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Seafood Processing in 21st Century: Different Technologies Making Our Food Safer, Healthier and More Sustainable

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Abstract

Seafood is a nutritious food that is often processed to extend its shelf life and create new products. Common processing methods include drying, curing, smoking and canning. Newer techniques like Ozone treatment, Freeze-drying, High-pressure processing and Pulsed light technology are also gaining popularity. These innovative techniques offer sustainable and effective ways to preserve seafood and meet modern food safety standards.

Keywords: Innovative techniques, Preservation, Seafood, Sustainable

Introduction

Seafood has been promoted as a key source of nutritious food, earnings and livelihood which is recommended by nutritionists and health professionals that it should be consumed more frequently. Seafood is widely recognized as a great source of a variety of nutritional elements such as protein, fats that are beneficial (polyunsaturated fatty acids, specifically omega-3 as well as omega-6), Iodine, vitamin D and calcium and so on and these compounds have been shown to help prevent many heart diseases and autoimmune disorders. It is necessary that the fish should be handled with care before and after the harvest to ensure the raw material quality used for processing. Processing the seafood primarily prevents and/or eliminates bacteria and enzymes that break down resulting in increased shelf life and safety of food. While the primary function of processing involves food preservation, it also extends shelf life and develops fresh products.

As shrimp is a highly perishable commodity, its quality changes rapidly after it is harvested. Hence the processing of the seafood is the most important step after harvesting. Some of the conventional methods used in seafood processing are salting, curing, drying, canning smoking, pickling and chilling while high-pressure freezing (HPF), high-pressure processing (HPP), ultrasound, Intense pulsed light technology, pulsed electric field, cold plasma technology is included in inventive techniques.

Treatment using Ozone

Ozone is a type of oxygen that can disinfect. Ozone is highly effective at destroying up to 99.9% of pesticides and microorganisms in food because it can oxidize contaminants. It is a powerful oxidizer that can eliminate harmful microorganisms and pesticides in seafood. It can also increase the shelf life of seafood by lowering bacterial growth. Ozone is safe for food and the Food and Drug Administration in the United States has approved its use. It doesn't leave any residue or affect the taste of food. It can be used to wash and dip seafood, disinfect processing equipment and treat storage chambers and warehouses. Ozone can also be used to produce ozonized ice, which can be used to store and transport seafood.

As ozone has pro-oxidant properties, it could rapidly destroy the microorganisms present in the food. Ozone disrupts the cell walls of microorganisms, especially Gram-negative

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microorganisms such as *Escherichia coli*, coliforms, viruses and parasitic cysts. Ozone and its by-products can both kill harmful microorganisms. Apart from microbes, ozone can oxidize insecticides, herbicides, natural organic matter and detergents in the food system. Some of the benefits of ozone are that it can improve the safety and excellence of seafood products as it is a sustainable alternative to traditional chemical disinfectants and also reduces waste (Pinnaduwa *et al*., 2020).

Freeze Drying

Freeze-drying is a fast and effective way to remove water from food, first used in Western Europe and then spread to the US, UK, France, Japan and other countries. In this method, the moisture in the food is frozen at low temperatures and then converted directly from solid to gas in a vacuum, a process called sublimation. In the food industry, freeze-drying has significant advantages over other dehydration methods. It keeps the original color, aroma, flavour, colour and taste and look of fresh food to the greatest extent possible while also protecting the composition and preventing nutritional ingredient loss, making it especially suitable for heat-sensitive goods. The freeze-dried meal may be simply reconstituted and rehydrated quickly. Food that has been frozen and dried reduces moisture content, making it perfect for meals, travel, meetings and entertainment.

Pulsed Light Technology

Using high-voltage electrical pulses to eliminate germs, pulsed light technology is a new non-thermal method of processing food. It is fast, effective and safe and it does not damage the food's quality. A wide range of items, including fruits, vegetables, meat, poultry and seafood, can be processed using this method. It can also be used to disinfect packaging materials and equipment. For the purpose of producing food, one to twenty pulses are typically applied in a second. Simply sandwiching the food products between two electrodes and exposing them to pulses of high intensity up to 70 kV cm^{-1} can accomplish this (Fine and Gervais, 2004).

Here are a few advantages of pulsed light technology for food processing:

✓*Improved food safety*: Pulsed light technology can kill harmful bacteria, such as *Salmonella* and *E. coli*, on food.

✓ *Reduced food spoilage*: By eliminating germs that cause food spoiling, pulsed light technology can increase the shelf life of food.

✓ *Preserved food quality*: Pulsed light technology does not damage the food's flavour, texture, or nutrients.

✓ *Reduced environmental impact*: Pulsed light technology is a sustainable process that uses less energy and produces less waste than traditional food processing methods.

Cold Plasma

Cold plasma (CP) is a modern technology that is being used to preserve highly perishable foods, especially seafood. Seafood is particularly susceptible to spoilage and oxidation because of its high moisture content, high-quality protein and unsaturated fatty acids. Spoilage reduces the nutritional value of seafood and can produce toxins, making it unsafe to eat. Recently, there has been rising demand for high-quality seafood with a long shelf life. Especially non-thermally processed foods are also becoming increasingly popular. CP technology is effective at inactivating microorganisms without promoting their resistance or triggering enzymes that cause spoilage. This makes CP a promising technology for preserving the quality of seafood. Cold Plasma is generated by different methods such as Plasma jets, Corona discharge, Dielectric discharge barrier (DBD) reactor and Microwave discharge. Cold plasma (CP) is a promising food decontamination technology because it does not use toxic or chemical agents and operates at near-ambient temperatures. It's also an environmentally friendly technology (Rathod *et al*., 2021).

High-Pressure Processing

HPP is a way to keep food fresh without using heat. It works by exposing food to very high pressures, from 100 to 1000 megapascals (MPa). HPP kills harmful microbes, including yeasts, molds and bacteria such as *E. coli*, *Salmonella* sp. and *Vibrio* sp., without affecting the taste, texture, or nutritional value of the food. HPP applies high pressure to food by compressing the liquid surrounding it. This pressure is applied evenly throughout the food product, ensuring that all microbes are killed. Le Chatelier's principle and the isostatic rule are two general scientific principles that are connected to HPP. In contrast to the first principle, which claims that pressure reduces volume, the isostatic rule states that pressure is quickly and uniformly distributed throughout the sample (Hayashi *et al*., 1989).

Ultrasound

Ultrasound processing uses high-frequency sound waves (above 20 MHz) to alter food material physically, mechanically, or chemically. Food applications use two types of ultrasounds: diagnostic ultrasound, which has low energy and high frequency and power ultrasound, which has high energy and low frequency. Ultrasound has been shown to kill a variety of food-borne pathogens, including *Salmonella spp.*, *E. coli*, *L. monocytogenes* and *S. aureus*. Ultrasound in food processing can reduce energy consumption, shorten processing times, increase throughput, reduce flavour loss, improve uniformity and save energy.

Conclusion

Due to the world's rising population, keeping food secure is now a critical concern. Because seafood is perishable, it must be processed efficiently to ensure that it can be distributed effectively. Customers prefer processed foods of the highest quality with little changes to their nutritional and sensory qualities. As a result, it must be emphasized that, in addition to the benefits of value addition, customers' concerns about food safety, quality and sensory qualities must be considered. Emerging food processing technologies can extend shelf life, preserve or improve taste and nutrition, ensure safety, increase convenience, reduce waste, boost exports and, most importantly, boost economic value.

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