Effects of Nano-Bubble Water on Meat Quality

許棕荃 (5124)

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Outline

Abstract

Brining and stewing are governed by mass-transfer and heat-transfer limits that can slow salt uptake or cause nutrient loss; recent “bubble engineering” strategies address both issues. This synthesis evaluates (II) generated bulk nanobubbles (BNBs) in ice-melt water during ice-stewed mutton and (III) ultrasound combined with microbubbles (USMB) during pork brining. In the cooking context, negatively charged BNBs (average ~60 nm; $\zeta < -20$ mV) spontaneously form and adsorb to meat surfaces, creating an isolation layer that protects proteins and prevents flavorful ions from leaching, effectively switching “stewing” toward a gentler, BBQ-like regime; EDS and protein analyses showed higher retained N/Na/Ca/Cl and slower myofibrillar protein loss, with tenderness improved (shear force ~2–3 kg vs. 6–7 kg in water). In the brining context, US/USMB markedly accelerated NaCl ingress; a constant-D Fick model fit the kinetics well, with diffusion coefficients increasing from 1.8×10^{-10} m² s⁻¹ (static) to 2.0×10^{-9} (US) and 2.5×10^{-9} m² s⁻¹ (USMB). SEM revealed sonoporation-like surface pores (~2–3 μm) that facilitate mass transfer; water-binding capacity declined across all methods, myosin became undetectable, and actin denaturation temperature decreased with time—traits advantageous for dehydration-oriented processes (e.g., dry-cured hams). Overall, BNB isolation improves quality retention during cooking, while USMB accelerates brining via microstructural poration and enhanced diffusion—together illustrating how bubble-mediated mass/heat transfer control can boost meat quality and processing efficiency.

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Visy, A., Jónás, G., Szakos, D., Horváth-Mezőfi, Z., Hidas, K. I., Barkó, A., & Friedrich, L. (2021). Evaluation of ultrasound and microbubbles effect on pork meat during brining process. *Ultrasonics Sonochemistry*, *75*, 105589.