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Opinion Article

Minimal High Hydrostatic Pressure to Freeze-Dry Berries for *Norovirus* Mitigation

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DESCRIPTION

Norovirus, a leading cause of foodborne gastroenteritis worldwide, poses significant public health challenges. Berries, often consumed fresh or as ingredients in various food products, can be vectors for *Norovirus* transmission if contaminated. As the demand for fresh and minimally processed food increases, effective decontamination methods are essential to ensure food safety. One positive technique is the combination of High Hydrostatic Pressure (HHP) and freeze-drying, which has shown potential in preserving the quality of berries while mitigating the risk of *Norovirus*.

Understanding *Norovirus*

Norovirus is a highly contagious virus that can cause severe gastroenteritis. The virus is resilient and can survive on surfaces and in food for extended periods. Berries, being delicate and often eaten raw, can easily become contaminated during handling, processing, or harvesting. Traditional decontamination methods, such as heat treatment, are often unsuitable for preserving the sensory and nutritional qualities of fresh berries. Thus, novel methods that ensure food safety while maintaining quality are essential.

HHP technology: HHP is a non-thermal food preservation method that applies pressure ranging from 100 to 800 MPa to food products. This process inactivates microorganisms, including bacteria, yeasts, molds, and viruses, by disrupting their cellular structures. The efficacy of HHP in inactivating viruses, including *Norovirus*, is well-documented. The mechanism involves altering viral capsid integrity and Ribonucleic Acid (RNA), rendering the virus non-infectious.

Mechanism of HHP in *Norovirus* inactivation

The inactivation of *Norovirus* by HHP occurs through several mechanisms.

Pressure-induced structural changes: The application of pressure leads to conformational changes in the viral capsid proteins, compromising the virus's structural integrity and leading to the loss of infectivity.

Membrane disruption: The pressure can disrupt cellular membranes of contaminating bacteria, thereby reducing the overall microbial load.

Enhanced solubility and diffusion: The high pressure enhances the solubility of gases and liquids, which may facilitate better penetration of the pressure into the berry matrices.

Optimal pressure levels: Research indicates that effective *Norovirus* inactivation occurs at pressures ranging from 200 to 600 MPa. However, the exact pressure required can vary based on factors such as the type of berry, initial contamination levels, and processing time. It is essential to optimize these parameters to ensure complete inactivation while minimizing damage to the fruit.

Freeze-drying process: Freeze-drying, or lyophilization, is a dehydration process that involves freezing the product and then reducing the surrounding pressure to allow the frozen water in the material to sublimate directly from the solid phase to the gas phase. This technique preserves the structure and nutrients of berries, making them lightweight and shelf-stable.

Integration of HHP and freeze-drying

The combination of HHP and freeze-drying presents a unique opportunity to enhance food safety while maintaining quality. The HHP process can be applied before freeze-drying to reduce the microbial load, including *Norovirus*. This step minimizes the risk of contamination during the drying process and ensures that the final product is safe for consumption.

Benefits of combined methodology

Enhanced safety: The dual approach effectively reduces *Norovirus* levels in berries, addressing food safety concerns.

Preservation of quality: Freeze-drying maintains the sensory qualities (taste, color, and texture) of berries, making them appealing to consumers.

Nutrient retention: This method helps preserve the vitamins, antioxidants, and other nutrients found in fresh berries, contributing to their health benefits.

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Research findings: Several studies have investigated the efficacy of HHP combined with freeze-drying for *Norovirus* mitigation. In a controlled study, berries subjected to HHP treatment at 400 MPa for 5 minutes showed a significant reduction in *Norovirus* titers, followed by freeze-drying. The final product was tested for safety, revealing no detectable levels of the virus.

Moreover, sensory evaluations indicated that consumers preferred the taste and texture of berries treated with HHP and freeze-drying compared to those treated with conventional methods. These findings suggest that this innovative approach can be both effective and marketable.

CONCLUSION

The combination of minimal high hydrostatic pressure and freeze-drying presents a viable strategy for mitigating *Norovirus* contamination in berries. This method not only enhances food safety but also preserves the quality and nutritional value of the product. Continued research and development are essential to optimize this technology and address the challenges associated with its implementation. As consumer demand for safe and high-quality food products grows, innovative solutions like this will play an important role in ensuring public health while meeting market needs.

Incorporating these advanced techniques in berry processing could significantly reduce the incidence of *Norovirus* outbreaks, ensuring that these popular fruits remain a safe and healthy choice for consumers.