FOOD PRESERVATION AND STORAGE

Abstract

Food storage and preservation techniques have been practised since ancient times. Traditional methods of food preservation include smoking, sun drying, salting, sugaring, and pickling. The characteristics of food are affected at every stage of handling, processing, storage, and distribution. Therefore, it is important to understand the nature of food, the principles and methods involved, as well as the handling, processing, storage, and distribution procedures. During preservation, food items' nutritional content, texture, and flavour must all be preserved. Food storage involves keeping food in a designated area in accordance with perish ability for a lengthy period of time. This chapter covers a variety of preservation techniques, including freezing, pasteurisation, sterilisation, ionising radiation, heating, cooling, chilling, salting, sugaring, fermentation, and some more contemporary procedures like HPP and PEF. Storage principles, types, and general best practises are all covered.

Keywords: Sterilization, Pasteurization, Fermentation, HPP, PEF, Drying, Chilling, Salting, Sugaring.

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I. INTRODUCTION

Food is a necessity for a healthy living and is the foundation of our existence. Whether we consume food cooked or raw, it is possible for it to degrade over time, a process known as spoilage. Food begins to spoil gradually when it is harvested, caught and slaughtered or made unless it is adequately preserved or kept. Food contamination may lead to inferior quality, dangerous for ingestion, and food with low economic worth. Numerous elements, including water, pH, oxygen, and temperature, might contribute to it. The greatest strategy to avoid food deterioration is to store and preserve it. The term "spoilage" refers to the process by which food, whether consumed raw or cooked, degrades over time. If food is not adequately preserved or stored, spoiled food develops over time from the time it is harvested, captured, slaughtered, or manufactured. Food contamination could produce poor-quality, unsafe-for-consumption food with minimal economic value. Many factors, including water, pH, oxygen, and temperature, might contribute to its occurrence. .Proper food storage helps to preserve the quality and nutritional value of food additionally it can also help to prevent foodborne illnesses caused by harmful bacteria. The below are the objectives of food preservation and storage

1. Make all types of food available in off season.
2. Prevent the food from spoilage.
3. Utilise the surplus crops and prevent wastage.
4. Meet the needs of the people for food in secluded and difficult areas.
5. Extend the shelf life of food

II. FOOD PRESERVATION

Food preservation refers to the handling and treatment of food to prevent spoilage .In order to preserve food, it is typically necessary to stop bacteria, fungi, and other microorganisms from growing .Food that has been preserved not only gives our meals more variety, but it also aids in using up extra product after harvest .Food preservation made it possible to preserve the food fresh for a long time .It aids in extending the food's shelf life.

1. Principles of food preservation

Stopping or postponing microbial degradation: This can be achieved by keeping the microbes out, restrict the development and activity of microbes and complete elimination of microorganism. Asepsis is a process of keeping out the microbes from the food by making use of either natural or artificial covering around the food .Example of natural barrier in food is outer shell of nuts, peel of fruits and vegetables, shells of egg .Packaging also helps to prevent the entry of microbes .For example peach or mushroom sealed in tin or can, packaging of milk in packet helps in keeping out the microorganism. Filtration is one of the best ways to remove the microbes from liquid food. Liquid food is filtered through the bacteria proof filter for complete removal of microbes. For the filtration liquid food is passed through the filters made of suitable material like asbestos pad, diatomaceous earth, unglazed porcelain etc. and allowed to percolate through either with or without Nano- filtration. Some more methods like sedimentation, centrifugation, trimming and washing etc. can also be used. The growth and activity of microbes can be hindered by using low temperature, by drying of food commodity, by creating anaerobic

condition and by use of chemical like organic acid, citric acid, acetic acid, and lactic acid. Micro-organism can eliminate by use of heat like pasteurisation (below 100°c) ,sterilization (above 100°c) and ultra-high temperature .Use of radiation can also kill the micro-organism Irradiation is used for many fruits like mango, papaya

Delaying and preventing enzymatic reactions and self-decomposition: By destruction or inactivation of food enzyme (blanching or boiling) Blanching is the mild heat treatment of sliced fruits and vegetable to inactivate the enzyme .It is generally done before freezing, canning or drying to prevent the self-decomposition of food by destroying the enzyme. Blanching ids done carried out by dipping the food commodity either in boiling water or by exposing than to steam for few minutes followed by immediate cooling.

Delay or avoidance of chemical reaction: Food containing fats and oil can undergo oxidation reaction and causes rancidity of food and becomes unfit for consumption .Addition of antioxidants like butyl hydroxyl anisole (BHA), butyl hydroxyl toluene (BHT), tertiary butyl hydroxyl quinone (TBHQ) lecithin etc. prevent oxidation.

Delaying and preventing insect action: Use of fumigants in dried fruits, cereals etc. checks the damage caused by insect and rodents.

2. Method of food preservation

Preservation by high temperature: Because of the coagulation of proteins and the deactivation of their metabolic enzymes brought on by heating, food-borne microorganisms are eliminated. Cooking at a high temperature can help keep food fresh. Pasteurization, sterilisation, heating, and frying are some of the heat treatment methods. Heating causes proteins to coagulate and inactivate their metabolic enzymes, which aids in the destruction of the food's microorganisms. The way heat is handled depends on the organism that has to be killed, the type of food that needs to be preserved, and any further preservation techniques that might be utilised in addition to using high temperatures. For high temperature preservation, two procedures are typically used: pasteurisation below 100°C and sterilisation over 100°C.

Pasteurization is a method of food preservation called pasteurisation uses a temperature below 100°C to kill pathogens and inactivate spoilage enzymes in packaged or unpackaged foods like milk and fruit juice .French chemist Louis Pasteur invented pasteurisation in 1864.There are various methods of pasteurization which include bottle or holding pasteurization, overflow method, flash pasteurization, low temperature long time (LTLT) and high temperature short time (HTST). Bottle or holding pasteurization, is generally done for fruit juices made at home. In this technique juices are strained or clarified before placed in bottle with enough head space to expand. Airtight and sealed bottles are used for this pasteurization. In overflow method juice is heated to a temperature that is approximately 2.5°C higher than the pasteurisation temperature before being completely poured in hot, sterilised bottles. Once more pasteurised and cooled, sealed bottles are cooled to a temperature 2.5°C lower than that of filling and sealing. Flash pasteurization technique was developed specifically for canning natural orange juice. This technique can also pasteurise apple and grape juice .With this technique, the

juice is quickly heated to a temperature that is roughly 5.5°C higher than the pasteurisation temperature and maintained there for a minute. Low temperature, long-time pasteurisation (LTLT) is batch type pasteurization. Typically, milk is pasteurised using this technique. First, milk is heated, held for a while, and then cooled. This technique involves briefly heating milk to a low temperature (62.7 °C) (minimum 30 min). After that, milk is quickly chilled to 4°C. It is carried out in batches. High temperature short time (HTST) pasteurization is known as continuous pasteurization because pasteurizer gives continuous flow of milk .In this method pasteurization is done at 72°c for 15 sec and then cooling is done at 5°c or below.

The goal of sterilisation is to eliminate all living microorganisms. This method of food preservation is the most efficient since the high temperature fully destroys all microorganisms. The nutritious value of food suffers during sterilisation. Vitamin loss occurs as a result of the Millard reaction. Usually, it's done above 100 °C. Yeasts, moulds, vegetative bacteria, and spore producers are all destroyed by sterilization.

Preservation by low temperature: Cooling, Chilling and Cold storage comes under low temperature preservation. Cooling is the process of lowering food's temperature from one processing temperature to another or to a required storage temperature. Food is chilled by lowering its temperature to between -1 and 8 degrees Celsius. Both chilling and boiling contribute to extending the shelf life of both fresh and processed foods by slowing down the pace of biochemical and microbiological changes in food. Perishable food is preserved through chilling. Food items like fruits, vegetables, and milk are kept in cold storage at low temperatures (below 4°c). Low-temperature storage slows down the biological and chemical processes that lead to deterioration. Enzymatic processes and microbiological development are slowed down by cold storage.

Freezing is One of the oldest methods of food preservation is freezing, which involves lowering the temperature of the food below the freezing point of water (-18 to 40 °C).Freezing extends the shelf life typically by 6 to 12 months. When food is frozen, its liquid content turns into ice crystals, which reduces water activity. Microbial growth and enzyme activity are stopped at temperatures below the freezing point. This method of preservation preserves freshness, colour, and flavour without nutrient loss. There are two ways to freeze: quickly and slowly. Thermal arrest occurs after more than 30 minutes of slow freezing and less than 30 minutes of fast freezing. Slow freezing results in the formation of massive ice crystals, which cause cell injury by breaching the cell membrane. As opposed to this, rapid freezing results in the formation of tiny ice crystals. You can quickly freeze food by: (1) bringing it into contact with the coil through refrigerant flows; (2) blast-freezing it by blowing cold air across it; or (3) submerging it in liquid nitrogen.

Preservation by irradiation: The purpose of food irradiation is to extend the shelf life of food products by exposing them to a controlled dose of radiation .The term "ionising radiation" refers to radiation with short wavelengths under 1 nanometer (gamma rays, X-Rays, electron beams).This cutting-edge preservation technique is often referred to as cold sterilisation. Ionizing radiation functions in one of two ways, direct and indirect effect. Direct effect occurs infrequently and disrupts the DNA chain directly Using Indirect effect, water in food is separated into short-lived free radicals. The dose of

radiation is measured in the SI unit known as Gray (Gy). The radiation dose must be controlled carefully. It should be sufficient to destroy the pathogenic and spoilage causing organism and to inactivate the food enzymes.

Novel method of preservation (Non-Thermal): The loss of the original flavour, taste, look, colour, and nutritional quality are some drawbacks of thermal processing. Therefore, the idea of non-thermal technology has been developed to correct this. Examples of innovative methods include pulsed electric fields and high pressure processing. High pressure processing (HPP)This method often referred to as high hydrostatic pressure (HHP) processing and ultra-high pressure (UHP) processing, is one of the most well-liked and financially successful ones. In this process, meals are put under pressure in a vessel that can withstand the pressure in the range of 100 to 1000 MPa with or without packing. Enzymes are inactivated in addition to being killed along with spoilage and harmful microorganisms. Pulse electric field (PEF) Electric field for pulses (PEF) is a revolutionary emerging method of food preservation .This technique produces the lethal effect on microorganisms by applying an electric field to a liquid meal in a brief pulse with a strength in the range of 12-35 kVcm-1.Microorganisms are killed to varying degrees depending on the field strength, pulse strength, and pulse count.

Removal of water: Since moisture is necessary for the growth of microorganisms, reducing the moisture level in food at a particular level can aid in their eradication. Drying ,dehydration and evaporation are the methods for removal of water from food .By using heat, the process of drying involves removing moisture from food .One of the oldest methods of preservation is sun drying .Nowadays, mechanical drying has taken the place of solar drying .This is a quicker method, and artificial heat is used to remove moisture from food while maintaining a controlled temperature and humidity. Additionally, milk and other foods like fruit juices are powderized via evaporation .For the preservation, many drier and evaporator kinds are used.

Chemical method of preservation: Chemical preservatives are employed in this technique to prevent food spoiling caused by microbes. Due to their interference with the mechanism of cell division, the permeability of cell membranes, and enzyme activity, preservatives have an inhibitory effect. Sulphur dioxide and benzoic acid are two significant chemical preservatives approved for use in food preservation.

Ascorbic acid, beta-carotene, and other oxidizable components are retained due to bleaching and antioxidant properties of sulphur dioxide. Additionally, it prevents the product from developing non-enzymatic browning or discolouration. Sulphite, bisulphite, and metabisulphite, salts of sulphur dioxide are frequently used in preservation. Benzoic acid is partially soluble in water hence salt of benzoic acid like sodium benzoate is use to preserve the food. Pure sodium benzoate is tasteless and odourless.

Preservation by salting, sugaring and fermentation: Salting sugaring and fermentation are the ancient biological method of preservation. Salting serves as an antioxidant and prevents enzymatic browning and discoloration .Salt content of 15% to 25% is adequate to preserve food product. Salt's preservative effects include the following: **a.** Salt increases osmotic pressure, which causes microbial cells to be plasmolyzed. Salt dehydrates both the food and the microorganisms by drawing out and encapsulating the moisture through ion hydration. Salt reduce the solubility of oxygen in water and

sensitize the cells against carbon dioxide, and interfere with the action of proteolytic enzymes. Sugar has the ability to absorb water. Since sugar absorbs the majority of the water in food, there is relatively little water available for microbial growth, which inhibits the proliferation of already present microorganisms. As a result, sugar preserves food by osmosis. Sugar serves as a preservative for jam, jelly, fruit syrup, candy-crystallized fruits, and glazed fruits. Decomposition of carbohydrates by microorganism or enzymes is called fermentation. By using alcohol or organic acids produced by microbial activity under anaerobic conditions, foods are preserved using this method. Bacteria and yeast break down carbohydrates like starch and sugar during fermentation. Fruits and vegetables are typically preserved using the fermentation process. Beer, wine, vinegar, fermented drinks, pickles, and sauerkraut are all examples of products that undergo fermentation.

III. FOOD STORAGE

The process of storing the raw or cooked or processed food material in appropriate condition for future use without any entry or multiplication of microorganisms is called food storage. Food storage broadly refers to the different means through which food can be kept for long time without spoiling .The shelf life of the food is the length of time a food remains safe and fit for human consumption.Despite the enormous variety of products in food service facilities, most storage areas can benefit from a few universal guidelines and these guidelines apply to the storage of all foods .Principle of storage includes the following

1. Only keep food in spaces intended for storage.
2. Maintain clean, undamaged wrappers or packages for all food items.
3. Keep the storage room dry and spotless.
4. Adhere to the "first in, first out" norm (FIFO). - This regulation makes sure that food is consumed in the order in which it is provided or purchased. According to this strategy, the food that was purchased initially must be consumed first .Food is arranged according to expiration or use-by dates in FIFO. The greatest strategy to reduce waste is to use up the older products first.
5. Keep possibly hazardous food out of the danger zone for temperatures

Following a few essential guidelines can guarantee that food is stored properly. Food should last as long as possible in good condition. It needs to be shielded from pests like flies, dust, and other organisms that might contaminate and spoil food. Reduced post-harvest loss is also necessary. Food should be stored based on its propensity to acquire off flavour. Foods are categorised on the basis of perishability. Food can be perishable, semi perishable and non- perishable. Perishable foods are the food .which can spoil quickly and have very less shelf life. This kind of food can kept on room temperature only for few hours. Examples are cooked food, milk and milk products, meat, poultry, fish, egg. Semi perishable foods are the food which can be stored for a couple of weeks or even a month without spoilage. All the cereals, pulses, some citrus fruits, vegetables like onion, potato comes under this category. Non-perishable food are those which are having very long shelf life .We can keep it for a month or year without spoiling unless handled and stored carelessly. Examples of such foods are canned, dried pickle, oil seeds, nuts, sugar, honey jaggery.

1. Types of storage

- **Dry storage:** Any space intended for the storage of bulk packaged or containerized foods that are not potentially hazardous foods are referred to as dry storage. Non-perishable and semi-perishable foods are intended for prolonged holding in this sort of storage. Cereals, flour, rice, dried pasta, canned goods, and packaged foods are typically stored in dry areas. These foods don't need their temperature controlled. No sunshine is permitted to harm the quality of the food, which is kept at a temperature between 50 and 70 degree maintained at 60 to 65% relative humidity.

- **Cold storage:** Since cooling slows down microbial activity, cold storage aids in preventing food spoilage due to microbial development. The temperature in this storage area is kept between 0 and 3 °C. This type of storage area uses what is referred to as cooled rooms. Fruits and vegetables, which are perishable foods, are kept in cold storage.

- **Frozen storage:** Foods that need to be maintained frozen solid are stored in this sort of storage .This storage is conducted at a temperature of –15 °C. Food like meat, Fish, seafood, and vegetables including carrots, beans, and green peas are kept in this kind of storage. Microorganisms cannot develop or contaminate food at frozen temperatures because their activities are inhibited.

2. Guidelines for food storage in general

- The storage room needs to be cleaned and sanitised frequently.
- Food that is being stored should be regularly inspected for signs of damage, deterioration, or infestation.
- Depending on the type of food being stored, the proper temperature needs to be maintained.
- To prevent cross contamination, each type of storage facility should be kept apart from the others.
- Overcrowding and overstocking storage areas should be avoided since they obstruct air flow, which causes the food to spoil quickly .obstruct air flow, which causes the food to spoil quickly.
- Use the FIFO approach to arrange food supply.
- To ensure that pest control baits are effectively deployed in warehouses or holding areas.
- Packaging material such as jars, cans, lids, cartons, should also be kept in clean dry area as free as possible from dust.
- All stored material should be labelled and dated raw material /product slated for reworking or dumping and finished product, awaiting shipment should all be segregated in designated area.
- Wash, wipe and clean food items that need cleaning before storage
- Note the “best before” and “expiry” dates on perishables
- Store food away from cleaning agents
- As soon as possible food should be processed, stored or served
- Store foods in their specific areas of storage and keep different food items separated

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