

特別寄稿

Highly Water Pressurized Brown Rice and Its Characteristics

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Abstract

Upon application of high water pressure up to 600MPa, brown rice exhibits various excellent characteristics compared to usual brown rice and also white rice. For example compared to usual brown rice, cooking of highly water pressurized brown rice becomes much easier and because of enhanced digestion and absorption of nutrients it exhibits excellent characteristics as healthy food. Specific smelling of brown rice also disappears. Because of completely free from spore-forming bacteria, highly water pressurized brown rice is totally suppressed from the oxidation and corruption, and can be brought in the factories for further treatments. Therefore various new types of products can be formed, such as highly water pressurized brown rice powder which exhibits much excellent characteristics compared with conventional cooking powder of wheat.

By applying water pressure of 600MPa on long period stored rice which was kept in a tinplate can for 45year by us, specific smelling of long-stored rice disappeared.

1. Introduction

Brown rice (BR) is known to be good for health because it contains various types of mineral and vitamins in bran. However it is not widely used because of difficulty of cooking and non-good feeling of chewing. However upon application of high water pressure up to 600MPa corresponding to the depth of 60000m below sea level, brown rice can be well cooked utilizing normal electric steam rice cooker.^{1,2)} Because of enhanced digestion and absorption of nutrients it exhibits excellent characteristics as healthy food. Specific smelling of brown rice also disappears upon application of high pressure. Because of completely free from spore-forming bacteria, highly water pressurized brown rice (HPBR) is totally suppressed from the oxidation and corruption, and can be brought in the factory for further treatments. Therefore highly water pressurized brown rice powder (HPBRP) exhibits much excellent characteristics compared with conventional wheat cooking powder and various new types of products can be fabricated.

2. Material

High pressure treatment of foods is known as a non-thermal food processing technique. Highly water pressurized brown rice (HPBR) was prepared by applying water pressure of 600MPa for 5sec on brown rice (BR) using a hydrostatic pressurizer specially designed. Non-pressurized brown rice (BR) obtained in Iinan area of Shimane prefecture was used as starting material. For comparison white rice (polished rice, PR) prepared by threshing BR to reduce bran and others was also studied.

3. Highly Water Pressuring Apparatus

Specially designed hydrostatic pressuring apparatus was used in this study. Brown rice (BR) was put in a pressure chamber and ultra-high water pressure up to 600MPa was applied for 5 second and after releasing the pressure the sample was used as highly water pressurized brown rice (HPBR).

The hydrostatic pressuring apparatus for food engineering and cross-section figure of the central pressuring area are shown in Figure 1. Detailed design of pressurizing part and schematic explanation of procedure are shown in our previous papers^{1) 2)}.

W and W, B area in these figures are filled with water and also with water and working material, in this case brown rice. Then these parts were introduced

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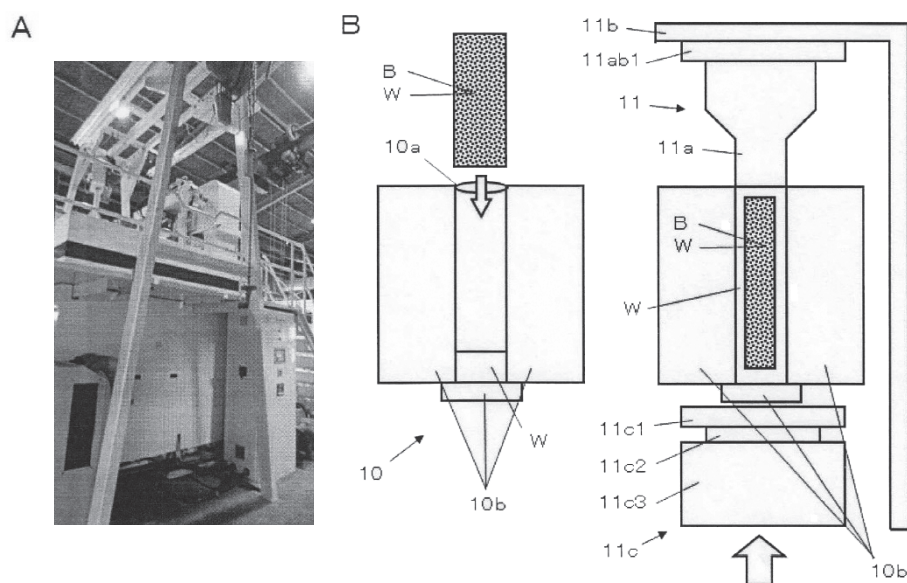


Figure 1. Highly water pressurizing apparatus for Food Processing
 A : Photograph of apparatus.
 B : Cross section figure of the part of pressuring chamber

in 10a. Then the piston of 11a is inserted a little in 10a. After this process, the large size of the jack of 11c1 is operated so that the part of 10b will be pressed upward from the bottom. Then the piston of the 11a will contact to the fixed part of 11b and then the piston 11a will be inserted in 10a and the water filled part will be pressurized.

4. Results and discussion

4.1 Properties of Highly Water Pressurized Brown Rice

Fundamental analyses of nutritional composition were performed at Shimane Institute for Industrial Technology and additional analyses were also performed at Shimane Environment and Health Public Corporation.

The nutrient composition in PR, BR and HPBR is summarized in Table 1.

Though carbohydrate and protein did not differ among these samples, there were more dietary fiber and larger amounts of vitamins in HPBR and BR. These facts suggest that high pressure treatment does not damage any nutrients. That is because the heat treating process is not applied in this case, excellent staffs such as minerals and vitamins in bran remain.

It should be noted that a cooking of HPBR by the usual rice cooker became much easier than BR. This

may be due to the enhanced water absorbency of HPBR. After soaking in water for 1 hour, the weight increased by 24.0% in HPBR, 20.5% in PR and, 9.3% in BR. Because of enhanced digestion and absorption characteristics, effectively nutrition will be enhanced in HPBR.

It should be noted that free ferulic acid of HPBR and BR was as high as 17.3mg/100g and much higher than that of PR. On the other hand upon fermentation of HPBR by the usual process of Sake fermentation the free ferulic acid of HPBR in sake lees was much enhanced up to 51.8mg/100g. Fermentation process in HPBR seems to influence on formation of free ferulic acid. The mechanism of this enhancement is now under study.

Table 1. Nutrient composition(per 100g)in polished rice(PR), brown rice(BR)and highly water pressurized brown rice(HPBR)

	PR	BR	HPBR
Energy (kcal)	358	353	356
Carbohydrate (g)	77.6	74.3	76.8
Protein (g)	6.1	6.8	7.7
Lipids (g)	0.9	2.7	2.0
Soluble fiber (g)	<0.1	0.7	4.1
Insoluble fiber (g)	0.5	2.3	3.0
Vitamin B1 (mg)	0.08	0.41	0.41
Vitamin B6 (mg)	0.12	0.45	0.32
Niacin (mg)	1.2	6.3	7.5
GABA (mg)	1.5	7.0	9.1

It should be also pointed out that GABA of HPBR was much higher than that of PR.

It should also be mentioned that the residual bacteria became non-detectable after high pressure treatment as shown in Figure 2. That is, as evident in this figure, residual bacteria in BR was as high as 50,000,000 CFU/g, but that in HPBR becomes extremely low of about 300CFU/g.

4.2 Powder of highly water pressurized brown rice

We have developed highly water pressurized brown rice powder (HPBRP) utilizing super powder mill SPM-R430 of Nishimura Machine Works Co. Ltd. by using HPBR as starting material. Usual processing of the powder formation can be applied in this case.

As explained in the former section high water pressure sterilize spore-forming bacteria and therefore the powder from HPBR was not-contaminated and can be brought in any factory for further processing, because free from bacteria.

Due to decrease of lipid and spore-forming bacteria, the oxidation and corruption of the powder from HPBR is also highly suppressed.

That is, this new type of powder have following specific properties.

- 1) Specific nutrition of HPBR will be effectively absorbed.
- 2) Characteristic smelling specific to brown rice was totally suppressed.
- 3) Enhanced food texture will satisfy eating. HPBR gives us chewy and also crisp feeling.
- 4) HPBR powder can be mixed with other complementally powder to enhance its utility.
- 5) It should be stressed that HPBR is free from glu-

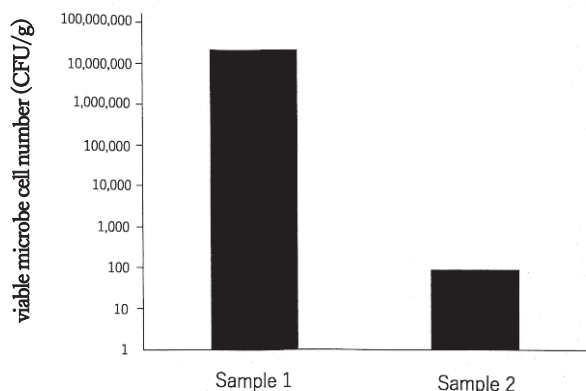


Figure 2. Effect of high water pressure on the residual bacteria
 sample 1 : Brown rice without treatment of high water pressure (BR)
 sample 2 : Brown rice with treatment of high water pressure (HPBR)

ten, and therefore can be used for persons who are suffering from allergy instead of the powder from wheat.

Figure 3 indicates examples of products obtained from the powder of highly water pressurized brown rice (HPBRP) .

4.3 Effects of highly water pressurized brown rice on dementia

Highly water pressurized brown rice HPBR is expected to be effective for improvement of dementia and Alzheimer's disease. We are collaborating with two groups, one is Doshisha University leadered by Prof. Hachiro Sugimoto and the other is Shimane University leadered by Prof. Michio Hashimoto. Details will also be discussed in this conference. Parts of the result were reported in the papers previously^{3), 4)} .

5. Effect of high water pressure on old rice kept in a tinplate can for 45 years



Figure 3. Examples of products made of HPBRP
 (a) Powder of highly pressurized brown rice (HPBRP)
 (b) Cake made of HRBRP
 (c) Pan-cake mix made of HRBRP
 (d) Noodle prepared from HPBRP

By applying water pressure of 600MPa on long stored-old rice which was kept in a tinplate box for 45year by us, specific smelling of long-stored rice disappeared and upon cooking the pressurized rice becomes eatable.

Figure 4 indicates the result of GCMS analysis of volatile components derived from rice samples.

GCMS analysis was carried out as follows; 1g of samples and 1ml of water were sealed into HS vials and incubated at 95 degree for 45 minutes. Then volatile components from samples were trapped by SPME method for 30 minutes. Concentrated components on SPME fiber were injected into GCMS instrument by splitless mode.

As evident in this figure the intensity of peak No.11 indicated by an arrow which was considered as n-Nonaldehyde by MS spectral library, was decreased by high pressure treatment. The n-Nonaldehyde is known as one of the components of old rice odor.

Non-smelling pressurized old rice could be cooked just like an old rice. The smelling totally disappeared and it tasted just like not-so old rice. Though I ate the

45years old rice, I have no difficulty in my stomach.

Summary

Highly water pressurized brown rice by 600MPs is totally different from usual brown rice and exhibits excellent characteristics as healthy food.

References

- 1) Katsumi Yoshino ;Tadashi Inoue. Ultra-high Hydrostatic Pressurizing and Food Process Engineering, J. Highly Water Pressurized Food Engineering. 2016, vol.1, p.6
- 2) Tadashi Inoue, Ultra-high pressurized grains and its preparation method, Patent No.1885894, 1994
- 3) Michiaki Okuda.; Yuki Fujita; Takuya Katsube; Hiromasa Tabata; Katsumi Yoshino; Michio Hashimoto and Hachiro Sugimoto,BMCComplementaryand Alternative Medicine, 2018,vol.18,p.110
- 4) Michio Hashimoto; Kentaro Matsuzaki; Shozo Yano; Eri Sumiyoshi; Osamu Shido; Takuya Katsube; Mitsumasa Tabata and Katsumi Yoshino, Phannacometris ,2017,vol.92, p.69-73

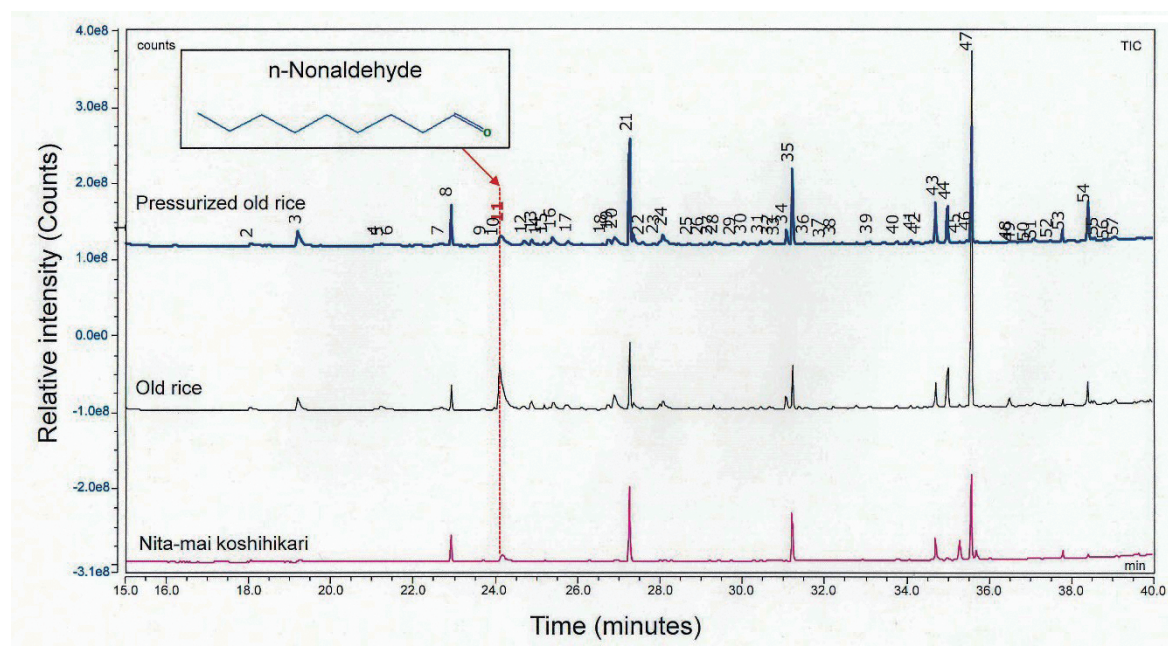


Figure 4. The result of GCMS analysis of volatile components derived from rice samples.

The intensity of Peak NO.11, which was considered as nonanal (n-Nonaldehyde) by MS spectral library, was decreased by high pressure treatment. The nonanal is one of the components of old rice odor.