Japanese consumer acceptability of commercial rice from Japan and Thailand

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Abstract

Most rice consumed in Japan is local white rice (Japonica varieties). Many varieties of rice in global market have been introduced and eaten by consumers including aromatic, brown, and other colored types. Understanding Japanese consumer acceptability with the current varieties of rice helps rice producers and marketers to meet the consumer demands and leads to a potential for rice trading in Japan. Eight different rice samples from Japan and Thailand were evaluated by a group of 102 Japanese consumers. A sensory evaluation by asking overall degree of liking, appearance liking, flavor liking, and texture liking in each sample was conducted. Cluster analysis, internal preference mapping, and regression analysis were used to reveal the Japanese consumer acceptance. The majority of Japanese consumers liked the white rice from Japan and also Jasmine rice from Thailand. Japanese brown rice was also received a good liking score from a number of Japanese consumers. Other colored varieties including red and black varieties were not preferred by Japanese consumers. Flavor was the most important factor effecting overall degree of liking. Appearance and texture had less importance in determining overall acceptance.

Keywords: consumer acceptability, rice, cluster analysis, sensory evaluation, hedonic scores

1. Introduction

Rice is a highly significant food crop around the world because it feeds more than half of the world's population (Zhai *et al*., 2001). In the past, consumers get used to eat just completely milled rice or white rice due to its popularity and perceived cultural factors. Nowadays, the trend of rice consumption gradually changes to healthier alternatives in some groups of consumers. With the varieties of choices and the considerations on consumers' health benefits, brown rice and other colored/pigment rice varieties (black, purple and red rice) have been continually accepted and consumed by consumers (Laokuldilok *et al*., 2010, and Tanaka *et al*., 2010).

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Different from other cereal crops, which are milled into flours, rice is mostly cooked and consumed in wholegrain form (Crowhurst& Creed, 2001). Thus, all sensory properties including appearance, aroma, flavor, and texture are all important factors in defining the character and sensory profile of a rice sample. Aromatic rice has much more dominant aromas than nonaromatic cultivars. Two popular aromatic varieties sold in markets are Jasmine rice from Thailand and Basmati from India and Pakistan. Over the past two decades, those two fragrant types of rice have become increasingly popular in many countries, especially in Asia and Europe and more recently in the United States (Mahatheeranont *et al.*, 2001).

Rice is the origin of Japanese food culture. In a traditional Japanese diet, the carbohydrates contained in rice are the main energy source; around one-third of the energy intake (Toriyama, 2005). In Japan, rice is eaten in several ways, most commonly as plain rice consumed as part of a typical meal accompanied by several dishes, various pickles, and miso soup. It is also used in sushi and rice ball. However, the Japanese government has the policy to support domestic rice producers by setting quotas and high tariffs on foreign rice. As a result, most rice consumed in Japan is domestically produced. However, price increases in recent years have led an increasing number of Japanese consumers and restaurants to seek out the cheaper rice imported from other countries. Thus, this situation might be a good chance for Thai rice exporters to have a potential in selling Thai rice to Japan rice market. To prove this possibility, consumer acceptability of current rice types which are available in markets such as brown rice, aromatic rice, and some colored/pigment rice for Japanese consumers should be studied.

2. Materials and Methods

2.1 Samples

Eight rice samples, purchased from local supermarkets and grocery stores in Thailand and Japan, were collected and prepared for testing. Samples used in this study included: Thai Jasmine, Non waxy Japanese types (Koshihikari), both white and brown forms, Thai Jasmine red rice, Thai Sang Yod brown rice, Thai Black rice (rice berry) , and Thai hill half milled brown rice. All raw rice samples were individually weighted into 2-cup portions and placed in plastic bags. The sealed samples were then stored in a refrigerator at 4°C until testing. A list of samples and their respective cooking procedures are presented in Table1.

Table 1 Rice Samples and Cooking Procedures

Product Name	Origin	Cooking times
Jasmine White Rice	Thailand	50 minutes
Jasmine Brown Rice	Thailand	1 hour 45 minutes
Non waxy White Rice (Koshihikari)	Japan	50 minutes
Non waxy Brown Rice (Koshihikari)	Japan	1 hour 45 minutes
Sang Yod Brown Rice	Thailand	1 hour 50 minutes
Black Rice (Rice berry)	Thailand	2 hours
Jasmine Red Rice	Thailand	1 hour 50 minutes
Hill Half Milled Brown Rice	Thailand	1 hour 50 minutes

2.2 Sample preparation

Rice samples were retrieved from cold storage and left out at the room temperature for at least 12 hours before cooking. Rice cookers (Sharp: Model # KS-C5H-W, 0.54L) were used to cook all rice samples. Samples were prepared using water to rice ratios based on the rice cooker instruction combined with the pre-test in order to control overall rice qualities (Table 1). The rice sample and water were put into the cooker holding chamber, covered with a vented lid, and cooked at a preset setting for “White Rice” or “Brown Rice” to be cooked. The remained samples covered throughout the cooking duration. When cooking was complete, the rice cookers were immediately unplugged. The rice samples were kept in a covered holding chamber for 10 minutes. The rice samples were then fluffed using a plastic spoon.

Each cooked rice was measured and placed into the plastic cups. Approximately 10 grams of cooked rice was placed into soufflés plastic cups (Japanese brand, 30 ml. size) covered with a transparent plastic lid (Japanese brand) with 3-digit codes. The completed samples were then placed and served to the consumers.

2.3 Participants

The consumer test was conducted as the central location test in the cafeteria of Graduate School of Horticulture, at the Chiba University, Matsudo campus, Japan. The consumers (age range 18–80 years old) were from Matsudo, Tokyo and other prefectures nearby. The participants were recruited though study announcement and walk-in on the Graduate School of Horticulture open house day. To qualify for the study, participants had to consume rice at least 2 times per month. Each consumer was assigned a log number, given a brief explanation of the test objectives and seated at a test table. All protocols for this study were approved by the Human Subjects Committee of the Graduate School of Horticulture Research. Once seated and briefed, each person received a questionnaire packet including

tasting part and exit survey. Each consumer was provided with a set of 8 spoons, some napkins, and a cup of water. Samples were presented on a white paper tray and identified by three digit codes. The order of presentation of the samples was completely randomized to balance out any potential serving order or carry-over effects. The study consisted of two sessions. During the first session, consumers evaluated a total of 4 samples with a 2–3 minute break taken after every 4 samples. The 9-point hedonic scale (Lawless &Heymann, 2010) anchored from “dislike extremely” to “like extremely” was used to assess the acceptance of the various products (overall liking, liking of appearance, flavor, and texture). In the second session, consumers completed an exit survey that assessed their demographics and consumption behavior. Consumers received a gift from Thailand for their participation in the study.

2.4 Statistical/Data analysis

Multivariate statistical techniques involved in interpreting consumer test data are internal preference mapping, cluster analysis, and partial least square regression (PLS). Preference mapping is a group of multivariate statistical techniques designed to develop a deeper understanding of consumer liking of products. Internal preference mapping derives a multidimensional representation of products and consumers. This technique is based on a PCA (Principal Component Analysis) (XLSTAT version 2012, Addinsoft, Paris, France) performed on preference data, as observations of the products, and as variables of the consumers (Naes *et al*., 2011). The results from running internal preference maps are easy to interpret by generating a map on which one can identify the consumers’ or groups of consumers preferences represented as vectors or groups of points. To have a better understanding in groups of consumer preferences, an additional statistical technique called cluster analysis can be used before analyzing internal preference mapping. Cluster analysis was used to segment consumers into subsets based on degree of similarity among their liking ratings for a set of products (MacFie, 2007). The Euclidean dissimilarity matrix and Ward’s method of agglomerative hierarchical clustering technique were used. Consumer liking was further analyzed by Partial Least Square Regression (PLS) (XLSTAT version 2012, Addinsoft, Paris, France). Overall liking was predicted from consumer liking of appearance, flavor, and texture as predictors. The regression coefficients expressed numerically the link between variations in the predictors and variation in the responses. Weighted regression coefficients (i.e. coefficients weighted by the variable mean value) were used to express their relative influence independently of differences in preference intensities.

3. Results and Discussion

3.1 Cluster analysis

Cluster analysis aims to group consumers or products into homogenous subsets. In sensory and consumer science, cluster analysis can be used to segment consumers into subgroups based on their liking ratings for a set of products. Such consumer segmentation is an essential step in preference mapping, where the goal is to understand drivers of consumer likings, and cluster analysis is used to summarize differences among consumers in their likes and dislikes (Næs *et al*., 2011; Parente *et al*., 2011). Cluster analysis was performed on the basis of consumer responses to reveal the numbers of consumer segments in each category including (1) appearance liking, (2) flavor liking, (3) texture liking and (4) overall degree of liking.

Three clusters were revealed in appearance liking, flavor liking and texture liking categories (Figure 1–3) and four clusters were obtained in overall degree of liking result (Figure 4). To see the distribution of consumer preferences and samples, internal preference maps were created based on the cluster analyses results.

3.2 Internal preference mapping

Internal preference maps were plotted to provide graphical representations of consumer responses and sample coordinates with the clusters derived from the cluster analyses. Both internal preference maps and average scores of each sample were used simultaneously in the interpretations.

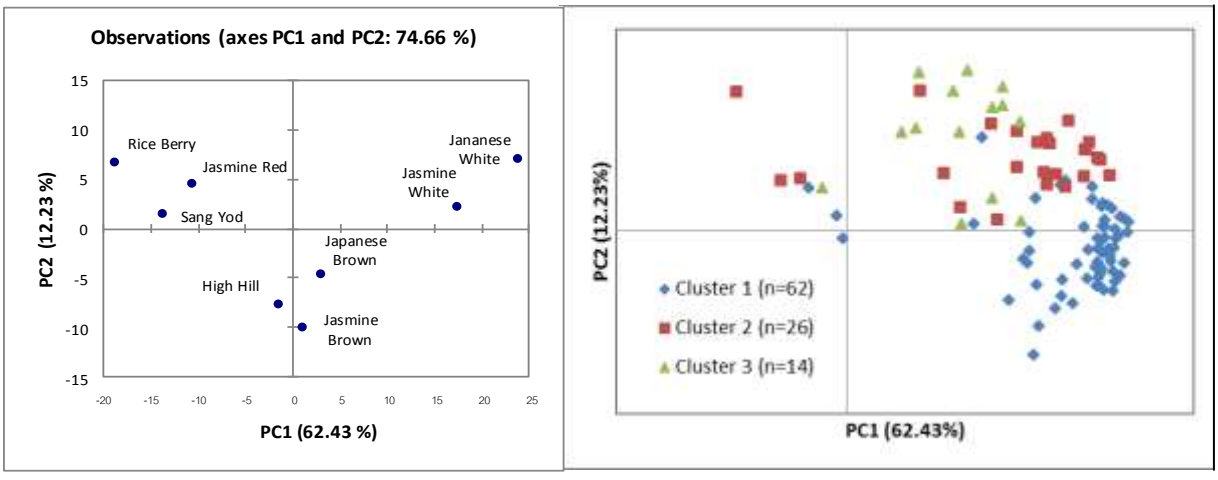

Figure 1 Internal preference map on principal components 1 and 2 (PC1 and PC2) for appearance liking among the 8 rice samples. PC1 and PC2 combined explain 74.66% of the variance in the data set (n=102)

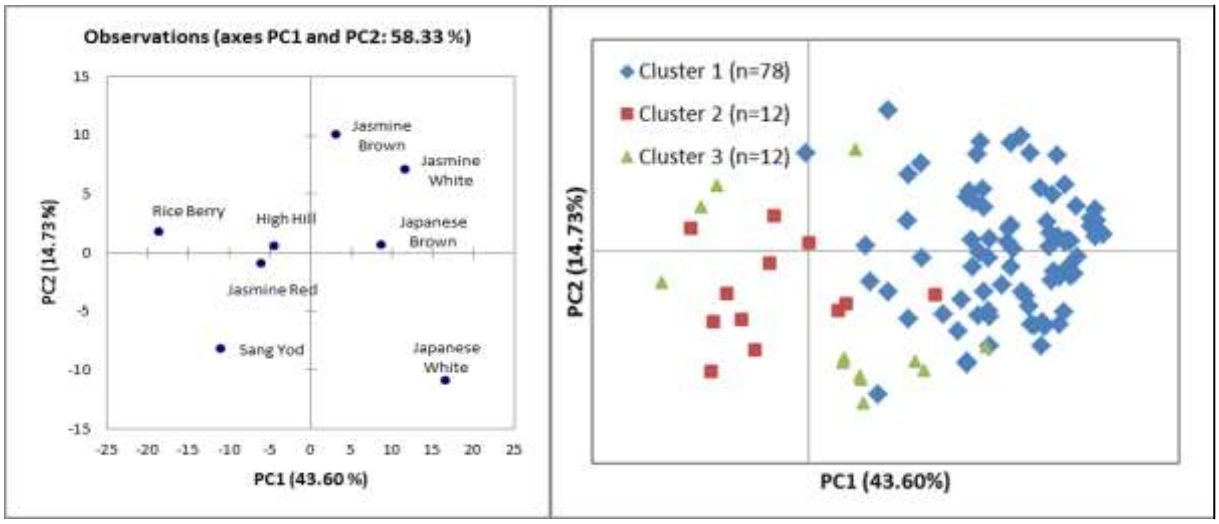

Figure 2 Internal preference map on principal components 1 and 2 (PC1 and PC2) for flavor liking among the 8 rice samples. PC1 and PC2 combined explain 58.33% of the variance in the data set (n=102)

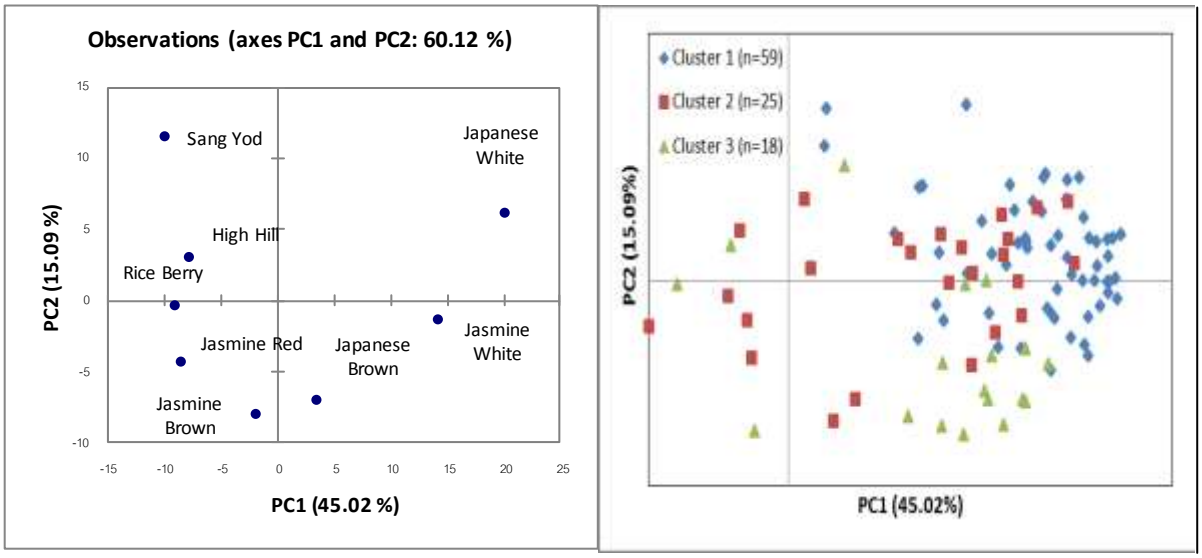

Figure 3 Internal preference map on principal components 1 and 2 (PC1 and PC2) for texture liking among the 8 rice samples. PC1 and PC2 combined explain 60.12% of the variance in the data set (n=102)

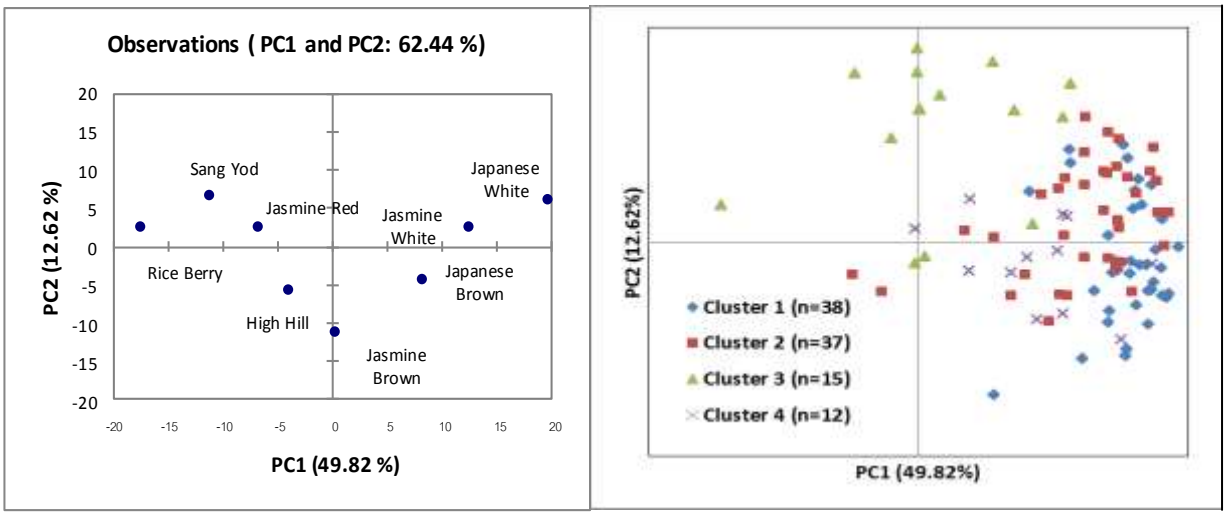

Figure 4 Internal preference map on principal components 1 and 2 (PC1 and PC2) for overall degree of liking among the 8 rice samples. PC1 and PC2 combined explain 62.44% of the variance in the data set (n=102)

According to a plot of appearance liking (Figure 1), consumers in all three clusters preferred the look of Japanese white rice and Jasmine white rice. The colored rice varieties including rice berry, Jasmine red and San Yod varieties were not favored by consumers in all clusters. Visual characteristics of grain by means of shape, size, or color are considered the physical quality of rice by consumers. From the result of appearance liking plot, it was clearly seen that Japanese consumers preferred the white rice appearance. The other colors such as brown, red, or purple did not receive some good scores on sensory evaluations. Another interesting point is the characteristics of shape and size of the rice grain. Japanese type is classified as short grain type and it has the round or oval shape while Jasmine rice from Thailand is characterized as long grain with slender shape. Thus, the shape and size of rice do not have a big impact on consumers' appearance liking when comparing with the color. This finding is consistent with the previous studies conducted by Suwansri et al. (2002) and Meullenet et al. (2001), degree of whiteness was one of the most important acceptance factors for Asian consumers. Their customs and familiarity in eating white rice should be the main reasons for Asian consumer preferences (Lyman, 1989).

In the flavor liking plot (Figure 2), consumers in cluster 1 (majority, n=78) liked the flavor of Japanese and Jasmine types in both white and brown forms but they disliked high hill (half milled), rice berry, Jasmine red and Sang Yod. In contrast to the flavor likings of cluster 1, consumers in cluster 2 (n=12) liked the flavor of colored varieties such as rice berry, Jasmine red and Song Yod rice. Consumers in cluster 3 (n=12) preferred mainly on Japanese white rice. The majority of Japanese consumers liked the flavor of Japanese and Jasmine varieties

in both white and brown types but they disliked colored rice varieties including high hill, rice berry, Jasmine red, and Sang Yod. This might be due to the flavor of the colored varieties. Bett-Garber *et al*. (2012) found that black rice had oily, darkberry, medicinal and smoky flavors. Red rice gave beany, animal related and earthy flavor. Moreover, the darker the color in rice cultivars, the more the bitter and astringent will be perceived. The main explanation supporting this finding is that Japanese consumers are used to eating Japanese white rice (Nanri *et al*., 2010). However, the result also shows that Japanese brown rice also preferred by Japanese consumers. Jasmine rice which is an aromatic variety from Thailand also got high acceptability in both white and brown forms. This result suggested that brown rice consumption in Japan is acceptable and Japanese people seem to be more interested in eating brown rice for health reasons.

In the texture preference map (Figure 3), the result shows the same manner as appearance liking plot. Consumers in all three clusters liked the texture of Japanese white rice and Jasmine white rice. However, in the texture preference map, Japanese brown rice was also favored by consumers in cluster 2 (n=25) and cluster 3 (n=18). A set of colored rice types (San Yod, high hill, rice berry, and Jasmine red) locate on the opposite side of Japanese white rice and Jasmine white rice. These colored types of rice did not receive high liking scores among the majority of consumers. The result of texture liking clearly presented that Japanese consumers preferred the white rice in both varieties (Japanese and Jasmine from Thailand). These two varieties have some similarities of texture when cooked. For rice, starch is the main factor influencing the texture characteristics. Two types of starch are found in rice: amylose, which makes the rice separate and fluffy, and amylopectin, which gives rice a sticky consistency when cooked (Syahariza *et al*., 2013). The high amylose rice, long grain, tends to be dry and fluffy with the grain well separated whereas short grain, low amylose, becomes tender, sticky, and chewy when cooked (Champagne, 2004). Japanese white rice is soft and sticky due to low amylose content (12–17%) (Mundo & Juliano, 1981). Jasmine white rice is also soft in texture but it is not as sticky as the Japanese white rice because the amylose content of Jasmine rice is between 13 to 19 % by weight which is not high enough to make the rice's texture dry and fluffy (Nakorn *et al*., 2009). Juliano et al. (1981) also mentioned the trend of textural preference on rice from the east to the South of Asia. Textural preference in the North and East Asia consumers is soft and sticky after cooking, whereas that in south of Asians is generally dry and fluffy. Southeast Asians prefer the texture of rice that comes in between. Another factor influencing texture in rice is the presence of a high-fiber bran coating (Bett-Garber *et al*., 2001; Juliano *et al*., 1981). The bran layer and the germ in brown rice or colored rice create some textural differences between unpolished rice and polished rice

(white). Brown and other colored rice have a chewier texture, stickier texture, more residue particle, more texture roughness, and more tooth packing than white rice. This might be one of the main explanations that lead to low consumer acceptability of unpolished rice in Japan.

As presented by a plot of overall degree of liking (Figure 4), the consumers in two big clusters (n=38 and n=37) liked Japanese white rice, Jasmine white rice, and Japanese brown rice but the majority of consumers in both clusters did not like any of colored rice types. The consumers in a smaller cluster (n=15) preferred Japanese white rice, Jasmine white rice, and Sang yod rice. The consumers in this smaller cluster did not like both Jasmine and Japanese brown rice, and high hill (half milled). The consumers in the last cluster (n=12) liked Japanese brown and Japanese white rice but they disliked a set of colored rice including rice berry, Sang Yod, Jasmine red, and high hill (half milled).

It should be noted that internal preference mapping suggests the direction of the preference of a set of products tested but not provide any prediction. To have the data on prediction, Partial least square regression (PLS) is analyzed.

3.3 Prediction of overall degree of liking from appearance liking, flavor liking, and texture liking (based on clusters)

Overall acceptance is predicted with by using consumer acceptance of appearance, flavor, and texture as predictors. The regression coefficients express numerically the link between variation in the predictors and variation in the responses. Figures 5, 6, 7, 8 are plots of weighted regression coefficients for a model predicting overall degree of liking from appearance liking, flavor liking, and texture liking scores in each cluster. For consumers in cluster 1, 2 and 4, flavor was the most important factor in determining their overall degree of liking. For consumers in cluster 1, appearance was the second most important and texture was the least important predictors. In cluster 2, consumers perceived that appearance and texture were same level of importance in deciding their overall degree of liking. Results of consumers in cluster 3 show that all three sensory predictors had almost the same level of importance. Finally, consumers in cluster 4 concerned that texture played more important role than appearance in order to predict the overall degree of liking. Based on the results of regression analyses, Japanese white rice and Jasmine white rice were the types of rice that Japanese consumers preferred most. Japanese brown rice was also liked by consumers in most of clusters. When comparing the relative importance among appearance, flavor, and texture, the results show that consumers in most clusters agreed that the most important factor in determining their overall liking of a rice product was flavor. Appearance and texture seemed to play a smaller role in determining overall acceptance in all consumer groups. These results in

Japanese consumers were inconsistent with the previous studies (Meullenet *et al*., 2001; Suwansri *et al*., 2002), which reported that appearance was the most important determinant for overall acceptance in Asian consumers.

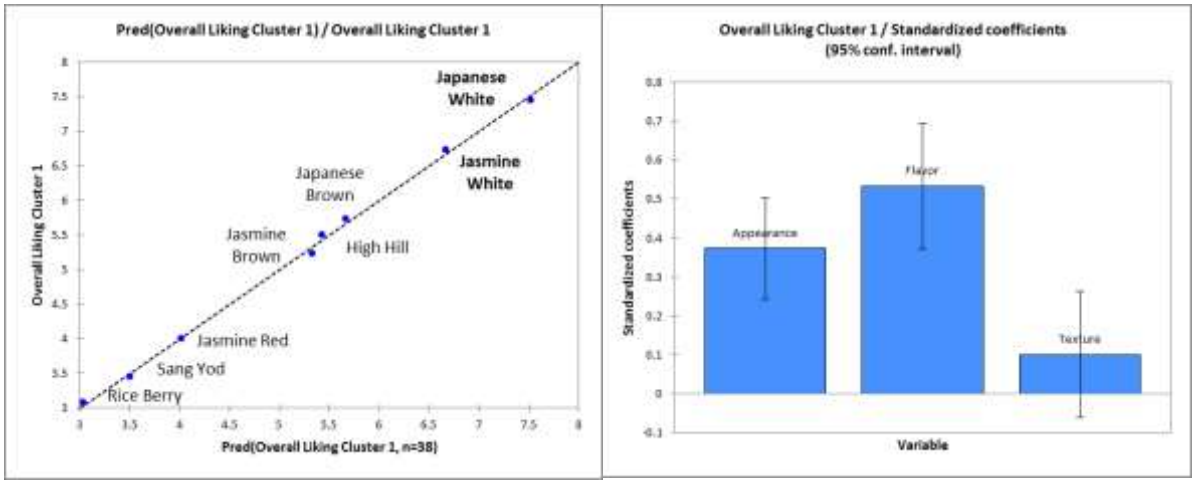

Figure 5 Predicted versus observed overall degree of liking and weighted regression coefficients for the partial least square regression model predicting overall degree of liking from appearance liking, flavor liking, and texture liking (consumers in cluster 1)

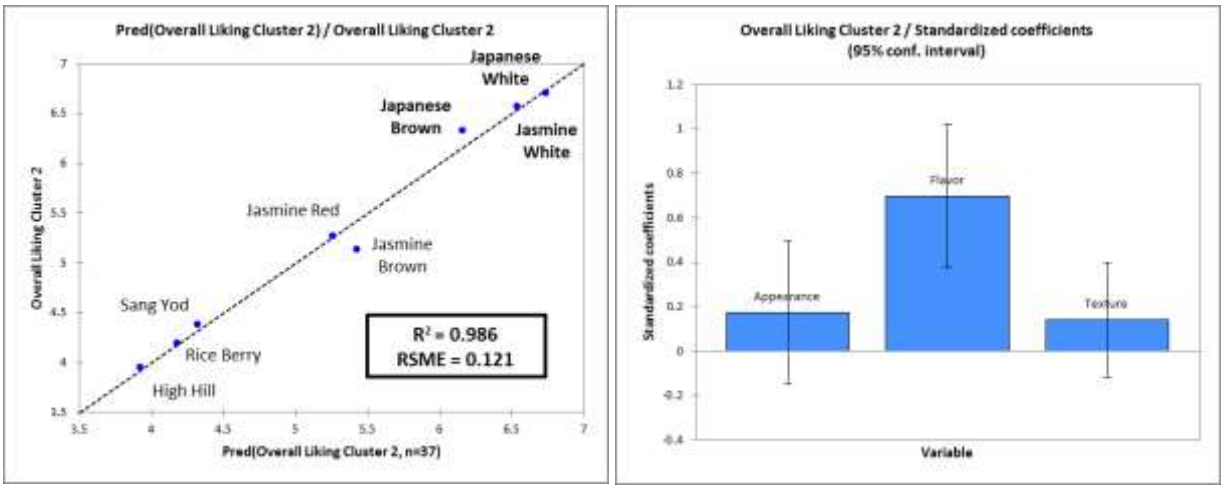

Figure 6 Predicted versus observed overall degree of liking and weighted regression coefficients for the partial least square regression model predicting overall degree of liking from appearance liking, flavor liking, and texture liking (consumers in cluster 2)

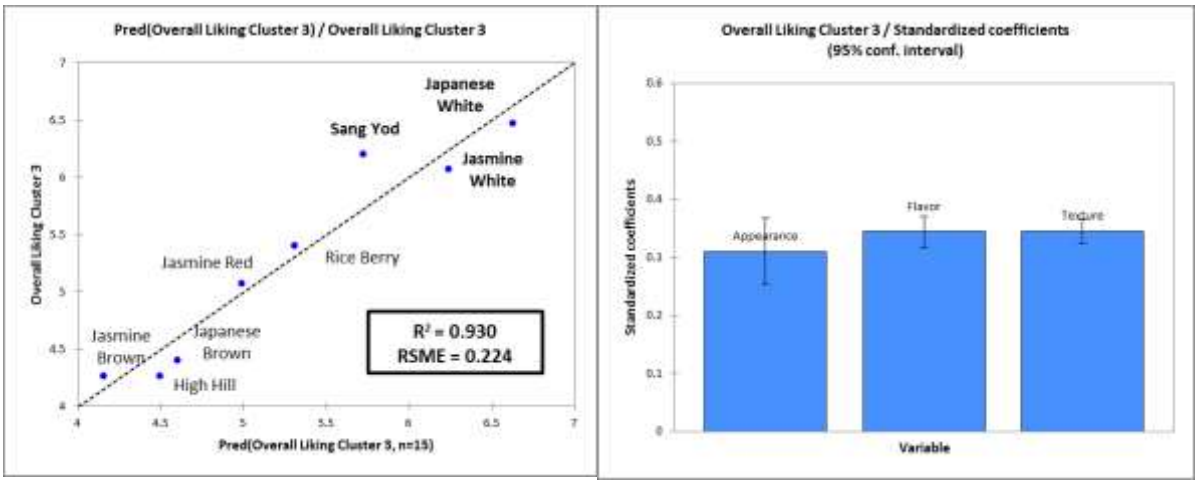

Figure 7 Predicted versus observed overall degree of liking and weighted regression coefficients for the partial least square regression model predicting overall degree of liking from appearance liking, flavor liking, and texture liking (consumers in cluster 3)

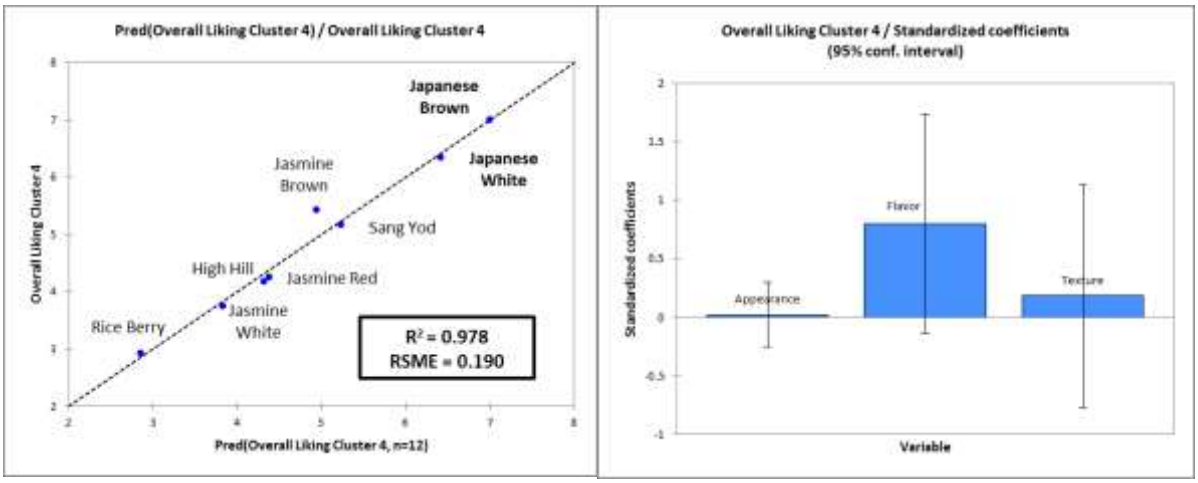

Figure 8 Predicted versus observed overall degree of liking and weighted regression coefficients for the partial least square regression model predicting overall degree of liking from appearance liking, flavor liking, and texture liking (consumers in cluster 4)

4. Conclusion

Among the rice samples from Japan and Thailand, Japanese consumers preferred the Japanese white rice and Jasmine white rice from Thailand the most. Japanese brown rice was another choice that Japanese consumers liked. Colored rice samples in this study got low acceptability scores. Regression analysis results show that flavor was perceived as the most important driver of overall liking in most of Japanese consumers. These findings could be useful to rice producers and rice marketers, to satisfy the desires of consumers in Japanese markets. This results also a good opportunity for Thai rice exporters for selling the Jasmine white rice to Japan.

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