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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation　Effect of D-allulose on fermentation of bread dough, and physicochemical, and organoleptic properties of bread
（パン生地の発酵およびパンの物理化学的性質と官能特性に及ぼすD-アルロースの影響）

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Bread is a staple food in many countries due to it is a convenient product serving with nutrients. Bread is produced from dough which is a mixture of wheat flour, salt, yeast, and water as the fundamental ingredients. Sugar, here is defined as monosaccharides and disaccharides, is frequently added to bread as an additional ingredient, which improves the quality of the bread in term of bread appearance, texture, flavor and storage stability. However, the effects of sugar on the bread quality greatly alters the type of sugars to add.

Rare sugar D-allulose (Alu), the C-3 epimer of D-fructose (Fru), has much lower calories than Sucrose (Suc) and shows several diseases-preventing effects such as anti-obesity and anti-diabetic. Furthermore, it is reported to become better textural and flavor properties to some foods. However, there is little information on the application of Alu on bakery foods with fermentation. This study aimed to investigate the effect of the addition of Alu as ingredient on bread processing and bread quality.

Chapter 2 investigated the effect of Alu as bread ingredient on processing properties and texture of bread. First, the effects of Alu on the fermentation of bakery yeast was investigated. Alu as carbon source was not utilized much by the yeast, but it inhibited yeast respiratory by D-glucose (Glc) or D-fructose (Fru), resulting in the low CO_2 generated by yeast fermentation, indicating that Alu partially inhibits dough fermentation. On the other hand, Alu did not affect the rheology properties of gluten. The hardness and gumminess were higher in Alu-bread than in sugar-free and Suc-bread. In addition, 94% of Alu remained in bread. The hardness of Alu-bread changed the least during storage. The present study clearly suggests that the use of Alu as a sugar material is not preferable in term of texture, but confers a health function to bread and prevents bread hardening.

Chapter 3 assessed the physical, chemical and sensory characteristics of bread in which 25%, 50%, 75% and 100% of Suc was replaced by Alu. The replacement of up to 75% of Suc by Alu did not differ from 100% Suc-bread in bread appearances; loaf height, volume and color texture properties. Breads in which up to 75% of Suc were replaced by Alu had similar hardness values to

100% Suc bread. Breads with the higher ratio of Alu substitution had stronger roasted and caramel-like odors and lighter alcoholic odors than 100% Suc-bread. Hedonic sensory results suggested that 100% Alu-substituted bread had a lower score in a preference test, while up to 75% Alu-substituted bread was equivalent to bread using traditional sugar, Suc.

In chapter 4, rare sugar syrup (RSS), a commercial syrup containing Alu, was applied to the bread making and the quality of the final bread products were compared to that of breads added with high fructose corn syrup (HFCS) and Suc syrup (SS). The addition of 2°Brix (Bx) RSS to bread did not show any differences on bread physical and texture properties from other breads. While, the addition of 20°Bx RSS resulted in reductions in loaf height and volume, moisture content, and a_w and increases in hardness and gumminess of bread crumb. Organoleptic analysis showed that RSS-bread had stronger roasted odor and lighter fermented odor than HFCS bread. 20°Bx RSS-bread was acceptable in overall preference similar to 20°Bx HFCS-bread. Furthermore, Alu was remained with relatively high rate in 20°Bx RSS-bread.

To be concluded, the 100% replacement of Suc in bread materials, significantly with Alu alters physicochemical and texture properties of bread. Alu had negative effect on bread texture and reduced the consumer acceptability of the bread. This is mainly due to the inhibition of yeast respiratory. Whereas, the partial replacements (25, 50, and 75%) of Suc with Alu do not inhibit CO_2 production, results in no large difference with 100% Suc bread in terms of bread texture. Bread with the low brix (2°Bx) RSS did not show a negative impact on the bread texture similarly to the breads replaced a part of Suc with Alu. To sum up, for developing bread with high quality in texture and flavor, fermentable sugars, such as Suc and Glc should be formulated to Alu. Moreover, the addition of Alu gives bread advantages in term of health benefits and storage stability.