The effect of processing conditions on quality changes of frozen surimi gels

Doctoral Dissertation

The effect of processing conditions on quality changes of frozen surimi gels

（凍結すり身ゲルの品質変化に及ぼす処理条件の影響）

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学位論文の要約

Summary

Surimi-based products are processed fishery products, which have gained worldwide popularity due to their high nutritional value and characteristic textural properties. Commercial surimi-based products are often stored in a frozen state before being sold in the market. However, it is said that the quality of surimi-based products is easy to be damaged by frozen storage, and few studies have elaborated on the relation between freezing conditions and quality changes as well as other factors that affect freezing damages in surimi products. Currently, the setup of freezing conditions including freezing rates, temperatures, and periods depends on the manufacturer's experience. Essentially, the use of freezing technology for surimi-based products is not supported by a scientific basis. Therefore, this study aimed to clarify the quality changes of frozen surimi gels. To achieve this purpose, this study used frozen surimi as raw material, adding water, salt to make surimi gels with or without starch.

Surimi gels frozen with two freezing methods, quick freezing or slow freezing, and stored under different freezing conditions. Microstructure, water holding capacity, breaking strength and deformation, hardness, adhesiveness etc. were used as quality indictors to analyze the quality changes of frozen surimi gels. Firstly, the factors affecting quality changes of frozen surimi gels were investigated. Furthermore, studies about the effect of starch properties on the quality changes of frozen surimi gels were performed. Finally, based on the research of quality changes in frozen

surimi gels with or without starch, procedure of "setting-freezing-reheating" for starch-surimi gels was successfully developed to reduce the quality changes of frozen surimi gels.

The conclusions can be summarized as follows:

1) Heating processes, freezing rates, frozen storage temperature, and time significantly affected the drip loss and gel properties of heated surimi gels. Although two-step heated gels showed better water holding capacity before freezing, larger ice crystals and higher drip loss were observed in these gels after frozen storage. The disulfide bond content decreased in both direct heated gels and two-step heated gels, but greater changes were observed in two-step heated gels. The breaking strength of direct heated gels increased gradually with increasing time of frozen storage; however, in case of two-step heated gels, the breaking strength tended to decrease within the first two weeks, and then increased with the increasing frozen storage period. Surimi gels subjected to quick freezing were observed to have smaller ice crystals and lower drip loss. The changes in disulfide bond content and breaking strength in these gels were less than those observed with slow freezing. Furthermore, slight changes were found in surimi gels stored at lower temperatures; these gels showed fewer microstructural changes, lower drip loss, and less increase in breaking strength.

2) Granule size and water-absorbing ability of starch significantly affected the quality changes of surimi gels after freezing and thawing. Potato and wheat starches with larger granule sizes could absorb much more water and had a higher water-absorbing ability during the thermal processing of surimi gels, which caused the formation of larger ice crystals, more structural damage, more drip loss, and textural changes after freezing and thawing.

3) Addition of native sweet potato starch with low pasting temperature (NSL) could improve the gelling quality of surimi gels after freezing. Before freezing, both sweet potato starch-surimi gels showed a similar microstructure, expressible drip and texture profile parameter values, because of the similar water-absorbing ability of both starches. However, after freezing, surimi gels containing NSL contained smaller ice crystals after freezing and showed less structural damage after thawing than those with ordinary native sweet potato starch (NS). Significantly lower total drip loss was observed in NSL-surimi gels. And the addition of NSL could retain the physical properties without an increase in hardness. Moreover, quick freezing method caused smaller ice crystals to form than those in slow freezing method. This could maintain the globular shape of starch granules as same as before freezing, which resulted in lower drip loss and better texture properties. Large degree of microstructure changes was observed in the surimi gels with slow freezing method, with the starch granules deformed and unevenly distributed around the ice crystals or voids.

4) The procedure of "setting-freezing-reheating" (SFR) can effectively reduce the quality changes of frozen starch-surimi gels. Larger size of ice crystals after freezing, greater damage of

microstructure after thawing and higher total drip loss were observed in the control gels subjected to SFR. However, due to the un-gelatinized starch granules before freezing and gelatinization after reheating, starch-surimi gels subjected to SFR showed the less structural damage, smaller void size and total drip loss. The results indicated that procedure of SFR can effectively reduce the quality changes of frozen starch-surimi gels.

These findings, if generally applicable to frozen surimi-based products, may have important implications for the frozen food industry.