carbon Dioxide.

**Regression curves showing the percentage of dark (Light Amber and Amber) 'Chandler' walnut kernels subjected to commercial shelling operation and stored for 0, 3 or 6 weeks at 77°F and 60% RH in air or 0, 3 or 6% Oxygen**

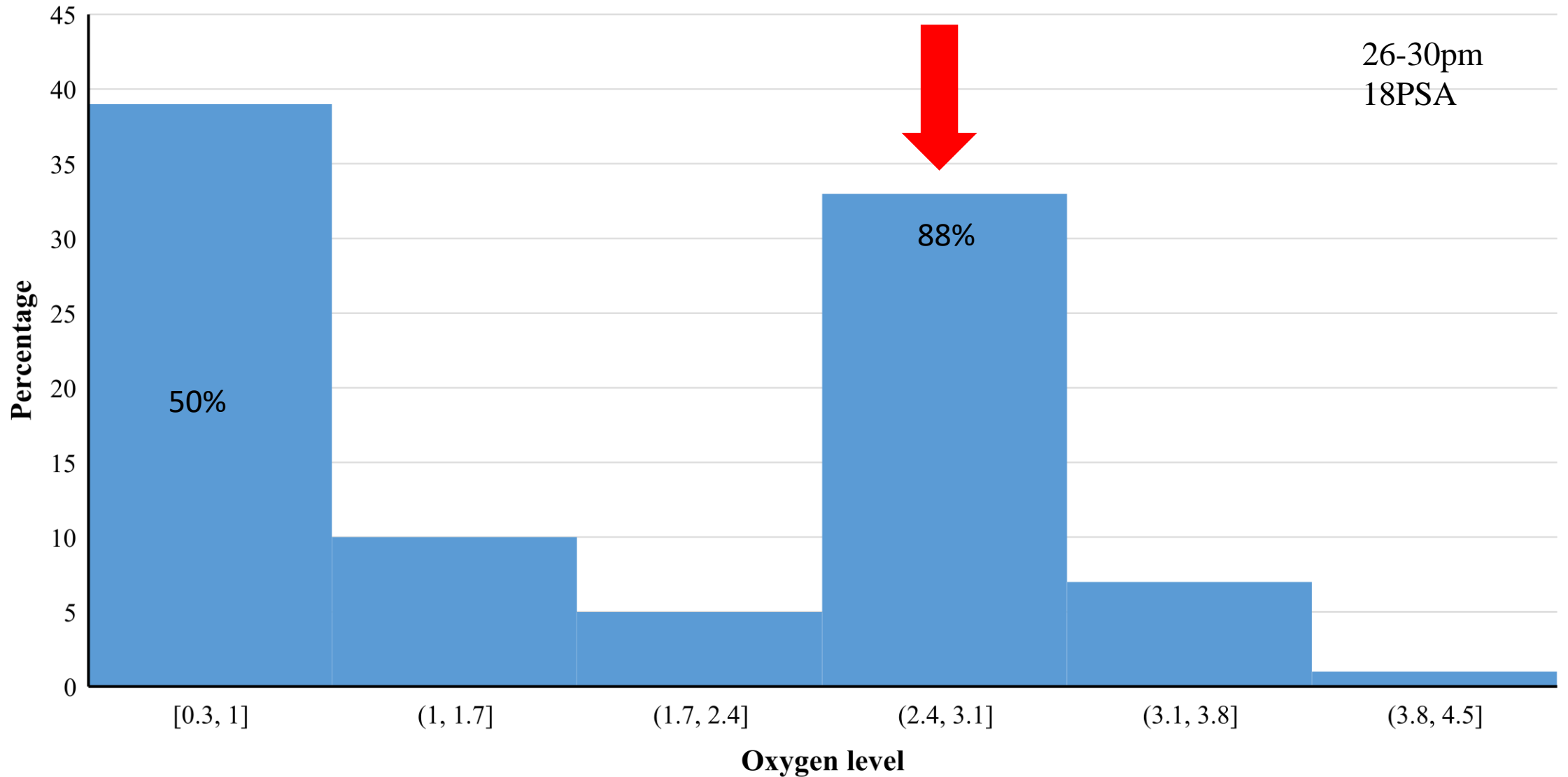


**Regression curves showing the percentage of dark (Light Amber and Amber) 'Howard' walnut kernels subjected to commercial shelling operation and stored for 0, 3 or 6 weeks at 77°F and 60% RH in air or 0, 3 or 6% Oxygen**



# Supervision: Survey

3-Pound bags



# Checking oxygen concentration using the Bridge Analyzer

(CO<sub>2</sub>/Oxygen MAP Gas Analyzer Model 900141,  
Bridge Analyzers, Inc., Bedford Heights, OH)



# Tips to Reduce Kernel Browning and Maximize Quality (Orchard factors)



**Fichtner, E., C. H. Crisosto, and B. Lampinen. 2019. Maximizing Quality to Improve Value in a Low-Price Year.. West Coast Nut July.**

Fields, R., I., Donis-Gonzalez, B. Lampinen, and C. H. Crisosto. 2020. Late Maturity and Excess Irrigation Trigger Kernel Darkening in ‘Howard’ English Walnut (*Juglans regia* L.) at Harvest, but not in ‘Chandler’. J. American Pomological Society, July issue (in press).

# Tips to Reduce Walnut kernel Browning (Amber)



## **Avoid Delays in Picking-Hauling-Hulling Operations.**

- Air temperatures at or above 90°F greatly speed kernel darkening (within 9 h).
- Walnuts left in the shade darken rapidly if air is above 104°F.
- Coordinate Harvest with Drying Process.

## **Control Drying.**

- Dehydration prevents deterioration, molding, and darkening, prolonging storage.
- Adequately dried walnuts should not contain more than 8.0% moisture.
- For drying, air temperatures should not exceed 110°F (43°C).

# Postharvest Cold Storage Tips to Reduce Walnut Kernel Browning (Amber)

The current recommended optimum storage temperature is 32 to 50°F, and 50% to 65% RH should be maintained to keep ~2.8-7.0 % moisture in the kernels with a water activity (aw) of 0.2 to 0.8 at 68°F (Kader & Thompson, 2002).

Nuts should not be stored or transported with commodities that have strong odors because their high lipid content allows them to absorb odors.



# Postharvest Handling Tips to Reduce Walnut Kernel Browning (Amber)

## Shelling-Cracking

- Reducing walnut pellicle damage during shelling delays postharvest kernel browning, prevents antioxidant turnover, and improves walnut oil stability.
- ‘Howard’ and ‘Tulare’ are more susceptible to pellicle damage than ‘Chandler’.

## Warm Storage–Snack Food Retailed Display (Ready-to-Eat)

- Use low oxygen packaging, especially, when proper temperature management is not available.
- The beneficial effects of oxygen **equal to or lower than 3%** have a great impact on reducing ‘Howard’ and ‘Tulare’ kernels deterioration.

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- Mauricio Bautista (WWR)
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- Max Mariani, Mariani Nut Co.
- Others
- **2015 Walnut Short Course Participants**