探討高靜水壓及冷凍處理對肉類產品中沙門氏菌滅活效果和理化特性的影響

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2025/09/24

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摘要

沙門氏菌 (*Salmonella*) 是造成食源性疾病的重要病原菌，在缺乏滅菌步驟的生肉加工食品製程中，產品更容易受到初級污染與交叉污染而致病於人類，因此其控制對食品安全而言至關重要。傳統熱處理雖能有效抑制微生物，但常導致食品風味與營養成分受損，因此食品業逐漸向非熱滅菌技術尋找替代方案，其中高靜水壓（High Pressure Processing, HPP）對處理熱敏感之富含蛋白質的肉類和魚類原料之滅菌效果佳，被認為是有利的替代方案，同時對感官特性的影響相對較小。研究顯示，HPP 結合乳酸及冷凍可有效降低生食寵物食品中沙門氏菌含量，且在壓力超過 600 MPa 與乳酸濃度高於 4.25 g/kg 後，其協同效益趨於穩定，並能保持良好的色澤品質（$\Delta E < 3$）。對於冷凍雞胸肉，500 MPa/1 分鐘的處理可使沙門氏菌數量至少下降 5 log CFU/g，並抑制內源菌群，HPP 處理雖會造成肉色白化及質地變硬，但在消費者感官評估下被認為是可接受的變化。應用於冷凍魚片的結果中，超低溫 HPP 的冰相轉變增強了沙門氏菌的滅菌效果，其中-32°C/3 分鐘的處理優於-50°C，且僅使魚片亮度增加，而外觀與氣味仍與對照組相近。總言之，HPP 在提升動物性蛋白質食品的微生物安全與延長保存期限方面具有顯著潛力，但仍需依產品特性精確調整壓力、保壓時間及輔助因子，以兼顧滅菌效率與產品品質。

Exploring the effects of high pressure processing and freezing on the inactivation of *Salmonella* and the physicochemical properties of meat products

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2025/09/24

Outline

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Abstract

Salmonella is a major foodborne pathogen, and in minimally processed raw meat products lacking sterilization steps, the risk of primary and cross-contamination is elevated, leading to potential human infection. Therefore, controlling *Salmonella* is critical for food safety. While conventional thermal treatments are effective in inhibiting microbial activity, they often compromise food flavor and nutritional quality. As a result, the food industry is increasingly turning to non-thermal technologies as alternatives. Among them, High Pressure Processing (HPP) has shown strong potential in inactivating pathogens in heat-sensitive, protein-rich meat and fish products, with relatively limited impacts on sensory properties. Studies have demonstrated that the combination of HPP with lactic acid and freezing can effectively reduce *Salmonella* levels in raw pet food. The synergistic effect plateaus when the pressure exceeds 600 MPa and the lactic acid concentration surpasses 4.25 g/kg, while maintaining desirable color quality ($\Delta E < 3$). For frozen chicken breast, treatment at 500 MPa for 1 minute reduced *Salmonella* counts by at least 5 log CFU/g and suppressed indigenous microbiota. Although HPP caused whitening of meat color and increased toughness after cooking, these changes were considered acceptable in sensory evaluations. In frozen fish fillets, ultra-low temperature (ULT) HPP enhanced *Salmonella* inactivation via ice phase transitions, with treatment at −32°C for 3 minutes being more effective than −50°C. This process increased fillet lightness but preserved overall appearance and odor similar to untreated controls. In conclusion, HPP shows substantial potential for improving microbial safety and extending the shelf life of animal protein-based foods. Nevertheless, treatment parameters—including pressure level, holding time, and auxiliary factors—must be carefully optimized for each product type to balance microbial inactivation with the preservation of quality attributes.

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