FDE 447
COLD PRESERVATION TECHNOLOGY

Content:

*Cold storage of fruits and vegetables
*Storage conditions
*CAS, MAP
*Climacteric behaviour of fruits
*Humidity
*Air velocity

Controlled Atmosphere Storage (CAS)

- The CAS technology involves reduction of oxygen (O2) and increasing carbon dioxide (CO2) as compared to the ambient atmosphere in the storage atmosphere combined with refrigeration.
- CAS implies continuous monitoring and precise adjustment of these gases within the storage container, to a predetermined level.
- It is mostly used in apple and pear storage in our country.

Modified Atmosphere Storage (MAS)

- The gas composition is modified initially and it changes dynamically depending on the respiration rate of produce.
- When the generation and stabilization of favorable atmosphere are obtained by packaging refrigerated produce in closed polymeric films of reduced dimentions (bags, boxes, pallets), the technique is called MAP.

By reducing Oxygen Ratio

1- Respiration rate decreases

2- Decomposition events in fruit slow down (chlorophyll loss, sugar, Acid,vitamin and vitamin C etc.)

3- Ethylene synthesis is reduced.

4- Aromatic substance synthesis regresses and its rise is delayed.

5-Some physiological disorders are reduced.

By increasing carbon dioxide ratio

1- The amount of air inside the fruit and dissolved CO_2 in water increases. Therefore, respiratory rate decreases and climacteric rise regresses, the rate of maturation and aging slows down.

2-Ethylene's effect is lost.

3- Sugar, organic acid and aromatic substance metabolism slows down.

4- The growth of fungi that damage the product is prevented.

Advantages and Disadvantages of MAP

Advantages

Increase in shelf life: 40-500%.

- Reduced economic losses due to longer shelf life.
- Provides a high quality product.
- No (some) chemical preservative is added.
- Olourless and convenient packages.
- Sealed packages (Barrier agains recontamination)

Disadvantages

- Cost rises due to addition of gases, packaging materials and machinery.
- Temperature control necessary.
- Gas formulation differs depending upon the product.
- Loss of benefit once packs are opened or if leaks found.
- CO_2 dissolving may lead to pack collapse and increased drip.

Climacteric behaviour of fruits

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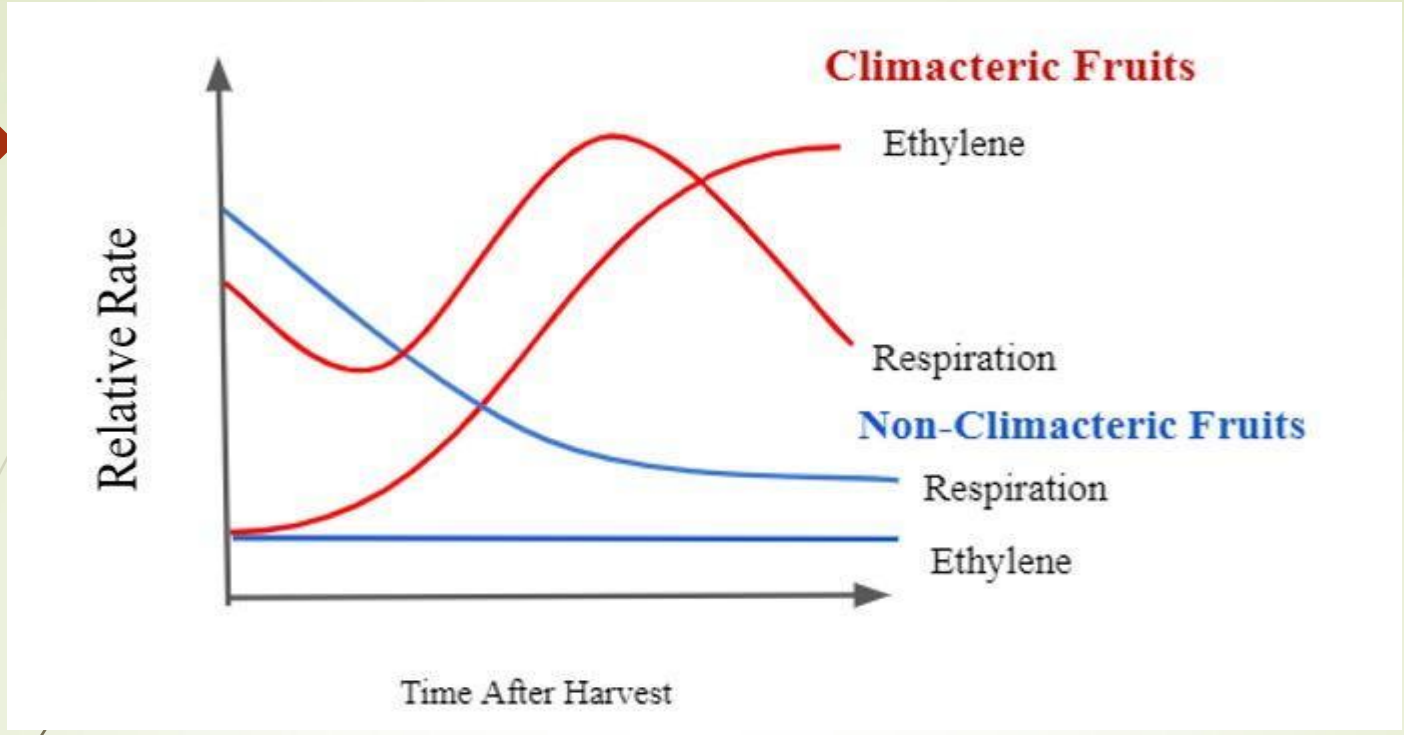
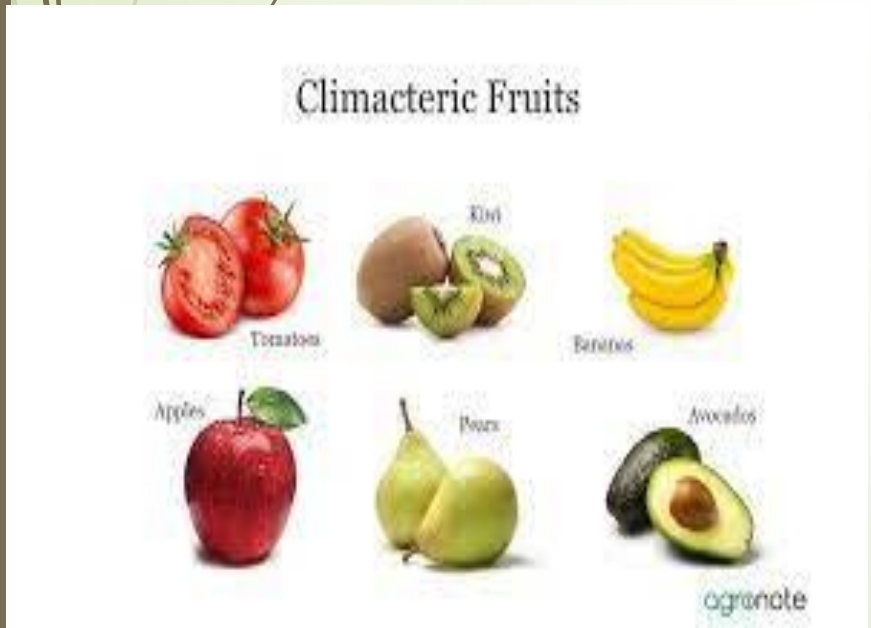
- The climacteric is a stage of fruit ripening associated with increased ethylene production and a rise in cellular respiration.
- Non-climacteric fruits once harvested do not ripen further. They produce very small amount of ethylene and do not respond to ethylene treatment.
- Therefore, they should be harvested at the right time.
- On the other hand, some fruits accelerate their respiration after a while in storage and, they begin to ripen rapidly. In these products, respiration slows down after the respiratory rate reaches a certain peak (peak). This behavior is called "climacteric" behavior.


Climacteric Fruits
Ethylene
Relative Rate
Respiration
Non-Climacteric Fruits
Respiration
Ethylene
Time After Harvest


Climacteric Fruits
Kiwi
Tomatoes
Bananas
Apples
Pears
Avocados
agranote

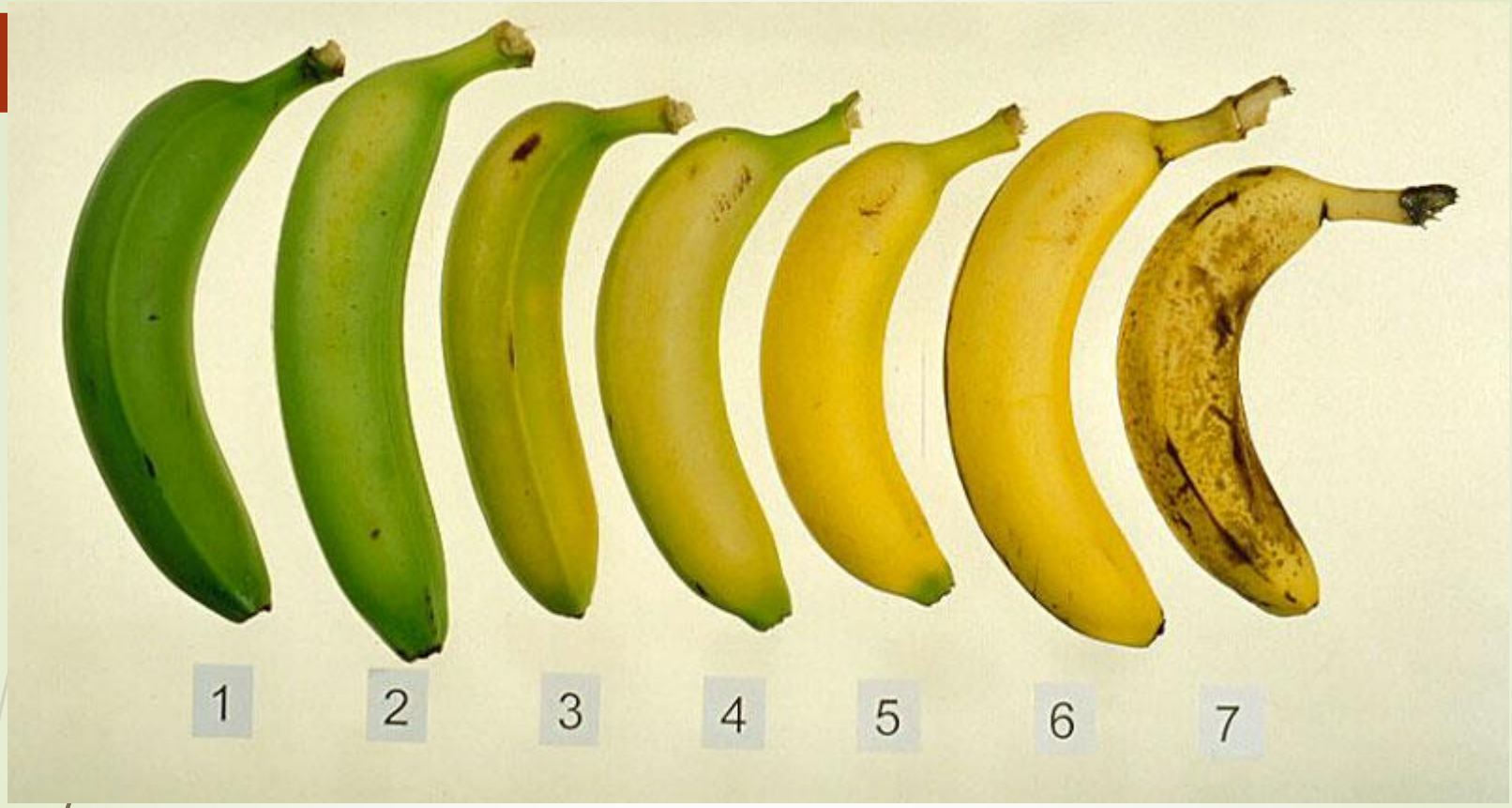

Non-Climacteric Fruits
Cherries
Watermelon
Grapes
Strawberries
Citrus
agranote

Non-climacteric

- Fruits which mature slowly while attached to the parent plant.
- Do not exhibit an increase in respiration rate when ripening begins.
- Low ethylene production rate, low respiration rate.
- Blueberry, cherry, grape, pineapple, potatoes.

Climacteric

- Fruits, vegetables with relative rapid increase in respiration rate.
- Rapid ripening period=climacteric period.
- High ethylene production during ripenin.
- Can also be provoked to ripen by ethylene treatment.
- Apple, apricot, avocado, banana, kivi, tomato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Humidity

- Fruits and vegetable contains about 85-95% water.
- Dehydration, or moisture loss, causes a product to shrivel or wrinkle and lose quality.
- Therefore, proper measures must be taken during cold storage of food items to minimize moisture loss.
- A fruit or vegetable that loses 5% moisture, for example, will weight 5% less and loses its quality.
- The loss of moisture from fresh fruits and vegetables is also called ***transpiration***.

Humidity

- The tendency of a fruit or vegetable to transpire is characterized by the transpiration coefficient, which is the rate of transpiration per unit environmental vapor pressure deficit.
- The transpiration coefficient of apples, for example, is 58 ng/s · Pa · kg, whereas it is 1648 ng/s · Pa · kg for carrots and 8750 ng/s · Pa · kg for lettuce.
- This explains why the lettuce dehydrates quickly while the apples in the same environment maintain their fresh appearance for days.

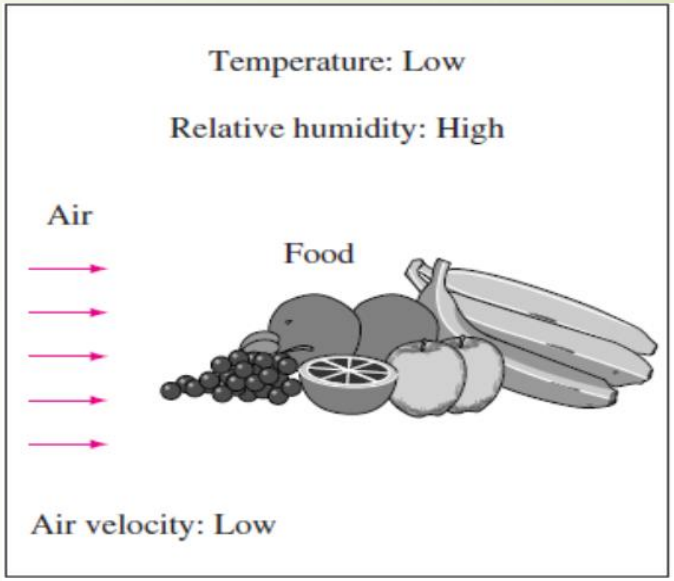
Moisture loss can be minimized by:

- 1) keeping the storage temperature of
- food as low as possible,

(2) keeping the relative humidity of the storage room as high as possible, and

(3) avoiding high air velocities.

- However, air must be circulated continuously throughout the refrigerated storage room to keep it at a uniform temperature.
- To maintain high quality and product consistency, temperature swings of more than 1°C above or below the desired temperature in the storage room must be avoided.
- Air motion also minimizes the growth of molds on the surfaces of the wrapped or unwrapped food items and on the walls and ceiling of the storage room.



The proper environment for food storage to minimize moisture loss

Humidity

As a general principle; leafy vegetables and many fruits should be stored in stores with 90-95% and 85-90% relative humidity in stores, respectively.

- humidity is 70% for some products such as onion, garlic and potatoe

Humidity in cold rooms

- The temperature of the evaporator cooling the tank is below 0°C. For this reason, the air touching the evaporator surface is cooled and saturated with moisture, and the excess water vapor is collected as snow or ice on the evaporator surface. In this way, the storage humidity decreases continuously.
- There is a constant balance between the storage humidity and the water vapor pressure of the stored product.
- If the water vapor pressure of the product is higher than the water vapor pressure of the warehouse atmosphere; The product loses water continuously until this imbalance is eliminated.
- The accumulation of water vapor in the storage air in the form of snow on the evaporators means that the relative humidity of the air decreases and thus the water vapor pressure of the air decreases. This is the reason why the product loses water.

Partial water vapor pressure of air and fresh fruits and vegetables (mm Hg)

Temperature ° C	Relative humidity of air				Fresh fruits and vegetables
	%50	%70	%90	%100	
0	2.29	3.21	4.12	4.58	4.58
5	3.27	4.58	5.89	6.54	6.54
10	4.60	6.45	8.29	9.21	9.21
20	8.77	12.28	15.79	17.54	17.54
25	11.88	16.63	21.38	23.76	23.76

[1] Because fresh fruits and vegetables contain high amounts of water, water vapor pressures is considered to be very close to or equal to the water vapor pressure of free pure water.

Example: Apples are stored in a warehouse with 90% relative humidity. With frost in the evaporator, the relative humidity of the warehouse drops down to 70%. Since the warehouse is operated at 0°C; Consider the situation in which apples face water loss at the beginning and after the relative humidity drops to 70%.

- For this reason, the temperature of the fruits and vegetables at the time of storage is highly effective on water loss.
- Fruits and vegetables have high water vapor pressure at high temperature
- For this reason, when they are transferred to the warehouse at high temperatures(15-20°C), a large amount of water is lost due to the low temperature of the warehouse.
- For this reason, pre-cooling should be applied to the fruits and vegetables to be stored or they should be cooled rapidly in high humidity warehouses.
- According to these explanations, products stored in cold storage lose more or less water.
- The lost water is carried to the evaporator via the storage air. Prevention of this is possible by keeping the humidity level of the warehouse air constant and by controlling it continuously.

- Humidity level of the warehouse should be kept constant by:
- giving water vapor to the warehouse,
- İnsulating the warehouse against the moisture,
- By regulating air movement,
- By selecting the evaporator surface area in the appropriate size.

Air velocity

- The air velocity is the most important factor affecting the water loss of the stored material.
- It was determined that the water loss of the stored product increased by ¼ when the air velocity was increased by 2 times.
- A less expensive method of adjusting the tank humidity is to introduce fine water droplets into the tank with spray nozzles or rotary brushes.

Air velocity

- The air velocity in the warhouse should normally be 0.2 m/s.
- Air movement is provided by the fans located behind the evaporators.
- If the air velocity is too high for some reason, it will cause moisture loss in the warehouse and thus water loss in the product. These inconveniences can be avoided by increasing the humidity of the warehouse.
- The stacking shape of the product is also effective on the air movement in the warehouse.
- Channels should be created for air circulation by leaving a gap of 10-20 cm between the stacks. Likewise, a gap of 30-50 cm should be left between the stacks and the walls and ceiling.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Death of fruits and vegetables by cold effect:

- Fruits and vegetables begin to freeze just below zero degrees, usually between -1 and -3°C.
- Pure water freezes at 0°C, but fruits and vegetables freeze below 0°C because of water soluble subtances.
- Cells die when fruits and vegetables freeze. Accordingly, freezing and death in fruits and vegetables are synonymous.
- The cause of death as a result of freezing is the significant loss of water in the cell.
- When the cell water freezes, the pure water turns into ice crystals, while the dissolved substances in the cell water form a concentrated solution.
- This dense solution causes cell proteins to denature and, in this way, to death of the cell.
- Even if the frost is thawed later, the cell is no longer alive.

**Fruits and vegetables should never be allowed to freeze during cold storage.

- No matter how favorable the conditions are in the cold storage; As a result of respiration of the product, some substances, especially sugars, are consumed.
- When the consumption of these substances reaches a certain level, respiration stops and death occurs.
- During respiration, the order in the chemical and biochemical reactions that develop regularly in the cells is lost, and as a result, various substances are formed.
- Thus, the aroma and flavor deteriorate, the texture softens and loosens. This is followed by microbiological deterioration.