安田女子大学大学院紀要　第25集
健康生活学専攻

The Influence of Different Washing Temperatures on the Quality and Taste of Bean Sprouts

Saori SHIMADA and Toshiaki SHIMIZU

Abstract

Bean sprouts are low-price and usable in variety of meals, being purchased in a large quantity in Japan. In this study, aiming at storage of bean sprouts as long as possible after opening of packaging film at home, we investigated the influence of the washing temperature on the quality and taste of bean sprouts to store them after washing. Standard plate counts, physical properties, light intensity and color were measured in bean sprouts washed at 25℃ and 50℃, and sensory evaluation was performed after heating. As a result, the difference in washing temperature of bean sprout did not affect the number of viable aerobic bacteria, physical properties, light intensity and color, but the bean sprouts washed at 50℃ was evaluated to have less bitterness in sensory evaluation. The standard plate counts increased regardless of the washing temperature even though bean sprouts were refrigerated at 4℃ after washing and reached a level of the initial stage of decomposition within 24 hours after the washing. Therefore, it is desirable to use them immediately after washing.

キーワード：bean sprouts, washing temperature, standard plate counts, physical properties, sensory evaluation

Introduction

Bean sprouts are generally produced from mung beans, black grams, and soybeans in factories. They are grown in a dark place for about 7 days after sprouting and shipped. Bean sprouts are physiologically active even after harvest and softening and decomposition progress during storage, so that the cultivation conditions and storage temperature affect the quality and storability[1]. Because of their low price and usability in variety of meals, bean sprouts are frequently included in daily cooking and purchased in a large quantity in Japan (Fig. 1). However, they should be immediately used after purchase because they cannot be preserved long. Families stocking food materials at home have recently increased with an increase in two-income families. Tajiri[2] reported that the optimum storage temperature for bean sprouts is 5℃ for both thin and thick bean sprouts, and the storage time is 5 days for thin bean sprouts and 5-7 days for thick bean sprouts. Hatae et al.[3] reported that storage at 4℃ for

about 6 days was possible when bean sprouts were stored in the film package without opening after purchase, but deterioration of the external appearance, changes in the ascorbic acid level, and a marked increase in the number of viable bacteria were noted when stored at room temperature (20℃ and 30℃), showing that storage of bean sprouts is strongly dependent on the temperature. Varoquaux et al.[4] stored bean sprouts using packaging film and observed that the duration of keeping freshness in the optimum packaging film at 8℃ was 4-5 days. In a study on time-course changes in the nutritional composition during storage at a low temperature reported by Kasahara et al.[5], the nutritional composition, hardness, and taste of bean sprouts in a sealed film package during low-temperature storage were reported.

As one-person and two-person households have recently increased, bean sprouts after opening of packaging film may not be used entirely and stored at home. In this study, aiming at storage of bean sprouts in a fresh state as long as possible at home even after opening of packaging film, we investigated the influence of the washing temperature on the quality of bean sprouts to store them after washing. Bean sprouts were washed at the general temperature of running water, 25℃ , and a high temperature not heating bean sprouts, 50℃ . Standard plate counts, physical properties, light intensity and color were measured over time, and taste of heated bean sprouts were evaluated.

Materials and Methods

1. Materials

We used black gram sprouts produced in Hiroshima Prefecture for the experiment. They were washed with running tap water. Standard plate counts, physical properties, light intensity and color were measured, and sensory evaluation was performed after heating.

2. Procedure for washing and storage

The washing temperature was set at 25 and 50℃. Bean sprouts (200 g) were soaked in 1 L of 25℃ tap water for 20 seconds. The water was changed, this treatment was repeated, and the sprouts were taken up in a colander. The sprouts were then soaked in 25℃ or 50℃ tap water for 3 minutes and used as a sample. Bean sprouts immediately after opening the package without washing were used as the control.

The samples were stored at 4℃ in a refrigerator and taken out immediately before the experiment.

3. Enumeration of viable aerobic bacteria

We used a medium sheet for microorganism detection Sanita-kun Aerobic Count (for standard plate counts) manufactured by JNC Co., Ltd.,. Sanita-kun Aerobic Count has a good correlation with an official standard method using agar plates (Morita et al. [6]). Designating the day with washing as day 0, the standard plate counts of tested bean sprouts samples were measured on day 1 (24 hours after washing) and day 2 (48 hours after washing). According to the preliminary results, storage was completed on day 2 because odor gas emitted from the samples on day 3 and it seemed to be inappropriate for eating.

Briefly, a stomacher bag was cut using disinfected scissors, placed on an electronic balance, and 90 mL of sterilized saline and 10 g of bean sprouts were placed in the bag, followed by stomacher treatment for 3 minutes. The prepared suspension was serially diluted, 1 mL of each dilution was plated on a Sanita-kun sheet (n=3), and cultured at 35℃ for 48 hours. The colonies formed on the sheet media were counted, and the standard plate counts per 1 g bean sprouts was calculated.

4. Physical property measurement

Using a rheometer (FRT-50N, Imada Co., Ltd.), 5 bean sprouts each were piled up into 2 layers (10 sprouts in total), and the rupture strength was measured in the central region of the hypocotyl of the bean sprouts using a wedge-type plunger.

5. Light intensity, color measurement and appearance

Using a color reader CR-20 manufactured by Konica Minolta Japan, the L*value, a*value, and b*value of bean sprouts were measured. Each 45 g of the sample was placed on a white paper plate. Photographs of the external appearance ware taken after the measurement. The L*value is a lightness index, and the color becomes brighter as the value increases. The a*value and the b*value are colorimetric indexes, and the higher the a*value, the stronger red. As for b*value, the higher the value, the stronger yellow, and the lower the value, the stronger blue.

6. Sensory evaluation

Bean sprouts (200 g) were divided into 100-g portions, and one was washed at 25℃ and the other was washed at 50℃. These were individually placed in a heat-resistant container and heated in a microwave at 500 w for 3 minutes to prepare samples for sensory evaluation. Food texture, bitterness, and preference were evaluated employing the 2-point test method. The panel consisted of 11 university students in their 20s who had experience in sensory evaluation. We verbally explained purpose of sensory evaluation, use of results as paper data, confidentiality of acquired personal information and management taking care not to leak information. Everyone's consent was obtained. We also explained that you can stop freely during the evaluation and that there are no disadvantages.

7. Statistical analysis

Statistical software SPSS (IBM, Statistics 23) was used. The results of light intensity and color measurement and physical property measurement were tested for significance by two-way factorial analysis of variance. When a significant difference was confirmed, a multiple comparison test (Scheffe's F test) was performed. All significance level less than 5% for data was determined to be significant.

Results and Discussion

1. Enumeration of viable aerobic bacteria

According to the results of the Family Income and Expenditure Survey by the Statistics Bureau, Ministry of Internal Affairs and Communications[7], the number of viable aerobic bacteria is 1 x 10^6/g or lower in unprocessed foods (uncooked foods) and 1 x 10^7/g or higher in

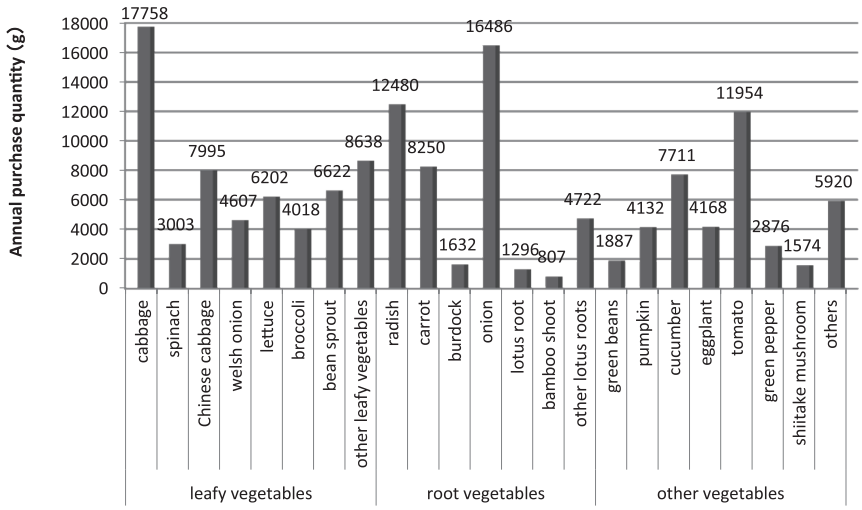

Fig.1 Annual purchase quantity (g) per item for two-or-more-person households
Extracted from Family Income and Expenditure Survey (Income and Expenditures)
Two-or-more-person households, Index by prefectural capital city and ordinance-designated city by item, average in 2016-2018, Statistics Bureau, Ministry of Internal Affairs and Communications[7)]

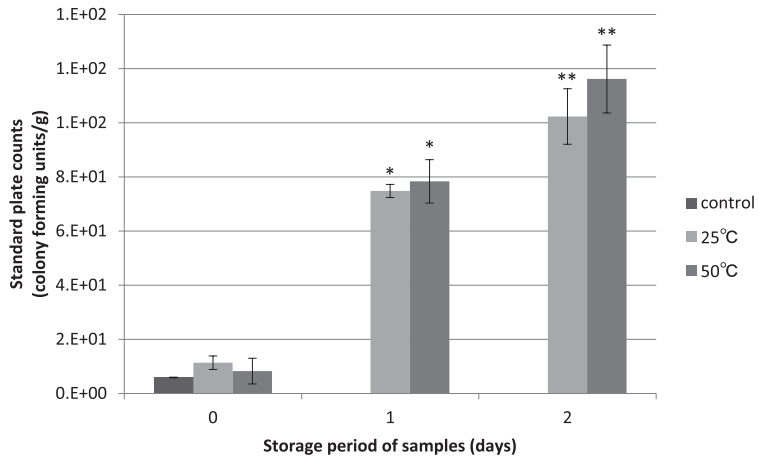

Fig.2 Standard plate counts when the test bean sprout samples were stored in a refrigerator after washing at 25 ℃ or 50℃
Each bar indicates the mean ± standard deviation (n=3). Control: without washing
Asterisked values(＊) were significantly larger than the values of corresponding day 0 without storage($p<0.01$).
Asterisked values(＊＊) were significantly larger than the values of corresponding day 1 ($p<0.01$).

the initial stage of decomposition, and a count of 1 x 10^8/g or higher indicates decomposition and causes organoleptic abnormalities. The results of measurement of standard plate counts are shown in Fig. 2. The number already exceeded the criterion of the initial stage of decomposition, 1 x 10^7/g, on day 1 and reached the criterion of decomposition, 1 x 10^8/g, on day 2. No significant difference due to the difference in the washing temperature was noted in standard plate counts.

2. Physical properties

The rupture strength of the hypocotyl, considered involved in the texture of bean sprouts, was measured. The results of measurement are shown in Table 1. The sprouts become harder and unlikely to be distorted (not flexible) as the value increases. No significant difference due to the washing temperature or duration of storage was noted, but the rupture strength of bean sprouts washed at 50℃ tended to be higher, giving crisp food texture, regardless of the duration of storage.

Table 1. Changes in the rupture strength of the hypocotyl of bean sprouts during storage*

Storage (days)	Rupture strength (kgf/cm^2)		
	Control	25℃	50℃
0	1.54 ± 0.24	1.72 ± 0.61	1.95 ± 0.45
1		1.34 ± 0.36	1.66 ± 0.16
2		1.54 ± 0.33	1.63 ± 0.44

*Bean sprouts were washed in tap water of 25℃ or 50℃ for 3 minutes before storage.
Each experiment was repeated 4 times and obtained data are represented as mean ± standard deviation unless otherwise indicated. No significant difference due to the washing temperature or duration of storage was noted.

3. Light intensity, colorimetric indexes and appearance

Table 2 shows the measurement results of bean sprouts light intensity (L*value) and color (a*value, b*value). The L*value indicating the degree of lightness was not significantly different between the control (no washing), 25℃ washing, and 50℃ washing on day 0 (just after washing). Similarly, no significant difference was found on day 1 and day 2. Only the light intensity (L*value) was significantly different between day 0 (just after washing) and day 2 ($p<0.01$). The light intensity (L*value) was significantly higher on day 2. This is probably because the bean sprouts are discolored as the storage period increases and gradually become brownish. Fig. 3 shows photographs of the external appearance of bean sprouts.

Table 2 The measurement results of bean sprouts light intensity (L*value) and colorimetric indexes (a*value, b*value)

	Day 0			Day 1			Day 2		
	Control	25℃	50℃	Control	25℃	50℃	Control	25℃	50℃
L * value	45.3 ± 7.2	48.4 ± 2.6	46.0 ± 4.9	54.2 ± 3.8	46.8 ± 6.6	48.8 ± 2.2	53.8 ± 3.4	51.5 ± 8.5	51.1 ± 3.8
a * value	0.12 ± 0.33	0.02 ± 0.28	0.18 ± 0.59	0.40 ± 0.59	0.32 ± 0.64	0.16 ± 0.31	0.30 ± 0.23	-0.10 ± 0.41	0.08 ± 0.19
b * value	6.96 ± 1.01	6.08 ± 1.38	6.28 ± 2.12	7.20 ± 2.65	6.50 ± 3.09	6.46 ± 1.48	6.62 ± 0.69	6.64 ± 1.89	7.34 ± 1.38

The samples for the light intensity and color were prepared by the same procedure as discribed in Table 1. Only the light intensity (L*value) was significantly different between day 0 (just after washing) and day 2 ($p<0.01$).

4. Sensory evaluation

The sprouts with better food texture, less bitterness, and preferred were selected on sensory evaluation. The results are shown in Table 3. Although there was no difference in the texture and preference, the number of panels that were evaluated as having less unique bitterness of bean sprouts washed at 50℃ was significantly higher.

Fig.3 Appearance of bean sprouts immediately after washing and after storage for 24 or 48 hours after washing
Bean sprouts were washed in tap water of 25℃ or 50℃ for 3 minutes before storage.
Control bean sprouts were not washed after opening the package.

Table 3 The effect of washing at 25 ℃ or 50 ℃ on taste of bean sprouts*

Sensory evaluation items	Number of respondents (n=11)	
	25℃	50℃
Choose the firmer one	6	5
Choose the bitter one	9	2
Choose the preferred one	4	7

*The samples for sensory evaluation were prepared by the same procedure as discribed in Table 1.

Conclusion

As a result, the difference in washing temperature of bean sprout did not affect the standard plate counts, physical properties, light intensity and colorimetric indexes, but the bean sprouts washed at 50℃ was evaluated to have less bitterness in sensory evaluation. In particular, the number of viable aerobic bacteria in bean sprouts increased regardless of the washing temperature even though bean sprouts were refrigerated at 4℃ after washing and reached a level of the initial stage of decomposition within 24 hours after washing. Therefore, it is desirable to use them immediately after washing.

References

1） Tajiri, T.: Influence of the storage temperature and temperature change during storage on the duration of keeping freshness of bean sprouts, J. Jpn. Soc. Food Sci. Technol., 26, 18-24 (1979)
2） Tajiri, T.: Appropriate Storage Temperature for Bean Sprouts Produced by Different Culture Methods, J. Jpn. Soc. Food Sci. Technol., 24, 109-115 (1998)
3） Hatae, K., Tominaga. N., and Tsukamoto, J.,et al: Effects of the Temperature on the Quality of Stored Black gramSprouts, *19th Int. Congr. Refrigeration Proc.,* 2,189-195(1995)
4） Varoquaux, P., Albagnac, G., The, C.N., and Varoquaux, F.: Modified Atmosphere Packaging of Fresh Beansprouts, *J.* Sci. Food Agric., 70, 224-230 (1996)
5） Kasahara, M., Konishi, A., Hatae, K., Shimada, A.: Changes in the Quality and Contents of Several Components of Bean Sprouts during Storage in CPP Film at Low Temperature, J. Home Econ. Jpn., 51(1), 23-31 (2000)
6） Morita, H., Ushiyama, M., Aoyama, S., Iwasaki, M., : Sensitivity and Specificity of the Sanita-kun Aerobic Count: Internal Validation and Independent Laboratory Study, Journal of AOAC International Vol. 86, No. 2, 355-366 (2003)
7） Statistics Bureau, Ministry of Internal Affairs and Communications: Family Income and Expenditure Survey (Income and Expenditures) 7. Two-or more person households, Index by Prefectural capital city and ordinance-designated city by item, average in 2016-2018 http://www.stat.go.jp/data/kakei/5.htm