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Perspective

Strategies for *Cronobacter sakazakii* Inactivation in Food by Using Thermal and Non-Thermal Techniques

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DESCRIPTION

Microbial contamination in food poses significant risks to public health, prompting rigorous research into effective methods of pathogen control. Among the pathogens of concern, *Cronobacter sakazakii* stands out due to its association with severe infections, particularly in vulnerable populations such as infants and the elderly. This article delves into the scientific strategies and advancements in the inactivation of *Cronobacter sakazakii* in various food matrices.

Cronobacter sakazakii, formerly known as *Enterobacter sakazakii*, is a Gram-negative bacterium found in the environment and occasionally in food products. It is notorious for causing infections such as meningitis, septicemia, and necrotizing enterocolitis, especially in neonates fed with contaminated Powdered Infant Formula (PIF). The ability of *Cronobacter sakazakii* to survive in desiccated environments, such as powdered formulas, makes it particularly challenging to control through conventional food safety measures.

Importance of inactivation strategies

Given the severity of illnesses associated with *Cronobacter sakazakii* and its potential presence in various food products, effective inactivation strategies are important. These strategies aim not only to ensure food safety but also to comply with regulatory standards and protect public health. Researchers and food manufacturers continually explore and develop novel techniques to mitigate the risk of contamination.

Heat treatment methods

Thermal processing: Heat treatment remains one of the most effective methods for inactivating *Cronobacter sakazakii* in foods. The application of heat through processes such as pasteurization and sterilization targets microbial cells, disrupting their cellular structures and enzymatic activities. For example, in powdered infant formula, manufacturers use precise thermal treatments to eliminate pathogens while preserving the nutritional quality of the product.

High Pressure Processing (HPP): High Pressure Processing involves subjecting foods to high pressures (usually between 100 and 1000 MPa) for a specific duration. This method disrupts microbial membranes and denatures proteins, effectively inactivating *Cronobacter sakazakii* without the use of heat that could damage heat-sensitive components in foods.

Non-thermal techniques

Irradiation: Ionizing radiation (gamma or electron beam) is another method employed to reduce microbial loads, including *Cronobacter sakazakii*. Irradiation disrupts microbial Deoxyribonucleic Acid (DNA) and cellular functions, preventing reproduction and ensuring microbial safety in a variety of food products. Despite concerns about public perception, irradiation is recognized as a safe and effective method when used within regulatory limits.

Chemical treatments: Chemical treatments involve the use of antimicrobial agents such as chlorine, ozone, and organic acids to control *Cronobacter sakazakii* in foods. These compounds disrupt cellular functions or inhibit microbial growth, depending on concentration and application method. However, careful consideration is required to ensure that residues of these chemicals do not exceed safety thresholds and affect food quality.

Emerging technologies

Pulsed Electric Fields (PEF): PEF involves applying short pulses of high voltage to foods placed between two electrodes. This technique creates pores in microbial membranes, leading to cell death. PEF is gaining attention for its ability to inactivate *Cronobacter sakazakii* while preserving the sensory and nutritional properties of treated foods.

Cold plasma: Cold plasma technology generates reactive oxygen and nitrogen species that damage microbial cell components.

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This non-thermal method shows guarantee for *Cronobacter sakazakii* inactivation in foods without altering their organoleptic properties.

While advancements in inactivation technologies are optimistic, several challenges remain:

Regulatory compliance: Adhering to strict regulatory standards for food safety and microbial reduction.

Consumer acceptance: Addressing public perceptions and concerns regarding novel technologies like irradiation and cold plasma.

CONCLUSION

The inactivation of *Cronobacter sakazakii* in foods is a critical area of research and development aimed at safeguarding public health. From traditional heat treatments to innovative non-thermal technologies, the food industry continues to evolve its methods to ensure the safety and quality of food products. Ongoing research will further refine these techniques, providing safer food choices for consumers worldwide. While the challenges are significant, the scientific community's dedication to finding effective solutions ensures that *Cronobacter sakazakii* can be effectively managed in food production, ultimately contributing to safer and healthier food options globally.