

Green Innovation: Ozone Powered Preservation for Fresh-Cut Fruits and Vegetables

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Abstract

Customers are now more conscious than ever of the dietary benefits of eating fresh fruits and vegetables on a regular basis, which lowers the risk of diseases and other ailments. Fresh fruits and vegetables tend to be consumed raw, after washing, peeling off, dicing, and shaping which renders them ready to consume after being processed. Among the several technologies aimed at prolonging the freshness of fresh-cut products, ozone technology appears to possess a particularly effective sterilization method. Attention to ozone has surged recently as an outcome of customer desire for 'greener' additives to food, legislative approval, and growing recognition that ozone constitutes an eco-friendly technology. The versatile properties of ozone enable it to be an appropriate food processing ingredient. Excessive ozone instantly decomposes to generate oxygen, leaving no trace in foods. Ozone is utilized as an oxidant in the treatment of water, sanitizing, cleaning, and disinfecting equipment, odor deletion, as well as vegetable and fruit processing. Ozone treatment ensures that food retains its sensory-related, nutritious, and physical characteristics. The objective of this review is to deepen our understanding of ecologically sound technologies that include ozone technology that prolongs the longevity and nutritional value of fresh produce without generating toxic chemicals that harm plant life and the ecosystem.

Introduction

Fruits and vegetables constitute the nutritional properties such as dietary fiber, vitamins, minerals as well as the antioxidants which are essential for a well-balanced diet. However, due to its perishable nature pushing towards the fastest consumption of produce in shortest time. In order to provide several health benefits to consumers mainly working women without compromising the nutritional quality of Perishable products by providing Minimally Processed products. Minimally Processed products also identified as Fresh cut produce or Ready to use produce generally involves washing, trimming, slicing, dicing, shredding the produce that provides less time for preparation of meal, adequate storage space and minimized waste disposal.

These operations causes mechanical damage to produce which leads to oxidative and enzymatic reactions results in undesirable changes at wound areas such as enzymatic browning, microbial infection and quality deterioration. The emerging non thermal Ozone technology ensures the extension of shelf life of minimally processed produce with enhanced antioxidant capacity. It is a promising eco- friendly technology which reduces the activity of enzymes and pathogens causing microbial spoilage without leaving any harmful residues on produce. Ozone is conceded as Generally recognized as safe (GRAS) compounds which also perform as sanitizing agent and it is unstable that decomposes automatically into oxygen atoms at ambient condition.

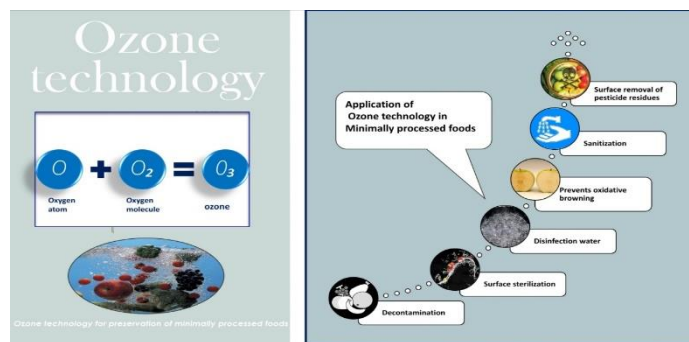


Fig.1. Application of ozone technology in Minimally Processed Products

Ozone generation

Ozone can be formed naturally from oxygen in surrounding air. When lightning blasts through air, Oxygen molecules split into atoms by high electricity during thunderstorm. Free energized oxygen atoms combine with other oxygen molecules to produce ozone. The two important principles involved in ozone generation are Corona discharge method and UV light. Traditional corona discharge method uses high electricity voltage to stimulate natural lightning to produce ozone from air then bubbles into water. The UV light method involves passing of oxygen into chamber and transforms into ozone when it is hits with 185 nm of UV light.

Prevention of Oxidative Browning: When minimally processed products are exposed to oxygen, chemical reaction such as oxidation occurs due to substantial

increase in activity of enzymes on the cut surface. Consequently, darker pigments appear on cut surface leads to deterioration of quality. When the cell membranes are broken, the phenolic components in the presence of Polyphenol oxidase (POP) oxidizes to orthoquinone which rapidly polymerized to form brown color pigment called melanin. As Ozone is a powerful oxidizing agent which produces High Reactive Species (ROS) when contact with cut surface comes results in degradation and inhibits the POP activity.

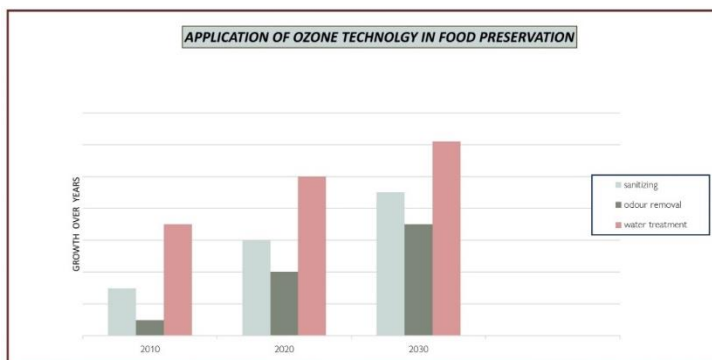


Fig.2 Application and development of Ozone technology over years

Removal of contaminants

Pesticide residues are found in surface of fruits and vegetables considered the direct source of contamination, sometimes acts as mutants and produces carcinogenic substances. As the minimally processed process such as washing, peeling can help to reduce contamination by 70% but the remaining contaminants present in final products have effects on health of humans if consumed. Prolonging the shelf life of produce eco-friendly technology such as ozone technology applied as gaseous or liquid form degrades the pesticides residues without leaving any harmful residues.

Sanitizing potential of ozone

Sanitization of fresh fruits and vegetables is one of the important operations held in minimally processed products to reduce the microbial contamination on the surface of produce which prevents food borne illness. The commonly used disinfectants such as chlorine as well as hydrogen peroxide leaves toxic residues while used in high concentration. Whether the ozone technology has considerable minimal effect on nutritional and sensory properties of minimally processed products, leaves no such residues on the final product. The minimal effect on quality of final product depends on time and concentration of ozone

treatment. Ozone is the promising sanitizing agent and water disinfectants in the recent times.

Recent technology – Micro Nano Bubbles (MNB)

The ozone treatments can be applied in both aqueous and gaseous forms. Micro Nano Bubbles enhance the reactivity and efficiency of aqueous ozone. It is the recent innovative technology which gains popularity in food processing sectors. Ozone is used as carrier gas for Micro Nano Bubbles that decomposes the organic matter which are difficult to decompose naturally. It decomposes pesticides residues and microbial toxins present on product surface. MNB can stay in water for long time while using as disinfectant. It reduces the growth of pathogenic bacteria, fungi and toxin producing molds present and maintains the freshness of produce.

Conclusion

Ozone technology presents a promising, natural solution for the preservation of minimally processed products. By harnessing the powerful oxidative properties of ozone, this innovative approach extends shelf life, preserves freshness, and maintains the nutritional integrity of foods, all without the need for chemical preservatives. As consumer demand for clean-label, minimally processed foods continues to rise, ozone technology offers a sustainable and effective alternative for the food industry, ensuring that products remain safe, fresh, and high-quality for longer periods. With its environmentally friendly and non-toxic nature, ozone is poised to play a key role in shaping the future of food preservation.

Reference

- Botondi, R., Barone, M., & Grasso, C. (2021). A review into the effectiveness of ozone technology for improving the safety and preserving the quality of fresh-cut fruits and vegetables. *Foods*, 10(4), 748.
- Monica, V., Rajan, A., & Mahendran, R. (2024). *Ozone Technologies in Food Processing, Preservation in Non-Thermal Technologies for the Food Industry*, CRC Press. (pp. 78-93).
- Sarron, E., Gadonna-Widehem, P., & Aussenac, T. (2021). Ozone treatments for preserving fresh vegetables quality: A critical review. *Foods*, 10(3), 605.
