

Advancements in Food Preservation Technologies

Food preservation is an indispensable aspect of food safety and security, which includes different approaches to extending of shelf life of food products. In this essay, food preservation's history and food processing's necessity are thoroughly discussed, as well as old techniques' limitations, the need for new technologies and new methods in food preservation that are available today are noted. The preservation of food has been a practice known since the first civilizations used to dry, smoke, salt, and ferment foods to prevent spoilage and ensure food supply during scarce periods. The assignment aims to explore the migration of these ancient methods into the current food processing techniques and the development of innovative technology to meet the exacting needs of the modern food industry. In today's world, which has become globalized and where food supply chains are complicated and diversified, the right preservation procedures are indispensable in maintaining quality foods, reducing food waste, and making food security possible. In this assignment, we will analyze the historical development of food preservation methods, uncover the problems of conventional methods, and figure out how advanced technologies are transforming the arena of food preservation.

History of Food Preservation and Need for Food Processing

The history of food preservation is proof of mankind's knowledge and never-ending desire for food security. From ancient times to the present, diverse techniques for food preservation and extending its shelf life have been revealed. Throughout history, people applied naturally occurring evaporating, smoking, salting, and fermenting to preserve food. Utilization of such methods was a lifesaver for the people, as they could store food for a long time, and survive the scarcities of the times. Such as the use of salt and honey in the preservation of meat by the ancient Egyptians or the development of fermentation techniques for preserving vegetables by the Chinese (Joardder et al., 2019; Knorr & Augustin, 2023). As societies matured, and with the opening of trade routes, the demand for refined food preservation methods became apparent. The expansion of cities and manufacturing increased food preservation needs, which increased the demand for these products. The requirement for food processing developed due to the necessity of making food more delicious, secure, and effortlessly ready to eat. The food processing industry embodies different techniques such as canning, freezing, and pasteurization which retain the nutritional value as well as the flavor (Ghoshal, 2018).

The significance of food processing lies in the fact that there is a necessity to prevent food poisoning. Poorly preserved foods might be the home to the bacteria and pathogens that cause horrid diseases. Food processing eliminates these risks by destroying negative microorganisms and giving food more shelf life. Furthermore, food processing increases the shelf-life of food and reduces the amount of food waste that occurs during storage and transportation. Also, food processing is at the center of meeting the dietary needs of a population that is growing. The world population is projected to peak at 9.7 billion by the year 2050, entailing a heightened demand for food (Valoppi et al. 2021). Food processing helps meet this demand by preserving food and making it more accessible and affordable.

Old Processing Techniques and Their Limitations

Traditional food preservation methods, like salting, smoking, and drying have been in existence for ages to increase the shelf-life of perishable items (Joardder et al. 2019). Salting, which is one of the oldest preservation methods, entails salting food items to pull out the moisture in them and suppress the growth of spoilage-causing bacteria. Among the old techniques, smoking comprises food exposure to smoke originating from burning wood or other materials which infuses flavor, plus provides a protective layer that prevents microbial growth. The other preservation method is the drying, which is also called the dehydration. It means removing the moisture from food items by exposure to heat and air which helps in preventing the growth of bacteria, yeast, and mold (Rahman, 2020).

Though they are helpful in the field of food preservation, the older methods entail some challenges including security and food quality. Such as salting which can result in an increased intake of sodium which can be detrimental to health, especially for patients with hypertension or other cardiac diseases. Besides, inappropriately salted food can be botulism dangerous, a type of food poisoning that can be fatal and is caused by *Clostridium botulinum* bacterium (Elias et al, 2020). Smoking for both the conservation of food and the infusion of taste may result in the addition of some carcinogens harmful compounds like polycyclic aromatic hydrocarbons (PAHs) and heterocyclic amines (HCAs), both are known carcinogens (Hee et al., 2023). Extremely large intake of these substances especially in the form of smoked meat is one of the factors associated with the high cancer incidence rate. Drying, although considered a safe conservation method, may introduce textural, flavor, and nutrition changes into food products. For instance, the dehydration process may make fruits and vegetables fragile or leathery, impacting their overall desirability and taste (Guiné 2018). Moreover, there are some vitamins and minerals such as vitamin C and folate, which are heat

sensitive and can be lost during the drying process hence decreasing the nutritional value of the preserved food.

Need for New Technologies

Conventional preservation methods, though effective in their category, are no longer sufficient to meet the needs of modern food production and consumption. A crucial factor is the growing complexity of the food supply chains and their need for longer shelf life. Traditional methods tend to be labor and time-consuming, thus rendering them unsuitable for bulk food transport or long-term storage. Likewise, the increase in the consumption of processed foods has led to a rise in the usage of more advanced preservation methods to ensure the quality and safety of the products (Ghoshal, 2018). Nevertheless, traditional methods of preservation may not be appropriate for these kinds of foods because they may not offer the right level of preservation or may change the taste and the texture of the food when processing. Besides that, the world food business is facing growing pressure to lessen food waste and develop sustainability. New preservation technologies will be able to reach the objectives by extending the shelf life of perishable foods, minimizing the number of preservatives or additives required, and improving the overall sustainability of the food supply chain.

New Age Technologies in Food Preservation

High-Pressure Processing (HPP)

HPP is one of the non-thermal food technology techniques that utilizes high pressure to control microbial enzymes as well as the shelf life of food products. The physical HPP mechanism relies on the effectiveness of high pressure in destroying the cellular structures of pathogenic bacteria thus preventing the growth and multiplication of microbes (Fam et al., 2021). Contrary to the conventional thermal processing techniques, HPP neither involves high temperatures and rather is an effective procedure in preserving the nutritional and sensory qualities of the food. While HPP has many benefits compared to traditional methods such as enhanced food safety, increased shelf life, and the preservation of nutrients and flavor, it does not fully replace all.

One of the significant benefits of HPP is that it can get rid of callous bacteria such as *Listeria monocytogenes* and *Escherichia coli*, thus making foods safe for people to eat (Silva, 2023). On the other hand, controlled atmosphere packaging escapes the opportunity to make these preserved foods healthier. Another benefit of HPP is the fact that it is no chemical

process. Therefore, it is a green process that is appealing to customers who are looking for natural food preservation methods.

Pulsed Electric Fields (PEF) Technology.

PEF or pulse-electric field technology is a form of cold processing in which short and high-voltage pulses deactivate bacteria and enzymes. The PEF principle is based off of the ability to poke holes into the cell walls of microbial organisms, which leads to their death. PEF technology is considered superior to conventional thermal processing methods in terms of food quality, extending shelf life, and minimal energy consumption (Ghoshal, 2023). PEF technology has proved to be an effective method of massively reducing the microbial count of food substances and hence safe for consumption. Moreover, PEF technology could help to maintain the nutritional integrity and quality of food products, thus all consumers acquire the optimum value of nutrition from their food. PEF technology is also a more sustainable choice compared to the heat thermal methods that take more electricity and generate fewer greenhouse gas emissions.

Modified Atmosphere Packaging (MAP)

MAP is a packaging method that entails adjusting the atmosphere of the package to keep food products from spoiling for longer. Through this process, the air inside the package is replaced by a gas mixture comprising nitrogen, carbon dioxide, and oxygen (Opara et al., 2019). The concept of MAP is that the modified atmosphere slows down the development of spoilage microorganisms and oxidation reactions which turns food into spoilage. MAP delivers some advantages such as extended storage time, the increased safety of food, and the reduction of food waste. MAP is an effective technology applied for preserving several products like fresh fruits and vegetables, meats, and bakery items (Tajeddin et al., 2018). Under the command of the atmosphere inside the package, MAP can preserve the freshness and condition of the food products thereby guaranteeing that they are delivered to consumers still in the best state. Beyond that, MAP helps in the reduction of chemical preservatives, making it a more natural and environmentally friendly alternative for food preservation.

Ultraviolet (UV) Light Technology

UV-light technology is a non-thermal way of processing that works through UV light inactivating microorganisms in food items. The idea behind UV light technology is that ultraviolet radiation damages the DNA of microorganisms, hence their DNA is unable to replicate, and their inactivation occurs (Singh et al., 2021). UV technology has several benefits over conventional thermal processing including enhanced food safety, extended shelf life, and energy saving. The efficacy of UV light technology in reducing the microbial load in

food products is one of the primary advantages that this technology offers (Singh et al, 2021). UV light processing can be used to stabilize different kinds of food items such as juices, dairy products, and fresh produce. Additionally, UV light technology is a chemical-free process, making it a more natural and environmentally friendly option for food preservation.

Challenges and Ongoing Research in Food Preservation Technologies

New and emerging food preservation technologies including High-Pressure Processing (HPP), Pulsed Electric Fields (PEF) Technology, Modified Atmosphere Packaging (MAP), and UV Light Technology have significantly changed the face of the food industry in more ways than one. These developments have also had several limitations and challenges.

Among the disadvantages of HPP is its exorbitant equipment cost and high energy intensiveness, rendering it not inexpensive for small-scale food producers (De Vries et al., 2018). Moreover, although the HPP helps remove microbial contamination, it cannot remove all pathogens, thus leading to the need for additional safety measures. PEF technology also faces challenges like high initial investment and its effect on food texture and quality (Chakka et al., 2021). MAP is effective in increasing the shelf life and reducing food waste, but conscientiously monitoring gas concentrations is vital in the maintenance of its efficiency (King et al., 2017). UV light-based technology is useful in microbial inactivation however can cause sensory changes in food and the application should be perfect to avoid safety issues (Singh et al., 2021). Continuing work in food preservation is devoted to improving the effectiveness and safety of these technologies. Such developments might include refining the equipment design for cost reduction, optimal process parameters for better quality retention, and exploring future possibilities like nanotechnology for targeted food preservation. The developments intend to solve existing problems and to make sure that safe and sustainable food storage is in place.

Conclusion

In conclusion, this assignment has delved into the history of food preservation, the requirement of food processing, old processing techniques, as well as the development of newer technologies in the food preservation era. The preservation of food has long relied on methods such as salting, smoking, and drying. Nevertheless, these traditional techniques have drawbacks regarding food safety and quality. The innovation of novel technologies like high-pressure processing (HPP), pulsed electric field (PEF) technology, modified atmosphere packaging (MAP), and ultraviolet (UV) light technology has prevailed in the arena of food

preservation. Many of these cutting-edge technologies provide multiple advantages compared to conventional techniques that ensure food safety, extended shelf life, and retaining nutritional quality and flavor. A good example will be HPP which can be used at low temperatures to eliminate pathogenic bacteria without affecting the food sensory properties. PEF technology can lower the number of microbes in food products allowing them to be safe for consumption. MAP controls the atmosphere inside the packages which helps in extending the shelf life of food, while UV light technology is very effective in destroying the microbial load in the food products without the use of chemicals. Majorly, new technologies in food preservation are essential for proper food safety, decreasing food wastage, and provision of food to the growing population. These technologies not only help food products to stay longer on shelves but also preserve their nutritional value and quality. With the global population growing rapidly the need for such technologies in modern food conservation is undisputable. They give us the possibility to make sustainable and effective ways of food conservation, guaranteeing the safety, wholesomeness, and availability of food for everyone.

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