Changes in quality properties of fish meat as affected by salting and subsequent freezing

［課程博士・論文博士共通］

博士学位論文内容要旨
Abstract

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論文題目 Title	Changes in quality properties of fish meat as affected by salting and subsequent freezing （塩漬とその後の凍結に伴う魚肉の性状変化）		

Salting is a conventional method used to maintain the quality and extend the shelf-life of foods, especially in the application of preserving highly perishable fish. With the transformation of lifestyle and urgent demands of healthy, fast, and tasty foods, lightly salted fish products are gaining popularity. Salt is now primarily used for unique mouthfeel, juiciness, flavor enhancement, and high yield rather than as a primary preservative. Freezing, an effective preservation method for fresh fish, can be conveniently and extensively applied, and numerous studies have been conducted on the effects of freezing and frozen storage on the quality properties of fish meat. However, there is limited information on the quality changes of pre-salted fish meat as affected by freezing and frozen storage. Therefore, the objectives of this study were (1) to investigate the effects of salting condition on the quality properties of frozen-thawed fish meat, (2) to study the freeze-thaw stability of pre-salted fish meat, and (3) to find out the appropriate storage conditions for lightly salted fish products to minimize the quality deterioration during frozen storage.

Literatures on the muscle structure and proteins, the effects of freezing and frozen storage on fish meat, and the effects of salting on fish meat were reviewed in chapter 1.

In chapter 2, the effects of salting and subsequent freezing on the physicochemical and histological properties of frozen-thawed tuna meat were investigated. Modifications in the tissue histology and ice crystal morphology were dependent on salt concentration. Salting facilitated the microstructural recovery as indicated by the decrease or disappearance of intracellular damages. The morphological transformation from ice columns to spherical ice crystals was tentatively attributed to the extraction/solubilization of myofibrillar proteins, contributing to increased water-holding capacity. However, increased thawing loss and centrifuging loss after thawing were observed in the 2 M and 3 M salted samples with large ice crystals and enlarged extracellular spaces. These modifications were closely associated with the insolubilization of water-soluble protein and decreased stability of myofibrillar proteins. Enhanced water-holding capacity and high yield could be maintained after freezing-thawing by using optimal salt concentrations (around 1 M).

In chapter 3, the changes in the physicochemical properties, quality attributes, tissue microstructure, and ice crystal morphology in tuna meat with various salting time in 1 M NaCl solution were studied during frozen storage. With the extension of salting, the myofibers shrank initially under osmotic pressure and then swelled with the disappearance of intracellular voids. Lightly salted tuna meat was characteristic of high water-holding capacity and unique textural properties with the “recovery” of intracellular microstructure from frozen damages in the materials, and after frozen storage these positive effects could be maintained with optimized salting time. Instead of the ice columns in the unsalted samples, numerous spherical ice crystals were found in those with proper salting time. With a further prolonged salting time, enlarged extracellular spaces caused decreased water-holding capacity and loose and mushy texture. In these samples, large ice crystals were also found. From the present results, the samples with salting time of 1 h had higher stability when subjected to frozen storage.

In chapter 4, the effects of various freeze-thaw cycles on the physicochemical and histological properties of lightly salted tuna meat were investigated. Enhanced water-holding capacity and springiness were obtained in the salted samples even after repeated freezing-thawing, which was ascribed to the modifications in tissue

microstructure, ice crystal morphology, and protein properties. Intracellular and spherical ice crystals were observed in the salted meat, rather than the extracellular and large ice columns in the unsalted counterparts. The proteins in the salted meat were more sensitive to the stresses imposed by freezing-thawing and would form cross-linking by hydrophobic interactions more readily. Though the oxidative stability of frozen salted tuna meat was decreased, the overall quality properties of lightly salted tuna meat could be maintained even after repeated freezing-thawing.

In chapter 5, the effects of different frozen storage temperatures on the quality properties of lightly salted tuna meat were investigated during frozen storage, aiming to find out the appropriate storage conditions for lightly salted fish products. The water-holding capacity, visual appearance, and textural properties of lightly salted tuna meat were maintained even after 16 w of frozen storage at −40°C or lower. Concurrently, lipid oxidation and metmyoglobin formation in these samples were suppressed significantly ($p < 0.05$). Therefore, lightly salted tuna meat should be stored at −40°C or lower to minimize quality deterioration during frozen storage.

Finally, the effects of salt concentration, salting time, repeated freeze-thaw cycles, and frozen storage temperature on the quality of fish meat were concluded in chapter 6. Frozen lightly salted fish products with unique quality characteristics can be obtained by applying optimal salting conditions and a low and constant storage temperature. Although further studies are needed, the present findings have great implications for the processing and storage of lightly salted fish products.