UCDAVIS POSTHARVEST TECHNOLOGY
Maintaining Produce Quality & Safety

Water Loss and Postharvest Quality

Key messages:
Minimize delay from harvest to cooling
Use appropriate packaging to reduce water loss
Use low temperatures throughout distribution

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Water Loss and Postharvest Quality

- How does water loss occur?
- What are critical levels of water loss?
- Where does water loss occur in handling?
- How to control water loss?

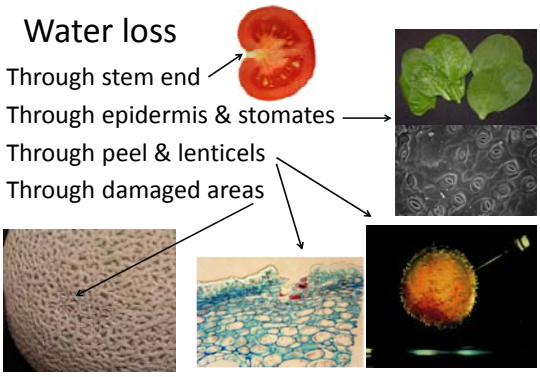
Postharvest Water Relations
Water loss
Water gain

Fresh Produce and Water Loss

- Fresh produce contains 65% (garlic) to 95% (lettuce) water; water content for most products is 85-90%
- Harvested products begin to lose moisture immediately upon cutting from the plant
- Water loss is also called transpiration
- Water loss = weight loss (except if dry matter loss occurs in storage)
- Water loss is water vapor movement from product to the environment
- Water loss is affected mainly by packaging, temperature, relative humidity and airflow as well as product characteristics.

Water loss

- Through stem end
- Through epidermis & stomates
- Through peel & lenticels
- Through damaged areas



J.L.J. Bezuidenhout. 2005. Lenticels different plant species, Thesis. Univ. Pretoria., SA. Light microscopy mango lenticels

Water loss is Cumulative

Impacts on Quality
Loss of Salable Weight
Loss of Fresh Appearance
- Gloss
- Shrivel
- Pitting, sunken areas

Loss of Texture, Turgidity
Changes in Product Physiology

Critical levels for many products
<3% no visual effect, texture
3-5% visual quality affected
>5% shrivel, lose salability

Weight loss
1 = 2%
2 = 4-5%
3 = 7-8%
4 = 10-12%
5 = 15-17%

Water Loss and Fruit Physiology

Water Loss and Fruit Ripening
Water loss during initial phase of ripening affects rates of ripening
Water loss is a stress and caused increased synthesis of ethylene
Therefore minimize water loss during initial 72 hours after harvest

Stage when induced water loss	Total % Water loss	Days to ripen
Pre-climacteric	5.6	14.1
Climacteric	5.3	15.7
Post-climacteric	5.2	17.0

- Early season fruit.
- Induced water loss 20C, 20%RH.
- Control, 20C 95%RH lost only 1.3% weight; 16.4 days to ripen.
- Decay was less on fruit from treatments with water loss than on control fruit.

Burdon, J. et al. 2005. Mode of action of water loss on fruit quality of 'Hass' avocadoes. NZ and Australia Grower's Conf., 2005

Fruit
100% RH in air spaces
Assume 25C 100% RH

Skin/epidermis

Environment
Temperature
Relative Humidity is <100%
Air velocity
Assume 25C with 40%RH

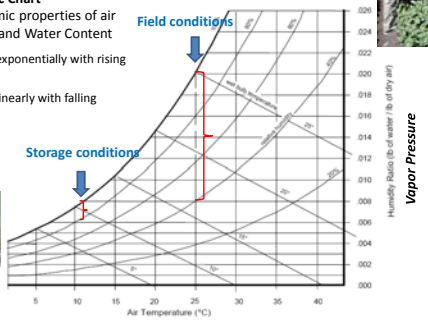
Water loss and temperature

Wt loss (%/day) = product K x VPD

Psychrometric Chart
Thermodynamic properties of air
Temperature and Water Content

VPD increases exponentially with rising temperature

VPD increases linearly with falling humidity



Handling at harvest is critical for water loss management

Basil
Highly susceptible to water loss
Very chilling sensitive

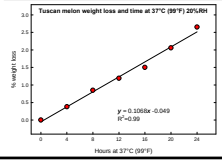
Situation:
Excellent quality crop
Harvesting late in day
High temperatures, ~30° C
Low RH, ~50%;
Little protection from ambient
Long delays to packinghouse

What can be done to improve this handling???

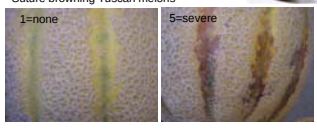
Water loss is Cumulative

Weight loss of Tuscan melons held for different periods at 37°C (99°F) before cooling, storage and shelf-life.

Cooling delay	% weight loss before cool	% weight loss storage 10D 5°C	% weight loss shelf-life 4D 20°C	Total Weight loss %	Suture browning score
0 h delay control	0.00	2.14	0.97	3.08	1.2
4 h delay	0.38	1.95	0.96	3.25	1.3
8 h delay	0.85	1.85	0.78	3.45	1.3
12 h delay	1.19	1.62	0.79	3.56	1.4
16 h delay	1.50	1.32	0.85	3.63	2.8
20 h delay	2.06	1.47	0.68	4.15	4.0
24 h delay	2.80	1.41	0.71	4.85	4.2
LSD.05	0.21	0.42	ns	0.60	0.8



Suture browning Tuscan melons



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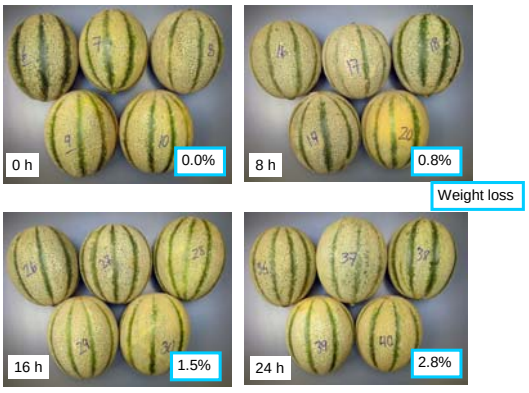
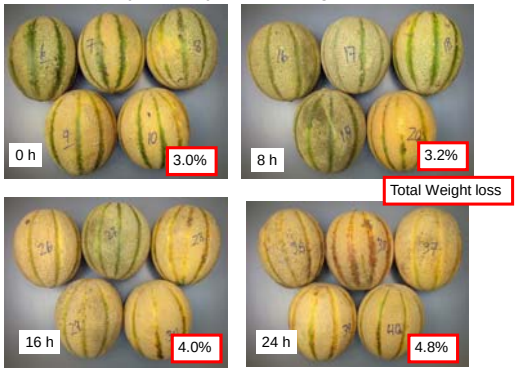
Delays to cool of Tuscan Melons; fruit held at 37°C (99°F)



Melon visual quality after delays to cool, storage at 10d 5°C + 4d 20°C



Litchi Browning:
Water loss is a major contributor: **8% water loss for peel browning**. Mechanical damage, senescence, improper storage temperature, and postharvest pathogens also contribute.

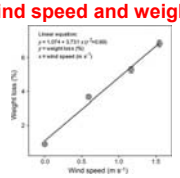
Predicted postharvest moisture loss from litchi with idealized handling.

Stage	Temp. (°C)	RH (%)	Wind speed (m s^{-1})	Duration (h)	Predicted moisture loss (%)	Cumulative moisture loss (%)
Harvest	30	65	1.5	3	1.87	1.87
Pre-cooling	5	75	1	5	0.38	2.25
Storage	5	75	0	5	0.06	2.31
Transport	7	66	0	12	0.23	2.54
Wholesale	5	75	0	3	0.04	2.58
Wholesale display	25	22	0	2	0.27	2.85
Transport	7	66	0	2	0.04	2.89
Retail	20	50	0.5	6	0.90	3.79

38h

Bryant, P.H. 2012. A model of postharvest moisture loss under air currents to reduce pericarp browning of litchi. Postharvest Biol. Tech. 73: 8-13.

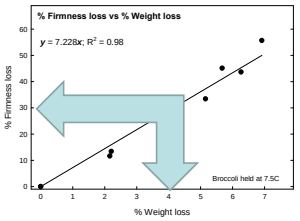
Wind speed and weight loss



Litchi
~8% weight loss =
desiccation browning

Harvest Conditions	Temp. (°C)	RH (%)	Wind speed (m s^{-1})	Duration (h)	Predicted moisture loss (%)
Standard	30	65	1.5	3	1.9
No wind	30	65	0	3	0.3
Delay	30	65	1.5	6	3.6
Extreme	35	50	1.5	6	6.3

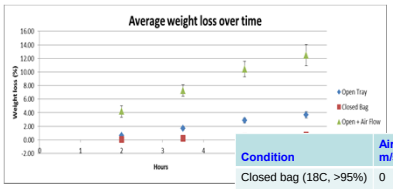
Bryant, P.H. 2012. A model of postharvest moisture loss under air currents to reduce pericarp browning of litchi. Postharvest Biol. Tech. 73: 8-13.



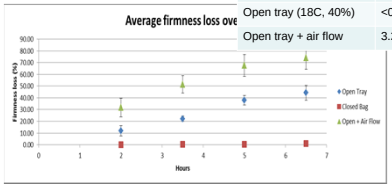
Broccoli head firmness and water loss

About 4% weight loss results in 30% decrease in firmness and this is likely the point at which a buyer would consider the head soft and would reject it.

Example Results



Condition	Air flow m/s	Weight loss, %/h	Firmness loss, %/h
Closed bag (18C, >95%)	0	0.06	0.09
Open tray (18C, 40%)	<0.4	0.50	6.3
Open tray + air flow	3.2	2.10	14.7



Role of cultivar in postharvest quality loss

Example: Grape tomatoes and weight loss

12days 20C 50%RH

Cultivar	Shrivel *	% weight loss
Ahern 299	3.5	13.2
Amsterdam	3.2	15.2
Harris LI-34	4.6	15.6
Hazera 1319	4.3	18.0
Rotterdam	2.4	11.8
TC 1260	3.6	14.9
LSD.05	0.6	1.5

*Shrivel score -1-5 scale, 1=none, 2=slight, 3=moderate, 4=moderately severe, 5=severe

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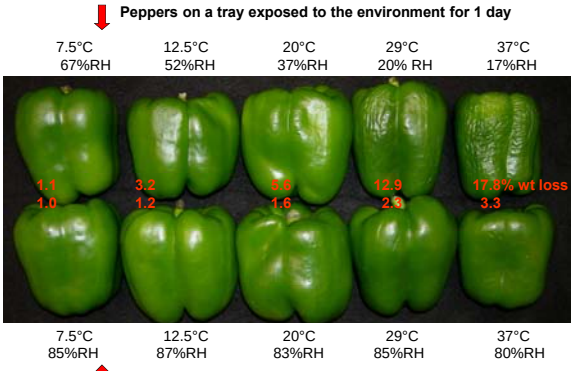
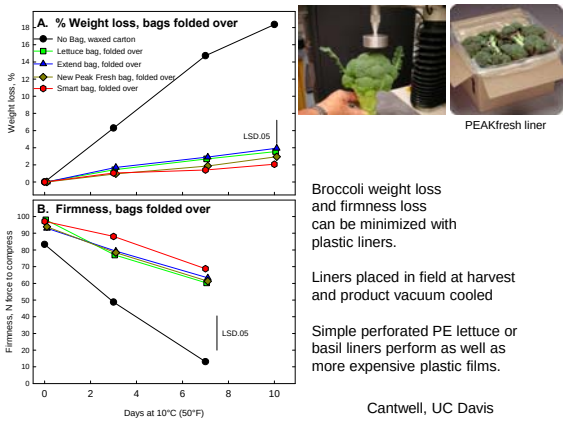
Simple packaging to reduce water loss.
Need to cool product before packaging (room or hydrocool) or used vented packaging and vacuum cool (romaine lettuces)





PEAKfresh liner

Broccoli weight loss and firmness loss can be minimized with plastic liners.

Liners placed in field at harvest and product vacuum cooled

Simple perforated PE lettuce or basil liners perform as well as more expensive plastic films.

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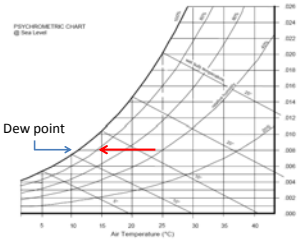
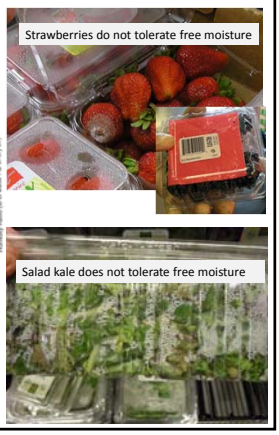
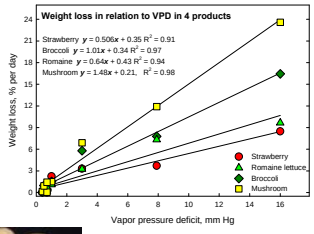
Condensation—worse than water loss for many products





A small amount of controlled water loss leads to longer postharvest life; Avoid free moisture



"Cold and Dry"

Bacterial growth: temperature and moisture

"Cold and Dry" Handling

Leafy green grower, Singapore. Product harvested in afternoon, cooled overnight in marine container, slightly dehydrated (5-8% weight loss) and then consumer packaged the following day.



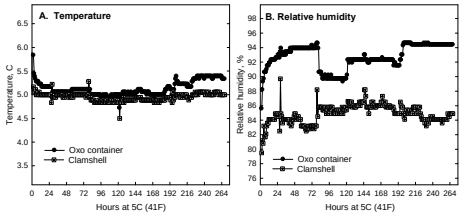

Water loss control
Low temperature
Packaging appropriate
Minimize time

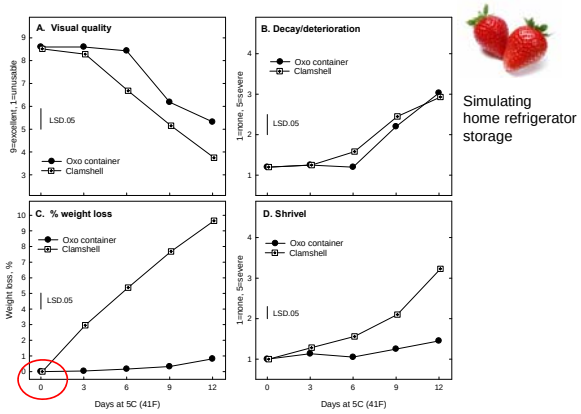

Water loss and Retail Handling—potentially very high rates of water loss

- Display ready reusable crates-what are advantages and disadvantages
- For product to tolerate such conditions at retail, must minimize water loss at earlier steps in handling chain
- Additional paper or plastic packaging can notably reduce water loss

Home Refrigerator Storage
Strawberry Clamshell and Oxo Produce Container

Quality loss due to:
Weight loss
Decay development





Simulating home refrigerator storage

Water Loss and Postharvest Quality

- Water loss occurs through natural pores and damaged areas
- Environmental conditions at harvest cause high water loss
- Harvest when cool
- Protect and shade in the field
- Reduce delays from harvest to start cooling
- Cool efficiently, then reduce air flow over product
- Temperature, RH, air flow during storage and transport
- Use protective packaging
- Protective treatments in some cases (waxes, coatings)
- Weight loss is cumulative, store only as long as necessary
- Problem conditions are at the beginning and end of the cold chain

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