
The effect of lipase and glucose oxidase on the retrogradation of starch in frozen cooked rice

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We previously reported that adding lipase (Lip) or glucose oxidase (GO) to cooked rice reduced the retrogradation of starch in cooked rice during frozen storage. It has been hypothesized that an enzymatic reaction promotes the formation of the intermolecular S-S bonds of proteins in rice grains, thus inhibiting water absorption by starch and reducing its retrogradation. This study aimed to verify this hypothesis.

For this study, 150 g of rice, produced in Japan in 2018, was mixed with 200 U of Lip and/or 1.5 U of GO and 202.5 g water then heated in an electric rice cooker. The cooked rice sample was stored in a freezer or a refrigerator. The peak area at $2\theta = 17^\circ$ on the X-ray diffraction diagram of the rice sample defined the degree of starch retrogradation. The contents of free SH groups in the rice protein were measured using a modified Ellman method and also in rice samples to which catalase had been added before cooking.

The content of free SH groups in rice samples with added Lip or GO tended to decrease in 4-20 and 2.5-5 min from the start of cooking, respectively, indicating that S-S bonds had been formed during those periods. Adding catalase, which catalyzes the decomposition of hydrogen peroxide, significantly increased the content of free SH groups in the samples with added GO, suggesting that the hydrogen peroxide generated in the presence of GO had promoted the oxidation of the SH groups and the formation of S-S bonds. The S-S bonds of rice proteins in rice samples with added Lip started to be formed at the gelatinization temperature, which suppressed the breakdown of starch granules due to excessive water absorption and thus reduced starch retrogradation during freezing. The S-S bonds of rice proteins in the sample with added GO began to be formed before the starch began gelatinizing, thus inhibiting water absorption during the gelatinization process and reducing starch retrogradation during freezing. Overall, the stage at which S-S bonds were formed in the proteins in rice grains affected the degree of starch retrogradation during freezing.