Sterilization effect of electrolyzed water on rice food

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Recently, a lot of instant foods have been made from rice. The main categories are aseptic packaged rice and rice cookies. In this food process, the control of microorganisms, especially heat-resistant spores from raw materials to products, is the most important point to confirm safety in product flow. If the heat-resistant spores can be controlled by pretreatment before cooking, excess heat should be omitted to make long shelf-life rice products, thus improving the quality of the products. Several papers have demonstrated the sterilization effects of electrolyzed water on food ingredients (Koseki et al 2004a,b).

In this paper, we try to confirm the sterilization effect on rice using electrolyzed water and check the quality of rice during pretreatment.

Materials and methods

Electrolyzed water is produced by electrolyzing tap water with the addition of a small quantity of NaCl. Acidic electrolyzed water (AcEW) created at the anode has been observed to have sterilization effects on microorganisms, and alkaline electrolyzed water (AlEW) created at the cathode has been observed to have a rinsing effect on organic compounds. In Japan, AcEW already was approved as an indirect food additive in 2002. The principle of electrolyzed water is shown in Figure 1.

We used a flow-type electrolyzed water producer (Rox-20TA: Hoshizaki Electric Co., Japan). This apparatus generates electrolyzed water by the electrolysis of a dilute (0.1%) saline solution in an electrolytic cell separated into an anode and cathode region with a diaphragm. The current passing

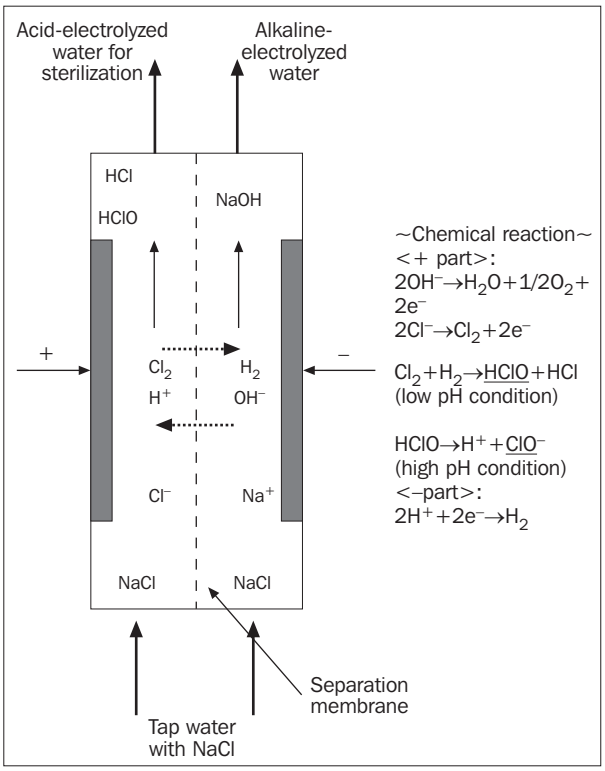

Fig. 1. Principle of acidic electrolyzed water. Left: process flow of apparatus, right: chemical reaction during electrolyzing process.

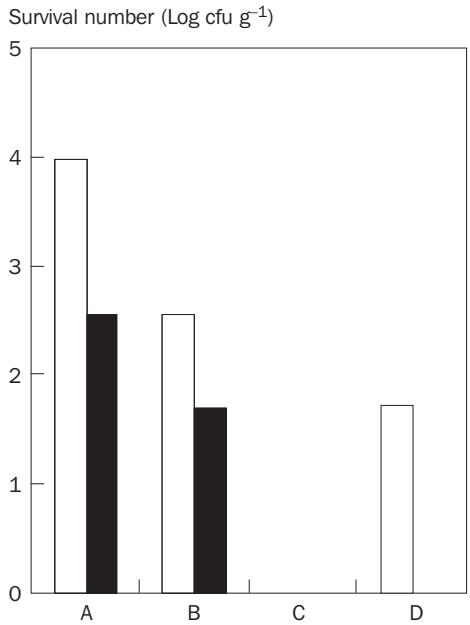

Fig. 2. Sterilization effects of combination of electrolyzed water on rice preparation. (A) Control rice, (B) washing with AlEW (5 min), (C) soaking with AcEW (30 min) after B treatment, (D) soaking with D/W (30 min) after C treatment.

through the electrolysis apparatus and voltage between the electrodes were set at 14A and 18V, respectively. AcEW was prepared within the anode region of the electrolytic cell, and AlEW was prepared within the cathode region. The physicochemical properties of electrolyzed water are as follows:

- AcEW: pH 2.7, oxidation reduction potential (ORP) 1,481 mV, available chlorine concentration 51.5 ppm.
- AlEW: pH 11.6, ORP –576 mV.

We used distilled water as a control processing solution.

Polished rice (Kinuhikari) was purchased and used as a sample. Prepared *Bacillus subtillis* PCI219 was used as a heat-resistant spore sample.

Some 1 mL of spore solution (10^9 cfu mL) was added to 9 mL of AcEW and mixed. The sample was collected from the mixed solution every 1 min and the survival number counted in each sample after cultivation.

Some 100 g of polished rice were prepared for each preparation test. We devised a preparation process with 3 stages (washing: 5 min, soaking 1 ½ min, soaking 2 ½ min). We used AcEW, AlEW, and distilled water, respectively, as each stage solution. pH and color of rice were measured by a conventional pH meter and color meter.

To confirm the microorganism control effect, we added the *B. subtillis* spore into the rice and we counted the survival number in each sample of the preparation test.

Results and discussion

We examined several tests to prove the influence on the microorganism and the change in the raw rice.

AcEW and AlEW changed the color and pH of rice rapidly. But, when the rice was treated with a combination of electrolyzed water (washing with AlEW, soaking with AcEW, and soaking with distilled water), pH and color of the treated rice were no different from conventional washing and soaking with distilled water.

AcEW showed a strong effect on microorganism control, even on heat-resistant spores in vitro. However, in the rice preparation test, AcEW could not kill *B. subtillis* spores on the rice completely. But, after washing by AlEW, AcEW could kill completely. So, finally, we set the optimum method of combination of electrolyzed water as follows. To remove rice bran powder and other foreign materials that coat the surface of the raw rice, at first we washed the rice with AlEW for 5 min and soaked it with AcEW to sterilize microorganisms for 30 min. Then, to remove the odor of chlorine and to revert the pH level, we resoaked the rice with distilled water for 30 min. Figure 2 shows the effects against microorganisms using the combination process of each electrolyzed water.

In this experiment, we could confirm the effect of the combination of electrolyzed water on microorganism control. This effect can be considered the result of available chlorine concentration and the rapid change in pH and it raises the sen-

sibility on the microorganism. From this experiment we can see the importance of the contact condition of the microorganism with the electrolyzed water, which increased the effect of sterilization.

We concluded that the combination of electrolyzed water for rice preparation before cooking (washing and soaking) is efficient in reducing heat-resistant microorganisms; therefore, this process will be able to help make rice products with a long shelf-life without excess heat treatment to keep the quality of these products.

In this experiment, we did not evaluate the quality (texture, flavor, chemical components, and so on) of the cooked rice. We must consider this quality before introducing this pretreatment.

References

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Notes

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