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A NEW APPROACH OF RICE PROCESSING FOR CONTROL OF COMPOUND CONTENTS AND EATING QUALITY OF COOKED RICE

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ABSTRACT Rice is one of the major commercial cereal grains. Unlike most cereals, rice is purchased as raw grain, and consumed as a steamed or boiled product. The ordinary process of rice cooking, which consists of adding water, boiling and post-heating, is very simple so that, generally, the quality of raw rice is important for its end products “cooked rice”. In this study, a new approach for rice quality control using changes in the grain tissue during processing was determined. During boiling, the formation and structure of grain tissue was changed or disrupted, this occurred by gelatinization of starch. Relation with such formation changes eluted compounds in the cooking water that were condensed by degrees, because the water was absorbed by the grain or evaporated during boiling. After boiling, the eluted compounds would coat surface of cooked grains. Because these complex changes occurred step by step, for example, the included enzyme related with eating quality was eluted in the early stage of boiling and the starch content was mainly eluted in the middle stage. To apply these changes, the compound content control and eating quality improvement for cooked rice products can be carried out by regulation of cooking water contents. The sensory test indicated that the controlled cooked grains had better eating quality.

Keywords: Rice, Tissue, Histological Structure, Boiling, Cooking Water

INTRODUCTION

In general, structures of foodstuffs are changed during processing and/or cooking in which includes heating process. The tissue of the grain of rice is also changed during cooking (Ogawa et al, 2005). In the process, the cell matrix of the grain must be destroyed and the constituents maintained in the cells are eluted in the cooking water. These phenomena should be affected by gelatinization of starch.

Relation with such structural changes, the eluted compounds in the cooking water are increased, and condensed because the water is absorbed by the grain or evaporated during boiling. The eluted compounds will become the material for surface coating of cooked grains and affected to textural properties of cooked grains (Ogawa et al, 2006).

In this study, in order to develop a new approach for cooking process of rice with control of compound contents and eating quality of the cooked rice, the process was arranged and resulted cooked materials were observed by microscopy and evaluated by sensory test.

MATERIALS AND METHODS

1. Materials Whole grain rice samples (*Oryza sativa* L., cv. Toyonishiki) were obtained from material harvested in 2007 in Akita, Japan. The grains were stored in a refrigerator at 5 °C and milled by rice polishing machine (BT-AE05 Zojirushi co., Osaka) before experiment.

2. Cooking procedure A modified experimental cooking procedure by means of beaker was applied to the milled rice samples. 75 grams of milled rice was soaked in 100 ml of water at 25 °C for 30 min for water absorption. Soaked rice with the water was preliminary heated at 50 °C for 20 min for included enzyme reaction such as amylase reaction. In this stage, a part of water was removed and kept for arranged cooked rice procedure at the end of the stage. After pre-heating, boiled water was added and the rice was boiled for 8 min (see figure 1). In this stage, the suitable amount of boiled water was removed and/or exchanged to the kept water as an arranged cooking procedure. Therefore, a part of constituents in the cooked rice eluted in the water could be removed by this process. After boiling, the cover on the top of the beaker within the boiled rice was kept the lid on for 10 min. Then the cooked rice was tested by sensory evaluation.



Figure 1. Photographs of rice cooking while boiling.

3. Microscopy The histological sections of the cooked samples were obtained by means of simple sectioning method (Ogawa et al, 2003). Samples were dehydrated in a graded ethanol series (30%, 40%, 50%, 60%, 70%, 80%, 90%, 95% x 2, 100% x 2) followed by lemosol reagent (Wako Pure Chemical Industries, Ltd., Osaka, Japan), which is an alternative of xylene, 1 day per step at 22 °C. The samples were transferred to melted paraffin at 70 °C and allowed to infiltrate for 1 day. The resulting paraffinized samples were placed into embedding molds with additional paraffin and chilled to allow for quick hardening of the paraffin. Before the paraffin was completely hardened, the microtome chuck was gently placed on top of the mold in order to secure the specimen for sectioning. Embedded samples were sectioned using an ordinary microtome (SM2000R, Leica,

Germany) with disposable blades (Feather S35 type) at ambient temperature and collected using adhesive tape (Toshiba Machine Co., Ltd., Japan). The section thickness was 20 µm and the tape plus section was adhered, face up, using another piece of tape to a glass slide. The paraffin was removed by treating with lemosol for 1 hour and the section was mounted in immersion reagent (MP500, Matsunami Glass Ind., Ltd., Osaka, Japan). Sections were captured by a digital camera (DS-5M-L1, Nikon, Japan) mounted on a fluorescent stereomicroscope (MZ-FLIII, Leica, Germany). The microscope equipped with a 100 W mercury arc lamp (ebq 100 dc, Leica, Germany) and a UV fluorescence filter set (Excitation filter 360/40 nm, Barrier filter 420 nm). All parameters of the imaging process such as focusing, lighting and shuttering were standardized for each section. Obtained digital images were inverted to gray scale images in this report.

4. Sensory test The cooked rice products had been done the sensory test. The 6 panels in twenties were employed, and they evaluated eating quality of cooked products by five graded points. The higher point shows good quality for the panel.

RESULTS AND DISCUSSION

1. Microstructures of cooked rice products Figure 2 shows longitudinal sections of the cooked rice grains with different cooking procedures. The sections (a, b) were from the grain of which cooked water was arranged. The sections (c, d) were from the grain of which cooked by ordinary cooking process. The voids account for most of the deformation and swelling of the grain during cooking and are probably the result of rapid pressure build up and subsequent expansion or localized explosion within the grain. Cell disruption by boiling can be determined each sample. Broken cell walls and a void were shown in the section indicating that the cells have expanded to the point where the cell wall was ruptured. The cells around outer area had been disrupted, therefore the inner contents should be eluted in cooking water. The coated surface was shown in the magnifications. The outstanding differences were not appeared each sample images.

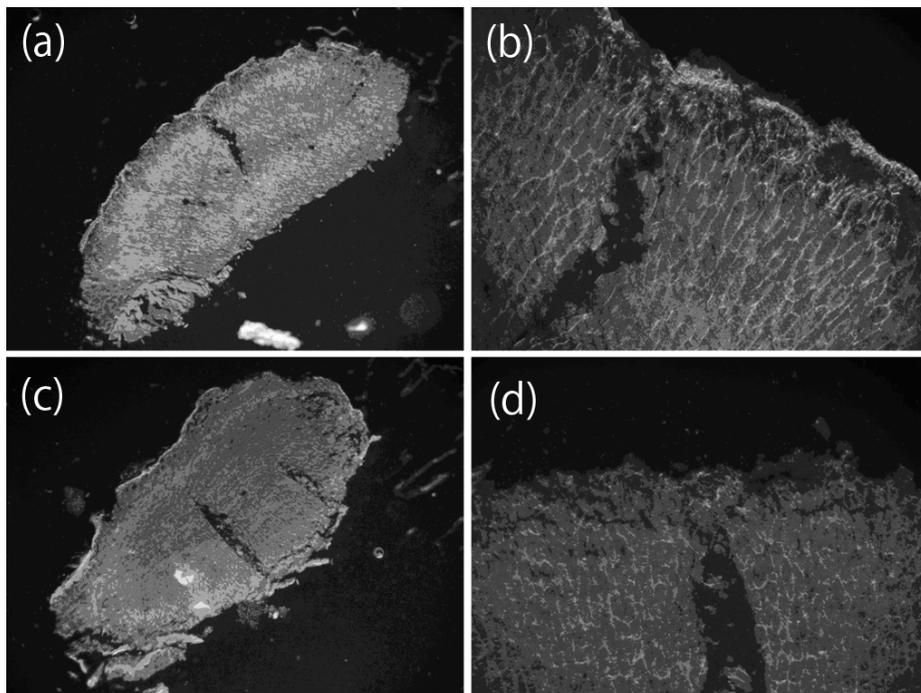


Figure 2. Microstructures of cooked rice samples. Constituent controlled cooked grain (a) and its magnification around outer area of the grain (b). Ordinary cooked grain (c) and its magnification around outer area (d).

2. Sensory evaluation To evaluate the arranged cooking procedure, simple sensory test was applied to the resulted cooked rice products. Figure 3 shows averaged sensory test point of the cooked grains with different cooking procedure. The point for cooked grain by exchanging to cooked water was higher than the grain processed by the ordinary procedure. However, the grain by exchanging to distilled water as an arranged process has lower point than others. This means that the cooking water at preliminary heating process, which includes a lot of constituents, should affect eating quality of cooked rice.

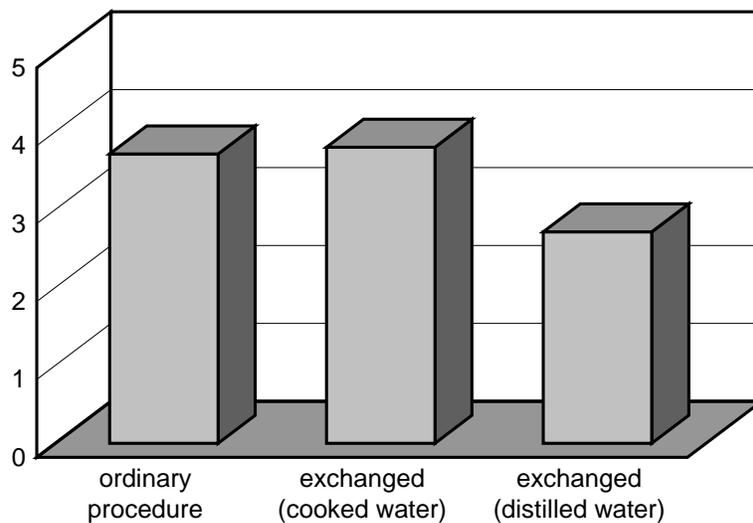


Figure 3. Points of sensory evaluation for cooked rice with different cooking procedures.

CONCLUSION Compound distributions in a grain of rice are not uniformity (Ogawa et al. 2001). So that the compound contents of cooking water which is from elution of grain should be changed successively during boiling. Therefore, the compound control for cooked rice grain could be carried out by arranged cooking procedure which contains removing of suitable amount of boiled water and/or exchanging to cooked water during boiling. The eating quality can be increased by the exchanging method. Low calorie and/or low protein content cooked rice may also be produced by such cooking procedure.

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