PRESERVATION OF FRUITS AND VEGETABLES BY REDUCTION OF ETHYLENE GAS

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WHAT DEFINES PRODUCE QUALITY?

- Color
- Size & Shape
- Freedom from blemishes
- Texture (appropriate to product/variety)
- Flavor
- Nutritional quality
- Absence of chemical contamination
- Absence of Bio-contamination (bacteria, mold, fungus)

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HOW DO YOU MAINTAIN QUALITY?

Quality cannot be improved after harvest – you can only slow down the rate of deterioration by managing the factors that accelerate post-harvest deterioration.

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Preservation Keys:

- ***Reduce Respiration Rate***
- ***Minimize Ethylene Production***
- Reduce Transpiration and Water Loss
- Prevent Physical Damage
- Eliminate Pathogens

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Preservation Basics:

- Use refrigeration to reduce metabolic rates (respiration) of processes that result in undesirable changes in color, composition, texture, flavor and nutritional status;
- Reduce water loss that can result in loss of weight, shriveling, softening, loss of crispness and nutritional status;
- Minimize bruising, friction damage and other mechanical injuries;
- Prevent development of physiological and pathological disorders;
- Remove ethylene gas from storage spaces.

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FACTORS TO BE MANAGED

- Respiration Rate
- Temperature
- Physical and Physiological Factors
- Exposure to Ethylene Gas

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RESPIRATION

Carbohydrate + O_2 $\longrightarrow$ CO_2 + energy + heat

High = bad

Low = good

Therefore, controlling respiration rates should be a focus of every postharvest activity

Rate of Deterioration Is Generally Proportional To Respiration Rate

Respiration Rate	Range at 41°F ($mg\ CO_2/kg\text{-}hr$)	Commodity examples
Very low	<5	Dried vegetables, nuts
Low	5-10	Celery, potato, pumpkin
Moderate	10-20	Cabbage, carrot (w/o tops), tomato
High	20-40	Carrot (w tops), cauliflower, lima bean
Very high	40-60	Artichoke, bean spouts, broccoli
Extremely high	>60	Asparagus, mushroom, parsley, peas

TEMPERATURE CONTROL
"Cold Chain Management"

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Cooling reduces:

- Respiration rates
- Effects of ethylene
- Moisture loss
- Decay development
- Pathogen development
- Progression of injuries
- Extends storage and market life

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Non-Chilling sensitive

- Apple
- Artichoke
- Asparagus
- Beans, lima
- Broccoli
- Cabbage
- Cauliflower
- Sweet corn
- Grape
- Lettuce
- Mushrooms
- Peas
- Peach
- Spinach

Chilling sensitive

- Avocado
- Banana,
- Beans, snap
- Cassava
- Cucumber
- Eggplant
- Olive
- Peppers
- Potato
- Pumpkin
- Sweet potato
- Tomato
- Watermelon
- Yam

Ethylene Gas (C_2H_4)

- Plant hormone involved in many aspects of plant growth and development; directly related to the ***Climacteric*** stage of Produce
- Physiologically active at low concentrations (<0.1ppm)
- Produced by :
  - Ripening Climacteric Fruit
  - External Contamination
  - Decay
  - Physical Injury

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Climacteric Characteristics of Produce

- **Definition of Climacteric**
  - **Climacteric** is the stage of fruit ripening associated with ethylene production and a rise in cell respiration.
  - Climacteric fruit ripen with respiration and ethylene bursts;
  - Non-Climacteric fruit have receptors which respond negatively to ethylene gas.
  - The Climacteric event marks:
    - the peak of edible ripeness (best taste & texture)
    - The stage after which fruits are more susceptible to fungal invasion and begin to degrade with cell death.

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Two Types Of Ethylene-Sensitive Produce

Climacteric	**Non-climacteric**
Apple	Cucumber
Banana	Olive
Pear	Pea
Peach	Grape
Kiwifruit	Strawberry
Tomato	Orange

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USDA Tropical Products Transport Handbook
Agriculture Handbook No. 668

Ethylene producers:

Apples, apricots, avocados, bananas ripening, cantaloupes, cherimoya, figs, guavas, honeydew, kiwifruit ripe, melons, mamey, mangoes, mangosteen, nectarines, papayas, passion fruit, peaches, pears, persimmons, plantains, plums, prunes, quinces, rambutan, tomatoes.

Ethylene sensitive:

bananas unripe, Belgian endive, broccoli, brussels sprouts, cabbage, carrots, cauliflower, chard, cucumbers, cut flowers, eggplant, florist greens, green beans, kiwifruit unripe, leafy greens, lettuce, okra, parsley, peas, peppers, potted plants, spinach, squash, sweet potatoes, watercress, watermelon, yams.

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Effects of Ethylene Gas

- Exposure to ethylene can:

- accelerate senescence, e.g. loss of greenness
- accelerate ripening, softening, and discoloration
- induce leaf disorders – russet spotting in lettuce
- induce accumulation of isocoumarin (bitterness in carrots)
- induce sprouting (potatoes)
- induce toughening of asparagus
- cause abscission of flowers

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Strategy For Ethylene Reduction

- Minimize Production and Hormonal Action
  - Temperature control;
  - Extend-A-Life™ Potassium Permanganate Filters;
  - Modified and controlled atmosphere (MA, CA) packaging.
- Avoidance
  - Ventilation
  - Isolate producers from sensitive product
- Destruction
  - Chemical, catalytic burners

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CONCLUSION:
Utilize Optimal Preservation Procedures:

- **Reduce Respiration By Maintaining Optimum Temperature Environment (“Cold Chain Management”)**
- **Physical Storage Management: Isolate Ethylene Producers from Ethylene Sensitive Produce**
- **Filter Ethylene from Storage Spaces**
- **Filter/Remove Mold and Fungus**
- **Maintain Sanitary Environment**

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