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## The smell and odorous components of dried shiitake mushroom, *Lentinula edodes* IV: survey of trends in consumer preferences and changes in sensory evaluation

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**Abstract** This study is part of an effort to improve the quality of dried shiitake mushrooms (*Lentinula edodes*) in accordance with consumer preference. Results are presented of a trend survey that examined the preferences of consumers using questionnaires combined with sensory evaluation. From the original preference (OP) survey, the distributions of OP divided by age class (AC) were statistically equal to the results obtained in 2000. The medians of OP for teenagers and twenties were “neutral” and “slightly like,” respectively. A firm preference change occurred between teenagers and those in their twenties. It is empirically realized that sensory intensity (SI) scores that were too high or too low led to a low hedonic preference (HP) score. The same tendency was seen for “neutralists” and “likers.” In addition, almost all distributions concerned with HP had no significant difference between 2000 and 2005; for example, that of SI divided by AC. These results showed that the preference for dried shiitake mushroom has been unaffected by the passage of the past 5 years. Dried shiitake mushrooms have been used from ancient times and for many dishes; therefore, the overall preference appears to have remained unchanged.

**Key words** Dried shiitake mushroom · Preference trend · Preference for food · Sensory evaluation

### Introduction

Dried shiitake mushroom [*Lentinula edodes* (Berk.) Pegler] has been eaten since ancient times, and is one of the most

popular edible mushrooms in Japan and other parts of the Far East. A preference survey conducted in 2000 showed that 70% of consumers liked dried shiitake mushroom, 15% were neutral, and 15% disliked them.<sup>1</sup> However, the amount consumed in Japan has gradually decreased in recent times.<sup>2</sup> According to age class (AC), the original preference (OP) for the over twenties was “slightly like” or “like.” On the other hand, that for teenagers was “neutral.”<sup>1</sup> As teenagers mature with their preference remaining unchanged, the amount consumed will decrease further.

Smell is one of the important factors in food evaluation,<sup>3–6</sup> and dried shiitake mushrooms, in particular, are known to have a characteristic smell. Mushrooms are regarded as a kind of favorite food, which means they are not essential to the daily diet; therefore, the characteristic smell of dried shiitake mushrooms is one of the main evaluation factors. One approach to increasing shiitake consumption is to provide dried shiitake mushrooms with a smell that is adapted consumer preferences. In the case of dried shiitake mushroom, the sensory intensity (SI) was especially important in evaluation, because there were optimal SIs providing the highest hedonic preferences (HP) for those who liked the mushrooms or were neutral.<sup>7</sup> On the other hand, the HP of dislikers started from neutral, and the HP ranking decreased in relation to increasing SI.

The HP of dried shiitake mushroom was mainly affected by OP and SI.<sup>1</sup> Frequent market research has indicated that time pressures lead to changes in preference for food. In particular, individual SI was influenced by many factors.<sup>8</sup> In addition, the amounts of dried shiitake mushroom that provided optimal SI ranged widely,<sup>1</sup> and fluctuation of these values was possible. Therefore, this study examined the findings of a consumer preference survey using questionnaires combined with sensory evaluation 5 years after an earlier similar survey, and reexamined the relationship between the smell of the dried shiitake mushrooms and consumer preference.

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**Table 1.** Breakdown of panelists

Age class (AC)	Men	Women	Total
Teenagers	52	50	102
Twenties	25	23	48
Thirties	21	28	49
Forties	23	23	46
Fifties	20	21	41
Over sixties	22	23	45
Total	163	168	331

## Materials and methods

The preparation and evaluation of dried shiitake mushrooms and analysis of odorous compounds were conducted using the same methods as in the previous report.<sup>1</sup> In accordance with the previous sensory evaluations for aromatic concentrations, the 1,2,4-trithiolane content in each bottle was adjusted, because it could serve as an indicator to estimate the smell of dried shiitake mushroom.<sup>7</sup> The 1,2,4-trithiolane contents in bottles BN-1, BN-2, and BN-3 were prepared at 0.4  $\mu\text{g}$ , 3.5  $\mu\text{g}$ , and 69.2  $\mu\text{g}$ , respectively. The survey was performed from November 2005 until April 2006. The following parameters were evaluated: sex, AC, OP, SI, HP, and sample amounts (SA). The rankings for OP and HP were as follows: -3 extreme dislike; -2 dislike; -1 slightly dislike; 0 neutral; 1 slightly like; 2 like; 3 extreme like. SI was ranked as follows: 0 almost no smell; 2 very weak smell; 4 weak smell; 6 moderate smell; 8 strong smell; 10 extremely strong smell.<sup>9</sup> The number of panelists was set to near that of the previous survey, because some established tendencies were acquired from the previous survey, for example, the relation between AC and SI.<sup>10,11</sup> The panelists consisted of 331 assessors: staff members and students of Yokosuka Civic Nagai Elementary School, Yokosuka Civic Iwato Junior High School, Kanagawa Prefectural Iwato Senior High School, Tokyo Metropolitan Engei High School, and Yokohama National University; employees of the Forestry and Forest Products Research Institute of Japan; and the public around Tsukuba City (Table 1).

## Results and discussion

### OP trend

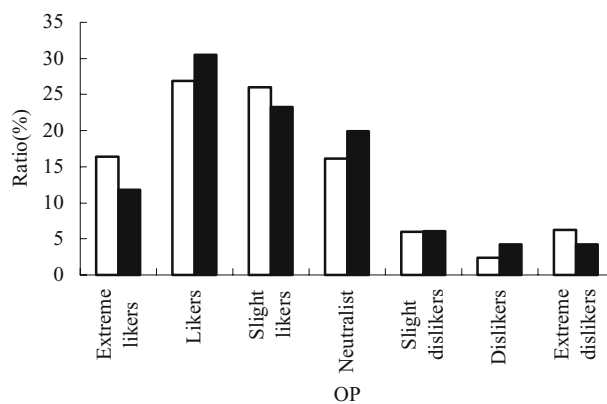
The percentages for OP in 2000 and 2005 for dried shiitake mushrooms are shown in Fig. 1, and no significant difference was observed at 5% risk by the chi square ( $\chi^2$ ) test ( $P = 0.225$ ). The total percentage of likers for 2000 was 69.3% and that for 2005 was 65.6%. These results showed that the OP trend for consumers was unchanged from the previous survey, and consumers generally liked dried shiitake mushrooms in both years. The Spearman rank order correlation coefficient between AC and OP was 0.487, which is significant at 1% risk (Table 2). The significant positive correlation between them shows that the preference for dried

**Table 2.** The Spearman rank-order correlation coefficients between parameters

	OP	SI	HP	SA
AC	0.487**	-0.289**		
OP		-0.205**	0.441**	
SI				0.438**

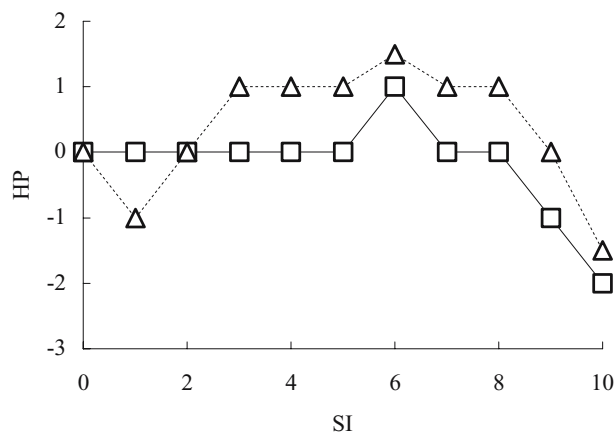
OP, original preference; SI, sensory intensity; HP, hedonic preference; SA, sample amount

\*\*Significant correlation at 1% risk

**Fig. 1.** The distribution of original preference (OP) in 2000 (open bars) and 2005 (closed bars)

shiitake mushroom increases with age, and the same result was also seen the previous survey.<sup>1</sup> The distribution difference between 2000 and 2005 when OP was divided by AC was calculated by the  $\chi^2$  test, and the  $P$  value for teenagers was 0.545, 0.076 for twenties, 0.338 for thirties, 0.734 for forties, 0.232 for fifties, and 0.480 for over sixties. These results show that the distributions of OP by AC in 2005 were equal to those in 2000. The OP median for teens was neutral, and those for the over twenties were slightly like or like.

This survey was performed 5 years after the previous survey. While the interval was short, it was needed to confirm where the preference change occurs between teenagers and twenties, because the decrease in consumption of dried shiitake mushroom was due to a decrease in the number of likers. To exclude influences from the previous survey, especially for teenagers and twenties wherever possible, all teenagers and over 90% of the twenties had not participated in the previous survey. Therefore, the preference change from neutral to slightly like between the age groups appears genuine. It has been reported that Japanese preferences for foods are affected by demographic factors, and the first factor is age.<sup>12-14</sup> It was predicted that a high score for food is caused by the multiple effects of high prevalence and frequent intake.<sup>15</sup> Actually, the impressions expressed for dried shiitake mushrooms by dislikers and the young included "artificial," while those for likers and older persons included "natural." Preference changed markedly from the twenties to forties, namely, the preference for "Japanese foods" changes from dislike to like between twenties and



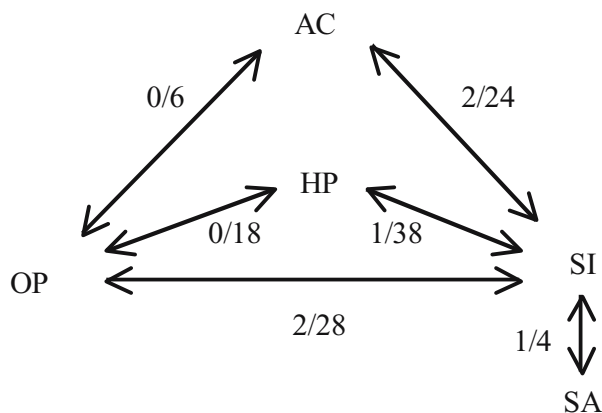
**Fig. 2.** The change in hedonic preference (*HP*) according to sensory intensity (*SI*). *Squares*, median for men; *triangles*, median for women

thirties, and that for “Western and heavy foods” changes from like to dislike between thirties and forties. Dried shiitake mushroom is looked upon as one kind of Japanese food, however, the change toward a preference for dried shiitake mushroom occurred more quickly than for other Japanese foods. The consumption amount of dried shiitake mushroom was gradually decreased, but people seemed to be familiar with them from an early time.

#### Parameters influencing HP

Spearman rank order correlation coefficients between AC, OP, SI, HP, and SA are listed in Table 2. AC, OP, and SI were significantly correlated with each other at 1% risk. The correlation coefficients between OP and HP, and between SA and SI were also significant at 1% risk. These correlations were also found in the previous survey.<sup>1</sup> The differences between sexes for OP, SI, and HP were calculated by the  $\chi^2$  test, and the *P* value for OP was 0.512, 0.047 for SI, and 0.057 for HP. The same calculation for SI was performed for each sample, and a significant difference for BN-1 was only seen at 5% risk. A number of studies have shown that women are more sensitive than men with respect to perception and discrimination of aroma.<sup>10,15-17</sup>

The median of HP for neutralists and likers by sex was plotted against SI (Fig. 2). The medians remained around 0 when the SI ranged from 0 to 5, scored the maximum HP at an SI of 6, and rapidly decreased when the SI was over 6. These results showed that HP gradually increased from no smell to optimum SI, rapidly decreased once optimum SI was exceeded, and finally preference was reversed from like to dislike. In the previous survey, optimal SI resulted in the highest HP for neutralists and likers.<sup>1</sup> It has been empirically realized that the HP scores are low when the fragrance is too strong or weak.<sup>18,19</sup> If the ranking scale, such as HP and SI, were to be converted to an interval scale, these relations could be applied to a cubic equation. On the other hand, dislikers did not find dried shiitake mushroom palatable because there was a negative correlation between HP and SI ( $\rho = -0.720$ ,  $P < 0.01$ ). To make dried shiitake



**Fig. 3.** The frequencies of the significant differences among factors; age class (*AC*), original preference (*OP*), hedonic preference (*HP*), sensory intensity (*SI*), and sample amount (*SA*). The *numerator* shows the number of significant differences and the *denominator* the number of total relations

**Table 3.** Optimal sensory intensity (SI) and the highest hedonic preference (HP) in 2000 and 2005

Original preference (OP)	2005					
	2000		Men		Women	
	SI	HP	SI	HP	SI	HP
Extreme likers	8	2	7	2	7	2
Likers	7	2.5	7	1	6	2
Slight likers	7	1.5	6	1	7	2
Neutralists	7.5	1	6	1	6	1

mushrooms appealing to dislikers, little or almost no odorous material would have to be included.

#### Differences between 2000 and 2005

The distribution differences among parameters between 2000 and 2005 were calculated by the  $\chi^2$  test. There were some significant differences between parameters in these years at 5% risk. These results are summarized in Fig. 3, in which the numerator shows the number of significant differences and the denominator shows the number of total relations. The significant differences of the highest HP and the optimal SI in these years (Table 3) were calculated by the Wilcoxon signed-rank test. The *P* values of the highest HP for men and women were 0.371 and 1.000, respectively, and those of the optimal SI for men and women were both 0.174. The results showed that there was no significant difference of the highest HP and optimal SI.

Because there is no significant difference in OP divided by AC in these years, OP is firmly related to AC. Namely, OP is unamenable to current circumstances. On the other hand, some differences were found for the relations concerned with SI in these years. It is reported that conflicting data arose from interindividual variability in nasal irritant,<sup>8</sup> and the individual olfactory variance caused by physical condition is well known. In addition, some parts of the brain

are concerned with aromatic stimuli, and different regions are activated by different preferences.<sup>20–24</sup> This means that deciding HP and SI for odor is an activity of the higher nervous system and changes easily according to circumstances. However, only 6 relations among 118 relations concerned with HP and SI showed significant differences. Moreover, there was no significant difference between 2000 and 2005 for the highest HP and the optimal SI. It was concluded that the olfactory preference of consumers for dried shiitake mushroom had not changed from 2000 to 2005.

Significant differences were not found for the highest HPs and optimal SIs, although the scores for 2005 were a little smaller than those for 2000. It was uncertain whether the differences were caused by margins of error or preferences toward a weaker smell. To confirm any trend, a long-term survey is needed. However, it is unlikely that any dramatic change in preference would occur, because dried shiitake mushrooms are used in many cuisines and many people are familiar with them. Therefore, various odorous concentrations in dried shiitake mushrooms are needed in order to satisfy different consumer preferences.<sup>2</sup> The SA values that brought the highest HP may be useful as indexes to make dried shiitake mushrooms appealing in accordance with consumer preference.

Although 70% of panelists liked dried shiitake mushrooms, the amount being consumed has been gradually decreasing.<sup>2</sup> Some of the panelists in the survey were interviewed and asked why they had become dissatisfied with dried shiitake mushroom. There were two main reasons; one was price and the other was the considerable time it took to prepare them. In 2005, 20% of respondents spent less than 30 min cooking dinner, and 60% spent between 30 and 60 min.<sup>25</sup> However, the recommended soaking time and temperature for dried shiitake mushroom is about 5 h and 5°C.<sup>26</sup> Recently, a dried shiitake mushroom was commercialized for which the soaking time in hot water was only 3 min. To increase the consumption rate, not only adjustment of smell but also measures to address the other sources of dissatisfaction are needed.

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