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ONLINE COURSE WARE

SUBJECT NAME: FOOD PROCESS TECHNOLOGY – II (FISH, MEAT, POULTRY)

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Module I 8L

Lecture 1: Introduction about the subject. Importance of Fishery in Indian economy.Basic classification of fresh water and marine fish.

1.1. Introduction to Fish Processing Technology

Fish is an exceptionally important component of the human diet and an enormous industry exists to provide a huge variety of consumer products in which fish is a major component. These offerings range from whole fish, large and small, to pieces of fish such as cuts and fillets, to canned fish in a multitude of forms, to dried and cured products, to fish oils and extracts, to frozen portions and complete meals through to reformed and gelled products. The list is enormous, the variety even within one product type is extensive and the range of species used as food runs well into the thousands. Each of these variations and combinations presents a huge matrix of possibilities, opportunities and problems.

Over the last 80 or so years, fish technologists and scientists have been endeavouring to draw some general rules from observation and experimentation on fish and fish products to control and predict their properties under a vast variety of circumstances.

1.2. Importance of Fishery in Indian economy

India has considerable marine and inland fishery resources, but the extent of these resources has not been properly assessed so far. Indian fisheries and aquaculture is an important sector of food production, providing nutritional security to the food basket, contributing to the agricultural exports and engaging about fourteen million people in different activities. With diverse resources ranging from deep seas to lakes in the mountains and more than 10% of the global biodiversity in terms of fish and shellfish species, the country has shown continuous and sustained increments in fish production since independence. Constituting about 6.3% of the global fish production, the sector contributes to 1.1% of the GDP and 5.15% of the agricultural GDP. The total fish production of 10.07 million metric tonnes presently has nearly 65% contribution from the inland sector and nearly the same from culture fisheries. Paradigm shifts in terms of increasing contributions from inland sector and further from aquaculture are significations over the years. With high growth rates, the different facets of marine fisheries, coastal aquaculture, inland fisheries, freshwater aquaculture, cold water fisheries to food, health, economy, exports, employment and tourism of the country.

Indian Fisheries	
Global position	3rd in Fisheries 2nd in Aquaculture
Contribution of Fisheries to GDP (%)	1.07
Contribution to Agril. GDP (%)	5.15
Per capita fish availability (Kg.)	9.0
Annual Export earnings (Rs. In Crore)	33,441.61
Employment in sector (million)	14.0

1.3. Basic classification of fresh water and marine fish

The major difference lies in the way that they regulate water and salts in their internal cells. Most freshwater fish and saltwater fish maintain a salt concentration in their blood of approximately 10 parts per thousand (ppt), or 10 grams of dissolved salt per liter of water. Since freshwater fish swim in water with approximately 0.5 ppt, the chloride cells in their gills are designed to pump sodium, calcium and chloride into the fish. On the other hand, since saltwater fish swim in water with approximately 35 ppt, the chloride cells in their gills are designed to pump salt out of the out of the fish. This process of controlling the flow of water across their body is called osmoregulation.

Constantly changing environments and ease of geographical separation of small bodies of water in freshwater habitat have resulted in a high degree of diversification of freshwater fish. The constantly changing environments have also forced freshwater fish to become more adaptive to their environment. In comparison, saltwater fish have been able to enjoy a relatively more stable environment in a larger ocean environment. Therefore, freshwater fish are generally more adaptable and hardier than saltwater fish.

1.4. Some more classification of fish

Sometimes freshwater fish is also classified as

i) Desi Carp, which includes major carps like Rohu, Catle, Mrigel etc. and minor carp which includes Bata, Lata etc.

ii) Exotic Carp, which includes fishes like Silver carp, Grass carp, American Carp, etc.

Fish can also be divided into 2 categories based on the anatomical differences.

i) Fin Fish – They have skeleton and fin appendages.

ii) Shell Fish – They have no skeleton and the body is partly or wholly covered by a hard shell.

  Shell fish are of two types such as

  a) Molluscs – Here the body isnot segmented and iscovered in shell. Eg. Oysters, clams, etc.

  b) Crustaceans – Here the body is segmented and covered with crust like cover. Eg. Crab, lobster, etc.

Lecture 2: Introduction on commercial handling of fish. Discussion on onboard and onshore handling of fish.

2.1. Introduction to handling of fish

The intrinsic and extrinsic qualities of fish vary considerably depending upon the location of the fishing ground, species, water quality and harvesting techniques. The primary objective of any handling method is to preserve the quality of the fish by bringing down the temperature near to 0^{0} C as quickly as possible. The factors such as delay in handling and chilling the catch, poor temperature control in the fish hold, damage from rough handling, poor standards of gutting, bleeding and washing the fish and mechanical damage due to the overfilling of the containers have a deleterious effect on the quality of fish and result in reduction of shelf life and loss of weight.

2.2. Onboard handling of fish

Maintaining the quality of fish begins with harvest and carries through the harvest-to - consumption. Careful handling of fish and shellfish on board the vessel or during transport to the processing plant is critical if the high quality of the product is to be maintained. There are, however, several constraints on handling the fish; the important among them are the bacteriological, chemical and physical processes that cause degradation of fish. The surface of dead fish & shellfish are ideal growth habitats for bacteria and the end result of such activity is spoiled fish. Reduction of temperature can prevent the growth of many bacteria that cause the spoilage Chemical breakdown due to oxidative and enzymatic reactions can lead to off odours and flavours and rancidity. Digestive enzymes can initiate decomposition in the dead fish. Physical factors can enhance the bacteriological or chemical processes: bruising, tearing, cutting etc. can expose fish muscle to more rapid bacteriological growth, cause internal bleeding which darkens the fillets and expose greater surface area for chemical oxidation.

2.2.1. Iced Storage for Fish

The major advantage of using ice for chilling the fish is that it has a high latent heat of fusion so that it is capable of removing large amount of heat as it melts without changing the temperature at 0 ^{0}C. During transition from ice to water 1 kg of ice absorbs 80 k cal of heat and this will be sufficient to cool about 3 kg of fish from 30 ^{o}C to 0 ^{o}C. Hence theoretically about 30 % of ice is needed to bring down the temperature from ambient conditions to 0 ^{o}C. However, ice is needed to maintain the temperature as well as to accommodate the heat from the environment. Hence in tropical conditions a 1: 1 fish to ice ratio is ideal for ice storage.

2.3. Onshore handling of fish

Post-harvest handling of the fish on land involves transportation of the catch, preprocessing the raw material and processing it to the desired product. Handling the fish on land has the same hazards as onboard handling such as autolysis, microbial and chemical spoilage that will affect the quality of the final product. These quality hazards vary linearly with temperature, being twice as fast at 2.5 ^{o}C, as at -1 ^{o}C. At 10 0C it is four times as at 0 ^{o}C. Hence during handling the temperature of the fish should be kept as low as possible to maintain the quality. The time taken to cool the fish will depend on the thickness of the fish.

Lecture 3: Discussion on the average composition of fish.

3.1. Composition of Fish

Composition of fish largely varies due to the variation of fat content of fish. The following are the composition of fish.

Water: 66 -84 %
Fat: 0.1 – 22 %
Protein: 15 -24 %
Carbohydrate: 1 – 3%
Mineral: 0.8 – 2 %
The edible portion of fish is 45 – 50 % of the whole fish body weight. It depends upon the species, maturity, before or after spawning, etc.

3.1.1. Water: The main constituent of fish flesh is water, which usually accounts for about 80 per cent of the weight of a fresh white fish fillet. Whereas the average water content of the flesh of fatty fish is about 70 per cent, individual specimens of certain species may at times be found with a water content anywhere between the extremes of 30 and 90 per cent.

The water in fresh fish muscle is tightly bound to the proteins in the structure in such a way that it cannot readily be expelled even under high pressure. After prolonged chilled or frozen storage, however, the proteins are less able to retain all the water, and some of it, containing dissolved substances, is lost as drip. Frozen fish that are stored at too high a temperature, for example, will produce a large amount of drip and consequently quality will suffer. In the living fish, the water content usually increases and the protein content decreases as spawning time approaches; thus it is possible, with cod for example, to estimate the condition of the fish by measuring the water content of the muscle.

3.1.2. Protein: The amount of protein in fish muscle is usually somewhere between 15 and 20 per cent, but values lower than 15 per cent or as high as 28 per cent are occasionally met with in some species.

All proteins, including those from fish, are chains of chemical units linked together to make one long molecule. These units, of which there are about twenty types, are called amino acids, and certain of them are essential in the human diet for the maintenance of good health. Furthermore, if a diet is to be fully and economically utilized, amino acids must not only be present but must also occur in the correct proportions. Two essential amino acids called lysine and methionine are generally found in high concentrations in fish proteins, in contrast to cereal proteins for example. Thus fish and cereal protein can supplement each other in the diet. Fish protein provides a good combination of amino acids which is highly suited to man’s nutritional requirements and compares favourably with that provided by meat, milk and eggs.

3.1.3. Fat: Taking all species into account, the fat content of fish can vary very much more widely than the water, protein or mineral content. Whilst the ratio of the highest to the lowest value of protein or water content encountered is not more than three to one, the ratio between highest and lowest fat values is more than 300 to one.The term fat is used for simplicity throughout this leaflet, although the less familiar term lipid is more correct, since it includes fats, oils and waxes as well as more complex, naturally-occurring compounds of fatty acids.

There is usually considerable seasonal variation in the fat content of fatty fish; for example a starved herring may have as little as ½ per cent fat, whereas one that has been feeding heavily to replenish tissue may have a fat content of over 20 per cent. Sardines, sprats and mackerel also exhibit this seasonal variation in fat content. As the fat content rises, so the water content falls, and vice versa; the sum of water and fat in a fatty fish is fairly constant at about 80 per cent. Although protein content falls very slightly when the fat content falls, it nevertheless remains fairly constant, somewhere between 15 and 18 per cent.

3.1.4. The minor components of fish muscle:

3.1.4.1.Carbohydrates: The amount of carbohydrate in white fish muscle is generally too small to be of any significance in the diet; hence no values are given in the tables. In white fish the amount is usually less than 1 per cent, but in the dark muscle of some fatty species it may occasionally be up to 2 per cent. Some molluscs, however, contain up to 5 per cent of the carbohydrate glycogen.

3.1.4.1.Minerals and Vitamins: These include a range of substances widely different in character that must be present in the diet, even if only in minute quantities, not only to promote good health but also to maintain life itself.

Although fish is very unlikely to be the only source of an essential mineral in the diet, fish does provide a well balanced supply of minerals in a readily usable form. The table of mineral constituents of fish muscle gives values averaged from a large number of species and is intended to serve only as a rough guide. It would be impracticable in this short note, and of limited value, to give a detailed analysis for individual species. Composition tables for fish often include a value for total ash. Since ash consists largely of a number of different minerals, and the total rarely exceeds 1-2 per cent of the edible portion, this figure has also been omitted, except from the table of fish products.

Vitamins can be divided into two groups, those that are soluble in fat, such as vitamins A, D, E and K, and those that are soluble in water, such as vitamins B and C. All the vitamins necessary for good health in humans and domestic animals are present to some extent in fish, but the amounts vary widely from species to species, and throughout the year. In general the vitamin content of white fish muscle is similar to that of lean meat and, with the exception of vitamin C, can usually make a significant contribution to the total vitamin intake of man and domestic animals.

Lecture 4: Introduction to spoilage of Fish and importance of preservation. Discussion on quality assessment of fish.

4.1. Spoilage of Fish

Spoilage of fish involves three steps

a) Rigor Mortis
b) Autolysis
c) Bacterial Invasion and Putrefication

Spoilage is a result of different separate processes which are Enzymatic Spoilage, Mechanical damage, Bacterial Action, Chemical Decomposition (Oxidation), etc.

4.1.1. Enzymatic Spoilage

Autolysis plays an important role enzymatic spoilage of fish. Careless handling of fish breaks the fish cell which release autolytic enzymes. These enzymes react with the fish cell and produces compounds that promote microbial growth. Sometimes the compounds produced are themselves spoilage causing component which leads to obnoxious smell and bitter taste.

4.1.2. Mechanical Damage

Bruised flesh leads to darkening of the fish muscle as blood vessels burst. Broken skin and torn guts provide an entry point for foreign contaminants to enter the fish body which leads to spoilage.

4.1.3. Microbial Spoilage

The healthy live fish muscles are almost free from bacteria. The slimy layer of the fish with different bacteria like *Bacillus sp., Pseudomonas sp., Serratia sp., Flavobacterium sp., Micrococcus sp.* may start the spoilage in the fish. Not only the slimy layer but also the gills and the intestines of fish contain a large number of bacteria. The numbers of microorganism depend on the presence of the organism present in water and the handling of fish. The fish from tropical regions contain more mesophiles and fish caught from northern part contains more psychrophiles. Marine fishes contain more number of halophiles.

4.1.4. Physiological Spoilage

After sometime of death rigor mortis sets in in fish. The glycogen present in fish muscle is converted to lactic acid and pH of the muscle is lowered. Bacterial spoilage cannot occur before it becomes freed from rigor mortis. As very little lactic acid is formed in fish the duration of rigor in fish is less than other animals.

4.1.5. Chemical Spoilage

The live fish has little smell, but after sometimes of death a characteristic fishy smell is found which indicates the onset of spoilage. The phospholipid and choline present in fish muscle is converted by bacteria into Trimethyle Amine which is responsible for the fishy smell.

4.2. Assessment of Fish Spoilage

There are different methods to assess the quality of fish.

Physical method include instrumental test piercing a ‘Torry-meter’ on the skin of about 16 randomly selected fish and picking 1 of the result as representing the entire lot.

Subjective method involves the use of human sense organs and not machines, chemicals or reagents called “Sensory tests”, may be biased but its represent the customers view.

Organoleptic test is done utilizing the sense of touch, smell, sight and taste for quality assessment of fish.

Chemical tests involve the estimation of total volatile bases, trimethyle amine (TMA) and TMAO formation in the fish.

Lecture 5: Discussion on canning of Fish

5.1. Introduction

Canning is an excellent way to preserve the fish. The heat treatment involved in canning is designed to provide commercial sterility. Once the lethality that destroys a number of pathogens is reached, the cans are cooled. Traditionally cans were put together from three pieces of metals. In modern days two-pieces of metals are also being used.

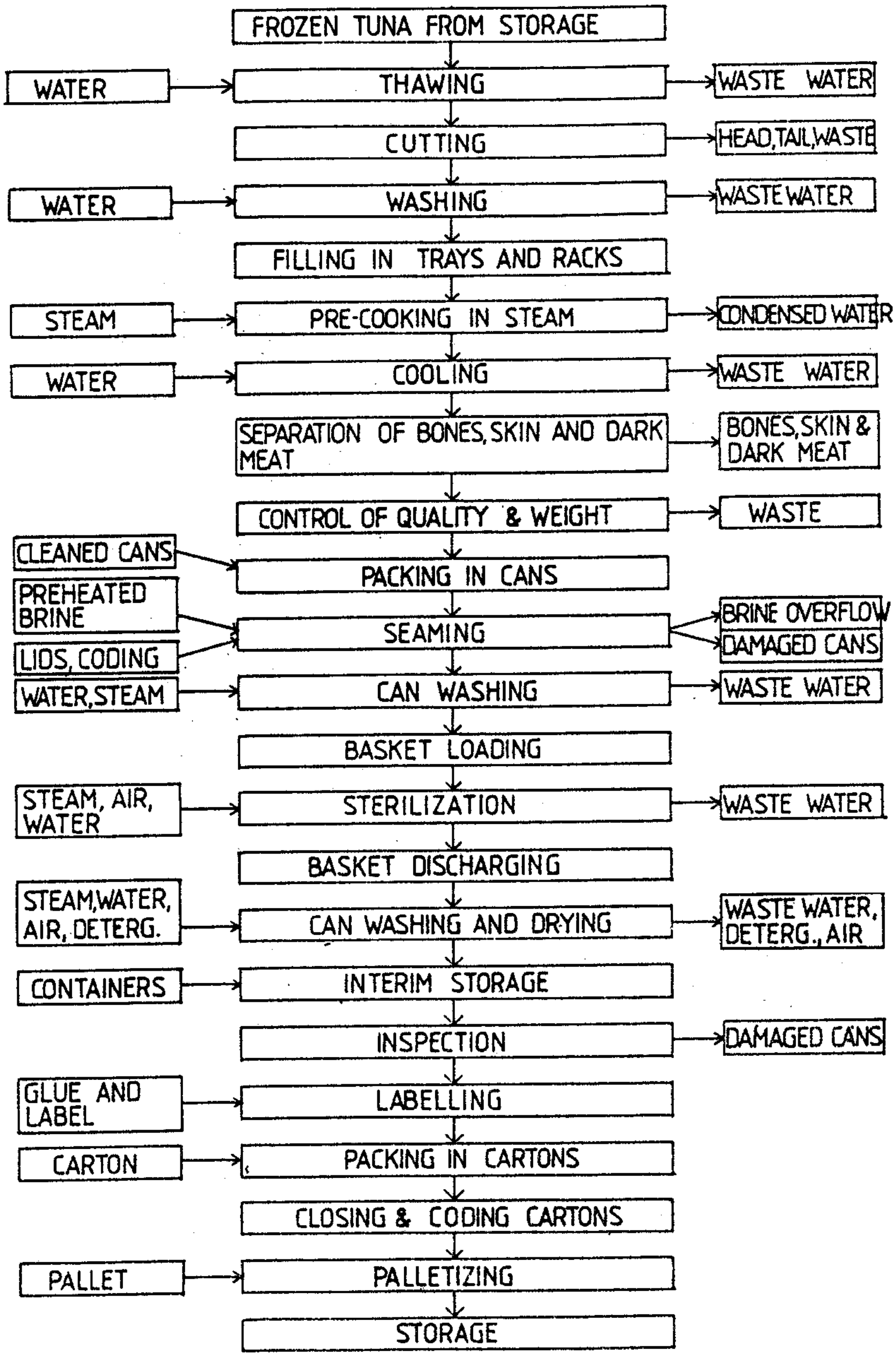
5.2. Method of Canning

The fish should be cleaned and washed thoroughly before canning. It takes about 25 to 35 pounds of whole fresh fish to fill about a dozen pint jars with boneless fish. The fish should be cut into desired size pieces so that they will easily fit into the canning jar. It is recommended to lightly brine (1 cup of salt per gallon of cold water for 15 minutes) the fish before packing into the canning jars as it firms the flesh to produce a more desirable product. Drain the brined fish and fill the pint jars leaving 1-inch headspace. Once fish is packed into the jars, wipe the jar rims and adjust the lids. Depending on your taste, tomato juice or other mixtures can be added to the fish before the canning process.

The only way to safely process canned fish is in a pressure canner to prevent the risk of botulism food poisoning. The pressure canner must be in perfect order including the accuracy of the pressure gauge. The recommended process time for fish in a dial-gauge pressure canner using pint jars is 100 minutes at 11 pounds pressure for elevations from 0 to 2000 feet. If using a weighted gauge pressure canner, process for 100 minutes at 10 pounds pressure for elevations from 0 to 1000 feet. Always follow the manufacturer's directions for the pressure canner you are using.

When the jars are cooled after canning check the lids to make sure they are depressed or concave and will not move when pressed to ensure they are properly sealed. If unsealed jars are found 24 or more hours after processing, you should dispose of the product, as it is not safe to eat.

5.3. Flow sheet for canning tuna in brine



Lecture 6: Discussion on freezing of Fish

6.1. Introduction to Freezing of Fish

Water accounts for 75-80% of the weight in most of the fish. This water contains several dissolved organic and inorganic substances like sugars, salts and other compounds. Besides more complex organic molecules like proteins are also present in colloidal suspension. Hence the water in fish is actually a suspension of solids which will have to be cooled down to a temperature at which the solute phase and the solvent phase will have the same vapour pressure. So the freezing begins in the fish usually at a temperature of -1 to -2 ^{o}C.

6.2. Freezing Procedure

In the simplest terms refrigeration means removal of heat from the body or atmosphere, which is desired to be cooled and its transfer to another medium. It is usually accomplished by the evaporation of a liquid refrigerant, which extracts heat from the medium to be cooled. The refrigeration cycle involves steps to remove the heat from the evaporating refrigerant by again converting it into the liquid state in order that it may be used repeatedly in a continuous process.

The freezing process in which the fish passes through the zone of maximum crystallization in 30 minutes or less is arbitrarily referred to as quick freezing. Quick freezing is the process employed in commercial freezing of fish. Slow freezing has the following disadvantages over quick freezing:

i) Large ice crystals are formed during slow freezing which can damage the cell walls. This may cause textural changes and increased thaw drip.
ii) Water tends to freeze out as pure water leading to a higher concentration of salts and enzymes in the unfrozen water. This can accelerate autolysis.
iii) Some bacteria may remain alive at 0 ^{o}C causing spoilage to continue in fish.

6.3. Freezing Equipments

Air Blast Freezer: Air blast freezer consists of an insulated room or a tunnel. Air is cooled by blowing a fan through the finned cooling coil of the refrigeration system. Cool air passes over the fish to be frozen and picks up the heat from the product, walls of the freezer etc. Temperature is maintained at -35 to - 40 ^{o}C.

Continuous air blast freezer: This is an improvement in the air blast freezer where a conveyor belt is used to move the fish continuously through the room or the tunnel. The speed of the conveyor can be adjusted to suit the type of the fish to be frozen. Air flow can be either countercurrent to the movement of the material or across the belt. Air velocity maintained at 150- 300 m/ sec. Makes intimate contact with the fish and accomplishes freezing at a fast rate. Freezing is quicker and any type of fish can be frozen in large quantities in shorter periods. Spiral belt freezers are an example.

Horizontal plate freezer: These freezers in general have 15-20 plates. The product to be frozen contained in metal freezing trays are loaded between freezing plates and are maintained in close contact with top and bottom plates under slight hydraulic pressure to ensure maximum heat exchange. The freezing trays are also covered with tightly fitting lids which will help to provide contact with the freezing plates at the top. Temperature is maintained between -35 and -40 ^{o}C. Fish freezes in 2-2.5 hours.

Vertical Plate Freezer: These are most commonly used for freezing fish at the sea. They consist of number of vertical freezing plates that form partitions in a container called stations. Fish are loaded between the plates until each station is full and then the plates are closed together to form fish blocks. Temperature ranges between -30 to -40 ^{o}C.

Immersion Freezing: In this method freezing is achieved by immersion in, or spraying with, a refrigerant that remains liquid throughout the process. Refrigerated aqueous solutions of propylene glycol, glycerol, sodium chloride, calcium chloride and mixtures of sugars and salt can be used as medium for freezing. Immersion freezing allows for intimate contact of every surface of the material with the freezing medium and thus ensures very efficient heat transfer.

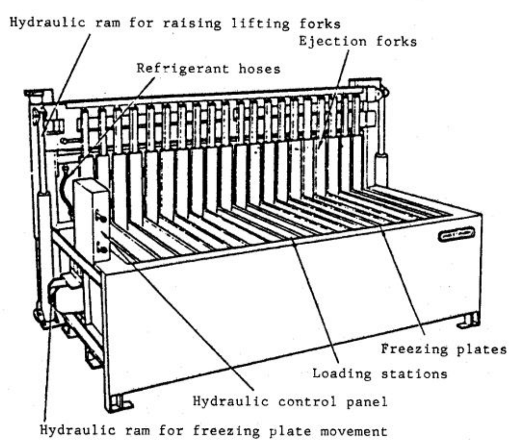
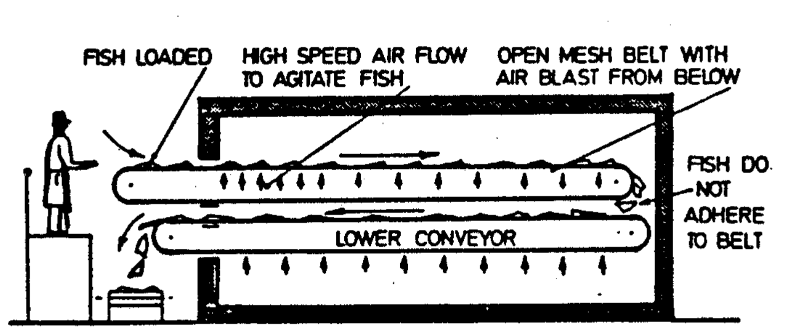


PLATE FREEZER



AIR BLAST FREEZER

Lecture 7: Discussion on curing and salting of Fish. Discussion on drying of fish.

7.1.1. Introduction to curing of fish

The traditional methods of processing fish by salting, drying, smoking pickling etc. are collectively known as 'Curing. Curing is the oldest method of fish preservation. Though traditional it is still widely practiced in developed and developing countries. Though produced in coastal areas, cured fish is usually consumed in the interior markets and hilly areas. This is the cheapest method of preservation also, since no expensive method or technology is used.

7.1.2. Dry Curing

This is the most widely used method of fish curing. All types of fishes except fatty fishes big or small are cured by this method. Here, the fish is gutted, beheaded or ventrally split open and the viscera removed. The fish is then washed clean. Larger fishes are dorso-ventrally split open and cleaned thoroughly. Scores are made along the thick flesh portion for better penetration of salt. Salt is then applied in the ratio 1:3 to 1: 10 (salt to fish) depending upon the size of the fish. The fish is then salted in cement tanks or containers. The bottom of the tank is covered with salt and a layer of fish is placed. Both fish and salt are alternately placed in the tank and wooden planks are over put down on the top and weighed down. The salt draws out the water in the fish and the weight placed keeps it under pressure. The fish is kept in this condition for 24-48 hours. After this the fish is taken out, washed in brine solution to remove adhering salt and drained. It is then dried in the sun to required level of moisture. Yield of the product by this method is about 35-40%. This product has a shelf life of 6-10 weeks.

7.1.3. Wet Curing

The initial stages of processing and salting are the same as for dry curing. Once the fish is put into the tank it is allowed to remain in the self-brine. The fish is not dried at all. The wet fish is then drained and packed in Palmyra leaf baskets or coconut leaf baskets and taken to the market. The fish is taken out only when there is demand. This method is particularly suitable for fatty fishes. This is mainly done for fishes like oil sardines, mackerels, and ribbon fishes etc. wherein the fat gets oxidised on exposure to air during exposure to air. That is why it is not dried. When immersed in the tank there is no contact with outside air.

These products have moisture content of 50-55% and the salt content around 25%. They are most susceptible to fungal attacks, bacterial degradation and general putrefaction. They have a very short shelf life.

7.1.4. Challenge of Salting

1. Sea salt is quite dirty and requires special treatment before it can be used.
2. Pink appearance due to halophiles or brown mold formation may occur.
3. For larger pieces of fish salting cannot be done in tropical countries at room temperatures as the fish would spoil before the salt penetrates the flesh.

7.2.1. Introduction to drying of fish

There are basically two methods of drying fish. The common one is by utilising the natural heat available from the sun. This is known as sun drying. The other is by using artificial means like mechanical driers for removal of moisture from the fish.

7.2.2. Sun Drying

This is the simplest method of drying fish. The fishes dried in this way are small, lean ones, which are available in plenty during the glut season. They are usually spread out on the seashore as whole with little preprocessing. Sometimes they are given a washing in the seawater. Drying takes place usually by the removal of moisture from the surface and later from the interior of the fish. Depending on the relative humidity, temperature, air velocity, the removal moisture takes place continuously.

Factors, which affect the rate of drying, are:

i) Size of the material, larger fish takes a longer time to dry whereas smaller ones lesser
ii) Surface area, large surface area will increase the rate of drying.
iii) Temperature, the higher the temperature the faster will be the rate of drying
iv) Relative humidity, the lower the RH the faster will be the drying
v) Air velocity, the greater the speed of the air, the faster the drying
vi) Fat Content, fatty fishes will take a longer time to dry than lean fishes
vii) Water content, the higher the water content the faster is the drying

Fish is also conventionally dried on coir mats, cement platforms, bamboo mats and jute sacks. Often this sort of drying gives a product, which is contaminated with sand, and other foreign matters. The fish dried on cement platform gets partially dried due to the excessive heat. It becomes necessary that the fish is turned over often to ensure a uniform dried material.

7.2.3. Mechanical driers

In mechanical driers the removal of water from fish requires an external input of thermal energy. This is brought about by burning fuel. This is an expensive method since there is need for fuel for heating and maintenance of the temperature. The drying chamber consists of a long tunnel in which the product is placed on trays or racks. A blast of hot air is passed over the material to be dried. After the required degree of drying the product is removed from drier and packed.

Lecture 8: Introduction to Smoking of Fish. Discussion on Fermentation of fish.

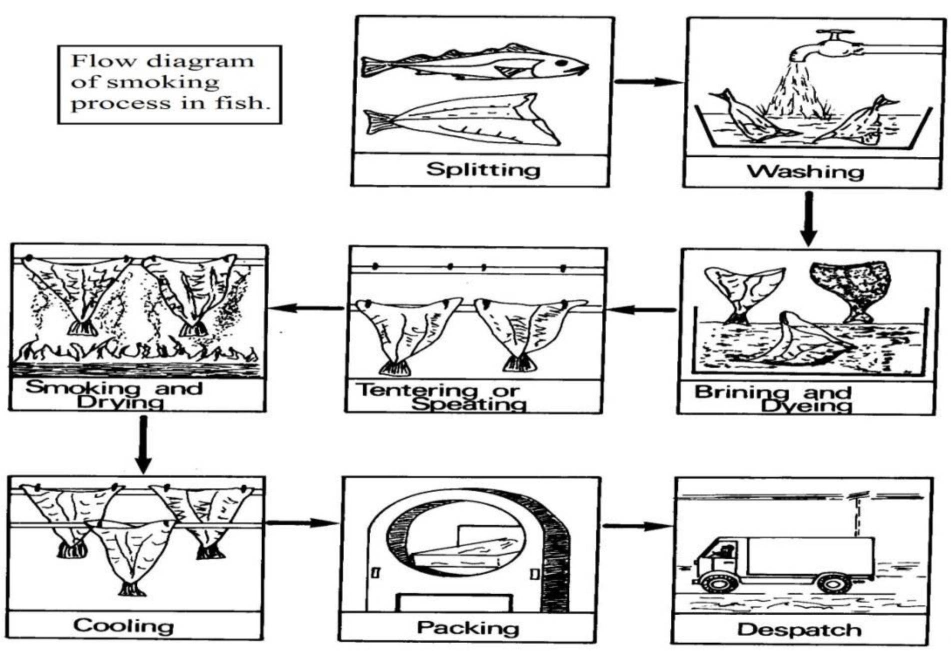
8.1.1. Introduction to smoking of fish

Smoking is another traditional method of `preservation of fish. Smoking is generally a combination of salting, and drying. Smoking is usually done in a kiln or a room, which is specially prepared for it. The source of smoke is wood or sawdust or coconut husk, depending on the particular flavour required. The fish that is salted and partially dried is used for smoking. Smoking imparts a typical flavour, different from foods obtained from other processes of preservation. The compounds produced are polyphenols, lactones, carbonyls, furans, etc.

8.1.2. Hot smoking and cold smoking methods

Temperature widely varies from 1 smoking method to another. If the fish is smoked at a higher temperature, the product will be cooked and will absorb some flavour. If temperature is moderate, the product will remain uncooked, only having strong flavour. Smoking can be cold, hot or liquid. If the temperature is below 35 °C, it is cold and which is 70 to 80°C it is hot.

In a tropical country like ours hot smoking processes is preferable. Hot smoked products are partially cooked due to the heat of smoke. The preserving effect of smoking on fishery products is attributed to a combination of surface drying, salting and deposition of phenolic and other antimicrobial constituents of smoke on the fish. Both salted and unsalted fishes are smoked. Small fishes are smoked whole whereas larger ones are smoked as fillets or chunks. Freshness of the fish is an important factor determining quality of smoked product. Smoked fish have the potential danger of containing certain carcinogenic compounds of smoke such as 3-4, bensopyrine harmful due to the presence of carcinogenic compounds.



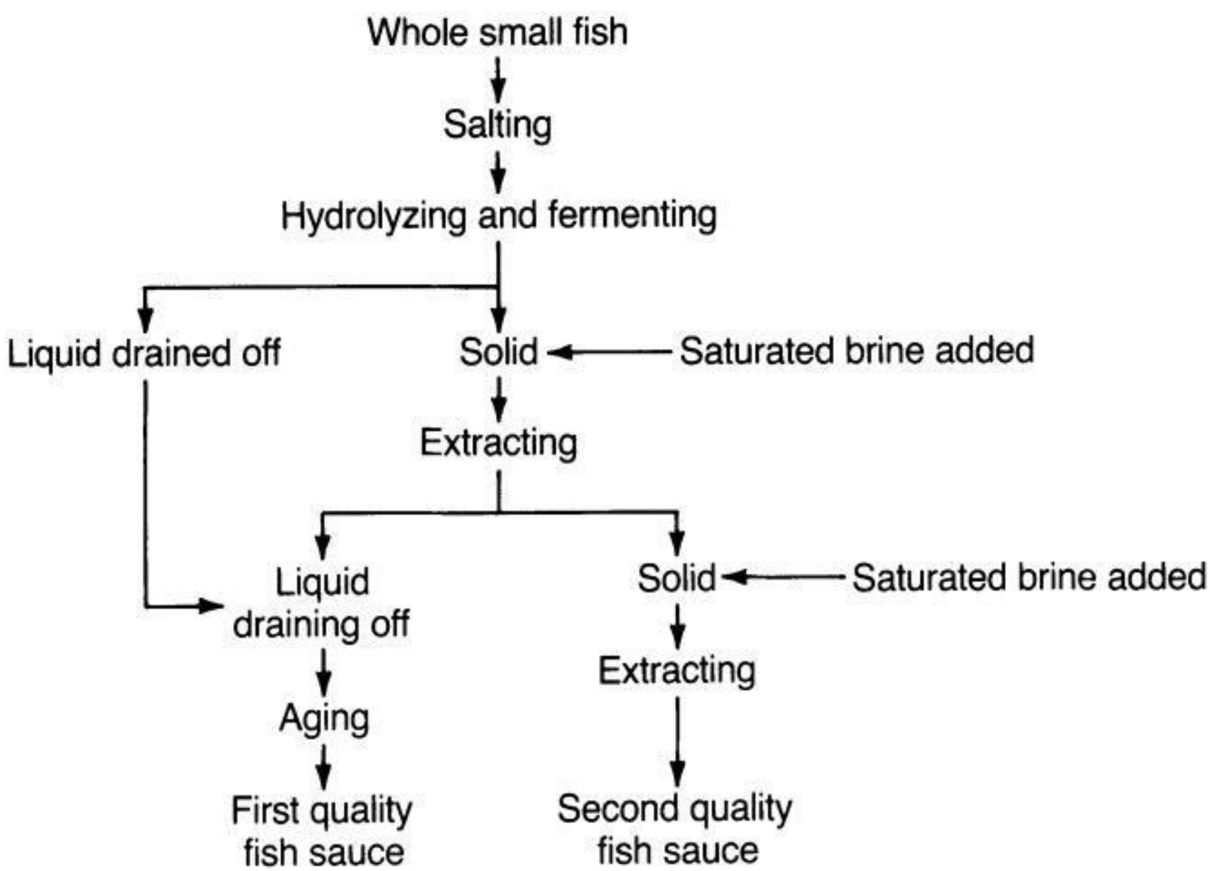
8.2.1. Fermentation of Fish

This process generally involves a complete or almost complete hydrolysis of the fish using their own digestive (proteolytic) enzymes. This preserves the fish and provides a very distinct pungent flavour. LocMoc from Vietnam is a typical example.

Fermented fish sauces, including some made with crustaceans, comprise a significant portion of the dietary protein consumed in Southeast Asia. Fish sauces are generally prepared by mixing 3 parts of fish or crustacean with 1 part salt and allowing a natural fermentation to proceed for a period of from several months up to a year or longer. The liquid supernatant is then filtered and cured for 3 or more months before being used or bottled. Fish sauce is the hydrolyzed product of the fish tissues which consist mainly of protein and lipid.

8.2.2. Processing of Fish Sauce

The fresh but not cleaned fish are mixed with salt and dumped into the vats. The fish are piled above the top of the vat. A final layer of salt is placed on the pile of fish. After 3 days, the collected liquid which is turbid and bloody in appearance is drained off. A part of it is returned to the vat; another portion is saved and used later. Meanwhile the fish have settled below the top of the vat and the layer of the salt has almost disappeared. The fish are now packed down thoroughly. Some of the clear liquid is then poured back over the fish until they are covered to a depth of about 10 cm. The contents are then covered with large bamboo wicker work of split



bamboo on top of which weights are placed.

Lecture 1: Discussion on Fish byproducts and Fish Meal.

1.1. Introduction to Fish Byproducts

Large amount of fish by-product are currently disposed or used for low –value products. There is a large potential for reducing the amount of by-product and to utilize a larger amount of the by-product for value added product for human consumption. Fish by-product contains the same valuable protein as the fish muscles. Recovery and alteration of protein present in the fish by-product is a feasible alternative. By using enzyme technology, it may be possible to produce a broad spectrum of food ingredients for wide range of applications

Fish by-products must consist of non-rendered, clean undecomposed portions of fish (such as, but not limited to heads, fins, tails, ends, skin, bone and viscera) which result from fish processing. If it bears a name descriptive of its kind, it must correspond thereto. Any single constituent used as such may be labeled according to the common or usual name of the particular portion used (such as fish heads, fish tails, etc.)

2.1. Introduction to Fish Meal

The total quantity of caught fish is not saleable. Due to problems of proper marketing, some fish becomes excess. Some fish is rejected due to its high bacterial load and non-hygienic condition. The non-edible portion of fish like bones, fins, heads, etc. and less favourable species of fish is used to produce fish meal. Fish meal is dry and hence can be stored easily for long time. This is a very good source of protein and is used to feed farm animals. If the raw material is oily, the fish oil is also produced a by-product of fish meal production.

2.2. Raw Material for Fish meal Production

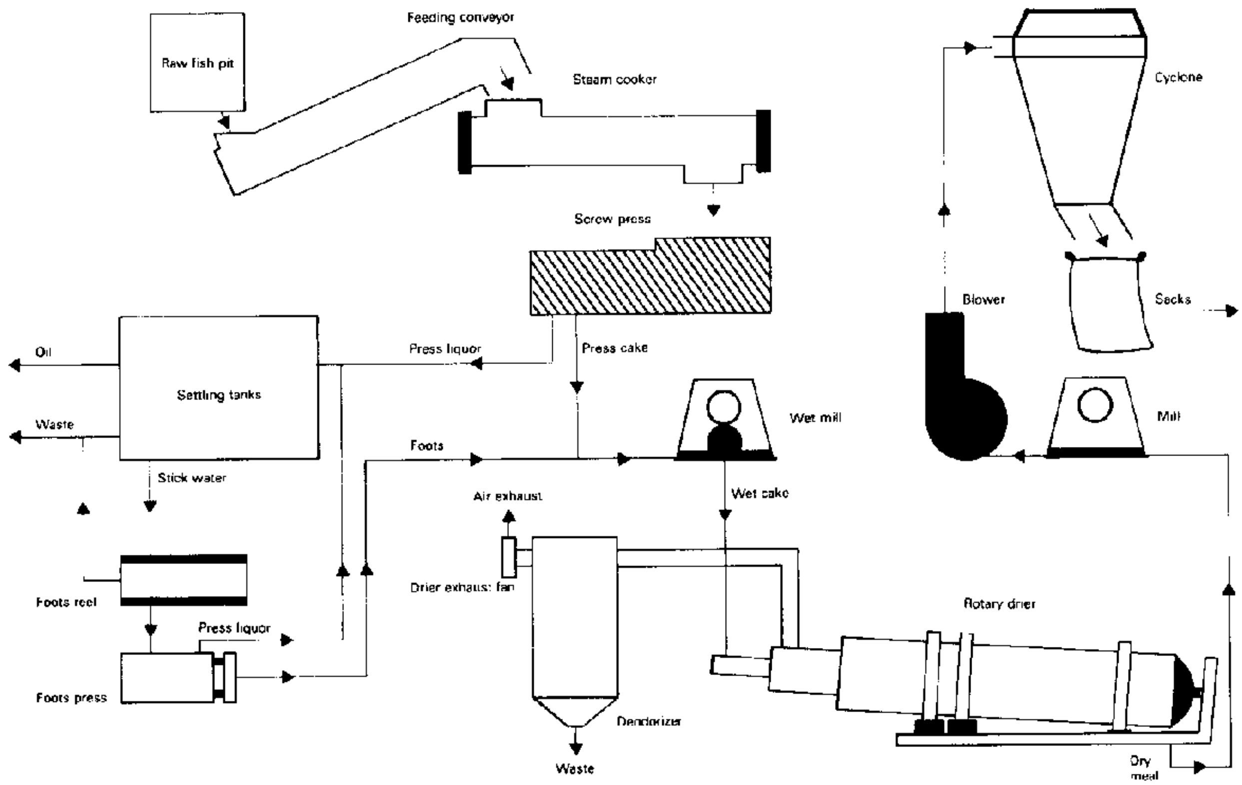
The raw material used for production of fish meal can be divided into three main categories:
1. Fish caught for the sole purpose of fishmeal production (often referred to as 'industrial fish'), e.g., anchovies in Peru, anchovies and pilchards in South Africa, herring and capelin in Norway and Denmark, and menhaden in America.
2. The 'by-catch' from other fisheries, e.g., prawn by-catch.
3. Fish offal and fish wastes from processing operations, e.g., carcases from a filleting operation, heads and guts from a canning line etc.

It is extremely important when planning the establishment of a fishmeal industry that a realistic estimate is obtained of the raw material available. Many fishmeal operations have failed because of over-optimistic assessment of the raw material available. In general, because of the high capital investment, running costs etc., a meal plant requires a regular large supply of fish to be economically viable. It is also very necessary to assess the price of the raw material and seasonal fluctuations in supply. Additional factors, such as the situation and distance from landing places etc., must also be taken into account.

It is also important to have information on the suitability of the raw material for meal manufacture. A number of tropical species of fish are known to contain toxins which could be harmful to livestock. If such toxic fish are likely to be included in the catch, it is important to carry out preliminary feeding trials to establish the suitability of the meal for livestock production.

The fat content of the raw material to be used for meal manufacture is also an important factor in determining the type of processing equipment necessary, the economics of production and the nature of the final product. Fish are normally grouped into two categories, namely oily (or fatty) fish of more than 2.5 per cent fat and non-oily (lean or white fish) with a fat content of less than 2.5 per cent.

2.3. Production methods for Fish Meal



Lecture 2: Discussion on the production of Fish oil.

2.1. Introduction to Fish Oil:

Natural fish oils contain omega-3 fatty acids which when part of a balanced diet are thought to have a number of positive effects on human health such as reducing heart diseases, increasing cardiovascular functions, and possible influences on brain growth during early infancy. Most of this oil is used for fuel and animal feed ingredients.Unrefined fish oils contain non-triglycerides, such as free fatty acids and oxidized components that may reduce quality. These components need to be removed before use in the more lucrative markets.

The longer these components remain in the oil, the greater their negative effect on final oil quality. Making high quality oils requires well-designed purification steps. Conventional fish oil refining is achieved through the following steps: degumming, neutralization, bleaching, and deodorizing.

2.2. Fish Oil production:

Commercial processing of fish oil involves many steps. After the fish are caught and transported to the factory, they are cooked with steam to denature the protein and to release bound water and fish oil. The fish solids and liquid (fish oil and water) are separated by pressing. The pressed fish solids are called “press cake”; the liquid is called “press liquor.” The press liquor contains particles of fish; therefore, the liquid is centrifuged and the particles removed and returned to the press cake. The press liquor is heated and centrifugedto separate the fish oil from the stickwater (liquid and small suspendedfish particles). At this stage, the oil is crude commercial fish oil. However,before the fish oil can be used in foods, it must undergo purification toproduce a more pure and stable product. The steps used in further oilprocessing include degumming, neutralization, washing, drying, bleaching,filtration, deodorization, and stabilization. Degumming and neutralizationare often done together and involve addition of sodium hydroxide

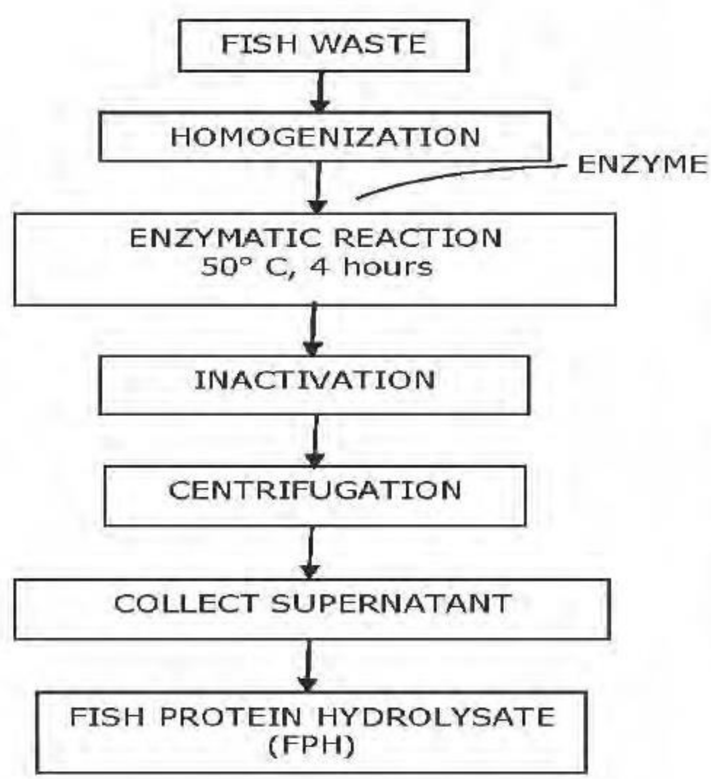
Lecture 3: Discussion on the production of Fish Hydrolysate.

3.1. Introduction to Protein Hydrolysate

Enzymatic proteolysis and solubilization of proteins from various sources has been studied extensively and described by several different authors over the last 60. Addition of proteolytic enzymes could make a hydrolytic process more controllable. Alcalase – an alkaline bacterial protease produced from *Bacillus licheniformis*- has been proven to be one of the best enzymes used in the preparation of fish protein hydrolysate.Flavourzyme is a fungal protease/ peptidase complex produced by submerged fermentation of a selected strain of *Aspergillusoryzae* which has not been genetically modified and is used for the hydrolysis of proteins under neutral or slightly acidic conditions. Flavourzyme has been used to produce a protein hydrolysate with acceptable functional properties.

3.2. Production of Fish Protein Hydrolysate

Fresh fish was filleted and the leftover processing by-products, including the frame, dark muscle, cut offs, viscera, skin, scales, small bones and fins, were collected for protein hydrolysis. The fish waste was stored in a polyethylene bag at 40 ^{0}C until used for FPH production.



Lecture 4: Discussion on Fish Silage production.

4.1. Introduction on Fish Silage:

An interest in fish silage is related to the desire to make maximum use of waste fish and fish offal in situations where the quantity involved, or the transport costs, prohibit conversion into fish meal. In small-scale fisheries in the tropics, this situation is common. Daily and/or seasonal gluts of fish occur and, because of transport difficulties and inadequate processing facilities, these surplus fish are often underused. The quantities involved do not permit profitable fishmeal manufacture since even the most modest fishmeal plant requires regular supplies of several tonnes of raw material per day for viable operation. Ironically, countries in this situation are often importing substantial quantities of fish meal to support their expanding animal production industries.In countries where investment capital is available and fish waste is concentrated in one area, the obvious solution is reduction to fish meal. Where this is not possible, the fish could be utilized by the cattle, pig and poultry industries in the form of silage. The technology of fish silage production is simple; essential equipment is cheap; and the scale of production may be varied at will. These are distinct advantages in developing countries.

Silage production relies on the fact that at acidic pH, the microbial flora of fish is eliminated or greatly reduced and the enzyme systems in the fish which break down fish protein are able to function more efficiently. Fish silage methods can be divided into two major groups:

1. Those employing acids, either mineral and/or organic, to lower the pH and to produce the conditions necessary for silage production, and
2. Those employing a process of fermentation with the generation of organic acids to conserve the product.

4.2. Production of Fish Silage

An outline of the steps involved in preparation is as follows:

1. The raw material should be as fresh as possible (this may include whole fish, filleting waste, offal or other suitable protein material).

2. The fish are comminuted by mincing, cutting or chopping (this operation may be manual or mechanical).

3. For manual preparation 10 - 15 kg quantities of minced fish are placed in a suitable container (this must be acid-resistant).

4. The minced fish is acidified with mineral acid or with formic acid to the required pH. The mix is constantly stirred until the desired pH is reached.

Lecture 5: Discussion on Fish Protein Concentrate.

5.1. Introduction to Fish Protein Concentrate

The idea of producing a fish protein concentrate is by no means new. However, it is only in the last twenty-five years that extensive endeavours have been made to produce fish protein concentrate, and only in the last few years that most of the technical problems of making FPC on a large scale have been solved. Fish protein concentrate is any stable fish preparation, intended for human consumption, in which the protein is more concentrated than in the original fish.

5.2. Production of Fish Protein Concentrate

The manufacturing process is quite complicated, but an outline of a typical process is shown in the figure. The sequence of operations is:

1. Fresh whole fish are rinsed with fresh water soon after landing, weighed and fed to a mincer by conveyor.

2. First extraction: the minced fish are fed to extractor 1 which dehydrates the fish; it is an unheated vessel in which the mince is agitated for about 50 minutes together with the liquid recovered from extractor 2, which contains some isopropanol.

3. Centrifuging: the contents of extractor 1 are fed to a continuous centrifuge, where the slurry separates into a solid known as wet cake, and a liquid. The wet cake is conveyed to extractor 2, and the liquid to a still for recovery of solvent and fat.

4. Second extraction: extractor 2 is jacketed, and the temperature is about 75°C. Here the liquid recovered from extractor 3 is added to the wet cake from extractor 1 and the mixture is agitated for 90 minutes. At the beginning of this stage the cake is almost completely dehydrated, but has a fat content of about 5 per cent, which is reduced to about 1 per cent during the extraction.

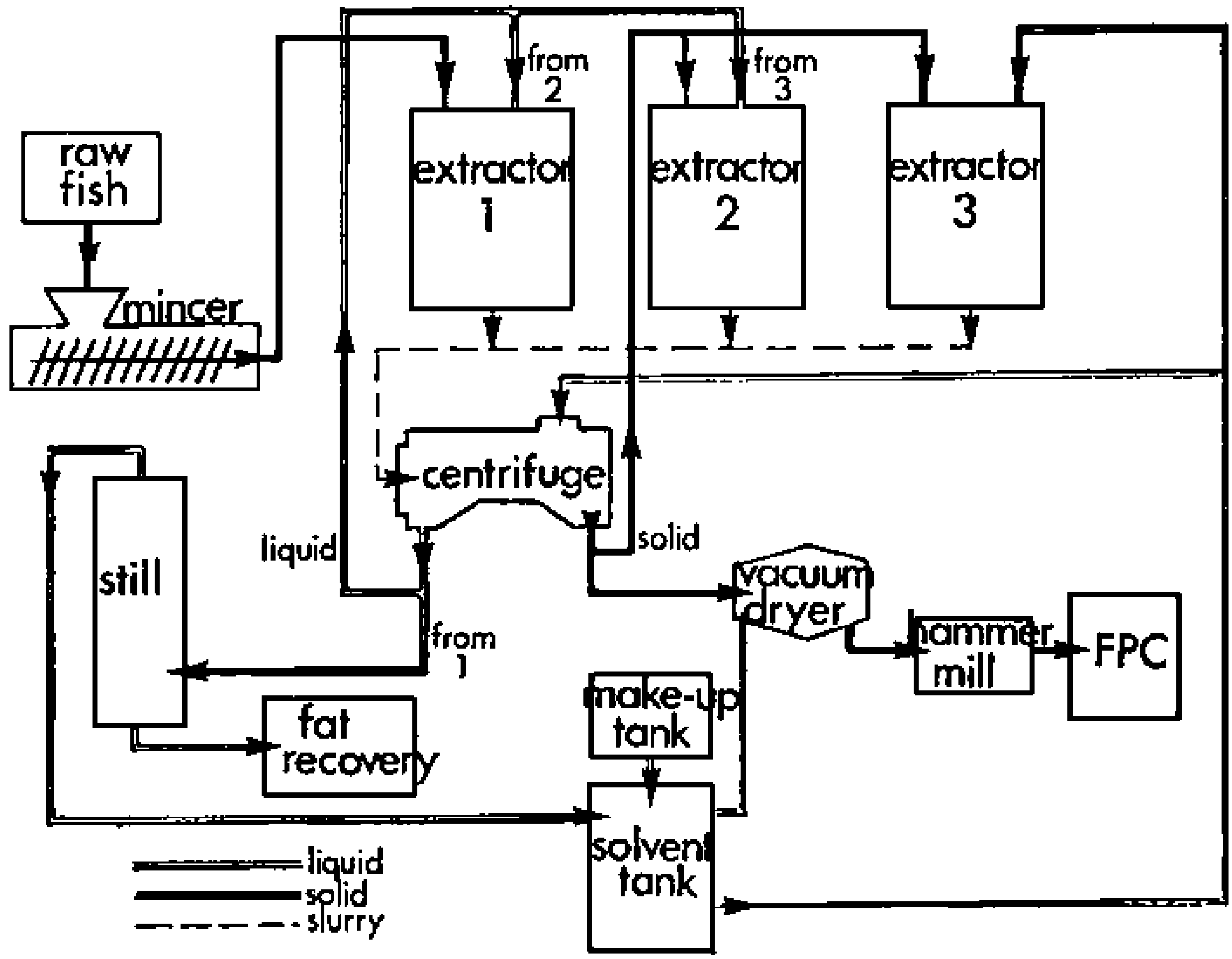
5. Centrifuging: the contents of extractor 2 are centrifuged, the wet cake is conveyed to extractor 3, and the liquid is returned to extractor 1 for the next batch of raw material.

6. Third extraction: extractor 3 is jacketed, and the temperature is again about 75°C. Fresh isopropanol is added to the wet cake and agitated for about 70 minutes. During this stage the fat content is reduced to about 0·3 per cent.

7. Centrifuging: the contents of extractor 3 are centrifuged and the wet cake is washed with pure isopropanol for about 50 minutes. The liquid is returned to extractor 2 for the next batch.

8. Solvent removal: the wet cake is heated in a rotating vacuum dryer to evaporate the solvent; the vapours are drawn off, condensed and used again.

9. Grinding and packing: the dried material is conveyed to a hammer mill, where it is ground to a fine powder and sieved. The FPC is typically packed in 50-lb fibreboard containers and sent to store ready for shipment.



5.3. Different Types of FPC

In 1968 FAO developed some specifications regarding FPC. They are specified into 3 categories like A, B, C.

Grade A is of highest purity and Grade C is the lowest purity. In 1969, USFDA defines FPC and approved it for human consumption and defined it as " Whole fish protein concentrate is derived from whole, wholesome fish and contains the whole fish including bones, head, fins, intestines and their contents, tails, etc."

Lecture 6: Discussion on Chitin and Chitosan.

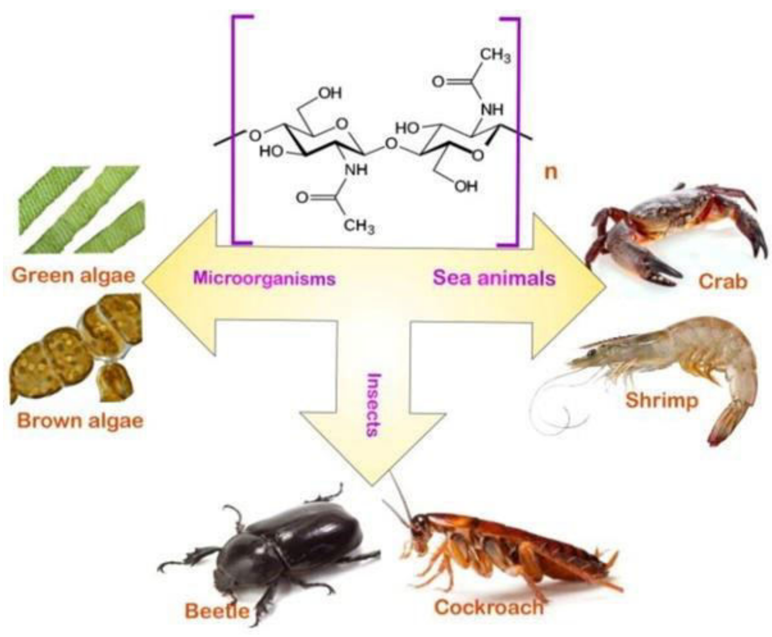
6.1. Introduction on Chitin and Chitosan

Chitin is the most abundant aminopolysaccharide polymer occurring in nature, and is the building material that gives strength to the exoskeletons of crustaceans, insects, and the cell walls of fungi. Through enzymatic or chemical deacetylation, chitin can be converted to its most well-known derivative, chitosan. The main natural sources of chitin are shrimp and crab shells, which are an abundant byproduct of the food-processing industry, that provides large quantities of this biopolymer to be used in biomedical applications. In living chitin-synthesizing organisms, the synthesis and degradation of chitin require strict enzymatic control to maintain homeostasis.

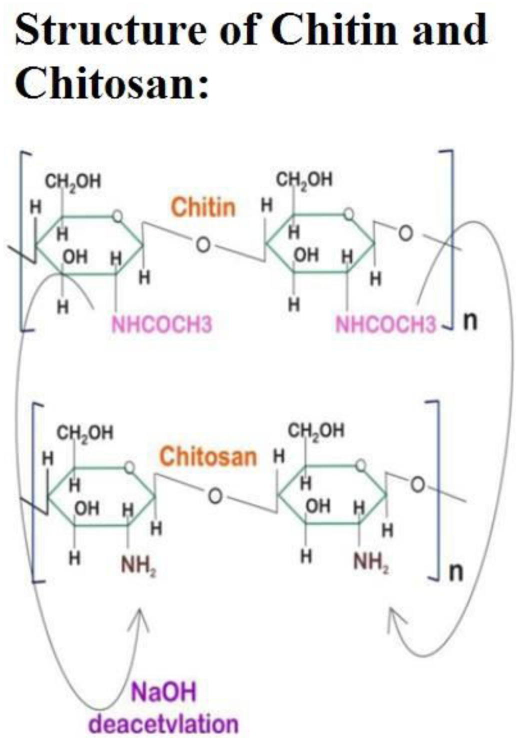
6.2. Structure and source of Chitin

Chitin (β-(1–4)-poly-N-acetyl-D-glucosamine) is widely distributed in nature and is the second most abundant polysaccharide after cellulose. Chitin, which occurs in nature as ordered macrofibrils, is the major structural component in the exoskeletons of the crustaceans, crabs and shrimps, as well as the cell walls of fungi. Chitin and chitosan are both biocompatible, biodegradable, and non-toxic biopolymers. They are also antimicrobial and hydrating agents.

Chitosan is the deacetylated form of chitin (that can have varying degrees of deacetylation), and it is soluble in acidic solutions. The conversion of chitin to chitosan is possible either by enzymatic preparations, or chemical hydrolysis



Sources of Chitin



6.3. Application of Chitin and Chitosan

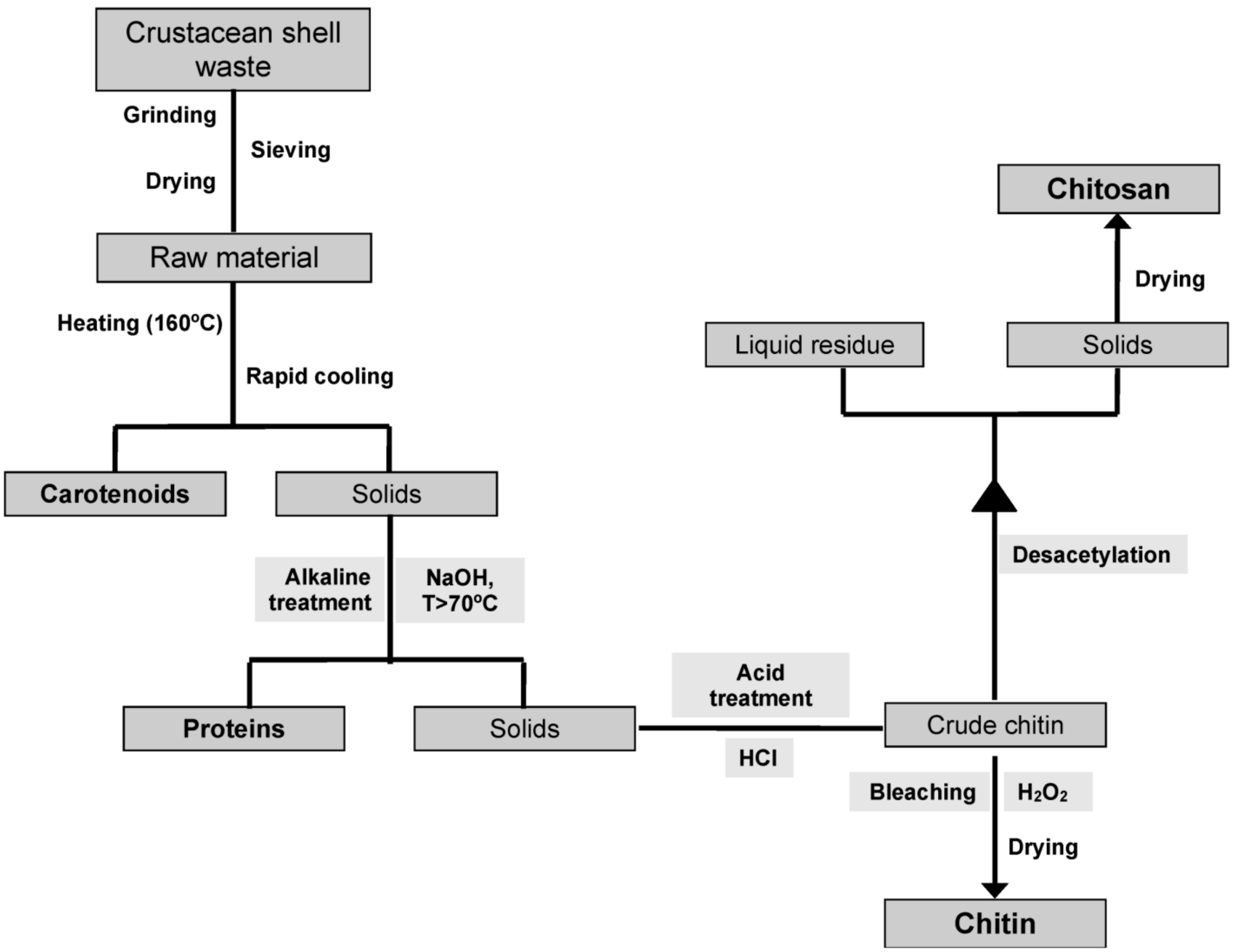
Chitin and chitosan, owing to their unique biochemical properties such as biocompatibility, biodegradability, non-toxicity, ability to form films, etc, have found many promising biomedical applications. Nanotechnology has also increasingly applied chitin and chitosan-based materials in its most recent achievements. Chitin and chitosan have been widely employed to fabricate polymer scaffolds. Moreover, the use of chitosan to produce designed-nanocarriers and to enable microencapsulation techniques is under increasing investigation for the delivery of drugs, biologics and vaccines. Each application is likely to require uniquely designed chitosan-based nano/micro-particles with specific dimensions and cargo-release characteristics. The ability to reproducibly manufacture chitosan nano/microparticles that can encapsulate protein cargos with high loading efficiencies remains a challenge.Consequently, chitosan may be used in oral, nasal as well as ocular routes, for drug delivery in both implantable and injectable forms. Chitin and chitosan in fiber or film state, are mainly applied for tissue engineering and wound care dressing Chitosan can be successfully used in solution, as hydrogels and/or nano/microparticles, and (with different degrees of deacetylation) an endless array of derivatives with customized biochemical properties can be prepared. As a result, chitosan is one of the most well-studied biomaterials.

Lecture 7: Discussion on the production of Chitin and Chitosan.

7.1. Production of Chitin

The isolation of chitin from crustaceans such as crayfish, crab, shrimp, and other organisms such as fungi is a time-consuming process. It requires 17–72 h including 1–24h of treatment with HCl and 16–48h of NaOH processing.

To produce 1 kg of 70% deacetylated chitosan from shrimp shells, 6.3 kg of HCl and 1.8 kg of NaOH are required in addition to nitrogen, process water (0.5 t) and cooling water.



Lecture 8: Discussion on the production of non-food items from fish processing waste.

8.1. Fish body oils

Fish body oils are usually produced during the wet reduction process used for meal manufacture, the liquor from the press being passed either to a series of settling tanks or to a series of centrifuges. The press liquor is an oil/water emulsion containing dissolved proteins and other substances as well as particulate matter; the quantity of organic matter other than oil depends on the condition of the fish when processed, the degree to which the fish is cooked and the manner in which the press is operated. Many fish oils are converted into solid compounds when atmospheric oxygen is absorbed, and such drying oils are suitable for use in paints and varnishes. A few oils are classified as semi-drying and these are not suitable for such purposes. These oils are also used in animal feeding especially as carriers for the oil soluble vitamins A and D.

8.2. Fish glue

A slow setting liquid glue can be made from fish skins and fish heads, which is suitable for furniture making, small repair work, and in book binding, labelling and similar uses. It would almost certainly be impractical to consider the use of fish heads in the developing countries and the use of skins could only be practised in the few countries where skinned fillets are frozen. In the United States, only thick skins from cod and similar species have been used in the past, the skins coming mainly from the cod salting and drying industries. Most tropical fish species have large scales and relatively thin skins and these would be unsuitable for glue manufacture. The skins are washed in cold fresh water, all salt and rubbish being removed. Fresh skins require up to two hours washing, salted skins may need as much as 18 hours. The washed skins are cooked for about eight hours in steam jacketed cookers fitted with perforated plates near the base, a weight of water equal to the skin weight being added. A second run may be made in a similar manner yielding a weaker glue.

8.3. Leather manufacture

An alternative use for fish skins would be to make leather from them. Only shark skins can be used to make an attractive hard wearing leather but suffer from the disadvantage that the shagreen (the shark tooth-like 'scales') must be removed; this cannot be achieved by scraping without damaging the skin and chemical methods must be used.

8.4. Fertilisers

There are still a few minor tropical fisheries in which small fish or otherwise unutilisable species are reserved for manure; usually the unsalted carcases are sun dried for ease of transport. Fillet waste from freezing or drying operations could also be used; the fillet waste from Maldive fish processing is dried beside the smokehouse fire for use in this way. The heads and shells of sun dried shrimps can be ground to make a useful fertiliser as can the carapaces of crawfish.

QUESTIONS FROM MODULE I & II

MCQ:

i) Value-added fish product from low – value fish is
   a) FPC   b) fish liver oil   c) Surimi   d) All of these

ii) Spoilage of fish begins from which of the following region?
   a) belly   b) gills   c) scales   d) fins

iii) Which of the following is a fermented fish product?
   a) Sushi   b) FPC   c) Fish Sauce   d) None of these

iv) The stomach wall of fish contains
   a) endoscopic gland   b) microscopic gland   c) exoscopic gland   d) demersalglan

v) Fat content of fish depends on
   a) Season   b) sex   c) both   d) none o of these.

vi) An example of crustaceans is
   a) crab   b) tuna   c) clam   d) None of these

5 Marks Questions:

i) Define 'drip –loss' with its relation to fish muscle. How can it be prevented? What are the different flavoring components of fish muscle? (3 +2)

ii) Discuss two physical and two physiochemical test method for assessment of fish spoilage. (2.5 +2.5)

iii) Highlight the significance of moisture content in fish muscle and comment on its various types that are present in the muscle. (3+2)

iv) Briefly discuss the steps for canning of fish. (5)

v) What are the challenges faced while salting of fish is preformed? What is Surimi ? (3+2)

vi) What are the adverse effects of freezing of fish? In drying of fish, what is referred to as stockfish? (4+1)

15 Marks Questions:

i) How is fish protein hydrolysate prepared from raw fish? Comment on raw materials and different enzymes used for preparation of FPH. Elaborate the process with a flow diagram. Discuss about the final product, its nutritional quality and its various applications. (3+2+7+3)

ii) How do perform pickling of fish? What are the potential problems with canning of fish? Explain the different changes in protein composition of the fish that occur due to freezing. What precautions should be taken to properly transport and handle the frozen fish?Discuss the process for production of chitin and chitosan (3+2+3+2+5)

iii) With a flow diagram discuss the process for production of fish-meal and fish oil. What are the different methods of extraction of fish liver oil? Briefly discuss the use of fish meal and fish liver oil. (5+5+2+3)

iv) How does the onboard storage process help in extending the freshness of fish? What considerations should be made while choosing ice for storing fish onboard? How does onboard gutting preserve the fish quality? How do we perform scaling of the fish? What are the steps in the post-filleting handling of fish? (3+ 3+2+2+5)

v) Write about the non-food by products obtained from fish processing. Give the detained production steps for fish protein concentrate. What are the different types of FPC that are available? (5+8+2)

vi) Write Short Notes on any 3 of the following

a) Fish Silage
b) IQF Shrimp
c) Fish Lipid
d) Salting of fish
e) Drying of fish

Module III **8L**

Lecture 1: Introduction about meat; Details about Slaughtering of animals

1.1. Introduction about meat

Meat is defined as the flesh of animals used as food. In a narrow sense this definition is restricted to a few dozen mammalian species, but it is often widened to include musculature, organs such as liver and kidney, and the brain and other edible tissues. An even broader definition of meat includes the same parts of poultry. The word meat will be used in this broader sense, and does not include fish.

Among mammalian species the meat of cattle, pigs, and sheep is primarily what is consumed by humans. In addition, the flesh of horses, goats, and deer is regularly consumed. Various other mammalian species are eaten in different parts of the world, according to their availability or because of local custom. Thus, for example, seal and polar bear are important in the diet of Eskimos; kangaroo is eaten by Australian aborigines. Rabbit and hare are generally considered separately, along with poultry. Poultry means any domesticated bird including chickens, turkey, ducks, geese, guinea fowls, or pigeons.

It must be recognized at the outset that, in the production of meat and meat products throughout the world, there are many differences of opinion among farmers, wholesalers, retailers, and the meat manufacturing industry as to what characteristics constitute quality. This is hardly surprising if consideration is given to the widely differing social and eating customs of the world's population and the wide range of meat products manufactured and consumed in different countries. To add to the complexity, legislation relating to meat and meat products varies from country to country.

The definition of quality can be described readily when the product is a simple substance such as sodium chloride, used for curing meat. Purity standards for such materials can be defined and determined with accuracy; the form and size of the salt crystal may be specified and controlled, keeping in mind the complexity of muscle tissue and the changes it undergoes after slaughter.

Distribution, and the fact that final estimation of meat quality is made by the consumer only by eating the cooked meat, makes understandable the difficulties of meat quality evaluation. In every case, meat quality evaluation starts with the quality control of raw meat obtained after slaughter.

The second step is the estimation of quality of cooked meat, and the final step is the quality control of meat products. In the following sections, the main quality indices of meat and meat products will be discussed.

Raw materials accepted for production should be free, as far as possible, from microbiological hazards, such as E. Coli O157 and Salmonella, from chemical hazards such as grease and dirt, and from physical hazards such as metal and other foreign bodies.

Temperature controls are important as bacteria can multiply quickly if meat is kept at a temperature that promotes bacterial growth. Poor hygiene will increase the potential for contamination of food, including transfer from meat to ready-to-eat products, and increase the possibility of food poisoning.

Some further processing techniques will result in a final product that the consumer will not need to cook further, and these products pose a considerably higher risk. Procedures are needed to minimise the risk of these hazards causing illness in consumers.

1.2. Details about Slaughtering of animals

- **General principles**

1. Object

These recommendations address the need to ensure the welfare of food animals during pre-slaughter and slaughter processes, until they are dead.

These recommendations apply to the slaughter in slaughterhouses of the following domestic animals: cattle, buffalo, bison, sheep, goats, camelids, deer, horses, pigs, ratites, rabbits and poultry. Other animals, wherever they have been reared, and all animals slaughtered outside slaughterhouses should be managed to ensure that their transport, lairage, restraint and slaughter is carried out without causing undue stress to the animals; the principles underpinning these recommendations apply also to these animals.

2. Personnel

Persons engaged in the unloading, moving, lairage, care, restraint, stunning, slaughter and bleeding of animals play an important role in the welfare of those animals. For this reason, there should be a sufficient number of personnel, who should be patient, considerate, competent and familiar with the recommendation and their application within the national context.

Competence may be gained through formal training and/or practical experience. This competence should be demonstrated through a current certificate from the Competent Authority or from an independent body accredited by the Competent Authority.

The management of the slaughterhouse and the Veterinary Services should ensure that slaughterhouse staff are competent and carry out their tasks in accordance with the principles of animal welfare.

- **Stunning methods: General considerations**

The competence of the operators, and the appropriateness, and effectiveness of the method used for stunning and the maintenance of the equipment are the responsibility of the management of the slaughterhouse, and should be checked regularly by a Competent Authority.

Persons carrying out stunning should be properly trained and competent, and should ensure that:

a) the animal is adequately restrained;

b) animals in restraint are stunned as soon as possible;

c) the equipment used for stunning is maintained and operated properly in accordance with the manufacturer's recommendations, in particular with regard to the species and size of the animal;

d) the instrument is applied correctly;

e) stunned animals are bled out (slaughtered) as soon as possible;

f) animals are not stunned when slaughter is likely to be delayed; and

g) backup stunning devices are available for immediate use if the primary method of stunning fails.

In addition, such persons should be able to recognise when an animal is not correctly stunned and should take appropriate action.

Lecture 2: Classification, composition and nutritive value of poultry meat

The gross poultry meat composition includes water, protein, fat, calcium, phosphorus, iron, copper and other components important to eating quality. Poultry meat has high content of protein around 21 per cent, fat 4.5 per cent. There is less fat on the meat of young chicken compared to aged chicken and hen. Fat content is influenced by feed, breed and species of poultry.

In case of chicken the fat is cutaneous, that is under the skin. Chicken cooked with skin is moist, succulent and flavoutfd due to fat. Skin may be removed before cooking for people who have been advised for low fat diet. However chicken meat is considered as white (light meat), has less fat compared to red meat of sheeplgoat or buffalo. Myoglobin and hemoglobin impart meat colour. Muscles of older animal contain increased amount of myoglobin and hence are darker in colour. Chicken meat has light meat on breast and wings and dark meat on legs. Light meats have comparatively less fat in breast and wing compared to dark meat (leg meat).

The gross composition of poultry meat and composition of selected poultry products are as below:

Name	Protein	Water	Fat	Ash	Calcium	Phos-Phorus	Iron Copper (mg/kg)	
Chicken	21.1	73.3	4.5	1.1	0.012	0.232	32.0	3.5
Duck	21.4	69.2	8.2	1.2	0.010	0.200	23.0	5.0
Turkey	24.0	68.2	6.7	1.1	0.030	0.420	45.0	1.8
Goose	22.3	69.5	7.1	1.1	0.009	0.175	24.0	3.3

1) Moisture: The moisture content of meat from broiler, roaster and hen are 71% to 74%, 66% and 56% respectively. The cooking loss in ready-to-cook whole broiler is around 23 per cent. The turkey meat is high in nutritive value and low in calories compared to chicken. In general, younger birds have higher moisture to skeletal muscle ratio as compared to other ones. The fat content of meat is inversely proportional to the moisture content.

2) Protein: Poultry meat is highly rich in protein and regarded as a concentrated source of high quality protein. It is higher in protein content as compared to red meats. Cooked poultry meat contains 25-30 per cent protein depending upon the part of the carcass and the method of preparation whereas beef contains 21 -27 per cent, pork 23-24 per cent and lamb 21-24 per cent.
Proteins of poultry meat are classified under first class category because these contain all the essential amino acids in balanced proportion. As in all meats, poultry meat is limited by sulphur containing amino acids. Different cuts of meat vary in their digestibility due to different-proportions of connective tissue. Muscle fibers are supported in body by connective tissue collagen, elastin and reticulin fibers which are fibrous tissue.

3) Fat: The fat is deposited around certain organs and under the skin and later marbling with muscle. Unlike red meats, most fat in poultry meat is deposited under the skin. Dietary fat influences body fat of chicken. High energy feed is required by broilers for fast growth. Diet includes animal fat and fat from oil seeds cake component of feed. Broiler has less fat than roaster and hen. The fat content of poultry meat also depends upon the part of the carcass. According to Scott (1956) the cooked turkey skin contains 33.8% fat and breast meat contains 6.7-8.3% fat. Cooked chicken meat contains only 1.3% fat. Poultry meat contains a higher proportion of unsaturated fatty acids than the fats from red meats. The proportion of desirable essential unsaturated fatty acids i.e. oleic and linoleic acid is more than 60% of the total fat.

4) Carbohydrate: Small quantity of carbohydrate in meat provides texture and eating quality. Conversion of glycogen to lactic acid during post-mortem aging determine the pH of the meat and influence water holding capacity, firmness and colour.

5) Vitamins: Poultry meat is a good source of many vitamins, such as niacin, thiamin (vit B,), riboflavin (vit B,) and ascorbic acid (vit C). Poultry liver is rich source of vit A, vit B complex, vit C.

6) Minerals: Poultry meat constitutes nearly 1 % of essential minerals like iron, copper, zinc and selenium in significant amounts.

Nutritive value: Meat from poultry contains several important classes of nutrients. It is low in calories in comparison to other type of meats. Due to its low energy value it is used as a good foodstuff for weight control diets and for elderly people.

Birds	Energy (Cal/100gm)
Broiler	150
Roasters	200
Hens	300
Duck	320
Turkeys	270

Meat fibers are tender, easy to chew or grind and easy to digest. Texture of meat is considered by some to be synonymous to tenderness -juiciness, softness of muscle fiber and connective tissue. Broiler meat is tenderer compared to birds of older age of same group. However layer hen meat after about 70 weeks of laying period produce tough meat. Its flavour is also mild and it blends well with seasonings and other foods. Flavour in chicken meat develops during cooking, and skin imparts typical chicken flavour. Sulphur compounds in meat accounts for flavour of meat. Diet of bids also imparts flavour.

Poultry meat provides all essential amino acids in balanced proportion required by human body. The availability of protein from animal source in India is only 4 to 8.9g per day capita per day while in developed countries it is 30 to 75 gm per capita per day. Growing children, women during pregnancy and lactation need more protein than adults. Poultry meat is a food of high nutritional value. Such high protein diet is necessary for growth and development of children and pregnant ladies. In addition, it compensates the day to day wear and tear of tissues of human body.

Chicken meat with low fat provides all the essential fatty acids. It is a *source* of both saturated and unsaturated fatty acids. These constitute cell wall, mitochondria and other cell components. Due to low energy value, chicken meat is a good food for weight control diets.

Chicken meat contains more phospholipids and low cholesterol than other meats and egg, which minimizes risks due to diabetes and heart diseases.

Poultry meat is rich in niacin and moderately rich in thiamine, riboflavin and ascorbic acid. It is a good source of iron and phosphorus. Half of iron in meat is present as haem iron, which is well absorbed (1 5-20%) compared with only 1 - 10% of iron from plant food. Also it enhances absorption of iron from other foods. Due to high biological value and easy digestibility, it is a choice food for aged persons as well as children. It has the ability to alleviate the nutritional stress condition in the human beings. It has a good aesthetic appeal. Poultry meat has non-religious inhibition and its many products satisfy the variety quest of the consumers.

Lecture 3: Post mortem changes of meat

Immediately after slaughter, changes occur in the muscle of an animal. These changes, like the changes in milk and eggs, can be retarded by method of handling and storage. They are brought about by enzymes and microorganisms, and by chemical and physical means which alter the structure and chemical composition of the meat.

Muscle in the living animal is (1) pliant, soft, gel-like, yet somewhat viscous. After slaughter the muscles pass from this state into a stiff or rigid one (2) known as rigor mortis, or muscle rigor. After some time the muscles again become pliant. This stage (3) is known as the passing of rigor. With longer storage enzymes and chemical means bring about (4) more extensive changes which produce ripened meat. With bacterial action and still more extensive changes (5) incipient putrefaction occurs. The passage from one stage to another is gradual with no definite dividing zone and is accelerated at higher temperatures and retarded at lower ones.

Meat may be cooked during any of these stages and heat denaturation causes characteristic changes which are part of the post-mortem changes. Meat cooked before the onset of rigor is said to be tender. But rigor develops quickly so that this period is short. Concerning the question of tenderness of meat before the onset of rigor.

Preservation of meat. Freezing. Meat may be frozen and then stored at temperatures of - 10° to - 15°F. In this way the post-mortem changes are nearly inhibited.

Curing. Common salt is the basis of all cures or pickles. Although many modifications are used, the methods may be divided into two classes, brine and dry-salt cures. Salt not only preserves but tends to dry the meat. Sugar may be added for flavor. Sugar also tends to keep the muscles softer than when salt is used alone and thus tends to increase the tenderness. When sugar is added to the brine, the process is known as "sugar cure" or "sweet pickle." Saltpeter (potassium nitrate) or Chili saltpeter (sodium nitrate) or the nitrite salts of potassium and sodium may be used in cured meat. The red color of cured meat is due to the action of nitrite on the hemoglobin of the muscle. If only nitrate salts are used in the brine, they are reduced to nitrite by bacterial action.

Cured meat may be smoked and partially dried on the surface. Actual smoke and not chemical treatment to produce a smoke flavor must be used in establishments under federal inspection.

Ham, bacon, and salt pork are probably the best known of cured pork products. The loins when cured are often known as Canadian bacon.

Dried or chipped beef and corned beef are among the more familiar cured-beef products. Beef cured in a brine is known as corned beef. Beef cuts most often cured are the plates, flanks, and rumps, though from the lower grades the chucks and rounds are often used. Dried beef is cured in a sweet pickle, then dried and smoked. Usually the rounds and sometimes the shoulder clods are used for dried beef.

Cold storage. The passing of rigor, ripening, and development of putrefaction are delayed by quickly chilling the dressed meat and keeping it at a low temperature just above the freezing point of meat. Moran states that if the dressed meat is chilled slowly more protein is denatured than if it is chilled quickly, and, because bacteria attack denaturated protein more rapidly than native protein, quick chilling is one means of increasing the storage life of meat.

Chemically conditioned cold. Moran states that with temperature control alone the storage life of chilled beef is about 35 to 40 days. If, in addition to low temperature control, what is sometimes known as "chemically conditioned cold," i.e., 10 per cent of carbon dioxide, is used in the storage atmosphere, the storage life of the meat may be extended to 60 or 70 days. The carbon dioxide retards or checks bacterial growth but if too much is used with red meats such as beef and mutton, the surface of the meat turns dark. This is because of the decreased amount of oxygen obtained by the meat when carbon dioxide is increased. For fish a higher percentage of carbon dioxide can be used. Stansby and Griffith have reported that haddock packed in ice and plus an atmosphere of 15 to 40 per cent of carbon dioxide have their storage life doubled over that when packed in ice alone.

Contamination with bacteria and storage life. Another factor affecting the storage life of meat is the initial contamination with bacteria. But with care the initial contamination should be small. Other things being equal, the smaller the initial load of bacteria the longer the storage life of the meat. Spoilage by bacteria, yeasts, and molds is largely surface, and in general does not extend to a greater depth than 1/4 to 1/2 inch. Hoagland, McBryde, and Powick in their investigations of changes in beef during cold storage above freezing found that "bacteria and molds grow on the surface of cold storage carcasses but do not penetrate to any great depth (less than 1 inch in 177 days)."

Microorganisms may enter the meat by penetration from the surface, which is a slow process, and by following the cavities in meat, that is, the blood and lymph vessels.

Empey found that bacteria grow and develop very slowly on meat during rigor, as a pH of approximately 5.3 to 5.6 is not a desirable one for their growth. Stansby and Griffith also found that bacteria do not develop rapidly on fish during rigor.

Humidity. Mueller and Richardson have reported that dry air as well as the low temperature is a factor in preventing bacterial growth. Hoag-land, McBryde, and Powick found that in a cooler with low humidity the growth of mold on the surface of the meat at 177 days was no greater than in a cooler with higher humidity at 53 days.

Lecture 4: Curing and smoking of meat

Smoking: Curing is the addition to meats of some combination of salt, sugar, nitrite and/or nitrate for the purposes of preservation, flavor and color. Some publications distinguish the use of salt alone as salting, corning or salt curingand reserve the word curing for the use of salt with nitrates/nitrites. The cure ingredients can be rubbed on to the food surface, mixed into foods dry (dry curing), or dissolved in water (brine, wet, or pickle curing). In the latter processes, the food is submerged in the brine until completely covered. With large cuts of meat, brine may also be injected into the muscle. The term pickle in curing has been used to mean any brine solution or a brine cure solution that has sugar added.

Salt inhibits microbial growth by plasmolysis. In other words, water is drawn out of the microbial cell by osmosis due to the higher concentration of salt outside the cell. A cell loses water until it reaches a state first where it cannot grow and cannot survive any longer. The concentration of salt outside of a microorganism needed to inhibit growth by plasmolysis depends on the genus and species of the microorganism. The growth of some bacteria is inhibited by salt concentrations as low as 3%, e.g., *Salmonella*, whereas other types are able to survive in much higher salt concentrations, e.g., up to 20% salt for *Staphylococcus* or up to 12% salt for *Listeria monocytogenes*. Fortunately the growth of many undesirable organisms normally found in cured meat and poultry products is inhibited at relatively low concentrations of salt.

Salting can be accomplished by adding salt dry or in brine to meats. Dry salting, also called corning originated in Anglo-Saxon cultures. Meat was dry-cured with coarse "corns" or pellets of salt. Corned beef of Irish fame is made from a beef brisket, although any cut of meat can be corned. Salt brine curing involves the creation of brine containing salt, water and other ingredients such as sugar, erythorbate, or nitrites. Age-old tradition was to add salt to the brine until it floated an egg. Today, however, it is preferred to use a hydrometer or to carefully mix measured ingredients from a reliable recipe. Once mixed and placed into a suitable container, the food is submerged in the salt brine. Brine curing usually produces an end product that is less salty compared to dry curing. Injection of brine into the meat can also speed the curing process.

Most salt cures do not contain sufficient levels of salt to preserve meats at room temperature and *Clostridium botulinum* spores can survive. In the early 1800's it was realized that saltpeter ($NaNO_3$ or KNO_3) present in some impure curing salt mixtures would result in pink colored meat rather than the typical gray color attained with a plain salt cure. This nitrate/nitrite in the curing process was found to inhibit growth of *Clostridium*. Recent evidence indicates that they may also inhibit *E. coli*, *Salmonella*, and *Campylobacter* if in sufficient quantities.

Several published studies indicated that N-nitrosoamines were considered carcinogenic in animals. For this reason, nitrate is prohibited in bacon and the nitrite concentration is limited in other cured meats. In other cured foods, there is insufficient scientific evidence for N-nitrosamine formation and a link to cancer.

Curing: Smoking is slowly cooking food indirectly over a fire. This can be done by using a "smoker," which is an outdoor cooker especially designed for this purpose. A covered grill can also be used for smoking food by placing a drip pan of water beneath the meat on the grill.

Completely thaw meat or poultry before smoking. Because smoking uses low temperatures to cook food, the meat will take too long to thaw in the smoker, allowing it to linger in the "Danger Zone" (temperatures between 40 and 140 °F) where harmful bacteria can multiply. Defrosted meat also cooks more evenly.

Never thaw food at room temperature. Keeping meat and poultry cold while it is thawing is essential to prevent the growth of harmful bacteria. The best way to safely thaw meat and poultry is in the refrigerator. Cook or refreeze it within 1 or 2 days.

The microwave oven can be used to thaw more rapidly. Smoke the meat immediately because some areas of the meat can begin to cook during the thawing process.

Food may also be thawed in cold water. Be sure that the sink or container that holds food is clean before submerging food. Two methods may be used when thawing:

1. Completely submerge airtight wrapped package. Change water every 30 minutes.
2. Completely submerge airtight wrapped food in constantly running cold water. If thawed completely, it must be cooked immediately.

Cook food in smokers made of materials approved for contact with meat and poultry. Don't smoke foods in makeshift containers such as galvanized steel cans or other materials not intended for cooking. Chemical residue contamination can result.

When using a charcoal-fired smoker, buy commercial charcoal briquettes or aromatic wood chips. Set the smoker in a well-lit, well-ventilated area away from trees, shrubbery, and buildings. Only use approved fire starters — never gasoline or paint thinner.

Lecture 5: Fermented meat products (sausages and sauces)

Fermented sausages are cured sausages and to produce salami of a consistent quality one must strictly obey the rules of sausage making. This field of knowledge has been limited to just a few lucky ones but with today's meat science and starter cultures available to everybody, there is little reason to abstain from making quality salamis at home. It is unlikely that a home sausage maker will measure meat pH (acidity) or a_w (water activity) but he should control temperatures and humidity levels in his drying chamber.

There is a difference in fermented sausage technology between the United States and the European countries. American methods rely on rapid acid production (lowering pH) through a fast fermentation in order to stabilize the sausage against spoilage bacteria. Fast acting starter cultures such as *Lactobacillus plantarum* and *Pediococus acidilactici* are used at high temperatures up to 40º C (104º F). As a result pH drops to 4.6, the sausage is stable but the flavor suffers and the product is sour and tangy. In European countries, the temperatures of 22º -26º C (72º -78º F) are used and the drying, instead of the acidity (pH) is the main hurdle against spoilage bacteria which favors better flavor development. The final acidity of a traditionally made salami is low (high pH) and the sourly taste is gone.

Some known European sausages are French saucisson, Spanish chorizo, and Italian salami. These are slow-fermented sausages with nitrate addition and moderate drying temperatures. North European sausages such as German or Hungarian salamis are made faster, with nitrite addition and are usually smoked.

Fermented sausages can be divided into two groups:

1. Sliceable raw sausages (Salami, Summer Sausage, Pepperoni)
2. Spreadable raw sausages (Teewurst, Mettwurst)

OR depending on the manufacturing method:

- Fast-fermented
- Medium-fast-fermented
- Slow-fermented. These can be smoked or not, or made with mold or without

Depending on the amount of moisture that they contain, they can be grouped as:

- moist - 10% weight loss
- semi-dry - 20% weight loss
- dry - 30% weight loss

There is also a group of non-fermented cooked salamis that are made in many European countries. This group will cover any sausage that is smoked, cooked and then air-dried for 1-3 weeks at 10º-12º C (50º-52º F). This reduces a_w (water activity) to about 0.92 which makes the product shelf stable without refrigeration. The fact that a raw sausage is safe to consume may sound questionable to some but we have been eating them for thousands of years and as far as we follow the rules of meat science we have nothing to be afraid of.

Lecture 6: Frozen meat & meat storage

Refrigeration

The ideal temperature for the storage of fresh meat is 28°F to 32°F. Meat should be stored in the coldest part of the refrigerator. As storage temperatures approach 40°F perishability increases. Rapid growth of bacteria begins at about 50°F. Meat in-transit from the place of purchase, or left to thaw at room temperature, invites the growth of spoilage organisms. If meat is not going to be used within a few days after purchase, it should be frozen as soon as possible to preserve optimal quality.

Cured and smoked meat, including luncheon meat and canned hams, are less perishable than fresh meats. These meat products should be refrigerated in their original packaging. Canned products such as soups or stews should remain on the pantry shelf until opens, but once the thermal seal has been broken, the can's contents should be refrigerated.

Freezing

Freezing is the most common method of meat preservation. Trimming excess fat and removing bones, if possible, will conserve freezer space. Meat should not be salted prior to freezing. Salting draws out moisture and oxidizes meat fat giving it a rancid flavor and reducing the time meat can be left in the freezer.

Animal fats, like other lipids, are subject to deterioration over time. They are especially prone to develop oxidative rancidity which results in objectionable flavors and odors. The more unsaturated fatty acids there are in the fat, the greater its susceptibility to oxidation and rancidity. This is why pork, which has more unsaturated fatty acids (monounsaturated and polyunsaturated) than other meats, is more perishable than beef and lamb. This fact provides the basis for limiting storage of properly wrapped pork in the freezer to six months, whereas beef and lamb can be stored in the freezer for up to 12 months. In the case of processed animal fats, rancidity is eliminated, or at least delayed, by incorporation of antioxidants, such as vitamin C or by hydrogenation of the fat.

Meat storage: Keep meat and poultry in its original packaging in the refrigerator. To freeze, slip the packaging into a resealable freezer bag. If you're freezing for several months, it's best to wrap pieces individually in plastic before bagging; this will make them less vulnerable to freezer burn. Another way to cut the risk of freezer burn is to buy vacuum-packed meats and poultry (which can also last about 2 days longer in the refrigerator). Leave seafood in its original packaging and, if possible, place on a bowl of ice in the refrigerator. However, live shellfish (like clams) should not be put on ice; open or poke holes in the packaging. To freeze seafood, slip the original packaging into a resealable freezer bag.

Storing beef

The most common bacteria are only to be found on the surface of whole pieces and dies at a temperature of 64 ° C. To fry the meat all around not only provides taste, it also kills the bacteria on the surface. The reason why minced meat is more sensitive than other meat is that bacteria, that usually stays on the surface, is ground down inside the meat.

Storing veal

Its low fat level makes veal meat more sensitive than beef. Store veal as carefully as pork and chicken.

Storing lamb

Lamb originates from young animals and is usually not tenderized, which means it should be consumed instantly.

Storing pork

Pork meat is a perishable commodity that should be consumed instantly. The reason pork is more sensitive than other red meat is because of the low content of fat in the meat.

Storing poultry

Chicken is especially sensitive to bacterial infection.

Storing minced meat

Preferably, minced meat should be cooked the same day as it has been ground. Fry the mince before you freeze it to preserve more taste and texture.

Avoid contact

Raw meat should never be in contact with food that is ready to be eaten. Carefully separate the two categories, using trays and plates to avoid cross contamination.

Combat oxygen

Oxygen is to blame for any decline in quality when you store foodstuffs for longer periods in the refrigerator or freezer. A marinade or a thin layer of olive oil protects the meat so that it keeps a little longer. Any layer of fat also protects the meat.

Short time –airy

Refrigerated fresh meat, about to be prepared, performs best if it is not covered with plastic. Instead, use a clean kitchen towel. It doesn’t matter if the surface of the meat dries – it disappears when you cook it.

Long time – vacuum

Professional kitchens maintain rigorous hygiene and use equipment to vacuum pack most items. Similar equipment is also available for domestic kitchens, but in a small scale kitchen it can suffice to store unopened packages for as long as possible and press out as much air as possible when you freeze meat. Always store vacuum-packed meat in the refrigerator or in the freezer. Vacuum-packed meat can be stored in the refrigerator for several weeks.

Meat that has been cooked at a temperature high enough to kill any bacteria is durable as long as it is kept in a vacuum and unopened package.

Lecture 7: By-products from slaughter houses and meat processing industries and their utilization

1. UTILIZATION OF MEAT INDUSTRY BY-PRODUCTS AND WASTES
2. DEFINITIONS Meat is defined as the flesh of animals used as food (Zhou et al. 2010). Meat products are defined as those in which fresh meat has been modified by any of several processing methods, including curing, comminution, dehydration, fermentation, or cooking (Simonin, 2012). A by-product is defined as a secondary product obtained during the manufacture of a principal commodity (David L. Meaker., 2009).
3. MEAT PROCESSING OPERATIONS IN MEAT Meat production contains unit operations such as 1. Screening 2. Stunning 3. Bleeding 4. Removal of mammary glands or penis 5. Evisceration 6. Spinal cord removal 7. Feet hide and horn removal 8. Head removal 9. Esophagus removal 10. Carcass splitting trimming and washing
4. MEAT PRODUCT PROCESSING Meat products processing unit operations like 1. Raw material receiving 2. Trimming 3. De-boning 4. Cutting/chopping/comminuting (size reduction) 5. Mixing/tumbling 6. Salting/curing 7. Utilization of spices/non-meat additives 8. Stuffing/filling into casings or other containers 9. Fermentation and drying 10. Heat treatment and smoking.
5. THE GENERATION OF BY-PRODUCTS Depends on 1. Tradition 2. Culture 3. Religion of the production countries
6. MEAT BY-PRODUCTS includes trimming, bones, blood, and skin (Nollet & Toldrá, 2011). Fertilizers as well as biodiesel generation, pharmaceutics, and plastic or energy, would be the main non-edible use of by-products (Ockerman & Basu, 2004a, 2004b; Pearl, 2004). The by-products and their value addition is shown in a diagram in fig 1.
7. By-Product/Waste Uses Blood Liquid Blood Serum for Pharmaceutical Industry Albumin Glue, textile and dye industries Dried Blood Blood flour, blood meal for animal feed and fertilizer
8. By-Product/Waste Uses Bones/Feet/Shank Bone Meal Animal feed or fertilizer Bone Combs, Buttons, Cutlery handles Bone Glue, Gluten, Tallow
9. By-Product/Waste Uses Hoofs and Horns hoof/horn meal fertilizer, gelatin and glue; also for combs, buttons and hairpins; objects d'art (including souvenirs and articles of tourist attraction) Hides and Skins Cured hides/skins leather - footwear, gloves, belts, bags, upholstery and saddlery.
10. By-Product/Waste Uses Hair and Wool Brushes, yarn, fabrics and fibres Glands and Organs Thymus, thyroid, pituitary, gonads, pancreas and gall bladder Pharmaceuticals
11. By-Product/Waste Uses Intestines Sausage casings, musical instruments/strings and surgical ligatures. Stomachs, other Offals and Condemned meat Meat/bon e meal Animal feed or fertilizer Tallow Soap and glycerine lubricants, grease
12. By-Product/Waste Uses Gut contents, Manure, Solid waste lubricants, grease
13. BIOACTIVE PEPTIDE PRODUCTION By-product treatment through enzymatic hydrolysis for peptide generation Meat by-product wastes (trimmings and mechanically recovered meat, collagen, blood) are, in general, very rich in proteins and thus, they constitute a good substrate for proteolysis. These proteins are subject to hydrolysis with specific commercial proteases like papain, bromelain, thermolysine, pronase or proteinase K (Vercruysse, Van Camp, & Smagghe, 2005).
14. BIOACTIVE PEPTIDE PRODUCTION Other commercial enzymes are Neutrase®, a metallo- protease from Bacillus amyloliquefaciens, Alcalase®, a serine-protease from Bacillus

licheniformis or crude enzyme extract from Raja Clavata. The hydrolysis reaction is usually carried out for a few hours either in batch-fed reactors or in continuous reactors using ultrafiltration membrane. Once the desired degree of hydrolysis is reached, the product is then submitted to fractionation and partial purification through filtration and/or chromatographic techniques (Arihara, 2006b). (Bioactive peptides generated from meat industry by-products 2015)

15. HIDES AND SKIN Hides and skins have the highest yield and value of all products of livestock other than the carcass, and in some livestock-rich developing countries such as Somalia and the Sudan, they account for substantial portions of export revenue. The approximate yield of green (or fresh) hides and skins in pastoral tropical livestock is as follows

16. HIDES AND SKIN Hides and skins are processed into leather by tanneries, hence it is necessary to preseve them for storage and shipment after removal from the animal. The method of preservation is curing, either in free air or by use of salt or both. In each of these methods the preservative principle is the same, namely, removal of moisture from the product to enhance keeping quality. Thus air acts by facilitating evaporation of moisture from the skin, and salt by osmotic withdrawal of water, thus making the moisture unavailable for growth of microorganisms. Salt has an additional protective effect as it penetrates the tissues and with its presence inhibits the growth of deteriorating organisms.

17. AIR-CURING Hides and skins must be cured immediately after removal from the animal body. Initially, they are prepared for this process by cleaning off residual meat, fat and manure from the surface in a process called fleshing. They are then washed, drained and trimmed to remove the ears and lips.

18._AIR-CURING To air-cure the hide or skin, the ideal method is to stretch it with strings from all sides and angles over a wooden frame or wire loop, and suspend it in the open to allow air to circulate freely around it and dry uniformly. This method is preferred to ground drying which yields a poor quality product with cracks, wrinkles and folds, as well as subjecting the hide or skin to moulding and putrefaction. Hot, dry environments such as prevail in some tropical savannahs are best suited to air drying, but not the humid or the wet-forest type. The main disadvantage about air drying is that shrinkage is high, about 40–50 percent of green weight; hence the finished weights are low, although they incur correspondingly lower shipping costs.

19. MEAT/BONE MEAL PRODUCTION The raw materials for quality production of meat/bone meal are all parts of the animal, less the skin or hide, hair, horn, hoof, blood and gut contents. This means that they may include skinned heads and feet, bones, viscera and carcass trimmings which are not utilized for food. Condemned material and relevant parts of freshly dead animals can be included, but not putrefactive material or that in a high state of decomposition. This material should be incinerated or buried in deep pits.

20._MEAT/BONE MEAL PRODUCTION A steam-rendering tank is used for meat/bone meal production. This is an oblong-shaped or vertical cylinder with a cone- shaped base built of heavy steel and fitted with a steam- charging mechanism to provide high temperatures for cooking.

21._MEAT/BONE MEAL PRODUCTION Water is first introduced into the tank, up to about one-third capacity; hence the term wet-rendering which is commonly applied to the operation. Dry-rendering excludes the addition of water and in fact expels moisture from the system. It is used mainly to extract fat from tissues. Tanks used in dry-rendering are of the horizontal type, the heat being applied at lower temperatures When water has been placed in the wet-rendering tank the relatively heavier materials like bones, feet and heads are put in next in reduced sizes at the bottom of the tank.

22. PRODUCTION OF BLOOD MEAL Blood is fairly rich in nutrients, especially protein, but being liquid it readily collects dirt once it leaves the animal body. Dirt starts putrefaction which lowers the blood's usefulness, and if drained outside on the slaughterhouse grounds sanitation problems arise by virtue of its clotting property. Other nuisances created by clotted blood are stench, filth, attraction of rodents and the breeding of flies. It is of utmost importance that blood when collected should be handled in a hygienic manner and processed with minimum delay.
23.COLLECTION AND YIELD Blood can be collected directly in metal or plastic drums if the animals are hoisted for bleeding, but if killed on the floor small enamel or plastic bowls can be placed immediately beneath the let-out to receive the blood and empty it into the drum.
24. SMALL SCALE PROCESSING Where only a few animals are slaughtered in a day, small-scale low-technology processing can be undertaken rather than to spill the blood to waste and create problems of sanitation. Thus from say 10 cows and 3 sheep, approximately 64 kg of fresh blood can be obtained which can yield at least 12 kg of dried blood.
25. SMALL SCALE PROCESSING To process this the blood is cooked in a tank to coagulate it, and is drained of liquids which collect on top after cooling. The coagulum is then broken up and spread on a tarpaulin or plastic sheeting for drying. Alternatively, the coagulated mass can be placed in a simple solar dryer for drying
26.WET RENDERING In plants that have steam-rendering tanks, the fresh blood can be mixed with selected non-carcass components are wet-rendered. In this instance, the blood should substitute for water in the tank. An advantage here is that the protein content of the offal meal will be raised quantitatively with the addition of blood, although some amino acids may be damaged by the strong action of the heat while others may leach into the cooking water.
27. COMMERCIAL DRYING A more productive approach is to process the blood under relatively reduced temperature conditions using a commercial blood drier. In principle, the blood-drier is a dry-rendering tank disposed horizontally and invested with a steam-jacket. Special devices are provided within the tank to prevent blood from coating on the interior walls and reducing drying efficiency.
28. COMMERCIAL DRYING Blood is introduced into the tank as a coagulated mass, previously obtained by steam action. As much liquid as possible should be squeezed from the coagulum. Heating is initiated at 82°C (180°F) and progressively raised to 94°C (200°F) for about three hours, then elevated to 100°C (212°F) for 7 hours. Drying is complete when the final moisture level in the dried product is about 12 percent. During drying, moisture is constantly and rapidly removed from the tank by means of condensers to which the tank is connected.
29. COMMERCIAL DRYING Complete moisture removal is not desirable otherwise the final product would darken or char, while above the 12 percent level the residual moisture can cause deterioration and loss of nutrients. The protein content of the finished product is about 80 percent.

Lecture 8: MAKAUT question paper solve

(Multiple Choice Type Questions)

1. i) PSE (Pale, soft and Exudative) meat is produced due to

a) Accelerated glycolysis b) Slower glycolysis c) both of these d) None of these

vii) When fresh meat is cooked it changes to a colour

a) pink b) brown c) yellow d) none of these

viii) 'Hot smoking' of meat occurs within the temperature range of

a) 230-250 F b) 165 – 185 F c) 100 – 120 F d) None of the above

ix) Meat is a good source of dietary

a) calcium b) iron c) magnesium d) zinc

x) Which one of the following is an example of a pork cut?

a) Round b) Ham c) Drumstick d) Brisket

xi) What is the process of subdividing raw meat into smaller pieces, chunks, chips or slices called?

a) Comminuting b) Blending c) Curing d) Ageing

xii) Which one is an example of Myofibril protein?

a) Actinin b) Collagen c) Elastin d) Cytochromes

xiii) The artificial casing in the sausage preparation is

a) Plastic material b) cellulose material c) collagen d) all of them

xiv) Rigor mortis sets in with a contraction of muscle fiber which is correlated to

a) Loss of glycogen from muscle b) disappearance of ATP from muscle

c) Both of them d) None of them

(Short Answer Type Questions)

2. What is the importance of antemortem inspection of animals? Give four names of meat by-products.
3. Discuss on the structure of meat.
4. What is liquid smoke? How it is prepared? What are the advantages of liquid smoke over gaseous smoke?

(Long Answer Type Questions)

5. What is curing? Explain the mode of action of different curing ingredients. How does it affect the meat colour? Give the purpose of smoking? (1+8+4+2)
6. Discuss the different types of by-products obtained after slaughtering of animals. Describe about the gas stunning method. What are the post mortem changes occur in meat muscle? (6+3+6)
7. How spoilage of poultry meat occurs? How this spoilage can be controlled? How smoking affects the nutritional quality of meat? Discuss the role of two chemical components of wood smoke during smoking of meat. (4 + 2 + 5 + 4)

Module IV **8L**

Lecture 1: Introduction about egg

Science defines egg as a cell from which a living organism takes birth and grows. All animals (including birds) lay eggs, except mammals which give birth to babies. An egg laying animal lays eggs, no matter whether they are fertilized or not. In other words, it does not have to be mated to lay an egg. In order to develop into an embryo, an egg must be fertilized by sperm before it is laid. The fertilized eggs, under favorable conditions hatch into living organisms.

It becomes crucial for humans to select good quality eggs which should be freshly laid, as one does not want to see a structural form of living organism, when an egg is broken. The eggs that we usually get in the market are unfertilized eggs.

Eggs are included in the list of potentially allergic foods, which also include milk, peanuts, tree nuts, fish, shellfish, soy and wheat. Eggs are included as the protein contained in the egg white has the potential to cause an allergic reaction as babies may have sensitivity towards this. Due to this, older infant feeding guidelines recommended delaying the introduction of these potentially allergic foods, as it was believed that introducing these foods too early could increase the likelihood of an allergy developing. Older recommendations also included feeding babies only the egg yolks and avoiding the potentially allergic egg whites.

Nutrition is always evolving and with new research and as we learn more, previous guidelines are amended and newer update recommendations are provided (hence why there is often confusion). Delaying the introduction of eggs has now shown to not offer any protective effect against an allergy and could possibly even increase the risk of an egg allergy developing.

The Australasian Society of Clinical Immunology and Allergy recommends: "Solid foods should not be introduced before 4 months of age. When your infant is ready, from 4-6 months of age, introduce foods according to what the family usually eats, regardless of whether the food is considered to be a common food allergen. Raw egg is not recommended". The American Academy of Paediatrics advice that there is no current convincing evidence that delaying food introduction beyond 6 months has a significant protective effect on the development of allergies. This includes delaying the introduction of foods that are considered to be highly allergic, such as eggs.

So instead of saying in a nut shell or as we discussing eggs, in an egg shell: there is no need to delay the introduction of eggs provided your baby is 6 months old, has followed the recommended process of food introduction, and does not have any other food allergies. As eggs are a potentially allergic foods, it is always recommended to introduce a new protein every 3-4 days so that if an allergy does occur, you are able to clearly identify which food potentially caused the reaction (verse introducing 2 proteins at the same time and then being unable to identify which one caused the reaction).

Breast milk provides your baby sole source of nutrition for the first 6 months and meets all your baby's nutritional requirements. After 6 months however, the composition of breastmilk can no longer meet all the nutritional requirements of a growing baby and therefore the importance of food introduction comes into play. Some important nutrients required by the diet after 6 months of age are proteins, fats and iron. The sunny side of eggs (excuse the pun) are that eggs are filled with all these important nutrients, making them a perfect food for your baby. The cholesterol in eggs are often a concern for parents but fats are very important in a baby's diet and play a vital role in brain development. Eggs are also a source of choline, which also plays an important role in brain development.

Lecture 2: Structure of eggs

An egg basically consists of three parts:

1. a shell
2. an egg white
3. an egg yolk

An egg from a hen consists of approximately 2/3 egg white and 1/3 egg yolk.

The eggshell

The shell is built of 8-10,000 pores, which ensures that oxygen can penetrate and CO_2 and other gases can escape. The shell represents about 10 % of the weight of the egg and consists mainly of calcium carbonate and calcium phosphate. The shell thickness and thus the strength depends on egg size, breed, the age of the hen, and feed composition.

Only the outer layer of the shell is coloured. The colour of the shell can be white or brown – depending on the breed. A white hen lays white eggs and brown hens lay brown eggs. There are also white hens that lay brown eggs but this breed is currently not being used for production in Denmark.

The egg white

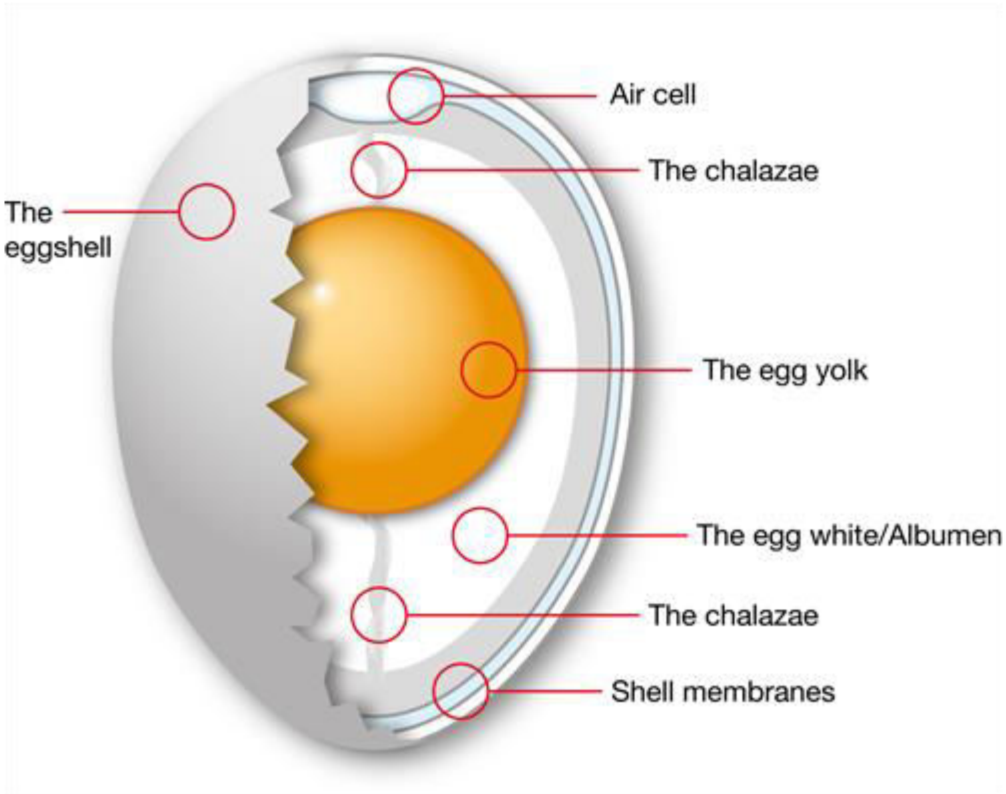
The egg white represents approx. 60 % of the weight of the egg and consists of 88 % water and 12 % dry matter, primarily protein. The white is divided into three parts: an inner and an outer liquid layer, and in between those a liquid layer with a thicker consistency. The white prevents external bacteria from penetrating the yolk.

The pale yellow-green colour of the white is due to the presence of riboflavin (vitamin B2). In completely fresh eggs there are lots of small air bubbles, which can give the egg white a dull milky appearance. This is because of carbon dioxide that has not yet leaked out through the shell. The older the egg, the more transparent the egg white.

The egg yolk

The yolk has a much lower water content than the egg white, just under 50 %. The yolk represents about 28 % of the weight of the egg and consists of approx. 2/3 fat and 1/3 protein. The fat content consists primarily of triglycerides, cholesterol, and the phospholipid lecithin. The amount of fat and cholesterol and the composition of the fat is influenced by the diet of the hen. The yolk is held in place by two screw-shaped egg white strands – the chalazae.

The diet of the hen determines the colour of the egg yolk. If the hen is mainly fed by yellow and orange-pigmented food, this is the colour that is more prominent in the egg yolk. A relatively colourless feed, gives almost colourless yolks. In conventional feed, the manufacturer often adds a small amount of plant supplements that provide the yolk with the colour that consumers like best – namely golden or lemon-coloured.



Shell membranes

Under the shell there is an outer and an inner shell membrane. The outer membrane, which is immediately inside the shell, is the most resistant. Besides serving a packaging role, the shell and the shell membranes also have a biological function; namely to regulate evaporation and air circulation, but also to prevent penetration of microorganisms. A colourless wax membrane called the cuticle surrounds the outer shell. It is highly alkaline and therefore acts bacteriostatic. This wax membrane dissolves by washing, which is why in Denmark washing the eggs before sorting is not allowed.

Air cell

When the egg leaves the hen, it has a temperature of 39 °C. When it is cooled, there is a contraction of the contents and air can penetrate through the shell. In the heavy end of the egg, the outer and the inner shell membrane are split and the air cell is formed here. The older an egg is, the larger the air cell, as water continuously evaporates from the egg during storage.

Bacterial retardant properties

The egg white protects the yolk, be it among other reasons because of the enzyme lysozyme, which splits the beta-(1,4)-glycoside bond in the cell wall of gram-positive bacteria, wherin the bacterial cell is destroyed. The protein ovotransferrin is also bacteriostatic, in that the binding of iron to ovotransferrin limits the possibilities of certain bacteria's growth.

Lecture 3: Composition and nutritive values of eggs

Chemical Composition of Eggs:

Egg consists of three main parts, the shell, the egg white and the egg yolk. The shell consists of calcite crystals embedded in a matrix of proteins and polysaccharide complex. Inside the shell the viscous colourless liquid called the egg white accounts for about 58 percent of the total egg weight. The composition of egg white and yolk is given in the following table.

Percentage composition of egg white and yolk

Nutrients	Egg White	Egg yolk
Water	88.0	48.0
Protein	11.0	17.5
Fat	0.2	32.5
Minerals	0.8	2.0

Egg White Egg white is composed of thin and thick portions. 20-25% of the total white of fresh eggs (1-5 days old) is thin white. The chief constituents of egg white besides water are proteins. Different types of proteins are present in egg white.

Ovalbumin This constitutes 55% of the proteins of egg white. This is a phospho glycoprotein and is composed of three components A1, A2, and A3, which differ only in phosphorus content. **Conalbumin** This constitutes 13% protein of the egg albumin. It consists of two forms neither of which contains phosphorus nor sulphur.

Ovamucoid It is a glycoprotein. This constitutes about 10% of the egg white proteins.
Ovomucin This protein is responsible for the jelly like character of egg white and the thickness of the thick albumen. It contains 2% of the egg white. Its content in the thick layers of albumin is about 4 times more than in thin layers. It is insoluble in water but soluble in dilute salt solution.
Lysozyme Lysozyme content of egg is 3.5%. This is an enzyme capable of lysing or dissolving the cell wall of bacteria. It is composed of 3 components A, B and C. It binds biotin and makes the vitamin unavailable.
Avidin Avidin is 0.05% of the egg white protein. It is denatured by heat and cooked eggs and do not affect the availability of biotin.

Ovoglobulin It is a protein consisting of two components G1 and G2 and both are excellent foaming agents. **Ovoinhibitor** % of egg protein is made up of ovoinhibitor. It is another protein capable of inhibiting trypsin and chymotrypsin.

Egg yolk : Solid content of yolk is about 50%.

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 bioavailable, in the edible part of the egg.

Lecture 4: Processing of eggs

Eggs that are not packed for consumption are processed in different products. These products can be classified as refrigerated liquid, frozen, dried and specialty products. For many years, eggs were marketed primarily as whole shell eggs, but in recent years egg consumption in the form of egg products increased. Egg products are used world-wide by food service industry, commercial food industry, cosmetic industry and painting industry.

The term "egg products" refers to eggs that have been removed from their shells for processing. The processing of egg products includes breaking eggs, filtering, mixing, stabilising, blending, pasteurizing, refrigerating or drying and packaging. Basic egg products include whole shell eggs, whites, yolks and various blends with or without non-egg ingredients that are processed and pasteurized and may be available in liquid, frozen, and dried forms.

Perception of egg quality depends on which sector of the production and marketing channel carries the evaluation out. Producers tend to relate quality to productivity, consumers to visual traits and industrials to final product quality. In a practical sense there are three major physical characteristics of eggs which consumers can describe qualitatively and quantitatively. Shell, albumin and yolk characteristics are to different degrees the criteria on which basis the quality judgment is made.

Of the 76.2 billion eggs consumed in 2009, 30% were in the form of egg products (eggs removed from their shells). Liquid, frozen, and dried egg products are widely used by the food service industry such as scrambled or made into omelets, or as ingredients in other foods, such as prepared mayonnaise, ice cream, salad dressings, frozen desserts, cream puff, cakes, confections, etc. The term"egg products" refers to eggs that are removed from their shells for processing at facilities called "breaker plants." The processing of egg products includes breaking eggs,filtering, mixing, stabilizing, blending, pasteurizing,cooling, freezing or drying, and packaging. This is done at USDA-inspected plants. The USDA's Food Safety and Inspection Service (FSIS), through its authority under the Egg Products Inspection Act (EPIA), provides over-sight of shell eggs after they have left the barn to either be placed in cartons for consumers or sent to an egg product processor .

Shell eggs must be washed and completely dried prior to breaking. Eggs with broken shell membrane are not permitted for human consumption. The egg breaking room should be separate from the egg washing room. The development of highly automatic, computer-controlled egg breaking and separating machines is a key achievement in the production of egg products. The basic egg breaking unit is composed of a cracker and a yolk-albumen separator. The crack head cracks the shells at the center and pulls the two shells apart. The yolk-albumen separator has two cups positioned one above the other. After cracking, the egg content falls into the top cup to retain only yolk while the white slides to the bottom cup . Many of these units are attached to a round or oval rotating table which provides great processing capacity, as many as 188,000 eggs per hour in modern egg breaking machines. Breaking machines are cleaned and sanitized after 4 h of operation, and at the end of the final shift of operation. Holding tanks and pipes are made of stainless steel and are cooled by ice water running between the inner and outer walls, keeping the liquid eggs as cold as possible. Strict sanitation and temperature control are the key factors in maintaining low microbial load. After breaking, the edible liquid products are filtered, ingredients (salt, sugar, etc.) are added, blended, standardized, and pasteurized prior to packaging in a separate room or further frozen or dried.

Lecture 5: Quality assessment (defects) of eggs

Egg defects

Individual egg defects are discussed in two groups: shell defects and internal defects. Shell defects are discussed first, as they are the most common cause of downgrading. Individual defects are discussed in general order of decreasing frequency of occurrence within each group. Each defect is described and illustrated, and its expected incidence at the point of grading is given for comparison where appropriate. (The given incidence is for eggs produced under conditions of good management.) Possible causes of an excessive incidence of each defect and the corresponding control measures are outlined.

To put an egg-quality problem occurring on a farm into the correct perspective, it is important to go through the following steps.

1. Quantify the extent of the farm problem Accurately determine the incidence or extent of the problem. Count all eggs with the problem, both at collection and at grading.
2. Determine flock age Flock age has a major impact on the incidence of both external and internal egg defects and so must be taken into account when assessing the severity of a problem. If the birds on the farm vary in age, calculate the weighted average age of the flock. An increased incidence of defects may be primarily the result of an increase in the average age of the laying flock.
3. Assess grading efficiency If too many poor-quality eggs are being packed for sale, the problem may lie in the grading-candling operation or subsequent rough handling. Factors that affect the efficiency of the grading-candling operation include:

Candling speed. As the time that the candling operator has to view each egg decreases (for example, from 0.6 seconds per egg to 0.2 seconds per egg), candling efficiency declines.

Proportion of second-quality eggs. As the percentage of second-quality eggs entering the candling booth increases (for example, beyond 8 to 10%), candling efficiency declines. Removing obviously poor-quality eggs before grading will help reduce the workload of candling operators.

Candling light. Although the intensity of light in itself is not critical, leakage of light around the eggs may reduce efficiency.

Candling mirror. Backing mirrors that are not adjusted to the eye-height of the candling operator will decrease candling efficiency.

Operator. The experience and capability of the operator is a major factor affecting efficiency. Operators should be able to stop the line when overloaded, and should not work at candling too long without a break.

Lecture 6: Byproduct Utilization – commercial processing of lecithin and other egg solids

The term "lecithin" is commonly used to refer to a complex mixture of naturally occurring phospholipids. A class of phospholipids, lecithins chemically exist as ester derivatives of phosphatidic acid. Lecithins are suitably modified to produce products possessing improved emulsifying properties besides increased dispersibility in aqueous systems. The products are used in a gamut of applications like food, pharmaceuticals, plastics, paints, coatings, cosmetics, pesticides, petroleum etc. The present review explores in great detail the various methods of producing structurally diverse lecithins and elucidates the advantages of these methods with regard to the specific applications of the modified products.

Lecithins are used mainly as emulsifiers. They are surface active; simultaneous hydrophilic (water-loving) and hydrophobic (water-repelling) properties enable lecithins to make stable blends of materials that otherwise do not mix easily and tend to separate. The amount of lecithin needed to blend substances such as the soybean oil and water in margarine, or the pigment and latex in paint, depends on the overall fat content in the end product. Lecithins also have characteristics that help:

- Disperse and suspend powders into liquids
- Control the viscosity of liquids and semi-liquids
- Prevent foods from sticking to contact surfaces
- Prevent adhesion of food products to one another

Most of the performance benefits of soybean-based lecithins come from the unique hydrophilic and hydrophobic surface- active properties of phospholipids, their primary component. These phospholipids are present in liquid lecithin:

Phosphatidylcholine (PC, 14 –16%)
Phosphatidylethanolamine (PE,10 –15%)
Phosphatidylinositol (PI, 10 –15%)
Phosphatidic acid (PA, 5–12%)

Soybean lecithins also contain triglycerides, sterols, small quantities of fatty acids and carbohydrates. De-oiling lecithin enhances the typical phospholipid composition as shown in the accompanying charts. Fractionating (breaking up) these complex mixtures, or adding elements such as refined oils or surfactants, can create new products tailored for specific applications. Fractionated phospholipid products are enriched in phospholipid content. Very delicate applications require the purest lecithin emulsifier that contains more than 80% phosphatidylcholine.

Commercial lecithin is the most important byproduct of the edible oil processing industry because of its functionality and wide application in food systems and industrial utility. The recovery of lecithin from oil is a relatively simple process. Hydration of the phosphatides by water or steam followed by recovery by centrifuge and drying is all that is required. But in order to maximize lecithin's utility and functionality, processing conditions all the way back to the bean or seed must be carefully controlled. Bean storage and handling, crude oil storage, refining pretreats, drying processes, bleaching, chemical modification, and storage all can affect lecithin quality and performance. The effects of processing on lecithin quality and performance is one of the major focal points in this presentation. Utilization of lecithins has expanded beyond the traditional application in paints, chocolate, and margarine. Food technologists have used lecithin as a functional ingredient in many modern systems. Its multifunctional properties and its "natural" status make commercial lecithin an ideal food ingredient. The major functional properties include: emulsification, instantizing and particle wetting, release, viscosity modification and nutrition. The nutritional impact of lecithin is currently being assessed in the medical field as an important factor in improving neurochemical disorders. Other medical and health related activity areas include positive changes in cholesterol, blood chemistry and circulatory factors. Lecithin is also used in numerous industrial and nonfood applications such as pigment dispersing, mold release, and animal feeds. The major source of commercial lecithin is from the processing of soybean oil. Evaluation of lecithins from other seed crops such as cotton, corn, and rapeseed is being pursued. The growth of these sources will be a function of demand.

Lecture 7: By-products from slaughter houses and meat processing industries and their utilization

Eggs are sources of protein, fats and micronutrients that play an important role in basic nutrition. However, eggs are traditionally associated with adverse factors in human health, mainly due to their cholesterol content. Nowadays, however, it is known that the response of cholesterol in human serum levels to dietary cholesterol consumption depends on several factors, such as ethnicity, genetic makeup, hormonal factors and the nutritional status of the consumer. Additionally, in recent decades, there has been an increasing demand for functional foods, which is expected to continue to increase in the future, owing to their capacity to decrease the risks of some diseases and socio-demographic factors such as the increase in life expectancy. This work offers a brief overview of the advantages and disadvantages of egg consumption and the potential market of functional eggs, and it explores the possibilities of the development of functional eggs by technological methods.

Nowadays, foods are not intended to only satisfy hunger and to provide necessary nutrients for humans, but also to prevent nutrition-related diseases and improve physical and mental wellbeing of consumers. However, human nutrition in developed countries is characterized by an excessive intake of protein, cholesterol, saturated fatty acids (SFA), *n*-6 polyunsaturated fatty acids (PUFA), calories or sodium, whereas consumption is deficient in *n*-3 PUFA, fiber and antioxidants. These imbalances are partly responsible for the high incidence of both obesity and the onset of chronic or degenerative non-transmissible diseases, from which cardiovascular diseases (CVD) are the leading cause of mortality and morbidity globally. The consumption of a lower fat diet is generally accepted in all clinical guidelines on CVD prevention, and is based on total fat consumption of 25%–35% of total calories, of SFA should be no more than 7%–10%, *trans* fatty acids less than 1%, unsaturated fats, mainly monounsaturated fats (MUFA) and *n*-3 PUFA should represent the rest of the calories from fat and cholesterol, for a total of less than 300 mg/day.

In order to improve public health, nutritional experts and related organizations, such as the U.S. Department of Agriculture and U.S. Department of Health and Human Services of the Spanish Society of Community Nutrition (SENC) , has persistently recommended a reduction in the intake of foods that are related to the occurrence of chronic diseases, and am increased consumption of fruits and vegetables, grains, legumes, low-fat dairy products, lean meats and fish, especially fatty fish species that are high in *n*-3 PUFA. Owing to the persistence of these recommendations, there is a high degree of awareness of this problem in the populations of developed countries, and, fortunately, nutritional composition is already a major factor in the choice of foods by the consumer. However, although there is a significant demand for healthier food, consumers are reluctant to change their dietary habits. This suggests that there is great potential for foods that are consumed regularly when they are converted to functional foods by changing the composition to include certain ingredients that are beneficial to health. Another way to obtain functional foods is to modify the quantity of certain components in the food to make it more suitable to the recommendations of nutrition experts.

In this sense, because eggs are a conventional food containing nutrients that play fundamental roles beyond basic nutrition, their promotion as functional foods should be considered. Eggs are of particular interest from a functionality point of view, because they offer a moderate calorie source (about 150 kcal/100 g), a protein of excellent quality, great culinary versatility and low economic cost, which make eggs within reach to most of the population. Eggs are also relatively rich in fat-soluble compounds and can, therefore, be a nutritious inclusion in the diet for people of all ages and at different stages of life. In particular, eggs may play a particularly useful role in the diets of those at risk of low-nutrient intakes such as the elderly, pregnant women and children. Additionally, it must be mentioned that eggs can be consumed throughout the world, having no use restrictions on religious grounds.

However, eggs are a controversial food for nutritional experts and health agencies, because of the saturated fat content (about 3 g/100 g) and cholesterol content (about 200–300 mg/100 g). Owing to these two characteristics, during the past 40 years, the public had been warned against frequent egg consumption due to the high cholesterol content in eggs and the potential association with CVD. This was based on the assumption that high dietary cholesterol consumption is associated with high blood cholesterol levels and CVD. Afterwards, subsequent research suggests that, in contrast to SFA and TFA, dietary cholesterol in general and cholesterol in eggs in particular have limited effects on the blood cholesterol level and on CVD.

However, the volume of eggs and egg yolk used by food companies in their formulations is constantly increasing. Nowadays, egg-yolk products are largely used by the food industry as a result of three very important properties: manufacture and stabilization of emulsions, foaming stability and thermal gelation, as it is a fundamental ingredient for the elaboration of several food products . Unfortunately, eggs and egg-derived foods are responsible for a large number of food-borne illnesses each year, mainly caused by *Salmonella* . For this reason, as well as for their lower price and ease of handling and storing compared to shelled eggs, the food service industry and commercial food manufacturers have shown an increasing interest in the use of liquid pasteurized egg products instead of fresh whole eggs.

Thus, it would be of major interest to develop egg-derived products, appropriate for food companies, with a modified nutritional composition that helps maintain the health of consumers. Nowadays, retail markets for functional eggs are available, mainly enriched with *n*-3 PUFAs or with low cholesterol content. However, in most cases, these eggs are obtained through modification of layer-hen's diet and management, whereas much less attention has been paid to the development of functional eggs by means of technological methods. The possible development of functional pasteurized liquid eggs by technological methods and their advantages in the food industry and from the point of view of nutritionists are also discussed.

Lecture 8: MAKAUT question paper solve

(Multiple Choice Type Questions)

i) Egg shell contain a high amount of

a) Calcium carbonate b) calcium phosphate c) calcium sulphate d) None of these

ii) Green rots in eggs is caused by the strains of

a) Pseudomonas b) Lactic Acid Bacteria c) species of Micrococcus or Bacillus d) Yeasts and

iii) Lecithin is present at

a) Egg white b) egg yolk c) egg shell d) None of the above

iv) Example of egg white protein is

a) Livetin b) Phosvitin c) Avidin d) both (a) and (b)

v) More spoilage of eggs is caused by

a) bacteria than molds, b) molds than bacteria, c) synergistically, d) none of these

vi) Green rots in eggs is caused by the strains of

a) *Pseudomonas,* b) Lactic Acid Bacteria, c) species of Micrococcus or Bacillus, d) Yeasts and Molds

vii) What is the temperature of an egg when laid?

a) 104° F, b) 121° F, c) 95° F, d) 75° F

(Short Answer Type Questions)

8. Why egg-white gets discoloured during dehydration and how this can be prevented? (2.5 + 2.5)

9. Why it is difficult to sterilize egg white? How it can be sterilized successfully at a lower temperature? (2+3=5)

10. What is candling of egg? Describe briefly egg preservation using water glass. Name two antimicrobial naturally occurring in egg albumin. (2+2+1=5)

(Long Answer Type Questions)

11. Discuss the structure of egg with illustration. Comment on the nutritional value of egg. How you can judge the freshness of egg? How does the spoilage of egg occur? (6+3+3+3)

12. Draw the structure of an egg. How spoilage occurs in egg during storage? What are the methods applied to prolong the storage life of eggs? (6+5+4=15)

13. Write short notes:

i) Quality evaluation of egg ii) Egg protein (7.5+7.5)=15