SRINIVASAN COLLEGE OF ARTS & SCIENCE, PERAMBALUR-12

DEPARTMENT OF BIOTECHNOLOGY

COURSE FILE

SUBJECT: FOOD TECHNOLOGY **CLASS: III B.SC., BIOTECHNOLOGY**

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Unit: 1 Food Chemistry

Constituent of Food

Carbohydrates:

Carbohydrates, in simplest terms, are sugars and contain carbon, hydrogen and oxygen. They are the main source of energy in the human diet. Carbohydrates can be classified as monosaccharides, the simplest form which includes include glucose, galactose and fructose; disaccharides such as lactose, maltose and sucrose which consists of two units of simple sugars and the most complex polysaccharides that consist of more than two units of monosaccharides viz. starch and cellulose. Rice, maize, wheat, barley, potato, sugarcane, beetroot, banana, grapes etc. are some of the important sources of carbohydrates. Carbohydrates are broken down by the process known as oxidation and energy thus released is utilized by the body to carry out all the functions. The released energy is measured in calories.

Proteins:

Amino acids are the building blocks of proteins. Proteins are complex high molecular weight compounds that play a structural and functional role in all living cells. They are essential for the growth and repair of the body tissues. In terms of human nutrition, proteins are of two types depending on their source – animal protein such as milk, cheese, meat, egg etc. and vegetable protein such as pulses, soya beans, nuts and grains. Proteins are metabolized to provide energy when the body is starved and is devoid of any carbohydrate source.

Fats:

This is the most concentrated source of energy. Fats are made up of carbon, hydrogen and oxygen; the oxygen content is much lesser as compared to that of carbohydrates resulting in the production of a larger amount of energy when oxidized. Fat forms energy reserves in the body and is mainly stored under the skin. Butter, ghee, milk, fish, meat, nuts and oils are the main sources of fat. One gram of fat when burnt gives nine calories of energy.

Vitamins:

Vitamins are vital for maintaining normal growth and health. Unlike carbohydrates, proteins and fats, vitamins do not provide energy but they are essential for proper absorption of carbohydrates, proteins, fats and minerals by the body. The various types of vitamins are A, B, C, D, E and K. There is no single food that provides all the vitamins required for our body, hence a variety of foods should be taken in balance in order to obtain all these vitamins in required amounts. Deficiency of vitamins leads to various disorders.

Minerals:

Minerals such as iron, calcium, copper, iodine, sodium, phosphorus, zinc etc. along with vitamins are required in small quantities by our body for normal growth and proper functioning. Iron is the main component of haemoglobin that transports oxygen to tissues. Calcium is required for the formation of bones and teeth. Likewise, each of the minerals has a role in maintaining body functions.

Water:

Water constitutes 70% of our body and is required for all the biological processes in our body. It is essential for transporting food, hormones and other nutrients throughout the body. It flushes out toxins and other wastes out of the body in the form of urine and sweat. It regulates body temperature

Roughage:

The fiber content of our diet that helps in easy movement of food in the alimentary canal is known as roughage. It is essential for the proper functioning of the digestive system. Fruits, vegetables, corn, salads and cereals are highly fibrous foods.

Contribution of Texture in Food

Texture is important in determining the eating quality of foods and can have a strong influence on food intake and nutrition. Perceived texture is closely related to the structure and composition of the food, and both microscopic and macroscopic levels of structure can influence texture.

Texture, and the related mouthfeel of a product, plays an essential role in how consumers evaluate a product. In some cases, these characteristics are even more important than those of taste, appearance, or smell. Texture refers to how the physical attributes of a food texture are processed by the brain during mastication. Characteristics like hard, soft, crispy, crunchy, are used by consumers to describe food texture. Mouthfeel is related to texture in that it refers to the interactions between the surfaces in the mouth and the food. In its most simple form, mouthfeel is exactly that: how it feels in the mouth.

Contribution of Flavor in Food

Flavor or flavour (see spelling differences) is the sensory impression of a food or other substance, and is determined mainly by the chemical senses of taste and smell. The flavor of the food, as such, can be altered with natural or artificial flavorants, which affect these senses.

Flavors help retain the original savoriness and aroma of ingredients, and are used as healthy seasonings in a wide range of food products. flavors incorporate natural components such as amino acids and peptides which contribute to savoriness and richness. Other such components include organic acids such as lactic and citrus acids, as well as inosinic acid, guanylic acid, and other nucleic acid-like substances.

Organoleptic Properties of Food

Organoleptic means making an impression on an organ of special sense: sight, hering, feeling, smell, and taste. The physical and chemical characteristics of food are stimuli for the eye, ear, skin and muscles, nose, and mouth whose receptors initiate impulses that travel to the brain where perception occurs. Perception or correlation of sensory impressions determines whether a food will be accepted or rejected.

Sight

The appearance of the food to our eyes is the most critical parameter. One eats with the eyes first! It is this feature of our senses the judges the food for its freshness, colour, appeal, dullness, glossy, juicy etc.If the eye appeal is not good then the food goes in for a complete rejection.

Smell

The smell of the food is defined as flavour in cooking odour, it contributes to the pleasure of eating. Volatile molecules from the food stimulate olfactory nerves and they guide our perceptions of food being sweet, bitter, spicy, sour or acidic. All these perceptions are associated with taste.

Aroma- is the smell of the food mixed with the taste buds. Flavour can be obtained by smelling but the aroma of the dish, one has to taste the dish.

Taste

Taste is registered on the taste buds on the tongue. The taste buds register the food being salty, acidic, bitter, spicy or pungent. There is another taste known as the sixth sense, which is an undefined taste. It is known as umami factor in Japanese. This taste cannot be described as it is a mix of many tastes that coat the tongue but one can feel the sensation on the palate for a long time.

Touch

This feature of the food can be defined in many ways such as texture, mouthfeel and even temperature of the food. We all expect tea coffee or soup to be very hot or chilled. If not served at the right temperature, it will be rejected. Many adjectives such as crunchy, soft, brittle, smooth describe the texture of food. Texture can also be described as a consistency. Liquids, semi-liquids

Sound

The crispy bite of fresh sliced onions or the crackling sound of the crispies satisfies the sound element of the food. One can thus see that the balance of organoleptic tasting completes the feeling of satisfaction. If even one element in the meal is missing, the overall experience does not seem to be right. The tasting of food is not only limited to the food trials and trade tests but also been done for F & B industry. Today tea, coffee and wine experts are being hired for tasting. Tasters are people whose sensitivity and consistency have been established by training and repeated tests. Such people are called connoisseurs.

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. Food additives also include substances that may be introduced to food indirectly (called "indirect additives") in the manufacturing process, through packaging, or during storage or transport

Types

Direct or intentional food additives which are added deliberately to improve its sensory quality, stability, ease in processing and retention of quality during handling and retailing.

Indirect or unintentional food additives which get included into foods incidentally during handling, processing and packaging.

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

- Incresasing shell life
- Modifying its texture
- 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.

Examples:

fertilizer and pesticies residue from farm, lubricants from food processing equipment and chemicals from packaging materials.

Function of Food Additives

- Preserve Flavour
- Enhance taste & Improves acceptability and appearance
- Maintain nutritional quality
- Enhancing quality
- 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

- Preservatives
- Antioxidants
- Sweeteners
- Food colour and Flavor
- Stabilizer
- Emulsifiers

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.

Antioxidants

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

For Example butylated hydroyanisole (BHA), Butylated hydroxy toluene (BHT), Tertiary butyl hydroquinone (TBHQ) are added to the oil in which snacks are fried to prevent the unsaturated from turning rancid.

Artificial sweetner

They are also called non-nutritive sweetner as they do not provide any calories or provide negligible calories as compared to sugar. Low calorie sweetner are available as sugar substitute in food and beverage.

Examples: cyclamate, aspartame, dulcin, saccharin, sucralose, ace sulfame k.

Food Colours

Coloring agent used in food processing industry include 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.

Note:

Permitted synthetic colour by Food and drug administration are :-

- Red-----Ponceau4, carmoisine, erythrosine

- Yellow--Taryrazine, sunset yellow FCF
- Blue- - - Indigo carmine, brilliant blue FCF
- Green---Fast green FCF

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.

Examples: 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.

Emulsifying Agents

Emulsifiers 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 is lecithin in egg yolk and caseinogens in milk. Synthetic Emulsifying agent are glyceryl mono sterate (GMS), stearyl tartarate and polyoxyethylene mono-sterate.

Enzymes in food processing

Microbial enzymes are widely used in food processing: many new enzymes and enzyme processes acting on nearly all types of organic food components — starch, sugars, proteins, fats, fibers, and flavour compounds — have come into the industry during the 1980s and their application has a major impact on enzyme technology in general

Processed foods provide convenience, improved shelf-life, increased palatability and offer variety in the diet. Several processing techniques – physical and chemical- are used for obtaining the finished product. Chemical methods are harsh and affect the quality of the product adversely. Enzymes offer an alternative to chemical catalysis as they work under mild conditions of pH and temperature.

Proteases

- Protein hydrolysis for flavour enhancement in protein digest
- Meat tenderization
- Enhanced digestibility of wheat gluten
- Degradation of the turbidity complex in fruit juice and alcohol
- Curdling of milk by breaking down kappa-caseins in cheese making

Amylase

- Starch liquefaction and sacchcarification
- preparation of maltose and high fructose syrup
- Increase bread softness and volume
- Conversion of dextrin to fermentable sugar for low calorie beer

Cellulase

- Starch liquefaction and sacchcarification
- Preparation of maltose and high fructose syrup
- Conversion of dextrin to fermentable sugar for low calorie beer

Lipase

- Cheese ripening
- Hydrolysis of milk fat, improve aroma in beverages
- Improve quality of edible of oils and fats
- Functional food ingredient to reduce cholesterol level in blood
- In-situ emulsification for dough conditioning

Pectinase

- Facilitate juice extraction, clarification and filtration
- Production of functional oligosaccharide (Pecto-oligosaccahride)
- Improves the yield and quality of essential oils (pepper and cardamom)
- Preparation of modified pectins used as functional food ingredient

Xylanase

- Dough conditioning, elasticity of the gluten network and crumb structure
- Increase bread softness and volume
- Xylo-oligosaccaride synthesis

β- Galactosidase

- Breakdown of lactose for the production of low-lactose/lactose free milk
- Production of galacto-oligosaccharides from lactose

Phytase

- Improve nutritional value of plant-based food
- Release phosphate and other nutrients from phytate and increase the bioavailability of some trace minerals, including copper, manganese, iron and zinc
- Enhance digestibility

Tannase

- Releasing of gallic acid and glucose from tannin
- Removal of tannins from a green tea infusion, preparation of instant tea

Unit: 2 Food Microbiology

Sources of Microorganisms in Food

The primary sources of microorganisms in the food are explained below:

Soil Microbial Flora:

The soil contains the greatest variety of microorganism of any sources of contamination. The fertile soil contains large number of microorganisms which are contaminating the surfaces of plants growing on it and animals roaming over the land. Soil dust whipped by air current and soil particles are carried by running water to get into or on to foods.

The soil is important source of heat resistant spore forming bacteria. The most important types of organisms contaminating through soil are Bacillus, Clostriduim, E. coli, Enterobacter, Flavobacterium, Pseudomonas, Proteus, Leuconostoc, Chromobacterium, Acetobacter, etc.

Microorganism in Water:

Water is an important sources of microorganism especially coliforms which are indicator organisms for fecal contamination. Natural water contains the natural flora as well as the microorganism from soil, animals and sewage. Surface water like stream, pools and stored water like lake and large pond contain variety of microbial flora.

Groundwater from spring or wells has passed through layers of rock and soil contributes variety and kinds of microorganisms. The important kinds of bacteria in natural waters are Pseudomonas, Chromobacterium, Proteus, Micrococcus, Bacillus, Streptococcus, Enterobacter, and E. coli. The common waterborne bacteria are called coliforms. These are gram- negative, non sporulating facultative motile /non motile rods indicate water contamination. Hence these organisms are called indicator organisms. The bacterial flora of seawater is essentially gram-negative and gram-positive including many varieties.

Airborne Microorganisms:

Air is another source of contamination in food. Because it contributes dust, droplets, droplet nuclei, aerosols and suspended particle. Disease organisms especially those causing respiratory infections may spread by air. Microorganisms get into air on dust, or lint, dry

Asoil, spray from streams, lakes, or oceans, droplets of moisture on walls, ceilings, floors, foods and ingredients.

The microorganisms in the air will not grow because the lack of nutrients but they will suspend in air for very long time. Fungal spores and bacterial spores are predominant in air, mould spores are more resistant to drying and persisting for very long time. Among bacteria cocci are predominant than rods. Yeasts are also present in air.

The number of microorganisms in the air may be depending on so many factors such as sunshine, location and the amount of suspended dust or spray. The number of organisms in air is increased by air currents caused by movements of people by ventilation and by breeze. Dry air contains more organisms than moist air. Rain or snow removes the organism from the air.

Microorganism in Vegetation:

The natural surface flora of plants varies with the plant but generally include the species of Bacillus, Pseudomonas, Alcaligenes, Flavobacterium, Micrococcus, coliforms and lactic acid bacteria. The number of bacteria will depends on the plant and its environment and may range from a few hundred or thousand per square centimeter of surface to million.

The outer tissues of unwashed cabbages might contain 1 million to 2 million microorganisms per gram but washed and trimmed cabbage might contain fewer organisms. Exposed surface of plants become contaminated from soil, water, sewage, air, and animal so that microorganisms from these sources are added to the natural flora.

Plants are associated with the bacterial plant pathogens such as Corynebacterium, Curtobacterium, Pectobacterium, Pseudomonas and Xanthomonas; and fungal pathogens among several genera of moulds.

Microorganisms from Animal:

The sources of microorganisms from animals include the surface flora, the flora of respiratory tract and the flora of the gastroin-testinal tract. Hides, hooves, and hair of animal contain large number of microorganisms from soil, manure, feed and water.

Similarly feathers and feet of poultry carry heavy contamination from soil and other sources. The skins of many meat animals contain Micrococcus, Staphylococcus, and β hemolytic Streptococcus. The feces and fecal contaminated products of animals can contain many enteric pathogens. Animal contributes their wastes and finally their bodies to the soil and water which contain large group of microbial flora.

So many pathogenic organisms are present in animal and animal products including Brucella sps, Mycobacterium tuberculosis, Coxiella burnetti, Salmonella typhi and paratyphi, Listeria monocytogens, Campylobacter jejuni, P haemolytic Streptococcus, enteopathogenic E. coil, Clostridium perfringens and Clostridium bolutinum.

Microorganisms from Food Handlers and Food Equipment:

The microbial flora on the hands and outer garments of handlers generally reflect the environment and habits of individuals and the organisms may be those from soil, water, dust and other environmental sources. Additional important sources are those that are common in nasal cavities, the mouth and on the skin, and those from the gastrointestinal tract that may enter food through poor personal hygiene practices. When vegetables are harvested in containers and utensils, it is expected to find some of the surface organisms on the products to contaminate contact surfaces. As more and more vegetables are placed in the same containers, a normalization of the microbial flora will takes place. Similarly, the cutting block in a meat market along with cutting knives and grinders are contaminated from initial samples, and this process leads to contribute meat-borne organisms.

Microorganisms associated with food

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. 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 traveller'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 immunocompromised, 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 watery diarrhea, which can reach up to 20 liters/ 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.

Fermentation of Food

Fermentation is a metabolic process in which an organism converts a carbohydrate, such as starch or a sugar, into an alcohol or an acid. For example, yeast performs fermentation to obtain energy by converting sugar into alcohol. Bacteria perform fermentation, converting carbohydrates into lactic acid. The study of fermentation is called zymology.

Why fermented food is so nutritive?

Food fermentation serves five main purposes:

- To enrich the diet through development of a diversity of flavors, aromas, and textures in food substrates
- To preserve substantial amounts of food through lactic acid, alcohol, acetic acid, and alkaline fermentations
- To enrich food substrates with protein, essential amino acids, and vitamins
- To eliminate antinutrients; and
- To reduce cooking time and the associated use of fuel.

What happens in Fermentation?

Fermentation occurs in the absence of oxygen (anaerobic conditions), and in the presence of beneficial microorganisms (yeasts, molds, and bacteria) that obtain their energy through fermentation. If enough sugar is available, some yeast cells, such as Saccharomyces cerevisiae, prefer fermentation to aerobic respiration even when oxygen is abundant.

During the fermentation process, these beneficial microbes break down sugars and starches into alcohols and acids, making food more nutritious and preserving it so people can store it for longer periods of time without it spoiling.

Fermentation products provide enzymes necessary for digestion. This is important because humans are born with a finite number of enzymes, and they decrease with age. Fermented foods contain the enzymes required to break them down. Fermentation also aids in pre-digestion. During the fermentation process, the microbes feed on sugars and starches, breaking down food before anyone's even consumed it.

What are the Advantages of Fermentation?

Fermented foods are rich in probiotics, beneficial microorganisms that help maintain a healthy gut so it can extract nutrients from food.

Probiotics aid the immune system because the gut produces antibiotic, anti-tumor, anti-viral, and antifungal substances, and pathogens don't do well in the acidic environment fermented foods create.

Fermentation also help to neutralize anti-nutrients like phytic acid, which occurs in grains, nuts, seeds, and legumes and can cause mineral deficiencies. Phytates also make starches, proteins, and fats less digestible, so neutralizing them is extremely beneficial.

Fermentation can increase the vitamins and minerals in food and make them more available for absorption. Fermentation increases B and C vitamins and enhances folic acid, riboflavin, niacin, thiamin, and biotin. The probiotics, enzymes, and lactic acid in fermented foods facilitate the absorption of these vitamins and minerals into the body.

Food Chemicals

Most of us go about our busy lives, grabbing food on the go without thinking much about what's in it. We mistakenly assume that because it's sold on a shelf, it's regulated with healthy and consumable ingredients. In reality, you may be surprised at what kinds of additives and chemicals are legally allowed in some of the food you eat daily.

Artificial Flavoring

Artificial flavoring is a blanket term that refers to man-made chemicals created to taste the same as natural flavors, such as vanilla, strawberry, or lemon. Because it's cheaper to use in most products, it's very common. Studies suggest it may result in behavioral changes.

High Fructose Corn Syrup

This sweetener, made from corn, is popular with food manufacturers because it's cheaper and sweeter than cane sugar, and it maintains moisture, while preserving freshness. This additive is extremely common in processed food and is believed to contribute to heart disease. In addition to accelerating the aging process, it also raises cholesterol and triglyceride fats in the blood, making it more prone to clotting.

Monosodium Glutamate (MSG)

MSG is made of components naturally found in our bodies of water, sodium and glutamate, but that doesn't mean it's meant to be ingested. MSG is a flavor enhancer often used in seasonings, condiments, bouillons, and snack chips. It reportedly causes headaches, seizures, nausea, tightening in the chest, and a burning sensation in the forearms and neck. MSG may also be listed as "hydrolyzed soy protein" or "autolyzed yeast."

Sodium Benzoate

Sodium Benzoate is used as a preservative in both drinks and food products. When used in conjunction with food color, sodium benzoate may increase hyperactivity in children. It may also react with vitamin C to create a cancer-causing substance called benzene.

Aspartame

Aspartame is an artificial sweetener commonly used in diet drinks and some food products. Aspartame has been controversial for years and has been reported to cause seizures, headaches, mood disturbances, and even cancer. It may be listed as a brand name such as Equal or NutraSweet.

Benzoic Acid

Benzoic Acid is an additive used in everything from chewing gum and ice cream to pickles and salad dressing. Benzoic Acid can contribute to asthma attacks and hyperactivity, as well as headaches and digestive issues.

Potassium Bromate

An additive banned in Europe, Canada, Asia, and Brazil, Potassium Bromate is an oxidizing agent that chemically ages flour, strengthening its elasticity. It has caused cancer in some animals, and even small amounts create a risk for humans. Consumers might also see it listed on a food label as bromated flour.

Sodium Caseinate

Sodium Caseinate is a biochemical found in many dairy products. It's suspected to contribute to or cause many milk-based allergies, which result in reactions such as skin rashes, stomach upset, or respiratory arrest. Ingesting large quantities of Sodium Caseinate can also harm your kidneys.

BHA (Butylated Hydroxyanisole)

BHA is a preservative frequently found in many foods such as butter, cereal, beer, baked goods, dessert mixes, and chewing gum. While it is "generally recognized as safe" by the Food and Drug Administration, the National Institute of Health categorizes it as "reasonably anticipated to be a human carcinogen."

Canthaxanthin

Canthaxanthin is a color additive used in foods that need a boost of yellow or red, like eggs or salmon. Studies have found that great quantities of Canthaxanthin can result in retinal damage.

Nitrates/Nitrites

Nitrates are a synthetic food preservative often added to cured meat. When nitrates are exposed to high heat during the cooking process, they convert to nitrites. Nitrites combine with amines to form cancer causing nitrosamines.

Coloring Additives

Coloring additives are found in almost every kind of processed food and drink. Artificial food coloring is widely thought to contribute to increased hyperactivity in children. In the 1970's Red #2 was banned when it was proven to cause cancer in lab rats, followed closely by Orange #1. While Yellow #1, #2, #3 and #4 have been made illegal, Yellow #5 is undergoing tests for links to anxiety, migraines, hyperactivity and cancer. Yellow #6 has caused adrenal tumors in animal testing, and occasional hypersensitivity reactions.

Food borne Diseases / Food intoxification

A disease caused by consuming contaminated food or drink. There are more then 250 known foodborne diseases. The majority is infectious and is caused by bacteria, viruses, and parasites. Other foodborne diseases are essentially poisonings caused by toxins, chemicals contaminating the food.

All foodborne microbes and toxins enter the body through the gastrointestinal tract and often cause the first symptoms there. Nausea, vomiting, abdominal cramps and diarrhea are frequent in foodborne diseases.

Many microbes can spread in more than one way, so it may not be immediately evident that a disease is foodborne. The distinction matters, because public health authorities need to know how a particular disease is spreading to take the appropriate steps to stop it. For example, infections with Escherichia coli O157:H7 (E. coli O157:H7) can be acquired through contaminated food, contaminated drinking water, contaminated swimming water, and from toddler to toddler at a day care center. Depending on which means of spread cause a case, the measures to stop other cases from occurring could range from removing contaminated food from stores, chlorinating a swimming pool, or closing a child day care center.

The most common foodborne infections are caused by three bacteria -- Campylobacter, Salmonella, and E. coli O157:H7 -- and by a group of viruses called calicivirus, better known as Norwalk-like virus:

Campylobacter -- Campylobacter is the most common bacterial cause of diarrheal illness in the world. The bacteria live in the intestines of healthy birds, and most raw poultry meat has Campylobacter on it. Eating undercooked chicken, or other food that has been contaminated with juices dripping from raw chicken is the most frequent source of this infection. Aside from diarrhea, common symptoms include causes fever, diarrhea, and abdominal cramps.

Salmonella Salmonella is widespread in the intestines of birds, reptiles and mammals. People can acquire the bacteria via a variety of different foods of animal origin. The illness it causes is called salmonellosis and typically includes fever, diarrhea and abdominal cramps. In persons with poor underlying health or weakened immune systems, Salmonella can invade the bloodstream and cause life-threatening infections.

E. coli O157:H7 E. coli O157:H7 has a reservoir in cattle and other similar animals. Illness typically follows consumption of food or water that has been contaminated with microscopic amounts of cow feces. The illness it causes is often a severe and bloody diarrhea and painful abdominal cramps, without much fever. But in 3 to 5% of cases, a life-threatening complication called the hemolytic uremic syndrome (HUS) can occur several weeks after the initial symptoms, resulting in anemia, profuse bleeding, and kidney failure.

Calcivirus (Norwalk-like virus)

Calicivirus (Norwalk-like virus) is an extremely common cause of foodborne illness (though it is rarely diagnosed, because the laboratory test is not widely available). It causes an acute gastrointestinal illness, usually with more vomiting than diarrhea, that resolves within two days. Unlike many foodborne pathogens that have animal reservoirs, it is believed that Norwalk-like viruses spread primarily from one infected person to another. Infected kitchen workers can contaminate a salad or sandwich as they prepare it, if they have the virus on their hands. Infected fishermen have contaminated oysters as they harvested them.

Food toxins Some foodborne diseases are caused by a toxin in the food that was produced by a microbe in the food. For example, staph bacteria (Staphylococcus aureus) can grow in food and produce a toxin that causes intense vomiting. The rare but deadly disease botulism occurs when the bacterium Clostridium botulinum grows and produces a powerful paralytic toxin in foods. These toxins can produce illness even if the microbes that produced them are no longer there.

Note:

Other foodborne diseases -- Among the many other foodborne diseases are the following: amebiasis (Entamoeba histolytica infection), Blastocystis hominis infection, bovine spongiform encephalopathy (BSE) and Creutzfeldt-Jakob disease (CJD), cholera, cryptosporidiosis (crypto), cyclospora cayetanensis, diarrheagenic Escherichia coli (E. coli), viral gastroenteritis, giardiasis, listeriosis, marine toxins shigellosis, travelers' diarrhea, trichinosis (trichinellosis), typhoid, Vibrio parahaemolyticus and Vibrio vulnificus infection.

Magnitude of the problem: An estimated 76 million cases of foodborne disease occur each year in the US alone. The great majority of these cases are mild and cause symptoms for only a day or two. Some cases are more serious, and CDC estimates that there are 325,000 hospitalizations and 5,000 deaths related to foodborne diseases each year in the US. The most severe cases tend to occur in the very old, the very young, those who have an illness already that reduces their immune system function, and in healthy people exposed to a very high dose of an organism.

Food spoilage

Food spoilage is the process of change in the physical and chemical properties of the food so that it becomes unfit for consumption and is caused by bacteria, moulds and yeasts. Food spoilage is any undesirable change in food. Most natural foods have a limited life: for example, fish, meat, milk and bread are perishable foods, which mean they have a short storage life and they easily spoil. Other foods also decompose eventually, even though they keep for a considerably longer time. The main cause of food spoilage is invasion by microorganisms such as fungi and bacteria.

Microbial spoilage

Microbial spoilage is caused by microorganisms like fungi (moulds, yeasts) and bacteria. They spoil food by growing in it and producing substances that change the colour, texture and odour of the food. Eventually the food will be unfit for human consumption.

When food is covered with a furry growth and becomes soft and smells bad, the spoilage is caused by the growth of moulds and yeasts. Microbial spoilage by moulds and yeasts includes souring of milk, growth of mould on bread and rotting of fruit and vegetables. These organisms are rarely harmful to humans, but bacterial contamination is often more dangerous because the food does not always look bad, even if it is severely infected. When microorganisms get access to food, they utilise the nutrients found in it and their numbers rapidly increase. They change the food's flavour and synthesise new compounds that can be harmful to humans. Food spoilage directly affects the colour, taste, odour and consistency or texture of food, and it may become dangerous to eat. The presence of a bad odour or smell coming from food is an indication that it may be unsafe. But remember that not all unsafe food smells bad.

Physical spoilage

Physical spoilage is due to physical damage to food during harvesting, processing or distribution. The damage increases the chance of chemical or microbial spoilage and contamination because the protective outer layer of the food is bruised or broken and microorganisms can enter the foodstuff more easily. For example you may have noticed that when an apple skin is damaged, the apple rots more quickly.

Chemical spoilage

Chemical reactions in food are responsible for changes in the colour and flavour of foods during processing and storage. Foods are of best quality when they are fresh, but after fruits and vegetables are harvested, or animals are slaughtered, chemical changes begin automatically within the foods and lead to deterioration in quality. Fats break down and become rancid (smell bad), and naturally-occurring enzymes promote major chemical changes in foods as they age.

Enzymic spoilage (autolysis)

Every living organism uses specialised proteins called enzymes to drive the chemical reactions in its cells. After death, enzymes play a role in the decomposition of once-living tissue, in a process called autolysis (self-destruction) or enzymic spoilage. For example, some enzymes in a tomato help it to ripen, but other enzymes cause it to decay Once enzymic spoilage is under way, it produces damage to the tomato skin, so moulds can begin to can attack it as well, speeding the process of decay.

Unit: 3 Food Processing

Characteristics of the Raw Materials used in Food Processing

Physical Characteristics

- Shape
- Surface area
- Appearance Size
- Density Drag
- coefficient
- Weight Porosity
- Center of gravity
- Volume
- Color

Mechanical Properties

- Hardness
- Sliding coefficient of friction
- Compressive strength
- Static coefficient of friction
- Tensile strength Coefficient of expansion
- Impact resistance Shear resistance
- Compressibility a. moisture b. thermal Elasticity
- Plasticity Bending strength
- Aerodynamic properties
- Hydrodynamic properties

Thermal Properties

- Specific heat
- Thermal conductivity
- Emmisivity
- Thermal capacity
- Surface conductance
- Transmissivity
- Thermal diffusivity Absorptivity

Electrical Properties

- Conductance
- Dielectric properties
- Resistance
- Reaction to electromagnetic radiation
- Capacitance & Conductivity—ability of seeds to hold a surface charge

Optical Properties

- Light transmittance & absorptance
- Contrast
- Light reflectance
- Color
- Intensity

Cleaning, Sorting and Grading of Foods

Cleaning

Food, whether from animals or plants are produced in the physical environment and are therefore exposed to the elements. Contaminants may fall in either physical, chemical or biological hazards. Physical hazards may include leaves, slicks, stones, metal, plastic, dust, sand, insect parts, and rat droppings. Chemical hazards may include natural toxins such as mycotoxins, and pesticides. Physiological hazards may be bacteria, yeast, mold, parasites and viruses. Much of these contaminants are removed at the cleaning stage. Cleaning may be by dry or wet method.

Dry cleaning is common in grains and pulse processing. Cleaning may involve a variety of mechanism. For example, passing the grain e.g. wheat through a stream of air to lift of light unwanted particles such a leaves and dust. Size separation devises such as seize are used to separate contaminants that are larger or smaller than wheat. Gravity tables are employed to separate materials by density such as stones. Imaging machines are used to identify and separate contaminants by color, and magnets are used to trap and remove metals.

Wet cleaning methods are more suitable for food that will not observe water such as fruits and vegetables. It is a more effective method than dry cleaning for removing dust and pesticides. However, if water is not removed from the surface properly, this may lead to spoilage. The need for clean water and treatment of effluent at the end of the process may increase operational cost. Common methods wet cleaning include soaking, spraying and floatation of produce in troughs (called fluming).

Sorting:

Sorting during the material preparation process involves placing produce into categories based on specifications or standards to be met. For example, foods may be processed based on differences in physical properties such as color, texture, size, shape and weight. For example, pumpkins for the fresh market should preferably be of uniform shape, weight and size for packing. Those that have irregular shape or are too big or too small can be diverted for cooking and pulping for use in value added products such as pies and or decorated and added to soups. Separation may also be done based on chemical composition such as bricks (sugar content). Juice processors for example will want fruits that have high sweetness with an acceptable balance in acidity. In flour milling, flour is stored into different streams and package based on bran and protein content.

Grading

Grading is the assessment of a number of characteristics of a food to obtain an indication of its overall quality. Grading is normally carried out by trained operators. Meats, for example, are examined by inspectors for disease, fat distribution, carcasse size and shape. Other graded foods include cheese and tea. In some cases the grading of food is based on laboratory analyses results. In the wine industry, grading also covers the necessary classification of the grapes harvested according to their degree of maturity (for example, sugar content). Many characteristics cannot be examined automatically and trained operators are employed to simultaneously assess several characteristics in order to produce a uniform high-quality product. Grading is more expensive than sorting (which looks at only one characteristic) due to the high costs of the skilled personnel required.

Physical Conversion Operations

Mixing

Mixing is the dispersing of components, one throughout the other. It occurs in innumerable instances in the food industry and is probably the most commonly encountered of all process operations. Unfortunately, it is also one of the least understood. There are, however, some aspects of mixing which can be measured and which can be of help in the planning and designing of mixing operations

Ideally, a mixing process begins with the components, grouped together in some container, but still separate as pure components. Thus, if small samples are taken throughout the container, almost all samples will consist of one pure component. The frequency of occurrence of the components is proportional to the fractions of these components in the whole container.

As mixing then proceeds, samples will increasingly contain more of the components, in proportions approximating to the overall proportions of the components in the whole container. Complete mixing could then be defined as that state in which all samples are found to contain the components in the same proportions as in the whole mixture.

Emulsification

Emulsions are stable suspensions of one liquid in another, the liquids being immiscible. Stability of the emulsion is obtained by dispersion of very fine droplets of one liquid, called the disperse phase, through the other liquid, which is called the continuous phase. The emulsion is stable when it can persist without change, for long periods of time, without the droplets of the disperse phase coalescing with each other, or rising or settling. The stability of an emulsion is controlled by

- interfacial surface forces,
- size of the disperse phase droplets,
- viscous properties of the continuous phase and
- density difference between the two phases.

The dispersed particles in the emulsion have a very large surface area, which is created in the process of emulsification. Surface effects depend upon the properties of the materials of the two phases, but very often a third component is added which is absorbed at the interface and which helps to prevent the droplets from coalescing. These added materials are called emulsifying agents and examples are phosphates and glycerol monostearate.

Size Reduction - Extraction / Grinding

Breaking of solid material through the application of mechanical force is a frequent requirement in many food-processing operations. The size reduction aids in obtaining of desired constituent from a composite structure e.g; flour from wheat grains or juice from sugar cane. Sometimes it is specific product requirement for. product development e.g; spices powder, icing sugar etc. Size reduction results in increase in surface area

In the extracting process, materials are reduced in size by fracturing them. The mechanism of fracture is not fully understood, but in the process, the material is stressed by the action of mechanical moving parts in the grinding machine and initially the stress is absorbed internally by the material as strain energy. When the local strain energy exceeds a critical level, which is a function of the material, fracture occurs along lines of weakness and the stored energy is released. Grinding is, therefore, achieved by mechanical stress followed by rupture and the energy required depends upon the hardness of the material and also upon the tendency of the material to crack - its friability.

Filteration

In another class of mechanical separations is filteration, it is achived by placing a screen in the flow through which they cannot pass imposes virtually total restraint on the particles above a given size. The fluid in this case is subject to a force that moves it past the retained particles The particles suspended in the fluid, which will not pass through the apertures, are retained and build up into what is called a filter cake. Sometimes it is the fluid, the filtrate, that is the product, in other cases the filter cake.

The fine apertures necessary for filtration are provided by fabric filter cloths, by meshes and screens of plastics or metals, or by beds of solid particles. In some cases, a thin preliminary coat of cake, or of other fine particles, is put on the cloth prior to the main filtration process. This preliminary coating is put on in order to have sufficiently fine pores on the filter and it is known as a pre-coat.

Centrifugation

It may be defined as a unit operation involving the separation of solid from liquids or liquids from liquids mixtures by application of centrifugal force. The principle of operation is the difference in densities between solid and liquid or liquid and liquid that are to be separated from each other. It is used mainly for the separation of two immiscible liquids, centrifugal clarification, desludging and centrifugal filtration.

The separation by sedimentation of two immiscible liquids, or of a liquid and a solid, depends on the effects of gravity on the components. Sometimes this separation may be very slow because the specific gravities of the components may not be very different, or because of forces holding the components in association, for example as occur in emulsions. Also, under circumstances when sedimentation does occur there may not be a clear demarcation between the components but rather a merging of the layers

Membrane separation

It is a process of separating food components by using semipermeable membranes, basing on the molecular size and molecular weight of the components. The driving force of the separation process is, for example, differences in concentration or pressure between the two sides of the membrane. Membrane separation processes can remove much smaller substances, such as viruses and dissolved ions, from the water.

Reverse Osmosis

It is a membrane separation process, driven by a pressure gradient, in which the membrane separates the solvent (generally water) from other components of a solution. The solvent flow is opposite to the normal osmotic flow.

Crystallization

It is an example of a separation process in which mass is transferred from a liquid solution, whose composition is generally mixed, to a pure solid crystal. Soluble components are removed from solution by adjusting the conditions so that the solution becomes supersaturated and excess solute crystallizes out in a pure form. This is generally accomplished by lowering the temperature, or by concentration of the solution, in each case to form a supersaturated solution from which crystallization can occur. The equilibrium is established between the crystals and the surrounding solution, the mother liquor. The manufacture of sucrose, from sugar cane or sugar beet, is an important example of crystallization in food technology. Crystallization is also used in the manufacture of other sugars, such as glucose and lactose, in the manufacture of food additives, such as salt, and in the processing of foodstuffs, such as ice cream. In the manufacture of sucrose from cane, water is added and the sugar is pressed out from the residual cane as a solution. This solution is purified and then concentrated to allow the sucrose to crystallize out from the solution.

Heat Processing

Heat kills microorganisms by changing the physical and chemi-cal properties of their proteins. When heat is used to preserve foods, the number of microorganisms present, the microbial load, is an important consideration. Various types of microorganisms must also be considered because different levels of resistance exist. For example, bacterial spores are much more difficult to kill than vegetative bacilli. In addition, increasing acidity enhances the killing process in food preservation.

Three basic heat treatments are

- Pasteurization, in which foods are treated at about 62°C for 30 minutes or 72°C for 15 to 17 s;
- Hot filling, in which liquid foods and juices are boiled before being placed into containers;
- Steam treatment under pressure, such as used in the canning method.

The heat resistance of microorganisms is usually expressed as the thermal death time, the time necessary at a certain temperature to kill a stated number of particular microorganisms under specified conditions.

Unit: 4 Food Preservation

Use of High Temperature

Heat treatment of products is one of the main techniques in the food industry for food conservation. Heat treatment stops bacterial and enzyme activity; thus preventing a loss of quality and keeping food non-perishable

Sterilisation:

Sterilization is a controlled heating process used to completely eliminate all living micro-organisms, including thermoresistant spores in milk or other food. It can be achieved by moist heat, dry heat, filtration, irradiation, or by chemical methods. Compared to pasteurisation, a heat treatment of over 100°C is applied for a period long enough to lead to a stable product shelf-life..

Generally in sterilization, the product is canned or bottled

Sterilization with moist heat:

In sterilisation with moist heat, temperatures generally range from 110 to 130°C with sterilization times being from 20 - 40min. For example, canned foods are sterilised in an autoclave at about 121°C for 20min. Higher temperatures and shorter times may have similar effects, e.g. 134°C for 3min. However, if conditions do not allow the germination of spores, lower temperatures and shorter times can also be applied. For example, with acid fruit juices, jam, or desserts, heating to 80 – 100°C for 10min is normally sufficient.

Sterilization with dry heat:

For killing bacterial endospores by dry heat, longer exposure times (e.g. up to 2 hours) and higher temperatures (e.g. 160 – 180°C) are required than with moist heat.

Sterilization by chemical means:

Chemical means may also be applied. Ethylene oxide is used to sterilize food, plastics, glassware, and other equipment.

UHT (Ultra-High Temperature) sterilization:

UHT (Ultra-High Temperature) sterilization has a heat treatment of over 100°C during very short times; it is especially applicable to low viscous liquid products. The basis of UHT, or ultra-high temperature, is the sterilization of food before packaging, then filling into pre-sterilized containers in a sterile atmosphere

UHT Treatment

UHT treatment means a very short heat treatment at temperature of approximately 140°C (135 - 150°C) for only a few seconds. This results in a sterilized product with minimal heat damage to the product properties. UHT treatment is only possible in flow-through equipment. The product is thus sterilized before it is transferred to pre-sterilized containers in a sterile atmosphere. This requires aseptic processing.

Pasteurisation

It is a controlled heating process used to eliminate any dangerous pathogens that may be present in milk, fruit-based beverages, some meat products, and other foods which are commonly subjected to this treatment. Pasteurization is the application of heat to a food product in order to destroy pathogenic (disease-producing) microorganisms, to inactivate spoilage-causing enzymes, and to reduce or destroy spoilage microorganisms.

The temperature and time requirements of the pasteurization process are influenced by the pH of the food. When the pH is below 4.5, spoilage microorganisms and enzymes are the main targets of pasteurization. When the pH of a food is greater than 4.5, the heat treatment must be severe enough to destroy pathogenic bacteria.

For example, the pasteurization process for fruit juices is aimed at inactivating certain enzymes such as pectinesterase and polygalacturonase. The typical processing conditions for the pasteurization of fruit juices include heating to 77 °C and holding for 1 minute, followed by rapid cooling to 7 °C (45 °F). In addition to inactivating enzymes, these conditions destroy any yeasts or molds that may lead to spoilage. Equivalent conditions capable of reducing spoilage microorganisms involve heating to 65 °C (149 °F) and holding for 30 minutes or heating to 88 °C (190 °F) and holding for 15 seconds.

In the pasteurization of milk, the time and temperature conditions target the pathogenic bacteria Mycobacterium tuberculosis, Coxiella burnetti, and Brucella abortus. The typical heat treatment used for pasteurizing milk is 72 °C (162 °F) for 15 seconds, followed by rapid cooling to 7 °C. Other equivalent heat treatments include heating to 63 °C (145 °F) for 30 minutes, 90 °C (194 °F) for 0.5 second, and 94 °C (201 °F) for 0.1 second.

Blanching

Blanching is a food preparation technique in which food is briefly immersed in some sort of hot liquid, like boiling water or oil, often but not always as a prelude to cooking it further. Fruits, vegetables and nuts are the foods that are most frequently blanched, each for different reasons.

The primary purpose of blanching is to destroy enzyme activity in fruit and vegetables. It is not intended as a sole method of preservation, but as a pre-treatment prior to freezing, drying and canning. Other functions of blanching include:

Reducing surface microbial contamination

Softening vegetable tissues to facilitate filling into containers

Removing air from intercellular spaces prior to canning

Blanching and enzyme inactivation

Freezing and dehydration are insuffcient to inactivate enzymes and therefore blanching can be employed. Canning conditions may allow suffcient time for enzyme activity. Enzymes are proteins which are denatured at high temperatures and lose their activity. Enzymes which cause loss of quality include Lipoxygenase, Polyphenoloxidase, Polygaacturonase and Chlorophyllase. Heat resistant enzymes include Catalase and Peroxidase

Methods of Blanching

Blanching is carried out at up to 100°C using hot water or steam at or near atmospheric pressure.

Some use of fluidised bed blanchers, utilising a mixture of air and steam, has been reported. Advantages include faster, more uniform heating, good mixing of the product, reduction in effluent, shorter processing time and hence reduced loss of soluble and heat sensitive components.

There is also some use of microwaves for blanching. Advantages include rapid heating and less loss of water soluble components. Disadvantages include high capital costs and potential diffculties in uniformity of heating.

Canning

It is the process of applying heat to food that's sealed in a jar in order to destroy any microorganisms that can cause food spoilage. Proper canning techniques stop this spoilage by heating the food for a specific period of time and killing these unwanted microorganisms. During the canning process, air is driven from the jar and a vacuum is formed as the jar cools and seals. Although you may hear of many canning methods, only two are approved which includes water-bath canning and pressure canning

Concept of Canning

Water-bath canning: This method, sometimes referred to as hot water canning, uses a large kettle of boiling water. Filled jars are submerged in the water and heated to an internal temperature of 212 degrees for a specific period of time. Use this method for processing high-acid foods, such as fruit, items made from fruit, pickles, pickled food, and tomatoes.

Pressure canning: Pressure canning uses a large kettle that produces steam in a locked compartment. The filled jars in the kettle reach an internal temperature of 240 degrees under a specific pressure (stated in pounds) that's measured with a dial gauge or weighted gauge on the pressure-canner cover. Use a pressure canner for processing vegetables and other low-acid foods, such as meat, poultry, and fish.

Procedure

- The filling of cans is done automatically by machines; cans are filled with solid contents, in many cases, with an accompanying with liquid(often brine or syrups) in order to replace as much of the air in the can as possible.
- The filled cans are then passed through a hot-water or stream bath in an exhaust box; this heating expands the food and drivers out the remaining air.
- Immediately after the cans are exhausted; they are closed and sealed.
- The sealed cans are then sterilized;i.e., they are heated at temperatures high enough and for a long enough time to destroy all microorganisms.

- The cans are then cooled in cold water or air, after which they are labelled.

Applications

- Suitable for high and low acidic foods
- Improves shelf life of food
- Prevents contamination

Freezing

It is the removal of heat from the packaged or whole foods resulting in the temperatures between slightly below the freezing point of food to -18°C. Frozen foods last many months without spoiling however, some quality loss may occur.

Some microorganisms grow even at sub-freezing temperatures as long as water is available. Conversion of water to ice increases the concentration of dissolved solutes in unfrozen water and leads to low water activity. Freezing prevents the growth of microorganisms due to reduced water activity

Slow freezing:

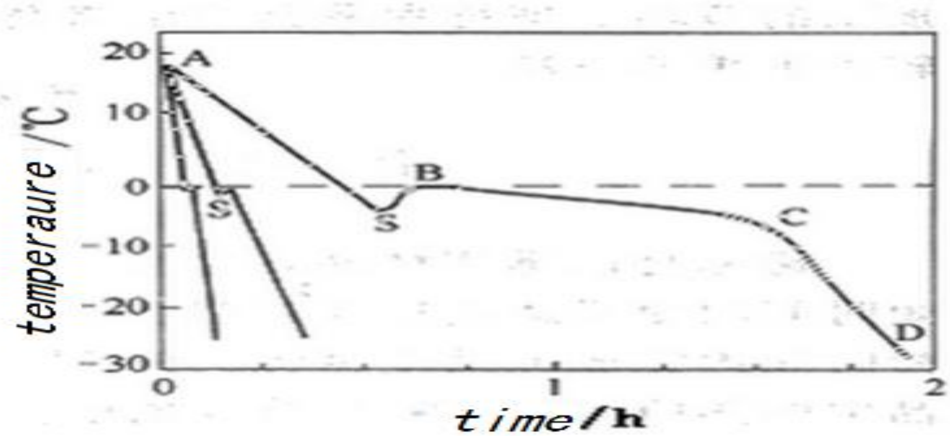
Slow freezing occurs when food is directly placed in freezing rooms called sharp freezers. It is also known as sharp freezing. This method involves freezing by circulation of air by convection i.e. through a specially insulated tunnel, either naturally or with aid of fans. The relatively still air is a poor conductor of heat and that is the reason for long time required to freeze the food. The temperature ranges from -15 to -29°C and freezing may take from 3 to 72 hours. The ice crystals formed are large and found in between cells i.e. extra-cellular spaces because of which the structure of food is disrupted. The structure of food is not maintained and thawed food cannot regain its original water content. Large ice crystals create quality problems like mushiness in vegetables etc.

Quick freezing:

Vigorous circulation of cold air enables freezing to proceed at a moderately rapid rate. In this process, the temperature is kept between -32°C to -40°C and the food attains the stage of maximum ice crystal formation in 30 minutes or less. Small ice crystals are formed within the cells and therefore, it does not damage the structure of food. On thawing, the structure of original food is maintained.

Freezing Curve Characteristics

The freezing process in food is more complex than just the freezing of pure water. Foods contain other dissolved solutes in addition to water, which display a similar behavior when frozen. The temperature evolution with time during the freezing process is called freezing curve. The freezing curve of a typical solution is shown in the figure below.



This curve has the following sections:

AS: The food is cooled below its freezing point of 0º C. At point S, which corresponds to a temperature below freezing, the water remains liquid. This subcooling can be up to 10 ° C below the freezing point.

SB: The temperature rises rapidly to the freezing point, because ice crystals will form and at a higher speed release latent heat, which is extracted by freezing the food.

BC: The heat is removed at the same rate as in previous phases, eliminating the latent heat with the formation of ice and the temperature remaining constant. Increasing concentration of solutes in the unfrozen water fraction causes the decrease of freezing point, so the temperature decreases. This is the phase in which most of the ice forms.

CD: One of the solutes reaches saturation and crystallizes. The release of the corresponding latent heat increases the eutectic temperature of the solute.

DE: The crystallization of water and solutes continues.

EF: The temperature falls for the mixture of water and ice.

In fact, the freezing curve for food is somewhat different from simple solutions, with the rate at which freezing occurs for food being higher

Factors Affecting the Quality of Frozen Foods

The type and extent of changes during freezing, frozen storage and thawing, which are directly related to the final quality of frozen foods, are affected by many factors. Here are the 4 most common ones:

- Rate of freezing
- Final storage temperature
- Stability of storage temperature, and
- Rate of thawing

Rate of Freezing

The rate of freezing of foods is very important, with rapid freezing rates being desirable since the formation of many small ice crystals is favoured. Freezing rates vary depending on the composition and physical structure of food, as this will influence the ability of food to conduct heat (an important parameter during both the freezing and thawing operations). Some food components such as fat and entrapped gases can act as insulators and impede the rate of heat transfer. Water is a poorer conductor of heat than ice. Other factors that influence the freezing rate are:

Temperature difference: the greater the temperature difference between the food and the refrigerant, the faster the freezing rate.

Product thickness/geometry and heat transfer rate: the thinner the food piece or greater the heat transfer rate, the faster the freezing rate.

Air velocity: the greater the velocity of refrigerated air or circulating refrigerant, the faster the freezing rate.

Degree of contact: the more contact between the food and the cooling medium, the faster the freezing rate.

These four factors are given great attention in the design of food freezing plants in order to maximize the rate of freezing so that quality attributes of the food commodity can be retained.

Final Storage Temperature

The final temperature for storage of frozen foods is dictated by a number of factors: texture changes, chemical reactions, etc. There are a number of reasons why the storage temperature of about -18°C is commonly used and the normal operating temperature of deep freezers sold for home use is also -18°C.

Stability of the Storage Temperature

As important as the storage temperature is the stability of the storage temperature. It is important to note that as the temperature of the frozen food increases, the amount of unfrozen water increases. Thus small fluctuations in storage temperature can cause melting of small ice crystals with subsequent refreezing of the liquid water on to other small ice crystals as the temperature drops, leading to the formation of fewer but larger ice crystals which can produce negative changes in the food quality.

Rate of Thawing

The rate of thawing of frozen foods is as critical to quality maintenance as the rate of freezing. Maximum quality retention is achieved by rapid thawing rates. Since ice is a good conductor of heat (it has a high thermal diffusivity) the temperature of a frozen food rapidly approaches the melting point of ice. After the rapid initial temperature increase, subsequent increases in temperature occur very slowly because of the need to supply the latent heat of fusion1 for the conversion of water from the crystalline state to the liquid state at 0°C.

Food irradiation

It is a processing and preservation technique with similar results to freezing or pasteurisation. During this procedure, the food is exposed to doses of ionising energy, or radiation. At low doses, irradiation extends a product's shelf life. At higher doses, this process kills insects, moulds, bacteria and other potentially harmful micro-organisms.

Food irradiation procedure

The food is exposed to ionising radiation, either from gamma rays or a high-energy electron beam or powerful x-rays. Gamma rays and x-rays are a form of radiation that shares some characteristics with microwaves, but with much higher energy and penetration.

The rays pass through the food just like microwaves in a microwave oven, but the food does not heat up to any significant extent. Exposure to gamma rays does not make food radioactive. Electron beams and x-rays are produced using electricity, which can be switched on or off, and they do not require radioactive material.

In both cases, organisms that are responsible for spoiling foods – such as insects, moulds and bacteria, including some important food poisoning bacteria – can be killed. Food irradiation cannot kill viruses.

Benefits of food irradiation

Some of the benefits of this food processing technique include:

- Extended shelf life of some products
- Less food spoilage
- Reduced risk of food-borne diseases caused by micro-organisms such as Campylobacter, Salmonella, E. coli and Listeria (especially in meat, poultry and fish)
- Less need for pesticides
- Less need for some additives, such as preservatives and antioxidants
- Lower risk of importing or exporting insect pests hidden inside food products
- Reduced need for toxic chemical treatments, such as those used to kill bacteria found in some spices
- As an alternative to current treatment for disinfecting imported fruits, grains and vegetables, which uses an ozone-depleting gas
- Reduced sprouting in potatoes, onions, herbs and spices.

Effects of irradiation on food

Some foods, such as dairy foods and eggs, cannot be irradiated because it causes changes in flavour or texture. Fruits, vegetables, grain foods, spices and meats (such as chicken) can be irradiated.

Irradiation causes minimal changes to the chemical composition of the food, however, it can alter the nutrient content of some foods because it reduces the level of some of the B-group vitamins. This loss is similar to those that occur when food is cooked or preserved in more traditional and accepted ways, such as canning or blanching.

Unit: 5 Manufacture of Food Products

Manufacture of Bread & Baked Products

Bread baking is one of the most important discoveries of mankind. Bread is made by baking dough which has for its main ingredients wheat flour, water, yeast and salt. Other ingredients which may be added include flours of other cereals, milk and milk products, fruits, gluten, etc. When these ingredients are mixed in correct proportions two processes commence: (i) the protein in flour begins to hydrate and forms a cohesive mass called as gluten (ii) evolution of carbon dioxide gas by action of the enzymes in the yeast upon the sugars. Three main requirements in making bread from wheat flour are formation of gluten network, aeration of the mixture by incorporation of gas, and coagulation of the material by heating it in the oven.

Principle of Bread Baking

There are three technological principles involved in baking of bread:

- Conversion of starch: Wheat flour starch is partly converted into the sugar, which is being used by yeast during fermentation producing alcohol with simultaneous release of CO_2 gas is responsible for porous, open honeycomb texture of the baked bread.
- Mechanical stretching: The hydrated wheat protein forms gluten fibers, which are stretched mechanically to obtain a fine, silky structure. This structure remains permanent when the protein is denatured during baking. The stretching of gluten is partially achieved by development of CO_2 gas during yeast fermentation and partly by mechanical mixing.
- Flavour development: Bread flavor is because of the alcohol and other compounds generated during yeast fermentation, together with flavor compounds formed during baking.

Ingredients and their Functions in Bread Making

Flour

Flour is essential to the structure of dough and subsequently the bread. Gluten (Gliadin and Glutenin) is the principle functional protein of wheat flour. Gluten forms fibrillar frame work when hydrated and mechanically worked. Thus the wheat flour is converted into cohesive, elastic, extensible dough. This viscoelastic three-dimensional gluten network retains gas formed by sugar fermentation and contributes to structure of dough and bread.

Starch plays important role in dough during baking. When heat is applied, gas cells expand gluten networks stretches, starch granules take up water and get partially gelatinized. This viscous paste sets to gel after baking. Satisfactory protein content for bread flour is 11 - 13% and moisture content not more than 14%.

Water

Water hydrates gluten proteins during mixing, gelatinizes starch during baking and serves as a dispersion medium for other ingredients such as yeast. Quality of water such as pH and hardness of water play important role in dough formation. Excessively alkaline water can retard the activity of yeast enzymes.

Yeast

Yeast produces carbon dioxide and ethanol by fermentation of fermentable sugars. During fermentation it also helps in formation of flavour precursors. Rate of fermentation of dough by yeast is controlled by temperature, nutrient supply, water, pH, sugar concentration, salt and level and type of yeast. Generally two type of yeasts are used in baking: Compressed yeast and dried yeast. Both the types consist of living cells of Saccharomyces cerevisiae.

Salt

Salt acts as flavour enhancer and helps control the fermentation by yeast. It also toughens the gluten and gives less sticky dough.

Production

The first step of bread making involves sifting of flour to remove any foreign matter and coarse particles, and to aerate and make the flour more homogeneous. The next step is dough mixing, which is accomplished by various methods of preparation of dough. Once the dough is formed, it is divided into pieces of requisite size. The divided dough is rounded to a ball shape and then passed through intermediate proofer, where the roughly stretched gluten fiber get time to recover their extensibility so that they can be moulded well without breaking the surface skin. After intermediate proving, the dough is passed through a set of pairs of roller to form a sheet. The sheeted dough is now passed through pressure board to get moulded into cylindrical shape.

The moulded dough pieces are then placed into greased individual bread baking tins. The panned dough pieces are then passed through final prover under controlled temperature and humidity. After complete proofing, the dough tins are transferred to the baking oven. Once baking is completed, the breads are de-panned, cooled and then sliced. Sliced breads are then packaged in suitable packaging material, generally polypropylene pouches.

Manufacture of Dairy Products

Processing of Milk

Pasteurization is most important in all dairy processing. It is the biological safeguard which ensures that all potential pathogens are destroyed.

Most milk today is pasteurized by the continuous high-temperature short-time (HTST) method (72 °C or 161 °F for 15 seconds or above). The HTST method is conducted in a series of stainless steel plates and tubes, with the hot pasteurized milk on one side of the plate being cooled by the incoming raw milk on the other side. This "regeneration" can be more than 90 percent efficient and greatly reduces the cost of heating and cooling. There are many fail-safe controls on an approved pasteurizer system to ensure that all milk is completely heated for the full time and temperature requirement. If the monitoring instruments detect that something is wrong, an automatic flow diversion valve will prevent the milk from moving on to the next processing stage. Higher temperatures and sometimes longer holding times are required for the pasteurization of milk or cream with a high fat or sugar content.

Pasteurized milk is not sterile and is expected to contain small numbers of harmless bacteria. Therefore, the milk must be immediately cooled to below 4.4 °C (40 °F) and protected from any outside contamination. The shelf life for high-quality pasteurized milk is about 14 days when properly refrigerated.

Extended shelf life can be achieved through ultrapasteurization. In this case, milk is heated to 138 °C (280 °F) for two seconds and aseptically placed in sterile conventional milk containers. Ultrapasteurized milk and cream must be refrigerated and will last at least 45 days. This process does minimal damage to the flavour and extends the shelf life of slow-selling products such as cream, eggnog, and lactose-reduced milks.

Ultrahigh-temperature (UHT) pasteurization

It is the same heating process as ultrapasteurization (138 °C or 280 °F for two seconds), but the milk then goes into a more substantial container—either a sterile five-layer laminated “box” or a metal can. This milk can be stored without refrigeration and has a shelf life of six months to a year. Products handled in this manner do not taste as fresh, but they are useful as an emergency supply or when refrigeration is not available.

Seperation

Most modern plants use a separator to control the fat content of various products. A separator is a high-speed centrifuge that acts on the principle that cream or butterfat is lighter than other components in milk. (The specific gravity of skim milk is 1.0358, specific gravity of heavy cream 1.0083.) The heart of the separator is an airtight bowl with funnellike stainless steel disks. The bowl is spun at a high speed (about 6,000 revolutions per minute), producing centrifugal forces of 4,000 to 5,000 times the force of gravity. Centrifugation causes the skim, which is denser than cream, to collect at the outer wall of the bowl. The lighter part (cream) is forced to the centre and piped off for appropriate use.

An additional benefit of the separator is that it also acts as a clarifier. Particles even heavier than the skim, such as sediment, somatic cells, and some bacteria, are thrown to the outside and collected in pockets on the side of the separator. This material, known as “separator sludge,” is discharged periodically and sometimes automatically when buildup is sensed.

Most separators are controlled by computers and can produce milk of almost any fat content. Current standards generally set whole milk at 3.25 percent fat, low-fat at 1 or 2 percent, and skim at less than 0.5 percent. (Most skim milk is actually less than 0.01 percent fat.)

Homogenization

Milk is homogenized to prevent fat globules from floating to the top and forming a cream layer or cream plug. Homogenizers are simply heavy-duty, high-pressure pumps equipped with a special valve at the discharge end. They are designed to break up fat globules from their normal size of up to 18 micrometres to less than 2 micrometres in diameter (a micrometre is one-millionth of a metre). Hot milk (with the fat in liquid state) is pumped through the valve under high pressure, resulting in a uniform and stable distribution of fat throughout the milk.

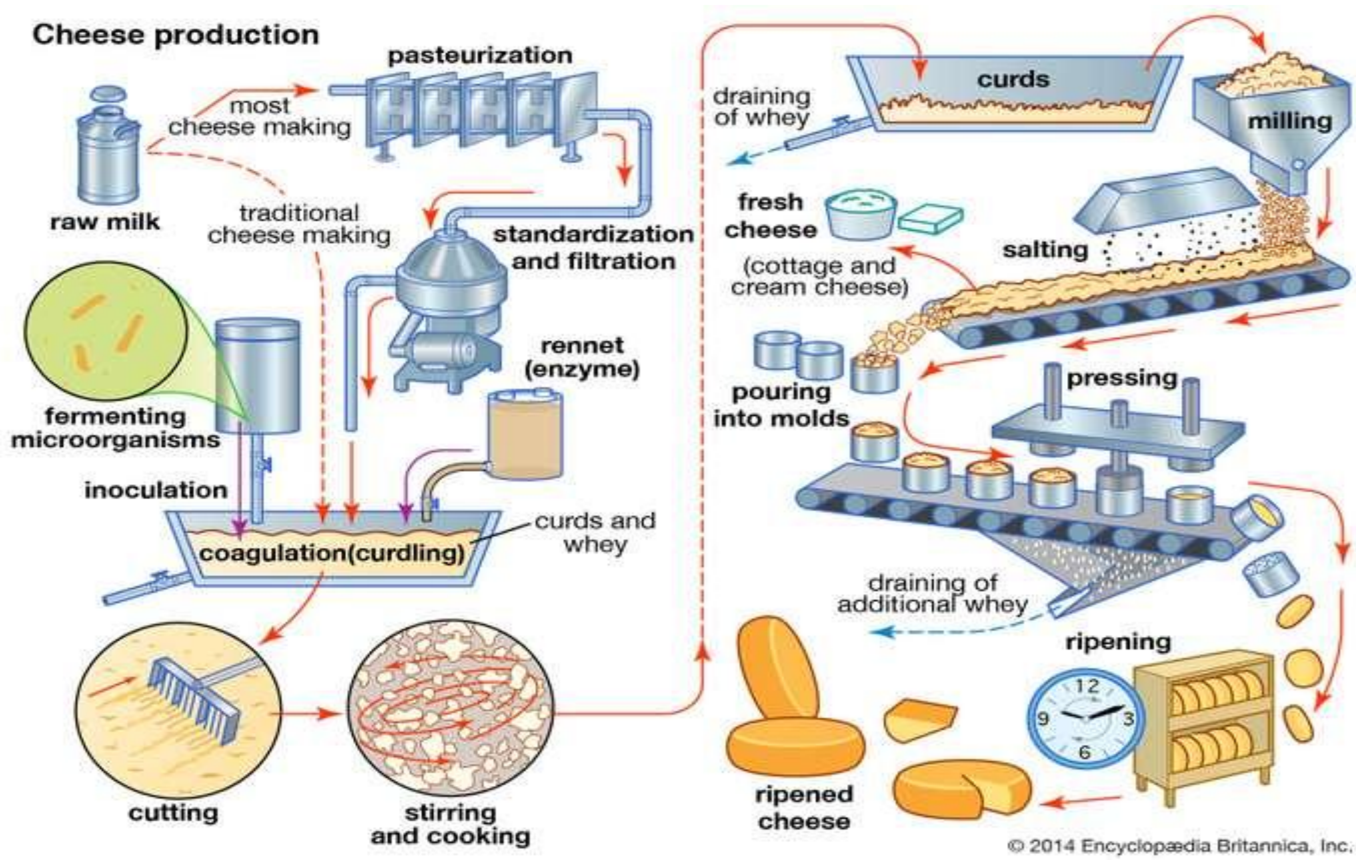
Two-stage homogenization is sometimes practiced, during which the milk is forced through a second homogenizer valve or a breaker ring. The purpose is to break up fat clusters or clumps and thus produce a more uniform product with a slightly reduced viscosity. Homogenization is considered successful when there is no visible separation of cream and the fat content in the top 100 millilitres of milk in a one-litre bottle does not differ by more than 10 percent from the bottom portion after standing 48 hours.

In addition to avoiding a cream layer, other benefits of homogenized milk include a whiter appearance, richer flavour, more uniform viscosity, better "whitening" in coffee, and softer curd tension (making the milk more digestible for humans). Homogenization is also essential for providing improved body and texture in ice cream, as well as numerous other products such as half-and-half, cream cheese, and evaporated milk.

Making of Cheese

The cheese-making process consists of removing a major part of the water contained in fresh fluid milk while retaining most of the solids. Since storage life increases as water content decreases, cheese making can also be considered a form of food preservation through the process of milk fermentation.

The fermentation of milk into finished cheese requires several essential steps: preparing and inoculating the milk with lactic-acid–producing bacteria, curdling the milk, cutting the curd, shrinking the curd (by cooking), draining or dipping the whey, salting, pressing, and ripening. These steps begin with four basic ingredients: milk, microorganisms, rennet, and salt.



Inoculation and curdling

Milk for cheese making must be of the highest quality. Because the natural microflora present in milk frequently include undesirable types called psychrophiles, good farm sanitation and pasteurization or partial heat treatment are important to the cheese-making process. In addition, the milk must be free of substances that may inhibit the growth of acid-forming bacteria (e.g., antibiotics and sanitizing agents). Milk is often pasteurized to destroy pathogenic microorganisms and to eliminate spoilage and defects induced by bacteria. However, since pasteurization destroys the natural enzymes found in milk, cheese produced from pasteurized milk ripens less rapidly and less extensively than most cheese made from raw or lightly heat-treated milk.

During pasteurization, the milk may be passed through a standardizing separator to adjust the fat-to-protein ratio of the milk. In some cases the cheese yield is improved by concentrating protein in a process known as ultrafiltration. The milk is then inoculated with fermenting microorganisms and rennet, which promote curdling.

The fermenting microorganisms carry out the anaerobic conversion of lactose to lactic acid. The type of organisms used depends on the variety of cheese and on the production process. Rennet is an enzymatic preparation that is usually obtained from the fourth stomach of calves. It contains a number of proteolytic (protein-degrading) enzymes, including rennin and pepsin. Some cheeses, such as cottage cheese and cream cheese, are produced by acid coagulation alone. In the presence of lactic acid, rennet, or both, the milk protein casein clumps together and precipitates out of solution; this is the process known as curdling, or coagulation. Coagulated casein assumes a solid or gellike structure (the curd), which traps most of the fat, bacteria, calcium, phosphate, and other particulates. The remaining liquid (the whey) contains water, proteins resistant to acidic and enzymatic denaturation (e.g., antibodies), carbohydrates (lactose), and minerals.

Lactic acid produced by the starter culture organisms has several functions. It promotes curd formation by rennet (the activity of rennet requires an acidic pH), causes the curd to shrink, enhances whey drainage (syneresis), and helps prevent the growth of undesirable microorganisms during cheese making and ripening. In addition, acid affects the elasticity of the finished curd and promotes fusion of the curd into a solid mass. Enzymes released by the bacterial cells also influence flavour development during ripening. Salt is usually added to the curd. In addition to enhancing flavour, it helps to withdraw the whey from the curd and inhibits the growth of undesirable microorganisms.

Cutting and shrinking

After the curd is formed, it is cut with fine wire “knives” into small cubes approximately one centimetre (one-half inch) square. The curd is then gently heated, causing it to shrink. The degree of shrinkage determines the moisture content and the final consistency of the cheese. Whey is removed by draining or dipping. The whey may be further processed to make whey cheeses (e.g., ricotta) or beverages, or it may be dried in order to preserve it as a food ingredient

Making of Butter

Butter is one of the most highly concentrated forms of fluid milk. Twenty litres of whole milk are needed to produce one kilogram of butter. This process leaves approximately 18 litres of skim milk and buttermilk, which at one time were disposed of as animal feed or waste. Today the skim portion has greatly increased in value and is fully utilized in other products.

Commercial butter is 80–82 percent milk fat, 16–17 percent water, and 1–2 percent milk solids other than fat (sometimes referred to as curd). It may contain salt, added directly to the butter in concentrations of 1 to 2 percent. Unsalted butter is often referred to as "sweet" butter. This should not be confused with "sweet cream" butter, which may or may not be salted. Reduced-fat, or "light," butter usually contains about 40 percent milk fat.

Production

Butter is produced when the cream emulsion in unhomogenized milk is destabilized by agitation, or churning. Breaking the emulsion produces butterfat granules the size of rice grains. The granules mat together and separate from the water phase or serum, which is known as buttermilk. (This milky liquid is drained away and is either concentrated or dried, later to become an ingredient in ice cream, candy, or other foods.) The butterfat is then washed with clean water and "worked" (kneaded) until more buttermilk separates and is removed. Ultimately, only about 16 percent of the water and milk solids present in the original milk remains trapped in the butter.

The churning process can take 40 to 60 minutes to complete in a traditional churn, but butter is more commonly made by high-speed continuous "churns" in factories. Although the basic principle is the same, in the continuous churn cream is pumped into a cylinder and mixed by high-speed blades, forming butter granules in seconds. The butter granules are forced through perforated plates while the buttermilk is drained from the system. A salt solution may be added if salted butter is desired. The butter is then worked in a twin screw extruder and emerges ready to be packaged.

Making of Ice cream

The essential ingredients in ice cream are milk, cream, sugar, flavouring, and stabilizer. Cheaper ingredients such as dry whey, corn syrup, and artificial flavourings may be substituted to create a lower-cost product.

Process

The first step in ice cream making is formulating a suitable mix. The mix is composed of a combination of dairy ingredients, such as fresh milk and cream, frozen cream, condensed or dried skim, buttermilk, dairy whey, or whey protein concentrate. Sugars may include sucrose, corn syrup, honey, and other syrups. Stabilizers and emulsifiers are added in small amounts to help prevent formation of ice crystals, particularly during temperature fluctuations in storage.

The ice cream mix is pasteurized at no less than 79 °C (175 °F) for 25 seconds. The heated mix is typically homogenized in order to assure a smoother body and texture. Homogenizing also prevents churning (i.e., separating out of fat granules) of the mix in the freezer and increases the viscosity. (Since smaller fat globules have more surface area, the associated milk protein can hydrate more water and produce a more viscous fluid.)

After homogenization, the hot mix is quickly cooled to 4.4 °C (40 °F). The mix must age at this temperature for at least four hours to allow the fat to solidify and fat globules to clump. This aging process results in quicker freezing and a smoother product.

The next step, freezing the mix, is accomplished by one of two methods: continuous freezing, which uses a steady flow of mix, or batch freezing, which makes a single quantity at a time. For both methods, the objective is to freeze the product partially and, at the same time, incorporate air. The freezing process is carried out in a cylindrical barrel that is cooled by a refrigerant, either ammonia or Freon (trademark). The barrel is equipped with stainless steel blades, called dasher blades, which scrape the frozen mixture from the sides of the freezing cylinder and incorporate or whip air into the product. The amount of air incorporated during freezing is controlled by a pump or the dasher speed. Depending on individual conditions, freezing can be instantaneous in the continuous freezer or require approximately 10 minutes in the batch freezer.

Semifrozen ice cream leaves the freezer at a temperature between −9 and −5 °C (16 and 23 °F). It is placed in a suitable container and conveyed to a blast freezer, where temperatures are in the range of −29 to −34 °C (−20 to −30 °F). While in this room, the ice cream continues to freeze without agitation. Rapid freezing at this stage prevents the formation of large ice crystals and favours a smooth body and texture. The length of time in the hardening room depends on the size of the package, but usually 6 to 12 hours are required to bring the internal ice cream temperature to −18 °C (0 °F) or below. In larger manufacturing plants, final freezing takes place in a hardening tunnel, where packages are automatically conveyed on a continuous belt to the final storage area.

Ice cream can also be freeze-dried by the removal of 99 percent of the water. Freeze-drying eliminates the need for refrigeration and provides a high-energy food for hikers and campers and a "filling" centre for candy and other confections.

Manufacture of Vegetable & fruit Products (Edible Oil and Fats)

Vegetable oils, or vegetable fats, are oils extracted from seeds, or less often, from other parts of fruits. Like animal fats, vegetable fats are mixtures of triglycerides. Soybean oil, rapeseed oil, and cocoa butter are examples of fats from seeds. Olive oil, palm oil, and rice bran oil are examples of fats from other parts of fruits. In common usage, vegetable oil may refer exclusively to vegetable fats which are liquid at room temperature. Vegetable oils are usually edible; non-edible oils derived mainly from petroleum are termed mineral oils.

Cooking oil is plant, animal, or synthetic fat used in frying, baking, and other types of cooking. It is also used in food preparation and flavouring not involving heat, such as salad dressings and bread dippings like bread dips, and may be called edible oil.

The Manufacturing Process

Some vegetable oils, such as olive, peanut, and some coconut and sunflower oils, are cold-pressed. This method, which entails minimal processing, produces a light, flavorful oil suitable for some cooking needs. Most oil sources, however, are not suitable for cold pressing, because it would leave many undesirable trace elements in the oil, causing it to be odiferous, bitter tasting, or dark. These oils undergo many steps beyond mere extraction to produce a bland, clear, and consistent oil.

Cleaning and grinding

Incoming oil seeds are passed over magnets to remove any trace metal before being dehulled, deskinned, or otherwise stripped of all extraneous material. In the case of cotton, the ginned seeds must be stripped of their lint as well as dehulled. In the case of corn, the kernel must undergo milling to separate the germ.

The stripped seeds or nuts are then ground into coarse meal to provide more surface area to be pressed. Mechanized grooved rollers or hammer mills crush the material to the proper consistency. The meal is then heated to facilitate the extraction of the oil. While the procedure allows more oil to be pressed out, more impurities are also pressed out with the oil, and these must be removed before the oil can be deemed edible.

Pressing

The heated meal is then fed continuously into a screw press, which increases the pressure progressively as the meal passes through a slotted barrel. Pressure generally increases from 68,950 to 20,6850 kilopascals as the oil is squeezed out from the slots in the barrel, where it can be recovered.

Extracting additional oil with solvents

Soybeans are usually not pressed at all before solvent extraction, because they have relatively little oil, but most oil seeds with more oil are pressed and solvent-treated. After the initial oil has been recovered from the screw press, the oil cake remaining in the press is processed by solvent extraction to attain the maximum yield. A volatile hydrocarbon (most commonly hexane) dissolves the oil out of the oil cake, which is then recovered by distilling the light solvent out. The Blaw-Knox Rotocell is used to meet the demands of the United States soybean oil industry. In using this machine, flakes of meal are sent through wedge-shaped cells of a cylindrical vessel. The solvent then passes through the matter to be collected at the bottom. Also still in use by a significant number of manufacturers is the Bollman or Hansa-Muhle unit, in which oilseed flakes are placed in perforated baskets that circulate continuously. The solvent percolates through the matter which is periodically dumped and replaced.

Removing solvent traces

Ninety percent of the solvent remaining in the extracted oil simply evaporates, and, as it does, it is collected for reuse. The rest is retrieved with the use of a stripping column. The oil is boiled by steam, and the lighter hexane floats upward. As it condenses, it, too, is collected.

Refining the oil

The oil is next refined to remove color, odor, and bitterness. Refining consists of heating the oil to between 107 and 188 degrees Fahrenheit (40 and 85 degrees Celsius) and mixing an alkaline substance such as sodium hydroxide or sodium carbonate with it. Soap forms from the undesired fatty acids and the alkaline additive, and it is usually removed by centrifuge. The oil is further washed to remove traces of soap and then dried.

Oils are also degummed at this time by treating them with water heated to between 188 and 206 degrees Fahrenheit (85 and 95 degrees Celsius), steam, or water with acid. The gums, most of which are phosphatides, precipitate out, and the dregs are removed by centrifuge.

Oil that will be heated (for use in cooking) is then bleached by filtering it through fuller's earth, activated carbon, or activated clays that absorb certain pigmented material from the oil. By contrast, oil that will undergo refrigeration (because it is intended for salad dressing, for example) is winterized—rapidly chilled and filtered to remove waxes. This procedure ensures that the oil will not partially solidify in the refrigerator.

Finally, the oil is deodorized. In this process, steam is passed over hot oil in a vacuum at between 440 and 485 degrees Fahrenheit (225 and 250 degrees Celsius), thus allowing the volatile taste and odor components to distill from the oil. Typically, citric acid at. 01 percent is also added to oil after deodorization to inactivate trace metals that might promote oxidation within the oil and hence shorten its shelf-life.

Packaging the oil

The completely processed oil is then I V measured and poured into clean containers, usually plastic bottles for domestic oils to be sold in supermarkets, glass bottles for imports or domestic oils to be sold in specialty stores, or cans for imports (usually olive oil).

Processing of Meat Products

Comminuted meat products

Comminution is the mechanical process of reducing raw materials to small particles called as minced meat. Depending upon the final use of the communited meat the degree of comminution is done which differs among various processed products and is often a unique characteristic of a particular product ranging from very coarsely comminuted , to finely comminuted.

Cured meat products

Curing of meat involves the essentially addition of **sodium chloride, sodium nitrite or sodium nitrate** and adjuncts to meat for increasing shelf-life and to obtain desirable colour and flavour. Sugar may or may not be added along with other ingredient to improve flavour. Curing can be done for both raw/cooked meats cut products as well for comminuted meat products.

Processing of Poultry Products (Egg)

Egg is processed to produce convenience forms of eggs for commercial, food service and home uses. Egg products can be classified as follows

1. Frozen products

Egg white, Egg yolk, Salted yolks, Sugared yolks, Whole eggs, Salted whole egg

2. Dried/Dehydrated products

Spray dried egg white solids, Instant egg white solids, whole egg or yolk solids, free flowing whole egg or Yolk solids (sodium silicoaluminate added as a free flowing agent).

Egg products are preferred to shell eggs by commercial bakers, food manufacturers and the foodservice industry because they have many advantages including convenience, labor savings, minimal storage requirements, ease of portion control, and product quality, stability and uniformity.

As per egg product inspection act all egg processing plants must follow below conditions:

- Pasteurization of all egg products is mandatory.
- Shell eggs used for egg products must be clean and of edible interior quality..

Production of frozen egg

Eggs are frozen to preserve them for use in food manufacturing. Before freezing, egg contents are separated from the shell and which may be frozen as whole egg, Egg yolk, Egg white or various mixtures of yolk and white.

Freezing plants are generally combined with egg breaking facilities where eggs are received, washed and dried. Then the eggs are broken to remove the egg content this could be done by hand or with the help of machines. While breaking the spoiled eggs are rejected as this could spoil the good product. The whole or separated eggs are mixed for uniformity, filtered to remove chalazae, membranes or bits of shell. Thus prepared egg contents are pasteurized at 60-62 deg /3-4 min and filled into suitable container for freezing. Freezing generally is done in a sharp freezer room with circulating air at -30 deg . Freezing may take about 48-72h.

Egg white and whole egg can be frozen as such without any additives but it is difficult in case of egg yolk. While freezing egg yolk becomes gummy and thick due to gelation. This can be prevented by the addition of 10% sugar or salt or glycerin 5%. Sugar yolk will be used by bakers, confectioners and salted yolk may be used by mayonnaise manufacturers. These ingredients should be dissolved in the yolk during mixing and prior to screening.

Production of spray dried whole egg

The whites, Yolks and whole eggs may be dried by several methods, like spray drying, tray drying, foam drying or freeze drying. Egg white contains traces of glucose and galactose which react with egg protein leading to maillard browning. This discolors the dried egg white. Browning can be prevented by removing glucose through fermentation by yeast or with commercial enzymes. This is known as desugaring and this is practiced prior to the drying of all egg white.

Processing of Fish Products

Fish and fish products is consumed as food all over the world. With other seafoods, it provides the world's prime source of high-quality protein;14–16 percent of the animal protein consumed worldwide. Over one billion people rely on fish as their primary source of animal protein

Fish Products

- **Fish oil** is recommended for a healthy diet because it contains the omega-3 fatty acids, eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA), precursors to eicosanoids that reduce inflammation throughout the body.
- **Fish emulsion** is a fertilizer emulsion that is produced from the fluid remains of fish processed for fish oil and fish meal industrially.

- **Fish hydrolysate** is ground up fish carcasses. After the usable portions are removed for human consumption, the remaining fish body – guts, bones, cartilage, scales, meat, etc. – are put into water and ground up.
- **Fish meal** is made from both whole fish and the bones and offal from processed fish. It is a brown powder or cake obtained by rendering pressing the whole fish or fish trimmings to remove the fish oil. It used as a high-protein supplement in aquaculture feed.
- **Fish sauce** is a condiment that is derived from fish that have been allowed to ferment. It is an essential ingredient in many curries and sauces.
- **Isinglass** is a substance obtained from the swim bladders of fish (especially sturgeon), it is used for the clarification of wine and beer.

Processing of Confectionery products

Confectionery is an important food item of great popularity among wide range of population. It has been enjoyed as a major food delicacy from ancient times. The term confectionery is ambiguous and describes a spectrum of sweet goods and takes on different meaning depending on the country in which it is used, Globally, confectionery foods represent 50% by volume of foods produced and 60% by value. The Indian confectionery market is estimated to be 1,38,000 metric tonnes (in 2005) and is segmented into sugar-boiled confectionery, chocolates, mints and chewing gums. Sugar-boiled confectionery consisting of hard-boiled candy, toffees and other sugar-based candies, is the largest of the segments and it is valued at around Rs. 20,000 million

Confectionery can be classified into four major groups. They are as follows:

- **Sugar confectionery**

  It includes products using mainly sugar such as boiled sweets ,fondants, fudge, jellies, toffees, etc.
- **Chocolate confectionery**

  It includes mainly cocoa, chocolate and chocolate products. Sugar confectionery coated with chocolate is also included in it.

- **Flour confectionery**

  It includes baked products such as cakes, biscuits, cream rolls, etc. Traditional Indian cereal and legume flour based sweets such as mysorepak, soanpapdi, badushah, jalebi, etc. are also included in this category.

- **Milk-based confectionery**

  It includes mainly Indian traditional milk-based sweets such as burfi, peda, rasogolla

Note:

In sugar confectionery, sugar is the main or principal ingredient while in other confectionery sugar is used as one of the ingredient

Products of Beverage Industries

Beverage is any liquid consumed by humans for quenching thirst, or merely for pleasure. Beverages come in various types

Non-Alcoholic Beverages (Soft Drinks)

There are two types of non-alcoholic beverages.

Hot Beverages

These are served hot. Hot beverages typically include tea, masala tea (spiced tea), milk, hot chocolate, and variants of coffee such as expresso, latte, and cappuccino.

Cold Beverages

These are served and consumed while chilled. Cold beverages include juices, mocktails, coolers, cold versions of tea and coffee, milkshakes, carbonated drinks, mocktails, and sherbets.

Alcoholic Beverages (Hard Drinks)

These are served cold. Alcoholic beverages are intoxicating and contain ethanol, commonly known as alcohol. Such beverages need to undergo fermentation and distillation to generate alcohol contents. The percentage of alcohol varies in the range of 0.5% to 95% depending upon the methods of fermentation and distillation.

If a beverage contains at least 20% Alcohol by Volume (ABV), it is called spirit. Liquors are similar to spirits. The only difference is that liquors come with added sweetness and flavoring. Liquors and spirits, both are strong alcoholic beverages. The following are a few most popular alcoholic beverages

Production of Soft Drinks

Most soft drinks are made at local bottling and canning companies. Brand name franchise companies grant licenses to bottlers to mix the soft drinks in strict accordance to their secret formulas and their required manufacturing procedures.

Clarifying the water

The quality of water is crucial to the success of a soft drink. Impurities, such as suspended particles, organic matter, and bacteria, may degrade taste and color. They are generally removed through the traditional process of a series of coagulation, filtration, and chlorination. Coagulation involves mixing a gelatinous precipitate, or floc (ferric sulphate or aluminum sulphate), into the water. The floc absorbs suspended particles, making them larger and more easily trapped by filters. During the clarification process, alkalinity must be adjusted with an addition of lime to reach the desired pH level.

Filtering, sterilizing, and dechlorinating the water

The clarified water is poured through a sand filter to remove fine particles of floc. The water passes through a layer of sand and courser beds of gravel to capture the particles.

Sterilization is necessary to destroy bacteria and organic compounds that might spoil the water's taste or color. The water is pumped into a storage tank and is dosed with a small amount of free chlorine. The chlorinated water remains in the storage Soft Drinktank for about two hours until the reaction is complete.

Next, an activated carbon filter dechlorinates the water and removes residual organic matter, much like the sand filter. A vacuum pump de-aerates the water before it passes into a dosing station.

Mixing the ingredients

The dissolved sugar and flavor concentrates are pumped into the dosing station in a predetermined sequence according to their compatibility. The ingredients are conveyed into batch tanks where they are carefully mixed; too much agitation can cause unwanted aeration. The syrup may be sterilized while in the tanks, using ultraviolet radiation or flash pasteurization, which involves quickly heating and cooling the mixture. Fruit based syrups generally must be pasteurized.

The water and syrup are carefully combined by sophisticated machines, called proportioners, which regulate the flow rates and ratios of the liquids. The vessels are pressurized with carbon dioxide to prevent aeration of the mixture.

Carbonating the beverage

Carbonation is generally added to the finished product, though it may be mixed into the water at an earlier stage. The temperature of the liquid must be carefully controlled since carbon dioxide solubility increases as the liquid temperature decreases. Many carbonators are equipped with their own cooling systems. The amount of carbon dioxide pressure used depends on the type of soft drink. For instance, fruit drinks require far less carbonation than mixer drinks, such as tonics, which are meant to be diluted with other liquids. The beverage is slightly over-pressured with carbon dioxide to facilitate the movement into storage tanks and ultimately to the filler machine.

Filling and packaging

The finished product is transferred into bottles or cans at extremely high flow rates. The containers are immediately sealed with pressure-resistant closures, either tinplate or steel crowns with corrugated edges, twist offs, or pull tabs.

Because soft drinks are generally cooled during the manufacturing process, they must be brought to room temperature before labeling to prevent condensation from ruining the labels. This is usually achieved by spraying the containers with warm water and drying them. Labels are then affixed to bottles to provide information about the brand, ingredients, shelf life, and safe use of the product. Most labels are made of paper though some are made of a plastic film. Cans are generally pre-printed with product information before the filling stage.

Finally, containers are packed into cartons or trays which are then shipped in larger pallets or crates to distributors.

Production of Hard Drinks

The process of Hard drinks making involves several steps and a series of chemical reactions in order to produce a quality product.

Yeast Propagation

A complex series of biochemical reactions must take place to convert raw substrate to fermentable sugars, allowing yeast to live and multiply, eventually converting those sugars to alcohol.

After the sugar solution has been prepared in the brewing house, yeast is added. The yeast will absorb simple sugars, turning them into carbon dioxide and alcohol.

The purity of the yeast strain used to produce your beer is key to its quality and consistency. Before "pitching", or adding the yeast, it's essential that the air vented in the container where the yeast is being propagated be free of microorganisms so that the culture does not spoil.

Trap Filtration

Trap filtration is an essential step for retaining diatomite particles and PVPP fines after diatomite filter clarification and PVPP stabilization. This step prevents the diatomite particles and contaminated yeast from ruining the current batch, as well as future batches.

Cold Sterile Filtration

Cold sterile filtration is an alternative technology to thermal pasteurization. Pasteurization is a traditional method used to inactivate spoilage bacteria, which is based on heating the product to a specific temperature for a pre-determined period of time. However, using pasteurization presents a greater risk of damaging the flavor of the product.

Cold sterile filtration effectively removes the spoilage microorganisms and particles without damaging the flavor of the product, allowing the product to be processed safely while maintaining freshness.

Carbon Dioxide Adjustment

Carbon dioxide adjustment is a process specific to alcohol processing. The level of carbon dioxide that already exists in beer due to the fermenting process and yeast propagation, along with the added carbon dioxide, must be adjusted appropriately to ensure a quality product.

Filling: Bottle Washer and Bottle Filler

Rinse water polishing ensures a good microbiological and particulate quality of the bottle prior to filling. It is essential that the water used be contaminant free.