

Effects of Fermentable Sugar Derived from Bunashimeji Mushroom on Fermentation in Bread Processing

Tokumitsu Okamura, Kazumi Hamada, Nobuko Okuda and Masahiro Ohsugi

*Department of Food Science and Nutrition,
School of Human Environmental Sciences,*

Mukogawa Women's University, 6-46, Ikebiraki-cho, Nishinomiya 663-8558, Japan

The addition of bunashimeji affected gas production in baker's yeast. After 4 hours of incubation, total gas production increased about 1.8 times that of standard dough, and a few large holes and many small holes appeared on top of the dough containing bunashimeji after 6 hours of incubation. Gas production increased with increasing consumption of glucose in bunashimeji. The addition of bunashimeji to wheat flour increased production of low molecular weight sugar (fermentable sugar). Therefore, we concluded that adding bunashimeji to white bread dough provided nutrients as fermentable sugar for the yeast. This resulted in excessive initial production of gas forming holes upon exiting the dough, and reducing the volume of the dough as a result. Consequently, dough in which holes were formed on top was broken before oven baking, and loaf volume and specific loaf volume of the bread containing 5% bunashimeji was markedly decreased when an automatic bread baker was used.

Introduction

Many attempts have been made to popularize bakery products because they are easy, convenient and an inexpensive means of taking in hygienically prepared, ready-to-eat nutrition¹⁾⁻⁵⁾.

Shiitake, enokitake, maitake, bunashimeji, kikurage and nameko are edible mushrooms, of which commercial cultivation has begun in many countries⁶⁾⁻⁹⁾. Mushrooms are rich in fiber, and thus could be used in fiber bread processing.

We previously reported various kinds of mushroom breads in which fiber-rich mushrooms were added to wheat flour, and the characteristics of these breads were compared with those of white bread. Because the addition of bunashimeji had effects on loaf volume, we recently reported the mechanism of gas production in mushroom bread processing^{10),11)}.

We describe herein the relationship between

fermentable sugars derived from bunashimeji and gas production by baker's yeast in mushroom bread processing.

Materials and Methods

1. Materials

Wheat flour "Kameriya" and dry yeast "Super kameria" were obtained from Nisshin Flour Milling Co., Tokyo, Japan. The flour contained of 12% protein, 1.8% lipid, 69% carbohydrate and 14.5% water. Raw bunashimeji mushrooms (*Hypsizygus marmoreus*) with a water content of 92.5% were purchased at a local market in Nishinomiya, Japan.

2. Measurement methods

The Bread Bakery SD-BT 7 (National Electric Co.), an automatic bread baker designed to sense temperature and automatically control the heating system during the entire process of baking, was used¹⁰⁾. All the steps, from mixing

to baking, were automatic. Table 1 shows the formulae of white bread and bunashimeji bread. Bunashimeji homogenized into small pieces (about 0.1 mm to 1 mm particles) were added at 5% (mushroom/wheat flour) to white bread dough, mixed, and then baked. Loaf volume was measured by rapeseed displacement.

3. Gas production and expansion

Portions of 10 g of dough, which was the same amount as in the white bread and bunashimeji bread formulae (Table 1), containing dry baker's yeast and bunashimeji, were placed in flat-bottomed tubes. The expansion of the dough in the flat-bottomed tubes was measured by determining the height of the dough during dough development (fermentation) at 30°C for 0 to 4 hours.

Table 1. White bread and bunashimeji bread formulae

	White bread		Bunashimeji bread*	
	amount(g)	ratio(%)	amount(g)	ratio(%)
Wheat flour	186.9	100	186.9	100
Sugar	11.3	6.1	11.3	6.1
Butter	7.3	3.9	7.3	3.9
Non-fat dry milk	4.0	2.1	4.0	2.1
Salt	3.3	1.8	3.3	1.8
Water	140.0	75	130.6	69.9
Dry yeast	2.0	1.1	2.0	1.1
Maitake	—	—	9.4	5
Total	354.8	—	354.8	—

* Bunashimeji homogenized into small pieces was added at 5% (mushroom/wheat flour) to dough, mixed, and then baked into bread.

4. High pressure liquid chromatography

Qualitative and quantitative analysis of the fermentable sugars from raw bunashimeji were performed by HPLC with a TSK gel Amide-80 column (4.6 I.D. X 250 mm, Tosoh Co., Japan) in a Tosoh HPLC system. The column was developed at a flow rate of 0.7 ml/min with a 20% acetonitrile at 80°C. The detection was performed by measuring the RI.

Results and Discussion

1. Making bunashimeji bread

The characteristics of bunashimeji bread, such as loaf volume, differed markedly from those of white bread. As shown in Figs. 1. and 2, loaf volume and specific loaf volume (specific loaf volume was expressed as loaf volume per gram of dough [loaf volume (ml)/weight (g)].) of the bread containing 5% bunashimeji was markedly decreased. The addition of bunashimeji to white bread caused the dough to lose its strength, and to become plastic and sticky to the touch.

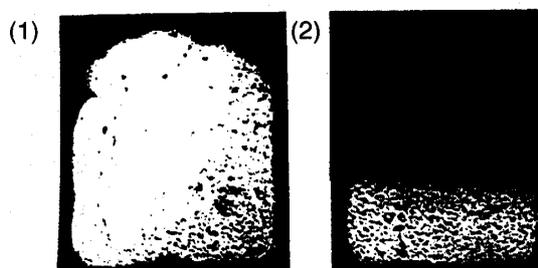


Fig. 1. Photographs of white bread and bunashimeji bread

(1), white bread (control);

(2), bunashimeji-added bread.

Bunashimeji was added at 5% (w/w) to wheat flour. Photograph shows the middle cutaway view of bread.

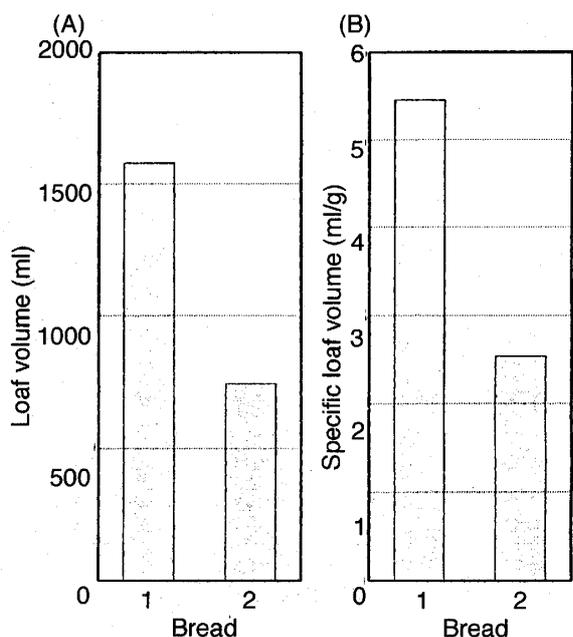


Fig. 2. Effects of the addition of bunashimeji mushroom homogenate on loaf volume(A) and specific loaf volume(B) in baking
 1, white bread(control);
 2, bunashimeji-added bread.
 Bunashimeji was added at 5% (w/w) to dough.

2. Effects of the addition of bunashimeji on gas production and dough development

As shown in Figs.1 and 2, the loaf volume and specific loaf volume of bunashimeji bread were markedly decreased compared relative to those of white bread. Therefore, the production of gas during fermentation(dough development) in mushroom bread processing was investigated.

To estimate the effects of addition of homogenized bunashimeji to white bread on gas production and dough development by alcohol fermentation, 5% homogenized bunashimeji was added to the basic dough(Table 1) with dry baker's yeast. The doughs containing 0% (without bunashimeji) and 5% bunashimeji were incubated anaerobically at 30°C.

Figure 3 shows the effects of adding the bunashimeji on gas production and dough development. The standard dough (without

bunashimeji) produced gas, but the dough containing 5% bunashimeji produced more gas by alcohol fermentation. Therefore, the addition of bunashimeji affected the gas production of baker's yeast.

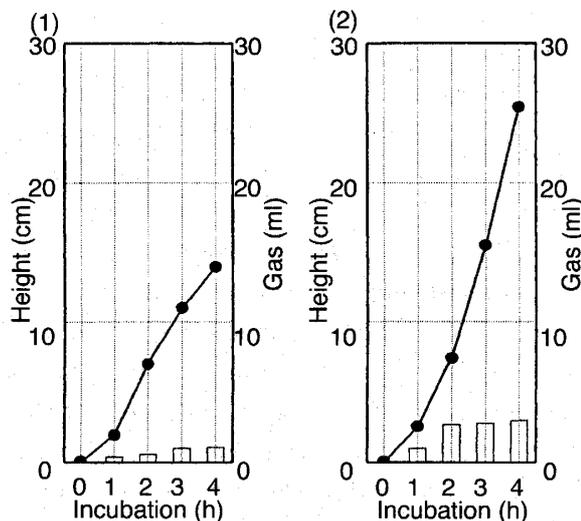


Fig. 3. Effects of adding bunashimeji to dough on the total gas production and expansion
 (1), standard dough(without bunashimeji);
 (2), bunashimeji-added dough.
 ●, total gas production; □, expansion

The expansion of the dough in the flat-bottomed tubes was measured by determining the height of the dough during dough development(fermentation). Dough containing 5% bunashimeji expanded more than standard dough during incubation at 30°C for 0 to 4 hours.

The standard dough and dough containing bunashimeji were also expanded by incubation at 30°C for 0 to 4 hours, and the loaf volume(height in cm) of the dough containing bunashimeji was found to be larger than that of the standard one. The other ingredients were the same in white bread and bunashimeji bread formulae, except for total weight(10g), as shown in Table 1, and as described Materials and Methods. The dough containing 5% bunashimeji expanded more than standard dough during incubation at 30°C for 0 to 4 hours. After 4 hours of incubation, the loaf volume

increased about 2.7 times that of standard dough. Also, the total gas production increased about 1.8 times that of standard dough.

Furthermore, there were a few large holes and many small holes on the top of dough containing bunashimeji after 6 hours of incubation. On the other hand, there were not many holes on top of standard dough. We concluded that the excessive gas produced by the yeast formed the holes upon exiting the dough, reducing the volume of the dough.

3. Supply of fermentable sugar from bunashimeji on the fermentation

Figure 4 shows the time course of fermentable sugar and gas production in bunashimeji.

Bunashimeji contains fermentable sugar, such as glucose. Glucose was consumed with fermentation by yeast during the first 1 hour of incubation. Gas production increased with increasing consumption of glucose. Therefore, it seems that the addition of bunashimeji to white bread supplies additional fermentable sugar as a carbohydrate source to baker's yeast and promotes alcohol fermentation under anaerobic conditions, thus increasing gas production. Therefore, we concluded that excessive gas production caused by adding bunashimeji to white bread leads to breakdown of the dough.

In general, wheat flour contains a low level of fermentable sugars (about 0.5%), a level that is too low to support yeast activity throughout the proof period, but is sufficient to produce gas for good-sized, well-aerated loaves. Consequently, excessive fermentable sugars produced by adding bunashimeji result in excessive gas production, producing sticky crumbs and decreased loaf volume in the resulting bread. Therefore, we confirmed that adding bunashimeji to white bread dough provided nutrients as fermentable sugar for the yeast, and that this tended to produce excessive initial gas, followed by a sharp fall in gas production. Consequently, dough in which holes were formed on top was broken before oven baking, resulting in bread with decreased loaf volume.

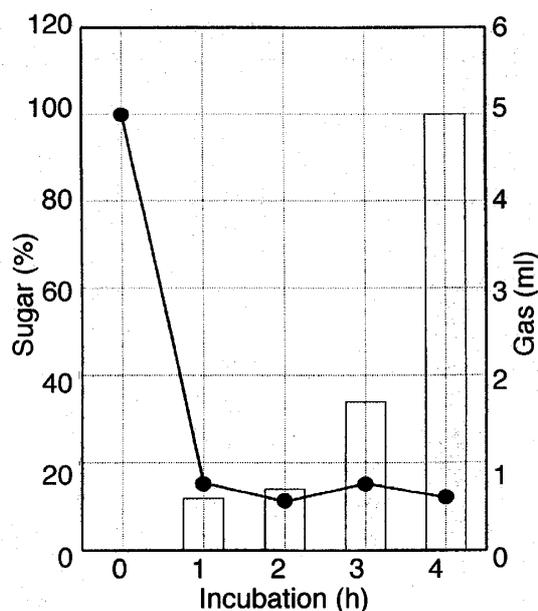


Fig. 4. Time course of fermentable sugar and gas production with bunashimeji

●, fermentable sugar (glucose);

□, gas production

Gas production increased in accordance with consumption of glucose.

References

- 1) Niihara, R. and Harigai, Y., *J. Home Economic*(Japan), **42**, 983-987(1991).
- 2) Takasaki, S. and Karasawa, K., *J. Cookery Sci. Jpn.*, **26**, 327-334(1993).
- 3) Nakano, A. and Oba, K., *J. Home Economic*(Japan), **46**, 321-329(1995).
- 4) Oba, K. and Nakano, A., *J. Home Economic*(Japan), **47**, 21-27(1996).
- 5) Tsuda, T., Hasumi, T. and Watanabe, T., *J. Cookery Sci. Jpn.*, **29**, 25-31(1996).
- 6) Eicker, A., *Mushroom Journal*, **513**, 19-21(1992).
- 7) Flegg, P., *Mushroom Journal*, **513**, 16-17(1992).
- 8) Bech, K., *Mushroom Journal*, **513**, 17-18(1992).
- 9) Okamura, T., Noda, H., Hoshino, Y., Sohigawa, E., Uesugi, S., Mohri, A. and Ohsugi, M., *Nippon Shokuhin Kagaku Kogaku Kaishi*, **43**, 333-335(1996).

Effects of Fermentable Sugar Derived from Bunashimeji Mushroom on Fermentation in Bread Processing

- 10) Okamura, T., Nishikawa, Y., Okuda, N.
and Ohsugi, M., *Mushroom Science and
Biotechnology*, **5**, 81-85(1997).
- 11) Okamura, T., Nishikawa, Y., Okuda, N.
and Ohsugi, M., *J. Cookery Sci. Jpn.*,
31, 30-36(1998).