The study on the quality improvement of salted roe product from Alaska pollack Theragra chalcogramma

［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	The study on the quality improvement of salted roe product from Alaska pollack *Theragra chalcogramma* (塩タラコ加工品の品質向上に関する研究)		

As a base of the study on the quality improvement of salted roe product from Alaska pollack, objective quality evaluation of commercial spicy pollack roe products was conducted. Based on the study conducted in chapter 2, effect of frozen storage on the quality of salted roe product was studied in chapter 3. Quality improvement of salted roe products was studied using $CaCl_2$ and MTGase in chapter 4 and chapter 5, respectively.

The lack of an objective quality evaluation system may have negatively impacted consumer perceptions of roe products and is considered as one of the reasons for the downward pressure on the average price of spicy pollack roe products. The purpose of chapter 2 is to develop a clear standard for the objective quality evaluation of salted roe products, and the evaluation methods developed were also a base of this study. A total of 31 parameters were assessed in high- and low-priced roe products as follows: ovary physical dimensions (ovary weight, ovary length, ovary condition factor, ovary membrane thickness, egg diameter), pH, color parameters (L*, a*, and b*), proximate composition (moisture, ash, lipid, protein, carbohydrate), salt content, water phase salt content, peroxide value (PV), thiobarbituric acid reactive substances (TBARS), free amino acids (sweet amino acids, umami-tasting amino acids, and bitter amino acids), mechanical properties (firmness, gumminess, stickiness, tensile strength, and breaking strength), protein composition (ovary membrane and eggshell), and differential scanning calorimetry (denaturation temperature and thermal transition enthalpy) in order to provide basic information for the establishment of evaluation standards for spicy pollack roe products.

Results of study conducted in chapter 2 indicated that average egg diameter of the high-priced roe products was significantly greater than the low-priced products ($p < 0.05$). All low-priced roe products showed significantly higher peroxide value and thiobarbituric acid reactive substances (TBARS) than those of high-priced roe products from the same company. Compared to low-priced roe products, those high-priced ones showed higher values for mechanical properties and thermal transition enthalpy, including ovary firmness, gumminess of ovary round slice, tensile strength of ovary membrane and egg breaking strength. Protein composition of eggshells and ovary membrane from roe products was analyzed by SDS-PAGE. Amounts of β-component (54 kDa) and γ-component (47 kDa) in eggshell protein of low-priced roe products were greater than those of high-priced products, which may be degraded from 100 kDa eggshell protein components. Moreover, ovary membrane protein in low-priced roe products was comprised of a relatively greater amount of low - molecular - weight components. Seventeen typical types of free amino acids were detected and identified in the roe products. More bitter amino acids were detected in the low-priced, compared to the high-priced roe products from the same company. It is proposed that these parameters can be used as potential objective standards for the quality evaluation of spicy pollack roe products.

Commercial spicy pollack roe products are usually processed from frozen roes, and the frozen storage period could be as long as one year. Roe products processed from fresh roe or those with shorter frozen period are generally believed to be high-quality. However, there is little information about the effects of frozen storage period on quality of spicy pollack roe. Therefore, the purpose of chapter 3 is to clarify the effects of frozen storage on the quality of Alaska pollack roe products from the scientific view point.

Both of the drip values of roe material and roe product prepared from fresh roe material (roe product 1) increased with frozen storage period. Drip of roe material was significantly higher than that of roe product 2 with the same frozen storage period. The mechanical properties and eggshell protein aggregation of roe product prepared from frozen roe material (roe product 1) decreased rapidly with frozen storage period, while those of the thawed products prepared from fresh roe decreased slowly. Compared at the same frozen storage period, roe product 2 showed higher ovary firmness, ovary round slice gumminess, and egg breaking strength than those of roe product 1. The higher egg breaking strength are considered as the main reason of higher ovary firmness and ovary gumminess. The endogenous total TGase activity of roe material decreased significantly, and it also decreased with frozen storage period significantly. It may be the main reason that the approx. 100 kDa eggshell protein component of roe product 1 decreased with frozen storage period, and it continually lead to the decrease of egg breaking strength.

Salt-reduced Alaska pollack roe is beneficial to public health by decreasing intake of sodium chloride (NaCl), however, it has a bad texture with low breaking strength. The study conducted in chapter 4 addresses the feasibility of NaCl reduction in salted roe product focusing on improvement of breaking strength using calcium chloride ($CaCl_2$). Salted roe products were prepared by immersing Alaska pollack roe in NaCl solutions (3.5%, 7.0%, 15.0%, 20.0%, and 25.0%), as well as in 7.0% NaCl solutions adding $CaCl_2$ (0.0%, 0.5%, 1.0%, 2.0%, and 3.0%). Breaking strength, moisture and salt content, eggshell protein composition, and total transglutaminase (TGase) of the salted roe products were analyzed. The addition of $CaCl_2$ enhanced eggshell protein crosslinking and breaking strength of salt-reduced roe product. An acyl transfer reaction catalyzed by a calcium-dependent TGase may be responsible for the eggshell protein crosslinking and the improvement of texture. It is possible to develop salt-reduced Alaska roe product using $CaCl_2$.

The commercial use of MTGase in the food industry started with the manufacturing of surimi in Japan. It is exerted world-wide for the preparation of meat, dairy, bakery, soy products etc. to improve the textural properties of protein foods in general. There are few references on salted pollack roe product added with MTGase. Therefore, Effect of MTGase on the quality of salted Alaska pollack roe product are clarified in chapter 5. Addition of MTGase enhanced the eggshell hardening during salting procedure by catalyzing aggregation reaction of β and γ protein components, and finally resulted in increase of ovary firmness and ovary round slice gumminess, and decrease of ovary round slice stickiness. Salted roe products with higher egg breaking strength and ovary firmness are considered as superior. To achieve maximum effect, at least 0.50% MTGase is needed, higher levels of MTGase did not bring additional benefit.

Finally, sensory evaluation was conducted to compare the effects of $CaCl_2$ and MTGase on salted roe products. No statistical difference ($P < 0.05$) in bitterness score was observed between the salted roe products with addition of 1.0% $CaCl_2$ or not. Addition of 1.0% $CaCl_2$ or 0.5% MTGase resulted in significant increase of hardness score. Salted roe product prepared only with addition of 0.5% MTGase exhibited significantly higher hardness score than salted roe product prepared only with 1.0% $CaCl_2$. Salted roe product prepared with 1.0% $CaCl_2$ and 0.5% MTGase did not show significantly higher hardness sore than those prepared only with 0.5% MTGase.

Therefore, application of fresh roe material, and addition of 1.0% $CaCl_2$ or 0.5% MTGase during salting resulted in quality improvement of salted pollack roe product, since salted roe products with higher hardness are considered as superior by most of pollack roe manufacturers or traders.