
Electric and magnetic field-based supercooling technology to ensure the freshness of yellowfin tuna (*Thunnus albacares*)

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Fish is one of the most perishable aquatic foods since it is easily spoiled and oxidized. Freezing is commonly used to extend shelf life to minimize pathogens and enzymatic activity; however, it accompanies quality degradation caused by ice crystallization. Supercooling is defined as the process of cooling a food product below its freezing temperature without ice crystal formation. Water in food is susceptible to be magnetized by a magnetic field (MF) since it is a diamagnetic material. In addition, water consists of dipole molecules, indicating that water molecules tend to realign and re-orientate under an applied electric field (EF). Therefore, electric and magnetic fields can directly act upon water in foods to prevent ice nucleation and promote supercooling during the freezing process.

Various strengths of EF and MF were applied to supercool sashimi-grade tuna fillets (~210 g) at -4 degC for 10 days, and quality changes, such as drip loss, color, microbial analysis, texture, and lipid oxidation, were examined and compared with samples subject to conventional refrigeration and freezing conditions.

The quality factors of EF and MF-treated tuna samples were compared with fresh, refrigerated, and frozen samples after 1, 4, 7, and 10 days of storage. The total volatile basic nitrogen (TVB-N) value of refrigerated tuna samples was significantly higher than frozen and supercooled tuna samples after 1, 4, 7, and 10-day of storage ($P < 0.05$). Specifically, the delta TVB-N value of the refrigerated tuna sample was 2.6, 5.4, 12.2, and 15.6 mg N/100g after 1, 4, 7, and 10 days, respectively. The aerobic count plate (ACP) value of the supercooled tuna sample was not significantly different during the storage of 7 days. Tuna samples preserved in the supercooled state showed significantly lower values in the drip loss (0.8%), compared to the refrigerated (2.1%) and frozen samples (8.2%). In addition, the color changes and texture evidenced that the supercooled state reduced quality degradation. Supercooling preservation using the combined EF and MF technology allowed the tuna fillets to improve their shelf-life while maintaining unfrozen and fresh at subzero temperatures.