

COURSE CODE:	APH505
COURSE TITLE:	Animal Products and By-Products
NUMBER OF UNITS:	3 Units
COURSE DURATION:	Three hours per week

COURSE DETAILS:

Course Coordinator:	Dr. (Mrs.) K. A. Sanwo
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COURSE CONTENT:

Pre- slaughter handling of different farm animals. Slaughtering methods, dressing and post-mortem changes in meat. Meat quality. Methods of meat preservation. Processing of abattoir by-products. Meat inspection and grading. Meat processing – bacon, sausages etc. Meat hygiene. Milk products and processing e. g. ice – cream, butter, yoghurt, cheese etc. Egg quality, handling, storage and grading. Animal by-products, blood, hooves faeces and their uses. Hides and skin processing- flaying, curing, tanning. Hides and skin utilization.

COURSE REQUIREMENTS:

This is a compulsory course for all 500 level students in the College of Animal Science and Livestock Production. Students are expected to participate in all the course activities and have minimum of 75% attendance of lectures and practical work to be able to write the semester examination.

READING LIST:

1. Dairy Cattle Husbandry, 2008. Agromisa Foundation and CTA, Wagenigen
2. Animal Products, Processing & Handling in the tropics, 2000 by Aduku & Olukosi
3. Meat Science and Technology: A Comprehensive Approach by Ikeme, A. I. African FEP Publishers Limited.
4. The Science of Meat and Meat Products by Price, J. F. and Schweigert, B. S. W.H. Freeman and Coy, San Fransisco.
5. The Principle of Meat Science by Forrest *et al.* W.H. Freeman and Coy, San Fransisco.

LECTURE NOTES

MEAT QUALITY AND MEAT PRESERVATION

Meat Quality

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

Factors contributing to the eating quality of meat are:

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

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

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

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

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

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

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

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

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

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

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

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

Components of Meat Quality

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

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

Marbling fat

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

Taint and effect of skatole

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

Fatty and composition

In non-ruminants it is well established that simply changing the type and quantity of oil and fat in the diet can change the fatty acid content of fat in the carcass. High concentration of polyunsaturated fatty acids have been associated with low values for tenderness, juiciness, flavour and overall acceptability; whereas high concentration of saturated and monounsaturated fatty acids resulted in

high overall score. Also, there is an increased risk of rancidity and 'off' flavour when oils are used in high quantity in pig diets.

Maturation and conditioning effects

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

Oxidation stabilization and Drip loss

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

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

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

Stress

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

tolerate stress, therefore reducing stress occurrence in animals, especially the organic form and minimizing the incidence of both PSE and DFD-type meat.

Effects of Feeding

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

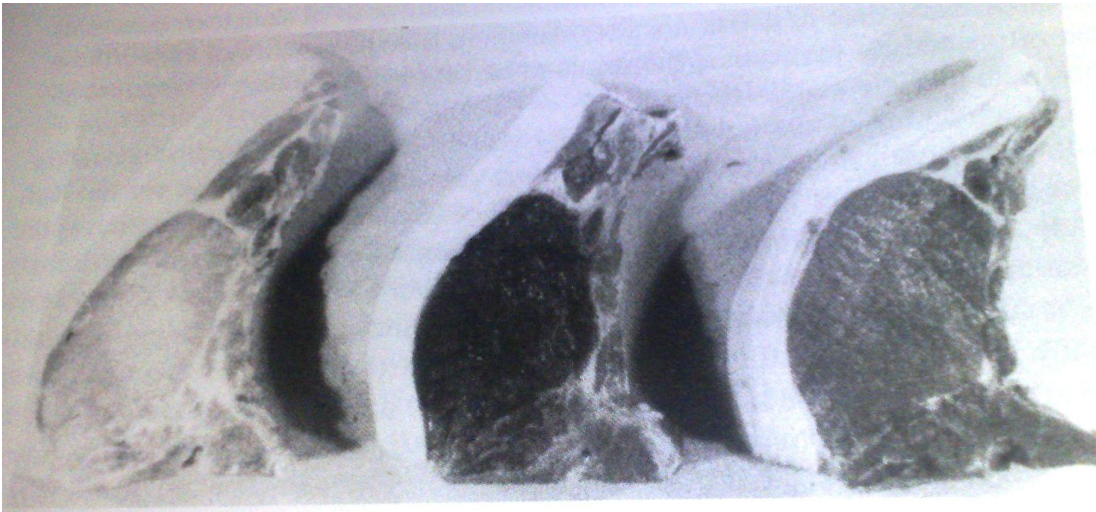


Figure 1: Pale, Dark and normal meat

MEAT PRESERVATION

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

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

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

Organisms cause spoilage by:

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

Preservation by Cold

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

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

Preservation by Drying

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

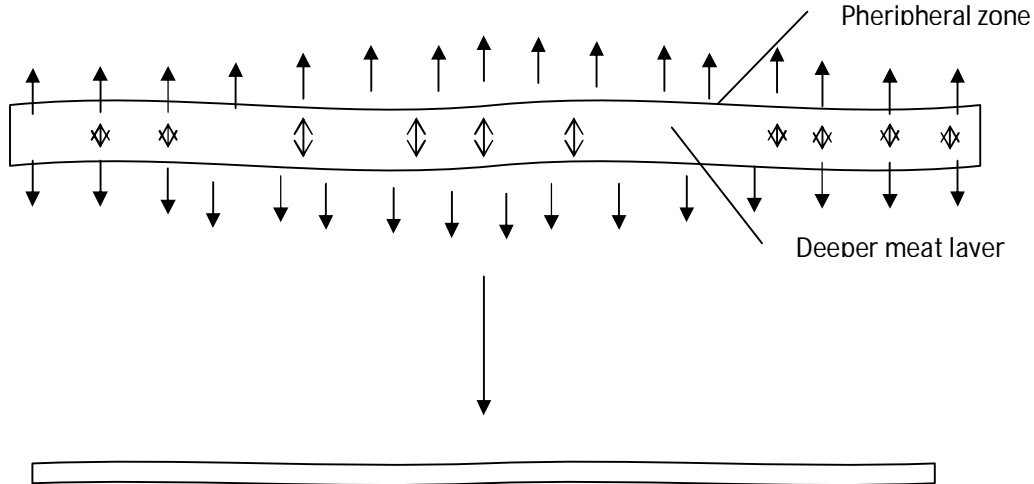
- Relative humidity of 30%
- Warm and dry air
- Small temperature difference between night and day.

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

Consistency also changes from soft to firm and hard.

Important Steps in Meat Drying:

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



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

Selection of Meat for Drying

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

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

Techniques of Cutting Meat Pieces for Drying

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

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

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



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



Figure 3: Cutting meat strips from a suspended muscle.

Recommended Treatment before Drying

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

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

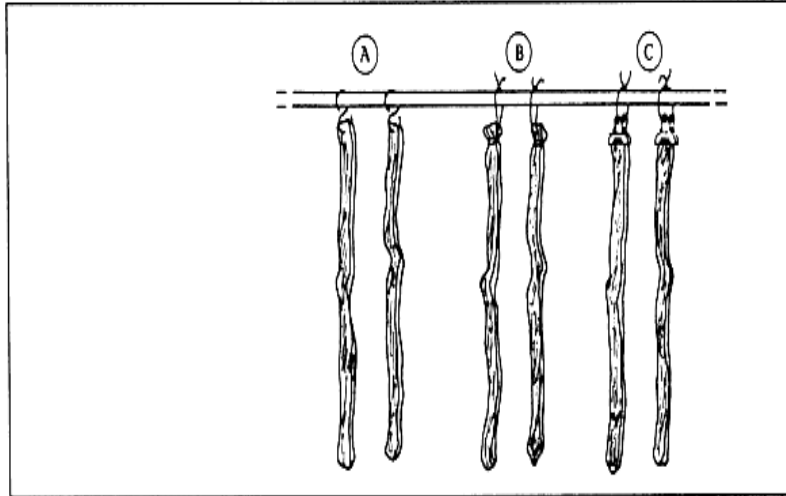


Figure 4: Suspension of meat strips on hooks (A), loops (B), and by means of clips (C).

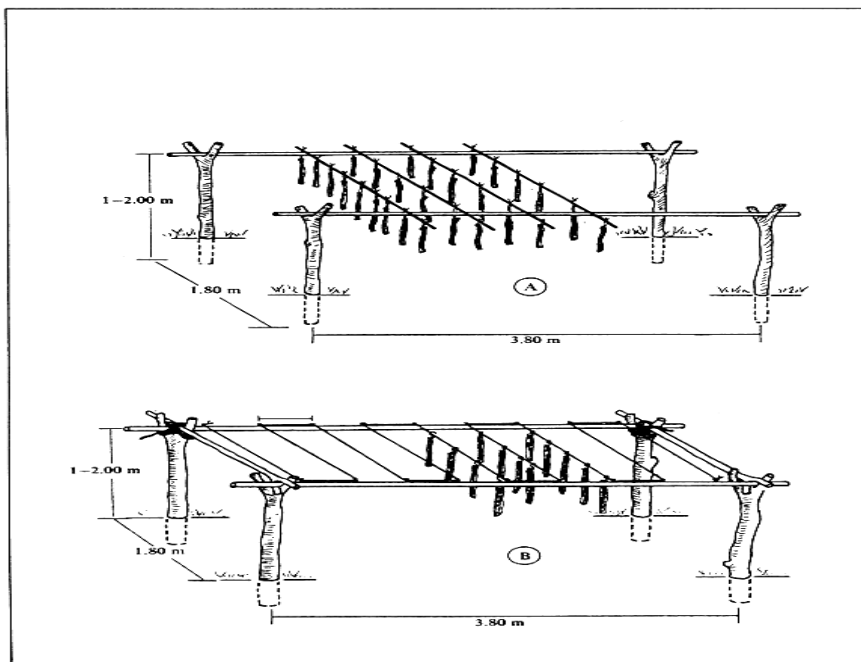


Figure 5: Sun meat dryer made of wood or metal (A and B)

Methods of suspending of meat strips for drying

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

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

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

Installation for drying entire batches of meat

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

Quality of the final products

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

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

Packaging and Storage

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

Meat drying in combination with additional treatment

i) Pre-salting ii) cured dried meat iii) smoked dried meat iv) dried meat with spices and additive e.g Kilishi

Meat Preservation by Thermal Treatment

Characteristics of Heat-Treated Preserved Meat and Meat Products

The prolonged shelf-life of heat-treated meat and meat products is achieved through reducing growth of, or inactivating, micro-organisms by a thermal process. The principal steps of the heat preservation method are to:

- place the product in a container (can, glass jar, pouches of synthetic material or laminate with aluminium) which is hermetically sealed after filling and which is impermeable to any external substances; and

- submit the hermetically sealed product to thermal treatment with a defined temperature and time combination.

Equipment for Thermal Treatment

Thermal or heat treatment is done by submerging the products in cooking vats or pressure cookers which contain hot water or steam or a mixture of both. It can be performed under pressure in pressure cookers (retorts, autoclaves) in order to reach temperatures above 100°C ("sterilization"). Sterilization is the most important and efficient type of heat treatment, since foods free from viable micro-organisms can be obtained and most of these products can then be stored without refrigeration. In contrast, temperatures up to 100°C can be achieved in simple cooking vats ("pasteurization"). A certain amount of micro-organisms resist this moderate heat treatment and the resulting pasteurized products must consequently be stored under controlled temperatures.

After thermal treatment the product must be chilled as quickly as possible, in order to avoid overcooking. Hence, this operation is done within the cooker by introducing cold water. The contact of cold water with steam causes the latter to condense with a rapid pressure drop in the retort. A high pressure difference between the cooker and the internal pressure in the containers must be avoided in order not to induce permanent deformation or damage of these containers.

Containers for Thermally Treated Preserves

Containers for heat-preserved food must be airtight in order to avoid recontamination by environmental microflora. Moreover, no traces of undesirable substances which the packaging material may contain, such as heavy metals (lead, tin), should be permitted to migrate into the product. Currently, most of the thermally preserved products are:

- i. Cans,
- ii. Glass jars or plastic or
- iii. Aluminium/plastic laminated pouches.

The advantages of aluminium cans are low weight, resistance to corrosion, good thermal conductivity and recyclability, but these cans cannot be soldered or welded. They are less rigid and more expensive than steel plate.

Meat Products Suitable for Canning

- cooked ham
- sausages with brine of the frankfurter type
- sausage mix of the bologna or liver sausage type
- meat preparations such as corned beef, chopped pork, etc.

- ready-to-eat dishes with meat ingredients such as beef in gravy, chicken with rice, etc.
- soups with meat ingredients such as chicken soup, oxtail soup, etc.

Organoleptic, Physical and Microbiological Aspects of Thermal Treatment

The intensity of heat treatment has not only a decisive impact on the inactivation of micro-organisms, but also on the organoleptic quality of the product. As a result:

- 1) There are products which undergo intensive temperature treatment without significant losses in quality.
- 2) Some other products may deteriorate considerably in taste and consistency after sterilization. In these cases less intensive thermal treatment is required but, at the same time, other hurdles, such as low pH value and/or water activity or a lower storage temperature, have to be built up in order to inhibit bacterial growth.

The intensity of thermal treatment can be defined in physical terms. The term widely used under practical conditions is the F-value, with which the lethal effect of heat on micro-organisms can be defined. The thermal death time for different micro-organisms calculated at 121°C and expressed in minutes, is used as the reference value.

The thermal death time for spores of *Clostridium botulinum* at 121°C is 2.45 minutes or in other words, an F-value of 2.45 is needed to inactivate all these spores in the product at 121°C. Spores of other micro-organisms are more or less heat resistant. Vegetative cells of micro-organisms are generally destroyed at temperatures of less than 100°C and therefore play no role in the F-value calculations. The definition of the F-value at 121°C is as follows:

F = 1: lethal effect at 121°C on micro-organisms after 1 minute

F = 2(3, 4, etc.): lethal effect at 121°C on micro-organisms after 2(3, 4, etc.) minutes.

The lethal effect can be shown in the reduction (in percentage) of the total number of micro-organisms present in the product. The destruction of micro-organisms is at an exponential rate, which means that the higher the initial bacterial load (using the same time-temperature combination), the higher the number of surviving bacteria.

Table 1. **Decimal reduction rates during heat treatment**

Initial bacterial load (micro-organisms/g)	Remaining micro-organisms		
	1 st Treatment	2 nd Treatment	3 rd Treatment
10 million	1 million	100 000	10 000
1 million	100 000	10 000	1 000
100 000	10 000	1 000	100
10 000	1 000	100	10
1 000	100	10	1

The initial bacterial load and the destruction rate are shown in Table 1. The table demonstrates the importance of proper meat hygiene. Highly contaminated raw material with bacterial loads of 10 million per g will, even after intensive heat treatment, still give final products with a rather limited shelf-life because of the high remaining rate of contamination.

Since the heat treatments will in many cases not be intense enough to destroy all spores, it is important that cans be chilled as rapidly as possible after retorting and that storage temperatures generally not exceed 20 to 25°C.

The nature of the heat-preserved product, its pH, amount of salt and other curing agents, and the number of spores present, together with retorting time and temperature, determine the degree of commercial sterility and product safety. It has been shown that F-values of 4 in heat-preserved products will guarantee commercial sterility. Products with F-values below this level need additional measures such as lowering the pH or refrigerated storage for their microbiological safety.

Micro-organisms have two adverse effects in improperly treated heat-preserved products:

- organoleptic deterioration through protein degradation;
- food poisoning by bacteria and/or toxins.

Categories of Heat-Treated Preserves

Pasteurized products

This requires only slight thermal treatment. Temperatures reached in the product centre are in the range of 82°C and below 100°C ("pasteurization"). The F-value cannot be determined, remaining almost at zero.

Inactivated: most vegetative micro-organisms

Not inactivated: spores of *Bacillus* and *Clostridium*

Storage required: uninterrupted cold chain (2–4°C), up to six months

Cooked preserves

This refers to thermal treatment only with boiling water (no pressure cooker).

Temperature reached in the product centre is up to 100°C. Low F-value.

Inactivated: all vegetative micro-organisms

Not inactivated: spores of *Bacillus* and *Clostridium*

Storage required: not higher than 10°C for one year. Spores will not grow under these conditions.

“Three-quarter” preserves

This refers to thermal treatment in pressure cooker. Temperatures reached in the product centre are between 108 and 112°C. F-value 0.6 to 0.8.

Inactivated: all vegetative micro-organisms, spores of *Bacillus*

Not inactivated: spores of *Clostridium*

Storage required: not higher than 15°C for one year. Spores of *Clostridium* will not grow under these conditions.

“Full” preserves stable under temperate conditions

This is Intensive thermal treatment in pressure cooker. Temperature reached in the product centre is about 121°C. F-value 4 to 6 (“sterilized product”).

Inactivated: all micro-organisms except thermophilic spores

Storage required: ambient temperature (for one year), but not tropical conditions (40°C or more).

“Full” preserves stable under tropical conditions

Very intensive thermal treatment, with a long period of 121°C or higher in the product centre. F-value of 12 and more.

Inactivated: all micro-organisms including thermophilic spores

Storage required: ambient temperature even under tropical conditions (up to four years).

Shelf-stable preserves

This group of preserves is different from those mentioned previously, since preservation is achieved not only by thermal treatment, but also by utilizing other means to prevent microbiological growth such as nitrite, low water activity and/or low pH. This combined effect has the advantage of a fully shelf-stable product under all ambient conditions without undergoing intensive thermal treatment (less than 100°C) and without major losses in organoleptic quality.

Factors Affecting the Shelf-Life of Meat and Meat Products

Though meat handling, storage and consumption may differ from one place to another, the factors limiting the shelf-life of these products are the same.

There are *endogenous* factors, such as:

- pH-value or the degree of acidity of the product;
- a_w value or the amount of moisture available in the product; and *exogenous* factors, such as:
- oxygen (from the air);
- micro-organisms;
- temperature;
- light; and
- evaporation and desiccation.

Pre - Slaughter Handling of Different Farm Animals

What is pre-slaughtering handling?

It is the way in which an animal is treated before being killed and after and this affects the post-mortem changes and the quality of meat.

N.B. in other words how the preparation made prior to few hours to slaughtering affects the farm animals and quality of meat produced. We want to discuss what happens when an animal is being moved from the farm to the slaughtering pen.

When animals are moved to unfamiliar surroundings, they may become excited, fatigued, overheated or chilled. All these conditions result from response within the animal body caused by various factors in the new environment. Hence referring to such reactions of animals under those conditions it is often noted that such animals are expressing stress.

The term stress is an expression referring to the physiological adjustments, such as the changes in heart rate, respiration rate, body temperature, and blood pressure that occur during the exposure of the animal to adverse conditions. Such conditions called STRESSORS. occur when the environment becomes uncomfortable or hazardous to the animal e.g Temperature, humidity, light, sound and space.

Physiological Responses during Stress

Naturally the animal body has a store of many natural defences against adverse conditions and those defences attempt to maintain those internal conditions that enable the animal to continue its life process (Homeostasis).

The adjustments in metabolism that occur during periods of stress are aided by the release of certain hormones. Hormones of importance are EPINEPHRINE and NOREPINEPHRIN from the adrenal medulla, ADRENAL STEROIDS from the adrenal cortex and THYROID HORMONES from thyroid glands. The adrenal hormone provides stress resistance.

Epinephrine helps break down the glycogen that is stored in the liver and muscle as well as the fat that is stored in several locations in the body in order to provide a ready sense of energy.

EPINEPHRINE and NOREPINEPHRINE helps to maintain proper blood circulation by their influence on the heart and blood vessels hormones from the adrenal cortex are also effective in reinforcing the ability of the tissues to respond during stress. Thyroid hormones increase metabolic rate and thereby provide increased available energy to the animal.

Factor That Causes or Contribute to Stress

1. Environment Factors e.g. temperature, humidity, light, sand and space.
2. Transportation of the animals: it is during transit that most death losses and tissue bruising occurs also muscle tissue shrinkage and reduction of weight of the dressed carcass can result from severe live weight in the marketing process, due to loss of gastro-intestinal tract contents.
3. Overcrowding
4. Poor ventilation
5. Mixing of unfamiliar animals
6. Physical discomfort
7. Excessive noise
8. Loading and Unloading animals by means of steep ramp or steps.

Remedy

1. Holding livestock in a stocky and prior to slaughter provides opportunity for resting and feeding. In addition it helps to improve the ability of the animal to withstand later handling, this in cow can influence the level of energy stored in the muscle.
2. Animals should not be manhandled. The use of sticks and whops should be discouraged.

3. Different social group of animals should not be mixed together, overcrowding should be avoided.
4. Animals should not be slaughtered immediately on arrival from long treks but should be rested in Lairage for at least 24hours.
5. Diseased animals should not be slaughtered.

Pre Slaughtering Handling from the Lairage to the Stunning Pen

Animals should be pasted for 12 – 16 hrs before slaughter to reduce the amount of undigested food and faeces in the intestine. Fasting also improves the quality of meat and reduces risks of contamination of the carcass by practice during evisceration

Animals to be held for more than 24hrs should be provided for with light feeding. If pigs are deprived of feed and water for more than 24hrs they may be unsuitable for the production of sausage or ham. From the holding yard, the animal should move through a clinte narrow enough to prevent turning and which should lead into a stunning pen.

Stunning is rendering an animal unconscious before being bled.

Requisites for Satisfactory Stunning Are

1. Quick rendering of unconsciousness without abuse or mutilation and
2. The prolongation of unconsciousness until the animal has bled out. Death should come instantaneously and without visible preparation to the animal.

For species like poultry:- they need to be rested in a good place and have access to water with no food for about 12 hours. Late feeding prevents good bleeding and makes the intestine tear easily during evisceration

Slaughtering Methods/ Techniques

There are two common method of slaughtering

i) Muhammedan method: is a common method in Nigeria. About 99% of abattoirs use the above method and in some countries the method is used on emergency cases. The 4 – legs are tied with rope. The animal is placed facing the eastern part as the butcher says some prayers before cutting the carotid artery and jugular vein. The positioning of the animal is called prone carcass.

Disadvantages

1. There can cause injury to the handler
2. Damage of hides and skin
3. It can serve as a source of entry to microbes which can cause PUTRIFACTION .
4. There is possibility of incomplete bleeding

ii.) Humane Method: quality of kindness

A stunning pen may be about 2.25m in length and 1m wide. If a stunning pen is not possible, a ring emplaced in the floor of the slaughtering house may be used to secure the animals head and this is in sure accuracy of the blow for stunning. The ring should be located where the animal does not see carcasses and where the floor is not slippery.

Stunning Methods

1. **Use of Gas:** Here the gas used is CO₂ the animal is lead into the air tight chamber and the within seconds it becomes unconscious.
2. **Electric Appliance:** The use of electricity for stunning has become the recommended practice. Electricity is applied with a prior of tons. For pigs the tongs are applied immediately below the ears for 6-10 secs. With a current of 60-70 volts the time and voltage is similar for calves and sheep but the tongs are applied between the eye and the ear.
3. **Captive Bolts Pistol:** it protects on cartridges. It is directed to the frontal lobe. It is often used for the big animals like bulls.
4. **Hammer:** it also directed on the frontal lobe of the animals. It is also used for big animals.

Slaughtering Stages or Abattoir Operations

Pre inspection → stunning → bleeding (hoisting)

Bleeding:- cattle throat is slashed where the vena cava, jugular veins and carotid arteries are situated.

Sheep and Goat:- a stuck behind the jaw below the ear

Pigs:- incision are made approximately 5cm above the breast bode on the front of the neck and the knife thus towards the entrance to the chest, cutting the carotid arteries and jugular veins.

→ scalding or skinning → evisceration → splitting of carcass into 2 equal halves →

Post-inspection → washing with warm water → wipe dry → chill

Post Mortem Changes in Meat/Conversion of Muscle to Meat

The conversion of muscle to meat involves a number of physical and chemical changes which take place over a period of several hours or even days. The maintenance of a physiologically balanced environment is termed HOMEOSTASIS. This could be regarded as a system that ensures uniformity and stability of the internal environment thereby providing the body with a means of coping with abnormal (stressful) conditions.

1.) Exsanguinations: Is the act of removing as much blood as possible from the animal. The loss of blood and resultant loss in blood pressure sends signals to the circulatory system via the brain and it adjusts its function in an attempt to maintain a blood supply to the organs. Exsanguinations marks the beginning of a series of post mortem changes in the muscle only about 50% of the total blood volume can be removed from the body, the remainder is held mainly in vital organs.

2.) Circulatory Failure to the Muscles

The function of the circulatory system is to transport essential nutrients to the muscle and carry waste products away from the muscle, but exsanguinations eliminates this line of communication between the muscle and its external environment.

In the living cell of a living animal, O₂ is picked up in the lungs and carried to the cells of the body by the haemoglobin pigment of the blood. The myoglobin of the muscle cells has a greater attraction for O₂ than does haemoglobin, a characteristic that helps transfer O₂ from the blood of the muscle cells. The myoglobin provides a place for storing the O₂ until it is used by the cells for metabolism. As the stored O₂ supply becomes depleted after exsanguinations the aerobic pathway through the citrate cycle and the cytochrome system must stop functioning. Energy metabolism is then shifted to the anaerobic pathway considerably less energy that will maintain the structural integrity and temperature of the cells for some time.

3.) pH Decline:- Since the circulatory system is no longer functioning lactic acid produced by anaerobic metabolism, instead of being transported to the liver for the synthesis of glucose and glycogen remains in the muscle and increases in concentration as metabolism proceeds. The lactic acid produced causes the lowering of the pH in meat, making the meat acidic. Thereby cause the denaturing of muscle proteins leading to loss of water holding capacity and the result is a muscle with pale colour. The pH of a living muscle from pork decrease from pH 7 to about 5.6 -5.7 within 6 - 8 hours post-mortem and then to an ultimate pH (reached after 24hours post-mortem) of about 5.3 -5.7. Muscle which have a very rapid and extensive pH decline will be pale in colour, will have very low WHC on the other hand, muscle to meat will be very dark coloured and very dry on the exposed cut surface because the naturally occurring water is tightly bound to the proteins.

4.) Post-Mortem Heat Production and Dissipation

As a result of exsanguinations and circulatory failure heat can no longer be carried to the lungs and other surface areas for dissipation, therefore causing a rise in muscle temperature. External factors associated with the slaughter process will also influence heat dissipation such as ambient temperature in the slaughter room, the length of the slaughter and dressing operation and the

temperature of the initial chill cooler will all have a considerable influence on the rate of carcass temperature decline.

5.) Rigor Mortis (Latin: "Stiffness of Death")

This is the stiffening of the muscle after death and is due to the formation of permanent cross-bridges in the muscle between the actin and myosin filaments. During the period immediately following exsanguinations muscle is quite extensible, if a force is applied to it the muscle will passively stretch and when the force is removed, then natural elasticity of the muscle will return to its original length. At that time only few actomyosin is present to prevent extension by a force. The period of time during which the muscle is relatively extensible and elastic is called DELAY PHASE OF RIGOR MORTIS

The Onset Phase of rigor mortis begins when the muscle begins to lose extensibility only in ensuring relaxation which the actomyosin bond. Rigor mortis therefore is an irreversible muscle contraction



When muscle glycogen stores is depleted, ATP produced becomes insufficient to maintain the muscle in a relaxed state.

6.) Loss of Protection from Bacteria Invasion

During the conversion of muscle to meat, following exsanguinations, the antimicrobial defence system ceases to function, membrane properties are altered and the muscle becomes susceptible to bacterial invasion unchecked.

7.) Enzymatic Degradation

In the muscle cells, proteolytic enzymes called cathepsins are held in an inactive state in organelles called lysosomes. The drop in pH at the death of the animal activates these enzymes and they begin to degrade the protein structure of the muscles. In addition the muscle proteins may be subjected to denaturation due to pH drop.

Relation between Ph Decline and the Development of Rigor Mortis

Muscle with a normal pH decline curve will have on poultry meat has been shown to be due to induction of rapid onset of rigor mortis and most directly related to the rapid pH decline of the meat while carcass is still warm. Beginning immediately after death, CP falls rapidly with pH following the same pattern as ATP levels. ATP breakdown now commences and proceeds rapidly until the level becomes low. As ATP levels declines, there is rapid decrease in muscle extensibility.

Stress affected meat becomes dark, blue –red in colour.

8.) Changes in the Physical Appearance of the Muscle

In living animals muscle with sufficient oxygen supply has a bright red appearance. In post mortem muscle, as the O₂ is used, the muscle becomes dark purplish red in colour. The lower the pH the lower the water binding properties of meat.

Cold Shortening

Muscles shorten as permanent bonds form during the development of rigor mortis. Minimum shortening occurs at 14°C to 19°C. If the temperature of the muscles is reduced to below 10 -16°C while they were still in the early pre-rigor condition (pH 6.0 – 6.4), there is a tendency for shortening and thereby toughness in cooking. This phenomenon is referred to as Cold Slaughtering.

Thaw Rigor

This is the shortening that occurs upon thawing meat that was frozen in the pre-rigor state. The onset of thaw rigor occurs while the amount of ATP is relatively high (40°C); meat becomes less tender. In case meat is not allowed to complete its rigor months before freezing, the meat should be rapidly thawed before using, since slow thawing with accumulation of a high concentration of salts in the thawed fluid appears to accelerate thaw rigor.

Ageing Meat

In the absence of microbial spoilage the holding of unprocessed meat above freezing point (usually 2-5°C) for about 2-4 weeks is known as CONDITIONING OR AGEING OR RIPENNING, this practice helps to increase tenderness and flavour.

Meat Quality

Meat quality refers to the condition of meat. Meat quality refers to a combination of traits that provide for an edible product that is attractive in appearance, appetizing, nutritive and palatable after cooking. The ideal level of meat quality combines the capacity to retain a high nutritive value in the cooked form with that to excel in satisfying numerous functional roles in the fabrication and processing of acceptable products. In determining the quality of meat parameters to look out for are:-

a) Colour (Appearance)

Appearance is a very vital component that strongly affects the consumer acceptability of fresh meat. The colour of fresh meat is determined by myoglobin and haemoglobin.

Dark Firm and Dry (DFD) and Pale Soft Exudative (PSE) are meat with pale colour as well as soft watery texture. DFD meat has a high pH which is above iso-electric point of actomyosin. It has an unpleased purplish-red colour of myoglobin and thus the meat appears dark. PSE pork comes from a rapid and severe post-mortem drop in pH resulting in denaturing of sarcoplasmic and myofibrillar proteins in the muscle. Factors that affect colour are:

- a) Age of the animal
 - b) The type of muscle involved
 - c) Degree of surface desiccation
 - d) Temperature
 - e) Bacterial growth
- b) Texture:** Meat that contains a high degree of marbling will be firmer than meat with little marbling muscles that are rough and coarse are of pork textural quality.
- c) Tenderness:** It is a sensation created. It is a complicated physical process, since chewing involves cutting, grinding, squeezing, shearing and tearing. Tenderness is measured by means of
- a) Shear press
 - b) Instron which is used in measuring textural properties of frozen and freeze – dried broiled meat.
 - c) A sensory test which requires taste panel.

Factors affecting tenderness include;

1. Age and maturity
 2. Activity: strengthen and toughen muscle – tissue
 3. Nutrition:- degree of fatness, processing, pre slaughter husbandry, chilling, scalding, ageing and freezing, sex of animal
- d) Flavour:** This is the combined effect of food on the sense of taste, odour and mouth-feel. Hence the evaluation of flavour is subjective. Flavour is the mixed sensation of aroma and taste by which individual foods are identified.

Methods of Meat Preservation

Preservation is defined as any method of treating food to prolong the length of time in which it retains its quality and appeal. Methods of preserving meat include refrigeration, freezing, thermal processing and dehydration. Following exsanguinations the process of converting muscle to meat. It begins by subjecting the meet to degradation by chemical, physical, enzymatic and microbiological reactions. Preservation is to prevent degradation from taking effect.

1) **Cold Storage**

I. Chilling Storage:- is generally regarded to be storage at temperature not far above freezing (0°C)s e.g. temperature ranging from 0°C to 1.1°C can chill the thickest part of carcass between 12 -21 hours which can be stored for 8 days for beef, 6 days for lamb. Temperature between 5°C – 10°C is limited to short period of storage.

II. Freezing:-

a) **Slow freezing:-** Involves freezing with only natural air circulation or at best with electric fans. Temperature is usually -23.3°C or lower and freezing may take from 3 to 72 hours.

Large ice crystals are usually formed within the muscle fibre. Ice crystals are usually needle like which are capable of destroying muscle fibre. There is much fluid loss

b) **Quick /fast freezing:** is accomplished either by

i) Direct immersion of food in a refrigerant e.g. freezing of fish in brine.

ii) In direct contact with the refrigerant where the food or package is in contact with the passage through which the refrigerant at -17.8 - -45.6°C flows or

iii) By air-blast freezing, where frigid air at -17.8 - -34.4°C is blown across the materials being frozen

2. **Dehydration Method:-** Removal of water by

i. **Sun Drying:-** weather must be warm and dry. The demerit of this method is that it is subject to weather condition and is contamination from dust and sand.

ii) **Hot air drying:-** only applicable to cooked meat.

iv. **Salting:** its diffusion in meat is by the process of osmosis. It improves the texture of meat and contribute to the pleasant flavour and aroma of the product. It inhibits the growth of bacteria although there are some salt tolerant bacteria.

iv) **Smoking:-** It decrease the more - soluble protein (myofibrillar and sarcoplasmic) content while increasing the amount of the more - insoluble (stomach) proteins.

v) **Meat curing:** - is an aspect of meat preservation in which salts, sugars nitrite/ nitrate, phosphate and other curing agents are used to improve meat colour and its acceptability after slaughter

Curing Ingredient

1. **Salt** (NaCl)

2. **Sugar and corn syrup solids:-** sugar is added to curives for its moderating action on flavour and to soften the products by counteracting the harsh hardening effects of salt by preventing some of the moisture removal. Corn syrup, corn syrup solids (corn syrup from

which most of the water has been removed) molasses and other natural sugar substitutes are sometimes used in place of sugar. Corn syrup consists of sugars formed by the breakdown of starch and contains dextrose maltose, higher sugars, dextrin, and polysaccharides CS is not so sweet and is less soluble than sugar.

3. Nitrate

- To stabilize the pink colour of the lean tissue
- To contribute to the characteristics flavour of cured meat
- To retard the development of rancidity
- To inhibit the growth of a number of a number of food poisoning and food and food spoilage organism e.g *Clostridia botulinum*

4. Phosphate

- o To increase the water binding capacity
- o Improve retention of brine.
- o Improve colour and flavor retention
- o Act as buffers

5. Ascorbates

- Salt of ascorbate acid are commonly used to hasten the development and stabilize the colour of cured meat by
 - a) Taking part in the reduction of metmyoglobin to myoglobin
Monosodium Glutamate (MSG)
- To enhance flavor not widely used in the industry

6. Canning: can either be sterile or pasteurized

- i.) **Sterile Product:** are shelf- stable and need no refrigeration e.g Luncheon meats, corned beef and sandwiched spread are example of sterile products
- ii.) **Pasteurized Product:-** Cooked ham.

Bulging cans could result to food poisoning e.g *Clostridia botulinum*. A disease condition as BOTULISM

Symptoms

1. Dizziness
2. General weakness
3. Severe headache
4. Loss of vision
5. Paralysis of throat muscle

This is because the toxins are very lethal which can kill almost immediately. In respiratory center leading to death, speech becomes impaired.

MEAT PROCESSING

Processed meat products are defined as those in which the properties of the fresh meat have been modified by the use of one or more procedures such as grinding or chopping, addition of seasonings, alteration of colour, heat treatment, drying and other processing /conservation processes.

Recipe

Meat	55 -65%
Seasoning	1-2 %
Additives	1-2 %
Fat	1-15%
Fillers/binders	20-25%
Water	13-15%

Seasoning - Coriander 70g, Nutmeg 40g, Mace 40g, pepper 115g, salt 200g, Monosodium glutamate 5g

It adds to flavour to whatsoever is been prepared. Seasoning are added to sausage to perform function like

- i. Influence the flavour of the product
- ii. Serves as preservatives
- iii. Stimulate the production of digestive juices which aid digestion and absorption
- iv. Influence colour and overall acceptability of the product

Additives

- i. Chemical additives
- ii. Natural additives

i. Chemical Additives

a) Polyphosphate

- i) Increase water binding capacity
- ii) Improve retention of brine
- iii) Improves colour retention
- v) They act as buffers

b) Ascorbic acid

- i) Use to hasten development and stabilize the colour of cured meat by –
- a) Taking part in the reduction of metmyoglobin to myoglobin, thereby accelerating rate of curing
- b) React with nitrite to increase the yield of nitric oxide to form nitrous acid
- c) Excess ascorbate acting as anti-oxidants, thereby stabilizing both colour and flavor

c) Monosodium glutamate:- they are needed to enhance flavour, but are not widely used in the meat industry

ii. Natural Additives:- This could be of protein source e.g. egg powder

Fat:- Back fat, they play major role in texture juiciness and flavour of comminuted meat products

Fillers and Binders:- they are basically carbohydrates and are starchy in nature e.g. wheat flour, cassava flour etc.

- a) To improve emulsion stability
- b) To improve water binding capacity
- c) To enhance flavor
- d) To improve slicing characteristics
- e) To reduce formulation cost i.e. it helps to add to the bulkiness of sausage

Water:-

- a) Increases juiciness and palatability
- b) Lowers the temperature of the product
- c) Aids thorough chopping and mixing
- d) Aids in dissolving salt
- e) Influence the texture of sausage mix.

Sausage Casing

These are containers used in packaging the comminuted meat and hold it together until it gets to the consumer. They determine the size and shape of the sausage. There are two types of casing, the natural and the artificial casing

i.) Natural Casings:- From intestine and bladders of cattle, dogs, sheep, pigs etc.

- a)** These containers protect the meat from sudden loss of moisture
- b)** The container is digestible and shrinks with meat as its water content reduces

Because of rise in demand for sausage meat natural casing could no longer meet the demand

ii.) **Artificial Casing:-** They are either cellulose from cotton inters(cotton by-products) or collagen (from the corium layer of beef hides). These casings can be made more uniform in size and performance characteristics than animal casing

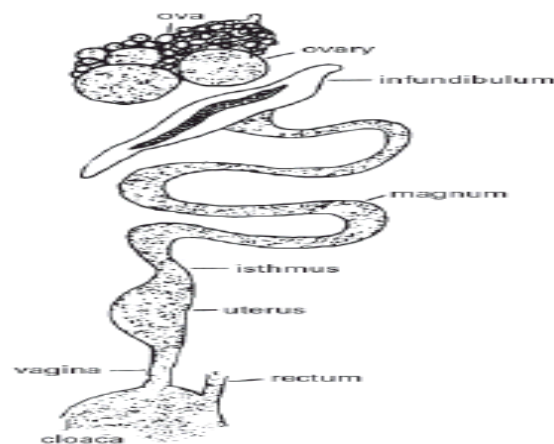
a) **Cellulose:-** it gives sausage and smoked meat the desired uniformity in diameter and length and the stability to withstand modern high temperature and rapid processing conditions . The advantages of cellulose casing are:

- Easy to handle and stuff
- Posses a high degree of resistance to breakage
- And permeable to smoke when moist
- Requires careful storage
- Humidity is very critical since cellulose becomes quite brittle when very dry.

b) **Collagen Casing**

It was developed as edible casing similar to animal casing but possessing the uniformly of a manufactured product. its best kept at a RH of about 40 -45%

EGG AS AN ANIMAL PRODUCT



FORMATION OF EGG

Figure 6: Reproductive tract of hen

The avian egg, in all its complexity, is still a mystery. A highly complex reproductive cell, it is essentially a tiny centre of life. Initial development of the embryo takes place in the blastoderm. The albumen surrounds the yolk and protects this potential life. It is an elastic, shock-absorbing semi-

solid with high water content. Together, the yolk and albumen are prepared to sustain life - the life of a growing embryo - for three weeks, in the case of the chicken. This entire mass is surrounded by two membranes and an external covering called the shell. The shell provides for an exchange of gases and a mechanical means of conserving the food and water supply within

The egg is formed in the mature hen by a reproductive system composed of an ovary and oviduct. Most females have two functional ovaries, but chickens and most other birds have only one ovary and one oviduct. In this oviduct, all parts of the egg, except the yolk, are formed. It is divided into five distinct regions: (1) infundibulum or funnel, (2) magnum, (3) isthmus, (4) uterus or shell gland, and (5) vagina.

The yolk is formed in the follicular sac by the deposition of continuous layers of yolk material. Ninety-nine percent of the yolk material is formed within the 7-9 days before the laying of the egg. When the yolk matures, the follicular sac ruptures or splits along a line with few blood vessels. If any blood vessels cross the stigma, a small drop of blood may be deposited on the yolk as it is released from the follicle. This causes most blood spots in eggs. After the yolk is released from the follicle, it is kept intact by the vitelline membrane surrounding it. The release of the yolk from the ovary is called "ovulation." There is a small white spot about 2 mm in diameter on the surface of the yolk. This is the germinal disk and it is present even if the egg is infertile. If the egg is infertile, the germinal disk contains the genetic material from the hen only. If the egg is fertile, it contains genetic material from both parents and is where embryonic development begins. The yolk material serves as a food source for embryonic development.

After its release from the follicle, the yolk falls into the hen's abdominal cavity. The infundibulum of the oviduct quickly engulfs the yolk with its thin, funnel-like lips. The yolk quickly enters the magnum section of the oviduct where the dense portion of the albumen is added. The shape of the egg is largely determined in this section.

The magnum of the oviduct is divided from the isthmus by a narrow, translucent ring without glands. The isthmus is smaller in diameter than the magnum. It is here the two shell membranes form. The shell membranes loosely contain the yolk and dense white until the rest of the albumen is added in the uterus.

The egg white (albumen) is produced by the oviduct. There are four types of egg white. The outer thin white is a narrow fluid layer next to the shell membrane. The outer thick white is a gel that forms the centre of the albumen. The inner thin white is a fluid layer located next to the yolk. The inner thick white (chalaziferous layer) is a dense, matted, fibrous capsule of albumen around the vitelline membrane of the yolk. The matted fibrous capsule terminates on each end in the chalazae,

which are twisted in opposite directions and serve to keep the yolk centred. The chalazae are twisted so that the germinal disk always orients itself upwards. During storage, however, the thick albumen becomes thinner allowing greater movement of the yolk.

The shell is added in the uterus or shell gland portion of the oviduct. The shell is composed mainly of calcium carbonate. It takes about 20 hours for the egg shell to form. If the hen lays brown eggs, the brown pigments are added to the shell in the last hours of shell formation.

The chalazae, two cord-like structures which keep the yolk centred in the egg, first appear in the uterus. The chalazae also function as an axis around which the yolk can rotate and keep the germinal disc in hatching eggs uppermost at all times.

In the last portion of the oviduct, the vagina, a thin, protein coating called "bloom" is applied to the shell. The cuticle somewhat seals the pores and is useful in reducing moisture losses and in preventing bacterial penetration of the egg shell. Much of the cuticle is removed from table eggs when they are mechanically washed. To replace the cuticle, table eggs are often sprayed with a light mineral oil mist. The egg passes through the oviduct small end first, but is laid large end first. In the vagina, the egg is turned horizontally just before laying. If the hen is disturbed on the nest, the egg may be prematurely laid with small end first. "Oviposition" is the act of pushing the egg from the oviduct.

When the egg is laid it is at the same temperature as the hen's body (about 105°F). As the egg cools to ambient temperature, the egg contents contract and the two shell membranes separate, generally at the large end of the egg, forming the air cell. The outer membrane sticks to the shell while the inner membrane sticks to the albumen. During storage, the egg loses water by evaporation, causing the air cell to enlarge.

Egg Formation Timeline

The average time an ovum spends in each structure as it passes down the oviduct

Infundibulum: about 15 minutes

Magnum: 2-3 hours

Isthmus: 1½ hour

Uterus: about 20 hours

Vagina: just a few minutes

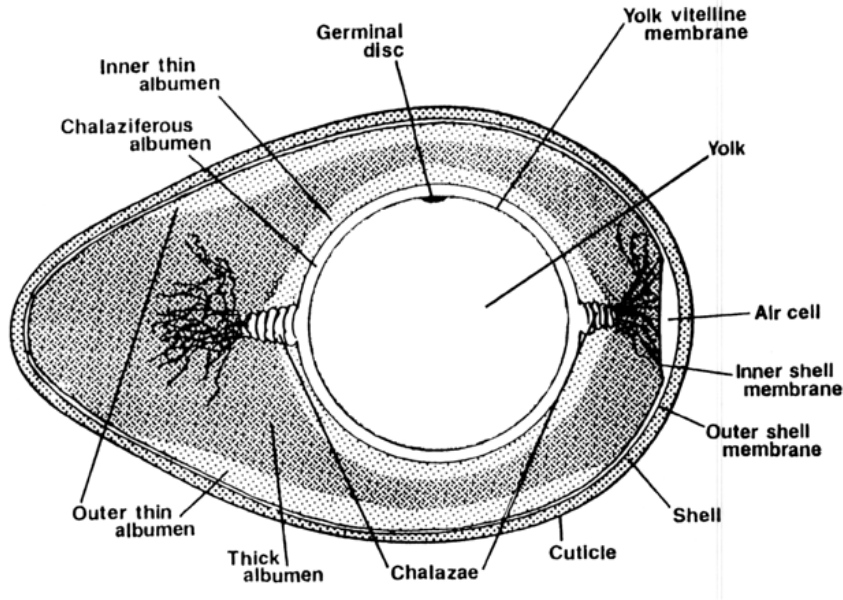


Figure 2: diagram of an egg

Egg sizes

Eggs are sorted into five different sizes according to weight: Jumbo, Extra Large, Large, Medium, Small, and Pee Wee. The following are the weight standards and approximate nutritional values associated with each of these sizes:

UK egg sizes

New Size	Weight
Very Large	$\geq 73\text{g}$
Large	63 - 73g
Medium	53 - 63g
Small	$\leq 53\text{g}$

US egg sizes

Egg sizes	Average weight
Jumbo	71g
Extra-large	64g
Large	57g
Medium	50g
Small	43g
Peewee	35g

The Nutritive Value of the Egg

The egg is one of the most complete and versatile foods available. It consists of approximately 10% shell, 58% white and 32% yolk. Neither the colour of the shell nor that of the yolk affects the egg's nutritive value. The average egg provides approximately 313 kilojoules of energy, of which 80% comes from the yolk.

The nutritive content of an average large egg (containing 50 g of edible egg) includes:

6.3 g protein

0.6 g carbohydrates

5.0 g fat (this includes 0.21 g cholesterol).

Egg protein is of high quality and is easily digestible. Almost all of the fat in the egg is found in the yolk and is easily digested.

Vitamins

Eggs contain every vitamin except vitamin C. They are particularly high in vitamins A, D, and B12, and also contain B1 and riboflavin. Provided that laying hens are supplemented according to the Optimum Vitamin Nutrition concept. Eggs are an important vehicle to complement the essential vitamin supply to the human population.

Minerals

Eggs are a good source of iron and phosphorus and also supply calcium, copper, iodine, magnesium, manganese, potassium, sodium, zinc, chloride and sulphur. All these minerals are present as organic chelates, highly bio-available, in the edible part of the egg.

Egg Grades

Grading is a form of quality control used to divide a variable commodity or product into a number of classes. The United States Department of Agriculture (USDA) standards for quality of individual shell eggs were developed on the basis of both interior and exterior quality factors. Commercially, eggs are graded simultaneously for exterior and interior quality. When determining the grade of an egg, the factor with the lowest grade will determine the overall grade of the egg. In the United States, egg grades include AA quality, A quality, B quality, and dirty. Only AA and A quality eggs are sold for supermarkets.

Egg Quality

Egg quality is a general term which refers to several standards which define both internal and external quality. External quality is focused on shell cleanliness, texture and shape, whereas internal quality refers to egg white (albumen) cleanliness and viscosity, size of the air cell, yolk shape and yolk strength.

Egg Size

The size of an egg is controlled by many factors. Among these factors including individual genetic markers, stage of sexual maturity, age, drugs and some dietary nutrients available to the bird. The most important nutritional factors known to affect egg size are protein and amino acid adequacy of a diet and linoleic acid.

Egg Shell Quality

Shell colour comes from pigments in the outer layer of the shell. Shell colour is primarily a **breed characteristic**, although there is often variation among individual hens in a particular flock even when all are of the same breed and variety. Egg shells of commercial breeds of chickens are white or brown. Breeds with white earlobe ordinarily lay white eggs while breeds with red earlobes ordinarily lay brown eggs. White eggs are most in demand among American buyers. In some parts of the country, however, particularly in New England, brown shells are preferred. The Rhode Island Red, New Hampshire and Plymouth Rock are breeds that lay brown eggs. Since brown-egg layers are slightly larger birds and require more food, brown eggs are usually more expensive than white. While darker coloured brown eggs tend to have thicker shells, shell colour has nothing to do with egg quality, flavour, nutritive value, or cooking characteristics.

The appearance of the egg, as influenced by severity of defects, is important for consumer appeal. Egg shells are evaluated on the basis of cleanliness, shape, texture, and soundness.

Cleanliness

Most eggs are clean when they are laid, but they can become contaminated with manure or other foreign material. In the United States, an egg with manure or adhering material on the shell cannot be marketed. It is classified as dirty and cannot be used for human consumption. Eggs with stained shells are unattractive in appearance and cause eggs to be downgraded to B quality or dirty depending on the severity of the stain.

Shape

The "normal" chicken egg is elliptical in shape. Eggs that are unusual in shape, such as those that are long and narrow, round, or flat-sided cannot be placed in Grades AA or A. Round eggs and unusually long eggs have poor appearance and do not fit well in cartons so are much more likely to be broken during shipment than are eggs of normal shape.

Texture

An egg shell that is smooth is preferred since rough-shelled eggs fracture more easily and have poor appearance. Eggs with extremely rough or uneven shells are downgraded to B quality. Some eggs

have a rough pimply appearance. The pimples (calcium deposits) are distortions to the shell. Infection is not responsible because pimpling also occurs in disease-free flocks. The defect may be partly hereditary.

Mottled shells have pale translucent spots (sometimes called "windows") of various sizes. Such eggs appear normal when laid. The mottling develops later and may be noticeable half an hour after laying, although it is more easily detected a day later. This abnormality is inherited, although a similar effect can be induced artificially, such as when a wet, newly laid egg slides across the wire cage floor instead of rolling, or when a hen's toenail scratches the surface of a recently laid egg.

Soundness

"Body checks" are eggs with shells that have been cracked during shell calcification in the hen and have had a layer of calcium deposited over the crack(s) before the egg is laid. Some body checks are covered by a relatively thick layer of calcium before being laid so are not easily detected unless eggs are candled. Other body checks are only covered by a thin calcium layer before being laid so they are easily detected.

The incidence of body checks will increase if hens are excited in the afternoon or early evening just as the egg shell begins to form in the oviduct. It is important, therefore, to keep hens as calm as possible, especially during the late afternoon and at night.

Body checks sometimes appear as ridges or bulges on the shell. Depending upon the extent and severity of the ridge or bulge, or the ease of detecting the checked area, body checks may be classified as B quality. These shells are usually weaker than normal shells, are more likely to break in shipment, and they lack consumer appeal.

Sometimes eggs have thin spots in the shell. The thin spots may appear gray and the shell is more likely to break in these areas.

Factors Affecting Shell Quality

Poor shell quality can result in downgrading. Producers should be aware of these factors so they can take preventive actions to minimize the occurrence of costly downgrades. Management plays an important role in controlling all of these factors to produce eggs of high quality. To assure the production of high quality eggs, one should select a strain of birds known to produce eggs of good quality because egg quality is a heritable characteristic. Avoid prolonged periods of temperature above 86°F in the laying house, if possible. Use high quality feeds and adjust feed formulations according to feed intake and the age of the hens. Practice the necessary steps to prevent disease and other physiological disturbances in the flock. The time pullets start to lay can be regulated by

controlling feed and light in a planned program. Because egg quality decreases with the **age of the hen**, the number of years to keep a hen should be considered in relationship to all aspects of the production plan.

If one **disease** had to be singled out as being responsible for the majority of the economically significant production losses in egg layers, it would be infectious bronchitis. Not only is egg shell quality affected, but internal egg quality also declines. Watery whites are very common and can persist for long periods after egg production returns. Also, an infectious bronchitis outbreak can result in a pale-coloured shell in brown eggs. However, other factors, such as **stress**, are also responsible for causing a pale-coloured shell.

Another disease which may affect shell quality is Egg Drop Syndrome 76 (EDS 76). EDS 76 was first identified in Britain in 1976. A vaccine was quickly developed and the disease seemed to disappear. However, it has recently reappeared in the Netherlands. The disease is mainly characterized by a drop in egg production early in lay, or by a sudden fall in production at a later stage in the laying period. In the beginning the symptoms include shell-less eggs and thin-shelled eggs, deformed eggs, and, in the case of brown eggs, a loss of shell colour. In addition, the whites of these eggs are very watery, and there is considerable variation in egg weight.

Internal Egg Quality

Interior egg quality is based on air cell size, albumen quality, yolk quality, and the presence of blood or meat spots.

Albumen Quality

The albumen has a major influence on overall interior egg quality. Thinning of the albumen is a sign of quality loss. When a fresh egg is carefully broken out onto a smooth flat surface, the round yolk is in a central position surrounded by thick albumen. When a stale egg is broken out, the yolk is flattened and often displaced to one side and the surrounding thick albumen has become thinner, resulting in a large area of albumen collapsed and flattened to produce a wide arc of liquid.

Properly refrigerated eggs stored in their carton in a home refrigerator will change from AA-grade to A-grade in about 1 week and from A-grade to B-grade in about 5 weeks. However, a properly handled and refrigerated intact egg will retain its nutritional value and wholesomeness for a considerably longer time.

Egg yolk from a newly laid egg is round and firm. As the egg gets older, the yolk absorbs water from the egg white, increasing its size. This produces an enlargement and weakness of the vitelline membrane; the yolk looks flat and shows spots. As soon as the egg is laid, its internal quality starts

to decrease: the longer the storage time, the more the internal quality deteriorates. However, the chemical composition of the egg (yolk and white) does not change much. Increases in albumen pH are due to CO₂ loss through the shell pores, and depend on dissolved CO₂, bicarbonate ions, carbonate ions and protein equilibrium. Bicarbonate and carbonate ion concentration is affected by the partial CO₂ pressure in the external environment.

In newly laid eggs, the yolk pH is in general close to 6.0; however, during storage it gradually increases to reach 6.4 to 6.9. Egg quality preservation through handling and distribution is dependent on constant care from all personnel involved in these activities. The quality of the egg once it is laid cannot be improved, so efforts to maintain its quality must start right at this moment. The decrease in internal egg quality once the egg is laid is due to the loss of water and CO₂. In consequence, the egg pH is altered, resulting in watery albumen due to the loss of the thick albumen protein structure. The cloudy appearance of the albumen is also due to the CO₂; when the egg ages, the CO₂ loss causes the albumen to become transparent, compared with fresh eggs.

To minimize egg quality problems two things are important: frequent egg collection, mainly in the hot months, and rapid storage in the cool room. The best results are obtained at a temperature of 10 °C. There are six main factors affecting internal egg quality: disease, egg age, temperature, humidity, handling, and storage.

Disease: Newcastle disease and infectious bronchitis produce watery albumen, and this condition may persist for long periods after the disease outbreak has been controlled.

Egg age: Eggs of several days' old show weak and watery albumen and the CO₂ loss makes the content alkaline, affecting the egg flavour.

Temperature: high temperatures cause a rapid decrease in internal quality. Storage above 15.5 °C increases humidity losses.

Humidity: high relative humidity (RH) helps to decrease egg water losses. Storage at an RH above 70% helps to reduce egg weight losses and keeps the albumen fresh for longer periods of time.

Egg handling: rough handling of the eggs not only increases the risk of breaking the eggs, but also may cause internal egg quality problems.

Storage: eggs are very prone to take on the odours of other products stored with them; separate storage is therefore advised.

The variables mentioned above are particularly important to ensure that a 1-week-old egg, properly handled, can be as fresh as a day-old egg kept at room temperature. If the egg is properly handled during shipment and distribution, it will reach the consumer's table with adequate freshness.

Storage of Eggs

1. Store eggs small end down in an egg carton to keep the air cell stable.
2. Date carton so you can use or sell the oldest eggs first and rotate your extra eggs. Try to use or sell all eggs before they are three weeks old.
3. Store eggs at 50-55°F and 70-75% relative humidity.
4. Never store eggs with materials that have an odour. Eggs will pick up the odours of apples, fish, onions, potatoes and other food or chemicals with distinct odours.
5. Never hold eggs at or above room temperature or at low humidity more than necessary. Leaving eggs in a warm, dry environment will cause interior quality to drop quickly.

How to Tell if Eggs are Still Good

Have a carton of eggs that have passed their use-by date? Here's how to test to see if they are still good. *Fill a bowl with cold water and place your first egg inside. If the egg sinks to the bottom, it's fresh. If the egg sinks to the bottom, but stands on its point, it's still good but needs to be used soon. If the egg floats to the top, it needs to be discarded.

Uses of Egg

Binder: One of the uses of eggs is as a binder. A binder helps other ingredients bind together (eggs are used to help bind together meatballs, meatloaf and flour mixtures). When eggs are heated they coagulate, this helps stick together the ingredients they are mixed with.

Coating: Another use of eggs is as a coating agent. The breading on fried chicken sticks because the chicken is dipped into an egg then a flour or crumb mixture. The eggs help hold the crumb mixture to the food when heated during the cooking process.

Thickening: Eggs have thickening properties. The protein in eggs will thicken when heated and become firm. If an egg is overheated or cooked for too long of a time it will become rubbery and

tough in texture. Eggs are often used in custards and sauces to thicken the finished product.

Emulsifier: Eggs are an **emulsifier**. An emulsifier permits small globules of one liquid to be inter-dispersed in another liquid. For example in mayonnaise the egg acts as an emulsifying agent in keeping the oil and vinegar mixed as one product and not separating out. Eggs also are emulsifiers in cakes.

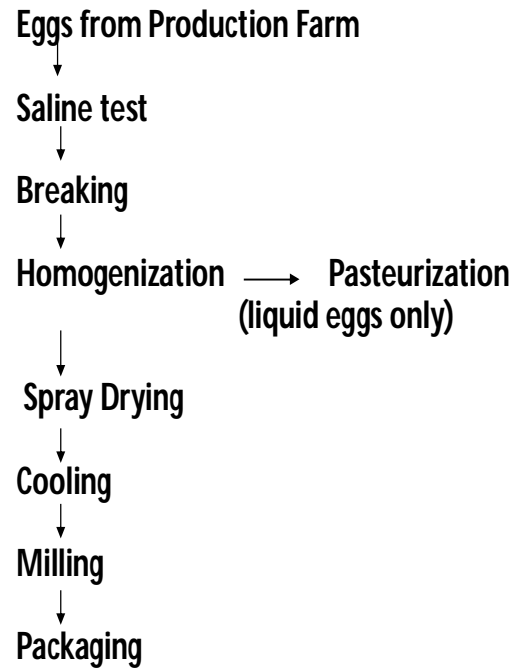
Crystallization: When a liquid freezes, ice crystals form. When eggs are added to a mixture, it helps prevent these crystals from forming. That is why another use of eggs is the prevention of **crystallization**.

Clarifier: The one use of the egg you probably are not very familiar with is using eggs as a **clarifier**. The egg is used to make a broth clear. Any unwanted particles in the broth will stick to the egg as it coagulates in the broth. The cooked egg is then removed.

Leavening: One of the most common uses of eggs is as a **leavening agent**. A leavening agent helps to make a cooked product rise. When eggs are beaten they hold air. When heat is added the structure will coagulate and traps the air. This is what gives angel food cakes, meringues and soufflés their light and fluffy texture.

EGG POWDER PRODUCTION

- Egg Products Processing and distribution Module



Summary table Processed Egg Products

<i>Product</i>	<i>Use</i>	<i>Properties</i>
<i>Liquid Whole Egg</i>	Bakery products, Omelette mix, Pie Filling	
<i>Liquid Egg White (Albumen)</i>	Bakery products, high protein foods, sausages etc	Binding, whipping
<i>Liquid Egg Yolk (Yellow)</i>	Salad Dressings, Sauces, Mayonnaise	Emulsifying
<i>Frozen Salted Yolk</i>	Salad Dressings, Sauces, Mayonnaise	Emulsifying
<i>Frozen Salted Whole</i>	Salad Dressings, Sauces, Mayonnaise	Emulsifying
<i>Frozen Sugared Yolk</i>	Bakery Items	Emulsifying
<i>Frozen Whole Egg</i>	Replacement for Shell or Liquid Egg	
<i>Dried Egg Whites</i>	Replacement for Fresh Egg White in bakery products, high protein foods, sausages etc	Binding, whipping
<i>Dried Egg Yolks</i>	Replacement for liquid or frozen yolks	Emulsifying

MILK

- Definition.: It is a white liquid produced by mammals and it is drunk by people
- **Facts about Milk**
- It is the source of nutrients and immunological protection for the young animals such as calf and kid.
- Shortly before parturition, milk is secreted into the udder in preparation for the new born.
- At parturition, a yellowish coloured, salty liquid 'Colostrum' is secreted. This has very high serum protein content and it provides antibodies to help protect the new born until its own immune system is established.

The composition of colostrum changes to that of fresh milk within 72hours allowing it to be used in food supply.

The Cow's Milk-The essence of Milk Processing

- ✓ In the cow, the period of lactation or milk production continues for an average of 305days, producing 7000kg of milk.
- ✓ It should be noted that a calf requires about 1000kg for growth. Hence, the need to process the excess.
- ✓ Within the lactation, the highest yield is 2-3months post-parturition, yielding 40-50litres/day.
- ✓ Within the milking lifetime; a cow reaches a peak in production about her third lactation, but can be kept in production for 5-6 lactations if the yield is still good.
- ✓ About 1-2 months after calving, the cow begins to come into heat again.
- ✓ The cow is usually inseminated about 3 months after calving so as to come into a yearly calving cycle.
- ✓ Heifers are normally first inseminated at 15 months so that she is 2 years when the first calf is born.
- ✓ About 60 days before the next calving, the cow is dried off (there is no milking during this stage). Reasons for this are:
 - **Milk has tapered off because of internal needs of the foetus.**
 - **Udder needs time to prepare for the next milking cycle.**

Table 2: The cycle often repeated for 5-6 lactations

Age	Event
0	Calf is born
15 months	Heifer is inseminated for first calf
24 months	First calf is born – starts milking
27 months	Inseminated for second calf
34 months	Dried off
36 months	Second calf is born –starts milking

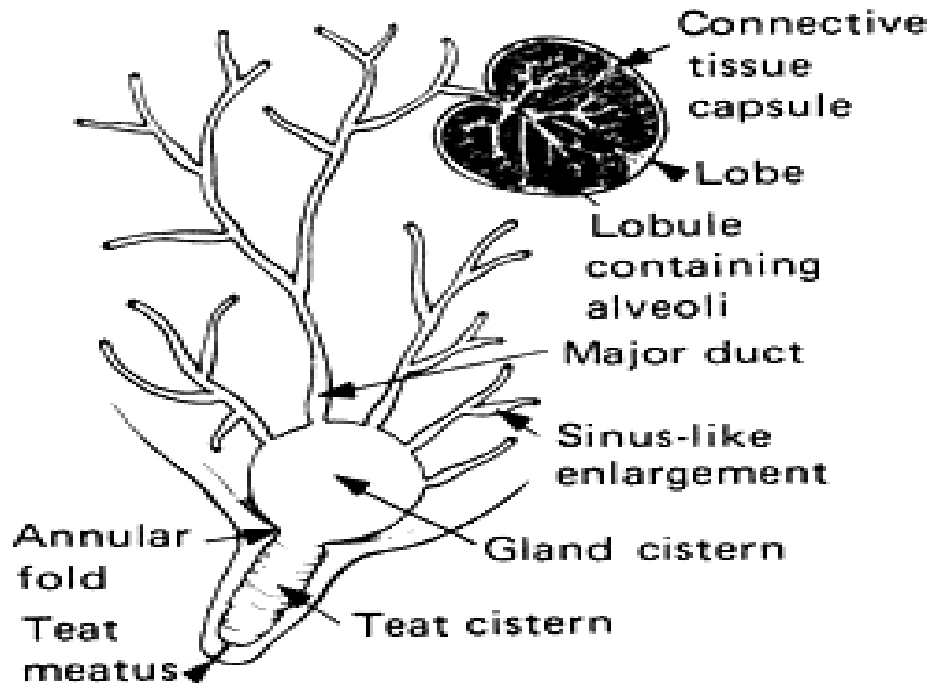
Milk Biosynthesis/Composition

- ✓ Milk is synthesized in the mammary gland. Within the mammary gland is the milk producing unit, 'the alveolus.'
- ✓ It contains a single layer of epithelial secretory cells surrounding a central storage area called the 'lumen', which is connected to a duct system.
- ✓ The secretory cells are, in turn, surrounded by a layer of myoepithelial cells and blood capillaries.
- ✓ The raw materials for milk production are transported via the blood stream to the secretory cells. It takes 400 to 800 litres of blood to deliver components for 1 litre of milk. The **components** are:

Proteins: The building blocks are amino acids in the blood. Casein micelles begin aggregation in golgi vesicles within the secretory cells.

Lipids: C4-C14 fatty acids are synthesized in the cells.

Lactose: This regulates the volume of milk secreted by controlling the osmotic equilibrium of milk with the blood.



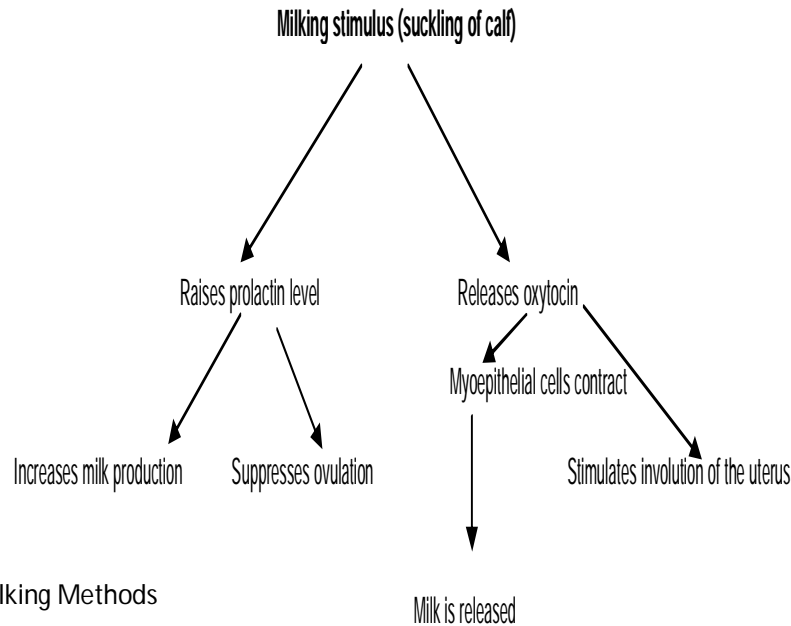
Udder showing mammary tissues

Biosynthesis of Milk

- ✓ The components of milk are synthesized within the cells mainly by the endoplasmic reticulum (ER) attached to ribosomes.
- ✓ The energy for the ER is supplied by the mitochondria.
- ✓ The components are then passed along to the golgi apparatus, which is responsible for their eventual movement out of the cell in the form of vesicles.
- ✓ Both vesicles containing aqueous non-fat components as well as liquid droplets (synthesized by the ER) must pass through the cytoplasm and the apical plasma membrane to be deposited in the lumen.

Milking stimuli such as a *suckling calf, a warm wash cloth, the regime of milk parlour, vaginal-tactile stimulation, the sight of the milking machine*, etc., causes the release of a hormone called '**oxytocin**' from the pituitary gland below the brain, to begin the process of milk 'let-down'.

- As a result of oxytocin stimulation, the muscles begin to compress the alveoli, causing a pressure in the udder known as '**letdown reflex**' and the milk components stored in the **lumen** are released into the **duct** system.
- The milk is forced down into the 'teat cistern' from which it is milked.
- The let-down reflex fades as oxytocin is degraded, within 4-7min.
- Below is a flow diagram depicting the influence of milking stimulus



Milking & Milking Methods

Lactation – the continuous secretion and storage of milk in the udder. The milk ejection or ‘let-down’ reflex effect is short term, inhibited by pain or fear but stimulated by good husbandry practices.

- ✓ At least 10% of secreted milk is retained in the udder as residual milk.
- ✓ Removal of milk is achieved when external forces such as suckling or milking open the teat duct at the teat end.

Milk Secretion: is continuous & usually at a constant rate for at least 12 hours resulting in a gradual increase in internal udder pressure. The ejection of milk is a neuro-hormonal reflex initiated by various stimuli at milking time. **Note: the stages of milk production are:**

1. **Cytologic and enzymatic differentiation**
2. **Copious secretion of milk components**

Assignment: Expatriate on the above two stages of milk production

Milking Methods

- **Hand Milking: Done using clean dry hands preferably with the full hand.**

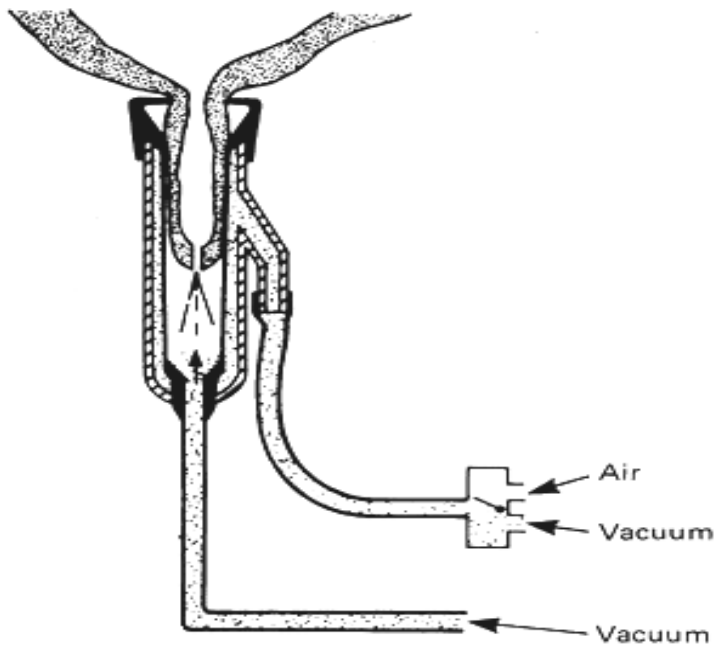
NB.

- ✓ **Avoid end-of –milking stripping with the fore finger and thumb**
- ✓ **Rear quarters should be milked first as they contain most milk**
- ✓ **Milking bucket should be hooded to reduce contamination from dust and hairs.**

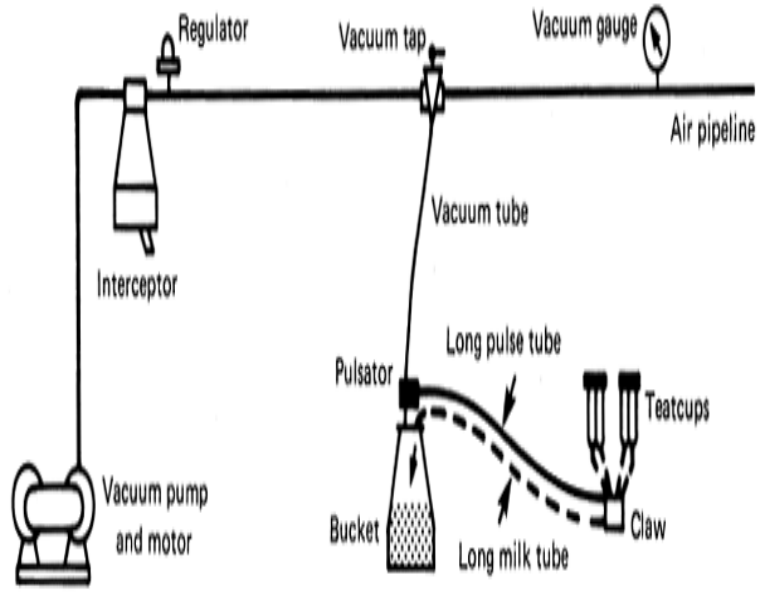


Hand milking with the full hand

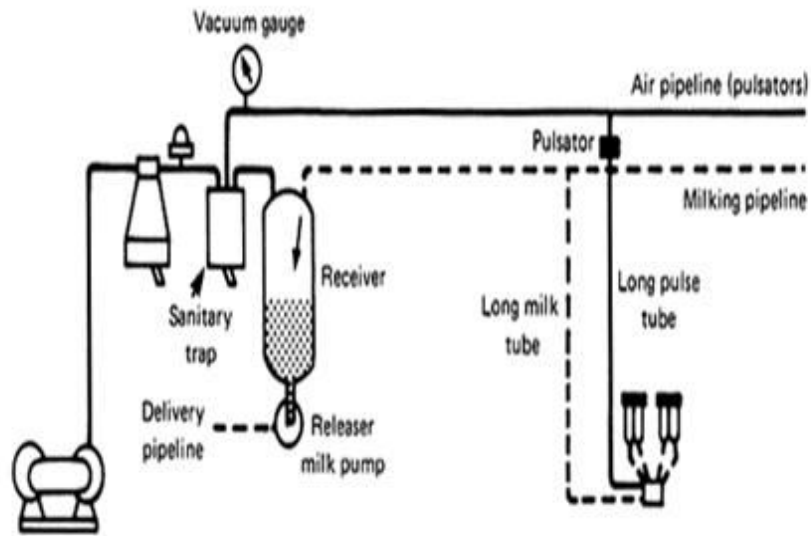
- **Machine Milking:** Designed to create a pleasant milking sensation for the cows and to avoid any possible hazard to udder's health.



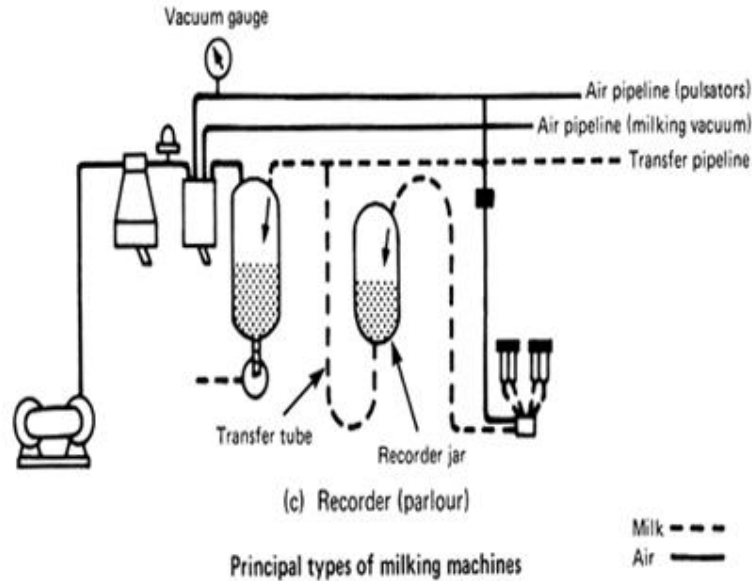
A typical milking machine



(a) Bucket (cowshed)



(b) Milking pipeline (cowshed and parlour)



Effect of milk handling on quality and hygiene

1) Cleanliness:- The environment of production has a great effect on the quality of milk produced. Hygienic quality assessment tests include sensory tests, dye reduction test for microbial activity, total bacterial count (standard plate count), tolerable acidity, somatic cell count, antibiotic residues and added water. The two common dye reduction tests are done using Methylene blue and Resazurin. These are synthetic compounds that accept electrons and change colour as a result of reduction.

Methylene blue turns from blue to colourless while resazurin turns from blue to violet to pink and to colourless. The reduction time is inversely correlated to bacterial numbers.

2) Temperature: Milk production and distribution in the tropics is more challenging due to the requirements for low temperature for milk stability. It is noteworthy that as the temperature increases, the numbers of bacteria/ml of milk after 24 hours increase. **For instance at 5°C the bacteria count/ml is 2 600 and as the temperature rises to 20°C, the bacteria count/ml geometrically increases to 450 000. Traditionally, this is overcome by stabilizing milk through refrigeration, immediate consumption of warm milk, by boiling or by conversion into more stable products like fermented milk.**

- Antibiotics: It noteworthy that antibiotics are frequently used to control 'mastitis' (inflammation of the lining of the udder). The presence of antibiotic residues in milk is very problematic, for at least three reasons;

- In the production of fermented milks, antibiotic residues can slow down or destroy the growth of the fermentation bacteria.
- Some people are allergic to specific antibiotics and their presence in food consumed can have severe consequences.
- Frequent exposure to low level of antibiotics can cause resistance, through mutation, so that they are ineffective when needed to fight a human infection.

For these reasons, it is extremely important that milk from cows being treated with antibiotics is withheld from milk supply.

Antimicrobial Systems in Raw Milk

- The natural antimicrobial systems in milk include:
 - ✓ **Lysozyme:** An enzyme that hydrolyses glycosidic bonds in gram positive cell walls. Its effect as a bacterio-static mechanism in milk is probably negligible.
 - ✓ **Lactoferrin:** An iron-binding protein that sequesters iron from micro-organisms thus taking away one of their growth factors. Its effect as a bacteriostatic mechanism in milk is also probably negligible.
 - ✓ **Lactoperoxidase:** An enzyme naturally present in raw milk that catalyzes the conversion of hydrogen peroxide to water. When hydrogen peroxide and thiocyanate are added to raw milk, the thiocyanate is oxidized by enzyme hydrogen peroxide complex thus producing bacteriostatic compounds that inhibit gram negative bacteria such as *E. coli*, *Salmonella spp.* and *Streptococci*

Milk Products

- Defn: Milk (**dairy**) products are generally defined as food stuffs produced from milk. A production plant for such processing is called a **dairy**.
- There are two broad divisions of milk products, viz., **Fluid milk products** and **Fermented milk products**.
- ✓ Fluid milk products include: Beverage milk, Cream, Recombined milk and Chocolate milk.

Fermented milk products include: Cultured buttermilk, Acidophilus milk, Sour cream and Yogurt.

FLUID MILK PRODUCTS

- **Beverage Milk:** This is either produced by partially skimming the whole milk, or by completely skimming it and then adding an appropriate amount of cream to achieve the desired final fat content. Vitamins A and D are often added in the form of water soluble emulsion to offset that quantity lost in the fat separation process.

➤ **Cream:** The fat-rich stream in the separation of whole milk. This usually comes off the separator with fat contents in the 35-45% range. Cream is used for further processing in the dairy industry for the production of ice cream and butter. Those used for packaging and sales are pasteurized to ensure freedom from pathogenic bacteria.

➤ **Recombined milk:** beverage milk can be prepared by recombining skim milk powder and butter with water. The concept is simple:

Skim milk powder is dispersed in water and allowed to hydrate.

Butter is then emulsified into this mixture by either blending melted butter into the liquid mixture while hot or by dispersing solid butter into the liquid through a high shear blender device.

A non-dairy fat source may be used. The recombined milk product is then pasteurized, homogenized and packaged as in regular milk production.

The final composition is similar to that of whole milk, approximately 9% milk solid-not-fat and either 2% or 3.4% fat.

➤ **Chocolate milk:** An industry standard for the production of chocolate milk consists of:

93% Milk, 6.3% Sugar, 0.65% Cocoa powder and 0.05% carrageenan (locust bean guar) used as stabilizer. The sugar, cocoa powder and carrageenan are dry blended and added to cold milk with vigorous agitation and then pasteurized. The final product is usually standardized to either 2% or 1% fat.

Fermented Milk Products

These are products that pass through fermentation aided by the addition of starter culture such as *Streptococcus thermophilus* (lactis) , *Lactobacillus bulgaricus*, etc.

✓ **Cultured buttermilk:** this product was originally the fermented by-product of butter but today it is common to produce cultured buttermilk from skim or whole milk. The culture most frequently used is *Streptococcus lactis*. Milk is usually heated to 95°C and cooled to 20-25°C before the addition of the starter culture which is added at 1-2% and the fermentation is allowed to proceed for 16-20hours to an acidity of 0.9% lactic acid.

✓ **Acidophilus milk:** skim or whole milk is fermented with *Lactobacillus acidophilus* (LA) which is said to have therapeutic benefits in the gastrointestinal tract. The milk is heated to high temperature (95°C for 1hr) to reduce the microbial load and favour the slow growing LA culture. The milk is inoculated at a level of 2-5% and incubated at 37°C until coagulated.

- ✓ **Sour cream:** the cream after standardization is heated to 75-80°C and is homogenized at >13MPa to improve the texture. The starter is similar to that used for cultured buttermilk but its fermentation is stopped at an acidity of 0.6%
- ✓ **Yogurt:** Whole milk, partially skimmed milk, skim milk or cream may be used in the production of yogurt. In the use of whole raw milk, the following conditions must be met:
Low bacteria count, Free from antibiotics and No contamination by bacteriophages.

The ingredients used are:

- Other dairy products such as concentrated skim milk, non-fat dry milk, whey and lactose
- Sweeteners: glucose or sucrose
- Stabilizers: gelatin, carboxymethyl cellulose, locust bean guar
- Flavour: contributed mainly by the following fermentation products: Lactic acid, Acetaldehyde, Acetic acid and Diacetyl
- Fruit preparations: including natural and artificial flavouring colour.
- The starter culture for most yogurt production is a symbiotic blend of *Streptococcus salivarius* subsp *thermophilus* (ST) and *Lactobacillus delbrueckii* subsp. *Bulgaricus* (LB). When used together, the rate of acid production is higher.
- **Symbiosis of the starter culture:** ST grows faster and produces both acid and CO₂. The formate (an acid) and CO₂ produced stimulate LB growth. On the other hand, the proteolytic activity of LB produces stimulatory peptides and amino acids for use by ST. The yogurt mixture coagulates during fermentation due to drop in pH.

Types of yogurt:

- Stirred style yogurt (mainly industrial)
- Set style yogurt: In this type, the yogurt is packaged immediately after inoculation with the starter culture and is incubated in the packages.
- Others are:
- Fruit-on-the-bottom style: fruit is layered at the bottom followed by inoculated yogurt. Incubation occurs in the sealed cups.
- Stirred style yogurt with fruit preparation.

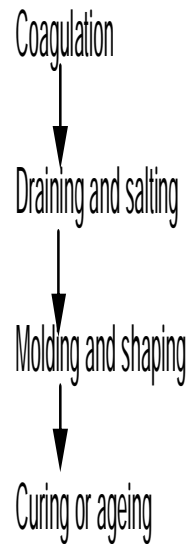
Assignment: Describe in detail the manufacturing of a stirred style yogurt.

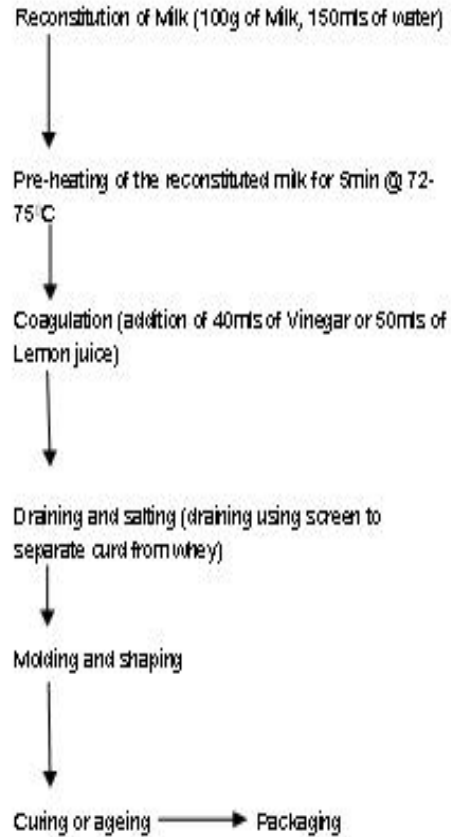
An overview of milk products



Cheese production

- Definition: this is produced by coagulating milk, separating it from whey and letting it ripen generally with bacteria and sometimes also with molds.
- To make firmer, longer lasting cheese and speed the separation process, an enzyme called 'rennet' is added. *Rennet is found in the stomach of milk-drinking mammals. It enables the young to digest the mother's milk. **It is extracted from the lining of the stomach of a milk-fed calf and made into powdery form.***
- ***Below is a flow chart on cheese making process:***





Flowchart of Cheese Production from Powdered Milk

ANIMAL BY-PRODUCTS

They are products from the abattoir slaughter slab or butchers shop that are not sold directly for human consumption. These are products of economic value to livestock industry e.g. hides and skin, blood, glands, fat etc. Their yields depend on method of processing, weight of the animal, sex of animal and species of animal.

- a. Weight of animal: e.g. calf of 200kg will give less blood than cow or bull of 400kg.
- b. Sex of animal: e.g. Bones of males are harder and heavier than those of females.
- c. Species of animal: Pigs produce more fat than lamb.

APPROXIMATE YIELD OF VARIOUS ITEMS OBTAINED FROM MEAT ANIMALS

Items	Steer	Lamb	Pig
a. Live weight (Kg)	455	45	100
b. Hide/Pelt (Kg)	36	7	Nil
c. Edible fats (Kg)	50	4	16
d. Blood (litres)	18	2	4
e. Inedible fats, bone meat scrap (Kg)	80	10	8

Pelt: animal's skin (rabbit) with the fur or hair on it.

In many developing countries where factories are few for making full use of animal components there is considerable loss of revenue through wastage and mismanagement of potential by-products.

1. **Hides and skin:** Hide is the outer covering of big/large animals e.g. cattle, horses, camels etc. While skin is the covering of smaller animals e.g. sheep, goats, pigs, reptiles etc. Hides, hair, fur are the most valuable and lucrative by-product of the livestock industry. In Africa, the extra cost for quality skin of this by-product is still under exploited when compared with the importance of livestock. Most countries in Africa are losing significant source of potential revenue by exporting hides as raw and untanned leather. Other developing regions are exploiting this potential by supplying finished leather goods to industrialized countries.

NOTE: Burkina- Faso prohibited exporting of animal skins

Many animal species such as crocodile, antelope, zebra are raised more for their skin, hair or fur than for their meat. Merino sheep are raised for their wool while Angora goats are kept for their mohair.

Mohair = thread or cloth made from their fine skinny hair of Angora goat.

The care of the hide or skin should be considered prior to slaughter. Indiscriminate branding reduces value of hide. Brand should be small and placed on an inferior part of the hide or skin such as ear, cheek, fore-leg, hind-leg. Scratches from barb wire, thorn bushes, whip lashes, wounds, parasitic diseases (ringworm, strep, mange) and tick bite can affect quality of leather. Unnecessary cut during playing, bad bleeding resulting in small cutaneous vessels being gorged with blood can affect leather quality.

Processing of Hide and Skin

The following steps are involved

- a. **Fleshing:** After removal from carcass, hide and skin should be cleaned and the adhering fat and muscular tissues carefully scrapped off to avoid damage.
- b. **Pickling:** using H_2SO_4 + industrial salt.
- c. Prevent deterioration using crome.
- d. Softening of the fibres using *Bagaruwa and syntan*.
- e. Softening leather using fat liquor.
- f. Preservation of hides and skin: By the following methods
 - **Air-drying:** simple inexpensive common in tropics. Protect products from hide beetle caused "*Dermetes maculates*" by dusting hides and storing with insecticides like DDT powder or Gammexane. Hides are laced by using strings (not wire) and stretched on rectangular frame constructed with wood, bamboo or pipe.
 - **Dry Salting:** Rub underside with salt and dry in sun one by one.
 - **Wet Salting:** Pilling up the hides on top of each other with salt in between.

Uses of Hides and Skins: For shoes, bags, belts.

2. **Bones:** Amount to about 15% of the weight of dressed beef carcass sterilized because of Anthrax, TB, etc by burning or boiling.

Uses: Bonemeal, gelatine (glue which is produced from Ossein (demineralised bone). Gelatin is used in making capsules, photographic films and paper.

3. **Blood:** Rich in protein (80%). At slaughter, 13-18 liters can be collected from cattle, 2litres from sheep, 2-4litres from pigs when carcasses are hanging.

Prone Carcass: Carcass with legs tied together on the floor, expels little blood, blood collection is difficult, causes damage to hides and skin.

Uses of Blood: Blood sausage, black pudding, blood meal, used to enrich low protein cereals products e.g. maize or cassava flour by absorption.

4. **Hooves and Horns:** Hooves will crack when exposed to sun. Both can be processed together or separately.

Uses: Hoof and horn meal as Nitrogenous fertilizer, horns for buttons, combs, knife's handle.

5. **Hair / Bristles/ Wool:** Wool is mostly from sheep. Bristles are long, stiff hair from back and tail of pig.

Uses: Wool for blanket, carpet. Hair for upholsteries; bristles for brushes (Tooth brush and floor brush).

6. **Intestines:** Should be separated from mesentery and fat and putting cold water to arrest fermentation.

Uses:

- Those of sheep for surgical catgut.
- Those of cattle (beef) for violin, strings.
- Those of cattle and sheep and pig as casings.

Conversion of Intestine into casing

- a. Stripping: Squeezing out the contents.
 - b. Fattening: Removal of fat.
 - c. Sliming: Removal of mucosa with sliming knife which is a piece of wood or bone resembling knife, leaving a thin transparent membrane now ready for curing.
7. **Fats:** Meat fat is complex mixture of different substances. The distillation of its components can yield glycerine or glycerol which is used in the manufacture of explosives and in medicine preparations.

Uses:

- fat for soap, chewing gum, lubricants.
- Beef and pig fat for candle.
- Pig fat for lard and sausages.

8. **Lungs and Liver:** Liver from cattle used for production of heparine (anticoagulant) from pigs for pet food.
9. **Glands (Ductless):** The labour required to remove and preserve some animals glands is too high for economy e.g. 1800 pigs will produce 0.45Kg pituitary gland whereas 10 pigs will produce 0.45Kg pancreas.

Uses:

- Pancreas produces insulin for *Diabetes mellitus*.
- Bovine ovaries produce estrogen for treatment of menopausal syndromes.
- Supra-renal produces adrenaline as local anaesthetic.
- Thyroid: Produces thyroxine which stimulates growth and deficiency is cretinism.
- Pituitary produces pituitrin for stimulation of mammary gland, ovary and wall of uterus.

Brain and Spinal cord: Source of cholesterol for cosmetic industries.