Lecture 1

MEAT QUALITY AND MEAT PRESERVATION

Meat Quality

In recent years, meat quality has assumed a greater consumer significance and public attention there is growing awareness of the link between diet and health and this is reflected in the demand for more information and for products which are healthy and of consistently high quality. As a consequence, this has lead to the demand for meat with a high lean content. On the other hand as animals, and especially pigs and poultry, have become leaner, more complaints have been received that the eating quality of the meat has declined, with complaints of dryness, toughness and lack of taste and flavour. Other concerns are about food safety and hygiene, especially the presence of micro-organisms, bacterial contamination and residues, as well as the welfare and husbandry conditions under which animals are kept. Thus, both the diets fed to the animals and the systems of animal production are being increasingly questioned. It is fortuitous that with the elucidation of the major factors influencing meat quality and hygiene new opportunities are being created for the development of a consistent, healthy, safe and attractive product which offers value for money. Factors contributing to the eating quality of meat are:

1. Appearance
2. flavour (smell at abattoir, taste)
3. tenderness (chew time)
4. texture

Appearance: This has to do with the colour of meat and its freshness. Colour is determined by the concentration of myoglobin. In young animals there is little concentration of myoglobin, but greater in older animals and the meat becomes darker.

Flavour: Flavour is the combined result of the taste and smells senses and, because it is a subjective property, is difficult to evaluate. Each species has its own characteristic flavour. Chemical reactions resulting in some 1,000 compounds during contribute to the individual meat's flavour

Tenderness: the meat from the young animals is more tender that the meat from old animals. At time of cooking a lot of connective tissues will become soft especially meat from the young animals. Connective tissues are easily broken in meat of young animals than the older animals because they do not easily disintegrate.

Texture: this has to do with the diameter of muscle fibre when muscles are associated with closely packed diameter. It is called fine texture and it is usually of young animals. Course texture is associated with wider diameter of muscle and it is usually meat of older animals.

Hofmann (1987) and Russo (1988) have broadly classified meat quality characteristics into four main categories:

- Organoleptic properties
- Technological quality
- Nutritive value
- Hygienic characteristics or food safety aspects

Organoleptic properties are the traits that influence the consumer to regularly purchase and eat meat.

Technological qualities refer to the suitability of meat for further processing and are primarily determined by treatment after slaughter.

Nutritional value is concerns with the chemical composition of the meat and its suitability for human consumption.

Hygiene or safety implies freedom from harmful microorganisms and any residues.

These can be controlled through legislation, proper feeding designs and strategies, quality management schemes on the farm and procedures in the slaughterhouse and processing plant.

Components of Meat Quality

The main factors contributing to the eating quality of meat are tenderness, juiciness and colour. These are dependent upon several metabolic and biological phenomena within the animal or carcass and include the following:

- Intramuscular content or marbling fat
- Taint, especially the content of skatole, indole and testosterone
- The type and fatty acid content of the animal's diet and hence its carcass
- Maturation or conditioning effects
- Drip loss and maintenance of the integrity of the cell membrane post-mortem
- Stress during transportation and lairage
- The potential to flavour meat
- The effect of feeding

Marbling fat

Acceptability in pigs, the effect of fat on eating quality depends on amount of marbling fat. Marbling fat is the lipid found in the connective tissue surrounding the muscle fibre bundle. It has been suggested that at least 2.0% marbling fat is required for optimal eating quality. Studies have shown that the lower the back fat thickness, the lower the percentage of marbling fat and the less the overall acceptability of the pork.

Taint and effect of skatole

Skatole (3-methyl indole) is a volatile compound produced in the hindgut of animal by microbial degradation of the amino acid tryptophan. Majority of skatole is degraded in the liver and excreted in the urine; the undegraded portion is deposited in the fat and muscle of the body. High concentrations in these tissues give rise to unpleasant smell and taste of meat, especially in entire male animals. Several studies have shown the effect of different diet component on skatole concentration in the intestinal contents, as well as faeces and back fat of pig, e.g. fibre and CP content.

Fatty and composition

In non-ruminants it is well established that simply changing the type and quantity of oil and fat in the diet can change the fatty acid content of fat in the carcass. High concentration of polyunsaturated fatty acids have been associated with low values for tenderness, juiciness, flavour and overall acceptability; whereas high concentration of saturated and monounsaturated fatty acids resulted in high overall score. Also, there is an increased risk of rancidity and 'off' flavour when oils are used in high quantity in pig diets.

Maturation and conditioning effects

The tenderness of meat improves with conditioning and storage after slaughter. Increasing the conditioning period from 1 to 10 days at $1^{o}C$ significantly improves the overall liking of meat. Also the injection of calcium salt solutions, such as calcium chloride, into the carcass of animals have been found to significantly improve the eating quality of meat and reduced the toughening effect of cooking.

Oxidation stabilization and Drip loss

Lipids are important components of meat and enhance several desirable characteristic such as flavour, tenderness and juiciness. However, one of the major causes of deterioration of meat, even during cold storage, is lipid oxidation which ultimately results in unacceptable flavour, odours and fatty acids, fat soluble vitamins and pigments. There is also concern about the production of peroxides and aldehydes and the formation of 'free radicals' which produce harmful chemical products.

Lipid oxidation is therefore a major cause of deterioration in the quality of meat. It also influences the yield of saleable meat, since the disruption of the sub-cellular membrane destroys the integrity of the cell wall, releasing intracellular fluid. This results in considerable fluid or drip loss, a major problem and economic loss in both poultry and pork. It is therefore beneficial to reduce both the occurrence and rate of lipid oxidation.

The role of vitamin E and Selenium as antioxidant is recognized and feeding of high dietary levels to both pig and poultry has improved meat quality by reducing the rate of lipid oxidation and maintaining the integrity of the cell membrane post-slaughter. This resulted in the meat keeping its fresh appearance and colour for longer, as well as reduced drip loss, allowing better presentation of both poultry and pork.

Stress

The most effective way to reduce the incidence of poor pork quality is to improve pre-slaughter management and handling and thereby reduce stress. Stress both during transportation and pre-slaughter can affect meat quality, since it can influence the rate and extent of post-mortem acidification in the muscle. If stress is induced over a long period, then muscle glycogen is depleted and dark, firm and dry (DFD) meat may result. Similarly, if the stress occurs immediately before or at slaughter, then the rate glycolysis is increased at a time when carcass temperature is high, resulting in PSE meat. Chromium has been recognized as an element which can assist animal to better tolerate stress, therefore reducing stress occurrence in animals, especially the organic form and minimizing the incidence of both PSE and DFD-type meat.

Effects of Feeding

The supply of nutrients to animals, influence carcass composition since it directly affects growth rate as well as the proportion of protein and fat in the body. The higher the level of feeding, the higher the rate of lean and fat gain, therefore the higher the eating quality of the meat. it has also been proved that the quality and type of raw ingredients included in the diets rather than the feeding levels per-se was response for the effects.

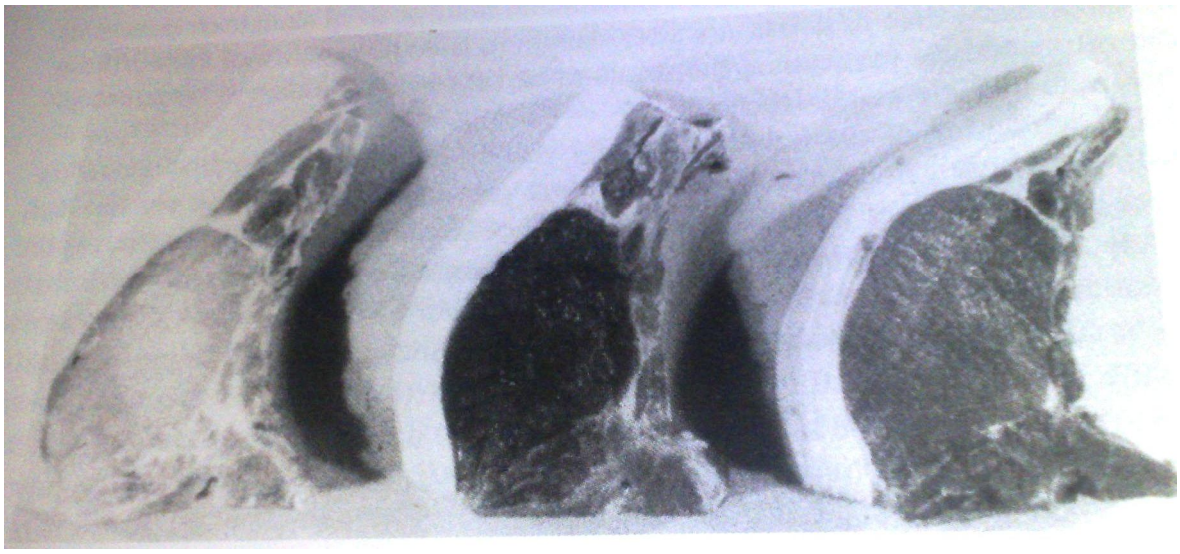


Figure 1: Pale, Dark and normal meat

MEAT PRESERVATION

Meat gets putrefied due to the action of bacteria, moulds and yeasts. In an effort to get nourishment from the meat after the meat alter the meat in various ways. To grow they require favourable temperature. It is therefore customary to classify organisms according to their temperature tolerance:

1. *Psychrophiles* which have an optimum temperature range of -2^{o}C to 7^{o}C.
2. *Mesophiles* which have an optimum temperature range of 10^{o}C to 40^{o}C
3. *Thermophiles* which have an optimum temperature range of 43^{o}C to 66^{o}C.

One can them preserve meat by reaching -2^{O}C (sub optimal temp.) by chilling or freezing and 66^{O}C (super optimal temp.) by pasteurizing, cooking or sterilizing. Organisms also need water for growth and so it is possible to preserve meat by dehydration, freezing or curing.

Organisms cause spoilage by:

- Disintegrating the connective tissue
- Producing gases as hydrogen sulphide, carbon dioxide, ammonia etc.
- Fermenting the muscle sugar (glycogen) to produce acetic and butyric acids, causing offensive smell and tastes.
- Discolouration of the meat by changing the myoglobin

Preservation by Cold

It is the simplest form of meat preservation. And it can be done for long time. This because bacteria are unable to multiple at low temperature and due mainly to the fact that water is changed to ice.

1. Chilling meat: It is useful when meat will be preserved for only 35days. It loses very little in appearance, nutritive value and taste. It is kept between -1.4^{o}C and 1^{o}C, preferably in the dark as light has the effect of oxidizing fats. The atmosphere should be kept dry. A concentration of 5% to 10% carbon dioxide helps to prevent the growth of mould and bacteria. Meats under this condition require more space as they will need to be hung on hooks to allow for adequate air circulation around them.
2. Freezing of meat: Temperature for ordinary freezing vary between -18^{O}C and -5^{O}C. This can be kept for a long time. Frozen Beef can be stored for 12 months, veal slightly less, mutton and lamb 8 months and pork 6 months without much deterioration. Frozen meat stored too long become dry, less palatable and rancid. It is less durable after thawing than fresh killed or chilled meat. Slow freezing or blast freezing can be used.

Preservation by Drying

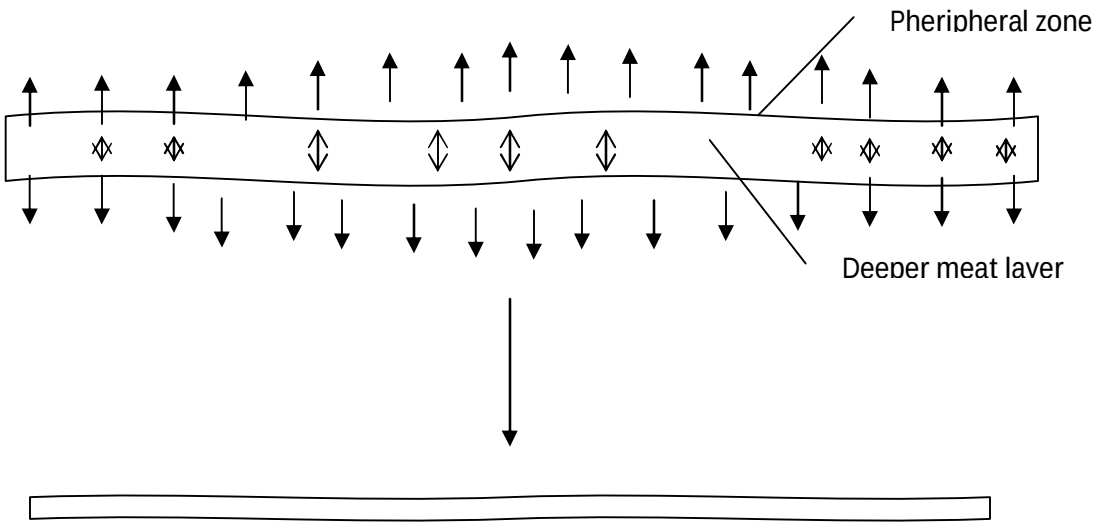
Temperature, humidity and circulation of air are the key factors in drying of meat. Gradual dehydration of meat cut to specific uniform shape that permits the equal and simultaneous drying of whole batches of meat. The optimal conditions for a successful and easy drying of meat are:

- Relative humidity of 30%
- Warm and dry air
- Small temperature difference between night and day.

Drying will be faster under high temperatures, low humidity and intensive air circulation. Relatively, there is high water evaporation in the first day of drying, after which evaporation rate continually decreases. As the meat dries it becomes smaller, thinner, thinner and to some degree wrinkled. Consistency also changes from soft to firm and hard.

Important Steps in Meat Drying:

i) slaughtering of the animal ii) carcass trimming iii) selection of the raw materials iv) proper cutting and pre-treatment of the pieces v) proper arrangement of drying facilities vi) Influence of unfavourable weather must be considered in order avoid quality problem or production losses



The secret of correct meat drying lies in maintaining a balance between water evaporation on the meat surface and migration of water from the deeper layers. In other words, care must be taken that meat surfaces do not become too dry while there is still high moisture content inside the meat pieces. Dry surfaces inhibit the further evaporation of moisture, which may result in products not uniformly dried and in microbiological spoilage starting from the areas where the moisture content remains too high.

Selection of Meat for Drying

Lean meats without visible fat tissues adhering to muscle are suitable for drying.

- Bovine meat, sheep, cameloids, goats and venison (e.g antilopes, dear etc.) are also used.
- Meat from medium aged animal, in good condition and not fat.
- Meat must be examined for undesirable alterations as discolouration, haemorrhagic spots, off-flavour, manifestation of parasites etc. Such defects must be trimmed off.

Techniques of Cutting Meat Pieces for Drying

Cutting muscle into thin strips can be done in two ways:

- Cutting after placing meat on clean chopping board (Fig 1)
- Cutting the muscle in hanging position (Fig 2)

In both cases the muscles have to be split exactly along the muscle fibres. The strips must be cut as uniformly and as smoothly as possible and the diameter of the strip must remain the same throughout the length. The length of the strips may differ, though it should not be less than 20 cm and not more than 70 cm. Meat cut into shorter strips requires considerably more time for hooking than the same quantity cut into longer strips. However, strips which are too long may break because of their weight.

Figure 2: Cutting meat streeps from the muscle on a chopping board.

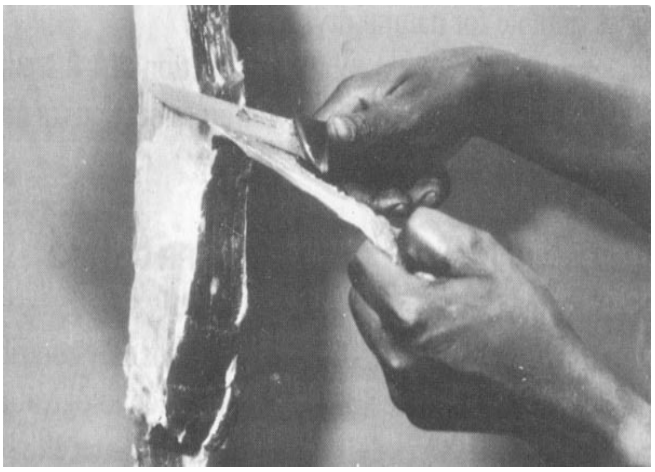


Figure 3: Cutting meat streeps from a suspended muscle.

Recommended Treatment before Drying

Pre-salting: the use of a 14% salt solution is preferred. It is bactericidal in action and also protect against insect during drying. The necessary amount of edible salt is added to water and dissolved by intensive stirring, the meat strips are dipped into solution, soaked for about five minutes and then drained. Draining can be done using plastic sieve. To make 14% of salt solution below are the volumes of water to the weight of salt:

Water (l)	**Salt (g)**
5	810
6	975
7	1140
10	1630

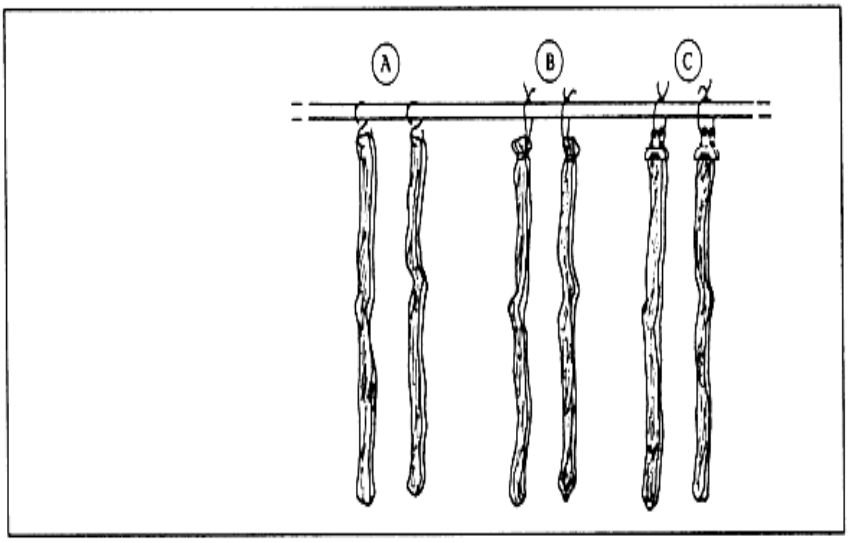


Figure 4: Suspension of meat strips on hooks (A), loops (B), and by means of clips (C).

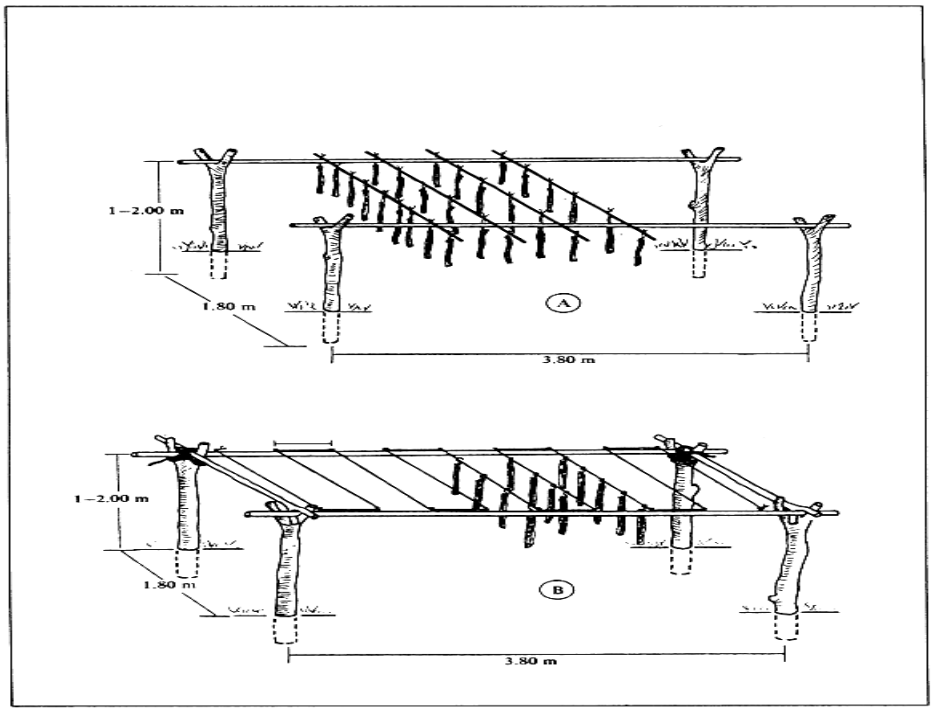


Figure 5: Sun meat dryer made of wood or metal (A and B)

Methods of suspending of meat strips for drying

Meat should be suspended individually from one end, thus ensuring, through arrangement on the drying facility, free air circulation along the whole length of the pieces and fat and uniform drying. The contact of meat pieces with each other must be avoided.

The suspension of meat strips can be done in different ways (Figure 4):

- ✓ Suspension using metal hooks
- ✓ Suspension using loops
- ✓ Suspension using metal clips

Installation for drying entire batches of meat

- ✓ Sun meat dryer made of wood or metal
- ✓ Mobile meat dryer
- ✓ Meat dryer with protection against extreme influence e.g. roof type or normal with protection.

Quality of the final products

- ✓ Appearance: absence of large wrinkles and notches indicate uniform dehydration of meat
- ✓ Colour: the surface and crosscut should be uniform and dark red.
- ✓ Taste and flavour: mild salty taste when spices are not added. No off-flavour. Some rancid flavour might occur.

Dried meat must be continuously examined for spoilage-related off-odour, which is the result of incorrect preparation and/or drying of the meat. Meat with signs of deterioration must be rigorously sorted out.

Packaging and Storage

This serves to protect against contamination. Paper, plastic foils, aluminium foils, cellophane and textiles. Vacuum packaging gives longer shelf-life. Cardboard can be used. Prevention of wet condition setting in order to prevent bacteria and mould under storage is important.