PAVENDAR BHARATHIDASAN COLLEGE OF ARTS AND SCIENCE

Food Technology

III B.Sc. Biotechnology

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Unit 1

Food chemistry

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.

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.

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.

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.

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.

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

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
- Amylase
- Cellulase
- Lipase
- Xylanase
- β-Galactose
- Phytase
- Tannase

Unit 2

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.

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 A soil, 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.

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.

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.

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.

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.

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.

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.

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.

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

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

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.

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

Heat Processing

Heat kills microorganisms by changing the physical and chemical 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

Sterilization:

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 sterilization 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.

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.

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.

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.

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

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

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.

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 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 CO2 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 CO2 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.

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.

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.

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.

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 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.