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# An Outline on the Techniques Used in Food Preservation

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**ABSTRACT:** Food is the key component of the survival of any organism. Food is the source of energy, vitamins, minerals, and so on. It is found in abundance in one part of the world and there is a lack of the bare minimum in other parts. To equalize the food availability and to protect them from spoilage, food preservation is done. The critical requirements of a good preservation technique is its ability to protect the food's nutrients, colour, texture and its spoilage for a long time. The technique chosen also depends on the type of food, its chemical and physical composition. Better techniques are being developed everyday. In this review, we discuss the conventional methods like drying, the unconventional methods like pasteurization, and the advanced and upcoming methods like ozone treatment, pulse electric treatment, Cold plasma technique.

**KEYWORDS:** Flight Food preservation, spoilage, wastage, sensory and nutritional qualities, alternative techniques, safe and sustainable.

## I. INTRODUCTION

Food is any substance consumed by an organism for nutritional support and is important for survival of all beings. Food is usually of plant, animal, or fungal origin, and contains essential nutrients. There is either abundance or lack of food in different parts of the world. Food preservation is the process by which vegetables, fruits, meat and other dairy products are chemically (by addition of chemical preservatives) or naturally kept safe from spoilage and preserve their nutritive value, colour and flavour. Spoilage and wastage of the food materials is high where it is in abundance while there is shortage and starvation in other parts so, naturally it becomes essential to preserve the foods to prevent it from spoilage and to make it available for people who are in need. Crude preservation has been done all over the world since earlier ages but now it's been done with precision and advanced accurate technologies. As more and more people are becoming increasingly conscious of their part in a sustainable environment, it becomes necessary to develop and practise alternative green methods of food preservation. These sustainable methods have the added advantage of preserving the nutritional and sensory aspects better than the traditional methods of food preservation[1]. Examples of preserved foods include properly packaged refrigerated, frozen, canned and dried products. This paper aims to discuss, the conventional, the unconventional and the upcoming techniques that will be implemented in the food preservation industries.

## II. LITERATURE SURVEY

The conclusion that food irradiation by safe amounts of gamma rays could be a better alternative to fumigation and other sterilization techniques and that consumers would become more eager to buy irradiated products when properly informed was made by Loaharanu. P, et al (1991). The process of freeze drying is an high operative cost operation and vacuum freeze drying is the only one used in industrial scale but other types are a viable option ( C. Ratti , 2001). Although, High Pressure Processing is a suitable option against almost all bacteria and viruses at respective pressure temperature conditions, more research is needed for the development of generalized conditions (V.M.Bala et al, 2008). Martindale et al (2017) have concluded that fresh food contributes more waste than frozen preserved food and frozen food is at times more sustainable than fresh food[2]. Ercan et al (2013) have concluded that ultrasound is safer preservation method with many advantages yet more research is needed for its standardization in the food industry as the food properties change based on the technique applied. Unpredictable olden methods of food preservation are being replaced by modern methods that are uniform and consistent across all parameters and better methods are under research(Iqbal RK et al ,2019). In addition to being a pre-treatment for various preservation techniques, Pulse Electric Field is an excellent tool in improving extraction processes, reducing purification steps in juices, etc. and more research is needed in it's interaction with bio compounds (Barba. F.J. et al, 2015). Sridhar et al (2020) has concluded that, a cost effective and suitable technique employed for preservation can end the consumption of highly processed food and promote sustainability and further research has to be done to investigate the toxicity of nano materials in food[3].

### III. CONVENTIONAL METHODS

Conventional or traditional methods include canning, freezing, drying, salting, pickling, sugaring, natural additives, blanching etc. The conventional methods that have been followed by food preservation is no less than the modern and advanced methods.

1. **Canning** involves cooking food, sealing it in sterilized cans or jars, and boiling the containers to kill or weaken any remaining bacteria as a form of sterilization[4].
2. **Freezing** is also one of the most commonly used processes, both commercially and domestically, for preserving a very wide range of foods, including prepared foods that would not have required freezing in their natural or raw state and when these food are kept under such temperatures it inhibits the microorganism growth thus preventing spoilage.
3. **Drying** is the process in which inhibition of the growth of bacteria, yeasts, and mold are done through the removal of water which is essential for microbial growth. Drying the food free of water is the trick behind the technique.
4. **Salting** is the method of preserving the food materials by sprinkling edible salt over the food. Salt is effective as a preservative because it reduces the water activity of foods. The water activity of a food is the amount of unbound water available for microbial growth and chemical reactions. Both the drying and salting method focuses on reducing the water level in the food which leads to inhibition of growth of microorganisms.
5. **Pickling** is a method of preserving food in an edible, antimicrobial liquid. Pickling can be broadly classified into two categories: chemical pickling and fermentation pickling. In chemical pickling, the food is placed in an edible liquid that is a pickling agent whose examples include brine, vinegar, alcohol, vegetable oil etc that inhibits or kills bacteria and other microorganisms. In fermentation pickling, bacteria in the liquid produce organic acids as preservation agents, typically by a process that produces lactic acid through the presence of lactobacillales. Some examples of this includes sauerkraut, kimchi etc.
6. **Sugaring** is the process of desiccating a food by first dehydrating it, then packing it with pure sugar. In northern areas fruits are preserved by sugaring method. Sugar is a very important and good preservative which shows excellent preservation results[5].
7. **Natural Additives** refers to the use of spices like Turmeric, Oregano, Thyme etc, organic acids such as citric acid and polyphenols extracted from natural resources like tea as antimicrobial agents.
8. **Blanching** is a cooking process in which a food, usually a vegetable or fruit, is scalded in boiling water, removed after a brief, timed interval, and finally plunged into iced water or placed under cold running water. Blanching stops enzyme actions which otherwise cause loss of flavour, colour and texture. It is also known as refreshing or shocking. Blanching is used both by home cooks and in industrial food processing for the process of preservation[6].

### Non Conventional Methods

Non Conventional or modern methods include freeze drying, pasteurization, high pressure processing food preservation, irradiation techniques etc.

### Freeze Drying

Freeze drying is not the most common used technique in the food industries due to its high cost and high energy consumption. It is also known as lyophilization or cryodesiccation. Freeze drying involves the following steps – freezing, vacuum, sublimation and condensation. The raw material is first frozen to a lower temperature and then kept in a vacuum chamber that removes the ice from the frozen material through sublimation. This is then freeze dried by removing its moisture content at low temperatures. Since the water from the material is removed at such low temperatures, the product retains much of its original nutritional value, colour, texture, cell structure etc of its raw counterpart. In addition to conventional freeze drying there are also microwave assisted freeze drying, adsorption freeze drying and fluidization freeze drying. These new and improved techniques cut down the drying time and cost significantly yet the qualities of the final

product are not poorer than the traditional freeze drying methods. Vacuum/Traditional freeze drying is the preferred method used at industrial scales to preserve high value food materials[7].

### Pasteurization

Pasteurization is mainly used in the dairy industry. It involves two types namely Batch and continuous pasteurization. Batch pasteurization uses the low temperature long time (LTLT) principle. It involves rapid heating at 63<sup>0</sup>C for 30 minutes followed by immediate rapid cooling at 10<sup>0</sup>C. This technique is mainly used for cream and flavoured milks. Continuous Pasteurization uses high temperature short time (HTST) and Ultra high temperature (UHT) principle. HTST involves heating at 72<sup>0</sup>C for 15 seconds followed by immediate cooling. UHT involves heating at 135<sup>0</sup>C for 2 to 5 seconds and then directly packaged into sterile/aseptic packaging. Today, pasteurization is most commonly used technique in the dairy industry and other food processing industries to ensure longer shelf life stability of product and achieve food preservation and food safety[8].

### High Pressure Processing Food Preservation

High Pressure Processing is a safer and sustainable form of Food Preservation that utilises high pressures (400-600MPa) at temperature below 45<sup>0</sup>C rather than using heat to effect preservation. Since HPP doesn't rely on heat, most nutraceuticals in the food are preserved, yielding a nutrient dense final product. HPP can be applied to both liquid and solids with high moisture content. This method works by reducing the volume and enhancing the temperature. In this technique only the non-covalent bonds of food particles are affected, thus the nutritional and sensory attributes are not compromised. It also eliminates the addition of chemical preservatives, catering to the interest of the consumers seeking additives free food. Since pressure is applied equally on all sided the food is not crushed but the spoilage microbes are eliminated. In certain meat products the thermal processing is not applicable; the meat is preserved by alteration of the configuration of certain meat proteins via HPP.

### Food Irradiation

Food irradiation is a harmless and safe form of food preservation that is slowly being accepted by consumers all around the world. It is a time conserving procedure that leaves no residues after treatment. The electromagnetic rays used for the process do not induce or leave radioactivity in the food product. The process can be applied to fruits, vegetables, meat, fish and related products and even to packaged food. It kills or inactivates spoilage micro organisms and spoilage inducing sprouts of tubers and roots. It also replaces the need to fumigate fruits and vegetables with chemicals to meet the quarantine requirements of other countries. It also doesn't alter the physical and chemical properties of the product too much. It also minimizes food losses.

Irradiation treatment is done using gamma rays of Cobalt-60, Cesium-137, X-ray generated from a machine at 5MeV or less or electrons emitted at 10MeV or less. Only at these levels, there is no residue of radiation. The process is carried out in a strongly shielded room that doesn't allow any radiation to escape, so, it is a completely safe and green process. When the radiation source is not in use, it is kept in water, so no radiation escapes. Although, there are many advantages to irradiation, there are also downsides to the process. It is a costly process and requires more product volume for the radiation process to be relatively cheap. Many consumers dislike irradiated products as they are pre conceived to the notion that irradiation leaves radioactive residues, so, companies are reluctant to employ irradiation as a preservation treatment despite its many benefits.

### Advanced Methods

Advanced methods include pulse electric field, ultra sound, ozone treatment, plasma technique etc.

### Pulse Electric Field

Pulse electric field is an emerging alternative to various processes including sterilization, preservation, bio refining, extraction etc. It is most applicable only to liquids. It involves placing between an electric field for a few milliseconds. Low

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electric fields break the biological cell membrane, making it lose its selective permeability temporarily or permanently. This is exploited in selective extraction and as a pre treatment for drying and freezing processes.

Employment of high electric field kills spoilage bacteria and enzymes, thus preserving the food while also preserving its sensory and nutritional qualities. It can also be used as an alternative to thermal treatment of liquids.

### **Ultra Sound**

Ultra sound preservation technique is an emerging green technique that uses ultrasonic waves for food preservation. It is an excellent alternative to thermal food processing. Since it is non thermal, the nutrient and sensory qualities of the food remain unchanged. Seldom is ultra sound is used alone rather it is used in combination with mild temperature or pressure or both. This constitutes the four types of ultra sound treatment namely,

1. Ultrasonification(US)
2. Thermosonification(TS)
3. Manosonification(MS)
4. Manothermosonification(MTS)

Of these, MTS is the best form of ultrasonification as it uses both pressure and low temperatures. It destroys almost all spoilage microbes and enzymes in a short time and leaves the product almost the same. The antimicrobial effect of ultrasonification is brought about by bursting of the unstable cavitation bubbles formed by the continuous vibrations of the ultrasonic waves. The bursting of the bubbles along with changes in temperature and pressure causes the microbial cell wall to break, resulting in its death.

The effect of ultrasonification depends on the time of action, frequency employed and the type of microbe present in the food. In general, higher frequency range of 200-600 kHz is sufficient for microbial inactivation. For example, Gram negative bacteria are more susceptible to cell wall breakage as they have thinner cell wall, whereas Gram positive bacteria have thicker cell walls and thus require adequate modification of time, frequency, pressure and temperature. Ultra sound treated fruit juices have been proven to retain their nutritional qualities better. For example, ultra sound treated lemon juice retained its vitamin C content better than untreated lemon juice at 20°C.

### **Ozone Treatment**

Ozone treatment is an emerging and safer food preservation technique showing great results in preservation of fish, removal of pesticides from fruits and vegetables, especially in tomato, lettuce and carrots. By just soaking the fruits and vegetables in the ozone water for 15-20 minutes, up to 45-90% of the selected pesticide was removed. Ozone dissolved water can be used to wash fish as it removes viruses and bacteria from the flesh and preserves its colour. Ozone ice slurries can be used to store the fish temporarily. Ozone quickly decomposes into elemental oxygen which is an excellent antimicrobial and antiviral agent, more potent than chlorine and peroxide. Moreover, the degradation of ozone leaves negligible residue. It can also be made instantly. It also eliminates the need to use chemical additives, making the food more safe and sustainable.

### **Plasma Technique**

Plasma technique is an emerging alternative to thermal treatment for the preservation of products that preserves food by using ionised gas species. The technique's main aim is microbial inactivation which maintains the original qualities of the food. This technique is considered safe as it doesn't use toxic and hazardous substances for preservation. It is also a green process, recyclable and does not leave any toxic residues. Plasma technique has its own disadvantages and the most important ones include the high cost of installation, need for a skilled labour of the area, safety measures etc. The technique causes the cell disruption of microbes by electroporation methods under low temperatures limiting the microbial growth. It is also effective against viruses and spores, making it an effective tool for surface sterilization.

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Plasma technique works by forming malondialdehyde(MDA) which results in DNA adduct formation in the microbe cells, resulting in its inactivation. It can also inactivate microbes and their enzymes by its interaction with their protein and fatty acids. It also aids in formation of phenolic compounds that extends the shelf life of the product.

The efficiency of microbial inactivation depends mainly upon the conditions of the surroundings and the system such as the surface of treating procedure, plasma device, gas composition, and mode of exposure. Increase in humidity of air increases and improves the efficiency and rate of the microbial reduction. This is a major disadvantage. Another disadvantage is that it is not effective against in-vitro models as it is a surface phenomenon and organisms like microbes present inside the food aren't affected. Therefore, it is only used for surface sterilization of the food products and more research is needed before employing this technique as the primary sterilizer.

#### IV. CONCLUSION

Food preservation has been an important part of our society since the beginning. As everything and everyone around us are developing, preservation has also evolved from simple processes such as salting, to more complex preserving methods such as irradiation and chemical additives. This paper has discussed the different types of food preservation techniques that have been in use and methods that are still under research. Even though the conventional methods are good, it lacks scientific accuracy and precision. Modern techniques give us the advantage of consistency throughout the product. Moreover, modern methods use green processes and are safer to consume as they don't leave any toxic residues either in the product or in the environment. Most of the modern techniques are non thermal; hence there is significantly less loss of nutrients. Also, as many preservation methods require precision and care to maintain food safety it is important that we know more accurate details about the technique before applying it to the food products for the safety of both the consumers and the food. More research is also needed for commercialization of green techniques like ozone treatment and ultrasonification. More consumer awareness of the upcoming and safe preservation techniques is also needed

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