

Molecular structure study of gelatinized and retrograded Domyoji-ko, Potato starch, and Wheat starch by NIR and IR spectroscopies

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Abstract

The molecular structure of Domyoji-ko, which is made from gluey rice, was investigated by means of NIR and IR spectroscopies. The intensity of a band at 4770 cm^{-1} in NIR spectra is decreasing with increasing of heating time, indicating that the hydration structure has been changed by heating process of Domyoji-ko with water. The NIR and IR spectra of Domyoji-ko in cooling process after enough heating with water were almost identical each other, suggesting that the Domyoji-ko is hard to retrograde. The NIR and IR studies on gelatinization and retrogression of potato starch and wheat starch have also been performed.

Keywords: amylopectin, gelatinization, retrogression, Domyoji-ko, potato starch, wheat starch

Introduction

The mechanisms and molecular structural changes for gelatinization and retrogression of starch are very complicated and still under discussion. Since the starch of Domyoji-ko consists gelatinized type, it is possible to eat that the mixture of Domyoji-ko with water; while the gelatinization is required in cases of wheat starch and potato starch.

To investigate the phenomenon of gelatinization and retrogression, we compared the molecular structure of Domyoji-ko, wheat starch (grain starch), and potato starch (rhizome starch).

Materials and methods

Materials

Domyoji-ko (100 % made from Japanese rice), wheat starch, potato starch were obtained by commercial products.

Sample Preparation

Domyoji-ko (50 g) and 75 ml of water were mixed in china cup. The mixture was heated by microwave oven (500 w) for 60 – 240 seconds. Small amount of obtained sample was put between two glass slides. For IR measurement, quite a small fragment of the samples were separated on a gold evaporated glass plate.

A 10 g of wheat or potato starch was mixed with 100 g of water in pan of aluminum. The

mixture was stirred by spatula until each gelatinized temperature, then boiling down to 10 % weight concentration. Small amount of obtained samples were put between two glass slides. One of each sample was kept in a refrigerator for 4 weeks.

Spectral Acquisition

The System 2000 NIR/FT-Raman (Perkin Elmer) spectrometer was used for NIR measurements. The NIR spectra were accumulated in the region of 15000 – 4000 cm^{-1} with 4 cm^{-1} resolution at room temperature.

The IR spectra were measured by Spectra One FT-IR (Perkin Elmer) equipped with Microscope apparatus. The spectra measurements were carried out by reflection mode, in the region of 4000 – 400 cm^{-1} with 4 cm^{-1} resolution, and at room temperature.

Results and discussion

Figure 1 compares NIR spectra of Domyoji-ko with water heated for 60 – 240 seconds. The intensity of a band at 4770 cm^{-1} , assigned to combination of OH stretching and bending modes of the amylopectin molecule in starch, is decreasing with increasing of heating time. This result indicates that the hydration structure has been changed by heating process of Domyoji-ko with water. The NIR and IR spectra of Domyoji-ko in cooling process after enough heating with water were almost identical each other, suggesting that the Domyoji-ko is hard to retrograde.

Figure 2 shows the IR spectra of gelatinized Domyoji-ko, wheat starch, and potato starch. While these spectra were almost identical each other, the feature about 1080 cm^{-1} is vary between Domyoji-ko and starches. This result may suggest that the hydration structure in Domyoji-ko is differ from the other starches.

Conclusion

NIR spectroscopy has high potential for study on structural changes of hydration between water and starch molecules of Domyoji-ko.

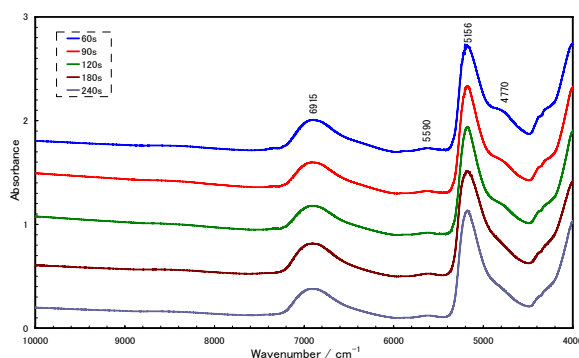


Figure 1. NIR spectra of Domyoji-ko heated with water.

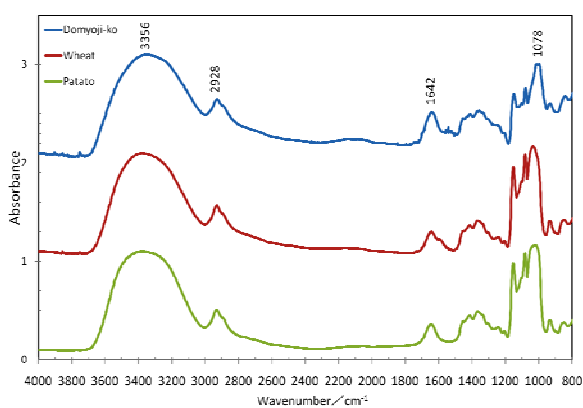


Figure 2. IR spectra of gelatinized Domyoji-ko, wheat starch, and potato starch.