Article ID 240205-S-16

Green Technologies in Food Processing and Preservation

Balasanthosh K.* and Priyanka S.

Faculty of Agriculture,Annamalai University,Chidambaram-608 002.

*Corresponding Author: balasanthosh2001@gmail.com

Abstract

Green is recognised as the colour of fresh leaves, and is often associated with something that is safe for creatures and the environment. There are several definitions of green technology, however the key words in those definitions are minimal impact on environmental pollution, safe for human, and sustainable natural resources. The application of the "green concept" in food technology not only imparts environmentally safe practices, but also produces healthy and nutritious produce. There are several technologies previously applied for non-food purposes that now can also be used for food processing, such as liquid or supercritical carbon dioxide, ultrasonic wave, pulse electric field. It is time to minimise or leave processes that cause environmental pollution pollute the environment to save this earth and next generations. Our next generations cannot be separated from the impacts of food intake, such as deterioration of intelligence and character. Therefore, from now on, we should start swapping to environmentally friendly food technologies. (1)

Introduction

The escalating concerns over environmental degradation, resource depletion, and climate change have spurred the adoption of sustainable practices in the food industry. Green food processing, characterized by its commitment to reduced energy consumption, waste generation, and ecological footprint, holds immense promise. This study investigates the application of conservation, transformation, and extraction techniques in green food processing, aiming to assess their effectiveness and potential for further enhancement. In the pursuit of more sustainable food production, the concept of green food processing has gained traction as a strategy to minimize environmental impact while ensuring efficient utilization of resources. This abstract encapsulates the essence of a comprehensive study titled "Sustainability Audit of Green Food Processing: Exploring Conservation, Transformation, and Extraction Techniques." The study delves into the evaluation of conservation, transformation, and extraction methods employed in green food processing, with a focus on their environmental, economic, and social implications. (2)

What are Green Technologies?

Safe or green technologies refer to the production and utilization of strategies, processes, and materials that help to save the key vital nutrients by reducing and eliminating the harmful effects involved during food processing. These technologies help to prevent the food from spoilage as well as preserve the nutritional value as compared to the conventional food preservation methods. Green technology includes a broad variety of manufacturing practices that enhance food safety. (3)

Green Food Processing Techniques:

Several innovative techniques exemplify the principles of green food processing. High-pressure processing (HPP) stands out for its ability to inactivate pathogens and extend shelf life without relying on heat or chemical preservatives (4). Similarly, pulsed electric field (PEF) technology disrupts bacteria and enhances the extraction of bioactive compounds using electrical pulses, offering a sustainable approach to food processing. Membrane separation techniques purify and concentrate liquids while reducing water and energy consumption, demonstrating the potential for resource-efficient processing (5). Additionally, supercritical fluid extraction utilizes CO_2 under high pressure and temperature to extract valuable compounds from plants without resorting to harmful solvents, furthering the cause of sustainable food production. (6)

Fig.1 Advantages of the use of green technologies (7)

Renewable Energy Solutions

One of the key pillars of green food processing is the adoption of renewable energy sources to power manufacturing facilities and processing plants. Solar panels, wind turbines, and biomass energy systems are just a few examples of renewable energy technologies being deployed in the food industry. By harnessing clean, sustainable energy sources, businesses can reduce reliance on fossil fuels, lower greenhouse gas emissions, and contribute to a more sustainable energy future. (8)

Sustainable Agriculture

At the heart of green food processing lies sustainable agriculture practices that prioritize environmental stewardship and conservation. Technologies such as precision farming, vertical farming, and hydroponics enable farmers to optimize resource use, minimize chemical inputs, and maximize crop yields. By leveraging data-driven insights and innovative growing techniques, farmers can cultivate crops more efficiently while minimizing their environmental impact. (8)

Fig. 2 Sustainable Agriculture in Green food processing (8)

Waste Reduction and Circular Economy Initiatives

Green food processing also focuses on minimizing waste and promoting a circular economy through innovative technologies and practices. Food waste reduction technologies, such as anaerobic digestion and composting, enable companies to convert organic waste into renewable energy or nutrient-rich soil amendments. Furthermore, the adoption of biodegradable packaging materials and recycling programs helps businesses reduce their environmental footprint and promote a more sustainable approach to packaging and waste management. (8)

Ozone and Food Safety

The ozone molecules are made up of three oxygen atoms, and also their unbound electrons are arranged around an oxygen nucleus in the middle, giving it a high reactivity (9). Because of its rapid decomposition, ozone persists as an inconsistent gas at ambient temperature. In chilled water, ozone is much more soluble as compared to hot water, with a solubility level 13 times that of O_2 (at 0–30°C). On account of decontamination of water, about half of the ozone is lost in 20 min. An unexpected shift in stress or temperature during electrolysis may also trigger an ozone emission. Ozone coalesces into a bright blue fluid at 112°C. (10)

Application of Ozone in Food Industries

In bacterial cytosol membrane, the cell wall is strongly and specifically oxidized by ozone. Ozone is used for disinfecting processing areas, plant machinery, and surfaces' sterilization, and fumigation. Ozone aids in the elimination of microflora including bacteria, allowing extended food shelf life. Smith and Pillai (2004) reported that ozone showed biocidal activity against microorganisms like Zygosaccharomyces bailii (11). In vegetables and fruits processing, ozone has been utilized to eliminate pathogenic microbes, as well as mycotoxins and pesticides and chemical traces (12).

Blackberries and grapes that have been treated with ozone have a much longer shelf life and are less prone to fungal infections. The impact of ozone in its gaseous form (0–5 mg/L) or moist ozone (0–10 mg/L) was observed in carrot shelf stability. The stiffness, weight loss rate, and color of carrots subjected to gases and moist ozone were not affected (13). Water-soluble ozone treatment has been added to fresh fruits and vegetables only daily to minimize microbial counts and extend shelf life. In a previous study of De Souza et al. (2018), ozone decreased the sharp rise in soluble solids throughout storage and extended the shelf life of carrots. Since the US Food and Drug Administration (FDA) authorized ozonation as a food additive, it gave a huge push to its use in multiple fruit drinks (14). The effectiveness of ozonation for inactivating microbes from fruit juice is dependent on the pH of juices, additives (emulsifiers and sugar content), the temperature, the composition, the ozone distribution frequency, the organic substance content as well as the total solids. The impact of O_3 on the fruit juice value is determined not only by the ozone intensity and exposure period but also by the chemical composition of juice (15). Among fruits and vegetables, stiffness is a crucial textural characteristic. Jaramillo-Sánchez et al. explored that ozone application was used to preserve tomatoes and strawberries (16). Aqueous ozonation creates hydroxyl radicals throughout the media, which can open ring structures and cause formaldehyde, organic acids, including ketones to be oxidized (17)

Conclusion

Green technologies aim to produce food that is both safe and of high quality. Replacement techniques could improve organoleptic and sensory properties while also ensuring food microbial protection. PEF, UV, nanotechnology, ohmic heating, and ozone are examples of novel food manufacturing technologies that have decreased energy usage, emissions' reductions, increased efficiency, enhanced productivity, and enhanced product quality. Combining these strategies could save resources while also improving food safety and food quality. The use of all these green techniques in the food sector has been investigated. However, more research is needed to determine the best treatments to combine to minimize the intensity of single-system processes and increase the overall characteristics of food and the safety of food. (18)

References

F Pratama, IOP Conference Series: Earth and Environmental Science, Volume 995, Sriwijaya Conference on Sustainable Environment, Agriculture and Farming System 29th September 2021, Palembang, Indonesia.

Jagoda Piatkowska, Department of Animal Science, Warsaw University of Life Sciences, Warsaw, Poland

Iravani, A. , Akbari, M. H. , & Zohoori, M. (2017). Advantages and disadvantages of green technology; goals, challenges and strengths. Int J Sci Eng Appl, 6(9), 272–284. 10.7753/IJSEA0609.1005

F.J. Barba, N.S. Terefe, R. Buckow, D. Knorr, V. Orlien New opportunities and perspectives of high pressure treatment to improve health and safety attributes of foods.

D. Bursać Kovačević, F.J. Barba, D. Granato, C.M. Galanakis, Z. Herceg, V. Dragović-Uzelac, P. Putnik Pressurized hot water extraction (PHWE) for the green recovery of bioactive compounds and steviol glycosides from Stevia rebaudiana Bertoni leaves

M.M. Poojary, P. Putnik, D. Bursać Kovačević, F.J. Barba, J.M. Lorenzo, D.A. Dias, A. Shpigelman Stability and extraction of bioactive sulfur compounds from Allium genus processed by traditional and innovative technologies

Predrag Putnik Faculty of Food Technology and Biotechnology, University of Zagreb, Pierottijeva 6, 10000 Zagreb, Croatia

Gayathri senthilkumar, Senior NPD/ R&D Associate, Dynamic Food Consultant, Food technologist, Flavorist, Driving Innovation in R&D, Flavor Creation & New Product Development

Jodzis, S. , & Patkowski, W. (2016). Kinetic and energetic analysis of the ozone synthesis process in oxygen-fed DBD reactor. Effect of power density, gap volume and residence time. Ozone: Science & Engineering, 38(2), 86–99.

Greene, A. K. , Guzel-Seydium, B. Z. , & Seydim, A. C. (2012). Chemical and physical properties of ozone. In O'Donnell C., Tiwari B. K., Cullen P. J., & Rice R. G. (Eds.), Ozone in food processing, (pp. 19–32). Wiley-Blackwell

Smith, J. S. , & Pillai, S. (2004). Irradiation and Food Safety. Food Technology (Chicago), 58(11), 48–55.

de Souza Machado, A. A. , Kloas, W. , Zarfl, C. , Hempel, S. , & Rillig, M. C. (2018). Microplastics as an emerging threat to terrestrial ecosystems. Global change biology, 24(4), 1405–1416

Beltrán, D., Selma, M. V., Marín, A., & Gil, M. I. (2005). Ozonated water extends the shelf life of fresh-cut lettuce. Journal of Agricultural and Food Chemistry, 53(14), 5654–5663. 10.1021/jf050359c

FDA, D. (2001). Hazard Analysis and Critical Control Point (HACCP). Procedures for the Safe and Sanitary Processing and Importing of Juice, Proposed Rule, 21, 20450–20486.

Choi, M. R. , Liu, Q. , Lee, S. Y. , Jin, J. H. , Ryu, S. , & Kang, D. H. (2012). Inactivation of Escherichia coli O157: H7, Salmonella typhimurium and Listeria monocytogenes in apple juice with gaseous ozone. Food Microbiology, 32(1), 191–195. 10.1016/j.fm.2012.03.002

Jaramillo-Sánchez, G. , Contigiani, E. V. , Castro, M. A. , Hodara, K. , Alzamora, S. M. , Loredo, A. G. , & Nieto, A. B. (2019). Freshness maintenance of blueberries (Vaccinium corymbosum L.) during postharvest using ozone in aqueous phase: Microbiological, structure, and mechanical issues. Food and Bioprocess Technology, 12(12), 2136–2147.

Patil, S., & Bourke, P. (2012). Ozone processing of fluid foods. In Cullen P. J., Tiwari B. K., & Valdramidis V. P. (Eds.), Novel thermal and non-thermal technologies for fluid foods, (pp. 225–261). Academic Press

Islam, F., Saeed, F., Afzaal, M., Ahmad, A., Hussain, M., Khalid, M. A., Saewan, S. A., & Khashroum, A. O. (2022). Applications of green technologies-based approaches for food safety enhancement: A comprehensive review. Food Science & Nutrition, 10, 2855–2867. 10.1002/fsn3.2915.

* * * * * * * *