Measurement of Starch by DSC

When heated together with water, starch absorbs the water and expands. Through continued heating, the starch particles will ultimately breakdown and dissolve. This is referred to as the “gelatinization” phenomenon. The progress of the gelatinization process is strongly related with the interaction between water and starch. In the process of gelatinization, water is took into the molecular structure of the starch as “bound water.” The melting point of bound water is below 0˚C, and it also varies depending on the strength of the interaction between water and starch.

When the gelatinized starch is cooled, the starch molecules dispersed in water recrystallizes and separates from the water. This phenomenon is referred to as the “retrogradation of starch.” In the initial stage of the retrogradation process, amyloses, which easily crystallize, retrogradate first, and then the retrogradation of amylopectins proceed over a longer period.

Using the DSC-60 with the TAC-60i cooling unit, we analyzed the gelatinization process of various types of starch, and also analyzed the changes in the melting points of bound water in potato and sweet potato starches depending on the progress of retrogradation.

Fig.1 DSC-60

■ Analyzing Gelatinization in Various Starches by DSC-60

Various types of starch were placed in aluminum seal cells, water was added and the temperature was increased at the rate of 5˚C per minute. We observed that the gelatinization occurs at different temperatures depending on the type of starch.

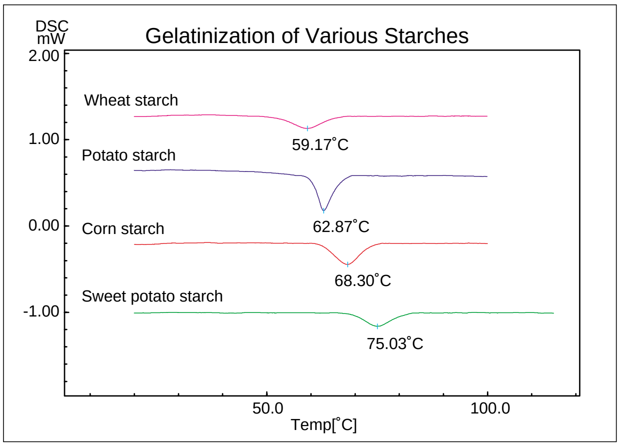

Fig.2 Gelatinization of Various Starches

■ Influence of Salt (NaCl) on Gelatinization

Wheat starches mixed with 2% and 10% NaCl aqueous solution respectively were heated at the rate of 5˚C per minute. We observed that the endothermic peaks caused by gelatinization shifted to higher temperature with increasing salt concentration.

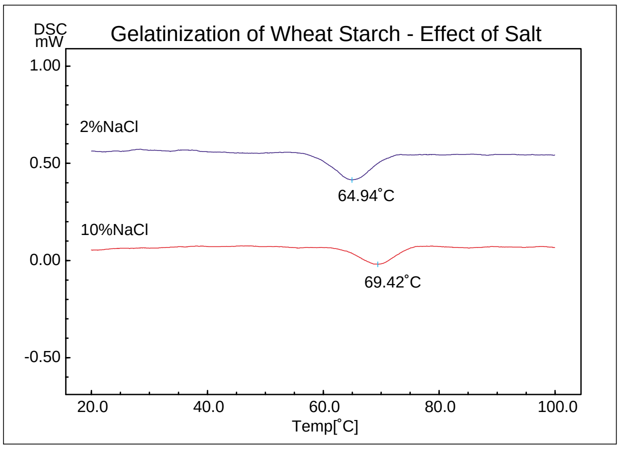

Fig.3 Effect of Salt on Gelatinization of Wheat Starch

■ Measurement of Bound Water during Retrogradation of Sweet Potato and Potato Starches

[Sample Preparation]
The starches were placed in aluminum seal cells and water was added so that its weight ratio was 0.4. The potato starch was kept at 80˚C for two minutes, and the sweet potato starch at 95˚C for two minutes for gelatinization. The samples were then stored at 5˚C for a fixed period.

[Measurement]
The samples were cooled to -45˚C using the TAC-60i cooling unit, and then heated at the rate of 2˚C per minute up to 30˚C.

[Results]
In Fig.4, the peaks at -5.94˚C and 0.19˚C observed immediately after the gelatinization are due to bound water and free water, respectively. The two peaks are clearly separated.
In Fig.5, where the sweet potato starch was stored for three days, the peak of the bound water is observed at -4.57˚C, 1.37˚C higher compared with the corresponding peak in Fig.4. Here separation from the free water peak is comparatively poor.
Similar results are observed in Fig.6 and 7, where potato starch was analyzed immediately after gelatinization and after being stored for three days.
As confirmed above, the melting temperature of the bound water increases with the progress of retrogradation and the peak due to the bound water is gradually overlapped by the peak of free water at around 0˚C.

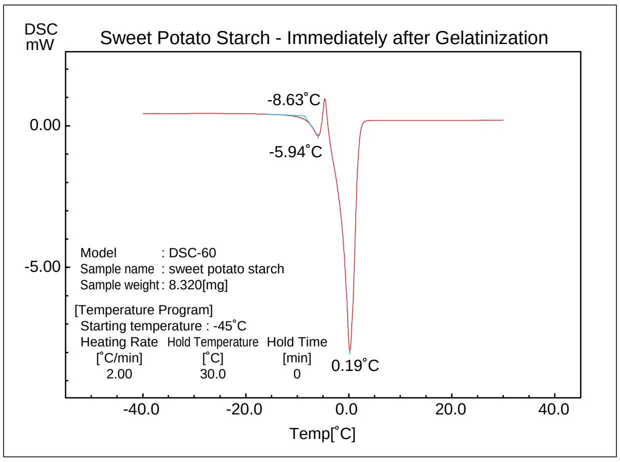

Fig.4 DSC Measurement Result for Sweet Potato Starch Immediately after Gelatinization

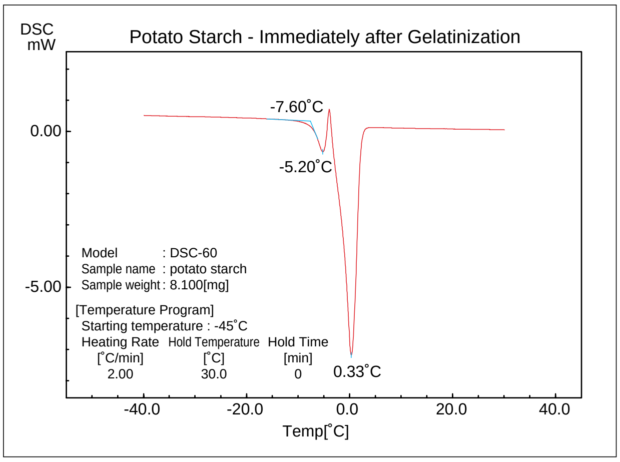

Fig.6 DSC Measurement Result for Potato Starch Immediately after Gelatinization

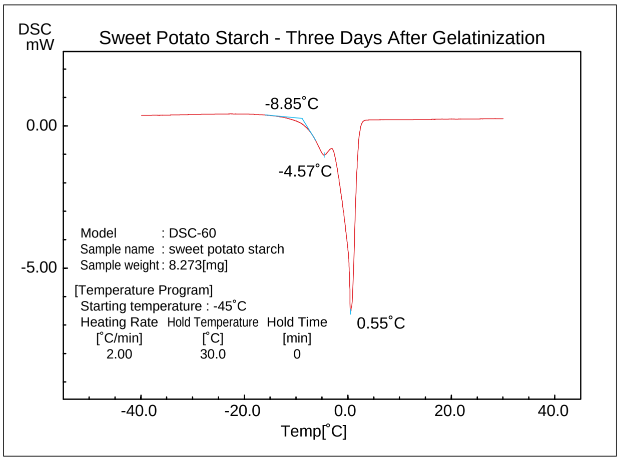

Fig.5 DSC Measurement Result for Sweet Potato Starch Three Days After Gelatinization

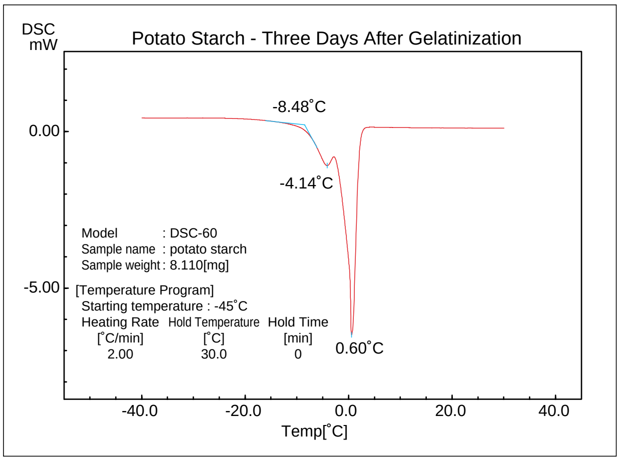

Fig.7 DSC Measurement Result for Potato Starch Three Days After Gelatinization

SHIMADZU

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