Lec. 13) *Causes of spoilage of fruits and vegetables and control measures during storage:*

Causes of spoilage / Deterioration of fruits and vegetables and control measures during storage:

Definition:

"Spoilage/Deterioration of fruits and vegetables is referred to the undesirable changes occurring in their texture, color or taste rendering them unfit for human consumption."

Causes of deterioration of fruits and vegetables:

A) Pre-harvest production practices:

Pre harvest production practices may seriously affect post harvest returns in terms of quality and resulting the rejection or downgrading of produce at the time of sale.

1. **Water supply (Irrigation):** Growing plants need a continuous water supply. Bad effects can be caused by;
   - **a)** Too much rain or irrigation, can lead to brittleness and easily damage the leafy vegetables and increase their tendency to decay.
   - **b)** Lack of rain or irrigation can lead to low juice content and thick skin in citrus fruit.
   - **c)** Dry conditions followed by rain or irrigation, can give rise to growth of cracks or secondary growth in potatoes or growth of cracks in tomatoes.
2. **Soil fertility, use of fertilizers:** Lack of plant foods in the soil can seriously affect the quality of fresh produce at harvest. On the other hand, too many fertilizers can harm the development and post harvest condition of produce.
3. **Cultivation practices:** Good crop husbandry is important in achieving good yields and quality of fresh produce.
   - **a) Weed control:** Weeds are commonly alternate or alternative hosts for crop diseases and pests and those growing in fallow land near crops are as important as those growing among the crop. Weeds also compete with crops for nutrients and soil moisture and thereby impair the quality and quantity of food produce.
   - **b) Crop hygiene:** Decaying plant residues, dead wood and decaying or mummified fruits are all reservoirs of infection causing post harvest decay. Their collection and removal are crucial factors in the reduction of post harvest losses.
4. **Agricultural chemicals:** Pesticides and herbicides are used as sprays or soil applications to control weeds, diseases and insect pests. They are dangerous because they can damage produce by producing spray burns if used incorrectly and can leave poisonous residues on the produce after harvest.

B) Physiological deterioration: When fresh produce is harvested, the processes of living continue, but in modified form. Because the crop can no longer replace food materials or water. It draws its stored reserves. As these are used up, the produce undergoes an ageing process which is then followed by breakdown; it will eventually become unacceptable as food because of this natural rot.

1. **Enzymatic changes:** Enzymes which are indigenous to plant tissues have undesirable consequences on the post harvest life of fruits and vegetables. Some of them are.

a) Post harvest senescence and spoilage of fruits and vegetables.
b) Oxidation of phenolic substances in plant tissues y phenolase (leading to browning)
c) Sugar starch conservation in plant tissues by amylase.
d) Post harvest demethylation of pectic substances in plant tissues (leading to softening of pant tissues during ripening).

2. **Respiration:** Respiration is a basic reaction of all plant material, both in the field and after harvest. It is continuing process in the growing plants as long as the leaves continue to produce carbohydrates and cannot be stopped without damage to the growing plant or harvested produce. Fresh produce cannot replace carbohydrates or water after harvest. Respiration uses stored starch or sugar and will stop when reserves of these are exhausted. The process of ageing follows and the produce dies and decays.
3. **Los of moisture (Transpirational losses):** Most fresh produce contains 65 to 95 % water when harvested. Fresh produce continues to lose water after harvest, but unlike the growing plant it cannot replace lost of water from the soil and so uses up its water content remain at harvest. This loss of water from fresh produce after harvest is a serious problem, causing shrinkage and loss of weight. When the harvested produce loses 5 to 10 % of its fresh weight, it begins to wilt and soon becomes unusable. To extend life of the produce, its rate of water loss must be reduced as far as possible.
4. **Ripening of fruits:** Fleshy fruits undergo a natural stage of development known as ripening. This occurs when the fruit has ceased growing and is said to be mature. Ripeness is followed by ageing (often called senescence) and breakdown of the fruit.
5. **Effect of ethylene:** Ethylene gas is produced in most plant tissues and is known to be an important factor in starting off the ripening of fruits. Natural ethylene production by fruits can cause problems in storage facilities. Flowers, in particular, are easily damaged by very small amounts of the gas. Ethylene destroys the green color of plants, so lettuce and other vegetables marketed in the mature green but unripe state get damaged if stored with ripening fruit.

C) **Post harvest damage to fresh produce:** Physical damage to fresh produce can result due to a number of causes. The most common are;

a) **Mechanical injury:** The high moisture content and soft texture of fruits, vegetables and root crops make them susceptible to mechanical injury, which can occur at any stage from production to retail marketing because of;

1) Poor harvesting practices.
2) Unsuitable filed or marketing containers and crates, which may have splintered wood, sharp edges, poor nailing or stepping.
3) Over packing or under packing of field or marketing containers.
4) Carless handling, such as dropping or throwing or walking on produces and packed during the process of grading, transport or marketing.

Injuries caused can take many forms:

1) Splitting of fruits and tubers the impact when they are dropped.
2) Internal bruising, not visible externally, caused by impact.
3) Superficial grazing or scratches affecting the skins and outer layer of cells.
4) Crushing of leaf vegetables and other soft produce.

Injuries cutting through or scrapping away the outer skin of produce.

1) Provide entry points for moulds and bacteria causing decay.
2) Increase water loss from the damaged area.
3) Cause an increase in respiration rate and thus heat production.

Bruising injuries, which leave the skin intact and may not be visible externally cause;

b) Increased respiration rate heat production

c) Internal discoloration because of damaged tissues.

d) Off flavors because of abnormal physiological reactions in damaged parts.

e) Injuries from temperature effects: All fresh produce is subject to damage when exposed to extreme temperature.

i) **Freezing injury:** All produce is subject to freezing at temperature between 0 to 2^0 C. frozen produce has a water soaked or glassy appearance. Produce which has recovered from freezing temperature from freezing.

ii) **Chilling injury:** Some types of fresh produce are susceptible to injury at low but non freezing temperatures. Such crops are mostly of tropical or subtropical origin.

iii) **High temperature injury:** If fresh produce is exposed to high temperatures caused by solar radiation, it will deteriorate rapidly. Produce left in the sun after harvest may reach temperatures as high as 50^0 C. it will achieve a high rate of respiration and if packed and transported without cooling or adequate ventilation, will become unusable. Long exposure to tropical sun will cause severe water loss from thin skinned root crops such as carrots and turnips and from leafy vegetables.

D) Diseases and pests

1. **Diseases:** Diseases caused by fungi and bacteria commonly result in losses of fresh produce. Losses from post-harvest diseases in fresh produce fall into two main categories.

Loss in quality, the more serous, occurs where deep penetration of decay makes the infected produce unusable. This is often the result of infection of the produce in the field before harvest.

Loss in quality occurs when the disease affects only the surface of produce. It may cause skin blemishes that can lower the value of a commercial crop. In crops grown for local consumption, the result is less serous since the affected skin can often be removed and the undamaged interior can be used. Infection after harvest can occur at any time between the field and the final consumers. It mostly results due to the invasion of harvesting or handling injuries by mould or bacteria.

The major post-harvest losses of fruits and vegetables are caused by speices of the fungi Alterneria, Botrytis, Dilplodia, Monilinia, Penicillium, Phomopsis, Rhizpous and Sclerotina dn of the bacteria Ermwinia and Pseudomonas. Most of these organism are week pathogens since they can only invade damaged produce. A few such as Coletotricum, are however, able to penetrate the skin of healthy produce.

2. **Pests:** Relatively few post harvest losses of fresh produce are caused by attacks of insects or other animals localized attacks caused y these pests are however serious. Insect damage is usually caused by insect larva burrowing through the produce. E.g. fruit fly, sweet potato tuber moth. Infestation usually occurs before harvest. Post harvest spread is a problem where produce is held in store or is exposed to lengthy periods of transport.

Rats, mice and other animal pests are sometimes a problem when produce is stored on the farm.

E) Improper storage: Delay after harvest in placing produce in cool stoage often causes rapid deterioration in quality. Poor control of storage conditions, over –long storage and inappropriate storage conditions for a particular commodity will also result in poor quality product.

F) **Mixed storage:** with mixed storage of different commodities, ethylene produced from ripening fruit can promote rapid senescence of leafy vegetables.

G) **Marketing:** A serious reduction in quality can occur in produce displayed for lengthy periods in retail outlets because of poor organization of marketing.

Control of deterioration/Spoilage:

1. **Proper production/Management practices:** Farmers should fallow proper production techniques so as to obtain high quality so as to obtain high quality an disease free produce with a loner shelf life.
   1) Irrigate crops as per their specific water requirement. Avoid excess or stress in irrigation.
   2) Maintain soil fertility by use of ample quantity of organic manures and a judicious use of chemical fertilizers to satisfy the crop needs.
   3) As far as possible, maintain the field plots clean. Proper control of weeds and removal of plant residues in the field should be carried out.
   4) Control of post harvest wastage should commence before harvest in the field or orchard. Wherever possible, source of disease infection should be eliminated and sprays for the control or eradication of the casual organism be applied.
2. **Harvest handling:**
   1) Harvest fruits and vegetables at the proper stage and size and at peak quality. Immature or over mature produce dost not last long in storage as that picked at proper maturity.
   2) Harvest should be completed during the coolest time of the day usually in the early morning and produce should be kept shaded in the field.
   3) The produce should be handled with care. The quality and condition of produce sent to the market and its subsequent selling price are directly affected by the care taken during harvesting and field handling. Crops designed for storage should be as free as possible from skin breaks, bruises, spots, rots decay and other deterioration.
   4) Damage can be prevented by training harvest labor to handle the crop gently,a t proper maturity, harvest dry whenever possible, handling each fruit or vegetable no more than necessary (field pack if necessary), installing padding inside bulk bins and avoiding over or under packing of containers.
   5) **Precooling:** Precooling is the first step in good temperature management. The field heat (heat that product holds from the sun and ambient temerature0 of a freshly harvested crop is usually high and should be removed through Precooling as quickly as possible before shipping, processing or storage. Rapid precooling to the products lowest safe is most critical for crops with inherently high respiration rates.
   6) **Sorting:** A preliminary sorting of produce helps to remove unmarketable produce and foreign matter. All discarded material should be quickly removed anyway form the packing house.
   7) **Cleaning and washing:** Cleaning by hand polishing or machine brusing can help to remove light soil contamination or dust from the produce. This should be done with care since damage to skin of fresh produce promotes decay. Washing is carried out to clean produce off the latex stains from injuries caused during harvesting. Ti should be carried out only when absolutely necessary. A fungicide should normally be applied immediately after washing.
3. **Preventing moisture loss:** Water loss from produce causes shrinkage of produce and saleable weight loss leading to reduced profit. It can be prevented by;

1) **Increasing humidity:** this is an effective method to reduce water loss. This reduces the vapor pressure difference between the produce and the air and hence the amount of water required to be evaporated from the produce before the air is saturated with water vapor. This can be achieved by spraying water as a fine mist, by introducing steam or by increasing the temperature of the refrigeration coils. Humidification devises can also be used.
2) **Restricting air movement:** The faster the air moves across the surface of produce, greater is the water loss. In a control store, restricting the air movement around the produce can help to reduce water loss from the produce.
3) **Packaging:** Water loss can be prevented by pacing a physical barrier around the produce to reduce air movement around its surface. Covering stacks with tarpaulins or packing the produce into bags, boxes or cartoons can serve the purpose.

4. **Storage:**
   1) Ethylene is natural hormone produced by fruits as they ripen. Ti promotes additional ripening of produce exposed to it. Ethylene producing products should not be stored with fruits, vegetables or flowers that are sensitive to it.
   2) While sorting or transporting different with respect to their requirements for temperature, relative humidity, atmosphere (oxygen and carob dioxide). Protection form odor and protection from ethylene.
   3) Storing the produce in cold storage at appropriate temperature helps to restrict deterioration without causing abnormal ripening or other undesirable changes, thus maintaining the produce in acceptable condition to the consumer for a long time.
   4) Following proper and appropriate post harvest treatments to produce like low and high temperatures, modified atmosphere, correct humidity, magnetic field, ionizing radiation, good sanitation and development of wind barrier help to control post harvest wastage of produce.
5. **Transportation:** poorer packaging and loading of reduce on suitable vehicles should be carried out. The produce should be kept in best possible condition during transport and the haulage be quick efficient.