EXTENDING THE SHELF LIFE OF READY-TO-EAT FOODS BY INHIBITION OF THE GROWTH AND STAPHYLOCOCCAL ENTEROTOXIN A (SEA) PRODUCTION OF *STAPHYLOCOCCUS AUREUS*

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I. OBJECTIVES

Staphylococcus aureus has been recognized as one of the food poisoning bacteria related to poor food handling. Staphylococcal food poisoning (SFP) occurs in various foods such as meat products, dairy products, and other processed foods in the world. In Japan, SFP occurs in ready-to-eat meals such as rice balls and lunch packs. To prevent SFP, it is important to inhibit the growth and staphylococcal enterotoxin A (SEA) production by *S. aureus* in ready-to-eat meals during retail storage. The purpose of this study was to clarify the effects of storage factors on growth and SEA production in cooked rice to extend the shelf life of ready-to-eat meals.

II. MATERIALS AND METHODS

To examine the effects of inoculum size and incubation temperature, we used the SEA-producing strains of *S. aureus*, respectively inoculated at the rate of about 10^2 or 10^6 CFU/g in cooked rice, and incubated at 15°C–37°C. To examine the effects of pH, glycine, and sodium chloride (NaCl), we used cooked rice, which was adjusted to a final pH of 4.0–6.3 with acetic acid. Glycine (0.5%–5%, w/w) or NaCl (1%–7%, w/w) was then added into cooked rice before inoculation with *S. aureus* at the rate of 10^6 CFU/g and incubated at 37°C. To screen for seasonings that are effective in inhibiting SEA production, 80 types of commercial seasonings were added to 1.5% NaCl-added rice, inoculated with *S. aureus* and incubated at 37°C. The concentrations of SEA were estimated by a Western blot analysis using the enhanced chemiluminescence method. The detection limit in cooked rice was ca. 400 pg/g.

III. RESULTS

As incubation temperature decreased from 37°C to 15°C, the growth and SEA production of *S. aureus* strains were decreased in cooked rice, while the time needed to produce SEA was prolonged. At the early stage of preservation, SEA detection required a longer time with inoculum size of 10^2 CFU/g than 10^6 CFU/g in cooked rice at 37°C. In cooked rice to which 2%–5% glycine and 3%–7% NaCl were respectively added, growth and SEA production of *S. aureus* strains were decreased, and the time needed to produce SEA was prolonged during the early stage of preservation. SEA production was inhibited at the early stage of preservation in cooked rice at pH 4.0 and 4.5. In particular, SEA production was inhibited at pH 4.0 even after 24 h of incubation at 37°C. Among the 80 seasonings added to 1.5% NaCl-added cooked rice, vinegars, lemon extract, Worcestershire sauce, mustard paste, rose hip tea, and pickled plum (*umeboshi*) paste were effective in inhibiting SEA production, even after 48 h of incubation at 37°C. SEA production seemed to be affected not only by

NaCl but also by food ingredients and pH of the commercial seasonings because the pH of these cooked rice was as low as 3.5–4.5.

IV. CONCLUSION

Scientific regulation and control by reducing food contamination (inoculum size), adding glycine, NaCl, and commercial seasonings as well as pH adjustment were effective for extending the shelf life of cooked rice. It is expected that the methods of scientific regulation obtained in this study will be applicable to meat products as well.

Keywords: food poisoning, processed food, shelf life, staphylococcal enterotoxin A