

FOOD STORAGE AND PRESERVATION

Abstract

The practice of food preservation is not new to human civilization. From the ancient time, leaves, branches of tree, bamboo have been utilized to keep the food items fresh and easy to transport. Now a days, researchers discovered many technologies to upkeep the shelf life of food items, but emphasis has been given to those techniques which not only enhance the shelf life of the product, but also lessen the nutrient loss and organoleptic properties loss. This chapter includes all the conventional and modern technologies, which are being utilized for this purpose.

Key words: spoilage, aseptic conditions, preservation, storage, food processing

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I. INTRODUCTION

Foods are the substances, either solid or liquid, which provide nourishment after the consumption. The foods do not only provide growth, health, satisfaction, pleasure to the human beings, but also satisfy the social needs. These food items contain several macro and micro nutrients in them to satisfy the physical needs of the human body. Though these nutrients do not have any fatal effect and entirely safe for the human consumption, but excess consumption of certain nutrients or consumption of spoiled food can be lethal for human health acutely or in the long run.

The food spoilage is a very natural phenomenon. The causes of food spoilage vary from mechanical, chemical, physical to microbiological. The physical and mechanical damage to food products started from the initial point of harvesting of the food products. Mishandling of food items during harvesting, processing and transportation could be the leading cause of such damages. The chemical changes in food products started due to overripening, extreme environmental conditions like moisture, pressure etc. Presence of different gases in the storage environment conditions can also leads to chemical destruction of the food items on molecular level. Microbial contamination is another reason for the food spoilage which sourced from contaminated soil, water, air and animals like insects and rodents.

To avoid the food spoilage and enhancing the quality of food by using different processing techniques, various methodologies have been utilized from ancient period. From using bamboo baskets to utilization of smoke for drying meat products, our ancestors have used many technologies to store and preserve foods. But in today's scenario, preservation and processing of food is not as simple or straightforward as it was in the past. Increasing demand of effective preservation and satisfaction of consumers in nutritional and sensory aspects is a key factor for the development of recent advances in food preservation and processing technologies. Understanding the preservation methods and effects of them on food has therefore become important in all aspects. This chapter provides overviews of the preservation techniques and food storage and its importance in food quality and safety assurance.

II. FOOD STORAGE

Food storage is a process of storing raw, cooked, processed or semi processed food items in proper storage conditions in such a way that food items would be utilized in future for consumption without any type of spoilage. The main aim of the food storage is to enhance the shelf life of food products. The shelf life of the food is described as the time frame in which a food remains safe and fit for human consumption. There are few universal principles of food storage to enhance the its beneficial effect. These principles of food storage are as follows:

- Dry and moisture free storage environment.
- Separation of storage and cooking spaces.
- Maintenance of clean and hygienic environment during cooking especially during non-thermal cooking procedures.
- Adherence to the rule of "First In- First Out" for the timely consumption of food items without spoilage.

- Maintenance of the required temperature for each food item and use of standardized procedures of thawing.

The proper storage is the key for reducing food spoilage by reducing post-harvest losses as well as reducing spoilage in small scale. The storage of food should be according to the type of food on the basis of their perishability. Foods are categorized as non-perishable, semi-perishable and perishable food items. The non-perishable food items like dehydrated fruits and vegetables, canned and pickled foods can be stored for months without any harmful effect. Foods which are semi-perishable like cereals, pulses, roots and tubers can be stored for weeks to months without much alterations in physical and chemical composition of foods. The foods which come under the category of perishable food items like dairy products, meat products require more attention during the storage, as they need specific storage environment for increasing the shelf life.

The food storage conditions differ for varying food items. Some of the food storage condition requirements for specific foods are as follows:

- 1. Storage of Cereals, Pulses, Flour and Breads:** The storage of cereals, pulses and rice depend upon the level of dryness in grains. They can be stored in closed containers at room temperature to prevent the spoilage from environments moisture and insect or rodents' infestation. The storage period reduces with further processing of grains. The flour of the cereals and flours need to be stored in the air tight containers in cool and dry places. Rice once cooked, should be consumed immediately. The breads made by cereal flours also have shelf life of 3-4 days maximum and mould growth appear, if not consumed within the specific time period.
- 2. Storage of Milk and Milk Products:** Milk and milk products come under the category of highly perishable food items because of its high nutrient content. Unrefrigerated milk and milk products generally spoil within 1 day of extraction. The care should be taken to keep the milk and other dairy products in clean and covered containers at low temperature.
- 3. Storage of Fresh Fruits and Vegetables:** Most of the fresh fruits come under the category of semi-perishable food items, till they not have been cut or damaged by any physical source. All fresh fruits should be stored in low temperature. The over ripened foods should always be kept separately from the other fruits as they can accelerate the ripening process by ethylene production.

The storage conditions of fresh vegetables require low temperature and dry atmosphere to prevent the spoilage. Roots and tubers can be stored in a cool, dry place with good ventilation system. The care should be taken to remove the sprouting buds to prevent the nutrient and organoleptic loss. Vegetables like onions and garlic should be well dried before storage and should kept in open area with good ventilation system.

- 4. Storage of Flash Foods:** The flash foods come into the category of highly perishable food items because of their high protein and moisture content. The main reason behind the faster spoilage of these food products is the presence of spoilage microorganisms in the surface of cuts of meat products which grow quickly and produce slime on the surface

of the food product. It is very important to dry, smoke or salt the meat and fish products before storage.

According to need of the food product, the storage of food product can be done in different storage systems listed below:

- Dry storage system
 - Cold storage system
 - Frozen storage system
- **Dry Storage System:** Dry storage is considered as any space which is used for the storage of packaged food products, which are listed in non-perishable or semi-perishable food items. Foods such as cereals, pulses, flour, canned or packed food products are typically stored in dry storage system. The temperature control is not required for such type of storage system but close monitoring on relative humidity is required as it should not be more than 60-65%.
- **Cold Storage System:** Low temperature prevents food spoilage by inactivating the microorganisms and catalytic enzymatic reactions in the food. The temperature in cold storage system is maintained between 0-3⁰C. This type of system is also referred as cold rooms. Perishable fruits and vegetables are generally kept in cold storage system.
- **Frozen Storage System:** Highly perishable food items like fish, seafoods and peeled vegetables like peas, beans are stored in temperature lower than 15⁰C. This temperature prevents the growth and development of harmful microorganisms and hence the food spoilage. The most important thing which has to be taken care during frozen storage is the thawing. Proper thawing methods should be used or otherwise it leads to early food spoilage and food poisoning after consumption.

III. FOOD PRESERVATION

Preservation of food is main objective of food science and processing. It starts with the complete physical and biochemical analysis of the food product. It's not only include the analytical process but also need in depth knowledge and understanding of food chain such as growing, harvesting, processing, packaging and distribution. The main objectives of food preservation are i) prevention of postharvest losses due to improper planning ii) production of value-added food products with better shelf life iii) provide variation in diet. The value addition in food products can improve the nutritional, functional and organoleptic characteristics. With the increasing awareness of consumers, the demand of convenient foods with enhanced nutritional value has been increased, which only can be supplement with more production of value-added food products. Variation in diet can be achieved only by the assurance of availability of food products throughout the year, which only can be achieved by adapting food preservation techniques, as most of the agricultural products are seasonal in nature.

IV. FOOD PRESERVATION TECHNIQUES

On the basis of the mode of action, the major food preservation techniques are as follows:

- Inhibition of microbial growth and chemical changes in food.
 - Inactivation of spoilage microorganisms and enzymes.
 - Avoidance of recontamination pre and post processing.
- A number of techniques or methods are there in each category.

1. Inhibition: Inhibitory methods of preservation are based on the principle of environmental control in storage atmosphere. Use of chemicals, control in temperature, water activity, pH value etc. are some of the effective techniques of this category, which are being used worldwide.

- **Use of Chemicals:** The use of chemicals in food preservation is a method utilized from centuries. Use of spices, oils and herbs is a well-known method of preservation. The main objective of chemical preservation is to control pH of the food and exert antimicrobial and antioxidant activity to keep the food safe from microbial spoilage. These chemical preservatives are either entirely synthetic in nature such as TBHQ or extracted from natural sources. The important criteria for selection of these food preservatives are that they must be safe for consumption after addition, irrespective of their source of origin. Nitrates and nitrides are used in foods especially for curing meat products as preservatives. Beside that many plants and herbs also contain some compounds with antimicrobial activity like eugenol in cloves, thymol in sage etc.

In regulation of many chemical, biochemical, and microbiological reactions, Hydrogen ion concentration, which are also measured as pH, is a very important controlling factor. Microorganisms need appropriate amount of water, nutrients, temperature and pH level to grow. Low pH is found successful in controlling microbial growth in the food products. Propionic, sorbic, and benzoic acids are few acidic components, which are very useful food preservatives in food industries.

- **Control of Water Activity and Structure:** Water is the most important component of each food item. According to various studies, high water activity is positively correlated with the growth of microorganisms as well as the food deterioration and explored the significance of water activity in determination of physical characteristics, shelf life and organoleptic characteristics of food. Below 0.6-0.7 water activity range, there is no reproduction in microorganisms, likewise water activity below 0.85-0.86, there is no growth in pathogenic bacteria. The most utilized method for reducing water activity is drying and dehydration, which is a century old method of food preservation. Earlier the drying was done by using natural sunlight, but now with the technological advancements, new sophisticated machineries has been developed like spray dryers, roller dryers, cabinet dryers etc.

Beside drying, Freezing method has also been used for changing physical state of the water from water to ice by removing the energy in the form of cooling below freezing temperature. The temperature below 18⁰C completely stop microbial growth and slow down enzymatic and non-enzymatic changes in the food during storage

period. The loss of nutrient and organoleptic characteristics is lower in freezing method as compared to drying, which is making it popular in current market scenarios.

- **Control of Atmospheric Environment:** The composition of air in the storage environment is a great indicator of shelf life of the food product. Various plant products generates a low-oxygen and high-carbon dioxide atmosphere during respiration, which helps in retardation of the ripening of fruit. This principle has been utilized for generation of different types of packaging techniques. Modified-atmosphere packaging can be utilized as a preservation technique which help in minimizing food spoilage due to microbial and chemical decay by changing the air atmosphere that can minimize the physiological and microbial decay of perishable produce by keeping them in an atmosphere that is different from the normal composition of air. In modified atmosphere packaging, the gas composition within the package cannot be monitored or adjusted, while in “controlled atmosphere packaging,” the altered gas composition inside the packaging is monitored and maintained at a preset level by means of scrubbers and the inlet of gases. Another technique is use of active packaging that can provide a solution by adding materials that absorb or release a specific compound in the gas phase. Compounds that can be absorbed are carbon dioxide, oxygen, water vapor, ethylene, or volatiles.

2. **Inactivation:** Inactivation of microbial growth and enzymatic activities is another important method of food preservation. It contains various techniques, which are listed below:

- Thermal Process
- Use of high pressure and ultrasound
- Use of electricity
- Use of radiation
- Use of magnetic field

Inactivation of microorganisms and spoilage enzymes by using heat is most widely used technique of food preservation. Few benefits of using heat energy are safe and chemical free nature of heat. It inactivates the microbial growth as most of the microorganisms are heat labile. Major loophole with the heat technique is that it changes organoleptic characteristics of food items, which is main attribute for consumer acceptability. With the increasing awareness of consumers today, there is high demand of foods with less processing treatments and chemical addition. The novel non thermal treatments like high pressure hydrostatic technologies, use of ultrasound energy is more effective in food industries. Other different forms of electrical energy are also being used in food preservation, e.g., ohmic heating, microwave heating, low electric field stimulation, high-voltage arc discharge, and high-intensity pulsed electric field etc. In irradiation process there is exposor of the foods, either prepackaged or in bulk, to a predetermined level of ionization radiation. It has potential in pasteurization, sterilization, and enhancing other factors beneficial to processing in food preservation.

- 3. Avoid Recontamination:** This is the indirect approach of food preservation, as it does not include any method or technique for avoiding food spoilage. But it includes other measures such as packaging and quality management tools to avoid contamination or recontamination. These measures play very crucial role in production of high-quality foods. Aseptic packaging like canning is one way to achieve microorganism free food products with limited chances of contamination. Another packaging method to increase the shelf life of the product is active packaging, which allows one-way transfer of gases away from the product or the absorption of gases detrimental to the product, antimicrobials in packaging, release of preservatives from controlled-release surfaces, oxygen scavengers, carbon dioxide generators, absorbers or scavengers of odors, absorption of selected wavelengths of light, and there are capabilities for controlled automatic switching. Another concept of edible or biodegradable packaging has also been evolved for environmental reasons. Processing and packaging can be integrated to improve efficiency.

V. CONCLUSION

Food spoilage and wastage is a major problem especially in developing countries which resulted from the unplanned agricultural and industrial practices. By adopting advance technologies for food harvesting, processing and storage, shelf life of the foods can be increased manifolds. Researchers need to focus on the new preservation techniques, which not only help in the increasing storage life of food, but also help in decreasing nutrient loss and sensory characteristics of food items

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