**MEKDELA AMBA UNIVERSITY**

**COLLEGE OF AGRICULTURE AND NATURAL RESOURCE**

**DEPARTMENT OF ANIMAL SCIENCE**

**MILK, MEAT AND POULTRY PRODUCTS PROCESSING AND**

**PRESERVATION**

**(AnSc. 436)**

**MILK, MEAT AND POULTRY PRODUCTS PROCESSING AND**

**PRESERVATION MODULE**

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**MOODULE INTRODUCTION**

\_Dear learners! Welcome to the module of the course “milk, Meat and Poultry Products

Processing and Preservation.” This module deals with the Dairy, Beef, Fish and Poultry product

processing and the mechanism of preservation. For that purpose the module is organized in to six

chapters that are further divided into sections.

The **first chapter** is the definition of some terminologies which is related to dairy and dairy

products. It also deals with the significance of milk and milk products. **Chapter two** will discuss

the chemical and physical properties of milk. It deals with physical status of milk, milk

constituents and factors which are affecting the composition of milk. **Chapter three** will discuss

milk microbioloogy. It deals mainly beneficial bacteria, pathogenic bacteria, spoilage bacteria

and their source of contamination. **Chapter four** is devoted for the discussion of milk

processing. The next two chapters focus on meat processing and poultry product processing.

Therefore it is highly important to get breif exposure to the most important livestock product

technology through the module. To help you easily understand, and self test activities have been

included in the discusions. Very few module questions are found at the end of each chapter. You

are strictly advised to ready and try those questions.

**Module objectives:**

Dear learners, at the end of this module you will be able to:

\_ Identify the meaning, subject matter, and relevance of livestock products.

\_ Identify the routine processing and preservaton the product of

\_ Dairy and Beef Animals

\_ Fish

\_ Poultry

**CHAPTER ONE: INTRODUCTION**

\_**Dear learner,** welcome to first chapter of this module. This chapter deals with some

terminologies which is related to milk and milk product. You might wonder hearing of the word

dairy, dairy farm/farming, dairy products and significance of milk if you have not been exposed

to different course of your discipline those you have been learned.

**What is Dairy?**

Literally dairy is a commercial establishment for processing or selling milk and milk products or

a place /building where milk is stored and milk products are processed.

**What are Dairy Cattle**?

The term dairy cattle comprise cows and bulls that are kept as farm animals primarily to produce

milk.

**What is Dairy Farm?**

Dairy farm is a farm that produces milk and milk products.

**What is Dairy Farming?**

It is the farming system that engages itself with milk and its products for food is said to be dairy

farming. Dairying**/**dairy farming is the business of a dairy farm.

**What is milk?**

Milk is a secretion of a cow's udder, free from colostrum, obtained by the complete milking of

one or more healthy cows. It is a complex biological fluid secreted in the mammary glands of

mammals. Milk function is to meet the nutritional needs of neonates of the species from which

the milk is derived.

**Other Related Terminologies**

**Alveoli:** A small bulb-shaped structures responsible for transforming nutrients from the blood

into milk. There are approximately one million alveoli in each cubic inch of udder tissue.

**Oxytocin:** Hormone that causes muscle contractions around the alveoli and therefore causes

milk letdown

**Mastitis:** A disease of the udder causing swelling and irritation of the mammary glands

**Stanchion:** Locking headgate for restraining dairy animals

**Colostrum:** The secretion of the mammary glands for the first few days of lactation. It has a

strong odour, bitter taste, slight reddish-yellow colour, and a high level of immunoglobulins that

confer disease resistance from cow to calf.

**Lactic acid bacteria:** A group of bacteria commonly added to milk as starter cultures to ferment

lactose to lactic acid. Lactic acid is responsible for the fresh acidic flavour of unripened cheese

and is important in forming and texturing of the curd.

**Organoleptic:** Describing the use of the senses.

**Pasteurised milk:** Milk which has been subjected to pasteurization (process of heating food for the purpose of destroying harmful microorganisms) and which, if retailed as such, has been cooled without delay and packaged with minimum delay under conditions which minimize contamination. The product must give a negative phosphatase test immediately after heat treatment.

**Standardization:** The process of adjusting the butterfat and/or solids content of milk by adding

or removing cream or non-fat milk solids so as to achieve a processed milk product of specified

butterfat content.

**Starter:** A culture of lactic acid bacteria that is used to initiate fermentation.

**Hawker/Vendor:** A person who buys milk from producers and sells it to consumers on the street or from door to door.

**Whey:** The liquid removed from cheese milk composed mostly of water, lactose, and proteins.

**Whey protein:** Water-soluble protein, which is not coagulated during manufacture of cheese. It is rich in essential amino acids.

**Dear learner, can you mention the importance/significance of milk and milk products?**

**Significance of milk**

Milk is the sole source of nutrients for most young mammals for lengths of time which vary with the species. Overall, milk serves the following broad functions;

a) Growth,

b) Reproduction,

c) Supply of energy,

d) Maintenance and repairs and

e) Appetite satisfaction.

The requirements of these categories vary with the individual, and in some instances not all the stated functions of the food need to be served, e.g. adults do not require food for growth whereas infants do. To fulfill its functions as a food milk contains various nutritionally important components.

**Chapter Summary**

Dairy cattle are mainly produced for milk production. In addition to this they also used for draught purpose, manure (for fuel and organic fertilizer), and hide (for leather production). Dairy cattle are also considered as measure of wealth-reserves of family wealth as a mark of responsibility and status within the community. Milk is a secretion of a cow's udder, free from colostrums, obtained by the complete milking of one or more healthy cows. Milk is used for growth, reproduction, supply of energy, maintenance and repairs, and appetite satisfaction.

**Review/Self-Test Questions**

**Part I. Multiple Choice Items**

**Direction: Choose the Best Answer from the Following Alternatives**

1. Dairy farming is a business sector that better deals more with cattle for

A. Milk B. Meat C. Both meat and milk D. All of the above

2. The hormone that causes muscle contractions around the alveoli to causes milk letdown is

termed

A. Adrenalin hormone B. Oxytocin hormone C. Thyroid hormone D. All of the above

3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is describing the use of the sense organs.

A. Physical properties B. Chemical composition C. Aseptic D. Organoleptic

4. A small bulb-shaped structure responsible for transforming nutrients from the blood into milk

is

A. Alveoli B. Udder tissue C. Ducts D. Capillaries

5. \_\_\_\_\_\_\_\_\_\_ is a farm that produces milk and milk products.

A. Dairy farming B. Dairy farm C. Dairy cattle D. All of the above

**Part II. True or False**

**Direction: Write True if the Statement is Correct and False if The Statement is Wrong**

1. The milk which has been subjected to pasteurization is termed as pasteurized milk.

2. Spore forming bacteria is a group bacteria commonly added to milk as starter cultures to ferment lactose to lactic acid.

3. A person who buys milk from producers and sells it to consumers is known as vendor.

4. Homogenization is the process of adjusting the butterfat content of milk by adding or removing cream so as to achieve a processed milk product of specified butterfat content.

5. Milk is the sole source of nutrients for most young mammals for lengths of time which vary with the species.

**Answer Key to Self-Test Questions**

**Part I. Multiple Choice Items**

1. A 2. B 3. D 4. A 5. B

**Part II. True or False**

1. True 2. False 3. True 4. False 5. True

**CHAPTER 2: CHEMICAL AND PHYSICAL PROPERTIES OF MILK**

**Introduction**

Milk and the range of dairy products derived from milk have long been central to diet in both developed and developing countries. This milk and milk products have their own chemical and physical properties. Section I considers key aspects of physical properties of milk. Section II and

III provides a foundation by summarizing current knowledge about the physical status and major constituents of milk, respectively. The last section (Section IV) of this chapter discusses how genetic, environmental, physiological and pathological factors influence the composition of milk.

**Objectives**

**At the end of this chapter student should able to**

\_ Know the physical properties of milk.

\_ Know the physical status of milk.

\_ Identify the chemical composition of milk or the constituents of milk.

\_ Identify the factors which are affect the chemical composition and yield of milk

**Section 1. Physical Properties of Milk**

**Overview:** The main purpose of this section is to introduce you with specific gravity, titratable

acidity and pH value of milk. These parameters are the common criteria which are used to

evaluate the quality of milk whether fit for human consumption or not.

**Objectives**

At the end of this section student will be able to

\_ Identify the standard specific gravity, titratable acidity and pH value of normal or fresh

milk.

**Outline of this Section**

1.1.Specific gravity of milk

1.2.Titratable acidity of milk

1.3.pH value of milk

**1.1. Specific gravity**

Milk is a fat in water emulsion, and its specific gravity is a function of the specific gravities of

the fat and that of the water. The specific gravity of the fat is about 0.93 and that of the solids

not-fat (SNF) is 1.5. Therefore, as the fat content of the milk increases, the specific gravity

decreases, and conversely, as the SNF content increases, the specific gravity of the milk also

increases. Milk normally has a specific gravity between 1.027 and 1.035 with an average value

of 1.032 at 16oC.

**1.2. Titratable acidity**

The sour taste of the milk is due to the lactic acid produced by lactic acid bacteria. The percentage of acid present in the milk is used as a rough estimation for the age and the manner in which it has been handled. Raw fresh milk has an initial acidity due to its buffering capacity.

Normal market milk has a titratable acidity between 0.15 and 0.16 percent expressed in terms of lactic acid. The range for normal milk from individual cows extends from 0.10 to 0.22 percent.

This acidity is largely due to the casein content, the phosphate, carbon dioxide, citrates and albumin content.

**1.3. pH value**

pH of cow’s milk is commonly stated as falling between 6.6 and 6.8. Further reduction in pH of

milk is brought about by fermentation through the metabolic activities of some bacteria.

Completely sour milk, for example, has a pH of about 4.4. On the other hand, there are certain

other bacteria which convert the milk components into ammonia products. This process

gradually increases the pH of milk, making it alkaline. Thus, knowledge of the pH of milk is extremely important to keep acid-base related disorders at bay.

**Section 2. Physical status of milk**

**Overview:** About 87% of milk is water, in which the other constituents are distributed in various

forms. Several kinds of distribution are distinguished according to the type and size of particle

present in the liquid. The main purpose of this section is to acquaint you with the concept of

ionic solution, molecular solution, colloid and coarse dispersion.

The following table shows the ionic, molecular solutions, colloids and emulsions found in milk.

**Kind of solution Particle diameter (nm)**

Ionic solution 0.01–1

Molecular solution 0.1–1

Colloid (fine dispersion) 1–100

Coarse dispersion (suspension or emulsion) 50–100

**Objectives**

At the end of this section you will be able to

\_ Know the different forms milk constituent which are exist within the liquid.

**Outline of this Section**

2.1. Physical status of milk

2.1.1. Ionic solutions of milk

2.1.2. Molecular solution of milk

2.1.3. Colloid dispersion of milk

2.1.4. Coarse dispersion of milk

***Dear learner, can you mention the difference between ionic solutions with that of molecular***

***solutions?***

**2.1.1. Ionic solutions**

An ionic solution is obtained when the forces that hold the ions together in a solid salt are overcome. The dissolved salt breaks up into ions which float freely in the solvent. Thus when

common salt (sodium chloride) is dissolved in water it becomes an ionic solution of free sodium and chloride ions. Ionic solutions are composed largely of inorganic compounds.

**2.1.2. Molecular solutions**

In a molecular solution the molecules are only partly, if at all, dissociated into ions. The degree of dissociation represents an equilibrium which is influenced by other substances in the solution and by the pH (or hydrogen ion concentration) of the solution. Molecular solutions are usually composed of organic compounds.

**2.1.3. Colloids**

***Dear learner, can you differentiate the colloid dispersion from course dispersion?***

In a colloid, one substance is dispersed in another in a finer state than an emulsion but the

particle size is larger than that in a true solution. Colloidal systems are classified according to the

physical state of the two phases. In a colloid, solid particles consisting of groups of molecules

float freely. The particles in a colloid are much smaller than those in a suspension and a colloid

is much more stable.

**2.1.4. Emulsions**

An emulsion consists of one immiscible liquid dispersed in another in the form of droplets the

disperse phase. The other phase is referred to as the continuous phase. The systems have minimal

stability and require a surface-active or emulsifying agent, e.g. lecithin in milk, for stability. In

foods, emulsions usually contain oil and water. If water is the continuous phase and oils the

disperse phase, it is an oil-in-water (o/w) emulsion, e.g. milk or cream. In the reverse case the

emulsion is a water-in-oil (w/o) type, e.g. butter.

**2.1.5. Dispersions**

Dispersion is obtained when particles of a substance are dispersed in a liquid. A suspension consists of solid particles dispersed in a liquid, and the force of gravity can cause them to sink to the bottom or float to the top. For example, fine sand, dispersed in water, soon settles out.

**Section 3. Milk Constituents**

The composition of cow milk is varying from breed to breed. Water is the main constituent of

milk and milk product. Milk processing is usually designed to remove water from milk or reduce

the moisture content of the product.

At end of this section you, will be able to

\_ recognize the constituents of milk and milk products

**Outline of this Section**

3.1.Milk constituents

3.1.1. Lipid or milk fat

3.1.2. Protein

3.1.3. Carbohydrate

3.1.4. Vitamin and mineral

3.1.5. Water

**3.1.1. Lipid/Fat**

Lipids are esters of fatty acids and related components. They are soluble in a polar solvent (e.g.

ethyl/petroleum ether or chloroform/methanol). The concentration of lipids for a species varies with breed, individual animal, stage of lactation, mastitic infection and plane of nutrition. Cow’s milk contains 4% of milk fat

The lipids of cow’s milk are composed of;

\_ 98% triglycerides and

\_ 1% phospholipids, plus

\_ Small amounts of diglycerides, monoglycerides, cholesterol, cholesteryl esters and

traces of fat soluble vitamins and other lipids.

Over 400 different FAs (fatty acids) have been detected in cow’s milk fat, although most occur

only in trace amounts. Crystallization properties and the melting point of fat are markedly

influenced by fatty acid composition (i.e. the melting temperature increases with fatty acid chain

length and with the level of saturation); hence, fatty acid composition is important for products

such as butter or spreads.

Almost all the lipids in milk are found in milk fat globules,

\_ Milk can be considered as an oil-in-water emulsion.

\_ Cow’s milk typically contains >1010 milk fat globules per millilitre.

\_ These globules are spherical and range in diameter from <0.2 to >15 μm.

\_ Fat globules are naturally emulsified by a surface layer

Lipids supply the body with a concentrated source of energy and are also important contributors to both desirable and undesirable flavours in milk and milk products. The gross energy supplied by milk can be calculated from its lactose, protein and fat contents. The metabolically available energy is approximately 4.0, 4.1 and 8.9 kcal/g (16.8, 17.0 and 37.0 kJ/g) for lactose, protein and fat, respectively.

**3.1.2. Protein**

***Dear learner, can you mention the classes and importance of milk protein?***

Cow’s milk generally contains 3.4% protein which is commonly divided into two classes on the basis of the solubility at pH 4.6:

A. Caseins (80% of total milk protein) = insoluble protein and

B. Whey or serum protein (20% of total milk protein) = soluble proteins

**A. Casein protein**

The caseins are thus the most abundant class of milk proteins. The caseins are a class of

phosphoproteins whose properties differ considerably from most other proteins;

\_ They are hydrophobic, have a relatively high charge and contain many proline and

only few cysteine residues.

\_ Cow’s milk contains four types of caseins, denoted α s1, α s2, β - and K-casein.

**B. Whey protein**

Whey proteins in their native form are soluble at pH 4.6 or in saturated NaCl, remain soluble after rennet-induced coagulation of casein micelles and cannot be sedimented by ultracentrifugation.

The class of whey proteins consists of a number of proteins, primarily

\_ β-lactoglobulin (β -lg),

\_ α-lactalbumin (α -la),

\_ blood serum albumin,

\_ immunoglobulins and

\_ proteose peptones.

Proteins are essential for the growth and maintenance of all cells in the body. The value of milk proteins depends primarily on their content of some ten essential amino acids which cannot be synthesized by the body. Fortunately, both cow and human milk are easily digested and the amino acids are readily absorbed. Cow milk forms a rather firm curd in the stomach and digestion is slower than with human milk. Diluting cow milk with water or high heat treatment softens the curd.

**3.1.3. Carbohydrates**

In milk from most mammals, lactose is the major carbohydrate, but small amounts of other carbohydrates also occur.

\_ Cow’s milk contains 4.8 g lactose 100 g−1, which is responsible for 50% of the osmotic

pressure of milk.

\_ Lactose is a disaccharide composed of d-glucose and d-galactose;

\_ The aldehyde group of galactose is linked to glucose, via a β -1, 4-glycosylic linkage.

\_ Lactose is synthesized from glucose in the Golgi apparatus of the mammary secretory

cells.

The chief function of lactose in milk is to;

\_ Supply energy for muscular activity and

\_ Maintenance of body temperature.

Like other disaccharides, lactose must be hydrolysed to its monosaccharide components, glucose and galactose, before it is absorbed across the intestinal membrane into the blood stream. Some

people cannot tolerate lactose because they lack the enzyme (lactase) which is required to hydrolyze it. Lack of lactase may result in abdominal cramps, bloating and diarrhea on drinking

milk. When lactose is removed from milk, or converted into lactic acid during cheese manufacture, milk products can be consumed by lactose-intolerant people.

Lactose has certain therapeutic properties;

\_ It is known to enhance the intestinal absorption of calcium and phosphorus.

\_ Its presence in the intestine favours an acid-type fermentation which may prevent intestinal disorders. Fermented milks may be preferable than fresh milk because they prevent the propagation of infectious diseases.

***Dear learner, do you know the role of vitamin and minerals in the milk?***

**3.1.4. Vitamins and Minerals**

Human and cow milk are excellent sources of vitamins. Vitamins A, D, E and K occur in the fat phase and the others in the aqueous phase of milk. Milk is a major source of some of the vitamins needed by infants and adults. It is relatively rich in vitamins A and E, thiamin, riboflavin, folic acid and vitamin B12.

Milk is also an excellent source of many minerals and supplies virtually all of the minerals required by humans. Cow milk furnishes a major portion of the total calcium consumed in many countries. The high levels of calcium and phosphorus in milk are important in bone and tooth

formation in young & children; both these elements play a significant role in preventing osteoporosis in elderly people. Milk also contains high levels of magnesium, zinc & iodine.

However, milk is a poor source of iron and neither human nor cow milk supply enough for

human infants. Fortunately, infants have a store of iron in the liver which is sufficient to meet the needs of the body during the first six months.

**3.1.5. Water**

Function of water

\_ Maintain blood volume

\_ Transport nutrient (glucose and oxygen to cell, tissue and organs)

\_ Transport waste material from cell, tissue and organs.

\_ Help to lubricate joints during movement

\_ Regulate body temperature via sweating

\_ Dissolve solid materials in milk or stabilize the fluid

Below figure shows the major milk constituents and a range of products that can be

manufactured from these constituents.

Separate milk precipitate supernatant

pH 4.5 Bacterial

fermentation

Churn cream

Remove moisture

**Figure 1.** Flow chart illustrating the incorporation of the major milk-solid fractions in milk products.

Whole milk solids

Fat Protein Lactose

Cream 35% fat Casein Whey protein

Whey

Lactic acid

Acetic acid

Propionic acid

Aldeyhdes

Ketones

Butter 82% fat

Hard cheese Cottage cheese

Butter oil 99% fat

**Section 4. Factor Affecting Composition of Milk**

**Overview**: Milk composition and production are the results of interactions of many elements within the cow and her external environments. Factors altering the composition and yields of milk are generally categorized as genetic, physiological, pathological and environmental.

Therefore, this section acquaints you with the concept of factors which are influence milk composition and milk yield.

**Objectives**

At the end this section, you will be able to

\_ Distinguish the factors which influence milk composition and milk yield.

**Outline of this Section:**

3. Factors affecting the milk composition

3.1. Genetic factors

3.2. Environmental factors

4.2.1. Ambient temperature

4.2.2. Feeding regime

4.2.3. Disease and drugs

4.2.4. Season variations

3.3. Physiological factors

4.3.1. Age and body weight at calving

4.3.2. Stage of lactation

4.3.3. Interval between milkings

4.3.4. Completeness of milking

4.3.4. Pregnancy

3.4. Pathological factors

**4.1. Genetic factor**

***Dear learner, do you know how genetic factor affect milk composition and yield?***

**Breed and individuality of the cow**

Both milk yield and composition vary considerably among breeds of dairy cattle. Jersey and

Guernsey breeds give milk with about 5% fat while the milk of Shorthorns and Friesians

contains about 3.5% fat. Zebu cows can give milk containing up to 7% fat.

Table 4.1. Average composition and yield of milk from cows of the major dairy breeds

**Breed Fat SNF Protein Lactose Ash Milk/yield**

**(305 days, Kg)**

Jersey 5.2 9.6 3.7 4.7 0.77 4016

Guernsey 4.8 9.2 3.5 4.8 0.75 4369

Ayrshire 4.0 8.7 3.3 4.6 0.72 5040

Brown Swiss 4.1 9.0 3.2 4.8 0.72 5535

Holstein 3.6 8.5 3.1 4.8 0.73 6324

Indigenous 5.5 809

Fat is the most variable constituent of milk where as minerals (ash) and lactose are the least variable. Differences in gene frequencies controlling the quantity and quality of milk

components largely account for the average genetic differences among breeds. Carotene, a

yellow pigment, is the precursor or of vitamin A. Guernsey and Jersey cows convert much less

carotene to vitamin A than other breeds of dairy cattle.

Milk of individual cows within a breed varies over a wide range both in yield and in the content

of the various constituents. The potential fat content of milk from an individual cow is determined genetically, as are protein and lactose levels. Thus selection for breeding on the basis

of individual performance is effective in improving milk compositional quality.

Heritability is defined as the ratio of genetic variance to total phenotypic ratio. The

concentrations (%) of the three major milk constituents are genetically controlled to a

considerable extent. Heritability’s of fat, protein, and lactose contents average 0.58, 0.49, and

0.5, respectively, while that of milk yield average 0.27. Some milk constituents are strongly

correlated

**4.2. Environment factors**

**4.1.1. Ambient Temperature**

The effect of ambient temperature on milk yield is dependent upon the breed. Holsteins and the

other larger breeds are more tolerant to lower temperatures, whereas the smaller breeds particularly the Jersey are much more tolerant to high temperatures. The optimum temperature for the Holstein cow is about 10 °C. Milk production declines when environmental temperature

exceeds 27 °C. The reduction in milk yield is largely due to drop in feed intake. High temperature affect high producing cows more than low producers and it is particularly harmful

during the peak of lactation.

**4.1.2. Feeding regime**

Underfeeding reduces both the fat and the solid-not-fat (SNF) content of milk, although SNF

content is the more sensitive to feeding level. Fat content and fat composition are influenced

more by roughage (fibre) intake. The SNF content may fall if the cow is fed a low-energy diet,

but is not greatly influenced by protein deficiency, unless the deficiency is acute.

**4.1.3. Disease and drugs**

Many diseases especially mastitis, ketosis, milk fever, and digestive upsets adversely affect milk

production and may alter the composition of milk. Many drugs, including pesticides, used in the

treatment of cattle disease are excreted into the milk. Such milk should be discarded to prevent

the drugs from entering human feed supply.

**4.1.4. Season Variations**

Seasonal variations in milk composition are commonly observed with dairy cattle in temperate

regions. In general, milk fat and solid-not-fat percentages are highest in winter and lowest in

summer. Milk fat and protein percentages are lower by 0.2-0.4% in summer than winter. Cows

calving in the fall or winter produce more fat and solid-not-fat than cows calving in the spring

and summer. Considerable variations in milk composition can also be observed in dairy cows

raised in pasture. Hot weather and high humidity decrease dry matter intake and increase feed

sorting, resulting in lower forage and fiber intake. Seasonal differences have become less

significant because of better feeding and management of the dairy cow.

**4.3. Physiological factors**

***Dear learner, can you define what physiology is?***

The dairyman has hardly got any control over the physiological factors but he has some control

over the environmental factors.

**4.1.5. Age and body weight at calving**

The amount of milk produced by the cow increases with advancing lactations (age). This is due

in part to an increase in body weight, which results in a larger digestive system and a larger

mammary gland for the secretion of milk. Another reason for increased milk production with age

is due to the effects of recurring pregnancies and lactations. Data on milk production with cows

suggest that 20% of the increase in milk production is due to increased body weight and 80% to

the effects of recurring pregnancy and lactations. Recurring pregnancies and lactation can result

in increases of 30% in milk production from the first to the fifth lactation. As cows grow older

the fat content of their milk decreases by about 0.02 percentage units per lactation while the fall

in SNF content is about 0.04 percentage units.

**4.1.6. Stage of lactation**

The concentration of milk fat and protein is highest in early and late lactation and lowest during

peak milk production through mid lactation. Normally, an increase in milk yield is followed by a

decrease in the percentages of milk fat and protein, while the yields of these constituents remain

unchanged or increase.

**4.1.7. Interval between milkings**

The fat content of milk varies considerably between the morning and evening milking because

there is usually a much shorter interval between morning and evening milking than between

evening and morning milking. If cows were milked at 12-hour intervals the variation in fat

content between milkings would be negligible, but this is not practicable on most farms.

Normally, SNF content does not vary with the length of time between milkings.

**4.1.8. Completeness of milking**

The first milk drawn from the udder contains about 1.4% fat while the last milk (or strippings)

contains about 8.7% fat. Thus, it is essential to milk the cow completely and thoroughly mix all

the milk removed before taking a sample for analysis. The fat left in the udder at the end of a

milking is usually picked up during subsequent milkings, so there is no net loss of fat.

**4.1.9. Pregnancy**

Pregnancy has an inhibitory effect on milk yield. Most of the reduction in milk yield occurs after

the 5th month of pregnancy. By the 8th month of pregnancy, milk yield may be 20% less for that

month compared with non-pregnant cow. The inhibitory effect of pregnancy is not likely due to

fetal requirement, which does not increase considerably until the last two months of pregnancy.

It is believed that the increase in estrogen and progesterone level as pregnancy progresses inhibits milk secretion.

**4.4. Pathological factors**

Pathogens can affect milk component content and distribution, the main disease that affect milk

yield of dairy cows is mastitis.

\_ Compositional changes in milk constituents associated with elevated somatic cell counts (a

measure of severity of the disease).

\_ Milk from cows with elevated somatic cell counts (>500,000 somatic cells/ml) has longer

coagulation time and forms weaker curds than milk from cows with lower somatic cell

counts.

\_ Mastitis results in a reduction in fat and casein content and an increase in whey content of

milk.

It impairs the ability of secretory tissue synthesize milk components and destroys the secretory

tissues and consequently lowering milk yield.

**Chapter Summary**

Milk and milk products have their own chemical and physical properties. A physical property is the main

mechanism which used evaluates the suitability of milk for human consumption. They can exhibit

whether milk is adulterated or not, age of milk (freshness of milk) and the manner in which milk has been

handled. The main constituent of milk is water, in which the other constituents are distributed in

different forms. Milk constituent are existing in the form of ionic solution, molecular solution,

colloid and coarse dispersion. It contain lipid or milk fat, protein, carbohydrate, vitamin, mineral

and water. Factors altering the composition and yields of milk are generally categorized as

genetic, physiological and environmental.

**Review/Self-Test Questions**

**Part I. True or False**

**Direction: Write True if the Statement is Correct and False if The Statement is Wrong**

1. All milk contains different kinds of constituents but the same amounts.

2. A shorter milking interval is associated with more milk yield with a lower fat content.

3. Milk from individual cows shows a greater variation than mixed herd milk.

4. Mastitis results in increasing fat and casein content of milk and decrease in whey content

of milk.

5. Molecular solution is obtained when the forces that collect the ions together in a solid

salt are breakdown.

**Part II. Multiple Choice Items**

**Direction: Choose the Best Answer from the Following Alternatives**

1. Which one of the following is/are **true** with regarding to a colloid?

A. The particle size is smaller than that in a true solution.

B. In a colloid, one substance is dispersed in another in a finer state than an emulsion.

C. The particles in a colloid are much larger than those in a suspension and

D. The systems of colloid have minimal stability

E. All of the above

2. Mastitis can affect milk component content and yields through

A. Changing milk constituents via elevating somatic cell counts.

B. Impairing the ability of secretory tissue synthesize milk components

C. Destroying the secretory tissues

D. All of the above

3. From the following alternatives, which one is **not** the class of whey proteins?

A. β-lactoglobulin and α-lactalbumin

B. blood serum albumin and immunoglobulins

C. β-casein and K-casein

D. proteose peptones

4. The average specific gravity of fresh or normal cow milk is

A. 1.035 B. 1.027 C. 1.032 D. 1.00

5. From the following alternative, which factor is influence the milk composition and yield?

A. Genetic makeup of animal

B. Physiological factors

C. Pathological factors

D. Environmental factors

E. All of the above

**Answer Key to Self-Test Questions**

**Part I. True or False**

**1. False 2. False 3. True 4. False 5. False**

**Part II. Multiple Choice Items**

**1. B 2. D 3. C 4. C 5. E**

**CHAPTER 3. MILK MICROBIOLOGY**

**Introduction**

Milk is an ideal medium for the growth of many organisms, having high water content, abundant

nutrients, and being nearly neutral pH (6.4–6.8). Microorganisms present in milk can be

classified into three main groups: beneficial, pathogenic and spoilage organisms. The purpose of

this chapter is to acquaint you with the concept of beneficial bacteria, pathogenic organism,

spoilage organism and their sources. You are greatly advised to study the section critically. It is

also important that you attempt all the learning activities and self-test questions. When you have

the activities and self test questions, you can compare your answers with the correct answers

given at the end.

**Chapter objectives:**

Dear learners after completing this chapter, you will be able to:

\_ Know beneficial bacteria

\_ Pathogenic microorganisms

\_ Spoilage microorganisms

\_ Sources of contamination

**3.1. Beneficial bacteria**

Beneficial bacteria used to make food products people like to eat. Beneficial bacteria and fungi

are either added or naturally occur in foods. They create a unique flavors and textures or improve

the body’s ability to digest foods or fight disease. For instance, cheese, yogurt, and buttermilk

are dairy foods that are produced with the help of beneficial bacteria.

The major group of bacteria in milk is the group of lactic acid bacteria.

\_ These are able to use the lactose in the milk and to convert it into lactic acid.

\_ The most important family in this group is the Streptococcus lactis.

Lactic acid bacteria is multiply and grow very fast when the milk is kept at ambient temperatures

after milking. The produced lactic acid causes the natural souring of milk. The primary source of

these bacteria is the environment: air, dust, dirty equipment and operators, etc.

***Dear learner, can you define what does fermentation means?***

**Fermentation**

\_ A process during which the bacteria break down the complex sugars into simple

compounds like carbon dioxide and alcohol.

\_ Fermentation changes the product from one food to another.

**3.2. Pathogenic Microorganisms**

***Dear learner, can you define what does pathogenic microorganism means?***

Pathogenic organisms are those capable of inducing food poisoning, thus posing a threat to

public health. Most microorganisms are undesirable in milk because they can be pathogenic or

produce enzymes that cause undesirable transformations in the milk.

***Human pathogens are usually classified into those causing food infection and those causing***

***food poisoning.***

***Food infection*** implies that the food, e.g., milk, acts as a carrier for the microorganism, which

enters the human body through milk.

\_ So a person can become ill, often not until a day or so after drinking the milk.

\_ In food infection, fairly small numbers of microorganism may suffice to cause illness,

according to the pathogen involved.

***Food poisoning***, the microorganism forms a toxin in the food (or such a toxin contaminates the

food by another route). In this case:

\_ The consumer rapidly falls ill.

\_ Large numbers of the pathogenic microorganism are usually needed to cause food

poisoning.

\_ The amount of toxin produced should be large enough to give symptoms.

\_ Unlike food infection, food poisoning does not imply that the pathogenic organism is still

in the food.

NB: Some toxins are more heat-resistant than the toxin-producing microorganism itself, e.g.,

*Staphylococcus* spp.

Numerous milk borne pathogens have been isolated from raw milk. The prevalence of these

varies considerably, depending on

\_ geographical area

\_ season

\_ farm size,

\_ number of animals on farm,

\_ environmental hygiene and

\_ Farm management practices.

The growth of milk borne pathogens is inhibited by cooling, pasteurization and competing nonpathogenic microorganisms.

***Dear learner, can you differentiate the pathogenic microorganism from spoilage***

***microorganism?***

**3.3. Spoilage Microorganisms**

Spoilage (non-pathogenic) organisms are capable of hydrolyzing milk components such as

protein, fat and lactose in order to yield compounds suitable for their growth. Such reactions can

lead to spoilage of milk by

\_ making off-flavours and odours

\_ changing the texture and appearance and

\_ decreasing their heat stability

**NB:** Furthermore, most heating processes applied in dairy processing do not destroy all

microorganisms or all microbial enzymes.

**Gram-negative psychrotrophic bacteria:**

The growth of psychrotrophic bacteria is of major concern when raw milk is kept at low temperature. During growth of these bacteria, heat-stable enzymes such as proteases and lipases are formed and consequently cause protein and lipid breakdown and related defects.

**Pseudomonas *species***

Species of the Pseudomonas genus are the most important because of their ability to produce

heat-stable enzymes (particularly proteases and lipases) during growth under refrigerated

storage.

***Characteristics of Pseudomonas organism:***

They are motile, gram-negative rods, with the ability to grow at temperatures just above

freezing, despite their optimum growth temperature being between 25 and 30oC.

***Enterobacteriaceae***

Enterobacteriaceae account 5–33% of psychrotrophic microflora present in raw milk. These

organisms are small, motile, gram-negative rods. Their optimum growth temperature (>30oC)

tends to be higher than that of pseudomonas, but they adapt well to growth at refrigeration

temperature. Coliforms belonging to this group are able to ferment lactose with production of

acid and gas at 32oC within 48 hours.

***Gram-positive bacteria***

\_ ***Spore-forming bacteria***

Spore-forming bacteria in raw milk are predominantly *Bacillus* species. The optimum growth

temperature for most *Bacillus* species is 20–40oC. These gram positive motile, spore-forming,

rod-shaped organisms have also been implicated as the cause of a variety of proteolytic defects.

\_ *B. cereus* is a common contaminant of raw milks, being present in over 80% of raw milk

samples.

\_ *It is* usually gives rise to milk spoilage defects such as bitty cream, sweet curdling and

various off-flavours.

***Clostridium species*** is also present in raw milk at such low levels that enrichment and most

probable number techniques must be used for quantification.

\_ ***Lactic acid bacteria***

Spoilage of raw milk resulting from growth of acid-producing fermentative lactic acid bacteria

occurs when storage temperatures are sufficiently high for these microorganisms to outgrow

psychrotrophic bacteria or when product composition is inhibitory to gram-negative aerobic organisms.

\_ The group of lactic acid bacteria which is responsible for spoilage of raw milk are;

*Streptococcus*, *Enterococcus, Lactobacillus, Leuconostoc, Lactococcus* and *Pediococcus*.

\_ *Lactococcus lactis* subsp. *lactis* is the main species responsible for spoilage of raw milk

at 10-37◦C, being able to produce acid to cause milk to sour.

**3.4. SOURCES OF CONTAMINATION**

***Dear learner, can you mention the sources of milk microorganisms?***

**1. The Cow**

During milking, microorganisms can enter the milk from the skin of the teats, which often are

contaminated by dung, soil, or dust. Flakes of skin, hairs, and dirt from the feet and flanks can

also enter the milk. Several types of microorganisms can contaminate the milk, including

coliforms, spore forming bacteria and yeast and molds.

Appropriate housing and care of the cows is an essential measure to promote clean udders. Dirty

udders have to be cleaned thoroughly before milking. However, the complete removal of bacteria

is impossible.

**2. Soil, Dung, Dust**

All of these contaminants can reach the milk and thereby increase counts. Moreover, spores of

bacteria, yeasts and molds also occur in air. Spores can enter milk through air sucked in during

mechanical milking, or fall directly into the milk during milking in open milking pails. The

cleanliness of the milking parlor and the restfulness of the cows during milking are among the

factors determining contamination of the milk.

**3. The Feed**

Feed often contains large numbers of microorganisms. Feed can sometimes fall directly into the

milk but, more significantly, certain microorganisms in the feed survive passage through the

digestive tract and subsequently enter milk through dung; it includes some human pathogens.

Spore-forming bacteria, including *Bacillus cereus*, *B. subtilis*, and *Clostridium tyrobutyricum*,

which can spoil milk and milk products, are especially involved. Large numbers of *C.*

*tyrobutyricum* occur in silage of inferior quality.

**4. Milking Unit**

Poorly cleaned and disinfected milking equipment can contain large numbers of microorganisms.

Since these organisms generally originate from milk, they will grow rapidly and can decrease quality. Use of milking equipment that can be adequately cleaned and disinfected is thus

paramount. Small cracks in worn-out rubber units and ‘‘dead ends’’ in the equipment that are

insufficiently rinsed should be avoided.

**5. Water Used**

Tap water may be of good quality. Any private water supply must be examined at intervals.

Surface water can contain many microorganisms, including human pathogens. Especially in

tropical countries, the water may have very high counts.

**6. The Milker**

The milker contaminate the milk directly, e.g., from his hands. If the milker suffers from a

microbial infection, he might directly contaminate the milk with pathogens.

**Chapter Summary**

Milk is best medium for the growth of many organisms, having high water content, abundant

nutrients, and being nearly neutral pH value. Microorganisms present in milk can be classified

into three main groups: beneficial, pathogenic and spoilage organisms. The common sources raw

milk contaminations are; udder of a health cows, udder of a mastitic cow, skin of cow a hundred,

milking parlor (soil, dung, dust, air), feed, milking unit, water for cleaning, rinsing and good

milker.

**Review/Self-Test Questions**

**Part I. True or False**

**Direction: Write True if the Statement is Correct and False if the Statement is Wrong**

1. Spoilage organisms are those capable of inducing food poisoning, thus posing a threat to

public health.

2. Beneficial bacteria are used to make food product suitable for consumption.

3. Pathogenic bacteria are a kind of organism which is cause food unfit for consumption.

4. Coliform bacteria are able to ferment lactose with production of acid and gas at 32oC within

48 hours.

5. Fermentation changes the product from one food to another.

**Part II. Multiple Choice Items**

**Direction: Choose the Best Answer from the Following Alternatives**

1. From the following alternatives, one **cannot** explain the features of food poisoning

A. The microorganism forms a toxin in the food.

B. The consumer rapidly falls ill.

C. Small numbers of the pathogenic microorganism are usually needed to cause food

poisoning.

D. None of the above

2. ------------------------ is an ideal medium for the growth of many organisms, having high

water content and abundant nutrients and being nearly neutral pH.

A. Water B. Milk C. Egg D. All of the above

3. What are the sources of milk contamination?

A. Un-health cows B. Milking equipments C. Labour D. All of the above

4. From the following alternatives, which one is categorized under Gram-positive bacteria?

A. Spore-forming bacteria

B. Pseudomonas bacteria

C. Coliform bacteria

D. All of the above

5. Among spoilage causing microorganisms, which one is categorized under Gram-negative

bacteria?

A. Spore-forming bacteria

B. Lactic acid bacteria

C. Coliform bacteria

D. All of the above

**Answer Key to Self-Test Questions**

**Part I. True or False**

**1. False 2. True 3. False 4. True 5. True**

**Part II. Multiple Choice Items**

**1. C 2. B 3. D 4. A 5. C**

**CHAPTER FOUR: MILK PROCESSING**

**4.1. Introduction**

In rural areas, milk may be processed fresh or sour. The choice depends on available equipment,

product demand and on the quantities of milk available for processing. In Africa, smallholder

milk-processing systems use mostly sour milk. Allowing milk to ferment before processing has a

number of advantages and processing sour milk will continue to be important in this sector.

Where greater volumes of milk can be assembled, processing fresh milk gives more product

options, allows greater through put of milk and, in some instances, greater recovery of milk

solids in products.

Equipment not available locally, such as a milk separator, has a cost advantage and quickly gives

a good financial return in terms of increased efficiency. Hand-operated milk separators are

durable and have a long life when properly maintained. Importing of such equipment is,

therefore, advantageous.

In many rural dairy processing plants monitoring equipment may not be available and, although

yields may be maximized by adhering to the prescribed procedures, all these products can be

successfully made by approximating temperature, time, pH etc. It is particularly important in

cheese making to proceed when the curd is in a suitable condition. Therefore, times given are

only approximate and the processor will, with experience, adopt methods suitable to his/her own

environment.

**4.2. Why processing?**

There are many reasons to process milk into dairy products, such as the following:

· Many dairy products can be kept longer than fresh milk; therefore the milk does not have

to be consumed immediately.

· The demand for fresh milk may be limited, and there may be more interest in dairy

products.

· If the daily amount of fresh milk for sale is limited, it may be more economical to process

the milk into less perishable products, store them, and sell them later in greater quantities.

· There may be no market for fresh milk close by, and only preserved products can be sold

at markets at a greater distance.

· Greater financial gain may be obtained.

Apart from these reasons, it should also be realized that many population groups in Asia and

Africa cannot or can hardly consume milk because of so-called lactose intolerance. Lactose

intolerance implies that the body is almost or entirely unable to digest the milk sugar, lactose,

which is found in milk. Only small amounts of milk (up to 200 ml) consumed several times a day

can be digested. Dairy products in which a proportion of the milk sugar is converted during

production, such as cheese, curd, yoghurt and sour milk or buttermilk, do not cause many

problems in this respect.

Before processing surplus milk, one must consider whether it is profitable to do so. The

processing is not always easy and there may be losses. For example, a waste product of cheese

making is whey, which contains many valuable nutrients. If the whey is not used, a valuable part

of the milk is lost. Furthermore, while milk is being processed quality deterioration may occur

and it can go off. Only when milk is drunk immediately can you be sure that nothing is lost.

**4.2.1. What problems can arise?**

Small-scale processing of milk means the processing of small quantities of milk, up to 100 liters’

at a time, using simple implements and as little extra equipment as possible. Processing milk in

the tropics can be difficult because of the high temperatures and high relative humidity often

found there. These conditions present special problems in choosing the right kind of dairy

products. Their storage life must always be taken into account.

High temperature is bad for cheese making, especially for maturing cheeses. High temperatures

also cause the bacteria already present in milk to multiply quickly. Milk sugar then turns sour,

leading to the curdling of milk. However, these lactic acid bacteria are not harmful to humans.

Thorough cleaning of dairy utensils and equipment is essential. Anyone handling milk must also

pay great attention to hygiene. Lack of hygiene can contaminate milk with other types of

bacteria, which turn it sour and reduce its storage life. The prevention of contamination is

especially difficult when milk is collected from various places and processed centrally. Addition

of even a small quantity of infected milk contaminates the total quantity of the milk.

A further problem is the lack of equipment. One has to try to manage with simple dairy equipment, but even this can be difficult to find for small-scale milk processing. Electricity is

usually not available so electric equipment (e.g. for cooling) cannot be used unless a generator is

installed. Additives such as rennet for cheese making are often difficult to obtain in the tropics.

**4.3. Processing techniques**

Milk can be stored longer if it has been processed. Extended storage is possible if you are able to

control the growth of micro-organisms. The processing technique used will determine the storage

life of the milk and dairy products. The following rules should be followed during the

production, storage and processing of milk.

Always wash your hands and avoid putting them in the milk if not necessary.

· See to it that all equipment used during processing is properly cleaned and disinfected if

needed.

· Take care that no dirt particles or insects enter into the milk.

· Try to prevent the use of copper utensils. (Copper can give off flavors’ in butter and

milk.)

· Do not expose milk to sunlight; store it in a dark place.

· The use of a thermometer is recommended.

· Make sure that milk used for consumption has always been boiled or pasteurised.

· Never store raw (i.e. unheated) milk if it is not immediately cooled below 4°C.

· Never drink raw milk because it may contain pathogenic bacteria like tubercular bacteria

and salmonella.

The following processing techniques will be dealt with in this chapter:

· Pasteurization

· Cooling

· Souring (acidification)

· Creaming.

Heating and cooling are in fact ways to preserve milk, but for convenience we will deal with

them under the heading of processing techniques.

**4.3.1. Pasteurization**

As you by now know, milk contains certain micro-organisms that can spoil it. These bacteria

grow best at temperatures between 10°C and 40°C. It is therefore important to cool milk as

quickly as possible. This can be difficult in the tropics if no cold water or refrigerators are

available.

Most bacteria will be destroyed during heating. The most effective temperature depends on the

heating time. In other words, heating for a longer period at a lower temperature can be as

effective as heating for a shorter period but at a higher temperature.

Pasteurization improves the safety and storage life of a product, while the taste hardly changes

and the loss of vitamins is minimal. A distinction is made between low and high pasteurization.

Although high pasteurization initially kills more bacteria, the resulting milk can usually not be

kept as long, because the high pasteurization temperature stimulates spores of some bacteria to

germinate. Moreover, the taste of high pasteurized milk has more or less the flavor of boiled

milk. Pasteurized milk can be kept for about one week at 4-6°C if no re-infection takes place.

The pasteurization temperature to be used depends on the product to be made of the milk.

· Low pasteurization is used for milk for direct consumption and cheese.

· High pasteurization is used for yoghurt, butter and kefir.

**Table:** Time–temperature combinations for pasteurizing milk

**Type pasteurization Time remarks Temperature remarks Time temperature**

**remarks**

Low pasteurizing 30 minutes

3 minutes

20 minutes

63oc

68 oc

72 oc

Quantity>5liter

Small quantity

Industrial equipment

High pasteurizing 2 minutes

20 minutes

82 oc

85 oc

(\*) continuous flow system; not for small-scale processing

If there is no thermometer to measure the exact temperature, heat the milk to its boiling point.

**4.3.2. Cooling**

Storing milk at a low temperature will greatly reduce the growth of bacteria. Bacteria develop

much slower in cold milk. The best storage temperature is 4°C. If this temperature cannot be

achieved, store the milk in a dark place at the lowest temperature possible. Without cooling, raw

milk will spoil within a day.

**Table: Quality of raw milk after storage for 24 hours under different temperature and**

**hygiene conditions.**

**Storage**

**temperature (°C)**

**Very hygienic**

**conditions**

**Hygienic**

**conditions**

**Unhygienic**

**conditions**

4 Good Good Poor

10 Good Poor Poor

20 Poor Poor Bad

35 bad Bad Bad

Put the hot pasteurized or boiled milk in a clean container (the high temperature will disinfect the

container). Let it cool down as quickly as possible, preferably in a large pan with cold water

(refresh the water if it warms up). Cooling down in air, e.g. in a cold cellar or a refrigerator is

very ineffective as the transfer of cold by air is very slow. If you use a pan with cold water make

sure that no water enters into the milk because it would contaminate the milk again. Add ice

cubes to the cooling water, if available. Stir both the water and the milk during cooling with a

clean spoon, using different spoons. As mentioned above, properly pasteurized or boiled milk

can be kept for about one week if stored at 4°C. At 10°C it will spoil quickly; if it is 15°C or

warmer, it should be consumed the same day.

**4.3.3. Souring by fermentation or acidification**

Another way of increasing the shelf-life of milk is to ferment it into soured milk products. Part of

the milk sugar is converted into lactic acid by bacteria, for example by the yoghurt bacteria

Streptococcus thermofilus and Lactobacillus bulgaricus or the bacteria that grows at room

temperature Streptococcus lactis.

Fresh raw milk can be left to sour spontaneously, but then you cannot control which bacteria are

growing. It is better to sour the milk with the help of specific lactic acid bacteria as a starter

culture after the milk has been pasteurized. Quality and taste are influenced by the products that

the different lactic acid bacteria produce.

**4.3.4. Creaming**

Cream is made from the fat that rises to the surface of cow milk. A layer of fat forms on the

surface of the milk after it has been left to stand for at least half a day. After a day this layer

contains about 20% fat. The simplest way of collecting it is by skimming it off the top of the

milk. Sheep and goat milk do not cream easily. You will need a creamer or centrifugal separator

to obtain good results. You should be able to get about 1 - 2 liters’ of cream from 10 liters’ of

milk.

The skimmed milk which remains after the removal of the cream is still very nutritious, because

it contains nearly all the protein of the milk. You can either drink it or use it for the production of

sour milk or cheese. Sour (fermented) cream and sour (fermented) milk are produced by

incubation of inoculated fresh cream or fresh milk. A culture of lactic acid bacteria is used for

inoculation of the fresh milk or the fresh cream.

Butter (80% fat) and buttermilk are made by churning cream or milk. One hundred liters’ of milk

with a 4% fat content produces 20 – 30 liters’ of cream, which yields about 4 kg of butter.

However, butter is not an important product in tropical countries because it melts easily at high

temperatures and it is expensive. There is generally little demand for butter. Butter and cream

can be used to make ghee. Ghee keeps better than cream and butter as it contains practically no

moisture; it is almost pure milk fat.

**4.4. Milk products**

**4.4.1. Fermented milk products**

Smallholder milk processing is based on sour milk. This is due to a number of reasons including

high ambient temperatures, small daily quantities of milk, consumer preference and increased

keeping quality of sour milk.

Products made from sour milk include fermented milks, concentrated fermented milks, butter,

ghee, cottage cheese and whey. Other products are made by mixing fermented milk with boiled

cereals. The equipment required for processing sour milk is simple and available locally. Milk

vessels can be made from clay, gourds and wood, and can be woven from fiber, such as the *gorfu*

container used by the Borana pastoralists in Ethiopia.

**4.4.1.1. Milk fermentation**

Raw milk produced under normal conditions develops acidity. It has long been recognized that

highly acid milk does not putrefy. Therefore, allowing milk to develop acidity naturally

preserves the other milk constituents. Raw milk produced under normal conditions develops

acidity.

Bacteria in milk are responsible for acid development. They produce acid by the anaerobic

breakdown of milk carbohydrate----lactose----to lactic acid and other organic acids. The

conversion of carbohydrate to organic acids or alcohols is called fermentation. Pyruvic acid

formation is an intermediate step common to most carbohydrate fermentations:

C6H12O6 --------> 2 CH3.CO.COOH

However, fermentations are usually described by the end product such as lactic acid or ethyl

alcohol and carbon dioxide.

A number of sugar fermentations are recognized in milk. They can be either homo-fermentative,

with one end product, or hetero-fermentative, with more than one end product.

· The lactic acid fermentation is the most important one in milk and is central to many

processes.

· Propionic fermentation is mixed-acid fermentation and is used in the manufacture of

Swiss cheese varieties.

· Alcohol fermentation can be used to prepare certain fermented milks and also to make

ethyl alcohol from whey.

· The coliform gassy fermentation is an example of spoilage fermentation. Large numbers

of coliform bacteria in milk indicates poor hygiene. The coliform gassy fermentation

disrupts lactic acid fermentation, and also causes spoilage in cheese.

The factors that affect microbial growth also affect milk fermentation. Fermentation rates

generally parallel the microbial growth curve up to the stationary phase. The type of

fermentation obtained depends on the numbers and types of bacteria in the milk, storage

temperature and the presence or absence of inhibitory substances.

The desired fermentations can be obtained by temperature manipulation or by adding a selected

culture of micro-organisms “starter” to pasteurized or sterilized milk. In smallholder milk

processing, a small quantity of milk from previous batches is often used to provide ‘‘starter’’ for

subsequent batches. Other sources include the container and additives such as cereal grains.

The fermentation is established once the organisms dominate the medium and continues until

either the substrate is depleted or the end product accumulates. In milk, accumulation of end

product usually arrests the fermentation. For example, accumulation of lactic acid reduces milk

pH to below 4.5, which inhibits the growth of most micro-organisms, including lactic-acid

producers. The fermentation then slows and finally stops. Fermented milks are wholesome foods

and many have medicinal properties attributed to them.

**4.4.1.2. Fermented milks**

The types of fermented milk discussed here are those made by controlled fermentation. This is

achieved by establishing the desired micro-organisms in the milk and by maintaining the milk at

a temperature favorable to the fermentative organism.

A variety of fermented milks are made, each differing markedly from the other. However, a

number of steps are common to each manufacturing process.

**I. Standardization**

Occasionally some fat is removed or skim milk is added to the fresh whole milk. In some instances, the removal of moisture during sterilization increases the proportion of solids in the final product.

**II. Heating**

Milk is heated to kill pathogens and spoilage organisms and to provide a cleaner medium in

which the desired micro-organisms can be established. Heating also removes air from the milk,

resulting in a more favorable environment for the fermentative organisms, and denatures the

whey proteins, which increases the viscosity of the product.

After heating, the milk must be cooled before it is inoculated with starter, otherwise the starter

organisms will also be killed.

**III. Inoculation with starter**

Starter is the term used to describe the microbial culture that is used to produce the desired

fermentation and to flavour the product. When preparing the starter, care must be taken to avoid

contamination with other micro-organisms. Companies that supply starter cultures detail the

precautions necessary. Care should also be taken to avoid contamination when inoculating the

milk with starter.

**IV. Incubation**

After inoculation the milk is incubated at the optimum temperature for the growth of the starter

organism. Incubation continues until the fermentation is complete, at which time the product is

cooled. Additives, e.g. fruit or herbs may be added at this stage and the product packed.

**Table: Manufacturing procedures for yoghurt, acidophilus milk and kefir.**

**Product Milk Standardize Sterilize Starter Incubation**

**temperature**

**(°C)**

**Incubation**

**time**

**(hours)**

Yogurt Cow Optional 850c

30 min

*S. thermophilus*

*L. bulgaricus*

42 4-6

Acidophilus

milk

Cow Optional 1200c

20 min

*L. acidophilus* 38 18-24

*Kefir* Cow

Ewe

Goat

Mare

- 850c

30 min

*Kefir* grains1 22 12

*Kefir* grains are irregular granules in which bacteria and yeast grow. When they are

introduced into the milk, the micro-organisms on the granules bring about the fermentation.

**V. Preparation of the fermentation vessel**

The fermentation vessel is washed, dried and then smoked by putting burning embers of *Olea*

*africana*, wattle or acacia into the vessel and closing the lid. The vessel is then shaken vigorously

and the lid opened to release the smoke. This procedure is repeated until the inside of the vessel

is hot. Smoking flavors’ the product and is also thought to control the fermentation by retarding

bacterial growth. While it is known that smoke contains compounds that retard bacterial growth,

the precise effects of smoking on fermentation have not been investigated. Once smoking is

complete the vessel may be cleaned with a cloth to remove charcoal particles. However, in some

areas the charcoal particles are retained to add colour to the product.

**VI. Milk treatment**

In some processes the milk is boiled before fermentation. It is then cooled and the surface cream

removed. In other processes the milk is not given any pre-fermentation treatment.

**VII. Fermentation**

The milk is placed in the smoked vessel and allowed to ferment slowly in a cool place at a

temperature of about 16--18°C. The fermentation is almost complete after two days, but may be

continued for a further two days, by which time the flavor is fully developed. The milk must

ferment at low temperature otherwise fermentation is too vigorous with resultant wheying off

and gas production. The product has a storage stability of 15 to 20 days.

**VIII. Concentrated fermented milk**

Concentrated fermented milk is prepared by removing whey from fermented milk and adding

fresh milk to the residual milk constituents. The fermentation vessel is prepared as for fermented

milk and the milk is allowed to ferment in a cool place for up to seven days, during which milk

may be added daily. After seven days a coagulum has formed and the clear whey is removed.

Fresh milk is then added and, following further fermentation, whey is again removed.

In this way the casein and fat are gradually concentrated in a product of extended keeping

quality. The degree of concentration depends on the amount of whey removed and of fresh milk

added.

**4.4.2. Butter making**

This is a very important process in many parts of Africa and countries with a developing dairy

industry. Smallholders produce one to four liters’ of milk per day for processing. Under normal

storage conditions the milk becomes sour in four to five hours. Souring milk has a number of

advantages. It retards the growth of undesirable micro-organisms, such as pathogens and

putrefactive bacteria and makes the milk easier to churn.

Milk for churning is accumulated over several days by adding fresh milk to the milk already

accumulated. The churn may hold up to 20 liters’ and the amount of milk churned ranges from 4

to 10 liters’. Butter is made by agitating the milk until butter grains form. The churn is then

rotated slowly until the fat coalesces into a continuous mass. The butter thus formed is taken

from the churn and kneaded in cold water.

The milk is usually agitated by placing the churn on a mat on the floor and rolling it to and fro. It

can also be agitated by shaking the churn on the lap or hung from a tripod.

A number of factors influence churning time and recovery of butterfat as butter:

· Milk acidity.

· Churning temperature.

· Degree of agitation.

· Extent of filling the churn.

**I. Effect of acidity**

Fresh milk is difficult to churn i.e. churning time is long and recovery of butterfat is poor;

however, milk containing at least 0.6% lactic acid is easier to churn. Acidity higher than 0.6%

does not significantly influence churning time or fat recovery.

**II. Effect of temperature**

Sour milk is normally churned at between 15 and 26°C, depending on environmental

temperature. At low temperatures churning time is long; butter-grain formation can take five

hours or longer. As churning temperature increases churning time decreases. ILCA trials have

shown that when churning sour whole milk using the traditional method, fat recovery values of

67% and 44% were obtained with churning temperatures of 18°C and 25°C, respectively.

Controlling the temperature is therefore critical. The optimum churning temperature is between

15 and 17°C.

**III. Degree of agitation**

Increasing agitation reduces churning time. Fitting an agitator to a traditional churn reduces

churning time and increases butter yield. The percentage of fat recovered as butter is increased,

with as little as 0.2% fat remaining in the buttermilk. The advantage of using the ILCA internal

agitator was demonstrated when churning sour whole milk at 18°C. Using the traditional clay pot

a fat recovery of 67% was obtained compared to a 76% fat recovery when using the clay pot

fitted with the internal wooden agitator.

**IV. Extent of filling the churn**

Churns should be filled to between a third and half their volumetric capacity. Filling to more

than half the volumetric capacity increases churning time considerably but does not reduce fat recovery.

Thus, when churning whole milk, the following conditions should be adhered to:

· Milk acidity should be greater than 0.6%.

· The temperature should be adjusted to about 18°C.

· Internal agitation should be used to reduce churning time and increase fat recovery.

· The churn should not be filled to more than half its volumetric capacity.

Once the fat has been recovered by churning the buttermilk contains casein, whey proteins, milk

salts, lactic acid, lactose, the unrecovered fat and some fat globule membrane constituents.

Buttermilk is suitable, and is often used, for direct consumption. It is also used to inoculate fresh

milk to encourage acid development and for cheese making.

**4.4.3 Butter & Ghee**

These products are almost entirely butterfat and contain practically no water or milk solids-notfat

(SNF). Ghee is made in eastern tropical countries, usually from buffalo milk. An identical

product called *samn* is made in Sudan. Much of the typical flavor comes from the burned milk

SNF remaining in the product. Butter oil or anhydrous milk fat is a refined product made by

centrifuging melted butter or by separating milk fat from high-fat cream.

Ghee is a more convenient product than butter in the tropics because it keeps better under warm

conditions. It has low moisture and milk SNF contents, which inhibits bacterial growth. Milk or

cream is churned as described in the sections dealing with churning of sour whole milk or cream.

When enough butter has been accumulated it is placed in an iron pan and the water evaporated at

a constant rate of boiling. Overheating must be avoided as it burns the curd and impairs the

flavor. Eventually a scum forms on the surface and can be removed using a perforated ladle.

When all the moisture has evaporated the casein begins to char, indicating that the process is

complete. The ghee can then be poured into an earthenware jar for storage.

A considerable amount of moisture and milk SNF can be removed before boiling by melting the

butter in hot water (80°C) and separating the fat layer. The fat can be separated either by gravity

or using a hand separator. The fat phase yields a product containing 1.5% moisture and little fat

is lost in the aqueous phase.

Alternatively, the mixture of butter and hot water can be allowed to settle in a vessel similar to

that used in the deep-setting method for separating whole milk. Once the fat has solidified the

aqueous phase is drained. The fat is then removed and heated to evaporate residual moisture.

Products made using these methods have excellent keeping qualities with a shelf-life of about six

months at ambient temperature.

**4.4.4 Cheese**

Cheese is a concentrate of the milk constituents, mainly fat, casein and insoluble salts, together

with water in which small amounts of soluble salts, lactose and albumin are found. To retain

these constituents in concentrated form, milk is coagulated by direct acidification, by lactic acid

produced by bacteria, by adding rennet or a combination of acidification and addition of rennet.

Rennet, a proteolytic enzyme extracted from the abomasum of suckling calves, was traditionally

used for coagulating milk.

**4.4.4.1 Cheese varieties**

Many cheese varieties are manufactured around the world but they are all broadly classified by

hardness, i.e. very hard, hard, semi-soft and soft, according to their moisture content.

Cheese is usually made from cow milk, although several varieties are made from the milk of

goats, sheep or horses.

**4.4.4.2 Cheese making with sour skim milk**

The casein and some of the unrecovered fat in skim milk and buttermilk can be heat-precipitated

as cottage cheese, known in Ethiopia as *ayib.* The defatted milk is heated to about 50°C until

distinct curd mass forms. It is then allowed to cool gradually and the curd is ladled out.

Alternatively, the curd can be recovered by filtering the cooled mixture through a muslin cloth.

This facilitates more complete recovery of the curd and also allows more effective moisture

removal. Temperature of heating can be varied between 40 and 70°C without markedly affecting

product composition and yield. Heat treatments between 70 and 90°C do not appear to affect

yield but give the product a cooked flavor.

The whey contains about 0.75% protein, indicating near-complete recovery of casein. Whey may

be consumed by humans or fed to animals. The approximate composition of cottage cheese made

at smallholder level is 76% water, 14% protein, 7% fat and 2% ash. It has a short shelf-life

because of its high moisture content. The shelf-life can be increased by adding salt, reducing the

moisture content of the cheese or by storing the product in an airtight container. Skim milk can

be heated in any suitably sized vessel that is able to withstand heat. Heating can be direct or

indirect. A ladle or muslin cloth can be used for product recovery. The yield depends on milk

composition and on the moisture content of the product, but should be at least l kg of cottage

cheese from 8 liters’ of milk (12.5%).

**Chapter Summery**

Milk and milk products have been used by man since prehistoric times. Fermented milks have

been prepared for more than 2000 years. Allowing milk to ferment naturally gives an acidic

product that does not putrefy. Fermented milks are wholesome and readily digestible; examples

of such products are yoghurt, *kefir, koumiss* and acidophilus milk.

The development of the milk separator in the 19th century made centralized milk processing

possible. Initially, cream was separated and retained for butter making and the fresh skim milk

was returned to the milk producers. As the nutritional importance of the non-fat component

(skim milk) became recognized, processes were developed to conserve milk solids-not-fat

(SNF). Casein and casein products as well as lactose and dried milk were prepared. Today, up to

60% of the milk produced in the world is converted into dehydrated milk products and foods

containing a large proportion of milk solids. In countries with commercial dairying these

processes are carried out in large-capacity processing plants.

Milk is processed primarily to convert it into a more stable product, e.g. fermented milk can be

stored for about 20 days compared with less than one day for fresh milk. Milk products are more

stable than fresh milk because they are more acidic and/or contain less moisture. Preservatives,

e.g. salt may also be added to milk products. Thus, by increasing the acidity and reducing the

moisture content, the storage stability of milk can be increased.

Cheese varieties peculiar to each region developed because of the different agricultural

conditions prevailing in each country. There are, at present, almost 2000 recognised varieties of

cheese.

**Check list questions**

**Choose the best answer**

1. In rural areas, milk may be processed fresh or sour. The choice depends on

A. Available equipment

B. Product demand

C. The quantities of milk available for processing.

D. All

E. None

2. Which one of the following statement is the reason to process milk into dairy products?

A. Many dairy products can be kept longer than fresh milk.

B. Demand for fresh milk may be limited, and there may be more interest in dairy

products.

C. Greater financial gain may be obtained.

D. All

E. None

3. All are responsible for the souring of milk except

A. Lactobacillus bulgaricus

B. Streptococcus thermofilus

C. Streptococcus lactis.

D. All

E. None

4. Which one of the following statement is true about creaming?

A. Cream is made from the fat that rises to the surface of cow milk.

B. Sour (fermented) cream and sour (fermented) milk are produced by incubation of

inoculated fresh cream or fresh milk.

C. The skimmed milk which remains after the removal of the cream is still very

nutritious.

D. All

E. None

5. All are sour milk products except

A. Butter

B. Cottage cheese

C. Whey

D. All

E. None

**CHAPTER FIVE: MEAT PROCESSING**

**5.1 Meat Production and Consumption in Ethiopia**

As Ethiopia’s 2003 estimated population of 70.5 million continues to grow at a rate of 2.7

percent, it is critical to understand the food situation. Many Ethiopians, like residents of other

developing countries, do not consume an adequate amount of meat. The few that do, however,

maintain a meat diet of beef, sheep, goat, and poultry. In 1987, 51 percent beef, 19 percent sheep,

14 percent goat, and 15 percent poultry contributed to a meat diet composition (Map Zones).

Most Ethiopians do not consume pork, in addition to many types of fish, due to religious beliefs.

The consumption of sufficient meat is a rare extremity in most developing countries. While

developed countries consumed a consistent level of 77kg of meat per capita annually, developing

countries struggled to maintain a diet with only 25kg of meat per capita annually. More

specifically, while the United States had an average meat intake of over 120kg per capita

annually, at hardly over 8kg annually, Ethiopians remained slightly below the meat intake of all

low-income countries consuming 9kg per capita annually (FAOSTAT, 2004).

**Table: Meat projection to 2020**

**Type Projected annual**

**growth of total**

**consumption %**

**1993-2020**

**Total consumption**

**(mmt)**

**Annual per**

**capita**

**consumption**

**(kg)**

**1993 2020 1993 2020**

Developed countries

Beef 0.4 32 36 25 26

Poultry 1 26 34 20 25

Meat 0.6 97 115 76 83

Developing countries

Beef 2.8 22 47 5 7

Poultry 3.1 21 49 5 8

Meat 2.8 88 188 21 30

Meat Production

Sub Sahara Africa

3.4 11 10

Meat Consumption

Sub Sahara Africa

3.5 12 11

Source: Courbois, Delgado et al. 1999

The meat consumption in developing countries increases slightly. At a 2.8 percent increase from

1993 to the year 2020, developing countries will consume 30kg of meat per capita in 2020. Meat

consumption in sub-Saharan Africa, however, remains at only 11kg per capita annually

(Courbois, Delgado et al., 1999).

**5.2. Structure of muscle**

Animal musculature is mostly of mesodermal origin. There are more than 300 muscles in the

animal body. These muscles constitute about 30-45% of the live weight or 35-60% of the carcass

weight of meat animals. In addition to the skeletal muscle, which forms the bulk of meat, a little

of smooth and cardiac muscles are also present in blood vessels and heart respectively. Smooth

and cardiac muscles are involuntary in nature. Skeletal and cardiac muscles are sometimes

referred as striated muscles due to their specific microscopic appearance.

**5.2.1. Skeletal Muscle and Associated Connective Tissue**

In general, skeletal muscles are directly attached to the bones, although some attach indirectly

via ligament, cartilage, fascia and skin. Each muscle is surrounded by a sheath of connective

tissue known as epimysium. From the inner surface of epimysium, a septum of connective tissue

penetrates into muscle and surrounds the bundles of muscle fibers or fasciculi. This connective

tissue is called perimysium. It contains major blood vessels and nerves. Muscle fibers or

specialized muscle cells are the structural units of the skeletal muscle tissue. Each muscle fiber is

surrounded by a connective tissue layer called endomysium, beneath which is delicate

sarcolemma or muscle cell membrane. It transmits nervous signals along the surface of muscle

fiber.

Skeletal muscle fibers are long, narrow, almost tubular multinucleated cells which may extend

from one end to the other end of the muscle. The nuclei are distributed peripherally close to the

sarcolemma. Muscle fibers are usually 10-100μ in diameter with conical or tapering ends and

their length ranges from 1-40 mm. The individual fiber may also be classified as red,

intermediate and white. Most animal muscles contain a mixture of these three types. Red muscle

fibers have smaller diameter, lower glycolytic metabolism and ATPase activity but higher

oxidative metabolism as compared to white muscle fibers.

Myofibrils have a number of elongated unbranched contractile muscle fiber that occupies almost

80% of its volume. They are responsible for the cross-striated appearance of the muscle fiber.

Each myofibril is about 1μg in thickness and may run the length of muscle fiber. The crossstriated

myofibrils remain embedded in the cytoplasm of the muscle fiber called sarcoplasm. The

myofibrils are surrounded by a complex system of membrane tubules. The longitudinal tubules

called sarcoplasmic reticulum run parallel to myofibrils. Another series of tubules run

transversely as invaginations of the sarcolemma. The sarcoplasmic reticulum and T-tubules are

arranged in a sequence and play an important role in generating Ca++ fluxes in the excitation contraction mechanism. Sarcoplasm also contains glycogen particles, lipid droplets etc.

Connective tissue serves as the major supportive element of the animal body. It envelops the

muscle fibers (endomysium) and bundles (perimysium) and finally the entire muscle

(epimysium) connective tissue fibers form the bulk of tendons and ligaments. The tendons attach

muscle with bone whereas ligaments connect two bones or support organs. Connective tissue

which is primarily made up of cells storing fat droplets. It is seen around kidneys, omentum and

in and around various muscles and organs.

**5.2.2 Smooth Muscles**

Smooth muscles are found in the gastro-intestinal tract, blood vessels, lymphatics and skin in

close association with the connective tissue layers. These are involuntary in nature. Smooth

muscle fibers are long, unevenly thickened in the centre and tapering on both the sides. The

myofibrils are homogenous and do not show alternating dark and light bands like those of

skeletal muscle. There is no Z or M-lines. The sarcoplasmic reticulum is also not much

developed.

**5.2.3 Cardiac Muscles**

The cardiac muscles found in the heart are also involuntary. Their muscle fibers are rounded to

irregular in shape and give off branches which get mixed up with those of nearby fibers. The

nuclei are placed in the centre of the fiber. Myofibrils depict striations similar to skeletal muscle.

The sarcoplasm shows numerous and much more mitochondria than the skeletal or smooth

muscles. The intercalaged discs are present at the position of Z-lines.

**5.3. Slaughtering facilities**

**5.3.1 Slaughter house construction and plant sanitation:**

***I. Site selection:***

A suitable site for an abattoir should have the following facilities.

· Main water supply & electricity.

· Main sewerage

· Contiguity with uncongested road and rail system.

· Proximity with public transport.

· Proximity to supply of varied labour.

· Freedom from pollution from other industries’ odours, dust, smoke, ash, etc.

· Sufficient size for possible future expansion.

· Good availability of stock nearby.

Abattoirs should not be constructed:

o In residential areas to avoid complaints about noise and smell.

o In industrial areas.

o In city expansion areas (urban sites should be avoided).

The compound should be Well drained, stable foundation (not soil), free from flooding. Therefore,

the actual site need not be a flat one. Slopes can provide suitable loading bays for stock and product.

The water should be potable (chlorinated), and storage tanks should be available.

***Structures included in ideal abattoir:***

An ideal abattoir include the following structures

· Adequate lairage (the place where animals are kept before slaughter), waiting pens for the

animals.

· Slaughter premises large enough for work to be carried out satisfactorily.

· A room for emergency slaughter.

· A room for slaughtering, stunning & bleeding.

· A room for emptying and cleansing stomach and intestine (eviscerating room).

· A separate room for dressing, cleaning and treatment of hides and offal’s.

· Sufficiently large chilling or refrigerating rooms.

· Lockable rooms for the accommodation of sick or suspected animals, the slaughter of such

animals, the storage of detained meat and the storage room for seized (condemned) meat or

products.

· In rooms where work on meat is undertaken – water- proof flooring, easy to clean and

disinfect, rat-proof, slightly sloping and suitable drainage system.

· Adequate ventilation, natural or artificial lighting.

· Changing rooms, wash basins, showers and flush lavatories.

· Adequate supply of hot potable water.

· An overhead system of rails for the further handling of the meat.

· An appropriate protection against pests.

· Veterinary office should have an adequately equipped lockable room. The room should be

provided with hand-washing and shower facilities, and lockers for clothing (work and

personal) and meat inspection equipment.

· Veterinary laboratory.

**5.4 Method of slaughtering**

All methods of slaughter aims at securing maximum bleeding of the animal and the humane

method also aim to avoid unnecessary suffering. The main method of slaughtering is:

1) Slaughtering with previous stunning (stunning prior to bleeding)

2) Slaughtering without previous stunning.

**Stunning methods**

Particularly with large animals, stunning is important to immobilize the animal to facilitate

severing the blood vessels (sticking) to kill it. Operator safety would be severely compromised

by trying to stick a conscious animal unless it was fully restrained. Manual restraint is feasible

for small animals like sheep but not for cattle. Restraint in specially designed pens is a feature of

Jewish slaughter in high throughput plants in Europe and North America. The value of stunning

in preventing the animal feeling pain or distress at exsanguination has been mentioned already.

To be effective in this regard the stunning process must render the animal insensible

immediately, or, if it is not immediate, the process must be completely pain and stress-free. By

relaxing the body, some stunning techniques may also benefit carcass quality.

There are different ways in which animals can be stunned. They fall into three main types. The

first is use of a mechanical instrument (captive bolt pistol, percussion stunner or free bullet)

which traumatizes the brain so that the animal loses consciousness instantaneously. The second

is use of an electrical current passed through the brain. The third is the induction of

unconsciousness by immersion in an anaesthetic gas such as carbon dioxide. All methods should

be considered to serve *only* to render the animal unconscious. After stunning the animal must be

killed by exsanguinating it as soon as possible. This is normally done by severing the blood

vessels in the neck (the carotid arteries and jugular veins) or the blood vessels from which they

arise where they enter the heart at the base of the throat (chest sticking).

**5.5 Meat Inspection**

Meat inspection refers to examination of meat for some abnormalities and diseases. It is an expert

supervision of meat with the objective of providing sound and wholesome meat for human

consumption. A proper meat inspection service consists of a veterinary examination of the live

animal (ante-mortem inspection), and examination of the carcass and offal (post-mortem

inspection) and where necessary, laboratory tests of body tissues and fluids.

**5.5.1. Ante-mortem inspection**

Ante-mortem inspection is an examination of the live animal on entry to the slaughter house.

Without ante-mortem inspection, it is difficult to provide adequate inspection of the carcass or meat

is possible. The reason for ante-mortem examination of all livestock for slaughtering is:

\_ To screen all animals destined for slaughter.

\_ To isolate suspects and perform detailed clinical examination.

\_ To select and detain extremely dirty animals not to contaminate the killing floor.

\_ To prevent the contamination of the premises, equipments, and personnel by animals

affected from communicable diseases.

\_ To ensure emergency slaughter for injured/suffering animals.

\_ To separate fevered and excited animals.

\_ To identify those animals harboring residues, e.g. Antibiotic residues.

\_ To detect animals affected with disease, which otherwise difficult to detect during postmortem

inspection.

**Guidelines and principles**

· No animal shall be slaughtered without undergoing ante-mortem inspection.

· All animals should be inspected within 24hrs of delivery.

· If 24hrs have elapsed after ante-mortem inspection, the ante-mortem inspection should be

repeated.

· Ante-mortem inspection should be made in well-lighted lairage pen and a crush for

examination of individual animals.

· Every animal should be properly identified and accompanied by certificate, which indicates

the origin of the animal.

· Presence of assistants to hold animals during inspection.

**5.5.1.1. Procedures of ante-mortem inspection**

Animals should be inspected at rest (to asses posture, detect lameness, to study their behavior) &

in moving condition.

Slow reaction or dullness could be attributed to diseases. Excitement may suggest specific

diseases such as rabies, tetanus, and poisoning. General examination should be followed by

examination of body system, for example, the digestive and respiratory systems.

***The digestive system***: is examined to assess rumination and nutritional status. Emaciation could

be attributed to diarrhea resulting from specific diseases such as Johne’s disease, salmonellosis,

infection with E. coli, clostridia, rinder pest and other viral disease.

***The respiratory system***: is examined to detect for the presence of nasal discharge, cough and to

determine the type of respiration. Forced respiration may suggest CBPP, CCPP, tuberculosis,

pasteurellosis, and lungworm parasites. The presence of excessive nasal discharge may suggest

affection of the upper respiratory system (rhinitis, *Oestrus ovis*). Excessive salivation may be due

to mucosal disease complex, FMD, rinderpest, or rabies.

**5.5.1.2. Judgment categories at ante-mortem inspection:**

The following decisions are passed during ante-mortem inspection

a) Approved for slaughter.

b) Condemned for slaughter.

c) Slaughter authorized under special precautions.

d) Authorization for slaughter delayed.

e) Emergency slaughter ordered.

***A. Approved for slaughter without any restriction:***

This judgment is passed, if during ante-mortem inspection, no evidence of disease is noted.

**B. *Condemned for slaughter***:

These are animals unfit for slaughter. This decision is made

I. If specific contagious diseases or zoonotic diseases have been detected with antibiotics.

II. If the certificate accompanying the animal reveals the information that the animal has been

treated with antibiotics.

Stock unfit for slaughter will include emaciated animals, those affected with diseases such as

tetanus, rabies etc &those carrying toxic residues; Immature, weak and diseased calves.

***C. Slaughter authorized under special precautions***

This judgment is passed, if the animal is suspected to have been infected with noticeable disease.

Such animal is slaughtered in a separate section of the slaughterhouse or at the end of the

slaughtering of healthy animals.

***D. Authorization for slaughter delayed***

This judgment is passed, if the period of rest has not been maintained; and the animal is affected

by a condition, which temporarily limits the fitness of meat for human consumption.

***E. Emergency slaughter ordered***

This judgment is passed, if at ante-mortem inspection, the animals are affected by a condition,

which does not affect the quality of meat and the public health. Such condition includes

traumatic lesions.

Emergency slaughter ordered refers the slaughter of an animal revealing an acute pain or

suffering from an injury, or approaching death or death is inevitable, provided that the meat does

not pose public health hazards.

This judgment is passed for two reasons. To relieve the animal from suffering and to save

economic loss, which may arise from death of the animal.

The main accidents, which lead to emergency slaughter, include fracture of limbs, pelvis or ribs

and extensive bruising. Diseases, which frequently lead to emergency slaughter, are dystocia,

transport tetany, pregnancy toxaemia in ewes, tympanitis, generalized mastitis, asphyxia and

obstruction of the esophagus.

Emergency slaughter should not be confused with ***causality slaughter*** refers to the slaughter of

animal suffering from chronic illness e.g. milk fever, obturator paralysis.

***Judgement on emergency slaughtered animals:***

Before passing the judgment on emergency and causality slaughter, the following examination

should be carried out.

· Examination of blood smear taken from the ear of the animal to ensure that the animals

were not suffering from any epizootic or zoonotic disease.

· Examination of lymph and lymph nodes.

· Exploratory incision in to the muscle to ensure that the animal has been bled efficiently.

· Inspection of the subcutaneous tissues to find extensive bruising, congestion of blood

vessels and oedema.

· Detailed examination of all joints.

· Bacteriological examination.

Judgment on emergency slaughtered carcass; the carcass needs to be totally condemned, if

The animal has died before slaughtering.

The carcass is not accompanied with visceral organs and presented for inspection.

The carcass reveals abnormal odour.

***5.4.1.3 Repetition of ante-mortem inspection***

Ante-mortem inspection shall be repeated, if

A. The slaughter has not been effected within 24hrs.

B. Additional information or diagnostic tests are required.

C. The animal reveals obscure dubious clinical signs during the initial ante-mortem inspection.

***Postponing the slaughter***

The slaughter of the animal may be postponed, if

a) Curable disease is diagnosed.

b) The animal is found in stage of late pregnancy.

c) The animal has been found treated with drugs, which may affect the consumer.

During ante-mortem inspection, special attention should be given to recumbent animals. On

occasions, dead animals will be encountered in animals within lairage waiting for slaughter.

Anthrax must always be born in mind and a blood smear should be taken, stained with

polychrome methylene blue and examined for *Bacillus anthracis*. Observation of the dead

animal, the nature and colour of any blood oozing from the natural orifices is of great value in

determining the possibility or otherwise of anthrax.

The greatest care must be taken in the handling, slaughter and carcass dressing of animals, which

may represent source of infection to plant staff. In particular such animal should be handled

separately from normal stock; staff should wash hands and arms frequently.

Avoid cuts and contamination of the eyes with body fluids, avoid handling udders and urogenital

tracts (hooks to be used instead), and incision in to these organs and the associated lymph nodes

should be provided. Adopt a high standard of personal cleanliness at all times and seek medical

advice if you have suspicion of disease exposure or fever has occurred. It is also important to

clean and disinfect the areas where such kinds of animals and their carcass and their product

have been in contact with water and appropriate disinfectant. The equipments used should be

sterilized.

**5.4.1.4 Reporting the result of ante-mortem inspection**

The ante-mortem inspector shall report the results of ante-mortem inspection to the person

conducting post-mortem inspection. If the same person is conducting the ante-mortem and postmortem

inspection, the results of the finding should be filed.

Veterinary certification of causality and emergency slaughter animals and carcasses places a

heavy responsibility on veterinary surgeons examining such cases.

The final report of ante-mortem inspection shall include the following:

· Date and time of ante-mortem inspection.

· Categorized according to species, sex and age, number of animals condemned, detained,

approved and number of emergency slaughter, reasons for condemnation, name and

signature of veterinarian who has carried the ante-mortem inspection.

**5.4.2 Post-mortem inspections:**

Post-mortem inspections refers to examination of the carcass and associated organs after

slaughtering to detect and eliminate abnormalities including contamination to ensure only meat

fit for human consumption is passed for food.

The main objectives of post-mortem inspection is

\_ To detect diseases and conditions which could not be detected during ante-mortem

inspection.

\_ To pass carcasses or organs which are fit for human consumption.

\_ To supervise and control the hygienic dressing of carcasses.

**5.4.2.1 Principles of post-mortem inspection**

The meat inspector should always be present during post-mortem inspection and before

beginning the slaughtering operations/he/she should ensure that

\_ The slaughter hall and equipments are clean.

\_ The sewage system is functioning properly.

\_ The availability of adequate supply of potable water.

\_ Availability of adequate light.

\_ Presence of adequate personnel and their hygienic status.

***Facilities required***

o Washing and disinfection facilities.

o Towel and soap.

o Carcass and organ hanging facilities, etc.

The following guidelines should be ensured (by the inspector) while post-mortem inspection is in

progress:

o Evisceration is effected without delay.

o Incisions are made without obliteration.

o Offal’s, carcasses, and heart are labeled and bear the same number.

o No lesion is removed before judgment is passed.

o No lesions are modified or obliterated to disguise meat inspection.

o No removal of organs or carcass before final judgment is passed.

o No removal of identification marks.

***Procedures of post-mortem inspection***

Meat inspection legislation throughout the world requires examination of the carcass and viscera

of each animal and bird. In general the disposition of the carcass, its organ, state of nutrition, any

ante-mortem report and the results of any necessary laboratory tests are all taken in to

consideration in making a final judgment.

Responsibility to the consumer must be the upper most priority in the inspector’s mind. As the

same time there must be no unnecessary wasting of valuable meat.

**5.6. Fabrication of meat**

***Basic Processing Procedures:***

**I. Comminution**

All processed meats can be classified as either non-comminuted or comminuted products. Noncomminuted

products are generally processed from intact cuts. These products are usually cured,

smoked and cooked, e.g. ham and bacon. Comminution refers to subdivision or reduction of raw

meat into meat pieces or particles. The degree of comminution or particle size varies with the

processing characteristics of products. Such meat particle size reduction helps in the uniform

distribution of seasonings and eliminates the toughness associated with meat of old animals and

lowers the fuel cost for cooking (Padda et al, 1987). Comminution is done with the help of meat

mincer for coarse ground products whereas bowl chopper is also employed for making fine meat

emulsion.

**II. Emulsification**

A mixture of two immiscible liquids where one liquid is dispersed as droplets in another liquid is

called emulsion. An emulsion has two phases; a continuous phase and a dispersed or

discontinuous phase. These phases remain immiscible due to the existence of an interfacial

tension between them. The emulsion remains unstable if interfacial tension is very high. The

emulsion can be stabilized by reducing the interfacial tension with the help of emulsifying agents

or emulsifiers. Homogenised milk is a good example of true emulsion in which fat droplets are

dispersed in an aqueous continuous phase. The size or diameter of dispersed fat droplets in a true

emulsion ranges from 1 to 5 micrometer (μm).

***Meat emulsion*** comprises of a dispersed phase of solid or liquid fat droplets and a continuous

phase of water containing salt and proteins .Here, continuous phase can also be referred as a

matrix in which fat droplets are dispersed. Due to the presence of matrix, many people call meat

emulsion as a multiphase system. For practical purposes, meat emulsion is an oil-in-water

emulsion where solubilised meat proteins act as emulsifiers. The fat droplets are usually larger

than 50 μm in size and remain coated with a soluble protein—either myofibrillar or

sacroplasmic. The amount of fat that can be incorporated in a stable emulsion depends on fat

particle size, meat pH, temperature during emulsification and the amount and type of soluble

proteins. It is very important to maintain low temperature during emulsion formation in order to

avoid melting of fat particles, denaturation of soluble proteins and lowering of viscosity. This is

done by adding ice flakes instead of chilled water during chopping.

For the preparation of a good meat emulsion, lean meat is first chopped with salt to extract salt

soluble proteins and then fat and other ingredients are added. Salt soluble proteins have a

relatively high emulsifying capacity. Once a good meat emulsion is formed, it has to be protected

during cooking or heat treatment. The emulsion breakdown can occur due to sudden exposure to

high temperature because of coalescence of finely dispersed fat particles into larger ones (fat

pockets). The encased or moulded emulsion is first exposed to heat at 550C so as to coagulate

the coating proteins and stabilize the emulsion.

**III. Meat extension**

A lot of non-meat food items can be incorporated in meat products. These are generally termed

as extenders, although tehse may be specifically referred as fillers, binders, emulsifiers or

stabilizers depending on the purpose of their incorporation in the basic meat formulation. In

developing countries, soy products, potato starch and flours of wheat, rice, pea, corn etc. are used

as fillers to reduce the cost of formulations. Several milk products such as skim milk powder,

dried whey, sodium caseinate etc. are frequently used as binders. Some gums like sodium

alginate, carrageenan, gum Arabic etc. may be used to stabilize fragile meat emulsions. Due to

high cost, extension of meat should be taken up on a large scale in order to ensure the availability

of meat products to the masses.

**IV. Preblending**

It refers to the mixing of a part or all the curing ingredients (salt, nitrite, nitrate etc) with ground

meat in a specified proportion. This process allows better extraction of proteins which in turn

helps in the formation of stable emulsion. It permits control of product composition by adjusting

the desired fat content. Besides, processors get enough time for the analysis of meat samples.

**V. Hot processing**

It refers to the processing of carcass as soon as possible after slaughter (certainly within 1-2

hours) without undergoing any chilling. The term pre-rigor processing is used when muscular

meat is processed in a pre-rigor condition. Though hot processing of meat has been a common

practice in India, it is rather a new development in western countries. This technique has many

advantages. It accelerates the processing steps and entire processing steps and entire processing

time is reduced to a great extent. There is improvement in the cooking yield and sensory quality

of the product. In addition, there are financial benefits due to reduced chiler space and labour

requirement. Thus, lot of energy is saved if hot processing is adopted at a pilot scale.

**VI. Cooking**

Meat and meat products are cooked by any one or a combination of three methods—dry heat,

moist heat and microwave cooking. Dry heat cooking is an accepted method for relatively tender

cuts of meat such as pork chops, leg and chops of lamb, ground and comminuted meats etc. The

product yield is relatively high due to comparatively less shrinkage. Dry heat cooking involves

broiling, roasting or frying. In broiling, meat held on a wire grill, is exposed to heat from above

as in electric and gas oven or below as in charcoal broiler. Meat is required to be turned for

uniform and sufficient cooking of all sides. Roasting is also practiced on tender cuts of meats

such as pork shoulder and loin; shoulder, rack and loin of lamb and cured ham etc. The roast

piece, at least 8 cm thick, is adjusted in open roasting pan with fat side up and placed in hot-air

oven at 115-1500C. Cooking temperature and time varies according to the cut. Roasting

generally gives good browning and improves the flavor of the product. Frying –deep fat or

shallow pan is also classified under dry heat cooking. This method is especially suitable for thin

cuts of meat such as sliced steaks, mutton chops, chicken meat pieces etc.

Moist heat cooking is recommended for relatively tough cuts of meat. In this method, hot water

or steam is continuously kept in contact with meat for cooking, so that moisture loss does not

take place beyond a particular stage. Pressure cooking, stewing, simmering etc. are popular

moisture cooking procedures. Higher cooking temperatures can be achieved in pressure cooking

facilitating the tenderization of tough cuts of meat. In stewing, tough meat pieces are first

browned in small amount of fat and then covered with water along with curry stuff and allowed

to cook at simmering temperature in covered container. The final product becomes tender along

with a curry. Simmering involves cooking in hot water at a temperature of 700C for considerable

time. Braising utilizes both dry heat as well as moist heat for proper processing of meat products.

Several meat cuts like pork chops and steaks, mutton breast and shanks etc. are first fried in a

frying pan and then put in a covered container along with water and seasoning for cooking at 80-

900C.

**5.7. Meat preservation**

Meat is a high perishable commodity due to nearly neutral PH (low acid food), high moisture

content and rich in nutrients. Contamination with spoilage organisms is almost unavoidable

which makes the preservation of meat more difficult than most other food. Unless proper

preservation methods are adopted, deteriorative microbial activity, enzymatic and chemical

reactions along with physical changes are bound to occur.

**5.7.1 Methods of meat preservation**

Efforts should be made to attain asepsis by avoiding contamination as much as possible,

however, once meat is contaminated with microorganism, their removal is difficult hence,

preservation of meat is usually accomplished by the use of low temperature, high temperature,

moisture control, direct microbial inhibition etc.

Since microorganisms are the main cause of spoilage, meat preservation involves methods which

either delay the growth of, or kill, the microorganisms.

**5.7.1.1.Physical methods of meat preservation**

**A. Retarding the growth of microorganisms**

***I. Preservation of meat by cold***.

Best known and most widely used method of preserving meat in the natural condition. The

following two methods are used:

***Chilling/refrigeration****:* The most widely used method of preservation for short-term storage of

meat because chilling or refrigeration slows down the microbial growth and enzymatic as well as

chemical reactions. Chilling temperature ranges from -1.4 oc to +2oc, or just above the freezing

point of the meat juices (-1.4oc.)

***Freezing:*** The preservative action of freezing is chiefly due to inhibition of growth of

microorganisms. It is import to notice that the microorganisms are not killed by the low

temperature. Viral diseases such as FMD and Rinder pest may be disseminated with frozen meat,

where the virus remains alive in the lymph nodes, the bone marrow or the liver. Freezing

temperature ranges from –2o oc to -40oc.

***Lyophilisation or freeze-drying:*** this is the process of removing water from frozen foods. The

food products must be incomminuted from (sliced or diced) packing must be completely

moisture-proof since the dried products are hygroscopic. At the present time beef, pork, chicken,

shellfish and other food such as mushrooms, fruits. Peas, vegetables are preserved by this

process.

***B. Preservation by killing the microorganisms***

The killing effect of heat upon microorganisms is explained as a consequence of denaturation

and irreversible coagulation of the proteins. Unfortunately, many of the organoleptic and

nutritive properties of food are affected by heat too. Two types of heat preservation can be used:

**I. *Pasteurization:*** 75oc moderated heating used for meat and meat products already

preserved by other methods like curing and smoking. E.g. sausages, hams, in order to

extend the keeping qualities of these products in the refrigerators. This semi-preserved

product should be marked ‘perishable keep under refrigeration.’

**II. *Sterilization:*** 115oc, severe heating, resulting in a product which is stable without

refrigeration. e.g. Corned beef.

***C. Preservation of meat by the use of chemicals***

Salting, pickling and curing, as meat preservation methods have been known since ancient times.

**I. *Salting:*** dry salt is rubbed in to the meat. The preservative factor in using salt (NaCl) is

that salt absorbs the water making it unavailable for the growth of microorganisms.

**II. *Pickling:*** salt is used in the form of brine. Brine is a solution of salt, nitrate and/or nitrite.

**III. *Curing:*** combination of pickling and smoking.

**IV. *Smoking:*** Since ancient times meat has been preserved by hanging over a smoky fire

from a few days to several weeks. Only wood should be used for smoking, and certain

verities of wood are better than other e.g. Oak, hickory, cedar. The preserving action is

due partly to heating, drying and to impregnation of the surface of the meat with certain

disinfectants found in the smoke, e.g. Formaldehyde, phenolics and cresols. In modern

meat industries, smoking is used for many types of sausages and meat products for the

advantages of importing a desirable flavor, surface color and glaze.

***D. Canning***

Canning is the rendering meat sterile by using thermal sterilization techniques. The main purpose

is to produce meat with long shelf life by creating unfavorable condition for microbial growth.

The food to be canned must be clean and of good quality, for the use of any material showing

obvious signs of spoilage will result in deterioration in quality of the product.

Canning Equipment/Container as a food container, the metal for canning should have certain

virtues which are not possessed by any other type of containers for heat processed foods. The can

should have High conductivity, Cannot be easily broken & should be opaque. Canning

operations involve exhaustion, processing, cooling, can washing &outside lacquering. Cans can

be filled manually or automatically.

**5.8. Meat quality & grading**

**5.8.1 Meat quality parameters**

Fresh meat can be referred as a product which has undergone imminent postmortem changes

following slaughter but has not been subjected to any processing. However, fresh meat which has

undergone freezing can be conveniently termed as raw meat. Some characteristics of fresh and

raw meat need to be properly understood in order to achieve the best results in processing.

**A. Meat Colour**

This is the total visual perception of meat. The hue (primary colour), chroma (intensity) and the

value (brightness) of meat colour are based on the quantity of principal muscle pigment

myoglobin and its chemical state. It is for this reason that meat colour varies with species, sex,

age and even among different muscles of the same species. Myoglobin content of more active

species and muscles is higher than the passive ones.

Myoglobin constitutes about 80-90% of the total meat pigments. The role of hemoglobin in meat

colour is negligible in a properly bled muscle. Catalase and cytochrome enzymes are of little

consequence as far as meat color is concerned. Myoglobin molecule has a protein portion

(globin) and a heme (iron containing) ring. It is one-fourth in size as compared to structurally

similar haemoglobin molecule. In intact meat, iron in the heme ring of myoglobin exists in the

reduced form.

Upon cutting, grinding or exposure to air, myoglobin is oxygenated to form oxymyoglobin

within 30-45 minutes. Oxymyoglobin has a bright red colour (bloom) which is very much

desired by the consumers. However, this pigment is comparatively unstable. In conditions of less

oxygen, partial vacuum or semipermeable package, myoglobin as well as oxymyoglobin is

oxidized to brown coloured metmyoglobin. At the time of meat purchase, brown colour is

usually associated, by the consumers with meat that has been stored for long although it is not

always true. In order to prevent the formation of brown colour, fresh meat is often packed in

films with very good gas (oxygen) transmission rate.

**B. Water Holding Capacity**

Water constitutes about 76% of fresh meat. It is a universal solvent and takes part in a large

number of biological reactions. In muscles, water molecules carry positive and negative charges.

The location of these molecules allows water to exist in three different forms—free water,

immobilized water and bound water. The water molecules held by capillary forces on the surface

make up free water which can be removed by application of even minor physical force. The

middle layer of water molecules remain in contact with proteins and make up immobilized water,

a large part of which can be removed by application of severe physical conditions. However, 4-

5% of water molecules are so tightly bound to the charged hydrophilic groups on the muscle

proteins that they do into allow this bound water to escape by application of any physical force.

The capacity of meat to retain its water during the application of physical processes is known as

water holding capacity (WHC). This property of meat has a special significance because it

contributes to the juiciness of cooked meat besides influencing the texture and colour. Fresh

meat with a good water holding capacity is less prone to shrinkage during storage. WHC of meat

is very important in processing where meat is subjected to physical forces such as cutting,

grinding, filling, pressing, heating etc.

**C. Marbling**

It refers to the intramuscular fat which can be visibly detected when the muscle surface is cut.

The solidification of this fat during chilling contributes to the firmness of meat. Marbling

prominently figures in the USDA quality grades for meat because of its merchandising value.

During handling of chilled meat, some special retail cuts like chops and steaks retain their

uniform thickness and typical shape due to marbling. Besides, marbling also enables meat to bear

the impact of comparatively high cooking temperature.

During thermal processing, moderately marbled meat yields a juicy and flavourful product

whereas too little marbling yields a dry and flavourless product. Excess marbling neither

enhances the eating satisfaction nor desired in a fat conscious society.

**D. Quantum of connective Tissue**

The amount of connective tissue in meat has a direct bearing on its textural characteristics.

During animals life time, more active muscles tend to deposit more connective tissue to gain

strength. The quantum of connective tissue per unit muscle does not increase with age and is not

responsible for tough meat of older animals. In fact, it is the increase in muscle fiber diameter

and consequent increase in muscle fiber bundles which account for the coarse texture of such

meat.

Most meat cutting practices are based on separation of coarse textured meat from the tender

meat, so as to facilitate the right kind of cooking procedure and derive maximum palatability

pleasure.

**E. Firmness**

The firmness of meat is a good quality parameter which plays an important role in carcass

setting, fabrication, aging, processing, slicing and product display. During carcass chilling, the

firmness increases due to loss of extensibility associated with the completion of rigor mortis.

Fresh meat having a high water holding capacity shows good firmness and tight structure. It can

be objectively measured by shear force apparatus or penetrometer. Meat with a good degree of

firmness yields a comparatively better quality processed meat products.

**5.8.2. Meat grading**

Meat grading and cutting are important commercially - but the details change from time to time

and from place to place.

***Principles of grading***

· The purpose of meat grading is to describe the value of a carcass in clearly **defined terms**

useful to the meat industry.

· Both the buyer and the seller need an impartial third party to grade the carcass.

· If the buyer and the seller have their own system of payment for high and for low value

carcasses, they can save time or money by not having the carcass graded.

· Grading facilitates long distance transactions and contracts for future shipments in which

one or both parties have not yet examined the carcasses.

· Three major factors determine the value of a carcass relative to market conditions, (1)

***carcass weight***, (2) the ***cutability*** or yield of salable meat, and (3) the ***quality*** of the lean

meat.

· All three factors are continuous variables measured in either absolute terms, such as

weight, or in relative terms, such as those used by a taste panel.

· In scientific experiments, accurate carcass evaluation is necessary to search for minor

differences between carcasses. But a less accurate system is adequate for commercial

transactions, and the continuous spectrum of carcass properties is subdivided into a

relatively small number of grades in a step-wise sequence.

· Thus carcasses placed in the same grade may exhibit small differences, but carcasses

placed into different grades should exhibit much larger and commercially significant

differences.

· The important grading systems are for beef, pork and poultry. Systems exist for the other

species but they are mostly ignored or used in a very simple way.

**5.9. Types of meat products**

Processing of meat products is divided into the following groups for further discussion:

I. Cured and smoked meats

II. Sausages

III. Intermediate moisture and shelf stable meat products

IV. Restructured meat products.

V. Other popular meat products

**I. Cured and Smoked Meats**

All meat products belonging to this class are cured, whereas only some of them are smoked. The

primal cuts of pork especially ham and bacon has been subjected to curing and smoking for a

long time. These days, it is a general practice to accomplish cooking also during smoking except

for Country ham, which is smoked without cooking.

**II. Sausages**

Sausage term was derived in the ancient times from the latin word ‘salsus’ meaning salt. It was

literally coined to refer to ground meat which was salted and stuffed in animal casings. Presently,

sausage may be defined as a meat product which is prepared from minced and seasoned meat and

formed into cylindrical shape by natural or synthetic casings. Though sausages originated in the

western world, these products acquired universal popularity due to variety and convenience to

the consumers. Sausages are economical also because these are generally prepared from cheaper

cuts of meat and by-products of industry.

**III. Intermediate Moisture and Shelf Stable Meat Products**

Sun drying of meat was one of the earliest preservative techniques used by man. Such meat had

meager rehydration capacity resulting in poor juiciness and texture. Later studies revealed that

meat products with 20-50% moisture had moderate juiciness and texture on rehydration. Such

products were resistant to bacteriological spoilage and could be held without refrigeration. These

products were referred as Intermediate Moisture Meats (IMM). The basic reason for the stability

of these products lay in the reduced availability of water to the microorganisms, since water

activity generally remains in the range of 0.6 to 0.85. These semi-moist meats are of special

significance to the developing countries where refrigeratin facilities are not always available.

Such products can be easily carried in defence expeditions and stress situations like floods,

famines etc. for air drop.

**IV. Restructured Meat Products**

It has now become possible to utilize less desired or secondary carcass cuts into the production

of highly preferred meat products such as steaks, roasts, chops, cutlets etc. The less desired

carcass cuts are carefully trimmed to remove sinews, excess fat and other connective tissue. Any

one of the following three basic procedures can be adopted depending on the appearance and

texture targeted in the finished product:

**A.** Chunking and forming

**B.** Flaking and forming

**C.** Tearing and forming

**V. Value Added Popular Meat Products**

***A. Luncheon meat***

It is a canned product usually prepared from pork along with some cereal component. The

product contains not less than 80% pork including pork fat which should not exceed 30% in the

final product. Besides, added water is limited to 3% and the cereal ingredients should not exceed

7% of the total formulation. Lean pork and pork fat are ground through 5 mm and 3 mm plate of

the meat mincer, respectively. These are initially chopped along with chilled water or ice flakes,

common salt and nitrite followed by other ingredients such as refined wheat flour, condiments

and dry spices.

***B. Meat patties***

Meat is one of the most popular products among the ground meat items and is generally used as

filling for burger roll or sandwich. Some people prefer to consume it separately with tomato

sauce or chutney.

***C. Meat loaves***

This important ready –to-eat comminuted meat product is prepared from coarse ground meat or

meat emulsion or a combination of both.

***D. Meat balls***

Indian consumers are familiar with this food item by the name of meat kofta. The product, raw or

cooked offers a great convenience to restaurants, hotels and housewives who can just put few

balls in the gravy and serve the food within 10 minutes.

***E. Meat nuggets****:*

It is a ready –to-eat convenient product which is obtained by cutting cooked and cooled

rectangular or cubical shape meat loaves into approximately 4 cm X 1.5 cm X 1.5 cm pieces. The

product is packed in unit pouches and can be stored at 40C for a week. It is usually shallow fat

fried before serving for breakfast or refreshment.

**5.10. Fish processing**

Global fish production has continued to increase in the past 10 years. Processed and canned fish

represent a large share within this growth. These facts also underline the importance and

progress of the processing industry. Fish meat has a high nutritive value. In addition to protein,

fat and carbohydrates, it is also rich in minerals and vitamins. The composition of fish proteins is

more valuable than that of mammals because it includes a favorable portion of essential amino

acids indispensable for humans. Carbohydrate content of freshwater fish is negligible.

The protein content of fish meat varies widely, depending on the species and, within that, on the

feeding, more precisely the type of *natural fish food*\* or the feed consumed. The mineral

compound content of fish meet slightly exceeds that of warm blooded animals. From among fatsoluble

vitamins A and D occur in fish in relatively large quantities. From among water-soluble

vitamins B1 and B2 are the most significant ones. Fish is also an excellent source of omega-3

and omega-6 fatty acids that are essential for human health.

As a consequence of the high water and protein contents fish meat is easily perishable. Spoilage

causes loss of quality and value and is primarily induced by microorganisms, enzymes and, after

some time, the oxidation of fish fat. In the course of processing efforts are taken to counteract

these factors to ensure a longer shelf life for fish meat. In short, preservation is the practice of

preventing spoilage while retaining physical and chemical characteristics of raw material along

with its biological value and taste.

Several methods are applied to curb the spread of microbes. These are cooling, freezing, drying,

smoking, heat treatment, salting and applying antimicrobial agents and antioxidants. Best way of

preserving freshness of a fish, is to keep it alive (Welcomme, 2001). Fish are covered with

micro-organisms that can cause spoilage if mishandled or processed improperly afterwards.

Therefore, it is essential to ensure a hygienic handling of fresh or processed fish products in each

and every phase of production, storage and transportation. Qualities which make fish suitable for

pro cessing (or not) are specified below.

**A. Cooling**

Cooling takes place at a temperature between 0 and 8 oC which slows down the process of

spoilage but does not prevent it. The method is primarily suitable only for short-term storage.

**B. Freezing**

The purpose of freezing is to prevent or reduce to the minimum processes which spoil the quality

of fish meat.

**C. Drying**

The oldest of physical fish preservation methods which is intended to extract water from fish in

the shortest possible time to avoid bacterial proliferation.

**D. Smoking**

It is an ancient mode of fish preservation. Components of smoke exercise a germicidal impact on

fish meat.

**E. Heat treatment**

Heat treatment is aimed to inhibit processes which lead to fish decay by preventing enzyme

activity and destroying microorganisms.

**F. Salting**

The method is based on the preserving effect of table salt which is hygroscopic\* hence it absorbs

water from microbes and the environment.

**G. Applying antimicrobial agents**

Antimicrobial agents (preservatives) retain food quality and ensure longer shelf life by protecting

fish from spoilage caused by microorganisms. Adding such agents in proper dosage to fish

lengthens their shelf life.

**H. Applying antioxidants**

This method is applied to prevent chemical spoilage. It means the inhibition of tissue enzyme

activity by adding spoilage preventives and/or microorganism destroyers to the raw material.

Such organic or inorganic antimicrobial agents are preservatives which inhibit metabolism by

modifying enzyme proteins. In terms of cellular impact location preservatives may target the cell

wall, the cell membrane and the cytoplasm. Even small dosages are sufficient. Nevertheless,

preservatives may exercise an unwelcome impact on the quality (taste, color, substance, valuable

nutritive compounds) of preserved material.

Additionally, chemical substances inhibiting or destroying microbial cells may influence human

body as well. It is a professional conviction that being cytotoxins by nature and accumulating in

the body which is followed by a slow leeching out, such agents may have a detrimental effect on

human body which is also made up of cells.

**Chapter Summery**

Meat has long been a central component of the human diet, both as a food in its own right and as

an essential ingredient in many other food products. Many Ethiopians, like residents of other

developing countries, do not consume an adequate amount of meat. The few that do, however,

maintain a meat diet of beef, sheep, goat, and poultry.

Meat is composed of different types of muscle. There are more than 300 muscles in the animal

body. These muscles constitute about 30-45% of the live weight or 35-60% of the carcass weight

of meat animals. In addition to the skeletal muscle, which forms the bulk of meat, a little of

smooth and cardiac muscles are also present in blood vessels and heart respectively. Smooth and

cardiac muscles are involuntary in nature. Skeletal and cardiac muscles are sometimes referred as

striated muscles due to their specific microscopic appearance.

All methods of slaughter aims at securing maximum bleeding of the animal and the humane

method also aim to avoid unnecessary suffering. The main method of slaughtering is stunning

prior to bleeding & slaughtering without previous stunning.

Meat inspection refers to examination of meat for some abnormalities and diseases. It is an

expert supervision of meat with the objective of providing sound and wholesome meat for human

consumption. A proper meat inspection service consists of ante-mortem inspection and postmortem

inspection; and where necessary, laboratory tests of body tissues and fluids.

Meat is a high perishable commodity due to nearly neutral PH (low acid food), high moisture

content and rich in nutrients. Contamination with spoilage organisms is almost unavoidable

which makes the preservation of meat more difficult than most other food. Unless proper

preservation methods are adopted, deteriorative microbial activity, enzymatic and chemical

reactions along with physical changes are bound to occur. Furthermore, meat is processed to

improve its market demand. The basic meat processing procedure consists of comminution,

emulsification, preblending, hot processing and cooking.

**Chick list questions**

**Choose the best answer**

1. \_\_\_\_\_\_\_\_\_\_\_\_ is the muscle which forms the bulk of meat.

A. Smooth muscle

B. Skeletal muscle

C. Cardiac muscle

D. All

E. None

2. The meat preservation method different from the other is

A. Freezing

B. Lyophilisation

C. Sterilization

D. All

E. None

3. The meat quality parameter that contributes to the juiciness of cooked meat besides

influencing the texture and colour

A. Meat color

B. Water holding capacity

C. Marbling

D. All

E. None

4. A septum of connective tissue penetrates into muscle and surrounds the bundles of

muscle fibers is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

A. Perimysium

B. Epimysium

C. Endomysium

D. All

E. None

5. All are chemical meat preservation method except

A. Pickling

B. Curing

C. Canning

D. All

E. None

**CHAPTER 6: POULTRY PRODUCT PROCESSING**

**Chapter Content**s: Poultry Meat Processing, The Slaughter of Poultry, egg quality measurement

and egg preservation

**Specific objectives:** At the end of this chapter you will be able to:

\_ Illustrate steps of poultry slaughter

\_ Identify egg quality measurement

\_ Explain egg preservation methods

**6.1. Poultry Meat Processing**

Poultry processing is preparation of meat from various types of fowl for consumption by

humans. Poultry is a major source of consumable animal protein. Chickens and turkeys are the

most common sources of poultry; however, other commercially available poultry meats come

from ducks, geese, pigeons, quails, pheasants, ostriches, and emus. Poultry is derived from the

skeletal muscles of various birds and is a good source of protein, fat, and vitamins and minerals

in the diet

**6.2. The Slaughter of Poultry**

The process of slaughtering is basically identical for all poultry species. This description will

mainly focus on the slaughter of broilers, for which slaughter technology is most advanced.

**Catching and transport, and implications on welfare and meat inspection findings**

Dir. 1/2005, Reg. 854/2004 and Reg. 1099/2009 provide legislation for the humane slaughter and

pre-slaughter treatment of poultry. This includes catching and transport to the slaughterhouse.

There are two systems of catching poultry: hand (manual) catching and automatic harvesting

(mechanicalcatching).

**Three** different systems are established for the transport of poultry to the processing plant, these

being:

1. **Liners** (fixed cages on the truck), whereby the birds must be carried to the truck,

2. **Crates** for manual catching (with a small opening in the lid through which the birds must be

put into the crate upon loading and pulled out upon unloading)

3. **Container systems.** Container systems are most popular in broiler transport, as they can not

only be used for later processing plant automation, but also for ducks, turkeys, and spent

hens. For the transport of other minor poultry species only the crate system is in use. The

risk of damage (broken wings, injuries to the back and thigh, bruises etc.) is greater with

transport crates in comparison to container systems.

**Steps in poultry processing:**

**1. Arrival of live chicken at the slaughterhouse**

The poultry arrives at the slaughter plant where the crates or the containers are offloaded. The

birds wait (normally) in an air-conditioned room until slaughter. The duration of their stay at the

plant is between 1-3 hours. A resting time of 2 hours is recommended. The advantage of a

constant resting time (of 2 hours) is a better meat quality. If waiting time is too short, the

glycogen concentration in the muscle may still be very high. If waiting time before slaughter is

significantly longer than 2 hours, this will lead to a higher pH value of the meat and to a darker

meat. The meat will then be tougher.

**2. Hanging, stunning and bleeding**

There are two (three) different stunning systems: electrical stunning (whereby hanging must

always take place in somewhat dark or blue illuminated areas and the birds must be hung on the

shackles before stunning):

\_ High-voltage, whole-body electrical stunning (birds pass upside down through an electrical

water bath)

\_ Head-only (or Top Kip) stunning, electricity only passes through the head of the chicken.

Currently

\_ Under development controlled atmosphere stunning (CAS):

\_ -Anoxia

\_ CO stunning

\_ Multiphase CAS (application of CO in two phases with up to 40% CO in phase I for a

gentle induction of unconsciousness in combination with an elevated level of oxygen,

followed by a higher concentration of CO

**In phase II.** With controlled atmosphere stunning (CAS), shackling can take place in fully

illuminated areas and can therefore become part of the more logical management circuit.

Hanging of the birds occurs after they have been stunned. Depending on the stunning system, the

slaughter poultry is either hung fully conscious (electrical stunning) or unconscious (after CAS).

For stunning and killing see also Council Reg. 1099/2009 for the protection of animals at the

time of killing.

The following section shall provide a short description of the different stunning systems with the

irrelevant advantages and disadvantages.

**Electrical stunning**

Research has shown that it is more humane to kill the birds in the electrical stunner (irreversible

stun or stun to death). Stunning to death means that bleeding is not supported by a pumping

heart. As the electric current pass through the whole body, bone fractures and hemorrhages are

very common with whole-body electrical stunning.

Top Kip stunning is so far only used for broilers and only as a prototype system. The birds are

stunned by their fixed heads coming into contact with a 500 volt electrified metal slope (wire).

The advantage of this system is that the electric current only passes the head. The birds’

areclinically dead but their hearts are still pumping, thus supporting the bleeding.

**3. Scalding and plucking**

After bleeding, while still suspending from the line, the birds pass through a scald tank in which

there is a continuous flow of agitating water at a constant temperature between 50 and 65°C. The

required scalding temperature depends on the type of poultry and the intended sales condition:

fresh or deep-frozen. Higher temperatures and longer times in the scalding tank will facilitate

feather loss, but may also contribute to skin tears and to blemishes of the epidermis. The

epidermis loosens more the higher the scalding temperature. For deep-frozen poultry the scalding

temperature may be slightly higher compared to poultry meat intended to be sold fresh. By

means of a controlled injection of air into the water through nozzles, (and / or mechanical

agitation) a consistent, powerful turbulence is achieved which gives a better scalding effect. The

scalding time should vary between 60 and 210 sec., depending on temperature and local

requirements. The scalding will loosen the feathers for the plucking process. In some countries

detergents are added to the scald water, making it much easier for the water to penetrate the

feather follicles.

There are different scalding systems which have an influence on the bacterial load of the

product: single bath scalding tank single bath with counter flow multi bath scalding tanks multi

bath with counter flow Multi bath scalding with counter flow reduces the bacterial count in the

last scalding tank, and subsequently lowers the counts in the water remaining on the bird after

scalding. Counter flow scalding leads to higher counts in the first scalding tank and to lower

counts in the last scalding tank. During plucking massive recontamination occurs, nullifying any

hygienic benefit achieved during scalding. Scientific literature did not prove any relation

between the contamination rate of the scalding water in the last scalding tank and the

contamination rate after plucking. According to Rosenquist, 2006, the *Campylobacter* count in

the scalding tank is of negligible importance with regard to the *Campylobacter* count on the

surface of the carcass.

Steam scalding, which was propagated 10 years ago as it avoids cross contamination during

scalding, is today no longer state of the art, as the control of temperature on the skin during the

operation is more difficult. Recently, the so-called jet stream scalder was introduced: the

downward force on the birds is achieved a direct water flow, not by air injection. This leads to

lower energy consumption and a better opportunity to pasteurize the whole system. This was not

possible with the air system of the former “Jacuzzi” Steam scalders.

After this procedure the birds will then pass into the plucking machines. These consist of

revolving drums with rubber beaters or discs with plucking fingers. The birds are continually

flailed or scraped by these rubber fingers while being sprayed with warm or cold water.

Cold water: harder plucking and picking

Warm water: softer plucking (picking). Fat is not attached to the plucking fingers. The plucking

process takes approximately 30–90 sec. Ducks are plucked by a hot wax process which

facilitates the removal of the finer feathers and the down.

Electro stimulation may be applied to the carcasses after plucking to accelerate the removal of

energy from muscles. Some systems carry out the electro stimulation before scalding. If electro

stimulation is performed before scalding it is more difficult to remove feathers, however, it will

save time. (The rigormortis process of the birds sets in earlier). Most of the bacterial cross

contamination occurs during picking (Berrang, 2000 and 2006; Heemskerk, 2005), as faeces are

expressed during this process. There is currently no picking technology available that can

prevent this.

After plucking the birds either drop onto a conveyor belt which transfers them from the “dirty”

section of the slaughterhouse to the “clean” section where they are hung up again by the hocks

on to the shackles of the evisceration line. This work is often facilitated by using automated

rehangers. Such rehangers bring the advantage of not only saving labour but also lead to less

carcass contamination through the hands of the workers (Chiarini et al, 2009).

**4. Trimming:** cutting head, tail, leg.

**5. Neck slitting and foot removal**

In processing plants in some southern EU countries where the bird is sold whole with the neck,

the neck skin is left on the bird. In this case a vertical incision is made in the skin of the dorsal

surface of the neck. Otherwise the head, the neck (plus neck skin) will now be removed. The feet

are removed automatically by a cutter on the line or by manually-operated scissors. In most

cases the feet are removed during automated rehanging from the slaughter line to the evisceration

line. For some markets the feet may stay connected with the carcass as this is the wish of the

consumer. Inspecting the feet of the birds may be of importance to detect animal welfare faults in

the farm of origin (foot pad dermatitis). In many processing plants 100 feet (from 100 different

birds) per batch are collected and inspected for food pad dermatitis. This is a requirement in

Sweden, Denmark, Finland, and the UK. Some slaughter plants in Germany and the Netherlands

are also evaluating foot pad dermatitis, an animal welfare is of major significance for an

increasing number of customers.

**6. Evisceration:** it is the process of removal of internal organs**.** Today the transfer from the

slaughter line to the evisceration line is thus performed automatically in modern broiler

slaughterhouses. The birds are subsequently washed by overhead sprayers. Following this

procedure the first post-mortem inspection may take place here. **Post mortem findings at**

**this inspection location are:**

A. undersized bird

B. As cites birds

C. cellulitis (deep dermatitis)

D. not fully bled birds

E. birds with skin defects e.g. Sarkomatosa (very rare)

F. abnormal colour

G. Bruises

H. broken wings or broken legs

I. breast blisters

**7. Washing**

**8. Chilling (either the whole carcasses or after deboning)**

**9. Packing**

**10 Distributions**

**6.3. Egg**

**6.3.1 Egg quality measuring**

Eggs are highly perishable. They must be handled carefully to prevent spoiling. Egg quality is

best preserved by keeping the eggs cool and at the correct humidity after they are laid and until

they are used.

The interior quality of the egg is determined by a process called candling. The eggs are examined

by using a high-intensity light. U.S. standards for grades of eggs do not consider the color of the

egg. The color of the egg does not affect its nutritive value. However, some markets prefer white

eggs, whereas others prefer brown eggs. Therefore, eggs are sometimes sorted by color for the

market in which they are to be sold. Consumer, wholesale, and procurement grades of eggs are

different classifications used in the marketing of eggs

As a natural product, all eggs are not equal and need to be routinely checked for quality to meet

the specifications being increasingly demanded by today's quality conscious retailers.

Most retailers impose on their suppliers a specification that all eggs should meet. This usually

embraces a range of quality characteristics, such as shell colour, Haugh Unit (HU) and yolk

colour, as well as checks on packaging, barcodes, print colours and eggs being packed correctly,

with the labels placed in the correct position.

One of the primary egg quality traits most frequently measured is albumen quality. Measured in

millimetres (the higher the reading the better the quality). This measurement is a very efficient

method of determining the quality and freshness of eggs.

**Albumen quality**

The albumen thins as an egg ages because the protein in the eggs changes in character over time.

That's why fresh eggs sit up tall and firm and why stale or older eggs spread out and run all over

a flat surface when they are broken out.

The Haugh Unit

In the 1930's, an American researcher, Dr R RHaugh, introduced a formula that is still used

internationally as the definitive method of defining true egg quality and freshness. This formula

takes into account egg weight in grams and albumen height in millimetres and provides -

rounded up to whole numbers - a range of HU values from single figures in extremely poor

quality eggs to over 100 plus in very good quality fresh eggs.

The HU calculation is commercially essential where eggs from different flocks and of different

sizes/ages/breeds are tested.

Haugh Unit versus air cell

Whilst in many countries the air cell is still used as the statutory measurement to define the age

of an egg, it should not be regarded as a method of guaranteeing egg quality - it is often possible

to have an air cell within legal tolerances yet have the HU in the poor/unacceptable categories.

This is why many retailers have been very specific in writing into their product specifications

HU levels usually in excess of 70.

The air cell height increases with age through loss of moisture. However long before the air cell

reaches the point where the egg changes its quality grade, the true consumer quality can already

have deteriorated. The speed of deterioration is dramatically affected by the storage temperature

and age of the egg.

Fresh egg, with a clean, smooth, brown or white shell, a pure, deep-yellow yolk and a

translucent, firm white this is the ideal of the egg producer and the consumer. How can producers

make sure that hens lay more eggs like this, and fewer with shell or internal defects?

Practicalguide to improving egg quality assurance

**Shell Defects**

· Gross cracks

· Hairline cracks

· Star cracks

· Thin-shelled eggs and shell-less eggs

· Sandpaper or rough shells

· Misshapen eggs

· Flat-sided eggs

· Body-checked eggs

· Pimples

· Pinholes

· Mottled or glassy shells

· Cage marks

· Stained eggs

· Fly marks

· Fungus or mildew on shells

**Internal Defects**

· Blood spots

· Meat spots

· Watery whites

· Pale yolks

· Mottled yolks and discolored yolks

· Discolored whites

· Rotten eggs

· Roundworms in eggs

· Off odours and flavors

**6.3.2. Eggs Preservation Techniques**

The spoiling of eggs is due to the entrance of air carrying germs through the shells. Normally the

shell has a surface coating of mucilaginous matter, which prevents for a time the entrance of

these harmful organisms into the egg. But if this coating is removed or softened by washing or

otherwise the keeping quality of the egg is much reduced. These facts explain why many

methods of preservation have not been entirely successful, and suggest that the methods

employed should be based upon the idea of protecting and rendering more effective the natural

coating of the shell, so that air bearing the germs that cause decomposition may be completely

excluded.

Eggs are often packed in lime, salt, or other products, or are put in cold storage for winter use,

but such eggs are very far from being perfect when they come upon the market. German

authorities declare that water glass more closely conforms to the requirements of a good

preservative than any of the substances commonly employed. A 10 per cent solution of water

glass is said to preserve eggs so effectually that at the end of three and one-half months eggs still

appeared to be perfectly fresh. In most packed eggs the yolk settles to one side, and the egg is

then inferior in quality. In eggs preserved in water glass the yolk retained its normal position in

the egg, and in taste they were not to be distinguished from fresh, unpacked store eggs.

Of twenty methods tested in Germany, the three which proved most effective were coating the

eggs with vaseline, preserving them in limewater, and preserving them in water glass. The

conclusion was reached that the last is preferable, because varnishing the eggs with vaseline

takes considerable time, and treating them with limewater is likely to give the eggs a limy flavor.

Other methods follow:

**I**

Eggs can be preserved for winter use by coating them, when perfectly fresh, with paraffine. As

the spores of fungi get into eggs almost as soon as they are laid, it is necessary to rub every egg

with chloroform or wrap it a few minutes in a chloroform soaked rag before dipping it into the

melted paraffine. If only a trace of the chloroform enters the shell the development of such germs

as may have gained access to freshly laid eggs is prevented. The paraffine coating excludes all

future contamination from germ-laden air, and with no fungi growing within, they retain their

freshness and natural taste.

**II.** Preserving with Lime

Dissolve in each gallon of water 12 ounces of quicklime, 6 ounces of common salt, 1 drachm of

soda, 0.5 drachm saltpeter, 0.5 drachm tartar, and 1.5 drachms of borax. The fluid is brought into

a barrel and sufficient quicklime to cover the bottom is then poured in. Upon this is placed a

layer of eggs, quicklime is again thrown in and so on until the barrel is filled so that the liquor

stands about 10 inches deep over the last layer of eggs. The barrel is then covered with a cloth,

upon which is scattered some lime.

**III**

Melt 4 ounces of clear beeswax in a porcelain dish over a gentle fire, and stir in 8 ounces of

oliveoil. Let the solution of wax in oil cool somewhat, and then dip the fresh eggs one by one

into it so as to coat every part of the shell. A momentary dip is sufficient, all excess of the

mixture being wiped off with a cotton cloth. The oil is absorbed in the shell, the wax

hermetically closing all the pores.

**IV**

The Reinhard method is said to cause such chemical changes in the surface of the eggshell that it

is closed up perfectly air-tight and an admittance of air is entirely excluded, 'even in case of longcontinued

storing. The eggs are for a short time exposed to the direct action of sulphuric acid,

whereby the surface of the eggshell, which consists chiefly of lime carbonate, is transformed into

lime sulphate. The dense texture of the surface thus produced forms a complete protection

against the access of the outside air, which admits of storing the egg for a very long time, without

the contents of the egg suffering any disadvantageous changes regarding taste and odor. The egg

does not require any special treatment to prevent cracking on boiling, etc.

Some object to this on the ground that sulphuric acid is a dangerous poison that might, on

occasion, penetrate the shell.

**V**

Take about half a dozen eggs and place them in netting (not so many as would chill the water

below the boiling point, even for an instant), into a boiling solution of boric acid, withdraw

immediately, and pack. Or put up, in oil, carrying 2 per cent or 3 per cent of salicylic acid. Eggs

treated in this way are said to taste, after six months, absolutely as fresh as they were when first

put up. The eggs should be as fresh as possible, and should be thoroughly clean before dipping.

The philosophy of the process is that the dipping in boiling boric acid solution not only kills all

bacteria existing on, or in, the shell and membrane, but reinforces these latter by a very thin layer

of coagulated albumen; while the packing in salicylated oil prevents the admission of fresh

germs from the atmosphere. Salicylic acid is objected to on the same grounds as sulphuric acid.

**VI**

Dissolve sodium silicate in boiling water, to about the consistency of syrup (or about 1 part of

the silicate to 3 parts water). The eggs should be as fresh as possible, and must be thoroughly

clean. They should be immersed in the solution in such manner that every part of each egg is

covered with the liquid, then removed and let dry. If the solution is kept at or near the boiling

temperature, the preservative effect is said to be much more certain and to last long

**Review/Self-Test Questions**

**Part I. Multiple Choice Items**

**Direction: Choose the Best Answer from the Following Alternatives**

1. One of the following is not categorized as step of poultry slaughter

A. Stunning

B. Scalding

C. Deboning

D. None

E. All

2. One is internal defect of egg

A. Blood spot

B. Meat spot

C. Pale yoke

D. All

E. None

3. The process of removing internal organ of chicken is called

A. Plucking

B. Scalding

C. Evisceration

D. Preservation

4. One is location where the post mortem inspection performs

A. Abnormal color

B. Bruises

C. broken wings or broken legs

D. breast blisters

E. All

Answer key 1 D 2.D 3C 4E

**Activity**

1. Mention and discus poultry slaughter steps (pts)

2. Explain egg quality measurement techniques

3. List and elaborate egg preservation methods

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