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Evaluation of viscoelastic properties and air-bubble structure of bread containing gelatinized rice

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Abstract

The impact of addition of gelatinized rice porridge to bread has been investigated on loaf volume, viscoelastic properties and air-bubble structure. We prepared four variety of bread: bread containing rice porridge (rice porridge bread), bread containing gelatinized rice flour (gelatinized rice flour bread), and wheat flour and rice flour breads for references. Instrumental analyses the bread samples were carried out by volume measurement of loaf samples, creep test and digital image analysis of crumb samples. Rice porridge bread showed the maximum specific volume of 4.51 cm^3/g, and even gelatinized rice flour bread showed 4.30 cm^3/g, which was larger than the reference bread samples (wheat and rice flour breads). The values of viscoelastic moduli of gelatinized rice flour bread and rice porridge bread were significantly smaller ($p < 0.05$) than those of wheat flour and rice flour breads, which indicates addition of gelatinized rice flour or rice porridge to bread dough encouraged breads softer. Bubble parameters such as mean air-bubble area, number of air-bubble, air-bubble area ratio (ratio of bubble area to whole area) were not significantly different among the bread crumb samples. Therefore, the bubble structures of the bread samples seemed to similar, which implied that difference of viscoelasticity was attributed to air-bubble wall (solid phase of bread crumb) rather than air-bubble. This study showed that addition of gelatinized rice to bread dough makes the bread with larger loaf volume and soft texture without additional agents such as gluten.

Selection and/or peer-review under responsibility of 11th International Congress on Engineering and Food (ICEF 11) Executive Committee.

Keywords: rice bread: gelatinization; porridge; air-bubble structure; viscoelastic property

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1. Introduction

Recently, making bread containing rice flour (rice flour bread) have been suggested as a newly method to make use of excessive rice in Japan. However, the quality of rice flour bread has been reported to be inferior to that of wheat flour bread, because its dough expansion is lower and the texture is harder than wheat flour bread. Okunishi[1] reported that adding cooked rice to bread dough could make high-quality bread with high volume and soft texture. One of the differences between rice flour and cooked rice is the degree of gelatinization. Several process patents are registered about manufacturing of bread by adding gelatinized rice (gelatinized rice flour, or rice porridge) to bread dough. Thus, adding gelatinized rice or rice to bread dough would have a possibility to effect texture, or physical properties of bread. However, no scientific data has not been reported about relationship between gelatinization of rice and bread quality.

The objective of this study is to investigate the effect of addition of gelatinized rice porridge on bread qualities of loaf volume, viscoelastic properties and air-bubble structure.

2. Material and Methods

Bread containing cooked rice porridge (rice porridge bread), gelatinized rice flour (gelatinized rice flour bread), wheat flour (wheat flour bread) and rice flour (rice flour bread) were prepared. Table 1 shows the ingredients of bread samples. In this study, substitution ratio of rice flour and rice to wheat flour in each sample was defined as 15 % of all the amount of flours (or cereal). Gelatinized rice flour was made by adding of water to rice flour and then heated by using microwave oven for 5 minutes. Meanwhile, rice porridge was made with rice cooker. They were mixed with other ingredients after cooled to room temperature.

Table 1. Ingredients of bread samples

			unit: g	
Ingredients	**WFB**	**RFB**	**GRFB**	**RPB**
Wheat flour	**1000**	**850**	**850**	**850**
Rice flour		**150**	**150**	
Rice				**150**
Water (mixed with gelatinized rice flour or rice)			**586**	**546**
Water (mixed with ingredients)	**690**	**690**	**104**	**144**
Sugar	**60**			
Salt	**20**			
Skimmed milk	**20**			
Shortening	**50**			
Dry yeast	**10**			

WFB: wheat flour bread, RFB: rice flour bread, GRFB: gelatinized rice flour bread, RPB: rice porridge bread

The breads were made based on straight method. Ingredients except shortening were mixed by use of bread mixer (KTM-10, Kanto Kongouki Industrial Co., Ltd., Tokyo, Japan). After adding shortening, the dough was mixed until its temperature reached to 27℃. Next, the dough was fermented in a dough conditioner (NS-D923FA, Matsushita Electric Industrial Co., Ltd., Osaka, Japan) at 27℃ in 75 % RH for 80 minutes. After the dough was divided into 420g ×4 and rounded, floor time (27℃, 75 %RH, 25 minutes) was ensured in the dough conditioner prior to rolling of the doughs into thickness of 4.5 mm by use of a molder (WR-01, Oshikiri Machinery Ltd., Kanagawa, Japan). The rolled doughs were set in pans and fermented in a proofer (toku hoiro, Tokura Shoji Co., Ltd. Shiga, Japan) at 38℃ in 85 %RH for about