Study on the physical and chemical property of emulsified surimi gel

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Doctoral Dissertation

STUDY ON THE PHYSICAL AND CHEMICAL PROPERTY OF EMULSIFIED SURIMI GEL

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学位論文の要約

Summary

Fish oil contains large amount of PUFA efficiently improves human health and the demand of products containing fish oil is continuously increasing. Even though the surimi-based products containing high amount of fish oil were available in the marked, understanding the changes of properties of product emulsified with the oil is greatly important to improve the quality of the products. In the thesis, therefore, several factors which are related to the gel property (gel-forming ability, water-holding capacity, oil-holding capacity, and rheological property) and oil oxidation in emulsified surimi gel were clarified for improving the physical and chemical property of emulsified surimi gels.

Chapter 1 gave the general overview of the basic information of surimi and emulsified surimi-based products, and then put forward the significance of this thesis.

In chapter 2, the material surimi with different emulsifying stability was used to prepare emulsified surimi gel, and the relationship between emulsifying stability and gel properties was clarified. From the result, improvement of the properties of the emulsified surimi gels was associated with the

emulsifying stability of Mf protein in the surimi. From the result, the greater the stability of the protein membrane surrounding the oil particles, the superior the obtained gel properties, and it was hypothesized that the protein film or membrane on the surface of oil particles influences the overall properties of Mf protein gels as well as the quality of the final products. These results suggest that the improving effect on gel properties by emulsification of surimi is related to the formation of a protein membrane surrounding the oil particles emulsified within the surimi gel.

In chapter 3, the pH of emulsified surimi gel was adjusted by NaOH or HCl and heated by different conditions, and then the combined effect of pH and heating condition on the property of emulsified surimi gel was clarified. The results showed that the gel properties of surimi gels fortified with fish oil, including breaking strength and moisture- and lipid-holding capacity, which were significantly influenced by the pH and heating conditions. Superior gel strength was obtained at pH 8.0 and from pH 7.5 to 8.0 upon direct heating and two-step heating, respectively. Under direct heating, gels in the emulsified group exhibited higher gel strength relative to those of gels in the control group; furthermore, the gel strength was found to change depending on pH and was associated with the emulsifying stability. Under two-step heating, the effect of emulsification on the gel strength was reduced or negligible. The expressible moisture and lipid content varied depending on the pH, and the corresponding changes were attributed to the protein solubility and emulsifying properties of surimi proteins, which were associated with the ability of the proteins to entrap the lipid particles. Analysis of the rheological properties showed that pH influenced the gelation process of gels in both the control and emulsified group during heating. Our current findings indicated that pH and heating conditions can be adjusted to control the properties of surimi gel fortified with fish oil.

In chapter 4, emulsified surimi gel was prepared with different content of salt and salt-substitute, and the effect of salt-reduction and salt -substitute on the property of emulsified gel under high-temperature treatment was clarified. The result showed that 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 chapter 5, for preventing oil oxidation in the emulsified surimi gel, the different preparation conditions were applied to prepare the emulsified surimi gel. The result showed that the oil with smaller particle size in the surimi gel had the better oxidative stability and the oxidation of oil could be efficiently prevented when the oil emulsified with surimi under vacuum followed by mixing under air condition. This approach allows the addition of functional fish oil in surimi with a high oxidative stability to enhance the commercial value and give the scientific evidence to produce the better surimi-based products containing high amount of oil.

In general, the changes of physical and chemical property of surimi gel emulsified surimi gel were investigated, and some mechanisms of the changes was clarified. These findings will provide the scientific basis for the production of emulsified surimi gel with fish oil.