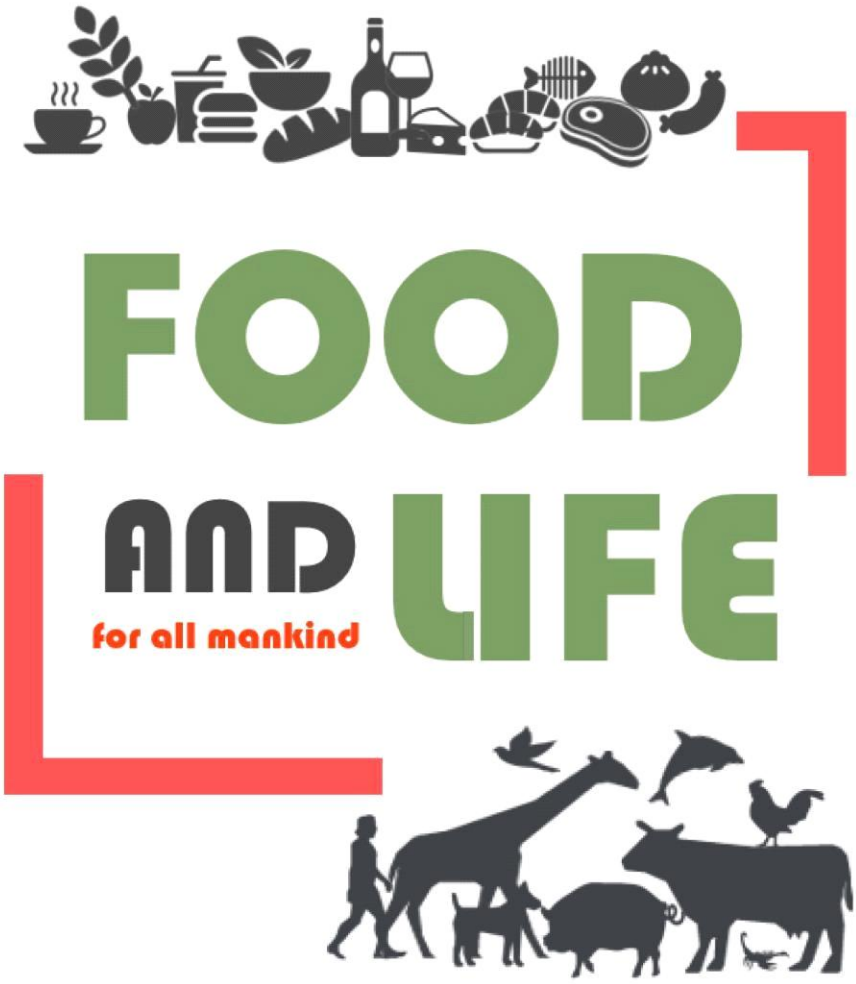

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Modern trends and techniques for food preservation

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Abstract

Food preservation is the process of stopping or inhibiting the spoilage of food that prohibits foodborne diseases while keeping the food's nutritional value, flavor, and texture. Food preservation plays a vital role in food safety and quality. Food preservation techniques are also helpful in meeting the global food demand as these techniques provide an opportunity to store food for a long time. Food safety techniques, like salting, drying, and fermentation to increase the shelf-life of raw food, have been used since the dawn of humankind, and our ascendants must have used these techniques. A wide range of chemical and biochemical reactions could be the root of food spoilage. So, appropriate preservation is necessary to stock the food for as long as possible without contamination. Primary and fundamental techniques like drying, freezing, pasteurization, biopreservation, and Nanoencapsulation have been instigated to stop or slow down food's chemical and biochemical destruction. Bio-preservatives are now commonly used to meet people's demand for food preservation as chemical preservatives are rejected. This review summarizes the various physiochemical and microbial components that cause food spoilage and the use of different food preservative techniques like salting, dehydration, freezing, smoking, irradiation, antimicrobial agents, preservatives, and nanotechnology in the food industry during processing and packaging.

Keywords: food spoilage, food preservation, biopreservatives, nanotechnology, food processing

Introduction

Food is an organic substance that can be in solid or liquid form and can be absorbed, digested, and assimilated in the body of an organism to gain the energy that the body needs to work, repair tissue, grow, and perform other vital processes. It consists of all the essential nutrients like proteins, fats, carbohydrates, vitamins, and minerals (Pinstrup-Andersen, 2009). It can be obtained from animal or plant sources (Harlan, 1976). The demand for food production is rising remarkably due to increasing population and changes in food diversity (Davis et al., 2021; Samad et al., 2024). As foods are nutritious enough, they can be spoiled by physical, chemical, and microbial processes (Rahman and Labuza, 2007). According to the World Health Organization (WHO), about 1 out of 10 people become ill from eating spoiled food. According to Fouladkhah et al. (2019), 420,000 people die every year due to food poisoning. It has been observed that during food transportation, the surrounding environment, including bacteria, chemicals, and the enzymes present in food, can cause changes in the morphology of food and reduction of nutrients in food (Gram et al., 2002). Thus, the food needs to be preserved to avoid spoilage by contamination and maintain food quality. Food preservation increases food stock storage and shelf-life without affecting nutritional values and qualities (texture, aroma, freshness, flavor, color). Food Preservation is also helpful in avoiding the oxidation of fat in food by inhibiting microbial growth (Prokopov and Tanchev, 2007). Food preservation is also known as food processing (Lianou et al., 2016; Necidová et al., 2019). The history of "Food Preservation" goes back to ancient culture when primary troops

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felt that there was a need to preserve food when a large animal could not be eaten at once. Similar basic techniques were applied to keep food in a distant society, which was the utmost evolutionary step (Nummer, 2002).

The food industry is trying to design new, less invasive technologies (use of high pressure, hurdle technology, radiations like UV light, Oscillating Magnetic Field) beyond the traditional conventional methods like drying, freezing, chilling, curing, heating, boiling, sugaring, salting, canning, pickling, and fermentation (Blum, 2012; Rahman, 2014). Bio preservatives are alternatives for preserving food to keep its characteristics, which is also helpful in fulfilling the demands of people who want to consume chemical-free food. Bio-preservation is a technique used to control microbes by adding natural antimicrobial compounds to increase the shelf-life of food products. It also uses beneficial bacteria to prevent spoilage and make pathogens inactive. Bio preservatives act by lowering the pH, changing the water activity, and adjusting the redox potential of food products (Rehman, 2020). Lactic acid bacteria (LAB) are widely used to preserve food (Gemechu, 2015).

Packaging is the other most crucial method of preserving food and providing all the necessary information regarding food products for commercialization (Davis and Song, 2006; Raheem, 2013). The properties of packaging depend upon the type of food that has to be protected. Commonly used packaging materials are paper, cardboard, glass, metal, and plastics (Kishimoto, 1990). While these materials cause pollution, the reaction between packing material and food may harm quality and health (Muzeza et al., 2023). Therefore, intelligent packing, in which technology is used to sense or monitor the overall quality of food, is considered. This approach may directly improve food safety by interacting with food. In intelligent packing, researchers apply bioactive substances (antioxidants, antimicrobials, moisture absorbers) to preserve food (Vasile, 2018). Another approach is biodegradable packaging, an alternative to conventional materials that are easy to produce, degrade, and recycle (Davis and Song, 2006) and mainly used to preserve fruits and vegetables (Butnaru et al., 2019).

Moreover, nanotechnology is the latest approach to food preservation (Chandra, 2016). Due to its excellent physiochemical and antimicrobial potential, nanomaterials are used in crop protection, food processing, and conservation (Baranwal et al., 2018; Fu, 2014). Nanotechnology is now used in food to produce desired properties (Sandoval, 2009); these are used as biosensors and packaging materials. However, there is a problem with nanotechnology as it could be more cost-effective for food processing (Adabi et al., 2017; He and Hwang, 2016). Considering the need for food preservation to avoid poisoning, spoilage, and other infirmities, this review pursues the traditional and latest food preservation techniques. This review also presents the implementations of nanotechnology in the processing, packaging, transport, and storage of food. Moreover, it explains the prevailing struggles to address the risk-related factors and toxicological effects of packaging in food sectors.

Classification of Foods

Food classification is done on various occasions, as discussed in Fig. 1 and further explained below.

Food classification based on shelf-life

There are three classes of food based on the shelf life of food (Perishable foods, Non-perishable foods, Semi-perishable foods).

Perishable foods

They can be stored for several days to 2-3 weeks (e.g., seafood, meat, milk and its products, poultry, eggs, and all

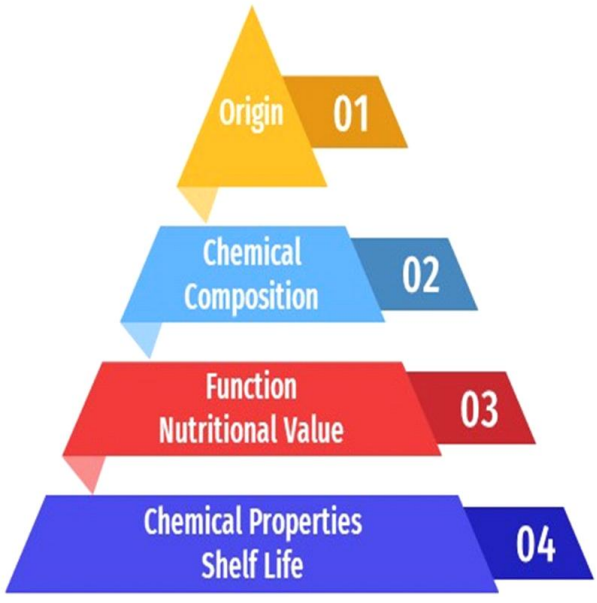

Fig. 1. Basis for classification of food.

cooked leftovers). They become spoiled if not refrigerated.

Semi-perishable foods

They can be stored for several months (about six months) under appropriate storage states (e.g., vegetables, fruits, cheese and potatoes, ginger, and biscuits).

Non-perishable foods

They are naturally processed foods with unlimited life and can be stored for several years (e.g., dry beans, nuts, flour, sugar, canned fruits, peanut, butter, mayonnaise, dry meat) (Jones and Lennard, 2020).

Food classification based on functions

Based on the functionality of food, they can be classified into two classes.

i) Bodybuilding and repairing hoods, ii) regulatory and protective food, iii) energetic foods.

Bodybuilding and repairing foods

Body-building and repairing foods increase the body's mass and repair cell and tissue damage, e.g., milk, meat, fish, vegetables, and nuts (Fakolujo et al., 2024).

Energetic foods

The foods that provide energy for the movement are called energetic foods, e.g., oil, butter, sugar, cereals, dry fruits, and starches (Gupta and Kaur, 2023).

Regulatory and protective foods

The foods that regulate the body through homeostasis and protect the body from external pathogens are called regulatory and protective foods. Water, raw vegetables, beverages, milk, meat, and fruits are regulatory and protective foods (Singh et al., 2023).

Food classification based on nutrients

Carbohydrate-rich foods are based on nutrients like rice, wheat, and starchy vegetables. Protein-rich foods include milk, meat, fish, eggs, and nuts. Oil, butter, and egg yolk are excellent sources of fat enrichment. Vitamins and minerals can be obtained from fruits and vegetables (Hoque et al., 2023).

Food classification based on the extent of processing

There are three classes of food based on their processing.

Unprocessed foods

Foods that are not processed or may be physically processed to make whole food more available. It makes food to preserve for more time. This includes fresh fruits, vegetables, nuts, pasta, tea, and coffee.

Processed foods

Those foods are those in which components of food are extracted to make it prepared for dish cooking. Vegetables, sweeteners, pasta, and noodle preservatives fall into this category.

Ultra-processed foods

Foods that are processed culinary to produce accessible, palatable, and readily available foodstuffs with longer shelf-lives (e.g., cakes, biscuits, bread, chocolate, milk drinks, sausage, salted, pickled, smoked, meat and fish, fish canned in oil) (Monteiro et al., 2010).

Food Spoilage Mechanism

The process that causes the reduction of food nourishing ability is known as food spoilage and is related to food safety (Steele, 2004). The extent of food spoilage can be determined by chroma, aroma, flavor, and taste. The mechanism of food spoilage is elaborated in the Fig. 2. Various factors that are the cause of food quality and causing food spoilage are explained below.

Physical spoilage

Physical spoilage occurs due to gain or loss of water or humidity, water movement between compartments, and their separation (Roos and Karel, 1991; Steele, 2004). Moisture content (Balasubramanian and Viswanathan, 2010), temperature (Kader et al., 1989; Steele, 2004), and crystallization (Levine and Slade, 1988) are physical factors that cause spoilage.

Microbial spoilage

It is the most common method of food deterioration. Microorganisms like bacteria, fungi, molds, and yeasts cause food deterioration and foodborne illnesses, especially in highly perishable foods. It can be prevented by lowering pH,

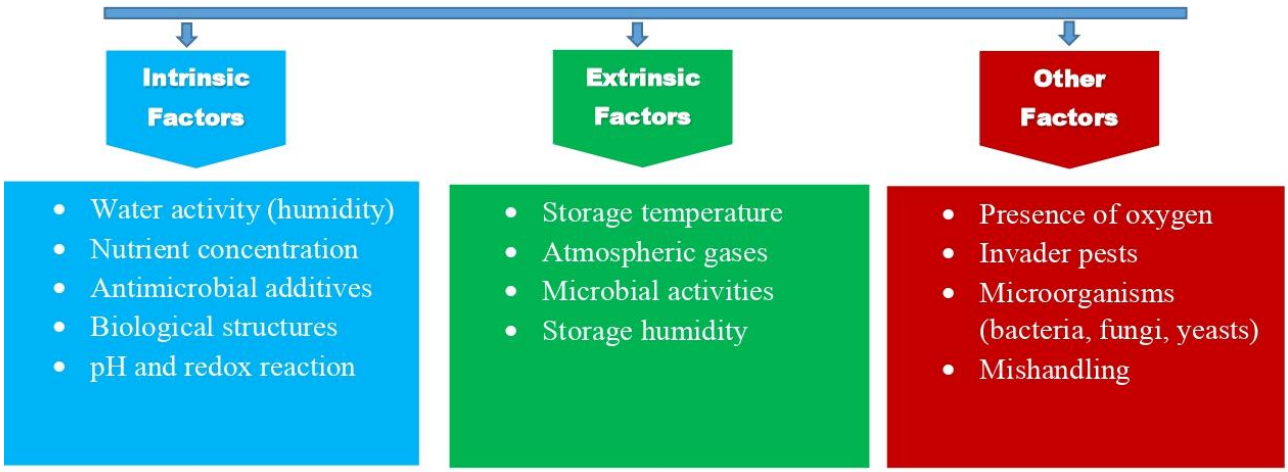

Fig. 2. Factors affecting food quality and causing food spoilage.

controlling water activity, adjusting temperature, properly packaging, and using preservatives (Tianli et al., 2014). Nutrient concentration, water content, pH, and redox reactions are *intrinsic factors* of food spoilage (Steele, 2004). Meanwhile, humidity, temperature, and the presence of microorganisms are *extrinsic factors* (Steele, 2004). Antibiotic resistance is the major issue while microbial Spoilage can be controlled by antibiotics (Samad, 2022). So, we need to use an alternative to stop microbial spoilage.

Chemical spoilage

Physiochemical and biochemical reactions naturally occur in food, which may cause color, odor, texture, and taste changes. Microbial activity and metabolism, redox reactions, proteolysis (Igarashi et al., 2007), hydrologic rancidity (Steele, 2004), putrefaction, and toxic compound production are factors that cause chemical spoilage of food.

Food Preservation Methods

There are several food preservation methods, which are explained below and also shown in the flow chart Fig. 3.

Physical methods

Dehydration

Dehydration or drying is the process of removing all the water content from the food items. The process of evaporation is used for drying purposes. It is one of the oldest preservation methods (Alnadari et al., 2023). After dehydration, microorganisms' growth is inhibited; they cannot cause spoilage as all the enzymes work at specific water activity, while in this process, moisture is lowered to the point where their functionality is lost (Rayaguru and Routray, 2010). Most microbes grow at 0.95 water content and do not grow when water is lowered to 0.88 (Troller, 1986). It has diverse advantages, as lowering the density and quantity of food is the cheapest way to preserve food (Agrahar-Murugkar and Jha, 2010) and making it easy to transport, store, and pack food. However, it also causes loss of aroma and flavor, vitamin C, proteins, lipids, and thiamine in dehydrated food products (Amit et al., 2017). Drying and freeze-drying methods preserve fruits, fish, vegetables, coffee, and tea.

Pasteurization

Pasteurization is a process in which food is heated to destroy all types of bacteria and enzymes (Shenga et al., 2010) to extend the shelf life of food items and keep them fresh for a longer period (Vieira et al., 2018). This process kills almost all pathogenic bacteria, yeasts, and molds, but the temperature and duration should be optimal. They must not destroy the vitamins and proteins of foods. This process is known to French scientist Loius Pasteur, who used this technique for the first time to preserve milk and milk products. Wine and beer are also treated by this process (Alsaedi et al., 2023). Modern procedures like low-temperature long time (LTLT), high-temperature short time (HTST), and ultra-high temperature (UHT) are also accessible (Boye and Arcand, 2012). LTLT is done on small plants (Salvato et al., 2003). This process must

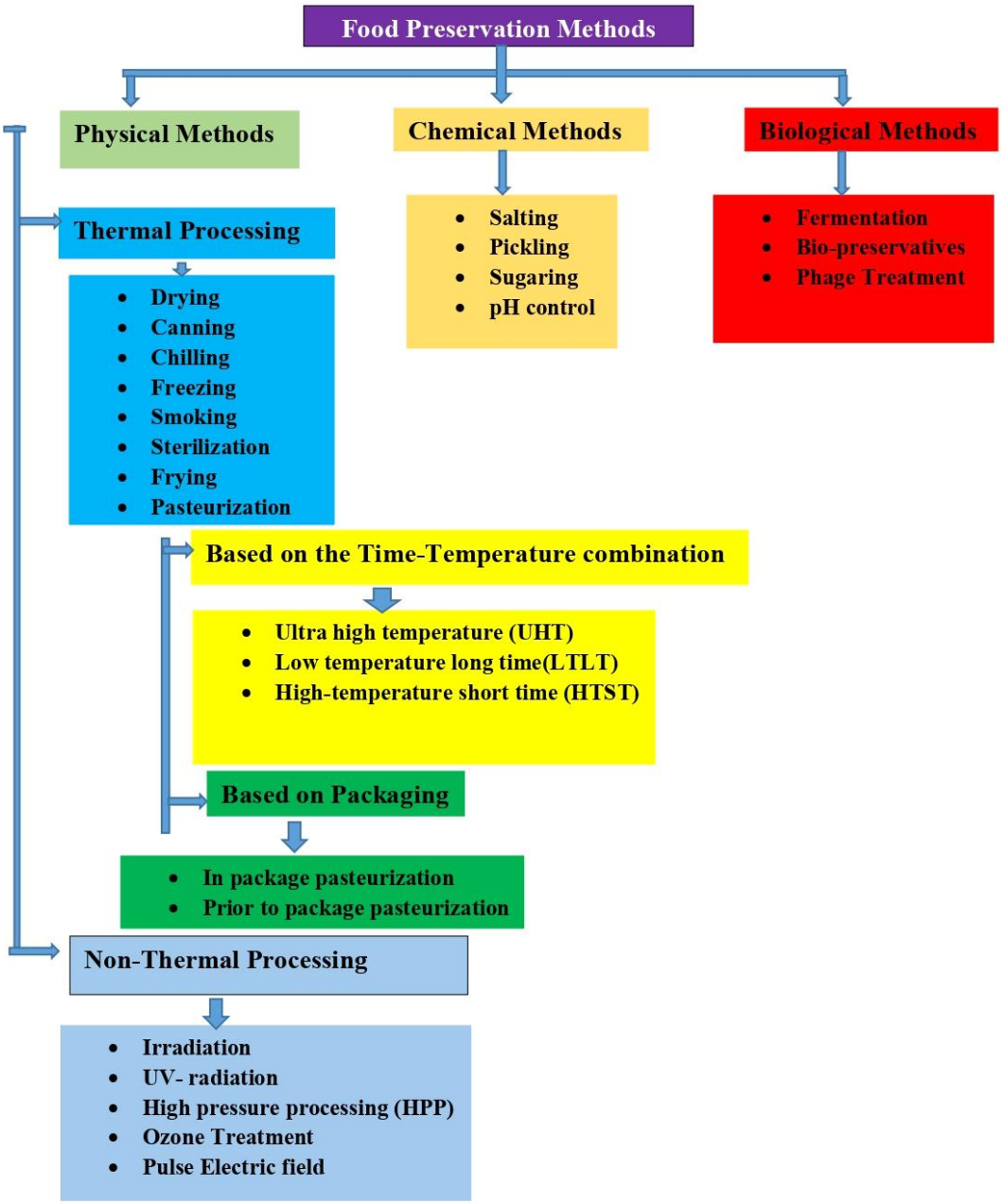

Fig. 3. Flow chart diagram of food preservation method.

control proper holding and prevent overheating or burning (Rahman and Labuza, 2007). HTST is done to perish the pathogenic microorganisms. It is a continuous "Flash Pasteurization" (Salvato et al., 2003). UHT is done to restrict heat-resistant spores and is more effective than LTLT and HTST (Poushi and Sharifi, 2024). Foods are heat-treated and aseptically packed in sterile containers. High heat treatment pasteurization causes a loss of 20% of vitamin C, 10% of thiamine and vitamin B_{12}, and 5% of calcium and soluble phosphorus, but this loss can be considered lower from a nutritional point of view (Rahman and Labuza, 2007).

Freezing

Freezing is an ancient method that reduces the physiochemical and biochemical reactions and thus inhibits or deteriorates the growth of pathogenic microorganisms (Rahman and Velez-Ruiz, 1999). This method is preferable over canning and dehydration because it is effective for the long-term

preservation of food and reduces metabolic responses (Fennema et al., 1973). In this method, water activity is reduced, and the temperature is reduced to 18℃ or lower (Fennema et al., 1973). Though they have a vigorous and effective capacity to control pathogens, frozen foods are not acquired in developing countries. So, it is not widely used in industrial food preservation, but in upper-class and uptown, freezers are widely used (Amit et al., 2017). In recent years, freezing has been widely used to preserve fruits, vegetables, and meat. Meat contains 50%-75% water; it is converted into ice cubes in the freezer, which occurs at -20℃ (Dave and Ghaly, 2011).

Chilling

Chilling is the process that reduces the initial temperature of food goods and maintains that temperature for a long period (Mercier et al., 2017). It is a short-term food storage as it reduces the physiochemical reactions and extends the shelf-life of fresh foods (Martínez and Carballo, 2024). The chilling rate is determined by the initial temperature of food, water content, amount of food, and equipment used for chilling food, and it can be done by an ice bank cooler, plate heat exchanger, or cryogenic chamber (James and James, 2023). It prevents the oxidation of lipids, deterioration of color, autolysis of fish, nutritional concentration, and moisture loss. However, at the same time, it puts down the crispness of food and dehydrates the uncovered food goods (Roudaut and Debeaufort, 2010).

Irradiation

Irradiation is the physical method of food preservation which results in disinfection, inhibition of sprouting, inactivation of pathogenic microbes, and increasing the safety of grains, vegetables, fruits, and other food goods (Heldman and Moraru, 2010; Kanatt et al., 2006).

This process uses ionizing radiation (IR) of specific strength to destroy the microbes of frozen food. Gamma rays, X-rays, and ultraviolet rays (UV) are natural IR; Electron beams, which are artificial sources of IR, are used for this purpose (Sommers and Fan, 2011). Vitamins, minerals, carbohydrates, and protein in food products are not affected at all by this process, but a minute amount of vitamins A, C, E, and B1 may be loosened.

Gamma rays are produced by Cobalt 60 (Co-60) (Ronholm et al., 2016), processed for some minutes to destroy microbes, and suitable for all foods. *X-rays* are produced by hitting electron beams on metal surfaces, processed for seconds, and are ideal for all food items to preserve them. The electron beam is produced by accelerated electrons for just seconds on thin products for preservation (Amit et al., 2017).

Smoking

Smoking is an ancient method in which wood containing formaldehyde and phenolic components (e.g., catechol, phenol, meta- and para-Cresol, and o-methylhydroquinone) are burned to preserve the food by dehydration. This method can maintain fish by adding flavor to food (Joardder and Masud, 2019).

Pulse electric field

It is a modern technique in which a pulse electric field with high voltage is applied to food (placed between two electrodes) for less than a second (Li et al., 2023) to preserve the food by killing vegetative cells. This process destroys all the gram-negative bacteria, but the spores are resistant, so it is useless against spores (Amit et al., 2017). It is a non-thermal technique and is also effective for liquid food samples.

High pressure preservation of food (HPP)

Ultra-high-pressure preservation is the only technique used to change the structure of food compounds (by changing the covalent bonds) and delay the onset of chemical and enzymatic changes that cause food deterioration. This method reduces the quantity and increases food temperature (Ashie et al., 1996). This process does not affect food's vitamins, proteins, flavor, texture, and minerals (Koutchma et al., 2016). The environment-friendly process required minimal waste to discharge while keeping the nutritional value constant (Nielsen et al., 2009; Yeung and Huang, 2016). However, it is a highly cost-effective method requiring high process costs.

Packaging

Packaging is placing minimally processed or completely processed foods into paper, plastic, or metal containers. This technique is becoming foremost because it is used to transport food from factories to sailing points with minimal changes in the characteristics of food (Butnaru et al., 2019; Raheem, 2013; Vasile, 2018). It preserves vegetables, fruit juices, and dairy products (Alvarez et al., 2014). Packaging materials may interact with food inside, so coatings of bio-edible films are used to inhibit pathogenic effects and reduce the harmful interactions between materials and food. For instance, glycerol

can be used to preserve potatoes by dipping them in it, and sorbitol or oil corn can be used for cheese protection (Romanazzi et al., 2016).

Nanoencapsulation is a technique that is mainly used for packaging solid or liquid food in nanocapsules (called shells) (Bratovcic and Suljagic, 2019). It helps the release of packed (canned) food flavor continuously during food storage. This method is not significantly used in developing countries but has various beneficial applications for food preservation in developed countries. Heating is done before packaging proteins – foods are heated and packed in cans or jars, but plant-extracted food items should not preheated to canning (Sahoo et al., 2015).

Biological methods

Fermentation

Fermentation is the most essential method for food preservation, using microorganisms like bacteria, fungi, and yeasts (Amara, 2024). These are used for fermentation of cereal food products, dairy, and meat products (Katz, 2001). It involves destroying carbohydrates using enzymes or microbes (Amit et al., 2017). This method is an alternative to many toxins-causing chemical techniques. Fermentation also enhances the digestibility, flavor, and nutritional value of food. There are many types of fermentation, including *alcohol fermentation* (yeast decompose the sugar and convert it into alcohol and carbon dioxide, which prevent the growth of aerobic microorganisms and increase the storage duration of food) (Sunte, 2023), *vinegar fermentation* (this method is used to preserve pickles), *lactic acid fermentation* (Heterofermentors produce *lactic acid bacteria,* ethanol, CO_2 which has flavor in foods (Guizani and Mothershaw, 2007).

Bacteriocins

Bacteriocins are antimicrobial agents produced by bacteria and antagonistically affect other bacteria of the same species or may be different (Johnson et al., 2018). The first bacteriocin, Colicin, was discovered in *Escherichia Coli* in 1952 and has antagonistic activity by reacting with the inner membrane and inhibiting the synthesis of DNase and RNase, therefore inhibiting the growth of bacteria (Preciado et al., 2016). Commercially prepared *lactic acid bacteria* like *Lactobacillus acidophilus* and *L. lactis* are mainly used to preserve food. These bacteria are permeable to the membranes of other bacteria, extracting internal components. They may compete with other bacteria for nutrition (*Staphylococcus aureus*, *Clostridium*, and *Enterococcus)* and inhibit their activity by producing Enterocins A and B (broad inhibitors of Gram-positive bacteria (Ryan et al., 1996). Enterocin, Pediocin, Leucocin, Lactoccocin, and Carnocyclin are some common bacteriocins that are being used in food preservation.

Use of herbs and spices

Plants like guar gum, cloves, ginger, garlic, and mustard seeds produce many antimicrobial substances. When added to food items, these inhibit the growth of pathogenic bacteria and increase food's shelf life, flavor, nutritional quality, and healthiness (Nilius and Appendino, 2013). These are compelling alternatives to chemical additives, including spices volatiles, which are very slow (Nilius and Appendino, 2013). Butylated hydroxyanisole (BHA) inhibits the growth of Gram-negative and Gram-positive bacteria and, when added to chicken, inhibits vegetative cells of *Bacillus spp.* (Shelef and Liang, 1982).

Chemical methods

Preservatives are the chemical or biological compounds that retard the growth of microorganisms and inhibit the deterioration caused by them hence, maintain the quality (texture, taste, odor, color) of food goods (Adams and Moses, 2008). Food preservatives may be artificial or natural. Bio preservatives (animal, plant, and microorganism sources) are grouped under natural preservatives, while (antioxidant and anti-enzymatic substances) are produced artificially for commercial purposes (Oladiji et al., 2024). Vinegar is a preservative that produces an acidic environment unfavorable for microbial growth. It is used to make pickled mangoes. *Rosemary extract* is used for oils, fats, margarine, and mayonnaise and is an antioxidant (Meyer et al., 2002). Different Chemical Substances are used for preservation, as shown in Table 1.

Salting and sugaring

Both salt and sugar work in the same way. When used in food like fish and meat, they cause dehydration (removing water from tissues) and help preserve and inhibit undesirable microbial growth (Dwivedi et al., 2017). Salt can be added on

Table 1. Different chemical preservatives used to preserve food

Products	Chemicals for preservation	References
Fruits	Sulfur dioxide, potassium sorbate	Ahmadi et al. (2021)
Vegetables	Vitamin C, sodium benzoate, calcium chloride	Pravitha et al. (2024)
Meat	Nitrites, nitrates, sodium chloride	Pöhnl and Pöhnl (2024)
Fish	Sodium nitrite, sodium chloride, potassium sorbate	Mula and Alrubeii (2024)
Dairy products	Sorbic acid, natamycin, sodium propionate	Kovacevik et al. (2024)
Baked product	Calcium propionate, sorbic acid, potassium sorbate	Hussain and Bashari (2023)
Beverages	Potassium sorbate, sodium benzoate, vitamin C	Usaga et al. (2017)
Canned food products	Citric acid, sodium chloride, EDTA	Costa et al. (2014)

the top of meat or fish to cover correctly or mixed in water to create a brine in which microorganisms undergo plasmolysis (high osmotic pressure) and die, causing meat drying (Horner, 2011). Salt also removes the water from cabbage leaves and is also used to give protection and flavor to sauerkraut. The relationship between sugar, pectin, and acid is responsible for the intensity of food preserved. Jams and jellies are held by sugaring and remain soft, but if the sugar quantity is low, it will cause stiffness of jellies (Luh et al., 1986).

Other modern techniques of food preservation

Hydrolysis

The process in which the activity of the pectinase enzyme is retarded is called hydrolysis. If the pectin present in the peel of the fruit begins to destroy, it will produce pectinase enzyme for the destruction and spoilage and also results in the softening of the fruit. Pectin is produced by fruits to protect them from environmental negative effects and to extend their lives. Pectin methylesterase can prevent fruit spoilage (Ashie et al., 1996; Silva et al., 2018).

Ozone treatment

If vibrio species are present, the use of gases or dissolved forms of ozone can cause leakage of cell membranes of microbes, and ultimately, their death occurs (Ronholm et al., 2016). Seafoods like shellfish and other fish can be stored by this method. Water treated with ozone can increase the shelf life of fish by creating a pre-chilled environment (Ronholm et al., 2016).

Phage therapy

Two phage groups, siphoviridae PVP-I and VP phage obtained from V. Parahaemolyticus, were used to treat the community of V. Parahaemolyticus that is found in raw oysters (Yang et al., 2020).

Nanotechnology

Nanotechnology is an experimental technique using nano-size particles for processing, manufacturing, preservation, and packaging (Keshwani et al., 2015). Different nanomaterials produce biosensors that detect changes in food's physiochemical and biological characteristics during packaging. Nanoparticles are used for heavy metal reduction, pesticides, drugs, and biofilm formation inhibition (Momin et al., 2013). Nanotechnology helps in food processing by anti-anticaking agents (improve consistency), gelating agents (improve food texture), and nano target carriers (protect flavor, aroma, and other ingredients in food) (Singh et al., 2017). It helps in food preservation by enhancing the physical properties of food, protecting against chemical deterioration, producing nano antimicrobial agents, and through nano-encapsulation (Momin et al., 2013). Mango meat, for example, is preserved and protected from being soft and brown by dipping in chemicals and forming a pectin coat (Tavassoli-Kafrani et al., 2022). Alginate and pectin form a gel-like coat that protects food from rotting and micro-organisms. A common plasticizer is glycerol (Silva et al., 2018).

Market Economy Analysis of Food Preservation

Food preparation and preservation techniques are growing instantly because of consumers' increasing demands for food texture, flavor, and aroma, so they predominate in the global

economy. Both developed and developing countries are employing advanced technology for food processing. In the future, developing countries like China and India will hold a strong position (Debnath and Khan, 2017; Regmi and Gehlhar, 2005). In developed economies like the US, demand will decline to replace preserved food with fresh fruit, vegetables, or other products. The demand for chilled food products like fish, salad, meat, seafood, pasta, and pizza shows an upward trend. In the UK, more than 15% of the chilled food growth rate extended. It is expected to reach 70 billion by 2024 (Yeung and Huang, 2016). Pasteurization is continuously used to produce milk. It constitutes about 70% of the global liquid milk market (Kim, 2013). Moreover, according to some studies in 2025, nanoencapsulation will take significant credit for nanotechnology by encapsulating essential nutrients and delivering them to the targeted point within the body by nano delivery system (Ashraf et al., 2021).

Conclusion

Serious foodborne diseases occur from consuming spoiled food, so the most efficient and secure preserving techniques should be discovered, considering the economic feasibility and social responsibility. Increasing the stock storage interval without compromising the primary characteristics of food is still a significant challenge. Modern techniques like bio-packaging have proven to be effective in food processing by improving the shelf-life of food. However, many biopolymers are still under observation to produce edible films and coatings to safeguard food. In the future, nanotechnology will be an analytical and conventional method for nutrient delivery in the body. However, researchers also prioritize testing nanomaterials before placing them on the market. Biopreservatives are in more demand than chemicals. So, food production and preservation sectors are expanding rapidly to meet consumers' needs. This review article has congregated different food types, mechanisms of food spoilage, and ways to preserve food. All these techniques are effective; they can maintain food without compromising quality. However, they also have some disadvantages that will be replaced with other food safety techniques.

Conflicts of Interest

The authors declare no potential conflict of interest.

Acknowledgments

Not applicable.

Ethics Approval

This article does not require IRB/IACUC approval because there are no human and animal participants.

Author Contributions

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