Study on the physical and chemical property of emulsified surimi gel

［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	Study on the physical and chemical property of emulsified surimi gel (乳化すり身ゲルの物理的および化学的性質に関する研究)		

Surimi-based foods are widely accepted and enjoyed throughout the world. Surimi is a mechanically deboned, washed (bleached) and stabilized fish meat containing myofibrillar (Mf) protein as the main protein. During processing, Mf protein is solubilized using salt to form a viscous state, which can then be mixed with a range of additives and processed into various forms. Therefore, surimi is a convenient intermediate product used in the preparation of a number of ready-to-eat seafood such as kamaboko, fish sausage, imitation crab legs and shrimp products. Recently, surimi-based foods enriched with EPA and DHA have demonstrated potential wide applicability. However, the study on the physical and chemical property of surimi gel fortified with oil was not fully investigate.

For providing the scientific basis for the industry to develop the emulsified surimi gel with the better quality, in this thesis, we are going to discussed relationship between the emulsifying properties and physical property of emulsified surimi gel with fish oil, and then to clary the oxidative stability of fish oil in the surimi product during storage.

In the Chapter 2, the effect of emulsifying stability of myofibrillar protein on the gel properties of emulsified surimi gel was investigated. Several kinds of emulsified surimi gels were prepared from different quality levels of Alaska Pollack surimi, and the relationship between the emulsifying stability (ES) of myofibrillar protein and the properties of the emulsified surimi gels was investigated. Fish oil emulsified into surimi gels enhanced the breaking strength, but this was decreased by denaturation of the surimi protein, and the rate of enhanced gel forming ability with emulsification decreased with decreasing ES. Expressible drip also decreased with emulsification; however, increasing amounts of lipid in the expressible drip were separated out from the gel upon protein denaturation of the source surimi. In the rheological properties of surimi paste, emulsification of fish oil enhanced the storage modulus and reduced the viscosity of surimi paste during heating. Scanning electron microscopy revealed that the shape of fish oil particles became irregular and some voids caused by oil leakage were observed with increasing storage period of the source surimi. The results suggested that the improvement in gel properties of the emulsified surimi gels was correlated with ES as well as the level of protein denaturation.

In the chapter 3, the effect of pH and heating condition on the properties of emulsified surimi gel was clarified. Results showed that pH conditions influenced the solubility and emulsifying properties of surimi proteins and that the gel properties were associated with the protein properties. Under direct heating, the highest gel strength was achieved at pH 8.0, in which condition the solubility was significantly higher than others. Higher emulsifying stability resulted in enhanced gel strength relative to that of the control group. However, the changes in the gel strength were not consistent under two-step heating. In addition, the expressible moisture and lipid content were found to vary depending on the pH values under both heating conditions. The corresponding changes in expressible moisture and lipid content could be

attributed to the high protein solubility and emulsifying properties of surimi proteins. Analysis of the dynamic rheological properties of the resulting surimi paste revealed that the gelation properties varied depending on the pH conditions during the heating process. In addition, the gelation temperatures changed according to the structure of surimi proteins, which in turn varied depending on the pH conditions.

In the Chapter 4, the effect of NaCl reduction and KCl substitute on the physical properties of emulsified surimi gel under high temperature treatment were investigated. With increase in the NaCl or KCl from 0.17 M to 0.51 M, the breaking strength of surimi gels decreased gradually because of denaturation of myosin tail (light meromyosin). In case of normal heating, at the NaCl concentration of 0.17 M and 0.34 M, the breaking strength of emulsified group were significantly higher than that of control group. In case of gel prepared with KCl, the emulsification did not show the positive effect. Under the high temperature treatment, the breaking strength of the gel was overall lower than that under the normal heating, and the emulsification contributed the negative effect on the breaking strength, the possible reason was the high temperature damage both gel matrix and emulsification structure. Hardness of gel decreased with increase of salt content, and hardness of emulsified gel was slightly lower than control gel in both heating conditions. The expressible moisture of emulsified group was significantly lower than that of control group under direct heating, however, the significant changes were not observed under the high temperature treatment. The expressible oil of emulsified gel under same heating condition showed the no significant changes except no salt (NS) and 0.51 M KCl group. However, expressible oil of emulsified gel under the high temperature treatment was significantly higher than that under normal heating. It possibly because the high temperature breaks the emulsification of the gel, then the oil was easier to squeezed out by the external force. These results suggested that NaCl reducing or KCl substitute could apply in the emulsified surimi gel because they did not contribute the tremendous negative impact on the physical properties. On the other hand, the high temperature treatment lowered the overall properties of emulsified gel due to the destruction of protein structure and weakness of protein-protein interaction.

In the Chapter 5, The emulsified surimi gels were prepared under different conditions to measure the oxidative degree of fish oil during storage. Under the high-mixing conditions, the oil was well-emulsified, and the small oil particles were generated; however, the oil particle size after mild mixing was much larger. The peroxide value and thiobarbituric acid reactive substances values of fish oil in each type of surimi gels gradually increased within the storage period. On one hand, the oxidation was suppressed when the oil particle size became smaller; lipid oxidation also suppressed under the condition of vacuum + air (Emulsification under vacuum followed by mixing with air). On the other hand, the oil particle size decreased in the surimi gels as the protein concentration increased, and the oxidative stability was significantly enhanced. These results indicated that the levels of emulsification affect the oxidation level of oil in surimi gel and that the complete emulsification protects fish oil from oxidation.

In this thesis, the several factors which related to the physical and chemical properties of emulsified surimi gel were investigated. It could provide the scientific basis for food industry to produce the surimi-based product fortified with oil with the better quality.