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Reliability of Sensory Test for Myanmar Rice Cultivars by a Myanmar Panel

Yuji Matsue[1]*, Khin Thanda Win[2], Aye Lae Lae Hlaing[3], Zin Thu Zar Maung[3], Khaing New Oo[3], Thinzar Nwe[3], San Mar Lar[3], Thein Lin[3] and Atsushi Yoshimura[2]

[1]*Global Innovation Center, Kyushu University, Japan*

[2]*Plant Breeding Laboratory, Faculty of Agriculture, Kyushu University, Japan*

[3]*Department of Agricultural Research, Ministry of Agriculture Livestock and Irrigation, Myanmar*

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***Corresponding author:** Yuji Matsue, Global Innovation Center, Ohashi Campus, Kyushu University, Shiobaru, Minami-ku, Fukuoka, Japan

Abstract

To establish a method for evaluating the palatability of rice in Myanmar, the reliability of the sensory test was verified by analyzing the panel's discerning ability and taste preference by conducting eating quality evaluations according to the Japanese sensory test method using seven commercially available Myanmar rice cultivars. In the overall eating-quality, the number of panel members who were judged to have discerning ability was high about 70% of the total panel members (14 out of 21). With regard to taste preferences, about 60% of panel members with high discerning ability differed from the whole evaluation, indicating a diversity of taste preferences. These indicate that the Japanese sensory test method can be used to evaluate Myanmar rice cultivars by a Myanmar panel, as the differences among cultivars in overall eating- quality by panel member were significant at the 5% level, despite the presence of diversity for taste preferences. This method of eating quality evaluation enables effective palatability selection for the development of highly palatable rice cultivars in Myanmar. The contribution of each evaluation item to the overall eating-quality, estimated from the ratio of the standard partial regression coefficients, was largest for the stickiness, followed by hardness and taste, while the contribution of appearance and aroma was small.

Keywords: Analysis of variance; Discerning ability; Myanmar; Palatability; Panel members, Rice; Sensory test; Taste preference; Eating quality

Introduction

Rice (*Oryza sativa* L.) is one of the world's most important food crops and is a staple food in Myanmar. Annual rice consumption per capita was approximately 200 kg (milled rice equivalent) in 2021, making it the country with the highest rice consumption in the world [1]. While increasing rice production is currently a top policy priority in Myanmar, consumers' preference for highly palatable rice cultivars is increasing as the wealthy population and national economy improve. Therefore, there is a need to develop highly palatable rice cultivars based on ensuring high yields. Improving the palatability of rice produced in Myanmar will also increase the income of rice farmers through the production of high-quality rice, as well as providing tasty rice to consumers. This could also contribute to sustainable and symbiotic development between urban and rural areas. In Asia, where incomes are rising rapidly, the development of highly palatable rice is essential for promoting rice consumption.

However, Myanmar has not focused on breeding of highly palatable rice cultivars so far, and there are no established evaluation methods of sensory test or criteria for palatability characteristics, and no breeding (selection) of cultivars based on these methods has been carried out. Therefore, to efficiently accelerate the development of highly palatable rice cultivars in Myanmar, it is first necessary to grasp the Myanmar people's taste preferences for rice and establish eating quality evaluation method based on their taste preferences. In addition, the choices of the panel members and the discriminability of differences between samples by the panel are extremely important elements to obtain eating quality evaluation data with high reliability [2].

There are no research reports on rice taste preferences or the reliability of eating quality evaluation methods in Asia, where rice is a staple food, except in Japan (3, 4, 5, 6, 7, 8, 9). Shimura et al. [3]

examined the reproducibility of eating quality evaluations by each panel member for the purpose of selecting panel members. Okuno & Adachi [4] examined the stability and reliability of the evaluation by sensory test. Matsue [5] examined the reliability of sensory test of a large number of rice samples by a small panel with the aim of improving the efficiency for sensory test of cooked rice. Yagashira et al. [6], Osato et al., [7] and Shigemune et al. [9] verified the reliability of palatability sensory tests for selecting highly palatable rice cultivars in paddy rice breeding projects. Accordingly, this study was conducted to grasp the taste preferences of Myanmar people for rice and to establish a sensory test method based on their preferences. The reliability of the sensory test was verified by analyzing the panel's discerning ability and taste preference by conducting eating quality evaluations according to the Japanese sensory test method using seven commercially available Myanmar rice cultivars.

Materials and Methods

The sensory test was carried out at the Department of Agricultural Research (DAR, Yezin, Naypyitaw), Ministry of Agriculture, Livestock and Irrigation, Myanmar, on February, in 2023.

Plant materials

The 7 Myanmar rice cultivars used are described in Table 1.

Table 1: Overview of the 7 Myanmar cultivars.

Cultivar	Overview of cultivars
Manaw Thu Ka	*Indica.* Short-culmed, medium-maturing, high-yielding cultivar. Raised in Malaysia in 1978. Most widely grown in the rainy season.
Ayeyar Min	*Indica.* Long-culmed, medium growth, high quality cultivar. Raised in Malaysia in 1977. Leading cultivar in irrigated paddy fields.
Shan Rice	*Indica.* A highly palatable rice cultivar with a sticky. Mainly grown in the Shan State. Local brand-rice. Market prices are high.
Shwebo Paw San	*Japonica.* Late-maturing native species. Local brand-rice. Most famous in Myanmar as a highly palatable rice cultivar with a fragrant. Market prices are high.
Pyapon Paw San	*Japonica.* Late-maturing native species. A highly palatable rice cultivar with a fragrant. Mainly grown in the Ayeyarwady Division.
Pathein 90 days	*Indica.* Early-maturing, high-yielding cultivar. Increasingly popular among farmers.
Hnan Kyauk	*Indica.* Early-maturing, high-yielding cultivar. Originated from Thailand. Increasingly popular among farmers.

Preparation of materials

The method of cooking the sample was as follows. After 1000g of polished rice from each cultivar was washed well in water, the rice was soaked in water for 30 minutes. The water was promptly thrown away after the maceration, and rice was cooked with 1,350cc (In Japan, 540cc) of water in an electric rice-cooker (1.2L). After allowing the rice to stand for 20 minutes, it was used for the sensory taste.

Sensory test

The palatability evaluation of cooked rice was evaluated by the Matsue method [5] to modify the Ministry of Agriculture and Forestry, Food Agency method [11]. Seven samples including a check cultivar are evaluated in one test at the same time by this method. The check cultivar for the sensory tests was Manaw Thu Ka. The following six sensory attributes were evaluated by 21 panel members; overall eating-quality, appearance, taste, aroma, stickiness and hardness. Six sensory attributes were classified into seven stages compared with a check cultivar; i.e., -3(considerably poor), -2(poor), -1(slightly poor), 0 (no difference), +1(good), +2(very good) and ⍰3(excellent), for overall eating-quality, appearance, aroma and taste, -3(considerably weak) ⍰+3(considerably strong) for stickiness and -3(considerably soft) ⍰+3(considerably hard) for hardness. Other details of the evaluation were as described previously [5]. About 50g of the sample was dished up on to a white plate. The palatability of cooked rice was evaluated 20 minutes after serving to identify the varietal difference.

Panel members

The panel consisted of 21 institute faculty members (4 men and 17 women) at Department of Agricultural Research. Twelve persons were in their30s, seven persons were in their 40s and two were in their 50s. The same panel members repeated the test three times.

Analysis of reliability of sensory test by each panel member

We performed an analysis of variance (ANOVA) for each panel member to examine whether the difference in palatability among cultivars evaluated by each panel members was significant. F value of this ANOVA was assumed to be an index of the palatability-discerning ability of each panel member, that is, an F- value higher than the 5% significance level was judged reliable.

Taste preference of panel member

The correlation coefficient between the mean values judged by the panel (21 members) and the mean of the values judged by each panel member was calculated. If this correlation coefficient value is close to 1, the evaluation by each panel member agrees to the whole average (evaluated by the panel). That is, the value of this correlation coefficient shows the corresponding level of the evaluation by the panel and by each panel member. This correlation coefficient value was assumed to show the taste preference of each panel member.

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Statistical analysis

Correlation coefficients was determined by Pearson's correlation coefficient test. An ANOVA was used in conjunction with Tukey–Kramer to test for significant differences. All statistical analysis was performed with the software statistical analysis system (Statcel-the Useful Addin Forms on Excel-3rd ed., 2012, OMS Publishing Ltd., Tokyo, Japan).

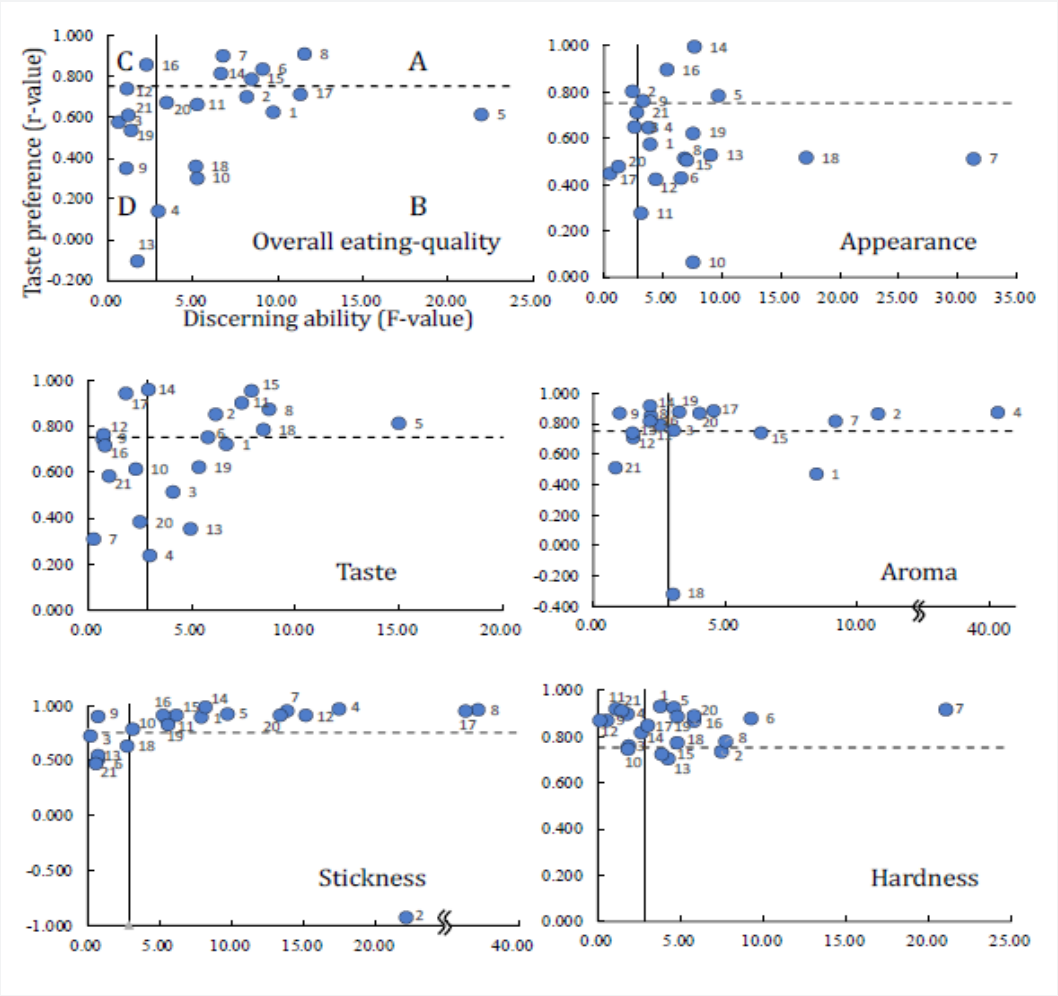

Figure 1: Relationship between reliability of sensory test and the taste preference of each panel member.
——————: 5% significance levels of the F-value.
○---------○: 5% significance levels of the correlation coefficient.

Results

Mean value of palatability evaluated by each panel member

The mean values of the palatability of 6 cultivars evaluated by each of the 21 panel members are shown in Table 2. For each evaluation item, the range of the value judged by each panel members (maximum value - minimum value) was 2.16 for overall eating-quality, 3.00 for appearance, 1.67 for taste, 1.27 for aroma, 2.39 for stickiness, and 1.78 for hardness. The range of appearance was wider than that of the other items and the range of the value of aroma was narrow. As for the judgment values, panel members No. 6 and No. 8 had larger values, and conversely, No. 13 had smaller values. The LSD (5%) for panel member's difference in overall eating-quality, appearance, taste, aroma, stickiness and hardness of six cultivars was 0.566, 0.688, 0.544, 0.483, 0.763 and 0.566, respectively, with larger values for appearance and stickiness.

Mean value of palatability evaluated for each cultivar

The mean values of the palatability of each cultivar evaluated by the panel (21 members) are shown in Table 3. The overall eating-quality of all six cultivars were superior to the check cultivars and no inferior cultivars were identified. Shan Rice was the highest at 1.26, followed by Phyar Pon Paw San 1.08 and Shwebo Paw San 1.02. The range of values judged by each panel member for each evaluation item was wide at 2.19 for hardness and 1.77 for

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stickiness, while the overall eating-quality was narrow at 0.51. The LSD (5%) for cultivar difference in overall eating-quality, appearance, taste, aroma, stickiness and hardness of six cultivars was 0.308, 0.371, 0.277, 0.230, 0.369 and 0.366, respectively.

Analysis of variance for palatability evaluation

Analysis of variance for palatability evaluation is shown in Table 4. Concerning the overall eating-quality, differences among cultivars and panel members were significant differences at the 1% level, and the interaction between cultivars and panel members was also significant. This indicates that the judgment of the difference among cultivars is significant as a panel member for the overall eating-quality, but the judgment of the difference among cultivars varies with the panel member. Also concerning the appearance, taste, stickiness and aroma showed similar trends to the overall eating-quality. On the other hand, the evaluation of hardness tended to differ from that of other items. Significant differences were found among panel members and cultivars, but there was no interaction between panel members and cultivars. This indicates that although there are differences in the evaluation of hardness by each panel member, there is a certain trend in the evaluation of the differences among cultivars by panel members.

Table 2: The mean values* of the palatability of 6 cultivars evaluated by each of the 21 panel members

Panel member No.	Sensory attributes					
	Overall eating-quality	Appearance	Taste	Aroma	Stickiness	Hardness
1	0.94	0.89	0.83	0.61	1.00	-0.67
2	1.17	0.50	1.11	0.61	-1.22	-1.17
3	1.33	1.00	0.89	1.00	0.11	-0.44
4	0.67	0.06	0.67	0.61	1.11	-0.33
5	0.72	0.83	0.72	0.17	0.67	-0.89
6	1.44	1.78	1.11	0.33	-0.56	-1.28
7	1.06	-0.61	0.22	0.50	0.94	-0.78
8	2.44	2.39	1.89	0.17	1.17	-1.78
9	0.83	1.11	0.72	0.056	0.83	-0.78
10	0.50	0.67	0.67	0.17	0.56	-0.83
11	1.17	1.61	1.44	1.33	0.17	-0.56
12	0.78	0.56	0.50	0.17	0.72	-0.28
13	0.28	0.33	0.33	0.83	-0.28	-0.17
14	1.53	1.00	1.22	0.44	0.72	-1.22
15	0.94	1.16	1.33	0.44	0.61	-0.50
16	0.94	1.11	0.72	0.44	0.50	-0.33333
17	1.28	0.89	1.06	0.89	0.78	-0.39
18	0.50	0.33	0.94	0.56	0.50	-0.83
19	0.78	0.50	1.11	0.50	0.28	-0.39
20	0.83	0.67	0.83	0.11	0.72	-0.72222
21	0.94	0.56	0.50	0.11	0.78	0.00
l.s.d. (0.05)	0.566	0.688	0.544	0.483	0.763	0.566

The check cultivar for the sensory tests was Manaw Thu Ka.
*: Average value of 18 (6 cultivars x 3 repetitions).

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Table 3: The mean values* of the palatability of each cultivar evaluated by the panel

Cultivar	Sensory attributes					
	Overall eating-quality	Appearance	Taste	Aroma	Stickiness	Hardness
Manaw Thu Ka	0.00	0.00	0.00	0.00	0.00	0.00
Ayeyar Min	0.92	1.59	0.71	0.14	-0.14	0.24
Shan Rice	1.26	0.65	1.35	0.60	1.63	-1.95
Shwebo Paw San	1.02	0.51	1.02	1.19	0.30	-0.48
Pyapon Paw San	1.08	0.56	1.02	0.44	0.54	-0.84
Pathein 90 days	0.75	0.84	0.46	0.22	0.02	-0.19
Hnan Kyauk	1.00	0.81	0.83	0.27	0.54	-0.87
l.s.d. (0.05)	0.308	0.371	0.277	0.230	0.369	0.366

The check cultivar for the sensory tests was Manaw Thu Ka.
*: Average value of 63 (21 panel members x 3 repetitions).
*: Average value of 63 (21 panel members x 3 repetitions).

Table 4: Analysis of variance for palatability evaluation of cooked rice

Source of variation	Overall eating-quality				Appearance				Taste			
	df	SS	MS	F	df	SS	MS	F	df	SS	MS	F
Total	440	398			440	575.27			440	346.41		
Panel members (P)	20	63.33	3.17	6.42**	20	121.36	6.07	11.10**	20	46.88	2.34	5.11**
Cultivars (C)	6	62.44	10.41	21.1**	6	86.25	14.37	26.30**	6	72.54	12.09	26.39**
Interactions P x C	120	127.22	1.06	2.14**	120	206.99	1.72	3.16**	120	92.32	0.769	1.68**
Error	294	145	0.49		294	160.67	0.55		294	134.67	0.458	
Source of variation	**Aroma**				**Stickiness**				**Hardness**			
	df	SS	MS	F	df	SS	MS	F	df	SS	MS	F
Total	440	246.71			440	618.89			440	677.06		
Panel members (P)	20	34.24	1.71	6.51**	20	103.56	5.18	6.41**	20	55.63	2.78	2.66**
Cultivars (C)	6	59.35	9.89	37.60**	6	137.02	22.84	28.28**	6	201.95	33.66	32.13**
Interactions P x C	120	75.8	0.63	2.40**	120	140.98	1.17	1.46**	120	111.48	0.93	0.89ns
Error	294	77.33	0.26		294	237.33	0.81		294	308.00	1.05	

**: Significant at the 0.01 probability level.
ns: Not-significant ($p<0.05$).
df: Degrees of freedom, SS: Sum of Squares, MS: Mean Square.

Contribution of each evaluation item to overall eating-quality

Table 5 shows the results of the multiple regression analysis with overall eating-quality over two years as the objective variable and the other evaluation items as the explanatory variables. The standard partial regression coefficients was positive for appearance and taste, and negative for aroma, stickiness and hardness, and the overall eating-quality tended to be higher for cultivars with lower stickiness and hardness and superior taste. The standard partial regression coefficients for each evaluation item was highest for stickiness at -1.568 and hardness at -1.524, respectively, followed by taste at 1.027. Aroma and appearance were low at 0.271 and -0.142, respectively. The contributions of appearance, taste, aroma, stickiness, and hardness estimated from the ratio of standard partial regression coefficients were 6%, 23%, 3%, 35%, and 34%, respectively, with stickiness making the largest contribution to overall eating-quality, followed by hardness and taste, and aroma making the smallest contribution.

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Table 5: Standard partial regression coefficient for evaluation item against the overall eating-quality of cooked rice.

Multiple correlation coefficient	Appearance	Taste	Aroma	Stickiness	Hardness
0.9999*	0.271†	1.027*	-0.142ns	-1.568*	-1.524*
Df =6, n=7	6.0#	22.7	3.1	34.6	33.6

*, †: Significant at P< 0.05 and 0.10, respectively.
ns: Not significant.

#: Contribution estimated from the ratio of standard partial regression coefficients (%).

Reliability of sensory test and taste preference of each panel member

Figure 1 shows the relationship between reliability of sensory test (discerning ability) and the taste preference of each panel member. The vertical solid line in the figure shows a 5% significance level of F-value that represent discerning ability of each panel member, and the horizontal dotted line shows the correlation between the taste preference of each panel member and all (21) panel members (taste preference) at 5% significance level. In terms of discerning ability and the taste preference, panel members were grouped into four categories: A, B, C, and D. Panel member A belonging to the upper right of the figure have high discerning ability and high the taste preference. It naturally qualifies as a panel. Panel member B belonging to the below right of the figure does not correspond to the taste preference of the panel, their discerning ability is high and are qualified as panel members. Panel member C belonging to the upper left of the figure corresponds to the taste preference of the panel (21 members), their discerning ability is low. Therefore, it is not qualified as a panel. Panel member D belonging to the se does not correspond to the taste preference of the panel, and their discerning ability is also low. Therefore, they do not qualify as panel.

As shown in Figure 1, there were as many as the number of panel member who had discerning ability for overall eating-quality at the 5% significance level was fourteen (about 70% of all panel members), and seven were ineligible to serve on the panel. In terms of taste preferences, the diversity of the taste preferences was observed, with only five panel members (about 30% of all panel member) having similar the taste preferences to the panel as a whole amongst those who qualified for the panel. For each of the other evaluation items, the percentage of panel members who could discern differences among cultivars at a significance level of 5% was 80%, 60%, 60%, 70% and 60% for appearance, taste, aroma, stickiness and hardness, respectively, all above 60%. In terms of taste preference, the proportion of panel members with significant discriminative ability and similar taste preferences to the panel as a whole was 20%, 30%, 40%, 70% and 50% for appearance, taste, aroma, stickiness and hardness, respectively, with appearance being the lowest.

Discussion

This study was conducted to grasp the taste preferences of the Myanmar people for rice and to establish a rice eating quality evaluation method based on the taste preferences. In Asia, where rice is a staple food, the reliability of sensory tests for cooked rice has not been examined, with the exception of Japan. Here, the reliability of the sensory test was verified by analyzing the panel's discerning ability and taste preference by conducting eating quality evaluations according to the Japanese sensory test method using seven commercially available Myanmar rice cultivars. The results obtained in this study can be used in selection methods for highly palatable rice cultivars based on the taste preferences of the Myanmar people. Furthermore, they can be effectively used as a countermeasure technology for highly palatable rice production.

Mean value of palatability evaluated by each panel member and evaluated for each cultivar

The range of values in each evaluation item by the 21 panel members in this study were all wider than those reported by Matsue [5]. The LSD (5%) values for panel members difference in the overall eating-quality were larger than the 0.518 reported by Matsue [5]. This is due to the fact that the range of overall eating-quality values (maximum value- minimum value) among panel members was larger than in Matsue [5]. On the other hand, the range of values for each evaluation item in the six cultivars were all smaller than previously reported [5,7]. The LSD (5%) values for cultivars difference in in the overall eating-quality was smaller than that reported for Matsue [5] 0.522 and Osato et al. [7] 0.429. This is due to the fact that the range of overall eating-quality values among cultivars was larger than in Matsue [5] and Osato et al. [7].

Analysis of variance for palatability evaluation

For the overall eating-quality, appearance, taste, aroma and stickiness, respectively, the judgment of the difference among cultivars as a panel was significant at the 1% level, indicating that the discriminability of the difference among cultivars was high, but the judgment of the difference among cultivars differed among the panel members. These results are consistent with those reported by Matsue [5]. On the other hand, the evaluation of hardness showed a different trend from the other evaluation items, indicating a certain trend in the evaluation of the difference among cultivars by each panel member, although there were differences in the evaluation among panel members. This means that there is no significant difference among the panel members in their evaluation of the difference among cultivars in the hardness of cooked rice (the judgment value is either positive or negative, never a mixture of positive and negative values). For hardness, it

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has been known that it is difficult to discern differences among cultivars [3,4,5,7]. However, in contrary to previous reports, hardness discrimination was high in the present study. This is a characteristic of the Myanmar panel, indicating a high level of awareness of hardness.

Contribution of each evaluation item to overall eating-quality

Stickiness contributed the most to the overall eating-quality evaluation, followed by hardness and taste, and aroma contributed the least (Table 5). The fact that taste and stickiness are strongly related to overall eating-quality is consistent with previous reports [9,11,12]. However, the result that hardness is also strongly related to eating quality, but appearance is weakly related, differs from previous reports. In particular, regarding stickiness, the Myanmar people who showed the taste preference for non-sticky rice differed from the Japanese the taste preference for stickiness, indicating that the taste preferences for eating quality of rice differ depending on the country or ethnic groups. The taste preferences of the Myanmar people, who prefer soft cooked rice with excellent taste, low stickiness, and softness, obtained here, will provide useful knowledge for the development of highly palatable rice cultivars based on Myanmar people's preferences in the future. By the way, although stickiness was positively correlated (r = 0.604) with overall eating-quality in the single correlation, it showed a negative value (-1.568) in the standard partial regression coefficient. This is because a negative correlation (r = -0.987) was found between stickiness and hardness, indicating that the overall eating-quality is mainly influenced by hardness rather than stickiness.

Reliability of sensory test and taste preference of each panel member

In the overall eating-quality, Matsue [5] and Ohsato et al. [7] reported that no panel members were observed who had discerning ability but whose taste preferences differed from the whole evaluation. However, in the present study, 60% of the panel members (proportion of panel members with discerning ability) were observed to have discerning ability, but whose taste preference differed from the whole evaluation. This is a characteristic of the Myanmar Panel, which can be an effective panel in developing highly palatable rice cultivars. However, in developing uniform rice cultivars with good eating quality, it is important to explain to panel members the purpose of good eating quality (Focused evaluation items) before the sensory test. Furthermore, in previous reports (5, 7, 9), the taste preferences of panel members with high discerning ability were consistent with the whole trend. In the present study, however, there was no constant relationship (r=0.336) between the discerning ability and taste preference of each panel member. This was due to a number of panel members whose taste preferences did not match the whole trend, despite their high discerning ability. Appearance and taste also differed from previous reports, with 80% and 50% of the panel members observed to have discerning ability and taste preferences that differed from the whole evaluation, respectively.

Conclusion

Concerning the overall eating-quality, Concerning the overall eating-quality, the proportion of panel members who were found to be able to discriminate was high, at around 70% of the total panel (15 out of 21). Regarding the taste preference, about 60% of the panel members with high discerning ability differed from the evaluation by the panel as a whole, indicating diversity. These indicate that the Japanese sensory test method can be used to evaluate Myanmar cultivars by a Myanmar panel, as the differences among cultivars in overall eating- quality are significant at the 5% level, despite the presence of diversity for taste preferences. The contribution of each evaluation item to the overall eating-quality, estimated from the ratio of the standard partial regression coefficients, was largest for stickiness, followed by hardness and taste, with aroma contributing the least.

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