III B.Sc BIOTECHNOLOGY

MAJOR BASED ELECTIVE II

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FOOD TECHNOLOGY

PG & RESEARCH DEPARTMENT OF BIOTECHNOLOGY

SUBMITTED BY

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BHARATH COLLEGE OF SCIENCE AND MANAGEMENT

THANJAVUR-5

MAJOR BASED ELECTIVE II

FOOD TECHNOLOGY

Objectives This course is designed to give adequate knowledge on food technology so as to train the students' entrepreneurs

Unit I Food chemistry

Constituent of food - contribution to texture, flavor and organoleptic properties of food; food additives - intentional and nonintentional and their functions; enzymes in food processing.

Unit II Food Microbiology

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases - infections and intoxications, food spoilage - causes.

Unit III Food Processing

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations - mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit IV Food Preservation

Use of high temperatures - sterilization, pasteurization, blanching, canning - concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods.

Unit V Manufacture of food products

Bread and baked goods, dairy products - milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

Text Books

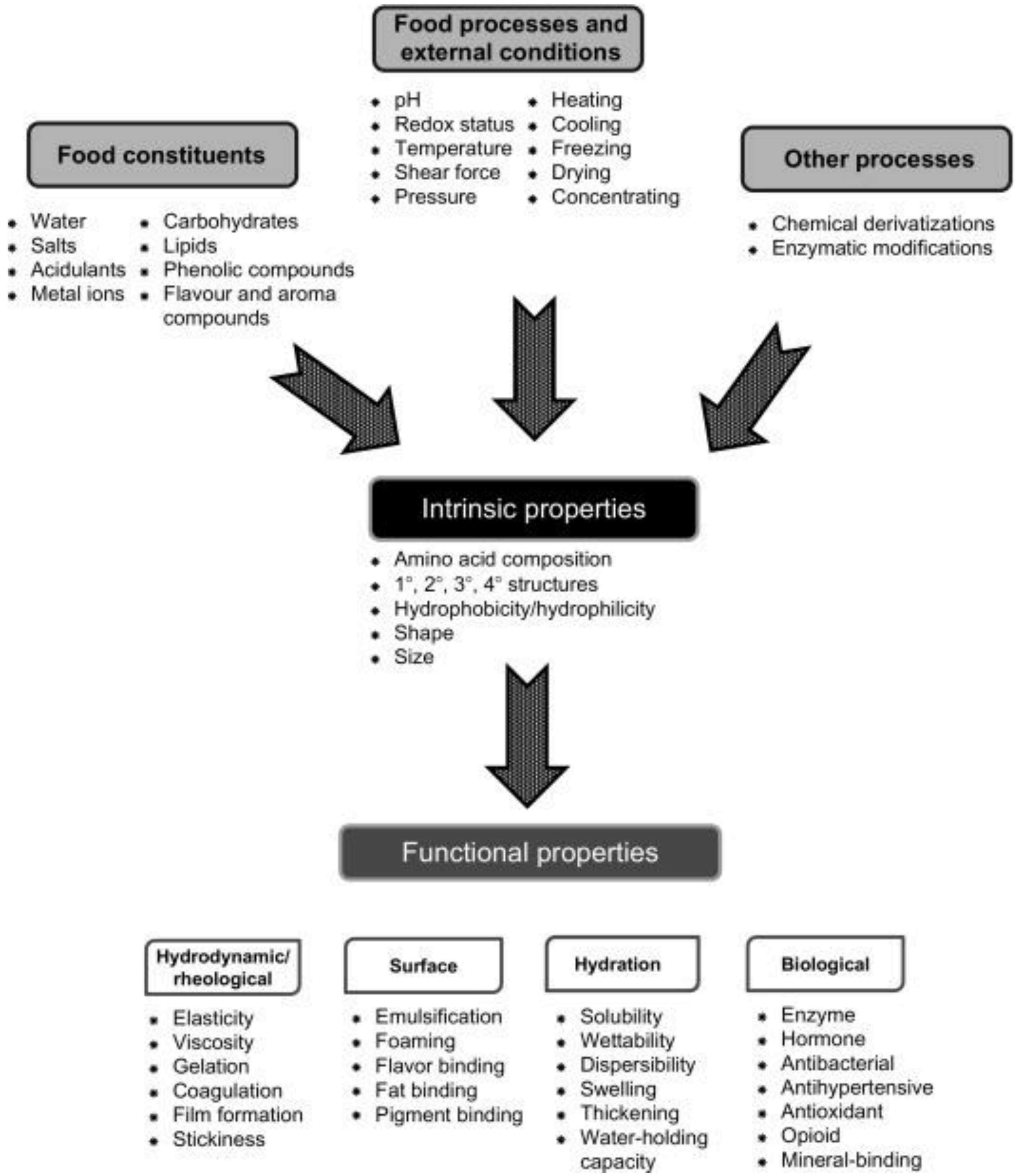
1. Crosby, N.T. 1981. Food packaging. Materials Applied Science Publishers, London.

2. David, S. Robinson. 1997. Food Chemistry and nutritive value. Longman group, UK.

3. Frazier, W.C. and Westhoff, D.C. 1988. Food Microbiology. 4th Edition. McGram-Hill, New York.

4. Pyke, M. 1981. Food Science and Technology. 4th Edition. John Murray, London.

5. Sivasankar, B. 2002. Food processing and preservation. Prentice Hall, New Delhi. Reference Books


Food processes and external conditions
pH
Redox status
Temperature
Shear force
Pressure
Heating
Cooling
Freezing
Drying
Concentrating
Food constituents
Water
Salts
Acidulants
Metal ions
Carbohydrates
Lipids
Phenolic compounds
Flavour and aroma compounds
Other processes
Chemical derivatizations
Enzymatic modifications
Intrinsic properties
Amino acid composition
1°, 2°, 3°, 4° structures
Hydrophobicity/hydrophilicity
Shape
Size
Functional properties
Hydrodynamic/ rheological
Elasticity
Viscosity
Gelation
Coagulation
Film formation
Stickiness
Surface
Emulsification
Foaming
Flavor binding
Fat binding
Pigment binding
Hydration
Solubility
Wettability
Dispersibility
Swelling
Thickening
Water-holding capacity
Biological
Enzyme
Hormone
Antibacterial
Antihypertensive
Antioxidant
Opioid
Mineral-binding

Food chemistry

Constituent of food

1. What are the 5 major components of food?

A. Carbohydrates.
B. Protein.
C. Fats.
D. Vitamins and Minerals.
E. Water.

2. Constituents of food and its functions

- Carbohydrates: Carbohydrates, in simplest terms, are sugars and contain carbon, hydrogen and oxygen.
- Proteins: Amino acids are the building blocks of proteins. ...
- Fats: This is the most concentrated source of energy. ...
- Vitamins: Vitamins are vital for maintaining normal growth and health. ...
- Minerals
- Water
- Roughage

Food Additives

Food additives are substances added to **food** to preserve flavor or enhance its taste, appearance, or other qualities. Some **additives** have been used for centuries; for example, preserving **food** by pickling (with vinegar), salting, as with bacon, preserving sweets or using sulfur dioxide as with wines.

- Preservatives: ascorbic acid, calcium sorbate, and sodium nitrite.
- Color additives: fruit and vegetables juices, yellow 5, and beta-carotene.
- Flavors and spices: 'real' vanilla or 'artificial' vanilla.
- Flavor enhancers: MSG and yeast.
- Emulsifiers: soy lecithin, mono and triglycerides.

Classification of Intentional food Additives

- Preservatives: ...
- Colouring agents: ...
- Antioxidants: ...
- Emulsifiers: ...
- Stabilizers and Thickeners: ...
- Bleaching and Maturing Agents: ...

- Sequestrants:

A variety of chemicals may be found in our food which have gained entry either intentionally or unintentionally.

Intentional additives are those chemical substances which have been purposefully added to food to perform a specific function such as:-

1) Increasing shell life
2) Modifying its texture
3) Improving its flavour

Unintentional additives are those chemical substances which find their way into food through a certain stage in manufacture or handling of food.

For e.g fertilizer and pesticides residue from farm, lubricants from food processing equipment and chemicals from packaging materials.

Definition

Food Additives are chemical substances which are not food items by themselves but are intentionally added to food to improve the overall quality.

Some additives have been used by our ancestors. E.g salting bacon, preparing pickles with vinegar and Sulphur dioxide for wine making.

Function of Food Additives:-

1. Preserve Flavour
2. Enhance taste
3. Improve acceptability and appearance
4. Maintain nutritional quality
5. Enhancing quality
6. Aid in food processing

Food Additives are grouped into different categories on the basis of the function they perform. The different categories are as follows :-

a. Preservatives
b. Emulsifiers
c. Antioxidants
d. Sweeteners
e. Food colour and Flavor

f. Stabilizer

1) Preservatives

Food deteriorate because of microbial action, enzymatic action or chemical reactions. The main function of Preservatives is to inhibit the growth and activity of microorganism. Preservatives are used in many products giving a long shelf life.

2) Antioxidants

These compounds are used to prevent oxidative rancidity of fats in food. They preserve organoleptic and nutritive value.

For e.g butyrate hydroyanisole (BHA), Butyrate hydroxyl toluene (BHT) or tertiary butyl hydroquinone (TBHQ) are added to the oil in which snacks are fried to prevent the unsaturated from turning rancid.

3) Artificial sweetener

They are also called non-nutritive sweetener as they do not provide any calories or provide negligible calories as compared to sugar.

Low calorie sweetener is available as sugar substitute in food and beverage.

For e.g of artificial sweetener are cyclamate, aspartame, dulcin, saccharin, sucralose, ace sulfame k.

4) Food Colours

Coloring agent used in food processing industry includes natural coloring matter, certified food dyes and derived colour

* Natural colour pigment such as anthocyanin,carotenoid, betalins, curcumin, cholorophyll and caramel are safe to use in any amounts.

Permitted synthetic colour by Food and drug administration are :-
1. Red-----Ponceau4, carmoisine, erythrosine
2. Yellow--Taryrazine, sunset yellow FCF
3. Blue- - - Indigo carmine, brilliant blue FCF
4. Green---Fast green FCF
5) Stabilizer

These additives are used to increase the viscosity of the food and to stabilize the texture of food system like foams, emulsions, and suspension.

e.g gums, starch, dextrin, agar, gelatin and pectin are used in ice cream, jellies, pudding, salad dressing, and chocolate beverages. They stabilize the food system by increasing the viscosity of the system.

6) Emulsifying Agents

Emulsifier are added to stabilze emulsions by Enhancing the formation of small droplets and reducing the rateat which droplets come together.

Emulsifying agent have both hydrophilic and hydrophobic groups and get attracted to wayer and oil at the interphase of the two liquid, thereby preventing the emulsions from breaking or water and oil from separating out.

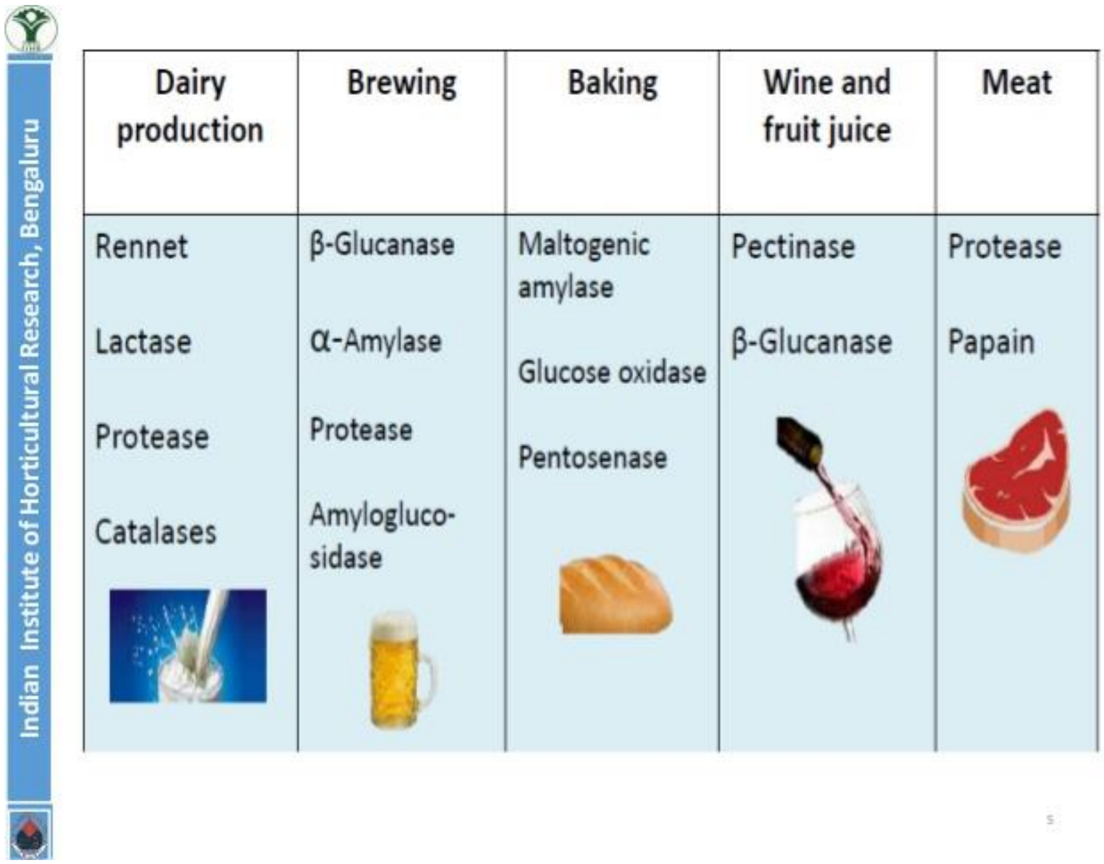
Emulsifying Agent may be natural or synthetic. Natural Emulsifying agent present in food are lecithin in egg yolk and caseinogens in milk. Synthetic Emulsifying agent are glyceryl mono sterate (GMS), stearyl tartarate and polyoxyethylene mono-sterate.

What is enzyme in food processing?

Enzymes, the natural catalysts for chemical reactions, are produced by all living cells. Their role in food processing has also been recognized for many centuries… In the food industry, microbial enzymes have been extensively used to increase the diversity, variety, and quality of food.

Applications of Microbial Enzymes in Food Industry

- A-Amylases. ...
- Glucoamylases. ...
- Proteases. ...
- Lactase (B-Galactosidase) ...
- Lipases. ...
- Phospholipases.



Dairy production	Brewing	Baking	Wine and fruit juice	Meat
Rennet	β-Glucanase	Maltogenic amylase	Pectinase	Protease
Lactase	α-Amylase	Glucose oxidase	β-Glucanase	Papain
Protease	Protease	Pentosenase		
Catalases	Amylogluco-sidase			

UNIT II FOOD MICROBIOLOGY

Micro-organisms in Foods

Micro-organisms, in relation to food, can have one of these 3 roles:

1. Pathogenic micro-organisms can cause infections or intoxications
2. Saprophytic micro-organism play a role in biodegradation and cause food spoilage
3. Cultured micro-organisms like probiotic bacteria are used in food processing.

Pathogenic micro-organisms

Pathogenic micro-organisms cause food-borne infections or intoxication, and include bacteria, viruses, parasites and moulds. It is important to note that pathogenic bacteria and viruses usually do not cause food spoilage, their contamination cannot be seen nor tasted.

- **The main factors that contribute to occurrence of foodborne diseases are:**

1. The use of raw food and ingredients from unsafe sources
2. Inadequate cooking or heat processing
3. Improper cooling and storing, for example leaving cooked foods at room temperature for longer periods of time, or storing foods in large containers in the fridge
4. Allowing several hours to pass between preparation and eating of food
5. Inadequate reheating
6. Improper hot holding, meaning below 65°C
7. Food handling by infected persons or carriers of infection
8. Cross contamination from raw to cooked food. For example by cutting vegetables for salad on a cutting board where you have cut raw meat before
9. Inadequate cleaning of equipment and utensils

Bacteria

- **Campylobacter jejuni:** Is a common cause of diarrhea humans as well as some animal species. The transmission can be by direct contact between humans and infected animals or their feces. More commonly, it is transmitted by the consumption of contaminated food or water, t person-to-person spread. The symptoms range from mild diarrhea to sever invasive disease which can include abdominal pain, fever, and blood and mucous in stools.

- **Non-typhi salmonellosis:** There are more than 2000 serotypes of salmonella spp, of which only a few cause Salmonella gasteroenteritis in humans. The symptoms include acute watery diarrhea accompanied by nausea, cramps and fever. Blood in stool may occur. Animals are the main reservoir, and transmission occurs by ingestion of contaminated products. Foods especially at risk are poultry, meat, eggs and milk.

- **Salmonella typhi and paratyphi:** Cause typhoid fever and paratyphoid fever respectively. Since the reservoir for both these bacteria are usually humans, transmission occurs mainly through person-to-person contact or contamination of food by food handlers.

- **Staphylococcus aureus:** The source of this infection is humans. The bacteria are often found in smaller amounts in the nose and on the skin of clinically healthy people. Higher amounts can be found in lesions of skin such as infected eczema, psoriasis or any other pus draining lesion. These people should therefore not be handling food. Food poisoning caused by this bacteria is caused by heat resistant staphylotoxin, resulting in diarrhea, vomiting, cramps and fever. The symptoms start suddenly and usually disappear within 24 hours.

- **Escherichia coli:** There are several serotypes, some of which are harmless to humans whereas others can cause gastroenteritis. Enterotoxigenic E.coli is the most common cause of traveler's diarrhea. The source is humans, and transmission usually occurs through contaminated food and water.

- **Listeria monocytogenes:** This bacterium is highly associated with food stored for long periods of time in the fridge because it is ubiquitous, and has the ability to grow slowly, even at low temperatures. Can be fatal in immune compromised, where it can cause septicemia and meningitis.

- **Shigella:** The source is humans and primates. Because it has low infectious dose, the main mode of transmission is person-to-person contact. It can also be transmitted through infected food and water. The symptoms of shigellosis are fever and watery diarrhea. The infection can also manifest as a dysenteric syndrome which includes fever, abdominal cramps and tenesmus, and frewuent, small volume, bloody stools containing mucous.

- **Vibrio Cholerae :** The source of this infection is humans. The main mode of transmission is through contaminated water and food, or person-to-person spread in overcrowded, unhygienic situations. It causes severe watery diarrhea, which can reach up to 20 liters per day.

- **Clostridium Botulinum:** Its source is the intestinal tract of fish, birds, and mammals. It is also widely distributed in nature. The bacterium is a spore producing anaerobe, with a highly potent heat labile toxin that affects the nervous system.

Viruses

Viruses, unlike bacteria, cannot multiply in foods. The main mode of transmission therefore by food handlers and the use of dirty utensils, which transfer the virus to food whereupon it is ingested by humans.

- **Rotaviruses and Norwalk virus** are the major causes of gastroenteritis
- **Viral hepatitis A** outbreaks are mainly caused by asymptomatic carriers which handle food.

Parasites

Many parasites, such as the helminths, have a complex lifecycle involving more than one host. The major route of transmission for these parasites to humans is by the route of food. The consumption of undercooked pork or beef, or the consumption of raw salads washed in contaminated water seems to be the trend.

Taenia solium and T. saginata: also called pig and beef tapeworms. Their cysts,, present in the muscle of the animal are ingested and the adult worm develops in the gut. The ova may develop into larvae that may invade other tissues, such as the brain, forming cysticercosis and severe neurological disorders as a consequence.

Trichinella spiralis: is found in undercooked pork. The larvae can invade tissues and cause a febrile illness.

Giardia lambila: This infection can be foodborne, waterborne or spread by interpersonal contact. It causes acute or subacute diarrhea, with malabsorption, fatty stools, and abdominal pain and bloating.

Entamoeba histolytica: The transmission is mainly food- or waterborne. The cysts pose a major problem since they are highly resistant to chemical disinfectants, including chlorination. The infection is usually asymptomatic, but may appear as either a persistent mild diarrhea or a fulminant dysentery.

Food Spoilage

It is the change of look, consistency, flavor and odor of foods, and is caused by bacteria, moulds and yeasts

Bacteria:

Examples of action of bacteria involved in food spoilage:

1. Lactic acid formation: Lactobacillus, Leuconostoc
2. Lipolysis: Pseudomonas, Alcaligenes, Serratia, Micrococcus
3. Pigment formation: Flavobacterium, Serratia, Micrococcus
4. Gas formation: Leuconostoc, Lactobacillus, Proteus
5. Slime or rope formation: Enterobacter, Streptococcus

Moulds:

Some strains produce mycotoxins under certain conditions

1. Aspergillus produces aflatoxin, ochrtoxin, citrinin and patulin
2. Fusarium
3. Cladosporium
4. Alternaria

Mycotoxins can penetrate into the parts of food that are not visibly mouldy as well. It is therefore necessary to throw away all of the food if any part of it is mouldy. They are also notoriously difficult to destroy as they are stable to both heat and chemicals.

- Hepatotoxins: aflatoxins, sporidesmins, luteoskyrin
- Nephrotoxins: ochratoxin, citrinin
- GIT toxins: trichocetens
- Neuro- and myotoxins: tremorgens, citreoviridin
- Dermatotoxins: verukarins, psoralen, sporidesmins, trichocetes
- Respiratory tract toxins: patulin

Foods most at risk for moulds:

1. Grains and grain products - many mycotoxin types
2. Peanuts, nuts and pulses - aflatoxin
3. Fruits and vegetables (raw and preserved) - patulin
4. Milk and milk products - aflatoxin

It is important to note that if any contaminated fodder is fed to animals, this is metabolized and the toxic derivatives can be found in animal products consumed by humans, e.g. milk and meat.

Microorganisms in food production

Most commonly used microorganisms are yeast, bacteria, moulds, or a combination of these. A good example of microorganism usage in food production is the process of fermentation, which results in the production of organic acids, alcohols and esters. These help to either:

1. Preserve the food
2. generate distinctive new food products

Yeast in food production

- Leavened bread and bakery products: *Saccharomyces cervisiae* ferments sugars to produce CO_2, the gas that gives the porous structure of bakery products. It also contributes to the flavor by formation of alchols, aldehydes, esters etc.
- Beer
- Wine
- Vinegar
- Pickles

Bacteria in food production

- Fermented milk products: *Lactobacillus, Lactococcus, Bifidobacterium*
- A variety of foods including Indian dosa, rabri: fermentation by *Leuconostoc mesenteroides, S. faecalis*
- Probiotics: are live food supplements used in yoghurt and other fermented milk products. It includes *Lactobacillus acidophillus and Bifidobacterium bifidum*. A minimum of 10^8 bacteria per 1 ml must get to the colon alive to have any significant effect. These bacteria improve the microbial spectrum in the gut and thus contribute to the following effects:

1. Influence immunity and hence prevent or make diarrheal diseases milder
2. Decrease the risk of colon cancer
3. Decrease cholesterol absorption
4. Produce acids that decrease the pH in the gut and thus increase the absorption of minerals such as calcium and phosphorous.

Mould in food production

- Cheese: Penicillium roqueforti and Penicillium camemberti (note that this one produces mycotoxin at 25°C, therefore the cheese production must happen at 15°C)
- Dry salami: makes the use of Penicillium and Scopulariopis moulds.
- Soy sauce: Aspergillus spp, especially A. oryzae, are involved in this production. There is also a subsequent lactic fermentation where lactic bacteria produce lactic acid.
- Sake: is produced using a combination of the mould Aspergillus oryzae and yeast.

Unit III Food processing technology

What is a food processing technology?

Food processing Technology includes set of physical and chemical techniques in the transformation of food ingredients or agricultural products into food. It includes many forms of processing foods, such as grinding grain to make raw flour to home cooking and complex industrial methods used to make convenience foods.

What are the types of food processing?

Food processing is a combination of several unit operations such as cleaning, peeling, grading, size reduction, drying, freezing, grinding, cutting, filtration, evaporation, liquefaction, emulsion formation, cooking, baking, roasting, toasting, frying, boiling, broiling, grilling sterilization, pasteurization, canning.

Food processing methods that are used to preserve foods include:

- Refrigeration and freezing.
- Canning.
- Irradiation.
- Dehydration.
- Freeze-drying.
- Pickling.
- Pasteurizing.
- Fermentation.

- Pasteurization or pasteurisation is a process in which water and certain packaged and non-packaged foods (such as milk and fruit juice) are treated with mild heat, usually to less than 100 °C (212 °F), to eliminate pathogens and extend shelf life. The process is intended to destroy or deactivate organisms and enzymes that contribute to spoilage or risk of disease, including vegetative bacteria, but not bacterial spores.Since pasteurization is not sterilization, and does not kill spores, a second "double" pasteurization will extend the quality by killing spores that have germinated.
- The process was named after the French microbiologist, Louis Pasteur, whose research in the 1880s demonstrated that thermal processing would inactivate unwanted microorganisms in wine. Spoilage enzymes are also inactivated during pasteurization. Today, pasteurization is used widely in the dairy industry and other food processing industries to achieve food preservation and food safety.
- Most liquid products are heat treated in a continuous system where heat can be applied using a plate heat exchanger or the direct or indirect use of hot water and steam. Due to the mild heat, there are minor changes to the nutritional quality and sensory characteristics of the

treated foods. Pascalization or high pressure processing (HPP) and pulsed electric field (PEF) are non-thermal processes that are also used to pasteurize foods.

Pasteurization process

General overview of the pasteurization process. The milk starts at the left and enters the piping with functioning enzymes that, when heat-treated, become denatured and stop the enzymes from functioning. This helps to stop pathogen growth by stopping the functionality of the cell. The cooling process helps stop the milk from undergoing the Mallard and caramelization. The pasteurization process also has the ability to heat the cells to the point that they burst from pressure build-up.

Pasteurization is a mild heat treatment of liquid foods (both packaged and unpackaged) where products are typically heated to below 100 °C. The heat treatment and cooling process are designed to inhibit a phase change of the product. The acidity of the food determines the parameters (time and temperature) of the heat treatment as well as the duration of shelf life. Parameters also take into account nutritional and sensory qualities that are sensitive to heat.

In acidic foods (pH <4.6), such as fruit juice and beer, the heat treatments are designed to inactivate enzymes (pectin methyl esterase and polygalacturonase in fruit juices) and destroy spoilage microbes (yeast and lactobacillus). Due to the low pH of acidic foods, pathogens are unable to grow. The shelf-life is thereby extended several weeks. In less acidic foods (pH >4.6), such as milk and liquid eggs, the heat treatments are designed to destroy pathogens and spoilage organisms (yeast and molds). Not all spoilage organisms are destroyed under pasteurization parameters, thus subsequent refrigeration is necessary

Equipment

Food can be pasteurized in two ways: either before or after being packaged into containers. When food is packaged in glass, hot water is used to lower the risk of thermal shock. Plastics and metals are also used to package foods, and these are generally pasteurized with steam or hot water since the risk of thermal shock is low.

Most liquid foods are pasteurized using continuous systems that have a heating zone, hold tube, and cooling zone, after which the product is filled into the package. Plate heat exchangers are used for low-viscosity products such as animal milks, nut milks and juices. A plate heat exchanger is composed of many thin vertical stainless steel plates which separate the liquid from the heating or cooling medium. Scraped surface heat exchangers contain an inner rotating shaft in the tube, and serve to scrape highly viscous material which might accumulate on the wall of the tube.

Shell or tube heat exchangers are designed for the pasteurization of Non-Newtonian foods such as dairy products, tomato ketchup and baby foods. A tube heat exchanger is made up of concentric stainless steel tubes. Food passes through the inner tube while the heating/cooling medium is circulated through the outer or inner tube.

The benefits of using a heat exchanger to pasteurize non-packaged foods versus pasteurizing foods in containers are:

- Heat exchangers provide uniform treatment, and there is greater flexibility with regards to the products which can be pasteurized on these plates
- The process is more energy-efficient compared to pasteurizing foods in packaged containers.
- Greater throughput

After being heated in a heat exchanger, the product flows through a hold tube for a set period of time to achieve the required treatment. If pasteurization temperature or time is not achieved, a flow diversion valve is utilized to divert under-processed product back to the raw product tank If the product is adequately processed, it is cooled in a heat exchanger, then filled.

High-temperature short-time (HTST) pasteurization, such as that used for milk (71.5 °C (160.7 °F) for 15 seconds) ensures safety of milk and provides a refrigerated shelf life of approximately two weeks. In ultra-high-temperature (UHT) pasteurization, milk is pasteurized at 135 °C (275 °F) for 1–2 seconds, which provides the same level of safety, but along with the packaging, extends shelf life to three months under refrigeration.

Membrane Separation Technology in the Food Industry

Membrane technology has been used in specialized applications in the food industry for more than 30 years. The technology can be applied to several production methods, including milk-solids separations in the dairy industry, juice clarification and concentration, concentration of whey protein, sugar and water purification, and waste management. Several filtration mediums exist as well as many types of membrane configurations. Knowledge of the various membrane technologies and how they are used in the food industry can enhance overall production and offers cost-cutting options for a variety of separations.

Membrane basics

Separation is based on principles that rely on the chemical and physical properties of particles and molecules. For example, centrifugation uses the physical property of weight to separate solids from liquids. Another example, ion exchange, relies on the principle of charge to separate different species from one another. Other principles such as vapor pressure, solubility and diffusion also can perform separations. Membranes use the principle of size to separate different materials

Membrane filters are very thin microporous sheets of film attached to a thicker porous support structure. At its most basic, a membrane serves as a sieve, separating solids from liquids forced through it. Not only can membranes separate solids from liquids, they can separate soluble molecules and ionic particles of different sizes from each other.

Membranes in the process industry use tangential flow filtration, or crossflow filtration. In tangential flow filtration (TFF) the flow of the feed stream runs parallel to the surface of the membrane at high velocities as illustrated.

As the fluid passes across the membrane surface it acts to sweep the retained components, or retentate, from the membrane surface and back into the bulk solution to avoid plugging the poresThis is opposed to traditional through-flow or dead-end filtration, in which the feed stream flows perpendicular to the surface of the membrane, the object of which is to form a dry cake. In TFF, the fraction that contains the solutes and lower molecular weight components that can pass through the membrane is known as permeate. The retentate is continuously recirculated, passing over the membrane surface until the desired effect—such as the concentration or clarification of a desired product—is achieved. The rate of permeation is known as flux and gives an indication of membrane performance.

TFF operations can perform both concentration and clarification applications. In concentration, the membrane retains the desired product, and liquid is removed as permeate. The retentate becomes more and more concentrated as permeate is removed. In clarification applications, the desired product passes through the membrane and is collected as permeate, perhaps leaving insoluble materials or other undesired compounds in the retentate. Both concentration and clarification operations are used extensively in the food industry, primarily to process juice and other beverages.

Membrane construction

Membranes are fabricated from many different types of materials. Initially, reverse osmosis and ultrafiltration membranes were cellulose-based, but are now made from polymers based on engineering plasticsTypical materials have included polyacrylonitrile (PAN) and blends of PAN with polyvinyl chloride (PVC), aromatic polyamid, and polyvinylidene fluoride (PVDF).[5,6] Today, most polymeric membranes used in the food industry are made of polysulfone (PS) or polyethersulfone (PES). As required by other processing equipment in the food industry, all membrane surfaces, backings, spacers, and support structures that make contact with food products must meet Part 177, of the Code of Federal Regulations, generally recognized as safe (GRAS), or otherwise approved by the FDA for food contact.Materials also are chosen for their cleanability and ability to withstand a variety of conditions under which it might perform.

Membranes can be divided into four basic categories: reverse osmosis (RO), nanofiltration (NO), ultrafiltration (UF), and microfiltration (MF). Each of these categories is distinguished by the size of the species they retain. Retention is based on the pore size of the membrane. A range of particle sizes at which each of these operates is illustrated

Reverse osmosis has the tightest pore construction, and can separate in the ionic range. Nan filtration, a newer category of membranes, operates similar to reverse osmosis but has a somewhat looser construction, allowing monovalent ions and some divalent ions to pass. Ultra filtration is used to separate different-size molecules such as proteins and other macromolecules. Microfiltration membranes have the largest pore sizes of all categories, and are primarily used for removing suspended solids and bacteria Another difference between these types of filtration is the pressures at which they operate. RO membranes operate up to 1,500 psi, NO membranes operate up to 300 psi, and UF membranes operate from 10 to 200 psi, while MF membranes operate in the range of 1 to 25 psiPore size differences between the membranes determine the operating pressure. Higher pressures are necessary to force liquid through membranes with smaller pore sizes.

Filtration foundation

The module design—or support structure—of a membrane is critical to its performance. Some factors to consider include flux (the rate of permeation), the solids content of the process fluid, cost, cleanability and scalability. Food industry applications make use of four basic module designs: spiral-wound, tubular, hollow-fiber, and plate-and-frame styled systems.

Spiral-wound membranes cover more than 60% of food-industry applications, mainly for dairy and other soluble protein processing, polysaccharide gum concentration, and in most RO and NO applications a schematic of the spiral-wound design. Fluid is pumped into the spacer channel parallel to the membrane surface and permeate passes through the membrane and into a porous permeate channel until it reaches a perforated tube at the center which acts as a permeate carrier.

Although resistance to fouling is good, these membranes have difficulty handling viscous material, or material with a high solids content.

Tubular systems account for about 10% to 15% of food industry applications. Tubular designs have a porous outer structure with a semi-permeable membrane coating on the inside of the tube. As seen in figure 4, the module consists of a collection of tubes fastened together at each end and encased in a module

The shell of the module collects permeate while retentate discharges at the end. Tubular designs are easy to clean and can be visually inspectedThey can handle liquids with high solids content and larger suspended particulates better than some of the other membrane designs. The membrane area, however, is typically small. Tubular membranes are suitable for beverage clarification or the reverse osmosis of pulp containing juices

Plate-and-frame and hollow-fiber systems are among the miscellaneous configurations that make up the remaining percentage of designs used in food industry applications.[5] In plate-and-frame styles, flat-sheet membranes are affixed to both sides of a porous plate and sandwiched in a holder. As indicated in figure 5, the feed stream enters the system and is directed via several channels to sweep over the surface of the membrane.

The fluid flows from these channels into the same outlet line and leaves as retentate. The permeate passes through the membrane into channels separate from the retentate and leaves as permeate. Several membranes and their supports can be stacked together in the holder to increase the overall membrane surface area. The advantage of this system is that if one membrane fails, it typically can be replaced at low cost. Also, plate-and-frame systems offer increased diversity. Once the initial capital cost to acquire the hardware is accomplished, a variety of membranes may be used in them. For example, both ultrafiltration and microfiltration processes may be done on the same unit merely by swapping out the proper membranes. Plate-and-frame systems have been used for the dealcoholization of beer in Europe and Australia, and also have been used for some high-viscosity concentration applications in the dairy industry.

Hollow-fiber membranes are similar to tubular membranes except that the hollow fibers are much smaller. The inside diameter of the fiber may range from 0.5 to 1.1 mm as opposed to 12.5 to 25 mm for the tubular designThe feed stream flows through the inside of the fibers and the permeate is collected in the containment shell. Hollow-fiber elements may have of hundreds of fibers all oriented in parallel. This allows for a high packing density and resistance to blockage of the flow channels. Also, this membrane can be backwashed to aid in cleaning. The strength of the fibers, however, is a limitation and low transmembrane pressures must be used to avoid bursting the fibers. The entire element must be discarded if even one fiber breaks

Reverse Osmosis

Reverse osmosis has become a standard process in the food industry. It is used to purify water for plant operations, to concentrate cheese whey proteins or milk in the dairy industry, for sugar concentration in the cereal processing industry, for concentration of juices, and for wastewater treatment in meat and fish processing industries. Reverse osmosis deserves a special look because of its suitability for a wide variety of applications.

Natural osmosis is a phenomenon in which a liquid passes through a semi-permeable membrane from a dilute solution to a more concentrated one. In reverse osmosis, pressure is applied to the more concentrated solution forcing water to flow towards the dilute solution

In this process, the reject water is typically 30% to 50% of the feed flowThus, at maximum efficiency, every 100 gallons of water entering the system would produce 50 gallons of purified water. RO is helping to save companies both energy and water by helping to limit evaporation steps or by treatment of wastewater streams.

Many foods require the removal of large amounts of water to concentrate the product for more efficient packaging or shippingAlthough evaporation is common, it requires substantial amounts of energy requirements compared with RO. In the U.S. the corn wet-milling industry alone consumes about 93.7 trillion Btu/year, which is equal to 90% of the energy consumed in grain milling operationsThe amount of water evaporated in this industry is around 35 billion lb/year for steep water, and around 12 billion lb/year for sweet water.[7] The energy required for RO is approximately 110 kJ/kg water versus 700 kJ/kg for the most efficient evaporator, resulting in substantial savings

Wastewater is a problem in any industry. Reducing the level of the dissolved solids and biological oxygen demand (BOD) is sometimes the only way processing plants can discharge water safely. Also, removing dissolved solids from water allows it to be reused, which not only cuts down on water usage but on the amount that is discharged.The collected solids also may be recovered if they are of value. For example, an RO system can recover proteins, sugars, and enzymes from wastewater that may be reused within plant operations.

Membrane technology has made a tremendous impact on the food industry over the last several years. The separation of materials for different applications has become an important industrial operation. Considerable progress continues to be made in membrane technology, and newer applications for existing systems are being discovered as the trend is to create integrated systems which utilize several different membrane types within a process.

CHROMATOGRAPHY - FOOD INDUSTRY

Analytical techniques
Foods, beverages and their raw materials, may be chemically tested for a wide variety of constituents. The presence of contaminants such as pesticides, antibiotics, heavy metals and adulterants etc. should also be determined. A wide variety of analytical techniques and instruments may be used for testing at all stages of the food and beverage production process. These techniques include pH measurements, ion selective electrodes, polarography, differential scanning calorimetry, mass spectrometry and its hyphenated variants, inductively coupled plasma spectroscopy, high performance liquid chromatography (HPLC), ultra high performance liquid chromatography, gas chromatography, ion chromatography (IC) and UV/Visible spectrophotometry, Raman spectroscopy and Fourier transform infra-red spectroscopy etc. All of these techniques each have their merits and application suitabilities.

The merits of IC
This discussion highlights the relevance of IC within food and beverage laboratories. IC is a derivative of HPLC. Here, the use of anion/cation exchange/pair/exclusion chromatography and/or detection of charged species is involved.
IC detection advantages are accuracy, speed, reproducibility, specificity and sensitivity. An IC conductivity detector must provide for low noise, high sensitivities, low drift, a wide range and fast response times.
Another benefit of IC is that it will enable the whole of a group of analytes of interest, to be determined within the same chromatographic run, with little or no sample pre-treatment.
IC is increasingly used for many measurements, such as:

- Lactic, acetic, citric, malic, phosphoric and other acids in coffees.
- Citric, ascorbic and acetic acids in other foods and beverages.
- Heavy metal limits in dairy products.
- Sucrose, lactose, galactose, and glucose in lactose-free dairy products.
- Propylene glycol, chloride, sulphites and nitrate, in beers and wines.
- Fluoride in teas.
- Sulphates, phosphates, nitrates and chlorides in sugars and sweeteners.
- Sulphates, phosphates and chlorides in sodium carbonate raw materials.
- Glucose, fructose, and sucrose traces in alcoholic spirits.
- Amino acids in specialised nutritional feeds.
- Fumaric, citric, and propionic acids in animal feeds.
- Calcium, magnesium, sodium, ammonium and potassium in sugar solutions.
- Carbonate in sparkling drinking waters.
- Iron, sodium, ammonium, potassium, calcium, magnesium, strontium, barium chloride, nitrite, bromide, fluoride, nitrate, phosphate and sulphate in mineral waters.
- Arsenic in rice.
-

Spoilage detection

Chromatography can be used in flavor studies and to detect spoilage in foods. Determining the amount of organic acids in foods provides key information about the quality of foods. Column chromatography is used to detect and quantify spoilage indicators such as pyruvic acid in milk. Pyruvic acid content is a measure of psychrotrophic bacteria present in milk.

The same separation method is used to assess total organic acid profile of milk and to measure lactose, which indicates the level of sweetness. Chromatography enables rapid analysis when compared with techniques such as bacterial plating, which may take several days to yield results. Rapid analysis is crucial in the food industry to prevent outbreak of spoilage and to minimize possible health risks.

Additive detection

Additives are added to foods to enhance their flavors or to give them a visual appeal. For example, the presence of added malic acid in apple juice is more difficult to detect because apple juice naturally contains malic acid. However, synthetic malic acid contains fumaric acid as a contaminant and hence its level in an apple juice sample is an indicator of the commercial malic acid. Chromatography has been successfully used to detect and quantify fumaric acid in apple juice.

Determining nutritional quality

Vitamin C depletion in foods can be an indicator of depletion of other nutrients and so the vitamin C content of foods and beverages is closely monitored during all stages of food processing using column chromatography. This analysis can be carried out rapidly using modern acid analysis columns coupled with electrochemical detection even in complex samples. This technique is used to quantitate vitamin C in juices, powdered drinks, and both fresh and frozen vegetables and fruits.

Column chromatography

Unit IV Food preservation

Discuss five methods of food preservation

- Canning. ...
- Freezing. ...
- Drying. ...
- Fermenting. Mean encouraging the growth of "good bugs" to inhibit the "bad bugs" that can spoil food. ...
- Pickling. ...
- Dry salting.

Cooling

Cooling preserves food by slowing down the growth and reproduction of microorganisms and the action of enzymes that causes the food to rot. The introduction of commercial and domestic refrigerators drastically improved the diets of many in the Western world by allowing food such as fresh fruit, salads and dairy products to be stored safely for longer periods, particularly during warm weather.

Before the era of mechanical refrigeration, cooling for food storage occurred in the forms of root cellars and iceboxes. Rural people often did their own ice cutting, whereas town and city dwellers often relied on the ice trade. Today, root cellaring remains popular among people who value various goals, including local food, heirloom crops, traditional home cooking techniques, family farming, frugality, self-sufficiency, organic farming, and others.

Freezing

Freezing is also one of the most commonly used processes, both commercially and domestically, for preserving a very wide range of foods, including prepared foods that would not have required freezing in their unprepared state. For example, potato waffles are stored in the freezer, but potatoes themselves require only a cool dark place to ensure many months' storage. Cold stores provide large-volume, long-term storage for strategic food stocks held in case of national emergency in many countries.

Pickling

Pickling is a method of preserving food in an edible, antimicrobial liquid. Pickling can be broadly classified into two categories: chemical pickling and fermentation pickling.

In chemical pickling, the food is placed in an edible liquid that inhibits or kills bacteria and other microorganisms. Typical pickling agents include brine (high in salt), vinegar, alcohol, and vegetable oil. Many chemical pickling processes also involve heating or boiling so that the food being preserved becomes saturated with the pickling agent. Common chemically pickled foods include cucumbers, peppers, corned beef, herring, and eggs, as well as mixed vegetables such as piccalilli.

In fermentation pickling, bacteria in the liquid produce organic acids as preservation agents, typically by a process that produces lactic acid through the presence of lactobacillales. Fermented pickles include sauerkraut, nukazuke, kimchi, and surströmming.

Canning

Canning involves cooking food, sealing it in sterilized cans or jars, and boiling the containers to kill or weaken any remaining bacteria as a form of sterilization. It was invented by the French confectioner Nicolas Appert.[8] By 1806, this process was used by the French Navy to preserve meat, fruit, vegetables, and even milk. Although Appert had discovered a new way of preservation, it wasn't understood until 1864 when Louis Pasteur found the relationship between microorganisms, food spoilage, and illness.[7]

Foods have varying degrees of natural protection against spoilage and may require that the final step occur in a pressure cooker. High-acid fruits like strawberries require no preservatives to can and only a short boiling cycle, whereas marginal vegetables such as carrots require longer boiling and addition of other acidic elements. Low-acid foods, such as vegetables and meats, require pressure canning. Food preserved by canning or bottling is at immediate risk of spoilage once the can or bottle has been opened.

Lack of quality control in the canning process may allow ingress of water or micro-organisms. Most such failures are rapidly detected as decomposition within the can causes gas production and the can will swell or burst. However, there have been examples of poor manufacture (underprocessing) and poor hygiene allowing contamination of canned food by the obligate anaerobe *Clostridium botulinum*, which produces an acute toxin within the food, leading to severe illness or death. This organism produces no gas or obvious taste and remains undetected by taste or smell. Its toxin is denatured by cooking, however. Cooked mushrooms, handled poorly and then canned, can support the growth of *Staphylococcus aureus*, which produces a toxin that is not destroyed by canning or subsequent reheating.

Irradiation

Irradiation of food is the exposure of food to ionizing radiation. Multiple types of ionizing radiation can be used, including beta particles (high-energy electrons) and gamma rays (emitted from radioactive sources such as cobalt-60 or cesium-137). Irradiation can kill bacteria, molds, and insect pests, reduce the ripening and spoiling of fruits, and at higher doses induce sterility. The technology may be compared to pasteurization; it is sometimes called "cold pasteurization", as the product is not heated. Irradiation may allow lower-quality or contaminated foods to be rendered marketable.

National and international expert bodies have declared food irradiation as "wholesome"; organizations of the United Nations, such as the World Health Organization and Food and Agriculture Organization, endorse food irradiation.[12][13] Consumers may have a negative view of irradiated food based on the misconception that such food is radioactive;[14] in fact, irradiated food does not and cannot become radioactive. Activists have also opposed food irradiation for other reasons, for example, arguing that irradiation can be used to sterilize contaminated food without resolving the underlying cause of the contamination.[15] International legislation on whether food may be irradiated or not varies worldwide from no regulation to a full ban.[16]

Approximately 500,000 tons of food items are irradiated per year worldwide in over 40 countries. These are mainly spices and condiments, with an increasing segment of fresh fruit irradiated for fruit fly quarantine.

freezing curve characteristics.

What is freezing curve?
The freezing curve predicts the amount of ice at any given temperature, which is a function of freezing point depression and hence the number of solutes (concentration of sugar, etc.).

What is the principle of freezing?
During freezing, the water in the food is separated out from other food components, and is frozen. Thus, a food is protected, preserved from deteriorating influences such as temperature and water. The lower temperature slows down the rate of chemical reaction and water is also removed from the sphere of activity

crystallization the same as freezing?
Crystallization. Most liquids freeze by crystallization, formation of crystalline solid from the uniform liquid. ... Because of the latent heat of fusion, the freezing is greatly slowed down and the temperature will not drop anymore once the freezing starts but will continue dropping once it finishes

What are the advantages of freezing?
Frozen vegetables are nutritionally more reliable than fresh as freezing prevents sensitive vitamins and nutrients from being lost during transportation. Freezing allows you to choose from a vast selection of seasonal ingredients all year round. Frozen food contains no preservatives.

Why is freezing point important?
The freezing point is the temperature at which the liquid solvent and solid solvent are at equilibrium, so that their vapor pressures are equal. When a non-volatile solute is added to a volatile liquid solvent, the solution vapor pressure will be lower than that of the pure solvent.

What is the difference between melting and freezing?
Freezing is the change that occurs when a liquid changes into a solid as the temperature decreases. Melting is the opposite change, from a solid to a liquid as the temperature increases. Freezing is a change from a high energy state to one of lower energy, the molecules are moving less as their temperature falls

What are the disadvantages of frozen food?
Disadvantages

- Vitamins B and C are lost in the freezing process. ...
- Freezer burn can affect texture and flavor. ...
- Many vegetables and most fruits lose their crispness when frozen, even if when you blanch them for a short time. ...
- Some items also change texture when frozen and do not taste/feel the same when thawed out and eaten.

  - The importance of freezing as a preservation method
  - Freezing preservation retains the quality of agricultural products over long storage periods. As a method of long-term preservation for fruits and vegetables, freezing is generally regarded as superior to canning and dehydration, with respect to retention in sensory attributes and nutritive properties (Fennema, 1977). The safety and nutrition quality of frozen products are emphasized when high quality raw materials are used, good manufacturing practices are employed in the preservation process, and the products are kept in accordance with specified temperatures.
  - The need for freezing and frozen storage
  - Freezing has been successfully employed for the long-term preservation of many foods, providing a significantly extended shelf life. The process involves lowering the product temperature generally to -18 °C or below (Fennema *et al.*, 1973). The physical state of food material is changed when energy is removed by cooling below freezing temperature. The extreme cold simply retards the growth of microorganisms and slows down the chemical changes that affect quality or cause food to spoil (George, 1993).
  - Competing with new technologies of minimal processing of foods, industrial freezing is the most satisfactory method for preserving quality during long storage periods (Arthey, 1993). When compared in terms of energy use, cost, and product quality, freezing requires the shortest processing time. Any other conventional method of preservation focused on fruits and vegetables, including dehydration and canning, requires less energy when compared with energy consumption in the freezing process and storage. However, when the overall cost is estimated, freezing costs can be kept as low (or lower) as any other method of food preservation (Harris and Kramer, 1975).
  - Current status of frozen food industry in U.S. and other countries
  - The frozen food market is one of the largest and most dynamic sectors of the food industry. In spite of considerable competition between the frozen food industry and other sectors, extensive quantities of frozen foods are being consumed all over the world. The industry has recently grown to a value of over US$ 75 billion in the U.S. and Europe combined. This number has reached US$ 27.3 billion in 2001 for total retail sales of frozen foods in the U.S. alone (AFFI, 2003). In Europe, based on U.S. currency, frozen food consumption also reached 11.1 million tons in 13 countries in the year 2000 (Quick Frozen Foods International, 2000). Table 1 represents the division of frozen food industry in terms of annual sales in 2001.
  - Advantages of freezing technology in developing countries
  - Developed countries, mostly the U.S., dominate the international trade of fruits and vegetables. The U.S. is ranked number one as both importer and exporter, accounting for

the highest percent of fresh produce in world trade. However, many developing countries still lead in the export of fresh exotic fruits and vegetables to developed countries (Mallett, 1993).

- For developing countries, the application of freezing preservation is favorable with several main considerations. From a technical point of view, the freezing process is one of the most convenient and easiest of food preservation methods, compared with other commercial preservation techniques. The availability of different types of equipment for several different food products results in a flexible process in which degradation of initial food quality is minimal with proper application procedures. As mentioned earlier, the high capital investment of the freezing industry usually plays an important role in terms of economic feasibility of the process in developing countries. As for cost distribution, the freezing process and storage in terms of energy consumption constitute approximately 10 percent of the total cost (Person and Lohndal, 1993). Depending on the government regulations, especially in developing countries, energy cost for producers can be subsidized by means of lowering the unit price or reducing the tax percentage in order to enhance production. Therefore, in determining the economical convenience of the process, the cost related to energy consumption (according to energy tariffs) should be considered

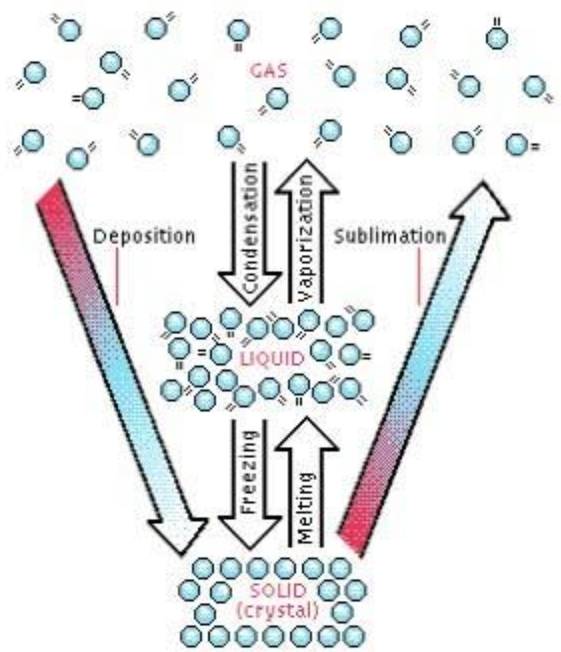
Freezing process

The freezing process mainly consists of thermodynamic and kinetic factors, which can dominate each other at a particular stage in the freezing process (Franks, 1985). Major thermal events are accompanied by reduction in heat content of the material during the freezing process as is shown in Figure 1. The material to be frozen first cools down to the temperature at which nucleation starts. Before ice can form, a nucleus, or a seed, is required upon which the crystal can grow; the process of producing this seed is defined as nucleation. Once the first crystal appears in the solution, a phase change occurs from liquid to solid with further crystal growth. Therefore, nucleation serves as the initial process of freezing, and can be considered as the critical step that results in a complete phase change (Sahagian and Goff, 1996).

Freezing point of foods

Freezing point is defined as the temperature at which the first ice crystal appears and the liquid at that temperature is in equilibrium with the solid. If the freezing point of pure water is considered, this temperature will correspond to 0 °C (273°K). However, when food systems are frozen, the process becomes more complex due to the existence of both free and bound water. Bound water does not freeze even at very low temperatures. Unfreezable water contains soluble solids, which cause a decrease in the freezing point of water lower than 0 °C. During the freezing process, the concentration of soluble solids increases in the unfrozen water, resulting in a variation in freezing temperature. Therefore, the temperature at which the first ice crystal appears is commonly regarded as the initial freezing temperature. There are empirical equations in literature that can calculate the initial freezing temperature of certain foods as a function of their moisture content (Levy, 1979).

Figure 1. A schematic illustration of overall freezing process.



There are several methods of food freezing, and depending on the method used, the quality of the frozen food may vary. However, regardless of the method chosen, the main principle behind all freezing processes is the same in terms of process parameters. The International Institute of Refrigeration (IIR) has provided definitions to establish a basis for the freezing process. According to their definition, the freezing process is basically divided into three stages based on major temperature changes in a particular location in the product, as shown in Figures 2 and 3 for pure water and food respectively.

Beginning with the prefreezing stage, the food is subjected to the freezing process until the appearance of the first crystal. If the material frozen is pure water, the freezing temperature will be 0 °C and, up to this temperature, there will be a subcooling until the ice formation begins. In the case of foods during this stage, the temperature decreases to below freezing temperature and, with the formation of the first ice crystal, increases to freezing temperature. The second stage is the freezing period; a phase change occurs, transforming water into ice. For pure water, temperature at this stage is constant; however, it decreases slightly in foods, due to the increasing concentration of solutes in the unfrozen water portion. The last stage starts when the product temperature reaches the point where most freezable water has been converted to ice, and ends when the temperature is reduced to storage temperature

The freezing time and freezing rate are the most important parameters in designing freezing systems. The quality of the frozen product is mostly affected by the rate of freezing, while time of freezing is calculated according to the rate of freezing. For industrial applications, they are the most essential parameters in the process when comparing different types of freezing systems and equipment (Persson and Lohndal, 1993).

Figure 2. Practical definition of the freezing process for pure water

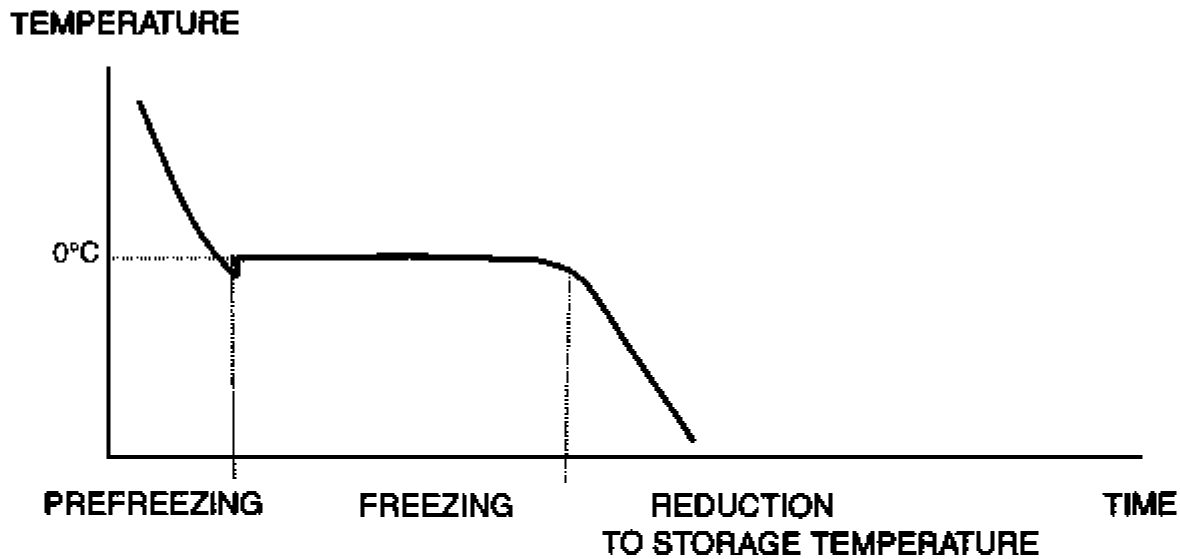
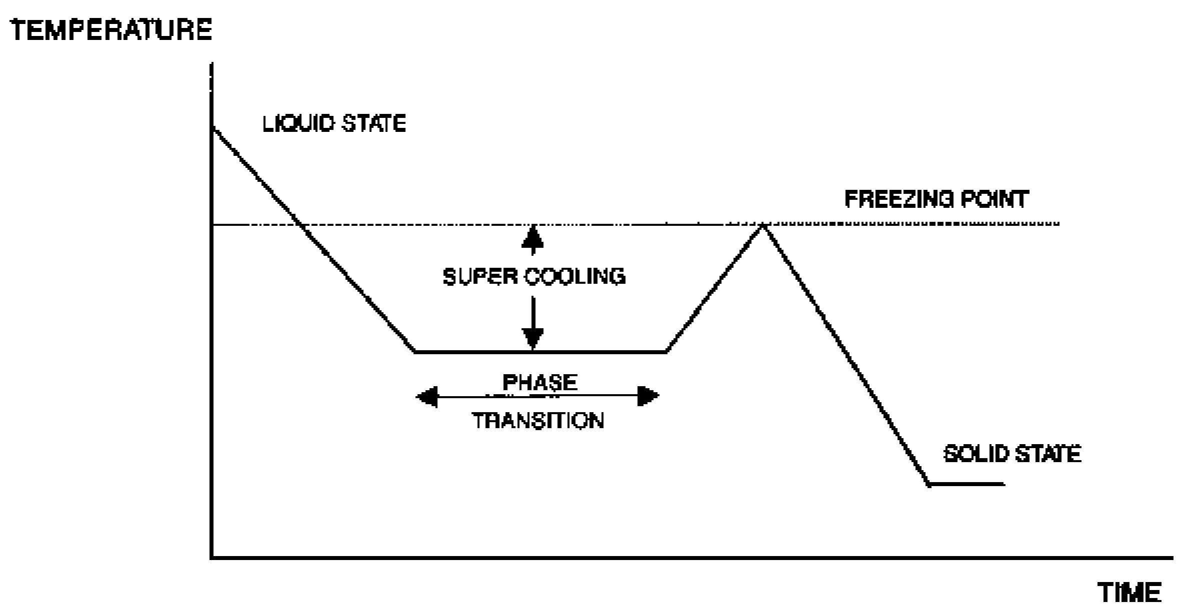


Figure 3. Practical definition of the freezing process for foods



Freezing time

Again, freezing time is one of the most important parameters in the freezing process, defined as time required to lower product temperature from its initial temperature to a given temperature at its thermal center. Since the temperature distribution within the product varies during freezing process, the thermal center is generally taken as reference. Thus, when the geometrical center of the product reaches the given final temperature, this ensures the average product temperature has been reduced to a storage value. Freezing time depends on several factors, including the initial and final temperatures of the product and the quantity of heat removed, as well as dimensions (especially thickness) and shape of product, heat transfer process, and temperature. The International Institute of Refrigeration (1986) defines various factors of freezing time in relation to both the product frozen and freezing equipment (Persson and Lohndal, 1993). The most important are:

- Dimensions and shape of product, particularly thickness
- Initial and final temperatures
- Temperature of refrigerating medium
- Surface heat transfer coefficient of product
- Change in enthalpy
- Thermal conductivity of product

Calculation of freezing time in food systems is difficult in comparison to pure systems since the freezing temperature changes continuously during the process. Using a simplified approach, time elapsed between initial freezing until when the entire product is frozen can be regarded as the freezing time. Plank's equation (Eq.1) is commonly used to estimate freezing time, however due to assumptions involved in the calculation it is only useful for obtaining an approximation of freezing time. The derivation of the equation starts with the assumption the product being frozen is initially at freezing temperature. Therefore, the calculated freezing time represents only the freezing period. The equation can be further modified for different geometries including slab, cylinder, and sphere, where for each geometry, the coefficients are arranged in relation to the dimension

Unit V Manufacture of food products

What is a baked product?

Baked goods are foods that are baked with grains and/or cereal products. A distinction is made between bread, small baked goods (e.g. rolls, pretzels), pastries (e.g. croissants, puff pastry), and dry baked goods (e.g. gingerbread).

What are the examples of baked products?

Bakery and baked goods categories like bars, breads (bagels, buns, rolls, biscuits and loaf breads), cookies, desserts (cakes, cheesecakes and pies), muffins, pizza, snack cakes, sweet goods (doughnuts, Danish, sweet rolls, cinnamon rolls and coffee cake) and tortillas.

Is bread a baked good?

Baked goods are cooked by baking, a method of cooking food that uses prolonged dry heat, normally in an oven, but also in hot ashes, or on hot stones. The most common baked item is bread but many other types of foods are baked as well.

What should I bake my bread on?

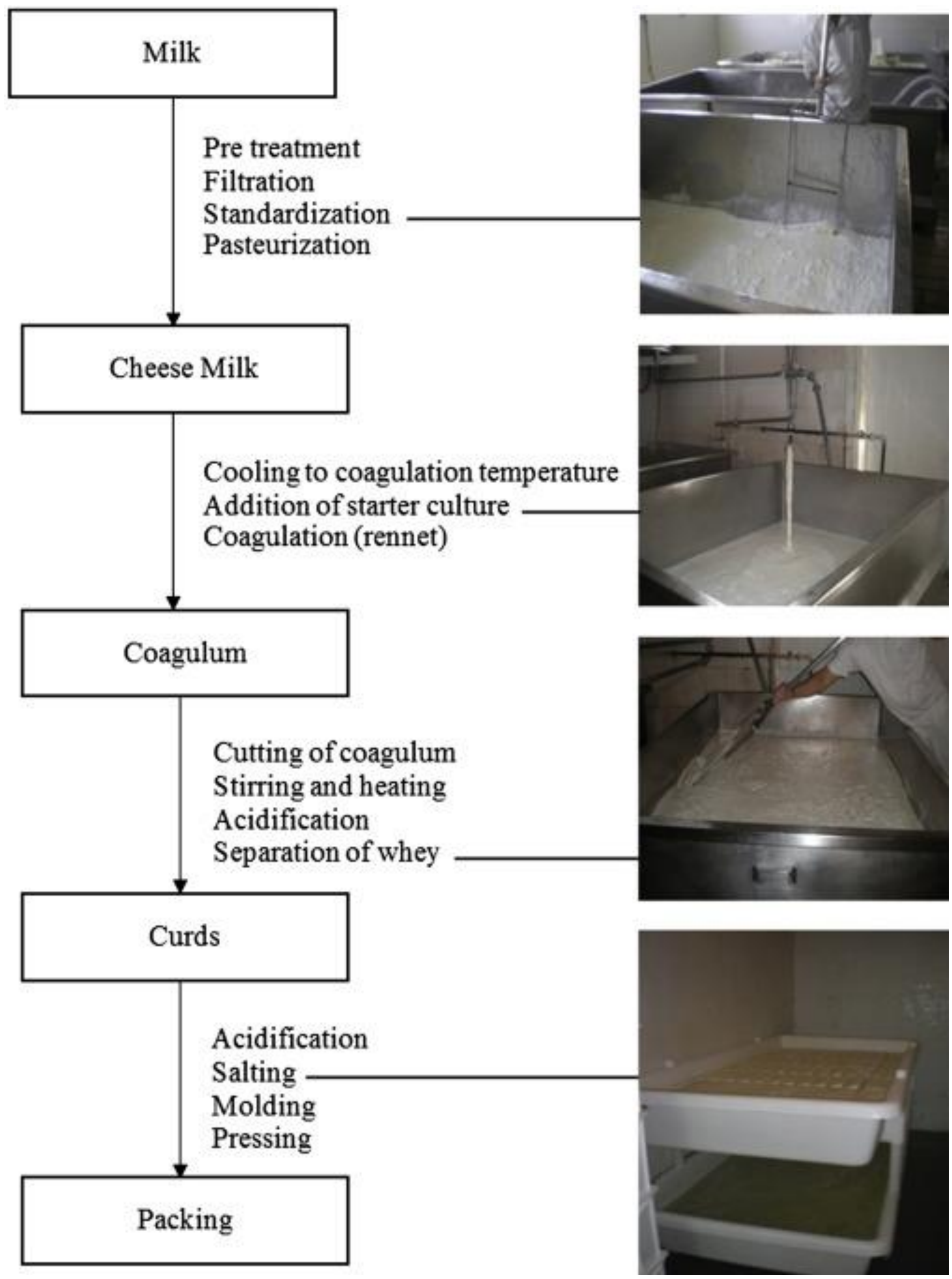
Generally, leaner breads (made with flour, water, and yeast) are baked at 400° to 425°. Richer breads (made with more fat and eggs) are baked at lower temperatures. Breads made with less than 1/2 cup sugar are generally baked at 375° and bread with more are baked at 350°. A loaf of bread can bake from 25 to 45 minutes.

Milk processing

Milk is a valuable nutritious food that has a short shelf-life and requires careful handling. Milk is highly perishable because it is an excellent medium for the growth of microorganisms – particularly bacterial pathogens – that can cause spoilage and diseases in consumers. Milk processing allows the preservation of milk for days, weeks or months and helps to reduce food-borne illness.

The usable life of milk can be extended for several days through techniques such as cooling (which is the factor most likely to influence the quality of raw milk) or fermentation. Pasteurization is a heat treatment process that extends the usable life of milk and reduces the numbers of possible pathogenic microorganisms to levels at which they do not represent a significant health hazard. Milk can be processed further to convert it into high-value, concentrated and easily transportable dairy products with long shelf-lives, such as butter, cheese and ghee.

Processing of dairy products gives small-scale dairy producers higher cash incomes than selling raw milk and offers better opportunities to reach regional and urban markets. Milk processing can also help to deal with seasonal fluctuations in milk supply. The transformation of raw milk into processed milk and products can benefit entire communities by generating off-farm jobs in milk collection, transportation, processing and marketing.



Cheese Processing and Critical Points of Contamination

Although there are more than 600 different types of cheeses, the manufacturing process of all cheeses can be arranged in five general, essential steps including pretreatment of raw milk, milk coagulation, treating of curd, ripening, and packaging. Technological processing of all cheeses has as their basic principle milk coagulation, which transforms milk into a solid mass that is then separated from the whey. Milk coagulates when casein micelles become unstable, which may be achieved by the addition of enzymes or acids. Some cheeses may be produced by mixed coagulation process, when rennet (the substance responsible for enzymatic coagulation) and specific lactic acid bacteria or lactic acid (responsible for acid coagulation) are added.

Butter Manufacture

Butter is essentially the fat of the milk. It is usually made from sweet cream and is salted. However, it can also be made from acidulated or bacteriologically soured cream and saltless (sweet) butters are also available. Well into the 19th century butter was still made from cream that had been allowed to stand and sour naturally. The cream was then skimmed from the top of the milk and poured into a wooden tub. Buttermaking was done by hand in butter churns. The natural souring process is, however, a very sensitive one and infection by foreign micro-organisms often spoiled the result. Today's commercial buttermaking is a product of the knowledge and experience gained over the years in such matters as hygiene, bacterial acidifying and heat treatment, as well as the rapid technical development that has led to the advanced machinery now used. The commercial cream separator was introduced at the end of the 19th century, the continuous churn had been commercialized by the middle of the 20th century.

Definitions and Standards

Milkfat

The lipid components of milk, as produced by the cow, and found in commercial milk and milk-derived products, mostly comprised of triglyceride.

Butterfat

Almost synonymous with milkfat; all of the fat components in milk that are separable by churning.

Anhydrous Milkfat (AMF)

The commercially- prepared extraction of cow's milkfat, found in bulk or concentrated form (comprised of 100% fat, but not necessarily all of the lipid components of milk).

Butter oil

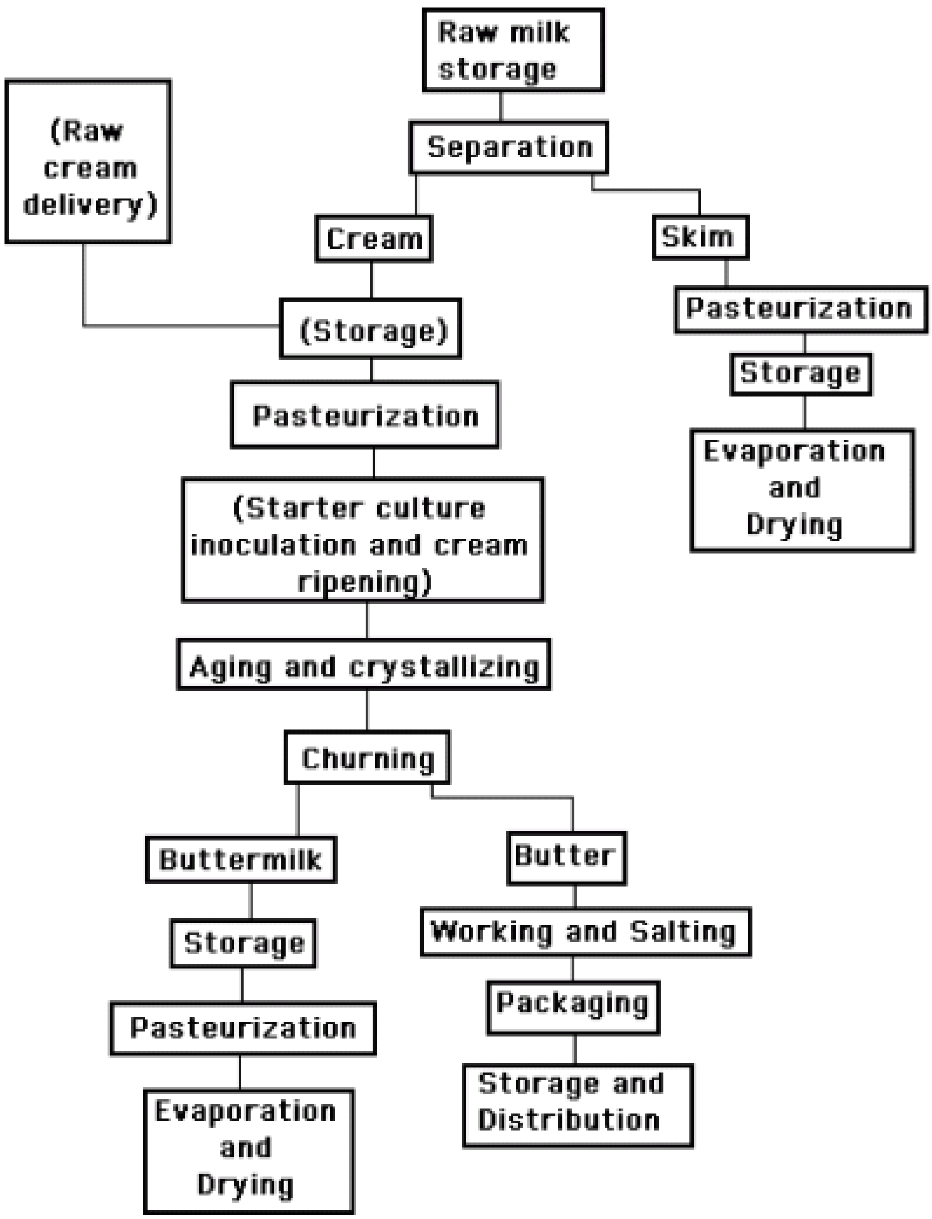
Synonymous with anhydrous milkfat; (conventional terminology in the fats and oils field differentiates an oil from a fat based on whether it is liquid at room temp. or solid, but very arbitrary).

Butter

A water-in-oil emulsion, comprised of >80% milkfat, but also containing water in the form of tiny droplets, perhaps some milk solids-not-fat, with or without salt (sweet butter); texture is a result of working/kneading during processing at appropriate temperatures, to establish fat crystalline network that results in desired smoothness (compare butter with melted and recrystallized butter); used as a spread, a cooking fat, or a baking ingredient.

The principal constituents of a normal salted butter are fat (80 - 82%), water (15.6 - 17.6%), salt (about 1.2%) as well as protein, calcium and phosphorous (about 1.2%). Butter also contains fat-soluble vitamins A, D and E.

Butter should have a uniform color, be dense and taste clean. The water content should be dispersed in fine droplets so that the butter looks dry. The consistency should be smooth so that the butter is easy to spread and melts readily on the tongue.



The buttermaking process involves quite a number of stages. The continuous buttermaker has become the most common type of equipment used.

The cream can be either supplied by a fluid milk dairy or separated from whole milk by the butter manufacturer. The cream should be sweet (pH >6.6, TA = 0.10 - 0.12%), not rancid and not oxidized.

If the cream is separated by the butter manufacturer, the whole milk is preheated to the required temperature in a milk pasteurizer before being passed through a separator. The cream is cooled and led to a storage tank where the fat content is analyzed and adjusted to the desired value, if necessary. The skim milk from the separator is pasteurized and cooled before being pumped to storage. It is usually destined for concentration and drying.

From the intermediate storage tanks, the cream goes to pasteurization at a temperature of 95oC or more. The high temperature is needed to destroy enzymes and micro-organisms that would impair the keeping quality of the butter.

If ripening is desired for the production of cultured butter, mixed cultures of S. cremoris, S. lactis diacetyl lactis, Leuconostocs, are used and the cream is ripened to pH 5.5 at 21oC and then pH 4.6 at 13oC. Most flavour development occurs between pH 5.5 - 4.6. The colder the temperature during ripening the more the flavour development relative to acid production. Ripened butter is usually not washed or salted.

In the aging tank, the cream is subjected to a program of controlled cooling designed to give the fat the required crystalline structure. The program is chosen to accord with factors such as the composition of the butterfat, expressed, for example, in terms of the iodine value which is a measure of the unsaturated fat content. The treatment can even be modified to obtain butter with good consistency despite a low iodine value, i.e. when the unsaturated proportion of the fat is low.

As a rule, aging takes 12 - 15 hours. From the aging tank, the cream is pumped to the churn or continuous buttermaker via a plate heat exchanger which brings it to the requisite temperature. In the churning process the cream is violently agitated to break down the fat globules, causing the fat to coagulate into butter grains, while the fat content of the remaining liquid, the buttermilk, decreases.

Thus the cream is split into two fractions: butter grains and buttermilk. In traditional churning, the machine stops when the grains have reached a certain size, whereupon the buttermilk is drained off. With the continuous buttermaker the draining of the buttermilk is also continuous.

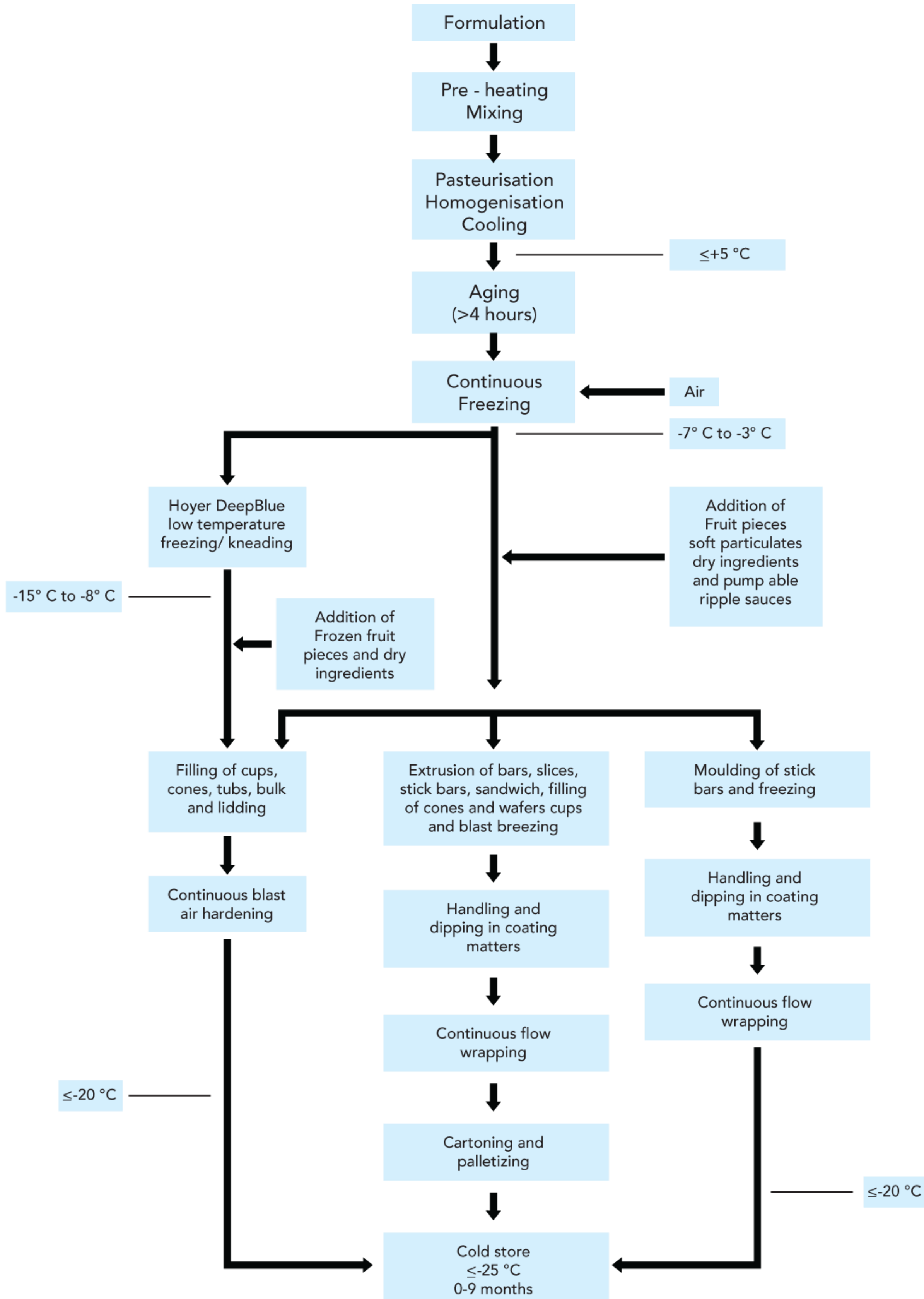
After draining, the butter is worked to a continuous fat phase containing a finely dispersed water phase. It used to be common practice to wash the butter after churning to remove any residual buttermilk and milk solids but this is rarely done today.

Salt is used to improve the flavour and the shelf-life, as it acts as a preservative. If the butter is to be salted, salt (1-3%) is spread over its surface, in the case of batch production. In the continuous buttermaker, a salt slurry is added to the butter. The salt is all dissolved in the aqueous phase, so the effective salt concentration is approximately 10% in the water.

After salting, the butter must be worked vigorously to ensure even distribution of the salt. The working of the butter also influences the characteristics by which the product is judged - aroma, taste, keeping quality, appearance and colour. Working is required to obtain a homogenous blend of butter granules, water and salt. During working, fat moves from globular to free fat. Water droplets decrease in size during working and should not be visible in properly worked butter. Overworked butter will be too brittle or greasy depending on whether the fat is hard or soft. Some water may be added to standardize the moisture content. Precise control of composition is essential for maximum yield.

The finished butter is discharged into the packaging unit, and from there to cold storage.

Ice cream production


Formulation
Pre - heating Mixing
Pasteurisation Homogenisation Cooling
≤+5 °C
Aging (>4 hours)
Continuous Freezing
Air
-7° C to -3° C
Hoyer DeepBlue low temperature freezing/ kneading
Addition of Fruit pieces soft particulates dry ingredients and pump able ripple sauces
-15° C to -8° C
Addition of Frozen fruit pieces and dry ingredients
Filling of cups, cones, tubs, bulk and lidding
Extrusion of bars, slices, stick bars, sandwich, filling of cones and wafers cups and blast breezing
Moulding of stick bars and freezing
Continuous blast air hardening
Handling and dipping in coating matters
Handling and dipping in coating matters
Continuous flow wrapping
Continuous flow wrapping
≤-20 °C
Cartoning and palletizing
≤-20 °C
Cold store ≤-25 °C 0-9 months

he basic steps in the manufacturing of ice cream are generally as follows:

- blending of the mix ingredients
- pasteurization
- homogenization
- aging the mix
- freezing
- packaging
- hardening

Processing of Fruits and Vegetables

In previous blog post we wrote about storage of fresh fruits and vegetables. But fruits and vegetables can be also stored in many other forms, such as canned, frozen, dried or juced. Modern lifestyle and diet, which prompted the human to adequately storage a variety of fruits and other plant organs, influenced on the development and implementation of the many methods and procedures for preservation of fruits and vegetables. Technological procedures of processing of fruit and vegetables can be classified into few processing methods:

- Traditional processing methods - drying, concentrating, heating (cooking, baking, frying) cooling, use of additives - preservatives, acidification, fermentation
- Improved traditional methods of processing - the application of increased temperatures (sterilization, pasteurization), the application of low temperature (cooling, freezing), aseptic packaging, controlled atmosphere -CA, freeze-drying, microfiltration and membrane processes, packaging (MA and vacuum)
- Procedures that are investigating - high voltage pulse techniques, photodynamic inactivation, microwave processing - heating, high pressure treatment, ionizing radiation, heating of electrical resistance effect and induction

Heat treatment and sterilization

One of the traditional methods of preserving process of fruits and vegetables is a thermal treatment, which involves the use of heat, ie. increased temperatures. Heat treatment is carried out by methods of sterilization, pasteurization and blanching, thus hermetically sealed packaging is used (usually made of metal, glass or plastic). Fruits, vegetables and their products represent a significant segment of the human diet, as they create the preconditions of proper nutrition. From a global point of view fruits and vegetables are present in the human diet all over the world, but it is also interesting that the relatively large producers of fruits and vegetables are developing countries.

Fruit and vegetable products

It is a large number of products that can be produced from fruits and vegetables. In the table below you can see the list of products.

Fruit products	Vegetable products

frozen fruit	frozen vegetables
jam	vegetable juice
fruit jellies	concentrated vegetable juice
pasteurized fruit	pasteurized vegetables
fruit cheese	sterilized vegetables
frozen pulp of the fruit	frozen pulp of the fruit dried vegetables
pasteurised mash	marinated vegetables
candied fruits	biological canned vegetables
dried fruit	vegetable sauce
fruit juice	other vegetable products
fruit juice powder	
fruit syrup	
low-calorie products	
compote	
marmalade	

Frozen, canned or dried fruits and vegetables have a lot of benefits, such as longer shelf life, convenience, year round availability, most vitamins are retained as they are generally processed and packaged within hours of being picked, easy storage, easy preparation etc. To learn more about processing of fruit, vegetables and also cereals, check out the knowledge base in Agrivi farm management system. Start using Agrivi now.

Meat, Poultry and Fish

Meat, poultry and fish are foods that may naturally contain bacteria that cause diseases.
The prevention of diseases whose source is in these foods is dependent on keeping to and insisting on the regulations that are detailed here, starting with the stage of buying, through storage and treatment at home.

Proper purchasing of meat, poultry and fish

- Purchase only those products having clear markings of the last use-by-date. For products that are pre-packaged, check that the last use-by-date has not passed;
- When purchasing raw (uncooked) food, that is not pre-packaged at the butcher shop, ask the butcher to show the original label of the food, including clear marking of the last use-by-date;
- Buy only in places that are air-conditioned, well-lit and clean;
- Buy only in places where the employees are cleanly and properly dressed;
- Buy raw (uncooked) meat and poultry that was ground in your presence or only if it is packaged and labeled.
- Buy only products that have characteristic appearances, colors and odors. Fish have special signs of freshness, and it is recommended that you pay attention to them (see below);
- Buy only products that are kept in the store according to the manufacturer's instructions. Fresh meat, poultry and fish/raw (uncooked) must be refrigerated (0^o-4^oC) or frozen (-18^o C) during all stages of marketing, and they should not be purchased if they are not in the refrigerator or the freezer.
  The manufacturer's recommended temperature appears on the product, and you can check that the product is properly kept in the store in the refrigerator or the freezer according to the manufacturer's recommendations (the manufacturer decides how the product is to be stored, and products marked as "chilled" are not to be frozen in the store or frozen products kept in the refrigerator).
  You are able to recognize if a frozen product in the store has been thawed and refrozen: if there are lumps of ice in the package, this is a sign that the product has thawed and been re-frozen, and it is not recommended to purchase this product.
- Purchase pre-packaged products only if the packaging is whole and proper;
- Place raw (uncooked) meat, poultry and fish in a clean bag, separate from other products you have bought.
  A separate, clean package will prevent dripping and contamination of other products when you are shopping.
- In the store, remove the meat, poultry and fish from the refrigerator as close as possible to the check-out time.
- Purchase chicken and turkey (frozen or chilled) only if it has the symbol of the veterinary supervision.
  The symbol appears on the product's label and contains the words "checked and approved" and the unique veterinary supervision number of the slaughterhouse.

Highlights for purchasing fish

- Buy fish that are not pre-packaged only if they are displayed in a refrigerator and are covered with ice chips;
- It is completely forbidden to touch the fish by hand before they are cleaned;
- Buy fish that are not pre-packaged only after they have been cleaned by the seller;
- Buy fish that are not pre-packaged only if they have the normal appearance, odor and color;
  - The fish's eyes are black, clear and bulging;
  - The gills are red and not white or gray, and without a rotten smell.

Be sure to take these five simple actions:

1. Separation – separate meat according to its type, poultry and fish separate from each other and from other foods

- Use special utensils (knives and boards) for dealing with raw (uncooked) meat, poultry and fish and which are kept separate from others used to prepare food that is ready to eat without cooking (like salad). It is recommended to deal separately with meat, poultry and fish.

2**. Cleanliness** – wash your hands, dishes and work spaces often

- Adherence to the cleanliness of the equipment and your hands before and after dealing with meat, poultry or fish is designed to prevent the transfer of bacteria that cause diseases from the meat, poultry or fish to other foods and to cooked products (“cross-contamination”).
- After cleaning, koshering, dismembering and all other treatments before cooking, all the remnants that are not to be used should be immediately disposed of, and dishes and hands should be thoroughly and well washed (with soap and water);
- It is especially important to scrub the cutting board with dishwashing liquid, rinse it thoroughly with hot water and dry it in the air – in order to remove the layer of bacteria that is not visible to the naked eye. Washing meat, poultry and fish before cooking may cause environmental contamination by bacteria. If you do wash the product, everything that has come into contact with the rinsing water (sink, countertop, etc.) should be disinfected.

3. **Cooking –** avoid eating meat, poultry and fish that are not cooked

- If you have a cooking thermometer, you can check that temperature at the center of the product has reached a minimum of 70^{o}C. After every check, the thermometer should be thoroughly washed to prevent it reinfecting the cooked product;
- If you cook the meat, poultry or fish when it is frozen, the cooking time needs to be extended compared with the thawed product, so that the entire product is properly cooked and will reach the recommended temperature;
- If you roast or fry the products on a grill (barbeque) or in a frying pan – one should use items that are as thin as possible in order to ensure thorough cooking;
- Use of a microwave oven is only meant for heating products that are ready to eat or to thaw frozen products. It is not recommend to use a microwave oven for cooking products;
- It is not recommended to taste the products during the cooking process, before they have reached the recommended temperature.

4**. Refrigeration** – keep products in the refrigerator or the freezer according to the instructions of the manufacturer or the butcher shop / butcher

- It is recommend to eat the meat immediately after cooking or to place it in the refrigerator (meat that has been cooked and left out of the refrigerator for more than two hours should not be used).

5**. Thawing** – meat, poultry and fish should only be thawed in the refrigerator or in a microwave oven

- The product should be thawed in a closed dish in order to avoid contamination of other products and especially food that is ready to eat;
- When thawing in a microwave oven, make sure to cook immediately after thawing.

- It is not recommended to thaw meat, poultry or fish and refreeze them – not even parts of them.
- When buying frozen products, it is recommended to purchase them in a size that is suitable for your immediate needs, in order to avoid thawing quantities larger than are needed.

Storage of meat, poultry and fish at home

- Store fresh meat, poultry and fish only in the refrigerator at a temperature of 0^o – 4^oC. They should be cooked as soon as possible (according to the instructions of the manufacturer or the butcher). If you wish to store them for a longer period of time, it is recommend to buy in advance frozen meat, poultry and fish;
- Store frozen meat, poultry and fish only in a freezer at a temperature that does not exceed -18^oC;
- Use the stored products no later than the last use-by-date that appears on the package;
- Avoid contact between raw (uncooked) foods of various types, such as meat, eggs and vegetables;
- Avoid contact between raw (uncooked) foods used as raw materials for cooking and foods that are already ready to be eaten.

Special highlights concerning the purchase, treatment and storage of ground meat

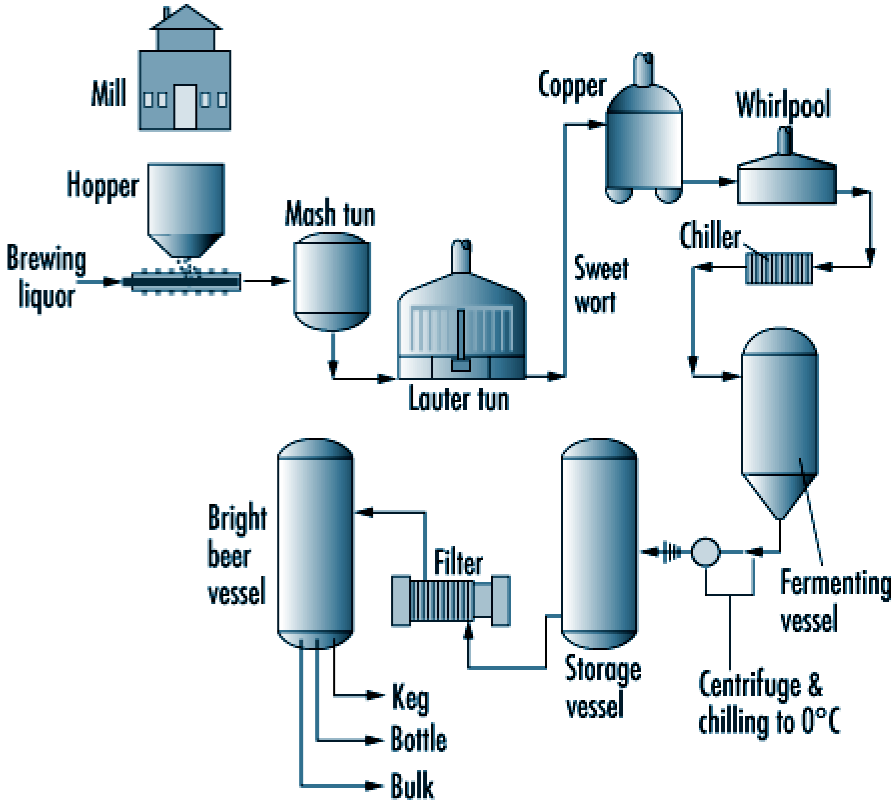
- Ground meat is especially sensitive to bacterial growth and is therefore likely to be dangerous if not treated properly;
- Buy only products that are packaged and labeled or demand that the meat be ground in front of you;
- Buy only frozen ground meat that is produced in a factory with a manufacturer's license; Butcher shops are forbidden to freeze ground meat or any other type of meat. Therefore, check that the frozen ground meat is marked with the name and address of the manufacturing plant.
- Fresh ground meat should be stored in the refrigerator and frozen ground meat in the freezer, until it is used.
- Fresh ground meat should be cooked as soon as possible
  If you wish to store ground meat for a lengthy period of time, it is recommended to buy frozen ground meat and to make sure to use it no later than the last use-by-date that the manufacturer has set;
- It is recommended not to mix ground meat from various types of animals, except during thorough cooking.
  The various types of ground meat (chicken, turkey, beef, mutton, goat, pork) have different types of characteristic bacteria that cause illnesses;
- Be sure not to consume ground meat that has not been thoroughly cooked or fried.
  It is recommended to eat the meat immediately after cooking or to refrigerate it (meat that has been cooked and left out for more than two hours should not be used).

BREWING INDUSTRY

Brewing is one of the oldest industries: beer in different varieties was drunk in the ancient world, and the Romans introduced it to all their colonies. Today it is brewed and consumed in almost every country, particularly in Europe and areas of European settlement.

Process Overview

The grain used as the raw material is usually barley, but rye, maize, rice and oatmeal are also employed. In the first stage the grain is malted, either by causing it to germinate or by artificial means. This converts the carbohydrates to dextrin and maltose, and these sugars are then extracted from the grain by soaking in a mash tun (vat or cask) and then agitating in a lauter tun. The resulting liquor, known as sweet wort, is then boiled in a copper vessel with hops, which give a bitter flavour and helps to preserve the beer. The hops are then separated from the wort and it is passed through chillers into fermenting vessels where the yeast is added—a process known as pitching—and the main process of converting sugar into alcohol is carried out. (For discussion of fermentation see the chapter Pharmaceutical industry.) The beer is then chilled to 0 °C, centrifuged and filtered to clarify it; it is then ready for dispatch by keg, bottle, aluminium can or bulk transport. is a flow chart of the brewing process.



Hazards and Their Prevention

Manual handling accounts for most of the injuries in breweries: hands are bruised, cut or punctured by jagged hoops, splinters of wood and broken glass. Feet are bruised and crushed by falling or rolling barrels. Much can be done to prevent these injuries by suitable hand and foot protection. Increase in automation and standardization of barrel size (say at 50 l) can reduce the lifting risks. The back pain caused by lifting and carrying of barrels and so on can be dramatically reduced by training in sound lifting techniques. Mechanical handling on pallets can also reduce ergonomic problems. Falls on wet and slippery floors are common. Non-slip surfaces and footwear, and a regular system of cleaning, are the best precaution.

Handling of grain can produce barley itch, caused by a mite infesting the grain. Mill-worker's asthma, sometimes called malt fever, has been recorded in grain handlers and has been shown to be an allergic response to the grain weevil (Sitophilus granarius). Manual handling of hops can produce a dermatitis due to the absorption of the resinous essences through broken or chapped skin. Preventive measures include good washing and sanitary facilities, efficient ventilation of the workrooms, and medical supervision of the workers.

When barley is malted by the traditional method of steeping it and then spreading it on floors to produce germination, it may become contaminated by Aspergillus clavatus, which can produce growth and spore formation. When the barley is turned to prevent root matting of the shoots, or when it is loaded into kilns, the spores may be inhaled by the workers. This may produce extrinsic allergic alveolitis, which in symptomatology is indistinguishable from farmer's lung; exposure in a sensitized subject is followed by a rise in body temperature and shortness of breath. There is also a fall in normal lung functions and a decrease in the carbon monoxide transfer factor.

A study of organic dusts containing high levels of endotoxin in two breweries in Portugal found the prevalence of symptoms of organic dust toxic syndrome, which is distinct from alveolitis or hypersensitivity pneumonia, to be 18% among brewery workers. Mucous membrane irritation was found among 39% of workers (Carveilheiro et al. 1994).

In an exposed population, the incidence of the disease is about 5%, and continued exposure produces severe respiratory incapacity. With the introduction of automated malting, where workers are not exposed, this disease has largely been eliminated.

Machinery

Where malt is stored in silos, the opening should be protected and strict rules enforced regarding entry of personnel, as described in the box on confined spaces in this chapter. Conveyors are much used in bottling plants; traps in the gearing between belts and drums can be avoided by efficient machinery guarding. There should be an effective lockout/tagout programme for maintenance and repair. Where there are walkways across or above conveyors, frequent stop buttons should also be provided. In the filling process, very serious lesions can be caused by bursting bottles; adequate guards on the machinery and face guards, rubber gloves, rubberized aprons and non-slip boots for the workers can prevent injury.

Electricity

Owing to the prevailing damp conditions, electrical installations and equipment need special protection, and this applies particularly to portable apparatus. Ground fault circuit interrupters should be installed where necessary. Wherever possible, low voltages should be used, especially for portable inspection lamps. Steam is used extensively, and burns and scalds occur; lagging and protection of pipes should be provided, and safety locks on steam valves will prevent accidental release of scalding steam.

Carbon dioxide

Carbon dioxide (CO_2) is formed during fermentation and is present in fermenting tuns, as well as vats and vessels that have contained beer. Concentrations of 10%, even if breathed only for a short time, produce unconsciousness, asphyxia and eventual death. Carbon dioxide is heavier than air, and efficient ventilation with extraction at a low height is essential in all fermentation chambers where open vats are used. As the gas is imperceptible to the senses, there should be an acoustic warning system which will operate immediately if the ventilation system breaks down. Cleaning of confined spaces presents serious hazards: the gas should be dispelled by mobile ventilators before workers are permitted to enter, safety belts and lifelines and respiratory protective equipment of the self-contained or supplied-air type should be available, and another worker should be posted outside for supervision and rescue, if necessary.

Gassing

Gassing has occurred during relining of vats with protective coatings containing toxic substances such as trichloroethylene. Precautions should be taken similar to those listed above against carbon dioxide.

Refrigerant gases

Chilling is used to cool the hot wort before fermentation and for storage purposes. Accidental discharge of refrigerants can produce serious toxic and irritant effects. In the past, chloromethane, bromomethane, sulphur dioxide and ammonia were mainly used, but today ammonia is most common. Adequate ventilation and careful maintenance will prevent most risks, but leak detectors and self-contained breathing apparatus should be provided for emergencies frequently tested. Precautions against explosive risks may also be necessary (e.g., flameproof electrical fittings, elimination of naked flames).

Hot work

In some processes, such as cleaning out mash tuns, workers are exposed to hot, humid conditions while performing heavy work; cases of heat stroke and heat cramps can occur, especially in those new to the work. These conditions can be prevented by increased salt intake, adequate rest periods and the provision and use of shower baths. Medical supervision is necessary to prevent mycoses of the feet (e.g., athlete’s foot), which spread rapidly in hot, humid conditions.

Throughout the industry, temperature and ventilation control, with special attention to the elimination of steam vapour, and the provision of PPE are important precautions, not only against accident and injury but also against more general hazards of damp, heat and cold (e.g., warm working clothes for workers in cold rooms).

Control should be exercised to prevent excessive consumption of the product by the persons employed, and alternative hot beverages should be available at meal breaks.