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Lecture title: **Meat Hygiene: Meat preservation part II**

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Summary:

Refrigeration:

chilling immediately post-slaughter reduces the surface temperature to a value below the minimum growth temperature for many pathogens. The combination of low temperature and surface drying inhibits the growth of spoilage bacteria. To provide long, safe, high-quality shelf-life, the temperature of the meat should be kept at a temperature close to it is initial freezing point.

The preservative action of refrigeration is based on the prevention of multiplication of harmful bacteria, yeasts, and moulds by the artificial lowering of the temperature. the failure of bacteria to grow at or below freezing depends on the removal of the available water as ice. About 70% is removed at -3.5°c.

FAO and WHO the commission pointed documents in relation to refrigeration include:

1- Meat passed for human consumption should be removed from dressing area without undue delay and placed into refrigeration under close supervision of the inspectors.

2- The following provisions should apply where carcasses, parts of carcasses, or edible offals are placed in chilling rooms, freezing rooms, or frozen storage as the case may be:

a- Entry should be restricted in personal necessary to carry out operation efficiently.

b- Doors should not be left open for long periods and should be closed immediately after use.

c- No chilling room, freezing room or should be loaded beyond it is designated capacity.

d- Where refrigerated equipment is not manned, automatic temperature records should be installed

e- If no automatic device is installed, temperatures should be read at regular intervals and the readings recorded.

3- Where carcasses, parts of carcasses or edible offals are placed in a chilling room for chilling:

a- There should be reliable method of monitoring the chilling.

b- Meat should be placed in suitable corrosion – resistant trays with adequate air circulation

c- Drips from one piece of meat to another must be avoided.
d- Temperature, relative humidity, and air flow should be maintained at suitable levels.
e- condensation should be prevented by the efficient operation of refrigerating process.

4- Where carcasses, or parts of carcasses, or edible offal are being frozen:
a- Meat which is not in cartons should be placed on suitable corrosion-resistant trays with adequate air circulation.
b- Drips on to uncartoned meat must be prevented.
c- The base of any tray should not be in contact with the meat stored beneath
d- Refrigeration coils should be deforested often to prevent loss of refrigerating efficiency.

5- Where carcasses, or parts of carcasses, or edible offal are placed in any freezer store:
a- No meat should be placed in a freezer store until it is temperature is of an acceptable level.
b- Meat should not be stacked directly on the floor but on pallets or dunnage with adequate air circulation around the stacks
c- The temperature of the freezer store should give adequate protection to the product.
d- Refrigeration coils should be deforested regularly to prevent loss of refrigerating efficiency.

Freezing of meat:

Two unfavorable changes take place because of the freezing of meat:

1- The physical state of the muscle plasma (globulin and albumin proteins) is altered. when meat is frozen below -2^{o}c the formation of ice crystals so raises the concentrations of these proteins that they become insoluble and do not regain their solubility when the meat is thawed.

2- The freezing point of meat lies between -1 and -1.5 ^{o}c, 35.5 % of the muscle water is ice, at -5^{o}c, 82% is ice, and at -10^{o}c, 94% is ice. during freezing the water present in the muscle fibers diffuses from the muscle plasma to form crystal ice.

For optimum results in chilling and freezing and prevention of growth of spoilage and food-poisoning bacteria, the following criteria should be adopted:

1- Initial design of refrigeration space must consider product tenderness, weight loss, possibility of spoilage, size of individual units, space needed, rail height and floor and wall surfaces.
2- Temperatures must be checked regularly.
3- Overloading must be avoided, and carcasses must not touch each other.
4- Door opening and closing must be kept to a minimum.
5- Adequate airflow around carcasses is essential.
6- Carcasses of different species must not occupy the same area.
7- Cold shortening must be avoided by not chilling below10°C in less than 10 hours

Weeping or "drip"

Weeping denotes the presence of a watery, blood –stained fluid which escapes from frozen meat when it is thawed and consist of water together with salts, extractives, proteins, and damaged blood corpuscles. The latter are responsible for the pink coloration of the fluid. Weeping is undesirable feature and is caused partly by the rupture of the muscle cells and tissues by crystals of ice.

Durability of frozen meat:

Frozen meat stored too long becomes dry, rancid and less palatable. The most important change being the breakdown of fat into glycerin and free fatty acids, with the production of rancidity. The degree of fluctuation in storage temperature and the type of wrapping (packaging) has the main influence on frozen storage life.

Freezer burn:

Occurs on the outer surface of frozen offals, particularly liver, hearts and kidneys, and is caused by loss of moisture from the outer tissues. It may sometimes be seen where a carcass is stored unwrapped, close to opening of a cold air duct, the meat or offals have a brown withered discoloration. This can be prevented by using suitable packaging or cryogenic freezing.

Smoking

Smoking improves keeping properties as well as color and flavor, traditionally, smoking was carried out over several days in a brick oven with smoldering oak, hickory or hardwood sawdust and hot ash piled on the floor. It is now more common to use an insulated steel cabinet enclosing a heat exchanger system. The cuts to be smoked are hung on racks and placed in the cabinet and the temperature raised to approximately 32^{o}c for 30 minutes. It is important to ensure that the temperature does not rise above 37^{o}c, or the fat may melt.

The chief bacteriostatic and bacteriocidal substances in wood smoke is formaldehyde. The combination of heat and smoke usually causes a significant reduction in the surface bacterial population. In addition, a physical barrier is provided by superficial dehydration, coagulation of protein and the absorption of resinous substances. There are three types of smoking:

- Cold smoking
- Hot smoking
- Liquid smoke

The main advantages of smoking method are:

- Inhibit growth of bacteria
- Add flavor.
- Prevent fats from developing a terrible taste.

- Makes color pleasing to eyes.
- Long shelf life

The main disadvantages of smoking method is that eating too much smoked meat can lead to some cancer risks.

Modified atmosphere packaging (MAP)

Utilizes sealed high-barrier packages in which the air has been replaced with a mixture of gases which reduce the rate of deterioration of the meat. Most often these gases include 10 -50% carbon dioxides, which inhibits the growth of many microorganisms that cause spoilage of refrigerated meat. For fresh red meat the mixture often contains 20-50% oxygen so that the myoglobin will be in the oxygenated cherry-red form. The meat must be sealed in high-barrier films which will keep the air out and prevent the modified atmosphere from escaping.

Preservatives

A preservative is defined as any substances which prolongs the shelf-life of food by protecting it against deterioration caused by micro-organisms There are three categories in use of preservatives:

1- Benefit to food industry, retailers and consumers
2- Safety in use.
3- Satisfactory standard of purity of the chemical.

Irradiation

Electromagnetic radiation is known to inhibit the growth of micro-organisms. close attention has been paid to the effect on the nutritional value of the treated foods, as well as the possible production of free radical carcinogens and induced radioactivity. the main types include high electron, γ and x cesium137. the main type of γ ray is cobalt 60. Which is more effective against bacteria and parasite and less effective against viruses and toxins.

Infrared radiation

Mainly used in fruits and vegetables in a wavelength of $3x10^{-4}$cm.

Ultraviolet radiation

Occur at wave lengths of radiation between 100 and 3000A^0 and are invisible, they have a bactericidal action which is especially valuable for destroying air-born bacteria and are utilized in storage vats and other tanks to destroy micro-organisms above the surface of the food. the penetration effects of the rays are considered to be low and influenced by factors such as:

- the length of exposure
-temperature
-PH
-relative humidity
- light intensity
-degree of contamination

The wavelength for maximum bactericidal activity of ultraviolet rays is about 2500A^0, spores and moulds are more resistant than vegetable organisms. Ultraviolet rays are currently used in the aging of meat at relatively high temperatures to control the growth of surface organisms. the bactericidal effect is also due to shorter wavelengths which converts the atmospheric oxygen to ozone, an added bactericide.

Ionizing radiation

Main uses of ionizing radiation:

- Decontamination of food ingredients such as spices.
- Reductions in the numbers of pathogenic micro-organisms such as salmonella, campylobacter and listeria in meat and meat products.

There are two cases of irradiation in meat:

- **Pre rigor mortis** the meat is fresh, unrefrigerated, with the presence of water when exposure to γ ray to about 10^4 this will cause division of water molecules and form of free radical electrons, if this effect is little it will be useful in killing micro-organisms in meat.
- **Post rigor mortis** the meat is chilled, and it is water is little (static), when exposure to γ ray, the oxygen is moved from hydrogen and then united due to crystallization, therefore we will need high dose to reach the division of water molecules reach about 8kGy

Campylobacter jejuni	0.18 kGy
E. coli	0.25 kGy
Cl. Perfringes	0.5 kGy
Aspergillus	0.4-0.6 kGy

Effectiveness:

The effectiveness of the process depends on the:

- Quality of raw material
- Dose applied
- Temperature during irradiation
- Type of packing
- Storage condition before and after irradiation.

Pathogen such as campylobacter and salmonella are sensitive to low levels of ionizing radiation. Higher dose may simultaneously introduce organoleptic changes which include odor and flavor changes which is unacceptable to consumers due to formation of volatile sulphur-containing substances-hydrogen sulphide, carbonyls, amines , with fresh poultry carcasses an irradiation dose of 2.5 kGy will virtually eliminate salmonella and extend the shelf-life of food by a factor of about 2 if the storage temperature post –irradiation is maintained below 5°c. irradiation doses up to 10 kGy can be applied to frozen poultry (-18°c) without

causing unacceptable organoleptic changes because in frozen state chemical reactions that bring about the desired effects of irradiation are hindered, and a higher dose is necessary to achieve the same goal.

Disadvantage of irradiation in meat:

1- Affect the nutritional value of meat especially vitamin A, E, K and B1 except vitamin D and C, especially when the dose is above the allowable range of meat
2- Lipids with presence of oxygen convert to lipid oxide which affect the cell membranes and cause rancidity especially in high doses in frozen meat.