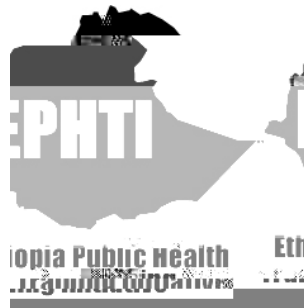


LECTURE NOTES

For Environmental Health Students

Food Hygiene Part II



Alemayehu Woldecherkos
Mezgebu Yitayal

University of Gondar

In collaboration with the Ethiopia Public Health Training Initiative, The Carter Center,
the Ethiopia Ministry of Health, and the Ethiopia Ministry of Education

May 2003

3.3.1. Traditional animal slaughtering	65
3.3.2. Main features of slaughterhouses	67
3.3.3 Transport of livestock	76
3.3.4 Essentials of slaughter.....	76
3.4. Methods of inspection.....	80
3.4.1. Ante mortem inspection.....	81
3.4.2. Post-mortem inspection.....	82
Review Questions.....	84

Chapter Four: Meat-borne Diseases

Objectives.....	85
Introduction.....	85
4.1. Bacterial diseases	86
4.2. Viral diseases	93
4.3. Parasitic diseases.....	97
4.4. Fungal diseases	97
Review Questions.....	102

References

LIST OF TABLES

Table 1.1: Percentage composition of milk of different food animals.....	9
Table 3.1: Comparative anatomy of different meat animals.....	49
Table 3.2: The vertebrae of different food animals.....	51
Table 3.3: Main differential features of the tongues of food animals.....	58
Table 3.4: The intestines of the different food animals.....	59
Table 3.5: The differential features of the liver of food animals.....	60
Table 3.6: The differential features of the p-12. Tw(4.t22 /eferences)Tj/T ii1 22o-.0003 Tc.0025 Tw	

DEFINITIONS

Adulteration of milk: This is the adding of water or extracting the fat by removing the cream.

Milk fat: This refers to the pure fat which consists of glycerol and fatty acids.

PH: This is the hydrogen ion concentration of milk.

Raw Milk: This is a secretion produced by all mammals before it has been altered to into any other form.

Cholesterol: This is an alcoholic compound of complex structure that, in milk, is mostly found in the fat globules.

Lactation: This is the giving of milk by mammals.

Lobster: This is a hard shelled animal that lives on the bottom of the ocean near the shore.

Specific gravity of milk: This is related to its density. It is found by dividing the density of the substance by the density of water at either 4⁰C (39 °F) or 20 °c (68 OF).

Mammary glands: These are special glands found in all mammals. In female mammals the mammary glands produce milk.

PREFACE

Food hygiene is a subject of wide scope. It aims to study methods for the production, preparation and presentation of foods that are safe and that are of good keeping quality. It covers not only the proper handling of many varieties of foodstuff and drink but also all the utensils and apparatus used in their preparation, service and consumption. It also covers the care and treatment of foods known to be contaminated with food poisoning bacteria which may have originated from the animal host supplying the food.

Food should be nourishing and attractive. It must be visibly clean and it must also be free from noxious materials. These harmful substances may be poisonous chemicals and even chemicals that can be harmless in small amounts but damaging in large quantities. They may enter the food accidentally during growth, cultivation or preparation, or they may accumulate in the food during storage in metal containers. Harmful substances may also form in the food through the interaction of chemical components, or, accumulate in the food during storage in metal, chemical, components. They may also be concentrated from the natural components of the food. Micro-organisms (germs) may be introduced directly from infected food animals or, during food preparation, from workers, other foods or the environment. Poisonous substances may be produced by the growth of bacteria and moulds in food.

Towards the end of the Nineteenth century the danger of infection from milk was recognized and in cities such as London the heat treatment of milk by pasteurization began. Pasteurization kills many bacteria in the milk, including those that are harmful. Incidents of tuberculosis infection from raw milk are no longer seen in the UK because of pasteurization and also because the infection of cows has been eliminated. The eradication of brucellosis in cattle has similarly reduced the incidence of undulant fever. Food poisoning or food borne infection from organisms such as the salmonellae and campylobacter still occur from “untreated” milk and from imperfectly heat-treated milk.

This lecture has been written for those environmental health professionals engaged in food handling or quality and safety inspection. It has been written, with the propose of simply explaining the nature of these various dangers, how they arise and how some of them can be prevented, specifically in relation to meat, milk, egg and fish hygiene control.

Thus we, the authors, believe that this lecture note will be helpful for environmental health students and other health sciences students, for teachers in the higher education and for all health professionals especially for environmental health professional who are engaged in different sectors.

ACKNOWLEDGEMENT

Our deepest gratitude goes to the Carter Center for financial aid and for the facilitation of the lecture note review in collaboration with Dilla College of Teachers' Education and Health Sciences, Faculty of Health Sciences.

Our special thanks also goes to the external reviewers, Mr. Nega Baraki from Alemaya University, Mr. Mamo Wubshet from Gondar University College and Mr. Hailu Endale from Jimma University, as well as the peer reviewers, Mr. Atsnaf Melaku and Mr. Sileshi Behailu, without whom the preparation of this lecture note would have remained in vain.

Lastly, we are thankful to Dr. Zelalem Kebede for his facilitation and provision of the necessary logistics and W/ro Zinash Ayalew for the typing of this lecture note.

UNIT ONE

Milk Hygiene

Objectives

At the end of the course, the students will be able to:

- Define milk
- Identify the chemical composition and physical properties of milk
- Identify milk products
- Identify diseases due to milk consumption
- Explain the sanitary practices and hygienic production of milk
- Explain how to make milk safe
- Elaborate the different types of laboratory examination of milk

1.1 Introduction

Milk is the first natural food of all young mammals during the period immediately after birth. The public health experts have defined milk as to be “the lacteal secretion of the mammary glands of a mammal, practically free from cholesterol, obtained by the complete milking of one or more healthy cows which contains not less than 8.25% milk solids-not-fat, and less than 3.25% milk fat.”

The public health reasons for the terms included in this definition are as follows: The food value of milk depends upon its milk fat and milk solids-not-fat content. If either of these contents is reduced to below

the range for normal market milk, the proteins, carbohydrates, minerals and certain vitamins are also reduced.

Practical experience shows that 3.25% of milk fat and 8.25% of solids-not-fat are a reasonable minimum for mixed herd milk. Cholesterol tends to produce intestinal disturbances in children. For this reason, milk obtained within 15 days before and 5 days after calving, the period during which cholesterol is produced, should be excluded.

1.2 Chemical composition of Milk

Milk is a complete food. It is the most nearly perfect food. It is not 'the' perfect food because it is not an entirely dependable source of all vitamins (vitamins C and D) nor does it contain sufficient iron. Why milk deserves this reputation is that it is the one food specifically prepared by nature for the young of mammals.

The composition of milk is extremely complex, consisting chiefly of water, protein in colloidal suspension, lactose and fats in emulsion, inorganic salts in solution, vitamins, enzymes, gases and other substances.

Table 1:1 Percentage composition of milk of different food animals.

Source of Milk species	Water	Fat	Lactose	Protein	Minerals
Human	87.58	3.74	6.37	2.01	0.30
Cow	87.35	3.75	4.75	3.40	0.75
Sheep	80.25	6.97	4.96	6.72	0.90
Goat	81.04	4.63	4.22	4.35	0.76
Camel	87.10	2.91	5.39	3.90	0.70
Donkey	90.12	1.37	6.25	1.78	0.48

1.2.1. Water

This is the principal constituent of milk and is the medium in which all constituents are in solution or in suspension. In some countries, such as Ethiopia, where the production and distribution of milk is not properly controlled, the adulteration of milk by the addition of water is commonly practiced.

1.2.2. Protein

Proteins are built up of amino acids in various combinations. The three principal proteins found in milk in colloidal suspension are casein, lacto albumin and lacto globulin. A complete protein contains all the essential amino acids and, therefore, has a high nutritive value, especially suited to the growth requirements of children.

Casein is a complete protein, insoluble in water and is found only in milk. It exists in milk in combination with calcium phosphate and this

combination causes precipitation. The acids in milk take the calcium from calcium phosphate and thus throw the insoluble casein out of the solution as curd. In the normal curdling or souring of milk the casein is precipitated by lactic acid produced through the action of bacteria upon lactose.

1.2.3. Lactose (Milk Sugar)

Lactose is composed of the simple sugar glucose and galactose. Lactose, like glucose, is a reducing sugar. Lactic acid bacteria present in milk readily germinates it. These bacteria produce an enzyme known as lactase which splits the lactose and ferments it into lactic acid and other products. This causes the milk to sour. Lactose by nature gives milk a sweet flavor and furnishes the body with heat and energy.

Chemically milk fat is composed of about 25 different fatty acids combined with glycerol forming a mixture of different neutral fats, such as olein, palmitin and stearin. When the fat is hydrolyzed the free fatty acids are liberated and as a result the fat becomes rancid.

Milk fat furnishes the body with heat and energy. It is rich in vitamin A and D. It also contains carotene (pro vitamin A) which gives a golden (reddish yellow) color to the milk.

The percentage of fat in milk has long been one of the standards by which milk is tested. Fat is the most variable in the constituents of milk. The amount varies with different animals and even in the same animal from time to time. A high fat standard encourages the breeding of better cows. The richness of fat in milk is more of an economic than a sanitary question.

Variations in the fat content are influenced by factors such as:

Breed of cow: Breeds producing large amounts of milk, such as Holstein, secrete milk of a lower fat content. Locally there are breeds which produce a low amount of milk but have a high fat content.

Age and health of cow: Fat content decreases due to old age and poor health.

Stage of lactation: Fat content decreases during the first 2 or 3 months of lactation.

Season of the





Enzymes are relatively unstable. High temperatures, an unfavorable pH, light, and certain chemicals tend to destroy or inactivate them.

The principal enzymes present in milk are:

- Phosphate: Acts on phosphates. It is a heat liable enzyme and is a normal constituent of raw milk. It is also important in connection with tests for the determination of proper pasteurization as it is almost completely inactivated at normal pasteurization temperatures.
- Lipase: Acts on fat or lipid.
- Lactase: Acts on lactose (milk, sugar).

Others like amylase, galactase, catalase, etc.

1.2.8. Gases

The principal gases in milk are CO_2 , O_2 and N_2 . They are introduced into the milk during the process of milking and handling.

1.3. Physical Properties of Milk

The major physical properties of milk are color, specific gravity, freezing point and boiling point. These are influenced by the composition of milk. They are also a great help in the processing and testing of milk for adulteration.

1.3.1 Color

The milk pigments influencing the color of milk are:

- Carotene (Vitamin A) of the fat in the milk that gives a golden color.
-



NB: Add 0.1 Quevenne Degree for each degree F above 60°F.

Subtract 0.1 Quevenne Degree for each degree F below 60°F

Calculation of specific gravity of milk (S.G):

$$\text{S.G} = \frac{(\text{Quevenne Lactometer reading})}{1000} + 1$$

$$= \frac{32}{1000} + 1 = 0.032 + 1$$

$$\text{S.G.} = 1.032$$

Therefore the milk is normal as its specific gravity is within the range 1.027-1.035.

Calculation of specific gravity of milk solids:

Fleischmann has proposed the following rule for calculating the specific gravity of the total solids in milk:

$$\text{S.G. milk solids} = \frac{\% \text{ of total solids}}{\% \text{ of total solids} - 100(\text{S.G of milk}-1)}$$

S.G of milk

Required: S.G. of milk solids?

Solution: S.G. of milk solids = % of total solids

% of total solids-100(S.G of milk-1)

$$\begin{aligned}
 &= \frac{12.5\%}{12.5\% - 100(1.031 - 1)} = \frac{12.5}{12.5 - 100(0.031)} \\
 &= \frac{12.5}{12.5 - 3.1} = 12.5 \qquad = \frac{12.5}{12.5 - 3.007} = \frac{1.317}{9.493} \\
 &\qquad\qquad\qquad 1.031 \qquad\qquad\qquad 1.031
 \end{aligned}$$

1.3.3. Freezing point

Pure water freezes at 0⁰_c (32⁰_F). Since the freezing point of a dissolved substance is lower than the freezing point of a solution, milk freezes at -0.55⁰_c (31.01⁰_F). As the freezing point of normal milk is constant, an increase in freezing point indicates the presence of added water in the milk. To determine whether milk is adulterated with added water, the freezing point is taken by the use of an apparatus called a “cryoscopy”. This test is highly sensitive and even a very small amount of added water is easily detected.

1.3.4 Boiling point

1.4.2. Curd

The coagulated part of milk. If milk is stands in a container for sometime at room temperature, it forms clots called curds which are contained in a clear liquid called whey.

1.4.3. Whey:

This is the watery part of milk after separation of the curd from the whole milk. It contains protein, lactose, minerals and salts.

1.4.4 Cheese

This is the clotting casein of milk. Cheese is made from separated milk or whole milk. The milk curd, after being removed from the whey, is pressed into solids and through other processes and forms cheese.

This is butter which has been heated and clarified. Butter is boiled over heat until the water is evaporated. It is then strained and ghee is produced.

1.4.7. Margarine

This is used for breakfast to spread on bread or for cooking. It is usually made from animal or vegetable fat. Milk or milk-products added to the margarine is only to give a buttery taste.

There are also some other milk products more popular with Europeans than Ethiopians:

Condensed milk: This is milk from which most of the water has been removed. The remaining part is canned or bottled and used as milk.

Sweetened condensed milk: This is milk that is evaporated after it is mixed with sugar. This type of milk stays fresh for a long time.

Evaporated condensed milk: This is also evaporated milk but with no sugar added. It is usually canned and hermetically sealed.

Condensed skimmed milk: This is milk with no cream before condensation. This is not good for infant feeding.

Ice cream: This is cream made by mixing milk products with other ingredients and then freezing them into a semi solid state. The principal ingredient of the cream is usually milk or cream flavoring and coloring materials, etc.

1.5. Milk-borne diseases

Milk is an excellent food for man but it is an ideal medium for the growth of micro-organisms. From the time milk leaves the udder of the animal, unless adequate safeguards are maintained, it may receive bacteria and other micro-organisms from the surroundings, for example the milker and other equipment used in milk processing, storage and transportation.

1.5.1. Diseases resulting from infected carriers

- Typhoid and paratyphoid fever such as salmonella typhi and salmonella aratyphi.
- Tuberculosis (human) such as mycobacterium tuberculosis.
- Epidemic diarrhea
- Diphtheria
- Scarlet fever

1.5.2. Diseases transmitted from infected cows

- Tuberculosis (bovbercul59 0 TD.0007 Tc9Tf-.459.001 Tc-.000val8857aimD.836imD.3 0 T

1.6.1. Sources of contamination

Preventive Measures

Contamination from human discharge and wastes:

- Construction of a proper waste disposal system
- Prevention of human discharge and wastes from contacting animals and milk
- Practices of good personal hygiene
- Segregation of animals from human habitation.

Contamination from air borne dust and droplets:

- Proper construction of the milking area
- Sneezing or coughing away from milking containers during milking
- Provision of clean surroundings and avoidance of dusty conditions during milking

Contamination from animal bodies, hides, udder and teats:

- Clipping, brushing, cleansing and sanitizing before milking

Milk containers (contamination from milking utensils and dirty water):

- Proper washing and storing of milking containers
- Using proper and easily cleanable utensils
- Using only safe water for washing and cleaning

Milk handlers and contamination from milkers and their clothing:

animal droppings. They should be kept free of dust and the floor should be dry, clean and fly and rodent proof. The interior and the surroundings of the barn, stable or cowshed should be kept clean and tidy. The walls, ceilings, windows and equipment should be free of filth, litter and vermin. Animal droppings and manure should be collected and disposed of properly.

Milk house or milk room

Construction

- The milk house or room (moderate size) shall
- Be provided with smooth, impervious, well graded and of good repair concrete flooring
- Be provided with smooth, of good repair and well painted walls and ceiling
- Have adequate natural and/or artificial light and adequate and a proper ventilation system
- Be provided with proper washing facilities
- Be used for no purpose other than milk house operation
- Be provided with a proper stage for milk containers and utensils
- Be provided with proper storage for of milk and cooling devices

Cleanliness

Everything within the milk house should be kept clean and tidy, free from filth and animal droppings. It should be kept free of dust and the floor should be dry, clean and fly and rodent proof.

Utensils and Equipment

Construction

All containers, utensils and equipment used in the handling, storing and transporting of milk shall:

- Be made of smooth, non- absorbent, corrosion resistant material
- Be constructed in a manner that can be easily washed and cleaned
- Be in good repair
- Be seamless and free of cracks.

Cleanliness

All utensils and equipment used shall:

- Be cleaned after each usage
- Be washed thoroughly after each usage
- Be sanitized before each usage
- Be protected from contamination and mishandling prior its usage
- Be stored free from flies and other vermin when not in use.

1.7 Hygienic production of milk

The use of correct and sanitary milking methods is an important step in protecting clean milk. Correct milking methods will reduce udder

injuries and mastitis infections, increase milk production, result in cleaner milk and reduce milk contamination.

There are two types of milking methods, namely manual (milking by hand) and mechanical (milking by milking machine).

Steps of milking milk by hand:

- Prepare all milking materials prior to milking
- Massage and wash teats and udder thoroughly with cloth or piece of towel dipped in warm water; if possible in warm bactericidal (chlorine) solution
- Draw out foremilk in strip cup squeezing a few hand squirts from each teat
- Fore milking stimulates milk flow
- Fore milking helps detect an abnormal milk resulting from a diseased or injured udder
- Before starting milking be sure that milker's hands are clean and dry
- Milking is done carefully without letting any foreign objects or vermin enter the open milking jar
- After finishing milking transfer the milk into a clean container by straining and immediately keep or store the container at a temperature of 50⁰_F (10⁰_C) or less

1.8. Methods of making milk safe

Milk as secreted by the udder cells of a healthy cow is probably sterile, i.e. it contains no micro-organisms capable either of souring the milk or causing disease. But when milk reaches its reservoir within the udder, and particularly in passing through the teat of the udder and reaching the milking pail, the risk of picking up detrious micro-organisms steadily increases.

Raw milk must undergo heat treatment to prevent not only its rapid deterioration but also any risk of its conveying disease to the consumer. Heat treatment is generally most satisfactory because it causes the minimum of change in the composition of flavors and acceptability of the milk. Effective heat treatment does not necessarily entail the destruction of all micro-organisms originally present but it accomplishes the destruction of any pathogens in the milk.

N.B. Milk produced under sanitary conditions still contains many bacteria. Therefore it must be treated properly before consumption. The most common method of treating raw milk is by applying heat. There are at least five methods of treating milk.

1.8.1. Boiling

This is the easiest and most practicable method of making milk safe in every home. As soon as raw milk is produced or delivered it should be boiled.

Boiling is raising the temperature of the milk to boiling point and maintaining the milk at this temperature for a few minutes. Then the milk should be immediately cooled. If it has to be stored the temperature should be maintained below 10⁰c. Since these may be impracticable in a home, every care should be taken to keep the milk as cool as possible> Preferably the milk should be consumed as soon as possible after cooling and not stored for an extended period of time after it has been boiled and cooled.

Boiling of milk destroys all microorganisms except the spore formers but it changes the nutritive value of milk, its flavors and palatability and appearance. However this disadvantage should be disregarded in favor of the safety of boiled milk i.e. its freedom from disease-causing microorganisms. Boiling is technically difficult to process on a large scale and is commercially uneconomical.

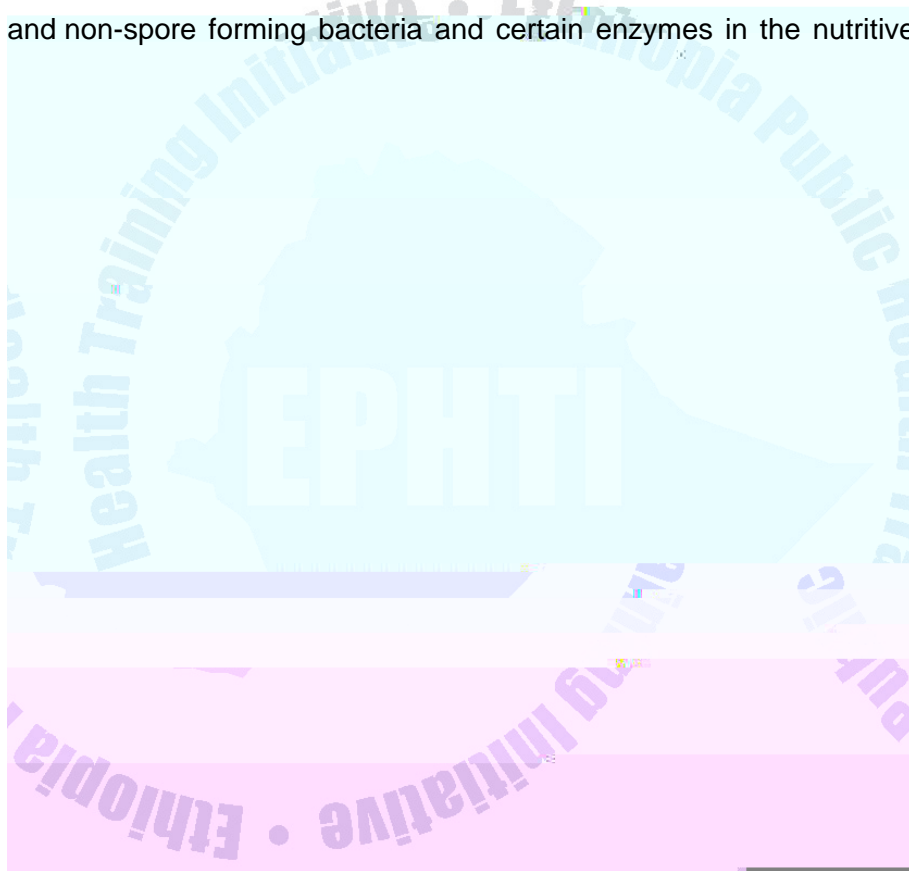
1.8.2 Pasteurization

The term pasteurization, named after Louis Pasteur (1822-1895) the famous bacteriologist, was first devised to be applied to other fluids, the main one being milk and used for controlling spoilage in wine and beer. Afterwards pasteurization became popular.

Pasteurization of milk is a universally known method of rendering raw milk safe through controlled heat treatment and can be defined as the process of heating every particle of milk and milk products to a

predetermined temperature and holding this temperature for a predetermined time.

Pasteurization of milk is not sterilization but it is a destruction of all pathogenic micro-organisms, a good number of other non-pathogenic and non-spore forming bacteria and certain enzymes in the nutritive



In the early days of milk pasteurization the first task was to determine a temperature/exposure/time point at which the most heat-resistant non-spore-forming pathogen commonly found in milk would be



The ultra-high temperature (UHT) method

In this process the milk is heated to at least 88°C (191°F), held at this



In developing countries like Ethiopia pasteurization of milk has several limitations:

- It can only be effectively done on a commercial basis
- It requires special and expensive equipment and budget
- It requires skilled technicians to operate



reason it is now being advocated that an automatic continuous flow type should be used

- An automatic milk flow stop is necessary to stop the forward flow of sub temperature milk in time when the heat source fails to provide the optimum temperature.

There are two types of automatic milk flow stops. One automatically shuts off the milk pump motor whenever the milk temperature falls below the pasteurization temperature. The other has a flow diversion valve that automatically directs the milk back to the heater whenever the temperature is too low.

1.8.3. Sterilization

In this process milk is heated to destroy all micro-organisms including spore forming and can only be done by keeping the milk at a temperature above normal boiling point (100°C or 212°F) for at least 20 minutes.

If the temperature of the heat treatment is higher and the sterilization effect is greater, there will be a more marked change in the color and taste of the milk. One important phenomenon is that with increasing temperatures spore destruction rates increase more than the influence upon the taste and the color of the milk. The nutritive value of the milk, namely some vitamins (heat sensitive vitamins) and proteins, is affected depending upon the type of the sterilization process.

1.8.4 Drying

This is a method where the entire water constituent is removed from the milk by evaporation. The solids remaining form what is called milk powder (dry milk). Milk powder can then be made into liquid milk by adding a proper amount of water. Drying is not a simple operation that can be accomplished by heating and evaporation in the home. It needs special equipment and arrangement. There are two known methods of drying.

1.8.4.1 Roller drying

The milk in small quantities is slowly poured over a heated and revolving roller. The roller is heated by steam or hot air. The heat in the roller will evaporate the water constituent of the milk. The solid parts will remain behind which will be collected and packaged.

1.8.4.2 Spray drying

This is also a mechanism whereby the milk is subjected to hot air. The process is simply spraying the milk through a current of hot air. The remaining powder will also be collected and packaged.

In both processes the milk powder is collected in sterile containers, usually cans. The cans are sealed airtight under sterile conditions, labeled and distributed to consumers in near and far away places.

1.8.5 Cooling

Since milk is an ideal medium for the multiplication of most disease-producing organisms, the milk should be kept at 50°F or below starting immediately after milking. This is very important especially if milk is going to be delivered raw to consumers. This temperature range is essentially needed to arrest the growth of micro-organisms specially brucella organisms. However milk should not be allowed to freeze.

The simplest method of cooling milk is submerging the cans of milk in troughs or tanks of ice water if possible. A trough should be concrete, preferably insulated by layers of cork or cotton pads. A 120-liter tab of water kept at 37°F will cool 40-liters milk from 85°F to 45°F, the recommended temperature.

1.9 Laboratory examination of milk

The laboratory examination of milk is done in the laboratory of the health department. The laboratory examination of milk is done in the laboratory of the health department.



- It has to be checked for its bacteriological content just after milking to see the extent of the bacterial colony
- It also has to be checked after pasteurization to see if the process has inactivated all enzymatic activities.

1.9.1. Sample taking

- If the milk is contained in bottles, one unopened bottle is enough.
- If the milk is in bulk containers it must be mixed with a sterile plunger before a sample is collected from well below the surface with a sterile dipper and poured into a sterile stopper or screw capped bottle with a capacity of about 125ml.
- Place the sample in an insulated box, label and dispatch to the laboratory.

1.9.2. Types of laboratory examination of Milk

Sediment Test

This is done in the field or laboratory. The purpose is to determine the amount of insoluble visible filth or extraneous matter in the milk.

To undertake the test: From a mixed milk sample force a measured amount of milk through a tester made of stiff cotton or pad discs measuring about 1 inch in diameter whereupon the sediment is

Interpretation: Although the amount of sediment on test discs often has little relation or no relation to the bacterial content of the milk, results of this test provide information about the care exercised during



Excellent: Very low bacterial count. Its decolorized time is about 8 hours i.e. not decolorized in 8 hours

Good: Low bacterial count. Decolorization time is 6-8 hrs i.e. decolorized in less than 8 hours but not less than 6 hours

Fair: High bacterial count. Decolorization time is below 2 hours i.e. decolorized in less than 2 hours

Poor: Very high bacterial count. Decolorization time is below 2 hours i.e. decolorized in less than 2 hours

Results of the test may be effectively used as a basis for improving the milk supplies, particularly milk intended for pasteurization. This test, combined with field investigations, serves as an effective means of correcting improper production methods and improving the general sanitary conditions of the dairy farm.

Resazurin Reduction Test

The purpose is to determine the sanitary quality of raw milk. This test is quite similar to that of the methylene blue test, except with changes in color in a very short time. This test also undergoes a series of color changes whereas methylene blue changes from blue to colorless.

In a test tube with 10ml of milk add 1/10 (0.1ml) of resazurin solution (0.05%). After mixing properly the sample is placed in a water bath or incubator at 35°C - 37°C . Observations for color changes are made at 15 minute intervals. The two most common applications of the resazurin test are:

example, if 30 colonies are counted in a Petri dish of 1/100 dilution, the SPC is $30 \times 1000 = 30,000$.

The standard is as follows:

- Raw milk: 200,000 maximum acceptance
- Pasteurized milk: 30,000 maximum acceptance. .

The interpretation of the results is based upon the fact that the bacterial population in milk serves as an index of sanitary quality i.e. a

Babcock Test (Fat Test)

The purpose is to determine the fat content of milk. After mixing well by shaking the raw milk sample, take about 17.6 cc (ml) by using a pipette and fill it into a graduated Babcock bottle. Carefully add to this bottle a 10cc. concentrated. Without delay shake it for 3 minutes and then centrifuge the bottle at 1400F. (if the milk sample is pasteurized add 7 cc more H₂SO₄ to the 10cc already filled and shake it for 1 minute.)

After centrifuging stand it for 5 minutes and add to it hot water up to the base of the neck and centrifuge for 1 minute. Take out the bottle from the centrifuge and put it on a hot water bath for sometime and do the readings.

Interpretation: The fat which rises into the graduated neck of a special Babcock bottle is measured directly with the aid of a caliper or geometrical divider, the length of the fat column from the lower surface to the highest point of the upper meniscus. Results are expressed in percent.

Fat content (%)	Quality
Below 3	Poor
3-3.25	Fair
3.25-3.50	Good
Above 3.50	Excellent



Review Questions

1. Discuss the chemical composition and physical properties of milk.
2. Mention at least four diseases due to raw milk consumption.
3. What is the difference between a sediment test and a methylene blue reduction test?
4. Discuss the various methods of milk preservation.

UNIT TWO

Egg and Fish Hygiene

Objectives

At the end of the course, the students will be able to:

- Identify the constituents of an egg
- Explain the causes of egg spoilage
- Elaborate the methods of inspection and preservation of an egg
- Identify the types, anatomy and characteristics of fish
- Identify signs of freshness and decomposition in fish
- Explain methods of inspection and the diseases of fish

2.1 Egg Hygiene

A hen's egg, although it is not a complete food for humans, is a complete food for a chicken embryo. A hen's egg weighs about 57 grams and its specific gravity (excluding the shell) is 1.048. The PH of an egg is 7.7.

An egg consists of three main parts:

The outer shell: This forms a hard protective layer that accounts for about 10% of the total weight of an egg. It is porous and allows air exchange to the growing embryo and its color is mostly white.

The egg white (inside the shell): This is a viscous colorless liquid that accounts for about 60% of the total weight of an egg and consists of protein, water, salts and vitamins.

The egg



covering by washing with water also permits the entry of micro-organisms.

Some of the common defects found in eggs are:

Black or red spots: This is when on candling an egg red and black spots are seen in an egg yolk, which was originally yellow.. If on candling the yolk is very dark the egg should be condemned.

Blood spots: This is when a drop of blood is detected in egg yolks through candling. If the spots are small, the egg can be used immediately for cooking but if stored longer it will decompose.

Fishy taste: This is usually due to feeding materials. It can be also due to improper storage. If the taste is pronounced the egg should be condemned.

Mold on shells: This is found mostly on cracked eggs. This defect is due to a poor storage system. Mold can cause quick decomposition and the egg should be condemned.

2.1.3. Egg inspection

Eggs may be examined in various ways for freshness:

the air space and any other changes within the egg. When the egg is fresh it is translucent, the yolk faintly seen and the air space is not more than a ¼ inch in depth. But when the egg is stale, dark spots or blood spots are seen within the shadow of the yolk and the air space is more than ¼ of an inch in depth.



growth of mold. The washing of eggs often does more harm than good.

2.2 Fish hygiene

Fish are cold-blooded vertebrates, that is their body temperature is close to and varies with that of atmosphere, varying considerably in size and shape. When fish are brought out of water into air they quickly perish.

Fish can be divided in two classes:

Round fish: These are swimming fish, which live at varying depth from the surface of sea and possess darkly colored dorsals but whitish ventral surfaces.

Flat fish: These live at the bottom of sea. They have asymmetrical bodies. They live on one side, usually the left, which is white, the upper side being a brownish color.

2.2.1 Types of fish

White fleshed fish: These include haddock, cod, sole, turbot and whiting.

Red fleshed fish: These include salmon and trout.

Greasy fleshed fish: These include mackerel, sprats, herrings, sardines and eels.

Shell fish: These include crabs, lobsters, oysters and mussels.

2.2.2 Anatomy of Fish

It is essential that a slight knowledge of the anatomy of fish should be gained in order to facilitate fish inspection.

Fins: Fish for their movement in water possess a number of limbs called fins:

- Dorsal fins that are situated along the back
- Ventral fins that are situated on the body
- Pectoral fins that are situated posterior to each gill and upon the shoulder.
- Anal fin that is situated underneath, near the anus.
- Caudal fin that is situated on the tail.

Skin: This is a layer of connective tissue to which scales are attached. The outer layer is called the epithelium.

Bones: A vertebral column passes down the middle of the body from the brain, long bones radiate from this column. The skull is cartilaginous and contains organs of smell and hearing. The eyes possess spherical crystalline lenses and protrude when newly caught or in water but collapse when exposed to the atmosphere.

Gills: Fish have gill flaps on each side of their heads adjacent to their jaws and opening into their pharynx.

2.2.3 Characteristics of fish



becomes soft, loose and inelastic. It is easy to press the fingers through the belly.



2.2.4 Signs of freshness and the decomposition of fish

Fresh

- I. **Eyes** - full and bright
- II. **Flesh** - firm, solid and elastic when pressed
not pit when pressed
- III. **Scales** - full and firm
- IV. **Abdominal cavity** - clean, not discolored
- V. **Gills** - clean, bright, not swollen
- VI. **Fresh fish** - will sink if placed in water.

Stale

- Eyes** - gray and sunken
- Flesh** - soft, strips form with fingers, flesh does bones, pits form when pressed with fingers
- Scales** -easily rubbed out
- Abdominal cavity** - smelling and with reddish discoloration
- Gills** - gray, brownish
slimy, swollen
- Stale fish** - floats in water

2.2.5 Inspection of fish

- Check the condition of eyes, scales and flesh of the fish
- Check if gills are firm and elastic; test with fingers if any doubt exists
- Split the fish and examine backbone for decomposition. If bone is pink or red from end of the tail towards the head, condemn/discard it
- Test the blood of the fish with the fingers; if the fish is stale there is a faint smell on the fingers
- Split down the lateral line and examine the backbone
- The abdominal cavity shows discoloration when the fish are stale.

2.2.6 Fish-borne diseases

Signs of the pox are located on muscles, skin and viscera. The flesh is soft, yellow and gelatinous and gives a bitter taste.

Action: Affected fish should be condemned /discarded.

Salmon disease (plague): This is caused by bacillus salmonis pests and affects fresh and seawater fish. Transmission is through abrasion or ulceration of the skin. Signs are the formation of white patches on sides, belly and head ulcer formation.

Action: Fish of this nature is rarely seen in a market. They are unfit for human consumption.

Furunculosis: This is caused by bacillus salmonicida and affects fish in fresh water only as seawater destroys it. Transmission is through skin contact. Signs are the formation of furriness and skin with several patches. When the tissue is affected it extends deeply into the bones. There are soft swellings, inflammation of the intestine and hemorrhages in peritoneum and liver.

Action: Fish with Furunculosis are unfit for human food and are rarely seen in a market since there is decomposition on the flesh. Fish are rapidly killed through the spread of the disease.

Tuberculosis: This is caused by tubercle bacilli and affectes fish such as cod and turbot. The signs are lupitus-like growths on skin near the tail (containing cheesy mater), soft yellow deposits in the liver, stomach and intestines.

Action: Fish are unfit for human consumption.

Parasitic diseases: These are caused by diphylobothrium latum. and affect fresh water fish. Transmission is through swallowing parasite larvae. Signs are found encysted in the muscles of fish.

Action: Fish affected with this parasite should be seized as being unfit for human food. It may be consumed if sufficiently cooked.

2.2.7 Methods of fish preservation

Refrigeration: This is when fish is properly gutted and washed, then preserved using ice or other cooling devices.

Drying: This is when fish are opened, cleaned and soaked in brine for several hours and left to dry in the open air for several days.

Smoking: This is when fish are gutted, cleaned, sprinkled with salt and hanged to be smoked with the help of a smoking fire such as saw dust or wood clippings.

Pickling: This is when a fish is gutted, cleaned and washed properly and finally placed in brine and pickled.

Salting: This is when a fish is gutted, cleaned and mixed with salt and packed into boxes or other containers.

Frying: This is when a fish is washed properly, filleted, skimmed and dipped in frying oil.

Canning: This is when a fish is gutted, cleaned and placed in brine. After it is properly prepared it is put into a can to be cooked and finally properly sealed.

Review Questions

1. Write down the constituent of an egg.
2. Discuss the different methods of egg preservation.
3. Discuss the signs of freshness and decomposition of an egg.
4. What are the diseases of fish?



UNIT THREE

Meat Hygiene

Objectives

At the end of the course, the students will be able to:

- Explain the purpose of meat hygiene.
- Identify the comparative anatomy of food animals
- Explain the main features of slaughter houses
- Elaborate methods of inspection of meat.

3.1 Purposes of meat hygiene

The primary purpose of good meat hygiene practice is:

- To prevent the transmission of animal diseases to man
- To provide safe, wholesome meat products for human consumption

The secondary purpose is an economic aspect:

- The reduction of loss of meat and its by-products
- The prevention of animal disease transmission to other domestic animals

The tertiary purpose is due to the adulteration of carcass meat, which is not required by consumers other than for food for animals:

- To prevent the sale and consumption of carcass meat, which is not demanded by consumer other than as food for animals



- Splanchnic or visceral skeleton - bones found embedded in viscera (internal organs). Example include ossacardis (bone of heart) in the heart, and hyoid bone at the base of the tongue.

Vertebral Column: The vertebral column or backbone consists of many vertebrae, which form a long fairly flexible chain extending from

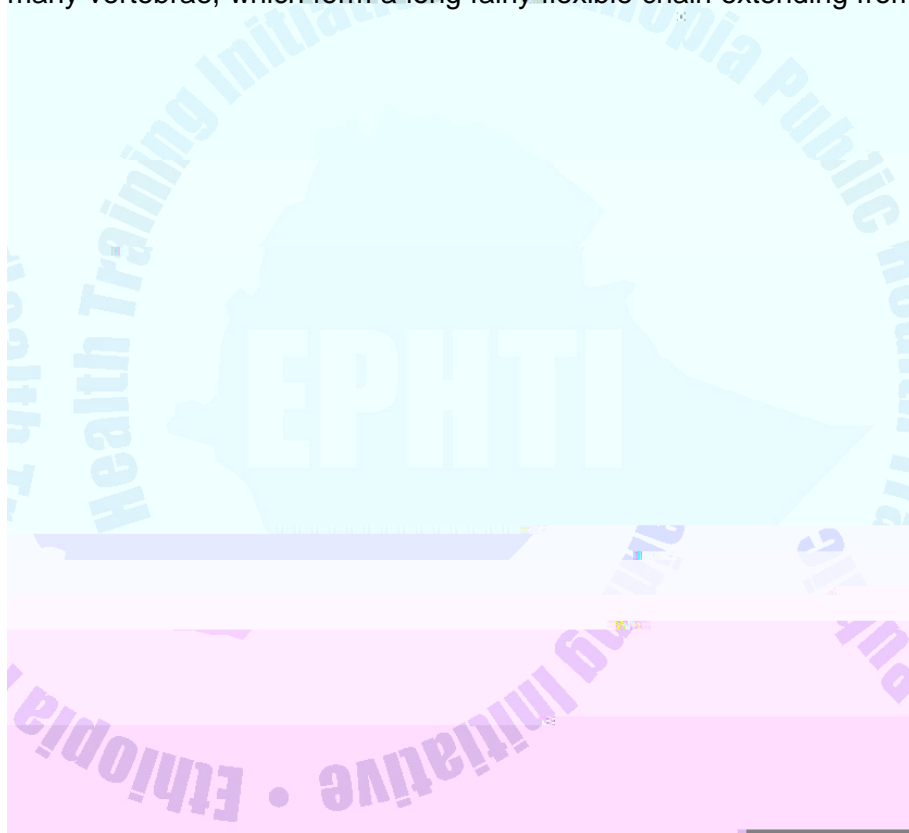


Table 3.1: Comparative anatomy of different meat animals

Ser. No	Anatomical structure	BOVINE	HORSE	SHEEP	PIG
1	Teeth	No incisors on upper jaw	6 incisors on each jaw	4 pairs of incisors on lower jaw	3 pairs of incisors and 1 pair of canines on lower jaw
2	Tongue	Thick at the base, pointed firm in texture, upper	Flattened and broad at free extremity two well marked circumvallate papillae	Thick at the base broad at the tip.	Smooth, one well defined circumvallate papillae, tip rounded.

No	structure				
4	Lungs	Left- 2 lobes Right –3 lobes	Left- to 3 lobes right- 4-5 lobes	Left to 3 lobes right-4-5 lobes	Left – 2-3 lobes, right –3 or 4 lobes
5	Liver	Usually 4 lobes, dark. No gall bladder; wt-11 lb.	Two large lobes, wt-2 lbs, bladder- present.	Two large lobes wt-2lbs Bladder- present	
6	Kidneys	Non lobulated right- heart and shaped left- long and narrow	Non- lobulated bean shaped, shorter, round.	Non-lobulated, bean shaped, shorter, round	Flat and bean- shaped
Ser. No	Anatomical structure	BOVINE	HORSE	SHEEP	PIG

7	Spleen	Long and scythe-shaped	Oyster-shaped, reddish brown, elastic	Oyster-shaped, reddish brown, elastic	Long, narrow, bright red strip.
8	Stomach	Single stomach	4 compartments	4 compartments	Round at apex-flat softer than in sheep
9	Heart	Less conical than in bovine; No bone; two grooves on exterior.	Similar to bovine but no bone, fat white and very firm	Similar to bovine but no bone, fat white and very firm	

Table 3.2: The vertebrae of different food animals

Animals	Cervical	Thoracic	Lumbar	Sacral	Coccyges
Horse	7	18	6	5	15-21
Ox	7	13	6	5	13-20
Sheep	7	13	6	5	12-20
Goat	7	13	6	5	12-20
Pig	7	14-15	7	4	18-23
Dog	7	13	7	3	20-23

Note: All those animals have seven cervical vertebral even the giraffe with its long tail has only the same number. Each of these animals has almost the same number of lumbar and sacral vertebral respectively. The number of tail vertebral varies in range, depending on the species of animals. The number of vertebral in the tail is different. The same number of vertebral in the tail is with its vertebral

The teeth are classified according to their position in the jawbones:

-

3.2.2 Sex differentiation and estimation of age

Sex characteristics of carcasses

Sex determination from an expert is important during any inspection of meat quality because of the possibility of substitution of cow's meat for that from a heifer or bullock or the substitution of ewe mutton for that of lamb. This may not be very important for day to day experience but when certain disputes arise between dealers and consumers expert judgment of the quality and type of meat can be important.

For example: Cattle or bovines can be classified into four classes: Cows, heifers, bullocks and bulls. The classification of other food animals according to sex is the same as in bovines. A sheep has four classes: Ram (tub), wither, glimmer and ewe.

1. Cattle

The cow is a female bovine after calving. After slaughtering the carcass has the following characteristics:

- The muscular development in the neck is almost completely absent
- At the udder region the removal part is obviously seen
- Supra mammary glands or a part may be left on the carcass
- Gracilis muscle is bean-shaped
- The pelvic cavity is wide And the pubic bone is thin

- Fat is irregularly distributed (scanty) and yellowish in color
- Bone size is comparatively small e.g. carpus

The heifer is the female cow before calving. After slaughtering the carcass has the following characteristics:

The muscular development around the shoulders and hindquarters is well formed

- The udder left after carcass is white, smooth and fatty
- The cartilage part is not ossified
- Fat is more evenly distributed and lighter in color
- The gracilis muscle is smaller and semicircular in shape

The Bullock or steer is castrated at an early age i.e. its testicles are removed to lessen its sexual characteristics. After slaughtering the carcass has the following characteristics:

The muscles are more developed with larger bones than the female bovines but with less development of the neck, shoulder and hindquarter as in the bull

- The scrotal fat is abundant in a larger round mass
- The root of the penis is present
- The gracilis muscle is triangular in shape
- The pelvic cavity is narrow and the pubic bone is large

The bull is a fully developed male animal. After slaughtering the carcass has the following characteristics:

- The massive muscles of the neck and shoulder are well developed
- The fleshy muscle is dark red in color with scanty fat
- The bones are relatively large
- The pubic bone is thick and strong
- The root of the penis is present and strong

2. Sheep

The ram or rup is a fully developed male sheep. After slaughtering the carcass has the following characteristics:

- Open inguinal rings
- Fat is sparse or absent
- Root of the penis is present
- Strong muscular forequarters

The wether is a castrated male. After slaughtering the carcass has the following characteristics:

- Muscle with evenly distributed fat
- Lobulated cod fat
- Root of the penis is present

The grimmer is a virgin female sheep. After slaughtering the carcass has the following characteristics:

- Characterized by its symmetrical shape
- The udder is smooth and fully fat

The ewe is a female sheep after lambing. After slaughtering the carcass has the following characteristics:

- Has a long thin neck and poor legs
- The udder is brownish and spongy
- Supra mammary node seen distinctly

Estimation of Age

By the teeth:

The method universally adapted for ascertaining the age of food animals is by the number and condition of the incisors or teeth. Dealers in cattle markets examine animals prior to purchasing by catch hold of the muzzle with one hand and pull down the lower lip with the other and by quick observation can estimate the animals' age.

The age is estimated by the period of time required for the permanent incisor teeth to erupt and come into wear. The periods of time that it

takes to wear them out are subjected to variations, depending on sex, breed and feeding habits.

In bovines the two-center incisors dropout soon after the animal reaches the age of one year and are replaced by the permanent teeth at a period of one year and nine months..

The next pair of temporary incisors is replaced by permanent teeth at the age of two years and six months. The third pair of permanent teeth attains their full size at three years and three months while the last external pair comes to be fully developed in the fourth year. In time the teeth wear out through the shrinking of the gums. The neck of the teeth are exposed with small spaces in between that indicates an animal of old age, about seven to eight years. In the other food animals such as sheep, the permanent incisor teeth attain full size as central teeth at two years and three months and as external teeth at two years and nine months.

By the bones: Another method of ascertaining the age of an animal is by the amount of cartilage present around the bones or the degree of ossification that they have. In old animals cartilage is found covering the ends of the bones at the joints. Where the teeth of the bovine animal are unavailable for inspection, the age can be estimated with reasonable accuracy by the examination of the carcass.

The ossification of cartilaginous extensions of the spines of the first five dorsal vertebral develop as the animal gets older. As the condition and degree of ossification develops showing of cartilage extension and color changes as the age of the animal increases.

By the horns: Estimation of the age of cattle by means of the horns entails counting the number of rings on the horns. The first ring appears at about 2 years and one appears every year thereafter so that the age of cattle with horns equals the number of rings present plus one.

By the flesh: In old animals the fat is scanty, the flesh is generally dark red in color and tight in texture. Muscles become tougher with age. The condition of the meat gives rise to more consumer complaints.

3.2.3 Other differential features in the skeleton

The following main differential features will help to distinguish between the different bones of animals most commonly used for food.

Carcasses of Horses and Oxen

- The spinal processes of the anterior vertebrae of the horse are shorter and stouter. They are also attached closer together and directed forwards, while in the ox they are separated and pointed slightly backwards.

- The thoracic cavity is longer in the horse. It has 13 pairs of ribs which are narrow and markedly curved whereas the ox has 13 pairs of ribs which are smoother and the lower thirds are broader.
- The scapula of the ox is more regularly triangular than that of the horse. It also has a thinner neck. There is a distinct notch in the glenoid.
- The ulna extends only half way down the radius in the horse. In the ox it is more developed and extends to articulate with the carpus.
- The fibula is rudimentary (undeveloped) in an ox, the small head of the fibula in the ox is hook-shaped, but in the horse it is separated and extends two-thirds down the length of the tibia.
- The sternum of the ox is flat and broad but in the horse it is keel-shaped or heaped.
- The pelvic bones of the ox are longer and narrower than those of the horse.
- Bones of the horse are generally more oily, the bone marrow is fatty and yellow and has an unpleasant odor. In the ox it has a fresh smell and it is firm and white in color.

Carcasses of Sheep and Goats

- The leg bones of the goat are usually slender and longer and spinous processes are also longer and more prominent than in sheep.
- The throat is barrel-shaped in sheep, but laterally flat in goats.
- The scapula of sheep is shorter and broad and the edge of the spine in the center is bent back and thick-ended, while goats possess a distinct neck and the spine is straight and narrow.
- The tails of sheep are fairly broad while they are thin in goats.

3.2.4 Differential of internal organs

Organs of the digestive system: The alimentary canal of the digestive system consists of the following consecutive segments: the mouth, the pharynx, the esophagus, the stomach and the intestines.

The tongue

The tongue is part of the mouth and is a muscular organ covered with thick, tough mucous membrane. The main differential features of the following four food animals are shown below in table 3.3

Table 3.3: Main differential features of the tongues of food animals

Features	Ox/cow	Horse	Sheep/Goat	Pig
Shape	Tip pointed	Tip spatulated	Tip round	Tip slightly pointed
Size	Large and swollen	Long and flat	Short and thick	Long and narrow
Color	Black pigment	No black spot	Pigmented	No pigment
Texture	Firm and			

2nd stomach: The Reticulum (honeycomb) has honeycomb compartments that regulates the flow of food.

3rd stomach: The Omasum (manipulus) has folds like leaves of a book and squeezes food.

4th stomach: The Abomasum (true stomach) has spiral folds that secretes gastric juices.

Horse stomach consists of a small and simple sac, sharply curved in shape. This animal has a single stomach compartment.

Pig stomach is simple, semi lunar or kidney in shape with a small pocket or diverticulum at one end. This stomach is a single compartment and white in color.

The intestine

The intestine is a long tube beginning at the pylorus in the stomach and ending at the anus. It is divided into two parts:

The small intestine is narrow and starts at the outlet of the stomach, the pylorus, and terminates at the entrance to the caecum. It is divided into two parts i).the fixed part, called the duodenum, is about 1m long ii) The menistic part, called the jejunum and ileum, is about 40 meters long.

The large intestine is greater in size and extends from the end of the ileum to the anus. It is divided into the following sections

Table 3.7: The differential features of spleen food animals

Differential features	Ox/cow	Horse	Sheep/Goat	
Color	Bluish gray	Purplish	Light brown	Saphtlyderes
Shape	Elongated oval	4-5kg	450-700 gm	1-2kg
Weight	0-9-1.5 kg	4	3	5
Hilus	Present	No gallbladder	Cigar shaped	Pear sheped
Lobes	None	None	None	None

Table 3.8: The differential features of the heart of food animals

Differential features	Ox	Horse	Sheep/Goat	Pig
Shape	Pear or conical	Blunter	Small same as ox	Broad and short
Weight	1-8-2-4 kg	4.5- 3.2 kg	80-120 gm	150-200
Ossacardis	Present	Absent	Absent and rare	Absent
Ventricular Furrows	3	2	3	2-3
Condition of fat	Well fattened, firmer and not so yellowish	Scanty, oily and yellowish	White fat and firm	Less fat, soft and greasy

Table 3.9: The differential features of the kidneys of food animals

Differential features	Ox	Horse	Sheep/Goat	Pig
Color	Reddish brown	Purplish	Dark brown	Light brown
Shape	Right k-bean Left K-3 sided	Right K. bean Left K-bean	Right and left Bean shaped	Elongated bean and flatter
Weight	280-340 gm	500-900 gm	50-80 gm	80-170 gm
Lobules	15-25	None	None	None
Renal papillae	15-25	One	One	10-12
Renal pelvis	Absent	Present	Present	Present

Respiratory system

The lungs are the central organs of the respiratory system where the exchange of gases between the blood and the air takes place. The other parts of the system are passages by which the air exchange passes to and form the lungs. The right and left lungs occupy a large part of the thoracic cavity. The differential features of the lungs helps to identify the different food animals as shown in table 3.10.

Table3.10: The differential features of the lungs of food animals

Differential features	Ox	Horse	Sheep/Goat	Pig
Trachea length	6.5 cm	75-80 cm	22-25 cm	15-20 cm
Trachea ridges	Present	Absent	Percent	Absent
Trachea rings	40-50	50-60	30-40	32-35
Lobes right	4-5	3	4	3-4
Lobes left	5	2	3	3
Accessory bronchus	Present	Absent	Present	Present
Weight	2-3 kg	2-3 kg	350-900gm	35-500 gm

position (site) of the lymph node is of great importance in meat inspection. If lymph nodes are found swollen, it is an indication of an abnormal condition in the animal body, due to diseases, bruising etc. On ingestion of these nodes various types of lesions may be found, such as tuberculosis.

The normal size of the lymph nodes varies from a pinhead to a bird's egg. The mediastinal lymph nodes of the ox may reach a length of 20 cm. In a horse the nodes are small in size and occur in large numbers, while in ruminants their number is few and are of a large size. Generally the nodes are smaller in older animals than in younger ones. The shape or form of these nodes is oval or spheroid. In texture the nodes are firm and hot soft. The color of animal lymph nodes during life is pink or reddish brown but when the animal is killed the color changes to gray or yellowish brown.

The sites of the principal lymph nodes are:

Internal lymph nodes of bovines

Protectoral glands (Lower cervical)

- Superficially lying on the entrance to the thorax, in front of the 1st ribs embedded in little fat
- Deep and lie just beneath the super facial gland, covered by a thin layer of muscle

Supra sternal glands

- Situated between the costal cartilages of the first 6 ribs near to their junction with the sternum. They are very small glands, usually embedded in fat.

Thoracic glands

- Situated just beneath the dorsal vertebrate and partly in the inter costal spaces joining the ribs with the vertebrate. These are also very small in size.

Renal glands

- Lie in the kidney hilum embedded in fat

Lumber glands

- Situated close to the lumbar vertebrae, partly covered by the lumbar muscles. These are small glands lying in series.

Iliac glands

These are two separate glands

- Internal illial gland, situated near the vertebral column and close to the external iliac gland
- Ischiatic gland, lies between the anus and other portion of the ischium, near the tail that has been removed

Supra mammary gland (in the female)

- Lies above and behind the udder, while the inguinal gland is situated in the neck of the scrotum, at the side of penis in male animals.

Pharyngeal glands (upper-femoral gland)

- Lie at the back of the pharynx, on either side. They are most easily examined after the removal of the tongue.

Sub mandibular or sub-maxillary glands

- Situated on the inner side of the mandible (jaw bone). They are usually attached to the tongue. When this organ is carefully removed it may be found attached to the tongue but may sometimes be left on the inner side of the jaw bone.

Lungs lymph nodes of Bovines

Bronchial glands

- Lie embedded in fat on either side of the tracheas, near its point of bifurcation. The left bronchial gland lies deeper than those on the side.

Mediastinal glands

- These are chains of glands that lie in mediastinal tissue between the lungs close to the esophagus.

3.3 Slaughterhouses

3.3.1 Traditional animal slaughtering

Raw meat is the most favoured food product enjoyed by many consumers in Ethiopia, in spite of its ill effects. This type of meat is

- Since it is the usual practice that all the people who attend the animal slaughter will share and eat raw meat, such as the tongue and a portion of tripe called “semer”, immediately after slaughtering they may contact tapeworm
- The stunning and slaughtering practice may be incomplete and as a result a portion of the blood may remain within the body of the animal and may lead to spoilage of the meat during storage
- The hygienic handling of meat during animal slaughter in open fields is at a minimum and the keeping quality of the meat will be affected
- The handling of meat outside the slaughterhouse may reduce some essential meat products and/or wastage of certain by-products which normally require special collection and care for further processing to be converted to valuable by-products
- The quality of hides and skins of ruminant animals that may be collected from rural and urban areas where traditional slaughter practice is undertaken are highly affected to the extent that their market value will be diminished and unacceptable for industrial production
- Above all illegal and indiscriminate animal slaughter practice in a community will create an insanitary environment that causes the breeding of flies, smell and nuisance to the nearby inhabitants.

To overcome the above and other related problems the fundamental principles of hygiene, as well as economic considerations, demand that the slaughtering of animals for human consumption be carried out in establishments especially designed and constructed for this purpose and kept under constant sanitary control.

3.3.2 Main features of slaughterhouses

The slaughterhouse or abattoir is a general term applied to an establishment engaged in killing livestock, or one or more species, for human consumption. It varies in size from the back yard of a local butcher to the great meat processing plants. In most countries slaughterhouses are either privately owned, depending on the local need, or are large premises capable of providing slaughtering accumulation for an entire city and are administered by the local authority. In Ethiopia this is the most common type of slaughterhouse.

quality control, readily available facilities for equipment cleaning and operators' locker rooms as well as special and separate rooms for the receiving of by-products, and animal lair age etc.

There are certain general principles to be considered in relation to the sanitary and economic standards for construction and operation, once the essential preliminary administrative and planning decisions have been finalized. Community involvement and acceptance in the planning stage is a prime factor with the technical approval from the health sector. Based on these the main features to be considered in the design and construction of slaughterhouses are:

Location and site

Locating will have to be decided under preliminary planning, that is from the already drafted town plan or future expansion zone areas. This should be legally approved by the designated agency who consider certain essential requirements such as the transport and supply of livestock, final product disposal system and other aesthetic factors. The prime consideration in connection with the building of any slaughterhouse is the site. The most important points to be considered in the choice of site are:-

- Accessibility by road and rail for the transportation of animals, meat and other products as well as staff workers.

- Availability of a safe and abundant water supply system preferably with a public pipe connection and on-site water storage tanks holding at least one-days consumption without interruption. The recommended water requirement is a minimum of 100 liters and a maximum of 200 liters per day per adult bovine animal
- Proper and convenient final sewage and other waste disposal area and facilities
- Accessibility to electrical power
- The slaughterhouse should be freely exposed and if possible sited in the outskirts of town
- A naturally sloping area assists both in the disposal of sewage and storm water
- Availability of adequate space for future expansion possibilities
- The immediate environment should be safeguarded from all possible alternatives that may endanger the health or safety of the inhabitants

Area and size

Depending on the need of the local community careful consideration must be given to the size of the site with future possible expansion space for buildings and vehicle movement.

The size and design of the rural slaughterhouses are standardized to meet local needs and to satisfy their operational objectives.

In such establishments a maximum 50 animals per day can be handled satisfactorily. This may occupy a plot of about one acre of land for all purposes.

The urban type of slaughter house which handles all ruminant animals and pigs, a 100-200 units per day, requires at least double the size of space in acres, while meat plants of larger capacity with a complete packing operation, occupy at least 3 times of plot size of that of a normal rural slaughterhouse.

Design and main facilities

The overall layout of the buildings of the slaughterhouse depends on the size and operational capacity that it undertakes, the environmental and climatic factors, such as prevailing winds, the land slope for both internal and external drainage systems and the handling of the by-products for useful materials with minimum nuisance.

The construction of the building parts and surfaces should fulfill the sanitary requirements that satisfy the essential housing standards.

Floors: These should be impermeable, rough finished and hard with a

permitted to allow sufficient intensity of light through the normal windows or sidewall openings to all workrooms where daylight operations are conducted; light inlet of an area approximately 25% of the floor area is recommended. However since most slaughterhouses operate during the night, it is necessary to install an efficient artificial light system to all the room and especially in those areas where maximum activity and detailed inspection techniques are required. It is generally recommended that the overall intensity should not be less than

50 foot - candles – at all inspection points

20 foot - candles – in all-purpose workrooms

10 foot - candles - in all other areas

All electrical line system should either be insulated and fixed in proper arrangement or most preferably buried inside wall lines to prevent fire, accident and human contact. In addition protective shields should be fitted to all artificial light lamps to minimize dust or insect deposits.

Ventilation: Adequate ventilation must be provided to prevent excessive heat, steam and condensation. Where possible all wall spaces and air inlets should be properly screened to prevent the entrance of insects, birds and other vermins. In case of urban type of slaughterhouses with or without meat packing processes the exchange of air should be taken either naturally through open side windows and other roof vent systems or by means of mechanical extraction fans. The efficiency of this ventilation process is

determined by the proper design and construction method. Properly installed screen mesh or doorways, well spaced for the easy

BOD to a minimum level in the effluent that finally will be absorbed into the surrounding surface area or joined with local watercourses.

Drainage: In the proper design and construction of any slaughterhouse it is vital to handle all waste products inside and outside the building. All animal waste, blood, offal content and other wash wastes should flow without interruption into the final disposal system. These drains should be closed but their size and slope should be carefully designed for their efficient operation. If these are not met the sanitary requirements will remain a nuisance and may affect the edible products. Any drainpipe of whatever material it is made of should have inspection chambers or gully traps at all possible line systems or connections. Regular inspection for maintenance and cleaning should be practiced to avoid blockages and unsightly conditions.

A model slaughterhouse with or without a meat packing plant entails a varying number of buildings or sections. The slaughterhouses in townships or rural areas of Ethiopia which are only limited to producing edible meat products should have the following essential working parts:

Lairage

Slaughtering hall

Meat hanging and inspection hall

Gut and tripe compartment sink
Hide and skin shed
Employee's dressing room
Office and store
Manure bay
Separated slaughtering place

Lairage: This is the accommodation provided for animals brought to the slaughterhouse before they are put to be slaughtered. In here animals are kept to rest for a period of 12-24 hrs by providing them with water and undisturbed resting conditions. For those animals needing isolation for observation grass should be available. In addition ante mortem inspection is done during the resting period.

The main sanitary requirements for lairage construction are

- To be well spaced and large enough to accommodate at least one day's slaughter and, depending on the source of supply, a 3 days collection of stock
- For the floor to be made of impermeable concrete and a non-slippery material with a proper drainage system
- A divided partition for different animals and a separate lair to serve as a quarantine space for sick and suspected animals
- To be easily accessible with a continuous pipe supply water trough
- For the passage from the lairage to the slaughtering hall to be built to permit a one-by-one flow of animals

Slaughter hall: This is the place where the actual slaughtering is done followed by complete a bleeding process and dressing. All blood and all external body parts are removed immediately to outside of the hall. In larger meat plants separate slaughtering places for each type of animal may be required. The sanitary requirements for the hall construction are

- For the internal walls and the floor structures to be smooth and washable
- For a sloppy drain to permit blood and wash waste to flow out easily
- For there to be properly installed meat-hanging chains with overhead rails
- Conveniently located running tap water with a well fastened washing hose
- For a on-site electrical steam boiler or sterilizer to be installed for slaughtering tools

Meat hanging hall: This is a place where all carcasses and organs are kept temporarily and serves primarily for inspection. The entire sanitary requirements that are applied should be the same as in the

and tripe preparation. Since this is a very important unit from a contamination point of view; it should be properly constructed and used.

The essential sanitary requirements and facilities for this unit are

- Impervious washing sinks with drained concrete slabs
- Running water taps with a continuous supply of water
- Properly built drainage systems throughout the final system
- Temporary waste contents collection container at close proximity

Hide and skin shed: This is a sidewalls open structure where after curing wet hides and skins of slaughtered animals can be permitted to dry for about a week. The structure is designed and built for a capacity of at least 50 hides and 100 skins each day, seven days a week. After the curing the hides and skins are tied to a strength to:sui Tf.4l2t2nm1u0 0wlt

should have resting or sleeping facilities. Toilets with an incorporated washing system must be provided.

Office and store room; This is a small sized room strictly for administration and storing certain meat inspection equipment nearer to the main gate, to permit a direct access to those who are authorized or to certain other visitors. The meat inspector or veterinarian and a clerk will use this room.

Manure bay

Depending on the size and type of slaughterhouse additional facilities may be required for the work to be carried out satisfactorily. In areas where the slaughter of animals rather than ruminants is to be carried out, such as pigs, a separate slaughtering and scalding room is necessary. There are times where suspected animals need special attention, it is then that a separate room for killing and the handling of the carcasses is required. Side-by-side with this a condemned moot distracter unit should be available. If the meat produced in the plant is to be used for packing or to remain in the place for an unlimited time the daily products need to be stored without being spoiled. For this purpose a sizable cold storage room with a cooling system and all other essential facilities should be provided close to the slaughtering hall section.

3.3.3 Transport of livestock

In general animals used for slaughter originate mostly from rural areas at variable distances. It is a normal trend that animals from rural villages are brought to market centers and sold to cattle dealers who finally drive the animals on foot to the slaughterhouses. As a result of long distance travel and other injury effects their meat products may be affected.

From the meat inspection point of view the proper transport of animals must satisfy the following requirements:

- The avoidance of unnecessary suffering during transport
- Improvement of the keeping quality of the meat
- Prevention of the spread of diseases
-

The practice applied in slaughterhouses is adopted from traditional experiences with the exception that since the number of animals attending for slaughter is large, one may not follow the same procedure as stated above. Depending on the species and body strength, animals may not be so cooperative as to easily lie down and bleed to death. They may instead struggle and reduce the efficiency

the animal's throat is severed (cut) across the carotid arteries and jugular veins or it is stabbed in the chest area or throat.

Puncture of the neck prior to bleeding (pitying): The neck is punctured using a sharp knife especially prepared for this purpose. This is inserted through the first cervical vertebrae, near the occipital bone. This causes damage of medulla oblongata, reduces breathing and heart action and finally makes the animal unconscious.

Stunning prior to bleeding: Use of this method is effected by a mechanically operated instrument and electricity or gas anesthesia without any adverse effects on the condition of the meat or its products. This process is to put the animal into a state of insensibility that lasts until it is slaughtered. The different techniques used in the stunning of animals are

- A striking instrument, such as a pole axe or any other appropriately hard tool, to blow on the forehead of the animal which causes a fracture of the frontal bone and damages the cerebral brain
- Captive bolt pistol, with penetrating and non-penetrating types of bolts, which when shot to different sites of the head of various animals cause unconsciousness as a result of brain damage
- Electrical instruments,, using a pair of tongs having 60-80 volts of power, depending on the size and type of animal. This

method of stunning produces a better bleeding by passing an alternating current through the brain or heart of the animal

- Anesthetic gas, such as carbon dioxide (CO₂), is commonly applied to pigs by a special apparatus. Once the pigs are exposed to the gas for a sufficient time it will render them insensible to pain until slaughtering. It is important that with the correct concentration of 65-70% CO₂, the period of exposure should be 45 seconds and bleeding should take place within 30 seconds.

All the above methods of stunning are not applicable in all slaughterhouses in Ethiopia, but their choice is worth considering especially in areas where high meat production is undertaken. Except where there are objections on religious grounds, compulsory stunning prior to slaughter has now been enforced by legislations in many countries. The ritual methods of slaughter vary from one religious sector to the other and all must be respected according to the consumers' need. In Ethiopia, as in other countries, there are three ritual methods of slaughtering: Christian, Muslim and Jewish. In traditional ways of slaughtering these are strictly followed. In public slaughterhouses Christians and Muslims kill animals either by previously stunning or directly by severing the throat to complete bleeding by individuals of the respective faiths and in their designated areas. At present even though there is no separate slaughterhouse for Jews the method of slaughtering is strictly followed from the

selection of the live animals to the correct applying of a knife across

- In a badly bled carcass when the incision is made to the intercostal muscles blood can be squeezed out

Rigor mortis

Rigor mortis or settling of the carcass is the process characterized by a hardening and contraction of all the voluntary muscles and finally stiffening of the joints, some hours after death.

Presence of rigor mortis is due to a chemical reaction. After death the muscles lose their extensibility when the supply of the adenosine triphosphate (ATP) and glycogen is used up, or the lactic acid acts on the protein muscles where coagulation of myosin in the body takes place, which finally causes settling.

The development of rigor mortis is influenced by

- The atmospheric temperature: Quick onset takes place in high temperatures and slows down in low temperatures
- The health of the animal: Where in a fevered carcass rigor mortis is absent or scarcely noticeable
- Rigor appears and disappears

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3.4 Methods of inspection

Proper meat inspection helps prevent the spread of meat-borne diseases and to produce a wholesome and safe supply of meat for human consumption.

Inspection of meat has two aspects

- Examination of live animals on entry to the slaughterhouse, referred to as *ante mortem* inspection
- Examination of the carcass and organs after slaughtering referred to as *postmortem* inspection.

In situations where animals are so injured or sick to death, or those involved in serious accidents or potential danger to life need not wait for ante mortem inspection but be immediately killed to save the meat. This is referred to as *emergency slaughter*.

3.4.1 Ante mortem inspection

This is the most important -21.5 gansd oc

5. Clear bright eyes	Dull, sunken and discharging eyes
6. Breathing – easy and regular	Difficult, rapid and painful breathing
7. Feed and drink normally	Loss of appetite, refusal of food
8. Normal temper	Abnormal behavior
9. Normal dung	Bloody diarrhea
10. Normal temperature	Abnormal temperature
11. Remain in herd	Separate from herd
12. General good body condition	Emaciated body

3.4.2 Post-mortem examination

This is carried out immediately after the slaughter and if possible a follow up inspection is done from slaughtering to dressing stages of the carcass. The most important requirement in conducting postmortem examinations is that it should be carried out in a methodical manner, following a definite sequence. Experienced inspectors can easily perform this. The main purpose of post-mortem examinations is to detect and eliminate abnormalities and states of contamination by ensuring that the meat is fit for human consumption. Routine post-mortem examinations must be carried out with care, in a hygienic manner and as much as possible avoiding unnecessary cuts and mishandling. Any incision made should be done in a proper

- Thoracic cavity: lungs, bronchial and mediastinal lymph nodes, heart, diaphragm
- Abdominal cavity: stomach, intestine, spleen, liver, and kidneys
- Reproductive cavity: uterus and ovaries, testicles and penis, udder, supra mammary and inguinal glands
- Connective tissue: fat, bones, joints, tendons
- Muscles: mostly active muscles
- Lymph nodes: at all sites of the carcass
- Feet: internal condition

After a general examination the carcass, organs and viscera must be subjected to a detailed postmortem examination for specific disease identification and judgment. Diseases vary in their severity, extent and spread within the animal body. They may occur as an acute stage and actively affect the animals or may be a mild and chronic

Review Questions

1. What are the purposes of meat hygiene?
2. What is the rationale of knowing the sex of food animals?
3. Discuss the main features of slaughterhouses.
4. Discuss methods of inspection in meat hygiene.

UNIT FOUR

Meat-Borne Diseases

Objectives

At the end of the course, the students will be able to

- Identify meat-borne diseases
- Explain meat-borne diseases

Introduction

Raw beef meat is one of the most popular national dishes in Ethiopia for those who can afford it. Most people consume it irrespective of its quality. This is because people have a low awareness about food borne diseases. Some of the common misconceptions in certain local and ethnic groups are:

- Eating raw meat is considered by many as a sign of “masculinity” or how to be a real man. Some others believe that if one suffers from amoebas one should eat beef meat periodically because the tapeworm that may develop at its matured stage will possibly eliminate the amoeba organisms.
- Most rural people believe that if rabid cow or ox meat is consumed it does not affect humans but instead will help to immunize people against the disease.
- Local tanners carelessly handle hides from animals infected with anthrax because they believe that they cannot contract the disease.

- A liver highly infested with liver fluke worms is consumed raw irrespective of its inferior quality.

The most prevalent specific diseases in Ethiopia that require attention are explained under the following classification:

- Bacterial: Such as bovine TB, anthrax, blackleg or tetanus
- Viral: Such as foot and mouth disease, render pest or rabies
- Parasitic: Such as tapeworm, liver fluke or hydatid disease
- Fungal: Such as actinomycosis

4.1 Bacterial Diseases

Tuberculosis: This is the infectious disease for most animals and humans and is characterized by the development of tubercles in any part of the body. It is caused by mycobacterium tuberculosis. There are three common types of tubercle bacilli affecting man and animals, the human (*Mycobacterium tuberculosis*), bovine (*Mycobacterium bovis*) and avian (*Mycobacterium avium*). There is also a fourth type which affects fish. Most sheep are very rarely attacked. The routes by which tubercle bacilli gain entrance to the body are respiration, ingestion, inoculation and congenital and genital organs.

The tubercle bacilli when they enter the body of animals produce primary lesions in the respiratory or digestive tract, followed by lesions in the associated lymph nodes. The specific reaction of the body tissues to the multiplication of invading tubercle bacilli is

manifested by a proliferation of the phagocyte cells at the point of rest forming a nodule or "tubercle". This primary infection is localized in the organs or associated lymph nodes due to either breathing in the tubercle bacilli into the lungs or swallowing the bacilli with infected food or by autoinfection.

As a result, the indications of this condition are that the tubercle bacilli are not very numerous and are not uniform in size but vary greatly. This is because they are in different stages of development and degeneration. After about three weeks the tubercle is just visible to the naked eye as a gray translucent nodule but with the onset of "necrosis" it becomes opaque and gray or yellowish white in color. Necrosis is followed by "caseation" in which the necrotic tissue becomes at the periphery of the lesion forming a capsule limiting the local spread of the disease process. Finally the capsule material may undergo "calcification" and the lesions become paler, hard and feel gritty. When completely calcified no further spread takes place and there is no infection at the localized area. However if the defenses are overcome, further spread may occur.

When tubercle bacilli enter the blood stream and reach to all parts of the animal body, the disease will tend to change from primary into secondary infection. In the stage of generalized Tuberculosis condition, the tubercles become numerous and scattered throughout

the body. As they are of the same age they have almost the same size, similar to that of a millet seed.

Miliary tuberculosis is a good example. Since some organs or parts of the body afford a better medium for growth than others, the muscles, blood vessels and the heart are very seldom affected. However when generalization has occurred, the lungs and the liver are the first to be affected, then the spleen, kidneys, udder, bones and other lymphatic glands.

Signs in live animals

- If the lungs are affected there is frequent coughing, breathing is rapid and difficult and in severe conditions emaciation occurred
- If the pleura or peritoneum are affected then the coat becomes rough and dry, the skin hard and inelastic and the body becomes highly emaciated
- If the udder is affected then the lymphatic glands become enlarged, $\frac{1}{4}$ of the organ is swollen and a small hard tubercle is felt

Post-mortem examination

Inspect by touch and incision all surfaces of organs and associated lymph glands for tubercles

- Examine in detail by cutting the lymph nodes into slices

- If required use bacteriological examination

If during these inspection and examination processes lesions and tubercles are found in certain organs and associated lymph nodes this is evidence of localized infection. If however the lesions and tubercles are manifested over the entire carcass as milliary

distribution though often restricted to particular areas. It is endemic in Ethiopia where cattle and sheep are highly affected, while the other food animals are more resistant. Man is affected when the bacilli enters the body by:

- Ingestion of flesh having the bacilli or its spores
- Contamination of wounds with bacilli or its spores
- Inhalation of bacilli or spores while working or handling in wool-sheep industry, tannery and hide and skin markets.

The blood of animals with anthrax contains numerous bacilli and once the animal is open to bleeding under favorable conditions in the open air where the presence of oxygen is sufficient, the bacilli will form spores. The spores are not found in the living animals and are formed at temperatures in the range of 12-43⁰c and when the oxygen supply is adequate. The sporulating form *Bacillus anthracis* is more resistant to distractive influences than the bacilli form. It is necessary to prevent the infusion of blood from all natural openings as well as other parts of the carcass. However for bacteriological examination drops of blood from the tips of the animal's ear or from under the surface the tail may be taken with great care. A blood smear is prepared on a slide making a normal staining laboratory procedure and then finally seen under a microscope. If positive, the bacilli appear blue surrounded by definite purple capsules.

Signs in living animals

In very acute cases animals become suddenly excited and fall dead. The disease is sudden in its onset and is usually manifested by high fever, up to 42⁰c, and death occurs within 48 hours of the onset of the illness. It may also have bloody diarrhea, dark red, tarry, unsaturated blood discharged from the nose, mouth and anus.

In less acute cases generally the animal separates from the herd with a hanging head and is very hard to move far. The body temperature rises up to 41⁰c, giving a bloody urine and dung. The muscles tremble or quiver and when hands are put over the body it shows crepitation of the skin.

Post-mortem examination

If the animal is killed and the body is opened without suspicion during the ante mortem examination or without the knowledge of the people, the following should be checked carefully:

- Spleen: Seen as swollen, up to five times its normal size, changes to black tarry color. Spleen enlargement in sheep is almost absent. In cross section it shows as a gray or white dot appearance
- Blood: The blood coming out from any opening of the animal's body is thick and black tarry in color and it does not clot easily.

Action to be taken:

The meat from anthrax-infected animals is dangerous to man although anthrax bacilli are readily destroyed by gastric juices. The spores are resistant and may gain access to the system through abrasions of the mouth or mucous membrane.

Therefore the following measures should be taken:

The carcass, including blood, hide, offal and internal organs, should be disposed of by burning, preferably by incineration or using a strong fire. The whole carcass and any other parts of the body available at the spot should be disposed of by burying in a pit. In preparing the pit the following points should be considered:

- Location: Choose a proper site for the burial place, one that should be away from sources of water and away from any dwelling areas
- Depth of the pit: At least 2 meters
- Pit covering: The carcass and other contents should preferably be covered with quicklime, up to 1 foot on top and 1 foot at the bottom of the body. Finally the pit should be covered with compacted earth material
- Fencing: This safeguards the burial place from wild animals. Therefore it should be protected by proper fence

The place where the carcass and all other contents are laying must thoroughly treated with an appropriate disinfectant. All slaughtering tools and articles used must be boiled and disinfected with a chlorine solution or formaldehyde.

All persons handling the animal must wear gloves, apron and plastic boots. An antibiotics (penicillin) injection is of great help for prophylactic treatment.

Black quarter, black leg or quarter leg

Blackleg is a world wide infectious disease of cattle and sheep. It is caused by bacteria called "clostridium chauvoei". It is a spore-former bacterium that results from soil infection, which affects animals that more commonly grass feed than stall-fed. Blackleg spores are very resistant to destructive influences and may retain their virulence for over 10 years in dried muscle and indefinitely in the soil.

Susceptible animals may be infected by inoculation or more commonly by the ingestion of spores in soil, dust, grass and water. Most often, young animals, between six months and two years of age are attacked. Black leg is not communicable to man, man is immune.

Signs in living animals

Generally black leg is characterized by severe inflammation of muscles with toxocemia and high mortality. The infection is followed by crepitate swellings as a result of gas formation when developed in the subcutaneous tissue. During ante mortem inspection the following conditions are detected:

- Swelling on the shoulder, neck, legs, loins and thigh and crepitation over the swollen part is commonly present
- Manifested with high fever
- Death occurs within 24 hrs.
- Cause lameness, if the limbs are affected

Post-mortem examination

- Muscles: These become blackish red and edematous at the periphery of the swelling and have a spongy appearance. Above all it emits a rancid and unpleasant odor
- Lesion: If it is cut it gives off gas with a pus-like odor
- Visceral organs: The liver and kidneys show marked changes, being enlarged and congested.

Action to be taken

If a live animal is found affected with black quarter, slaughter of the animal is forbidden. If however after slaughter the carcass and organs are found to be affected they should be rejected and disposed of properly because the flesh of such animals is highly affected and spoiled to the extent that it gives off a rancid taste and odor.

Tetanus (Lockjaw)

Tetanus is an acute, highly fatal and infective disease. It is caused by bacteria called "clostridium tetani". All animals can be affected, principally horses, sheep and cattle and rarely pigs. Tetanus

organisms have their natural habitat in the intestines of horses and other animals. They commonly exist in the top layers of the soil which has specially been fertilized with manure. In animals it is caused by contamination with soil of open wounds or the umbilical cord in newborn animals. In man contamination is by of wounds or penetration through skin or mucus membrane. The organisms themselves do not penetrate the blood, but remain at the site of inoculation where they produce a very acute toxin, which cause the acute tetanus spasms, stiffness of the body and finally death.

Signs in living animals

The examination during ante mortem is incomplete by itself, but by taking specimens from the wound of the animal or drawing blood from the body a bacteriological test is done to confirm the disease.

- At the site of inoculation the tissue becomes edematous.
- Causes muscular spasm in the muscles of the jaw (master muscle)
- Causes stiffness of the body, starting from the jaw and spreading to the legs
- Attacks the nerve cells of the spinal cord and brain.

Microbiology

- Slight pathological change may be observed in the heart, liver and kidneys
- The internal muscles may become soft and change color to grey
- The dead animals show evidence of asphyxia.
- The blood of the animal becomes dark red showing some tendency to clot.

Action to be taken

Since the whole carcass is to be affected because of the reaction of the body, the carcass and the organs must be rejected as unfit for human consumption.

4.2 Viral diseases

Foot and Mouth disease

This is an acute, contagious, febrile disease caused by entrovirus and occurring in cloven-footed animals, such as cattle, pigs, sheep and goats. The virus of the disease is most concentrated in the infective fluid from the vesicles, which characterizes the infection. Grazing or stable animals with vesicles, while feeding and walking, will have their blisters burst out and contaminate the pasture and grazing land with viruses that have been discharged. These viruses will get access to other grazing animals through their feet when walking or their mouthparts while feeding. Infection with the virus of the foot and

mouth disease is rare in man and usually takes a mild form. The disease can be spread by means of infected fodder, by meat affected by the disease and by consuming milk from the infected cow.

Signs in living animals

- Excessive salivation as a result of affected mouthparts
- The principal locations of the vesicles or blisters are the membrane of the lips, muzzle, tongue and fibrous pad
- Lameness as a result of vesicles between the digit, at the base of the supernumerary digits, around the horns and pairs of hooves
- Lesions in

Cattle: Found on the tongue, lips, dental pad, feet and udder. The size of vesicles or blisters are $\frac{1}{2}$ to 2 inches and they have a white clear appearance and contain a yellow fluid.

Sheep and goats: Found generally on the feet and seldom in the mouth, the lesions in these animals are smaller than cattle ones.

Pigs: Found on the feet, inside the nasal septum and sometimes on the teat of the udder.

Action to be taken

Once the ante mortem inspection is done properly to identify the condition of the infection, the postmortem examination is not

necessary as a routine procedure, but for an overall check up of the internal condition of the lesions, it should be practiced.

In this case the whole carcass, organs, hide and teat of an animal suffering from foot and mouth disease must be seized and destroyed and when need arises should be burnt properly. In addition thorough cleansing and disinfection of all tools, materials and all places in contact should be done to safeguard any further contamination of meat products.

Render Pest (Cattle Plague)

Render pest is an acute, infectious and febrile disease affecting particularly cattle, which when once introduced spreads very fast and may lead to the almost complete extinction of animals over large areas. It is endemic in Ethiopia as in other places. This disease also affects game animals. It is caused by viruses that are characterized by inflammatory neurotic changes of the mucus membrane of the alimentary tract. The disease is spread through direct contact or through water and grass contamination to other animals.

Signs in living animals

- If the animal is affected with the disease, it is dull looking and it stands with its head down with its back hunched

- It has a high fever, 41⁰c-42⁰C.
- Onset of diarrhea with a black and smelly condition is frequent, which causes the animal to rapidly become emaciated
- The animal loses its appetite and stops ruminating
- The mouth shows an acute inflammation of the mucous membrane, with its muzzle dry and eyes having a discharge.

Post-mortem examination

- Inflamed patches are seen on lips and throat area
- Red streaks on the rectum are visibly
- Liver is enlarged and the gall bladder is distended
- The associated lymphatic glands are swollen
- Dehydration and emaciation of the carcass may be seen.

Action to be taken

Since it does not affect man but gives a poor quality meat and poor protein content, because of the high fever and toxemic condition of the animal, the carcass and organs affected must be totally condemned and destroyed. In areas where render pest is endemic, as in Ethiopia, vaccination coverage is of great help preventing the spread of the disease for fairly long time.

Rabies

Rabies (hydrophobia) is an acute, infective viral disease, which is usually transmitted by a bite from an affected animal. Man is

susceptible and is usually infected by a dog bite. Almost all carnivorous animals such as dogs, wolves, hyenas, jackals etc are also susceptible and become infected through the bite of other rabid animals.

Signs in living animals:

Rabies has 3 stages of symptoms.

1st stage- Melancholic (depression)

- Normal temper changes to irritation and aggressiveness
- Animal tends to hide away, becomes uneasy and moves actively
- Is frightened of any noise heard

2nd stage- mania (madness)

- Excitability increases and wanders aimlessly
- Animal's normal appetite is changed and attempts to eat strange articles
- Starts attacking other animals though man is rarely attacked
- Slight paralysis starts and the animal cannot swallow .

3rd Stage- paralysis

- Larynx and pharynx are first attacked and the voice of the animal changes
- Muscles of mastication are affected and the eyes become paralyzed
- Continuous dripping of saliva starts

- Muscles of locomotion and breathing are affected
- Finally, when paralysis is complete, the animal dies of asphyxiation.

Post-mortem examination

4.3 Parasitic diseases and infestation

The most important parasites in meat inspection are those which are transmissible to man by the consumption of the flesh of affected animals or by coming into contact with such flesh. Other parasites, though not causing diseases in man, may render such flesh or organs to deteriorate and therefore, be unfit for sale for human consumptions. The three most common parasites of animals to be dealt here are: tapeworm, liver fluke and echinococcus.

Tape worms in humans

Tapeworms (cestodes) are parasites, when mature inhabitants of the intestines. The presence of numerous tapeworms in the intestine may exert a deleterious effect and discomfort on the host. The adult tapeworm possesses a head or scolex and a number of segments (proglottids) which vary from three to many hundreds. Tapeworms exist in two stages, each resident in a separate host, called the cysticercus's (cyst) stage and the adult (matured) stage. The cysts are non-feeding, immature stages are lodged in the muscles or other tissues and organs while in the adult form, the parasite attains complete sexual development, in the intestine.

The two common tapeworms requiring attention in meat inspection in Ethiopia are *Tania saginata* and *Tania Solium*.

***Tania saginata* (Cystecercus bovis)**

The adult beef tapeworm occurs in the small intestine of humans where the intermediate stage, *Cysticercus bovis*, is found in cattle. The adult tapeworm measures from 3 -10m in length with a head or scolex having four suckers and a long segment (proglottides). The life cycle of beef tapeworms takes place at two stages in a different host. The stage of development that concerns in meat inspection is that part which takes place in cattle. The eggs which are discharged contain an open fluid which may remain over the grass and will be ingested by cattle. In time these hatch out in the intestine, penetrate the gut wall and reach the blood stream by which they

diaphragm, tongue, neck, shoulder, inter costal and abdominal muscles.

During ante-mortem inspection of tapeworms in living animals, it is not easy to identify the signs and symptoms of the disease. Therefore it is not done as a routine procedure. A meat inspector instead may have the knowledge of the area from where the animals originate and this may give him a hint for a thorough examination of the muscles during the postmortem examination.

Action to be taken

Since consuming meat raw or partially cooked meat with tapeworm cysts infects man, the following measures should be taken:

- Localized infection, where the organs or part of the muscles are offered with only a few in number of cysts, the only affected part has to be seized and disposed of properly.
- In generalized infection, where the cysts are found in most organs or parts of the muscles in a significant number, the whole carcass should be condemned.

In order to save the meat there are certain practical measures that may be taken if they are properly handled. Cysts in meat can be destroyed by adequate boiling or cooking, at least 140°F (60°C), or cysts in meat can be inactivated or killed by cold storage or deep

refrigeration at temperature 20⁰F (-6.6⁰C) for 3 weeks or at a temperature of 14⁰F (-10⁰C) of 2 weeks.

Liver Fluke (*Fasciola Hepatica*)

Fasciola hepatica is a common liver fluke that is responsible for the acute and chronic inflammation of the liver and bile ducts. It is distributed almost universally throughout the world. It is usually flat, leaf shaped and pale brown in color with an oral sucker. The parasite is 32 mm long and 8.4 -13 mm wide. The animals most commonly affected are sheep and cattle. The life cycle of the parasite takes place in different hosts. The stage of development in sheep or cattle is the part that concerns meat inspectors. The intermediate host, in which the cycle of maturity takes place, is in the snails who favorably inhabit marshy areas. After the eggs are discharged from the host they develop into meracidium and in a favorable condition they finally reach cercariae stage. These cercariae settle on the blades of grass and other plants in the pasture where grazing animals eat them.

Within the animal intestine the liberated embryos finally reach the liver and develop into the adult flukes. Flukes live in the liver and bile ducts of the animals, which then affects the organ.

In an acute case there is a condition of distinct swelling and congestion of the liver and bile ducts, as a result of invasion of the liver by a large number of young flukes. In chronic cases, the liver

become distorted, the bile ducts enlarged, thickened and turn to a bluish color.

the definitive host, while man does not harbor the adult worm. The incidence of echinocoecus infection in an area can be determined

muscular tissues. Liver is heavily infected and in the long run cyst degeneration takes place through a process of cassation and calcification.

During the examination the cysts that form on the organs and other parts of the carcass should be checked carefully.

Prevention: The cycle can be interrupted by having proper human waste disposal, by preventing dogs from entering the slaughter place and if possible by boiling and the cooking of water.

Action to be taken

All affected organs and parts of the carcass are unfit for human consumption and so they should be condemned and disposed of properly.

Other Measures:

- Condemned meat parts should not be disposed of anywhere but burnt or buried with care.
- Dogs should be prohibited from entering slaughterhouses or similar places, proper fencing is required
- Food and vegetables should be prevented from being contaminated with dog faeces.

Actinomycosis (Lumpy Jaw)

This is a chronic disease of cattle commonly known as “Lumpy Jaw”. A fungus called “actinomyces bovis” causes it. Pigs are more affected than other animals. Actinomyces boviis is responsible for actinomycosis of the bone in cattle and the main cause of udder actionmycosis in the pig. The infection of bone may be regarded as the true form of actinomycosis, while infection of the softer tissues is caused by actinobacililus, another bacterial species. In cattle the lesions of actinomycosis are usually confined to the head, and may involve the jawbones to produce “lumpy Jaw”, the lower jaw is more affected than the upper one. The bone part of the jaw is thickened and forms a honey-combed appearance on section.

Signs in living animals

- The lower jawbones are distinctly seen to be affected
- Some extended lesions may be seen in the head part
- Tongue ulceration, enlargement and hard formation takes place
- Pigs (sow's) udder is affected.

Since the most affected parts of the head and other organs can be easily checked externally, there is no need for a post mortem examination.

Action to be taken:

Affected organs, such as head, tongue udder, stomach or lungs, should be condemned.

Review Questions

1. What are the common causes of meat-borne diseases:
 - a. Bacteria?
 - b. Viruses?
 - c. Parasites?
 - d. Fungi?

2. What are the main symptoms for anthrax identification during ante mortem examination?

3. What are the main symptoms for tetanus identification during post mortem examination?

4. Discuss the various measures to be taken to prevent anthrax diseases.

References