UNIT 2: Packinghouse handling of fresh herbs
Outcomes

After completing the course, students should be able to:
1. Explain principles, storage method & equipment maintenance of refrigerated storage of minimally processed products.
2. Explain the principles of modified atmosphere storage.
3. Explain principles and techniques to turn under quality produce and processing waste into profit.
2.1 Cooling requirement

- When fresh culinary herbs first arrive at the packinghouse, they should be cooled to remove the field heat. Warm product put immediately into cold storage *without cooling may result in condensation formation that may enable microbial growth.*

- Ice and / or ice slurries may also be used to cool fresh culinary herbs thus providing another *possible contamination source if ice is not handled appropriately* or if contaminated water is used to make the ice. Ice used on fresh culinary herbs should be included in routine water quality testing.

- The packing facility should have a *cold storage area with refrigeration* that is appropriate for the product. Refrigeration units *should be inspected on a regular basis and kept in good operating condition.*
Cold room

- fully rebated door. This allows for great insulation, which cannot be achieved by slab or semi rebated doors.
- -5 to +2 degrees centigrade temperature range.
There are four main components in a refrigeration system:

1) **Compressor** - the function of a compressor is to increase the pressure, and corresponding saturation temperature (boiling point) of the refrigerant vapor to high enough level so the refrigerant can condense by rejecting its heat through the condenser.

2) **Condenser** - device or unit used to condense a substance from its gaseous to its liquid state, by cooling it.

3) **Expansion Device** - allows the liquid refrigerant flow into the evaporator in the amount that corresponds to the rate at which the evaporator liquid refrigerant boils into steam.

4) **The Evaporator** - used to turn any liquid material into gas.
How it works!

1. The compressor constricts the refrigerant vapor, raising its pressure, and pushes it into the coils on the outside of the refrigerator.

2. When the hot gas in the coils meets the cooler air temperature of the kitchen, it becomes a liquid.

3. Now in liquid form at high pressure, the refrigerant cools down as it flows into the coils inside the freezer and the fridge.

4. The refrigerant absorbs the heat inside the fridge, cooling down the air.

5. Last, the refrigerant evaporates to a gas, then flows back to the compressor, where the cycle starts all over.
2.2 Storage Technique

- Dry, well-aerated, limited temperature fluctuations, off-the-ground
- Fresh products = 1 – 5 °C
- Frozen products = < 18 °C
- Fumigation against pest attacks only when necessary – only by
  1) licensed personnel
  2) registered chemicals
Two is better than One!

Think. Pair. Share

Find an article/journal regarding the storage condition in packinghouse and discuss with your partner.
Store house condition

- **Storage area** should be well organized and tidy. Special attention should be paid to cleanliness and good maintenance.
- Any accidental spillage should be cleaned up immediately using methods that minimized the risk of contamination.
- Different herbal material should be stored in separate areas.
- To protect the store material, and reduce the risk of pest attacks, the **duration of storage** of any herbal material in unpacked form should be kept to **minimum**.
- Incoming fresh herbal material should be **processed, unless specified otherwise, as soon as possible**. If appropriate, they should be **stored between 2 Deg C and 8 Deg C**, where as frozen materials should be stored below – 18 Deg C.
- Avoid **Direct exposure to light, air or microbial organism effect** on active component of herb which leads to lower the therapeutic efficacy of drug; but if the herb are stored in bulk to reduce the risk of mould formation or fermentation it is advisable to store them in aerated rooms or container using natural or mechanical aeration and ventilation.
- The room should be **rodent free**.
- Hence raw material should kept with proper storage with **appropriate packaging material**. Raw drug may be stored under conditions that prevent contamination and deterioration. Any variation organoleptic or phytochemical readings are indication of poor quality of herbs in terms of therapeutic activity.
Storage Area

- Well organized
- Good maintenance
- Quick spillage response
- Quarantine area
- Good segregation of materials

<table>
<thead>
<tr>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen &lt; 18 °C</td>
</tr>
<tr>
<td>Cold 2-8 °C</td>
</tr>
<tr>
<td>Aerated room (natural/mechanical)</td>
</tr>
<tr>
<td>Prevention insects/rodents/animals</td>
</tr>
</tbody>
</table>

- Storage – above floor
- Ensure humidity, temperature, light penetration adhered
- dry
Material for specific packaging and storage of raw herbs:

- Stem, heartwood, bark - Gunny bags and woven sacks
- Creepers, leaves - woven sacks with LD liner, high gauge HMHD bags, woven sacks with LD liner, High Gauge polyethylene bags.
- Fruits and rhizomes - High gauge HMHD bags, woven sacks with LD liner, Wooden boxes.
- Flower, anthers, stigma, petals, seed - Corrugated box with polypropylene woven sacks, HDPE containers, Fiber board's liner.
- Herbal extracts and compounds - Air tight HDPE containers, corrugated box with polyethylene woven sacks and fiber board's drums with polyethylene bags
2.3 Controlled atmosphere packing & storage

Controlled Atmosphere (CA) is a storage technique whereby the level of oxygen is reduced and CO2 is increased. Quality and the freshness of fruit and vegetables are retained under Controlled Atmosphere conditions without the use of any chemicals. Under CA conditions, many products can be stored for 2 to 4 times longer than usual.
Modified atmosphere packaging is the enclosure of a food/products in a package in which the atmosphere has been changed by altering the proportions of carbon dioxide, oxygen, nitrogen, water vapour and trace gases.

The process limits microbial as well as biochemical activity.

This modification is performed by gas flush packaging – air is removed and replaced by a controlled mixture of gases.

Temperature control should be considered extremely in MAP design, as this Film permeability also increases as temperature increases.
Advantages of MAP

a) Increased shelf-life allowing less frequent loading of retail display shelves;
b) Reduction in retail waste;
c) Improved presentation-clear view of product and all round visibility;
d) Hygienic stackable pack, sealed and free from product drip and odour;
e) Easy separation of sliced products;
f) Little or no need for chemical preservatives;
g) Increased distribution area and reduced transport costs due to less frequent deliveries;
h) Centralised packaging and portion control;
i) Reduction in production and storage costs due to better utilisation of labour, space and equipment.
Disadvantages of MAP

- a) Capital cost of gas packaging *machinery*;
- b) Cost of *gases and packaging materials*;
- c) Cost of analytical equipment to ensure that correct gas mixtures are being used;
- d) Cost of quality assurance systems to prevent the distribution of leakers, etc.
- e) increased pack volume which will adversely affect transport costs and retail display space;
- f) potential growth of food-borne pathogens due to temperature abuse by retailers and consumers;
- g) benefits of MAP are lost once the pack is opened or leaks.
GASES USED IN MAP

Carbon Dioxide is a colorless gas, and slightly corrosive in the presence of moisture. CO2 dissolves readily in to produce carbonic acid (H2 CO3) that increases the acidity of the solution (Coles et al., 2003). Carbon dioxide has a powerful inhibitory effect on bacterial growth. However, carbon dioxide does not retard the growth of all types of microorganisms. Carbon dioxide permeates packaging film up to thirty times faster than any other gas used for the packaging of products (Parry, 1993).

Oxygen is probably the most important gas in food deterioration being used metabolically by both aerobic spoilage microorganisms and plant tissues and taking part in some enzymic reactions in agricultural products. Therefore, in MAP, oxygen is either excluded or the levels set as low as possible.

Nitrogen is a relatively un-reactive gas with no odor and color and with a low solubility in both water and fat. It is commonly used in MAP to displace oxygen. It can also indirectly influence the microorganisms in perishable foods by retarding the growth of aerobic spoilage organisms. The third role of nitrogen is to act as a filler and prevent package collapse in foods that absorb carbon dioxide (Parry, 1993).
Proportion of gases in packaging

**BAKED PRODUCTS**
- Oxygen: 30-80%
- Carbon dioxide: 20-70%
- Nitrogen: 30-80%

Shelf life (days) | Storage temp (°C)
--- | ---
3 months | ambient

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**STRAWBERRIES**
- Oxygen: 95-91%
- Carbon dioxide: 4.6%
- Nitrogen: 1.8%

Shelf life (days) | Storage temp (°C)
--- | ---
7 | 5°C

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**ICEBERG LETTUCE**
- Oxygen: 93-91%
- Carbon dioxide: 2.9%
- Nitrogen: 3.6%

Shelf life (days) | Storage temp (°C)
--- | ---
21 | 5°C
Proportion of gases

- **Oxygen**
- **Carbon dioxide**
- **Nitrogen**

**RED MEAT**
- Shelf life: 21 days, Storage temp: 0°C
- Shelf life: 7 days, Storage temp: 2°C

**COOKED MEAT**
- Shelf life: 10 days, Storage temp: 2°C

**POULTRY**
- Shelf life: 11 days, Storage temp: 1°C

**OILY FISH**
- Shelf life: 10 days, Storage temp: 0°C
- Shelf life: 5 days, Storage temp: 2°C
Table 1. Recommended modified-atmosphere conditions for some fruits and vegetables. (Adapted from Kader et al., 1998; Gorris and Peppelenbos, 1999; Rahman and Amad, 2012)

<table>
<thead>
<tr>
<th>Products</th>
<th>Temperature (°C)</th>
<th>Recommended modified atmosphere</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruits</strong></td>
<td></td>
<td>O₂ (%)</td>
<td>CO₂ (%)</td>
</tr>
<tr>
<td>Apple</td>
<td>0–5</td>
<td>1–3</td>
<td>1–5</td>
</tr>
<tr>
<td>Apricot</td>
<td>0–5</td>
<td>2–3</td>
<td>2–3</td>
</tr>
<tr>
<td>Avocado</td>
<td>5–13</td>
<td>2–5</td>
<td>3–10</td>
</tr>
<tr>
<td>Banana</td>
<td>12–15</td>
<td>2–5</td>
<td>2–5</td>
</tr>
<tr>
<td>Cherry, sweet</td>
<td>0–5</td>
<td>3–10</td>
<td>10–15</td>
</tr>
<tr>
<td>Fig</td>
<td>0–5</td>
<td>5–10</td>
<td>15–20</td>
</tr>
<tr>
<td>Grape</td>
<td>0–5</td>
<td>2–5</td>
<td>1–3</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>10–15</td>
<td>3–10</td>
<td>5–10</td>
</tr>
<tr>
<td>Kiwi fruit</td>
<td>0–5</td>
<td>1–2</td>
<td>3–5</td>
</tr>
<tr>
<td>Lemon and lime</td>
<td>10–15</td>
<td>5–10</td>
<td>0–10</td>
</tr>
<tr>
<td>Mango</td>
<td>10–15</td>
<td>3–5</td>
<td>5–10</td>
</tr>
<tr>
<td>Olive</td>
<td>5–10</td>
<td>2–3</td>
<td>0–1</td>
</tr>
<tr>
<td>Orange</td>
<td>5–10</td>
<td>5–10</td>
<td>0–5</td>
</tr>
<tr>
<td>Peach and nectarine</td>
<td>0–5</td>
<td>1–2</td>
<td>3–5</td>
</tr>
<tr>
<td>Pear</td>
<td>0–5</td>
<td>1–3</td>
<td>0–3</td>
</tr>
<tr>
<td>Persimmon</td>
<td>0–5</td>
<td>3–5</td>
<td>5–8</td>
</tr>
<tr>
<td>Plum</td>
<td>0–5</td>
<td>1–2</td>
<td>0–5</td>
</tr>
<tr>
<td>Raspberry and other cane berries</td>
<td>0–5</td>
<td>5–10</td>
<td>15–20</td>
</tr>
<tr>
<td>Red currant</td>
<td>0–2</td>
<td>5–10</td>
<td>15–20</td>
</tr>
<tr>
<td>Strawberry</td>
<td>0–5</td>
<td>5–10</td>
<td>15–20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Vegetables</strong></th>
<th></th>
<th>O₂ (%)</th>
<th>CO₂ (%)</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asparagus</td>
<td>0–5</td>
<td>Air</td>
<td>5–10</td>
<td>Excellent</td>
</tr>
<tr>
<td>Bean</td>
<td>5–10</td>
<td>2–3</td>
<td>4–7</td>
<td>Fair</td>
</tr>
<tr>
<td>Broccoli</td>
<td>0–5</td>
<td>1–2</td>
<td>5–10</td>
<td>Excellent</td>
</tr>
<tr>
<td>Brussels sprout</td>
<td>0–1</td>
<td>2–4</td>
<td>4–6</td>
<td>Excellent</td>
</tr>
<tr>
<td>Cabbage</td>
<td>0–5</td>
<td>2–3</td>
<td>3–6</td>
<td>Excellent</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>3–7</td>
<td>3–5</td>
<td>10–15</td>
<td>Good</td>
</tr>
<tr>
<td>Celery</td>
<td>3–5</td>
<td>1–4</td>
<td>0–5</td>
<td>Good</td>
</tr>
<tr>
<td>Chicory</td>
<td>5</td>
<td>2–3</td>
<td>5–10</td>
<td>Excellent</td>
</tr>
<tr>
<td>Corn (sweet)</td>
<td>0–5</td>
<td>2–4</td>
<td>5–10</td>
<td>Good</td>
</tr>
<tr>
<td>Cucumber</td>
<td>8–12</td>
<td>3–5</td>
<td>0</td>
<td>Good</td>
</tr>
<tr>
<td>Leek</td>
<td>0–5</td>
<td>1–2</td>
<td>3–5</td>
<td>Good</td>
</tr>
<tr>
<td>Lettuce</td>
<td>0–5</td>
<td>1–3</td>
<td>0</td>
<td>Good</td>
</tr>
<tr>
<td>Onion</td>
<td>0–5</td>
<td>1–2</td>
<td>2–5%</td>
<td>Good</td>
</tr>
<tr>
<td>Pepper</td>
<td>8–12</td>
<td>3–5</td>
<td>0</td>
<td>Fair</td>
</tr>
<tr>
<td>Spinach</td>
<td>0–5</td>
<td>Air</td>
<td>0–20</td>
<td>Good</td>
</tr>
<tr>
<td>Tomato</td>
<td>12–20</td>
<td>3–5</td>
<td>0–3</td>
<td>Good</td>
</tr>
</tbody>
</table>
Expected shelf life

<table>
<thead>
<tr>
<th>Item</th>
<th>Shelf Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole spices, whole herb leaves and whole flowers</td>
<td>1-2 years</td>
</tr>
<tr>
<td>Seeds and barks</td>
<td>2-3 years</td>
</tr>
<tr>
<td>Roots</td>
<td>2-3 years</td>
</tr>
<tr>
<td>Ground spices and herb leaves</td>
<td>1 year</td>
</tr>
<tr>
<td>Ground roots</td>
<td>2 years</td>
</tr>
</tbody>
</table>
Packaging material: Thermoplastic polymers

Nearly all packaging for this process is based on thermoplastic polymers. The reasons for this are that they:

• have greater flexibility, i.e. can be formed into different shapes;
• are light in weight;
• provide a gas barrier;
• can be sealed easily;
• can be printed on.
Thermoplastic polymers

Thermoplastic polymers are also used because they:
• are resistant to physical pressures of manufacturing, distributing and retailing;
• have good aesthetic properties;
• can be multi-layered with other materials to enhance overall properties.

The most commonly used polymeric films;
Polyethylene (LDPE)
Polypropylene (PP),
Polyamide (Nylon)
Non plastic MA packaging

Non plastic MA packaging example: aluminum
Vacuum packaging is a method of packaging that removes air from the package prior to sealing. This method involves (manually or automatically) placing items in a plastic film package, removing air from inside, and sealing the package. Shrink film is sometimes used to have a tight fit to the contents.
Vacuum packaging
Brainstorming Activity

Discuss the management & utilization of damaged produce from raw material?
Suggest a few example of products that may be develop
Assignment

- Define and compare in terms of differences in the microclimates (temperature, etc.), packaging materials used, transportation and marketing requirement, and your considerations for choice of method of storage between refrigerated storage vs MAP technique.