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## **Meat and Ante – mortem examination of meat**

Welcome to the session on food technology. In today's lecture we are going to learn about meat and ante – mortem examination of meat.

By the end of today's lesson you will be able to understand the following concepts:

1. Meat and its properties
2. Antemortem examination of meat and its objectives
3. Postmortem inspection
4. Carcass judgement
5. Hazard Analysis Critical Control Point (HACCP)

### **1. Introduction**

India's total meat production is estimated at 5.8 million tones. Buffalo in India contributes about 30% of total meat production. The contribution by cattle, sheep, goats and poultry is 30%, 5%, 10%, 10.2% and 11.5% respectively. Livestock sector essentially plays an important role in the welfare of India's rural population. Livestock sector contributes 9% to Gross Domestic Product (GDP) and generates about 8% employment of the labour force. This sector is fast emerging as an important growth leverage of the Indian economy. In the recent years, livestock output has grown at a rate of about 5% per year, which is actually higher when compared to the growth of the agricultural sector.

#### **1. Meat**

Meat has long been considered as a highly desirable and nutritious food. Unfortunately, it is also highly perishable because it provides the nutrients needed to support the growth of many types of microorganisms.

#### **Relevant properties of meat**

##### **a. pH**

In the living animal, muscle is neutral in reaction. Once the animal dies, the muscle pH becomes more acidic in nature i.e the pH falls below 7. This is due to the conversion of carbohydrates such as glycogen, glucose (which are the energy reservoirs of the muscle) to lactic acid via a biochemical process termed as glycolysis. The higher the amount of glycogen in the muscle, greater is the amount of lactic acid formed. A concentration of about 1% is sufficient to result in the production of lactic acid to bring down the pH to about 5.5. In case of unstressed animals, the normal ultimate pH of muscle is in the range 5.5 – 5.7 and muscle of this pH has a normal appearance and texture. In cases where the muscle was depleted of glycogen before death, the pH fall will be much less. Meat which has a pH of 6 or

higher will have significantly different properties such as darker colour, firmer and drier meat (DFD meat). Spoilage bacteria will grow rapidly in meat of high pH.

#### **b. Exudate**

When meat is stored, a liquid known as weep exudates from it. Excess weep is undesirable as it detracts the visual appearance of the meat and results in effective loss of the product. The volume of weep can be influenced by a variety of factors such as area of cut surface of the muscle and storage temperature. The most important factor being pH because high pH favours water retention and less exudates is produced.

#### **c. Freezing point**

Water in meat is made of a solution of salts which begins to freeze at  $-1.5^{\circ}\text{C}$  in contrast to pure water which freezes at  $0^{\circ}\text{C}$ . The optimum storage life of non – frozen fresh meats is achieved at  $-1^{\circ}\text{C}$ . At this temperature, bacterial growth is extremely slow and the biochemical changes which occur during storage occur at a minimum rate.

### **Factors affecting the growth of microorganisms on meat**

Several environmental factors play a major role in influencing the growth of microorganisms on meat. Some of the important factors are as follows:

#### **a. Temperature**

Growth rates at  $0 - 1^{\circ}\text{C}$  are only about half of those at  $5^{\circ}\text{C}$  and are further reduced as temperature falls. A storage temperature which can be maintained as low as possible should be practiced, keeping in mind the product and circumstances. Usually, a temperature of  $-1^{\circ}\text{C}$  is optimal.

#### **b. Gas atmosphere**

In the presence of carbon dioxide, the growth of certain types of microorganisms is inhibited. This happens in the absence of oxygen as well. This is usually by the manipulation of the redox potential. Nitrogen is inert in terms of microbial growth.

#### **c. Water activity ( $a_w$ )**

Water is essential for the growth of microorganisms. As water content is reduced, growth rates get reduced. Water activity is the term used to specify the amount of water that is available or “active” in a food i.e water which is not chemically bound. The water activity in carcass meat is 0.99. The minimum water activities at which important spoilage and pathogenic microorganisms can grow is given in the table below:

Table 1. Minimum water activities supporting the growth of microorganisms under aerobic conditions

Water activity	Micoorganism
0.96	<i>Pseudomonas</i>
0.95	<i>Clostridium botulinum</i> <i>Enterobacteriaceae</i> ( <i>Enterobacter</i> , <i>Escherichia</i> , <i>Salmonella</i> )
0.94	<i>Brochothrix thermosphacta</i>
0.93	<i>Lactobacillus</i> <i>Streptococcus</i>
0.91	<i>Staphylococcus</i>
0.91	<i>Pediococcus</i> , <i>Micrococcus</i> , <i>Lactobacillus</i> (few strains)
0.87	<i>Yeasts</i>
0.85	<i>Penicillium</i>
0.65	<i>Aspergillus</i>

#### d. pH

Most of the microorganisms can grow in a pH range of 5.4 – 7.0. This factor becomes important coupled with the others. For example, if lean red meat is placed in an environment where oxygen is no longer available, the composition of the flora which will grow is largely influenced by the muscle pH.

#### e. Other microorganisms

Certain species of microorganisms are capable of inhibiting the growth of others. This can happen actively, by the production of antibiotic like compounds or toxic metabolites or passively by the competition for nutrients.

#### f. Chemical inhibitors

In the case of processed meats, the addition of certain ingredients to meat results in a modification of the microbial flora present. For instance, the concentration of salt used in processed meats is usually high enough to prevent the growth of *Pseudomonas* species and the level of sodium nitrite used in curing reduces the growth of certain spoilage microorganism species.

The interaction of factors as discussed above may be synergistic i.e act in combination with one another. For example, pH and gas atmosphere. Overall, good control of temperature remains the factor of prime importance for the storage of meats which are not shelf – stable.

## 2. Antemortem examination of meat

## **Major objectives of antemortem examination**

Some of the major objectives of antemortem examination of meat are as listed below:

- To screen all the animals which are to be slaughtered
- To make sure that the animals are properly rested and to obtain proper clinical information which will assist disease diagnosis
- To check contamination on the killing floor by separating dirty animals and condemning the diseased animals if required by regulation
- To ensure that injured animals or those suffering from any kind of pain receive emergency slaughter and that animals are treated humanely
- To identify reportable animal diseases to prevent killing floor contamination
- To identify sick animals and those being treated with antibiotics, chemotherapeutic agents, insecticides and pesticides
- To ensure the cleaning and disinfection of trucks which are used for the transportation of livestock

Both sides of an animal should be examined i.e at rest as well as in motion. Antemortem examination should be carried out within 24 hours of slaughter and repeated if slaughter has been delayed over a day.

Antemortem examination should be carried out in adequate lighting where the animals can be observed both collectively and individually at rest and motion. The general behavior of animals should be observed. Also, their nutritional status, cleanliness, signs of diseases and abnormalities should be checked. Some of the abnormalities which are checked on antemortem examination include:

1. Abnormalities in respiration
2. Change in behavior
3. Abnormalities in gait and posture
4. Abnormalities in structure and conformation
5. Abnormal discharges or protrusions from body openings
6. Abnormal colour and odour

Abnormalities in respiration commonly refer to frequency of respiration. If the breathing pattern is different from normal the animal should be segregated as a suspect.

Abnormalities in behavior are manifested by one or more signs such as the animal may be walking in circles or show an abnormal gait or posture. It may be pushing its head against a wall, charging at various objects and act aggressively, show a dull and anxious expression in the eyes. An abnormal gait in an animal is associated with pain in the legs, chest or abdomen or is an indication of nervous disease.

Abnormalities in structure (conformation) are manifested by:

1. Swellings or abscesses
2. Enlarged joints

3. Umbilical swelling which is associated with hernia or omphalophlebitis
4. Enlarged sensitive udder indicative of mastitis
5. Enlarged jaw which is often called “lumpy jaw”
6. Bloated abdomen

Some examples of abnormal discharges from the body include discharges from the nose, excessive saliva from the mouth, protrusions from the vulva, intestine, rectum, uterus, vagina, growths on the eye and bloody diarrhea. Abnormal colour such as black areas on horses and swine, red areas on light coloured skin which is inflammation, dark blue areas on the skin or udder (gangrene).

An abnormal odour is usually difficult to detect under a routine antemortem examination. The odour of an abscess, a medicinal odour, stinkweed odour or an acetone odour of ketosis may be observed. Since most abattoirs in developing countries do not have accommodation station for animals, the inspector's have to perform antemortem examination at the admission of slaughter animals.

### **3. Postmortem inspection**

Routine postmortem examination of a carcass needs to be carried out as soon as possible once the dressing is completed so that any abnormalities can be detected. This facilitates the products to be conditionally fit in for human consumption. All organs and carcass portions should be kept together and correlated for inspection before they are removed from the slaughter floor. Postmortem inspection should give all the relevant information which is needed for the scientific evaluation of pathological lesions pertinent to the wholesomeness of meat. The following criteria should be considered:

1. Viewing, incision, palpation and olfaction techniques
2. Classifying the lesions into two types – acute or chronic
3. To classify whether the condition is localized or generalized and also to assess the extent of systemic changes in other organs or tissues
4. To determine the significance of primary and systemic pathological lesions and their relevance to the major organs and systems, particularly the liver, kidneys, heart, spleen and lymphatic system.
5. Coordinating the components of antemortem and postmortem findings to make a final diagnosis
6. Submitting the samples to the laboratory for diagnostic support, if in case abattoir has holding and refrigeration facilities for carcass under detention.

### **4. Carcass judgment**

Trimming or condemnation may involve:

1. Any portion of a carcass or a carcass which is abnormal or diseased
2. A portion or the whole carcass being infected with a condition that may present a hazard to human health

3. A portion or the whole carcass that may be repulsive to the customer

### **Localized versus generalized conditions**

In a localized condition, a lesion is restricted by the animal defense mechanisms to a certain area or organ. Systemic changes associated with a localized condition may also occur. For example, jaundice caused by liver infection or toxemia following pyometra which is an abscess happening in the uterus.

In a generalized condition, the defense mechanism of the animal is not able to stop the progression of the disease by way of its circulatory or lymphatic systems. The lymph nodes of the carcass has to be examined if pathological lesions are generalized. Some of the signs of a generalized disease include:

1. Generalized inflammation of lymph nodes including the lymph nodes of the head, viscera.
2. Inflammation of joints
3. Lesions in different organs such as liver, spleen, kidneys and heart
4. The presence of multiple abscesses in different portions of the carcass

Generalized lesions usually require more severe and careful judgement than localized lesions.

### **Acute versus chronic conditions**

An acute condition implies that a lesion has developed over a period of few days, whereas a chronic condition refers to the development of lesions over a period of some weeks, months or even years.

The acute condition is characterized by the inflammation of different organs and tissues, enlarged haemorrhagic lymph nodes and haemorrhage of the mucosal and serous membranes and different organs like the heart, kidney and liver. An acute infection progresses in parallel with generalized disease complex, when an acute infection tends to overcome the animal's immune system and become generalized.

Each of the cases which show systemic lesions should be individually assessed taking into consideration the significance of these lesions towards major organ systems, especially the liver, kidneys, heart, spleen and lymphatic system as well as the general condition of the carcass.

### **Guidelines for minimum antemortem inspection requirements**

1. Except in sheep and goats, the bronchi should be opened up by a transverse incision across the diaphragmatic lobes.
2. The entire gall bladder should be viewed. For cattle over 6 weeks of age, incise as deemed appropriate should be done to detect liver flukes.
3. Kidneys and uterus has to be viewed and checked

The above guidelines can be made more or less intensive depending on the outcome of the examination. In general, the carcass is examined to determine any signs of disease or defect. Attention has to be paid to the bodily condition, efficiency of bleeding, colour, condition of serous membranes (pleura and peritoneum), cleanliness and presence of any unusual odours.

## **5. HAZARD ANALYSIS CRITICAL CONTROL POINT (HACCP) CONCEPT IN MEAT INSPECTION**

A specific HACCP concept tailored to each abattoir and the class of animal should be developed to ensure the most efficient and effective concept of sanitary control.

The introduction of specific HACCP concept involves the following:

- a. identifying hygienic hazards
- b. ranking these hazards
- c. defining the critical limit
- d. identifying the critical control points
- e. recommending necessary control
- f. record keeping
- g. verification procedures to ensure efficiency
- h. tests to ensure that the concept is working

The Hazard Analysis Critical Control Point (HACCP) Concept was introduced in the food industry in 1971 to ensure that there would be effective control of the quality of processed foods. The World Health Organization (WHO) recommends that this concept also be applied to Meat Inspection and Meat Hygiene in particular to control Salmonellosis. It can also be used to reduce bacterial contamination during slaughtering and dressing and to ensure quality control in Meat Inspection.

Meat Inspection and Meat Hygiene shall make sure that meat and meat products are safe and wholesome for human consumption. The practise of meat inspection has gradually changed over the last three decades. The classical antemortem and postmortem procedures were designed to detect disease in an animal before slaughter and the lesions produced by the disease after slaughter respectively. This was done by the use of senses (organoleptic tests) such as the use of touch (palpation), sight (inspection and observation), smell (gangrenous smell) and taste (only in cooked products). Zoonotic diseases, particularly tuberculosis received high priority. Laboratory tests were done to confirm the disease when necessary or as appropriate.

With the gradual reduction in the incidence of animal tuberculosis in many countries along with the development of intensive methods of animal husbandry and the widespread use of pesticides and veterinary drugs, new problems are emerging. These are associated with residues on one hand and increased human infections with zoonotic agents contaminating animal foods on the other. There appears to be a general trend worldwide, with a few exceptions where human Salmonella infections have nearly doubled during the last five year period and human Campylobacter infections have nearly tripled during the same period.

Other bacteria that are causing increasing concern as food contaminants are Yersinia spp. and Listeria species. There is simultaneously a greater consumer expectation of a longer shelf life

in the finished fresh meat product. All these factors suggest that in the practise of meat inspection, it would be advantageous to use the HACCP concept to identify the critical control points at which these bacterial groups and other spoilage organisms may contaminate the carcasses, so that appropriate action can be taken.

During red meat production, major contamination occurs in the abattoir during skinning and evisceration, that some contamination could occur during transport, lairage and deboning and that the most effective control point is in the chiller. Therefore, it is absolutely essential for meat inspectors to ensure that skinning and evisceration are done properly. The critical control points during the slaughter of poultry are picking and evisceration. In developing countries where these tasks are not automated, it is necessary to ensure that proper hygienic precautions are taken during each of these operations. In automated plants, the machinery for picking and evisceration would need to be sanitised regularly, in particular when birds from different sources are slaughtered.

## **Conclusion**

Meat has long been considered as a highly desirable and nutritious food. Unfortunately, it is also highly perishable because it provides the nutrients needed to support the growth of many types of microorganisms.

The main objective of antemortem examination of meat are twofold:

- a. To ensure that only healthy, physiologically normal animals are slaughtered for human consumption and that abnormal animals are separated and dealt with accordingly.
- b. To ensure that meat from animals is free from any form of disease, wholesome and poses no risk to human health

These objectives are achieved by antemortem inspection procedures and by hygienic dressing with minimum contamination. Whenever appropriate the Hazard Analysis Critical Control Point (HACCP) principles should be implemented and followed. The inspection procedures should be appropriate to the spectrum and prevalence of diseases and defects present in the particular class of livestock being inspected using the principles of risk assessment.