Food Microbiology and Food Safety
Research and Development

Vijay K. Juneja
Hari P. Dwivedi
John N. Sofos *Editors*

Microbial Control and Food Preservation

Theory and Practice

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Chapter 1
Food Preservation and Safety

Azlin Mustapha and Jee Hye Lee

Abstract Food preservation has evolved from primitive, simple methods like sun drying to sophisticated techniques like high pressure processing. Although the techniques employed in food preservation vary drastically, the goal is one and the same, which is to increase the safety and shelf-life of food. This, in turn, results in a continuous supply of nutritious, safe and palatable food for humans and animals globally. Food preservation can be achieved via chemical, physical or biological treatments or modification of foods. This chapter will briefly introduce the concept and history of food preservation, important considerations to be taken, its benefits and some examples of food preservation techniques. Because food is marketed to consumers, consumer perspectives of various food preservation techniques will also be covered. Because of the fluidity of agricultural systems, global markets, climate changes and market trends, the science and technology of food preservation will continue to evolve.

Keywords Food safety • Shelf life • Chemical preservation • Physical preservation • Biological preservation

1 Introduction

Food preservation has been an essential process in human civilization because it allows for the production of a varied supply of food with longer shelf lives. Food preservation methods have been developed alongside the evolution of civilization and with the development of the food industry. Preservation methods aim to inhibit the growth of microorganisms, maintain the appearance of the food and slow down chemical reactions that result in product deterioration. In this chapter, the purpose,

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significance and history of food preservation will first be introduced. Secondly, some traditional and modern preservation methods will be briefly reviewed; and finally, consumers' perspectives on food preservation will be introduced.

2 What Is Food Preservation?

The practice of preserving food began in the prehistoric age when ancient humans hunted animals and ate fresh animal meat. Acquired foods were sometimes stored to prevent famine and different food preservation methods for improving food quality were attempted. For example, grains were sun-dried to extend their storage period and fresh food were stored in cool, dry caves. About 400,000 years ago, Peking Man (*Homo erectus pekinensis*) may have utilized cooking methods using fire, such as grilling food over a fire to improve its flavor (Table 1.1). The main

Table 1.1 Historic events in food preservation (from Noh et al. (2009))

Year	Summary
Before 1500	Natural drying agents, such as fire, wind, sun, seawater, and halite were used for preservation, along with cooking, grilling, roasting, and curing with salt or sugar; and natural cool storage, such as caves, were mostly used. In 1492, American Indians were using fire for drying pemmican
1600s	A low-heat air-drying room for using the hot air artificial drying method was developed
1780	In the UK, preconditioning with hot water for drying vegetables was performed
1795	In France, hot air was used for drying vegetables
1800s	In 1804, Nicolas Appert (France) invented a canning method using wide-mouth bottles. In 1810, Peter Durand (UK) discovered the tin can. In 1819, Thomas Kensett (UK) started to can shrimp, salmon, and oysters
1875	Carl von Linde invented a compression refrigerating machine using ammonia for making ice
1900s	Canning was more developed in this period
1916	Rudolph Planck proposed a theoretical quick-freezing technique
1922	Franklin Kidd and Cyril West (England) began studying methods of gas storage
1929	Clarence Birdseye (USA) invented a quick-freezing system and began to make frozen food
1942	During WWII, freezing, cooling, drying, canning, and bottling processing techniques were further developed
1950	Vacuum concentration of liquid food and lyophilization of dehydrated food became available
1953	In the US, studies into the application of radiation to food began
After 1960	Until 1950, processing techniques and equipment were being improved side-by-side, and through the incorporation of food chemicals and additives, the quality of processed food similarly improved. Also, through the development of petro-chemistry, many types of plastic products were developed for use as packaging materials or containers. Electronic engineering, such as microwave ovens, thermoelectric cooling, supersonic machining, etc. are applied to food processing

functions of food preservation are to prevent food quality deterioration and to extend the time between production and consumption so that the food could be stored for longer periods. Food preservation aims to minimize the physical and chemical changes that occur during storage, while at the same time, ensure food safety. Some food preservation considerations (Bowers 1992; VanGarde and Woodburn 1994) are as follows:

- Good food preservation must *maintain the food's acceptability.* Food preservation is useless if adequate appearance, odor or taste of the food is not maintained.
- Good food preservation must *keep the food safe*. Properly monitoring the food during storage and evaluating it before consumption are good ways to ensure food safety.
- Good food preservation must *retain nutrients*. Ensuring a minimal loss of nutrients, including protein, carbohydrates, fibers, minerals, and vitamins during storage is important.
- Good food preservation must *be an asset to the food distribution chain.* From an operator's viewpoint, practical uses of packaging materials are helpful for effectiveness of food distribution.
- Good food preservation must *be feasible and applicable*. Food preservation is practiced not only by food manufacturers but also by consumers, thus, a simple, yet effective preservation technique, such as fermentation, is useful.
- Good food preservation must *conserve available energy resources.* Food preservation methods should be evaluated based on the appropriateness of the preservation process for a specific food and environmental condition.

3 Why Food Preservation Is Important

Food preservation techniques can be grouped into three categories: physical techniques (e.g. drying, pasteurization, or freezing), chemical techniques (e.g. addition of salt or sugar), and biological techniques (e.g. microbial fermentations) (Lück and Jager 1997).

The objectives of food preservation are:

- to preserve quality.
- to eliminate pathogens.
- to eliminate or reduce spoilage-causing microorganisms.
- to extend the shelf-life of the food.

The outcomes of effective food preservation are:

- to overcome the restrictions of time and region (e.g. seasonality).
- to improve the palatability of the food (e.g. flavor, appearance, or texture).
- to improve nutrient availability in the food (e.g. protein).

The benefits gained from food preservation (Noh et al., 2009) are discussed below:

3.1 Planned Manufacturing and Distribution

Food preservation allows for the planned production, processing and movement of food according to seasonal, climatic and distribution demands because food can be mass-produced without fear of the surplus decomposing.

3.2 Economically Favorable Containment and Distribution

The use of proper sizes and types of food containers in the food industry maximizes the efficiency of food processing and distribution.

3.3 Prevention of Loss in Food Quality

Undesirable changes and decay of food are prevented by proper preservation processes. These processes can preserve the quality of the food in terms of its nutritional and organoleptic qualities, leading to greater economic benefits.

3.4 Stabilization of Price

Considering the nature of agriculture, stockbreeding, and fishing, some variations in food supplies are expected, even with proper planning. A big harvest or haul results in a decrease in price whilst a poor harvest or haul causes the opposite. Thus, maintaining supplies of preserved food helps keep the price stable over time.

4 Food Preservation Methods

Current food preservation methods are designed to minimize undesirable changes in the wholesomeness, sensorial qualities, and nutritional composition of food through efficient and effective ways of controlling the growth of microorganisms. Food preservation can be addressed via chemical, biological, and physical methods. Chemical preservation methods can be applied by adding substances, such as sugar, salts, acids, or smoke to food. Biological preservation is based on the principles of alcoholic or acidic fermentation. Physical preservation is accomplished by controlling the food products' temperature and water activity (A_w), and by the use of packaging. Physical methods are commonly used in commercial food preservation around the world (Jang 2015).

5 Current Food Preservation Methods

5.1 Dehydration/Drying

Drying is one of the first techniques for preserving foods developed by humans. Fresh foods become less perishable when their A_w is decreased. A decrease in A_w usually translates to a delay in microbial growth and chemical reactions. The minimum A_w limit for growth of most bacteria is 0.86 and that for most molds and yeast is 0.61 (Fontana 2007). The principle of drying is the most simple, in that available water is removed, which can be accomplished using natural methods, such as sun, fire, or wind. Around 12,000 B.C., the Middle Eastern and Asian cultures commonly dried foods using the sun (Nummer 2002).

Various types of drying methods exist: sun drying, roast drying, hot air drying, heated-surface drying, and vacuum drying. Sun drying is a method which is still being widely used around the world. Roast drying is a process by which heat is applied to dry foodstuffs and food are stirred as they are roasted to heat evenly. Hot air drying is a method where water in the food is evaporated by hot air. Various types of dryers can be used for hot air drying: bin dryer, cabinet dyer, conveyor dryer, fluidized bed dryer, kiln dyer, spray dryer, tunnel dryer, and pneumatic dryer (Shinh et al. 2009). When heat is applied to dry food using a heated surface, the process is referred to as heated-surface drying. This process has a high thermal efficiency and can be done without oxygen. On the other hand, vacuum drying for solid foods is a process by which heat is applied to a sealed container with a pressure of 5–30 kPa at 35–80 °C (Brennan 1994; Oakley 1997).

The application of drying preservation techniques results in changes to the food, including a movement of water molecules from the internal parts of the food to the surface, shrinkage of food volume, surface hardening, and loss of vitamins (Lee 2013).

5.2 Chilling/Low Temperature Storage

Low temperature is also effective for the extension of food storage periods. The deep parts of caves, dark cellars, and cool streams are still being used as cool storage places in some countries (Kim et al. 2000). The refrigerator, which was invented in the 1800s (Burstall 1963), is a major milestone in the development of food preservation techniques because it effectively prevents the growth of microorganisms, inhibits post-harvest metabolic activities in plant tissues and post-slaughter metabolic activities in animal tissues, as well as deteriorative chemical reactions, including enzyme-catalyzed oxidative browning or oxidation of lipids, autolysis in fish, and other chemical changes that affect food quality (Shinh et al. 2009). Further, refrigeration reduces the loss of nutrients and moisture, and helps satisfy consumers' needs for health and freshness.

Although the growth of thermophilic and mesophilic organisms can be inhibited during low temperature storage, psychrotrophic bacteria can still proliferate. For example, *Vibrio* and *Acinetobacter* can grow in fish, and *Pseudomonas*, *Micrococcus* and *Lactobacillus* can grow in meat products during low temperature storage (Shinh et al. 2009). Low temperature storage can also result in undesirable changes in food quality after a certain amount of time. One of the examples is 'chilling injuries' which can occur in fresh foods, such as fruit and vegetables, if appropriate temperatures are not maintained (Wang 1994).

5.3 Freezing

Ancient freezing methods were useful only in places with an appropriate climate, *viz*. cold weather. In the late nineteenth century, Clarence Birdseye discovered that freshly caught fish that was instantly frozen under thick ice, tasted fresh when thawed, a condition referred to now as "quick freezing" (Birdgeye and Fitzgerald 1932). Freezing preserves food at a very low temperature, and prevents the growth of microorganisms as well as changes caused by chemical reactions in the food. During the freezing process, however, physical and chemical changes can still occur in the food, including recrystallization, oxidation of lipids, enzymatic browning, destruction of vitamin C, and rapid insolubility of proteins (Noh et al. 2009). Slow freezing and thawing are more effective at decreasing microbial survival rates than are quick freezing and thawing (Geigeis 1996).

5.4 Controlled Atmosphere (CA) and Modified Atmosphere (MA) Storage

Food preservation can be achieved through controlled and modified atmospheres of the storage environment. An inhibition of microbial growth and a decrease in respiration of fresh fruits and vegetables occur when the oxygen density in the storage environment air is decreased and carbon dioxide concentration is increased (Brenna and Day 2006). There are three ways to change the composition of air in a storage environment (Shinh et al. 2009): (1) Controlled atmosphere storage (CAS) involves regulation of oxygen, carbon dioxide, and ethylene gas, (2) Modified atmosphere storage (MAS) is when the storage environment is sealed so that the air is changed by the natural food respiration, and (3) Modified-atmosphere packaging (MAP) is done by sealing the product to change the composition of the air.

6 Emerging Food Preservation Methods

Emerging food preservation methods that use newer technologies have been developed to meet greater food market requirements for foods with better quality and sensorial attributes, and containing fewer additives while maintaining a longer shelf life. Some of these methods are discussed below.

6.1 High Pressure Processing/High Hydrostatic Pressure/ Ultra High Pressure

High pressure processing (HPP), also called high hydrostatic pressure (HHP) or ultra high pressure (UHP), has been used to kill bacteria since 1895 (Hite 1989; Patterson et al. 2006). High pressures of 5–6 GPa or less have been applied in commercial food applications (Crossland 1995). HPP at 100–800 MPa is usually employed for liquid and solid foods without packaging within a range of temperatures (<0 °C to >100 °C) for more than 20 min (Smith and Hui 2004). Pressure kills various microorganisms, including spoilage-causing and pathogenic microorganisms. Previous studies supported the antimicrobial effects of HPP on selected microorganisms, such as *Aspergillus awamori* and *Saccharomyces cerevisiae* in Satsuma mandarin juice (Ogawa et al. 1992), *Listeria innocua* in minced beef muscle (Carlez et al. 1993), and *Listeria monocytogenes*, *Vibrio parahaemolyticus*, and *Salmonella* Typhimurium in phosphate butter at pH 7.0 (Metrick et al. 1989; Patterson et al. 1995; Styles et al. 1991). Although spore-forming bacteria, such as *Clostridium botulinum*, can be inactivated by HPP at 500–700 MPa and 90-110 °C, some types of *C. botulinum* spores) can survive (Smith and Hui 2004). HPP contributes to the retention of freshness and sensorial and nutritional attributes of the products, but it is quite costly at the initial establishment stage (Aleman et al. 1994; Deplace 1995).

6.2 Ultrasound Treatment

Ultrasound is an oscillating pressure produced by ultrasonic sound waves at frequencies of 20 kHz and higher (McClements 1995). In the food industry, ultrasound treatment has been combined with other technologies. Low energy, high frequency ultrasound (<1 W/cm^2; >100 kHz) confers an antimicrobial effect in a broad range of food matrices, including fats, milk, bread, fruits and sauces, while high energy, low frequency ultrasound (10–10,001 W/cm^2; 20 ~ 100 kHz) is employed to improve the efficiency of various food processes (Torley and Bhandari 2007).

Ultrasound treatment is an emerging method that inactivates microorganisms by disrupting cellular structural and functional components using ultrasonic waves (Smith and Hui 2004). It has been shown to have antimicrobial effects on bacteria, spores, yeasts, fungi, and viruses, but the sensitivity of microorganisms to ultrasound treatment differs, and some spores or viruses are less sensitive than Gram positive and Gram negative bacteria to ultrasound (Earnshaw 1998; Earnshaw et al. 1995; Manas and Pagan 2005; Nakano et al. 1989; Raso and Barbosa-Canovas 2003; Ross et al. 2003; Palacios et al. 1991; Piyasena et al. 2003). Ultrasound treatment at low temperature is less effective. In a study by Palacios et al. (1991), *Bacillus stearothermophilus* spores were not affected by ultrasound treatment at 12 °C and *C. botulinum* spores showed the same results in a study by Nakano et al. (1989).

6.3 Pulsed Electric Field

Pulsed electric field processing is an emerging non-thermal preservation method in which a food is placed between two electrodes in a high-voltage electric field, typically 20–80 kV/cm^{-1} (Yang et al. 2004). This method reduces the metabolic activities of microorganisms but minimizes undesirable changes of sensorial properties of the treated food, such as flavor, taste, and color, as well as nutrients (Mertens and Knorr 1992; Knorr 1999; Ayhan et al. 2001, 2002) and functionality (Li et al. 2003).

The inactivation effects of pulsed electric field on food enzymes have also been evaluated by previous studies. For example, Ho et al. (1997) showed that after a specific pulsed electric field treatment, conducted at 13–87 kV/cm, 0.5 Hz, 2 s pulse width and 30 pulses, significant reductions of lipase, glucose oxidase, and amylase in foods occurred. The inactivation effect of pulsed electric field on several microorganisms showed reductions of *S. cerevisiae* in orange juice at a field strength of around 6.5 kV/cm^{-1}, *E. coli* in milk at a field strength of around 21 kV/cm^{-1}, and *Salmonella* Dublin in milk at a field strength of around 18 kV/cm^{-1} (Sitzmann 1995).

7 Natural Antimicrobial Preservatives

Increasing consumer concerns about the use of chemical preservatives in foods have generated greater demand for “naturally produced antimicrobial agents” and “minimally processed” food (Cleveland et al. 2001). Thus, the food industry and food scientists alike are currently expending more efforts to utilize useful antimicrobial agents from natural sources. Some promising options come from the natural defense mechanisms or competitive abilities of certain plants and microorganisms (Rahman 2007).

Two components of milk, lactoperoxidase and lactoferrin, possess antimicrobial properties. Lactoperoxidase has been shown to have a bactericidal effect on *Listeria* and *Staphylococcus* (Beumer et al. 1985a, b, 1988; Bibi and Bachmann 1990; Borch et al. 1989; Denis and Ramet 1989; Earnshaw and Banks 1989; El-Shenawy et al. 1990; Kamau et al. 1990a, b; Siragusa and Johnson 1989; Wray and McLaren 1987), and lactoferrin has an antibacterial effect on *E. coli* K-12 (Visca et al. 1990). Nisin, which is produced by *Lactococcus lactis*, is a well-known antimicrobial protein. Nisin has an antimicrobial effect on a wide range of Gram-positive bacteria and some Gram-negative bacteria (Stevens et al. 1991, 1992). In addition, it also has a similar effect on spores (Hall 1966).

Generally, bacterial starter cultures, such as *Lactococcus*, *Leuconostoc*, *Pediococcus* and *Lactobacillus* have their own bactericidal effects on other organisms. For example, *Pediococcus* FBB-61 inhibits strains of *Bacillus cereus*, *Clostridium perfringens*, *L. monocytogenes*, *Listeria* spp., and *S. aureus* (Spelhaug and Harlander 1989). Starter cultures are effective at inhibiting Gram-positive spoilage and pathogenic bacteria (Ray and Daeschel 1994). Dillon and Board (1994) emphasized four desirable characteristics of starter cultures as biopreservatives. First, they should be effective against many Gram-positive food spoilage-causing and pathogenic bacteria, as well as spores. Second, they should be effective regardless of different food environments, and thirdly, they should provide economic value but should not affect food quality.

Spices and essential oils also possess antimicrobial properties. Allicin, a diallyl thiosulfinate in garlic, exhibits antimicrobial effects on a broad range of bacteria, including *Enterobacter*, *Escherichia*, *Klebsiella*, *Proteus*, *Pseudomonas*, *Salmonella*, *Serratia*, and *Shigella* (Srivastava et al. 1982; Stoll and Seebeck 1949). Thyme and oregano have an inhibitory effect on the growth of *V. parahaemolyticus* (Beuchat 1976; Deans and Ritchie 1987).

In addition, various antimicrobial compounds are found in food plants and vegetable oils. For example, the antibiotic influence of anthocyanins, leucoanthocyanidins, and phenolic acids on bacteria, such as *Salmonella* Typhi, *Shigella* spp., and *E. coli* have been tested (Powers 1964). An antimicrobial effect of phenolic compounds from olive extracts on *Lactobacillus plantarum, S. aureus,* and *Salmonella* Enteritidis has been proven by several researchers (Etchells et al. 1966; Radford et al. 1991; Ruiz-Barba et al. 1990, 1991; Nychas et al. 1990).

8 Consumer Perspectives on Food Preservation Methods

In the twenty-first century, modern food preservation techniques provide numerous benefits to consumers, including an improvement in food safety, an extension of food storage periods, prolonged shelf-life, availability of various food products throughout the year, and convenient access to food products from different regions. Further, food preservation techniques have advanced in response to consumer trends. Consumer demands can be considered from two perspectives: (1) improved food quality and (2) consumer health (Fox et al. 2002; Gayán et al. 2014; Grebitus et al. 2013; Haugaard et al. 2014; Junqueira-Gonçalves et al. 2010; Zink 1997). Consumers prefer fresh, attractive and hygienic qualities, including good color, flavor, and odor. Consumers' perception and evaluation of food quality (color and shelf life) are important factors in purchasing decisions. In a study by Grebitus et al. (2013), consumers preferred a bright red meat color and showed a willingness to pay more for such meat. Modified atmosphere packaging with the inclusion of carbon monoxide (CO-MAP) contributes color stabilization to meat. Thus, a brighter red color of fresh red meat is possible. Interestingly, however, this study showed that consumers had a lower willingness to pay for red ground beef when they are given more detailed information about CO-MAP technology. It might be that consumers perceive the new technology as having its own health risks since most people have been warned about the dangers of carbon monoxide in other situations.

In addition, consumers' concerns for health show up in a number of different ways. A demand for minimal use of chemical additives in food products is one of them. In a study by Haugaard et al. (2014), consumers showed positive attitudes and purchase intentions toward new preservation techniques that use natural preservatives in food products.

Many irradiated food products, including meats, have been approved or endorsed by several authorities, including the FDA, USDA, WHO, and FAO, and scientists agree about the safety of irradiated food (CAST 1986). However, in a study by Kwon et al. (1992), more than two-thirds of 600 Korean participants exhibited fear about irradiated foods and were confused about the difference between irradiated and radioactively contaminated food. In a survey conducted by Junqueira-Gonçalves et al. (2010), the respondents perceived irradiated foods as radioactive foods.

Novel food preservation technologies are developed and introduced in order to satisfy consumers and food markets. However, the introduction of new food preservation technologies for commercialized foods evokes fear that consumption might carry possible risks. This concern is often seen in the case of irradiated food products (Fox et al. 2002; Gunes and Tekin 2006), which consumers believe will cause short- or long-term health effects when consumed (Cardello 2003; Deliza et al. 2003; Cardello et al. 2007). Ample research pointed out that providing more information about the process and advantages of irradiation resulted in positive attitudes (Deliza et al. 2003; Ornellas et al. 2006; Gunes and Tekin 2006). The positive relationship between a higher level of knowledge and a tendency to buy irradiated food was supported by Crowley et al. (2002). As the conceptual model (Fig. 1.1) shows, food industry marketers should try to provide accurate information about new preservation technologies and promote their benefits since media exposure has a critical influence on consumers' attitudes.

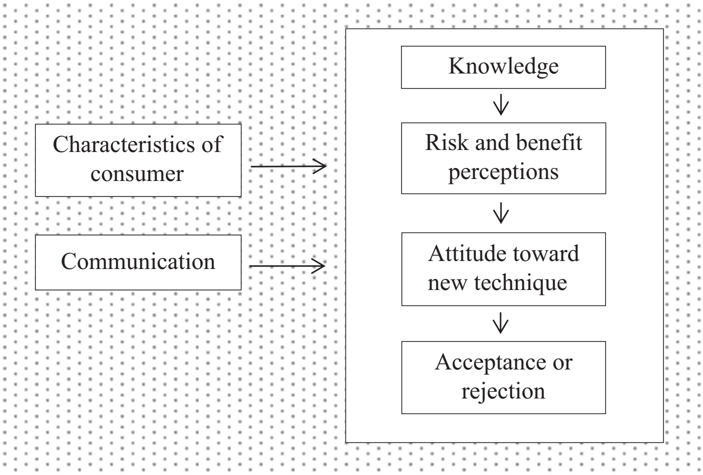

Fig. 1.1 Conceptual framework for attitude formation toward new preservation techniques (Haugaard et al. 2014)

9 Concluding Remarks

Food preservation and food safety are intricately intertwined. Although food preservation is concerned with prolonging the shelf life of food by way of preventing the growth of spoilage organisms or chemical reactions, often times, the same processes also confer a safety aspect to foods by inhibiting pathogens from growing or eliminating them altogether. Many preservation methods used by humans in ancient times are still being used today. However, modern time food processing systems have evolved into a high technology science. Because of the ever-changing way of how we grow, process, market, transport, and consume our food, the science and art of food preservation and food safety will continue to evolve to ensure safe and consumable food for the world's population.

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Chapter 2
Principles of Food Preservation

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Abstract Food preservation is an action or method used to maintain foods at certain desirable properties or quality to obtain maximum benefit. A good method of food preservation is one that slows down or prevents altogether the action of the agents of spoilage without damaging the food. To achieve this, certain basic methods are applied depending on the food types. Food preservation has been an essential activity throughout human history. The cycle of seasons brings periods of shortage and abundance of various foods at different times of the year. Preservation makes it possible to consume some of these foods during off seasons, throughout the year. Food preservation usually involves controlling or preventing growth of microrganisms or minimizing the quality degradation due to microbial spoilage or unwanted chemical changes in foods such as rancidity due to oxidation of fats over time. Preservation of foods is no longer simple and straightforward today; it has evolved to a highly inter-disciplinary field of science. In recent years, many new sophisticated preservation techniques have developed to extend the quality and shelf-life, minimize risk, protect the environment, and improve functional, sensory, and nutritional properties. Many of emerging preservation technologies have already

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reached commercial adoption in specific applications while many others remain promising. Development of suitable equipment, especially for continuous processing for a variety of foods and standardization of the process parameters for easy regulatory approval will pave the way for improved food preservation. The objective of this chapter was to examine the science and technology involved in the manipulation of conventional as well as sophisticated emerging preservation methods.

Keywords Thermal preservation • Advance thermal technology • Emerging nonthermal preservation • Pulsed light • Membrane technology

1 Introduction

Preservation of foods involves controlling or preventing the growth of microorganisms such as bacteria, fungi and yeasts, although in some instances food preservation can be achieved by introducing benign microorganisms to the food. Preservation is also achieved by retarding the oxidation of fats that cause rancidity. Processes that inhibit visual deterioration of foods, for example the browning of apples due to enzymatic reaction once apples are cut is also considered as food preservation. In some cases food preservation involves a number of different food methods each of which independently as a separate preservation technique. Preparation of Jam or Jelly, for example, involves steps as heat treatment or boiling to lower the moisture content of fruit and to kill microbes, etc., addition of sugar as preservative to control the re-growth of organisms and lastly sealing of the food within an airtight container in order to stop recontamination of the final product. Many old preservation methods which been used traditionally in the past have been proven to be less energy intensive and have lower carbon footprint compared to modern intentions (Preserving food without freezing or canning 1999). Quality maintenance, for example preservation of color, flavor, texture, micronutrients and overall nutritional quality in an integral part of food preservation.

2 Advantage of Food Preservation

Food preservation has many advantages. It makes possible to prevent the spoilage foods due to the action of inherent microorganisms and enzymes. Preservation prolongs the duration of safe storage of foodstuffs and thereby creates its availability throughout the season and makes up for the deficiencies. Preservation also makes food transportation much easier.