Utilization of Modified Atmosphere Packaging to Increase Shelf Life

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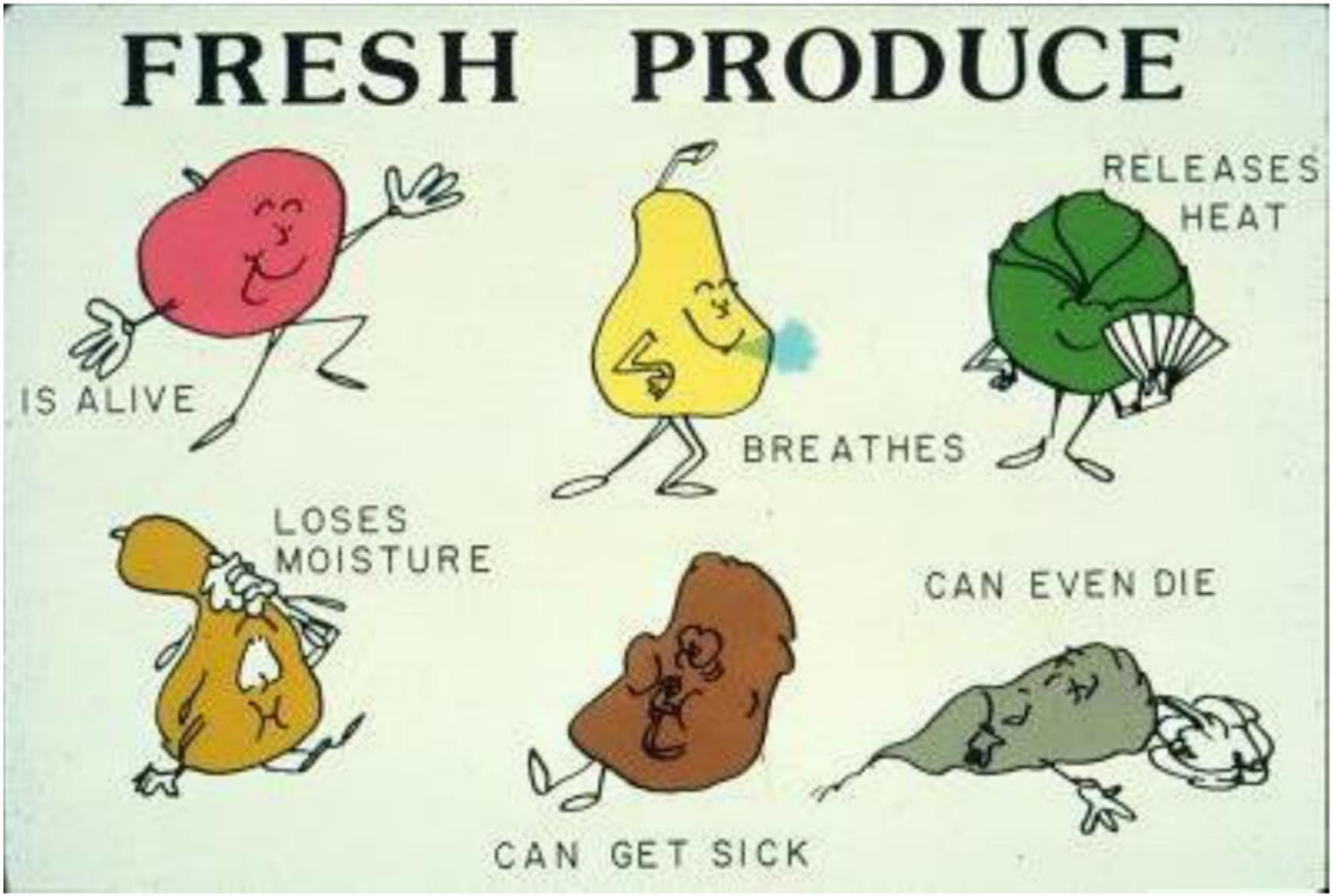
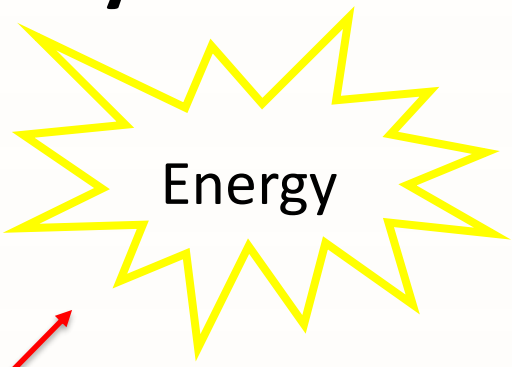
Fresh Produce is Alive!



Fresh Produce is Alive!

Ongoing **Metabolic Activity**

RESPIRATION



$Sugar + O_2 \Rightarrow CO_2 + Water$

Modified Atmosphere Packaging (MAP)

"The practice of changing the composition of the internal atmosphere of a produce bag/tray"

Air: 20.95% O_2 & 0.04% CO_2

MAP typically aims in an atmosphere with:

- ↓ Reduced O_2
- ↑ Increased CO_2

} ↓ Respiration Rate ↓ Metabolism

e.g. MAP for Spinach: 3% O_2 & 10% CO_2 at 0°C (Suslow & Cantwell, 1998)

Goal: Maintain quality & extend shelf life

Suslow, T.V., Cantwell, M. (1998). " Spinach: Recommendations for Maintaining Postharvest Quality. Perishables Handling #94 ", http://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/Datastores/Vegetables_English/?uid=32&ds=799 (accessed 12/15/2016)

MAP Types

Active MAP: Flushing of the desired gas concentration

+ Rapid Atmosphere Modification
- Expensive

Passive MAP: Atmosphere is modified by product respiration rate & gas permeability of the packaging film

+ Cheap
- Long period for establishing desired atmosphere

Riviera picture : http://jerp.jim2story.com/produce-item/fresh-express-riviera-blend/ (Accessed at 12/13/2016

MAP Beneficial Effects

- Slowing down ripening/senescence
- Reduction of produce sensitivity to ethylene
- Alleviation of certain physiological disorders (e.g., chilling injury)
- Reduction of produce susceptibility to post-harvest pathogens (e.g. *Botrytis cinerea)*
- Insect control
- High RH Maintainance

MAP Adverse Effects

Unfavorable MA conditions can cause:

- Initiation of physiological disorders & physiological breakdown
- Irregular ripening
- Development of off-flavors and off-odors
- Increased susceptibility to decay
- Stimulation of sprouting and retardation of periderm development in some root and tuber vegetables
- Moisture Condensation

MAP & Temperature

Temperature is a **CRITICAL** element in MAP Design

- MA packaging is designed for optimum storage temperature

Temperature increase: disparity between increase in respiration rate and film permeability

O_2 depletion & CO_2 accumulation

- Irregular ripening
- Physiological disorders
- Off-flavors & Off-odor
- Increased susceptibility to decay

Picture http://www.iconsdb.com/red-icons/temperature-2-icon.html (Accessed at 12/13/2016)

Low O_2 Injury

High CO_2 Injury

Picture from http://postharvest.ucdavis.edu/Commodity_Resources/Fact_Sheets/Datastores/Fruit_English/?uid=7&ds=798 (Accessed 12/15/2016)

Fruit & Vegetable O_2 Tolerance Limit (Kader et al., 1989)

Minimum %O_2	Commodities
1	Specific apple cultivars of apples and pears, broccoli, mushrooms, garlic, onion
2	Most cultivars of apples and pears, kiwifruits, apricot, cherry, nectarine, peach, plum, strawberry, papaya, pineapple, olive, cantaloupe, sweet corn, green bean, celery, lettuce, cabbage, cauliflower, Brussels sprouts
10	Avocado, persimmon, tomato, pepper, cucumber, artichoke
15	Citrus fruits, green pea, asparagus, potato, sweet potato

Kader, A. A., D. Zagory and E. L. Kerbel (1989). "Modified Atmosphere Packaging of Fruits and Vegetables." Critical Reviews in Food Science and Nutrition 28(1): 1-30.

Fruit & Vegetable CO_2 Tolerance Limit (Kader et al., 1989)

Maximum %CO_2	Commodities
2	Apple (Golden Delicious), Asian pear, European pear, apricot, grape, olive, tomato, sweet pepper, lettuce, endive, Chinese cabbage, celery, artichoke, sweet potato
5	Apple (most cultivars), peach, nectarine, plum, orange, avocado, banana, mango, papaya, kiwifruit, cranberry, pea, chili pepper, eggplant, cauliflower, cabbage, Brussels sprouts, radish, carrot
10	Grapefruit, lemon, lime, persimmon, pineapple, cucumber, summer squash, asparagus, broccoli, parsley
15	Strawberry, berries, fig, cantaloupe, sweet corn

Kader, A. A., D. Zagory and E. L. Kerbel (1989). "Modified Atmosphere Packaging of Fruits and Vegetables." Critical Reviews in Food Science and Nutrition 28(1): 1-30.

Extending Shelf-life using Passive Modified Atmosphere

"Postharvest treatments to improve quality and safety of locally-grown vegetables stored at non-optimum temperatures"

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Extending Shelf-life using Passive Modified Atmosphere

1st Objective

Utilize MAP at non optimum temperature for three different crops – spinach, broccoli, asparagus – to extend shelf life

- Passive MAP bags:
  - -Farmers bags (by Chandra Associates) for spinach and broccoli
  - -Produce bags (PEAKfresh USA) for asparagus
- Control: non MAP produce bags

- Produce was stored at 55 °F (Optimum ≈ 35 °F)

Extending Shelf-life using Passive Modified Atmosphere

Conclusions

- Passive MAP bags : extend the shelf life in 4, 7 and 7 days compared to control for asparagus, broccoli and spinach respectively stored at 55 °F

- Could be an alternative for small acreage growers

Extending Shelf-life using Passive Modified Atmosphere

Asparagus

Extending Shelf-life using Passive Modified Atmosphere

Broccoli

Extending Shelf-life using Passive Modified Atmosphere

Spinach

Future Research

- Investigate the use of MAP to **prolong the shelf-life** of organic tomato and spinach during storage in **non optimum** temperatures

  - Investigate the effect of MAP on :
    - Overall
    - Organoleptic
    - Nutritional

    } Quality

United States Department of Agriculture
National Institute of Food and Agriculture

Questions