Identifying Sensory Consumer Perceptions of Cooked Thai Jasmine Rice from Each Northeastern Provinces, Thailand

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Abstract

Descriptive sensory analysis (10 sensory attributes; 10 trained panels) and acceptance test (4 liking items; 50 consumer panels) were used to identify sensory perceptions of cooked Thai jasmine rice from each Northeastern provinces (N=20), Thailand. The sensory data were analyzed using principal component analysis. Three principal components (PCs) were found to describe the underlying sensory dimensions of the cooked Thai jasmine rice. They were designated as (1) plumpness, whiteness, sweetness, stickiness, softness, and fineness, (2) length and crumb, and (3) cooked rice odor and roughness. Then, the first two PCs were profiled into two dimensions of the sensory-perceptual map. The map showed that cooked Thai jasmine rice from Nong Khai province had the highest intensity of the attributes in both dimensions. The acceptance data were analyzed using analysis of variance. The result showed that cooked Thai jasmine rice from Nong Khai province had almost the highest mean scores of all liking items (p < 0.05).

Keywords: *Descriptive analysis, cooked Thai jasmine rice, principal component analysis, sensory perceptual map*

1. Introduction

Being the commercially important agricultural commodities produced in Thailand, Thai jasmine rice is particularly important and also known as "Kao Horm Mali (KHM)" as well as "Thai fragrance jasmine rice" (Kao = rice, Horm = fragrance and Mali = jasmine flower). It is the long grain rice, which is the most popular aromatic rice variety for cooking quality (Pitiphunpong et al., 2011). All types of Thai jasmine rice exports must not have a moisture content of more than 14%. Despite its high price and good grade, Thai jasmine rice is very popular in many countries such as Hong Kong and China (Rattiwan, 2014) and it is also in great demand overseas (Thailand Board of Investment, 2013). Total Thai jasmine rice exports are as high as 6.59 million metric tons, valued at 3.4 billion US dollars, or 105.8 billion baht. In terms of export value, Thailand remains the world's largest rice exporter (Post Today, 2014).

It is one of the main export products of the central and northeastern of Thailand. The famous Thai jasmine rice source is in the northeastern provinces (Sumner et al., 2001). Because of the most suitable geographic location, Thailand can grow the best quality and unique jasmine rice. Due to the most suitable environment factors, such as the ample amount of sunlight throughout the year, amount of rainfall, the best taste of Thai fragrance rice can only be grown in these provinces.

Jasmine rice from the individual northeastern province is advertised differently to be the best one of Thailand. There is one hypothesis, differentiate of landscape and climate in plenty of fields has an effect on quality and consumer acceptance or not. It is not known exactly what some Thai jasmine rice of northeastern provinces is more acceptable to consumers. Thus, it is interesting to evaluate the sensory characteristics of Thai jasmine rice in each province of this region using descriptive sensory analysis. Due to it as a scientific discipline used to evoke, measure, analyze, and interpret reactions to those characteristics of foods and materials (Anonymous, 1975). Descriptive analysis technique has been used for identifying and measuring products that are important to consumers scientifically and systematically (Nanthachai et al., 1997).

Principal component analysis (PCA) is a multivariate statistical technique to analyze descriptive data for reducing a set of dependent variables (attributes) into a smaller set of underlying variables (factors) using correlation among the attributes (Lawless and Heymann, 1998). The results can then be profiled product characteristics and differentiated products based on the attributes important to consumers include improved product characteristics for increasing market share for a given set of products.

This study was performed to identify sensory perceptions and consumer acceptance toward cooked Thai jasmine rice of twenty northeastern provinces of Thailand. It was done in an effort to see how each of cooked Thai jasmine rice was preferred and what sensory attributes make some cooked Thai jasmine rice relatively more liked than the others.

2. Objectives

To identify sensory consumer perceptions of cooked Thai jasmine rice from each of Northeastern provinces, Thailand.

3. Materials and Methods

Sample preparation

Twenty Thai jasmine rice grains (same KHM 105 variety grade A) from 20 northeastern provinces (20 mills) of Thailand were sampling. They were Amnat Charoen (AN), Bueng Kan (BK), Buriram (BR), Chaiyaphum (CP), Kalasin (KS), Khon Kaen (KK), Loei (LO), Maha Sarakham (MS), Mukdahan (MD), Nakhon Phanom (NP), Nakhon Ratchasima (NS), Nongbua Lamphu (NB), Nong Khai (NK), Roi Et (RE), Sakon Nakhon (SN), Sisaket (SK), Surin (SR), Ubon Ratchathani (UB), Udon Thani (UD) and Yasothon (YT). Each jasmine rice samples had to be harvested and milled in the same year. Before tasting, each of them was cooked in the same procedure using conventional rice cookers (Sharp KSH-211 model) and then controlled at the temperature of $50^{o}C$ (Nanthachai et al., 2003). Each sample was served with approximately 100 grams in a clear plastic container and closed cover for 100 grams and encoded for blind tasting with three digit random numbers to avoid any biases.

Subjects

There were two groups of subjects:

(1) Ten trained panels, of which five females and five males (subjects aged 18 to 35 years old) were chosen to conduct the experiment using a triangle test as described by Lawless and Heymann (1998). They were staff and students of Khon Kaen University, Nong Khai Campus of Thailand. And they had been trained to recognize each sensory attribute by informally evaluating the reference samples until their scoring had high consistency reliability. The same subjects participated throughout the study.

(2) Fifty consumer panels, of which twenty-five females and twenty-five females males (subjects aged 18 to 35 years old) were recruited using purposive sampling at Khon Kaen University, Nong Khai Campus. They were lecturers, technicians, supporting staff and students. These subjects had never been trained in taste testing before.

Panelists were not informed in any way about samples and were avoid not to use any cosmetics and not to consume foods at least 30 minutes before test sessions. Each subject was of good health and was willing to participate in this study.

Construction of sensory questionnaires

Descriptive sensory test as described by Stone and Sidel (1998) and acceptance test as described by Lawless and Heymann (1998) were carried out on the cooked Thai jasmine rice. Thus, two types of sensory questionnaires of both tests were constructed.

For a descriptive sensory test, ten sensory attributes of cooked jasmine rice (Nantachai et al., 2003) which derived using repertory grid method (Gains, 1994) were used as questionnaire items of the descriptive sensory questionnaire. Each of the items was associated with a 100 millimeters horizontal continuous line scale with anchor points five millimeters for both ends (not at all and extremely). This questionnaire was used to evaluate the intensity of each sensory attribute for each cooked Thai jasmine rice sample by each subject.

Acceptance testing was used to determine how much each sample was liked by consumer panels based on a 9-point hedonic scale questionnaire. A set of scale items were likings of overall, appearance, flavor and texture where 9 = like extremely and 1 = dislike extremely.

Sensory evaluation

Both of descriptive sensory and acceptance tests were carried out at the sensory laboratory of the Agro-Industry Department, Faculty of Applied Science and Engineering, Khon Kaen University, Nong Khai Campus. For the sensory room, it consisted of individual booths which were controlled the temperature at 25°C.

Each of cooked Thai jasmine rice samples was presented to individual trained and consumer panels for each sensory test according to their perceptions. Samples were all presented in a randomized order to an individual subject. Since 20 samples it was too much to evaluate them simultaneously, Randomized completed block design; RCBD (Harnmongkolpipat, 2007) was used for the sequence of sample serving. Four samples were tested per session to avoid palate fatigue from the tasting. They were provided with drinking water for rinsing and cleansing the palate.

For trained panels, they had to taste and indicate the level of their perceptions of each sensory attribute of cooked Thai jasmine rice by placing a vertical line across the scale of the descriptive sensory questionnaire at the place that best reflects the intensity of that sensory attribute.

Consumer panels had to taste and rate the degree of their likings of each scale item (appearance, flavor, texture, and overall liking) of cooked Thai jasmine rice by scoring the 9-point hedonic scale questionnaire.

Data analysis

Descriptive sensory and acceptance scores were subjected to analysis of variance (Stone and Sidel, 1998). Differences between means were determined by calculating the least significant difference after analysis of variance. Cronbach's alpha of the descriptive questionnaire was also calculated to test the scale reliability (George and Mallery, 2003)

Only descriptive data were further analyzed using principal component analysis (PCA) (Nanthachai et al., 1997) to identify any factors differentiating the jasmine rice samples. And, only the principal components (PCs) with an eigenvalue of at least 1.0 were selected for further interpretation. These PCs were then subjected to a varimax rotation, before interpretation.

Each selected and rotated PC was interpreted judgmentally by determining attributes that were highly correlated with the particular PCs. Only the attributes with component loading of 0.5 or more were used in the description of the selected PCs (Nanthachai et al., 1997).

The means of the component scores of all respondents on each product across all selected and rotated PCs were also calculated. Since all selected PCs (axes) were always orthogonal to each product can be viewed as coordinates of that specific product on the space defined by those axes. These coordinates could be simply used to plot the products on an n-dimensional map.

All data analyses were carried out using the statistical package for social science (SPSS) version 21.0 developed by SPSS (2012).

4. Results and Discussion

Cronbach's alpha at baseline of descriptive questionnaire for trained panels was 0.758 as total item sum (Cases = 10; items = 10), indicating that the scale internal consistency was the acceptable range according to George and Mallery (2003) which stated that Cronbach's alpha of multi-dimensional scale > 0.7 was indicated that the scale reliability was good or high.

Table 1 showed that BR, KK, NS and SN jasmine rice samples had the highest scores for all sensory attributes. For LO, NK, RE and UD jasmine rice samples had the highest scores for all sensory attributes were highest but crumb attribute was low.

From PCA results, the sensory attributes of jasmine rice were reduced into three uncorrelated PCs (Principal components) with 62.09 cumulative percentage of the total variance, as shown in Table 2. PC1 consisted of plump, white, sweet, soft, sticky, and fine. PC2 consisted of long and crumb of rice and PC3 consisted of rough and rice flavor. Then the first two PCs were plotted as a sensory perceptual map (Figure 1). Twenty cooked Thai jasmine rice samples were positioned on this map with ten sensory attributes. It could identify the difference between these cooked Thai jasmine rice samples. NK jasmine rice sample had the highest positive loading for both of PC1 and PC2 (Right up space), it means NK sample was perceived

to be most plump, white, sweet, soft, sticky, fine, long, and crumb of rice more than other samples. But RE jasmine rice sample had high score only for PC1 more than others. Mean scores of hedonic response were considered together (Table 3), the result showed that NK sample was also most acceptable "appearance, flavor, texture and overall liking. However, the hedonic score in the flavor of NK and UD jasmine rice sample was not different significantly. These results may relate to motives of food choice and may be of considerable commercial value in marketing especially to an advertisement (Product storytelling) to promote jasmine rice from NK and UD. Although result from Table 1 showed that NK and UD jasmine rice samples had a low score for crumb attribute, it may be an advantage of jasmine rice property. It was noticeable that both provinces located on the north-eastern and closed up to Mae Khong river of Thailand mostly, the atmosphere may be influenced on the property of jasmine rice as well.

Table 1 Mean scores of sensory attributes evaluated by 10 trained panels on a range of twenty cooked jasmine rice samples

Sources	Plump	Long	Rough	White	Crumb	Sweet	Rice flavor	Sticky	Soft	Fine
AN	**5.9**^{abcd}	5.4^{cd}	**4.6**	7.7^{ab}	3.3^{e}	**4.9**^{abcde}	6.3^{ab}	6.2^{ab}	7.5^{a}	5.7^{ab}
BK	**6.8**^{a}	3.8^{d}	**5.3**	6.3^{bcd}	3.2^{e}	3.7^{cdef}	5.3^{abc}	6.4^{a}	7.2^{abc}	5.9^{ab}
BR	**6.2**^{ab}	5.8^{abc}	**5.3**	7.4^{ab}	5.6^{abc}	5.3^{abc}	6.4^{ab}	5.4^{ab}	6.3^{abcd}	6.2^{a}
CP	4.7^{cd}	5.2^{bcd}	**5.0**	3.6^{g}	4.7^{bcde}	3.4^{def}	4.2^{d}	5.0^{ab}	5.1^{d}	4.8^{abc}
KS	4.6^{d}	**6.4**^{abc}	**5.5**	3.5^{g}	**6.9**^{ab}	3.9^{bcdef}	6.0^{abc}	3.1^{ab}	3.2^{e}	4.3^{bc}
KK	**6.0**^{abcd}	**6.6**^{ab}	**4.6**	6.6^{abc}	**6.4**^{ab}	5.2^{abc}	6.6^{ab}	5.3^{ab}	5.8^{abcd}	5.7^{ab}
LO	**5.9**^{abcd}	5.7^{abc}	**5.5**	7.4^{ab}	4.9^{bcde}	5.2^{abc}	6.1^{ab}	4.8^{abc}	5.9^{abcd}	5.9^{ab}
MS	**5.7**^{abcd}	7.1^{a}	**5.3**	3.7^{fg}	7.0^{a}	3.6^{cdef}	6.6^{ab}	2.9^{d}	2.8^{e}	3.7^{c}
MD	**5.6**^{abcd}	5.4^{cd}	**5.4**	4.7^{efg}	3.5^{de}	4.2^{bcdef}	6.3^{ab}	5.8^{ab}	6.0^{abcd}	5.1^{abc}
NP	5.1^{bcd}	5.6^{abc}	**4.6**	7.4^{ab}	4.4^{cde}	2.7^{f}	6.5^{ab}	5.8^{ab}	6.4^{abcd}	5.8^{ab}
NS	**5.8**^{abcd}	**6.2**^{abc}	**4.4**	8.1^{a}	5.7^{abc}	**6.2**^{a}	7.0^{a}	5.4^{ab}	6.4^{abcd}	6.2^{a}
NB	**5.6**^{abcd}	5.5^{abc}	**4.8**	7.0^{ab}	5.3^{abc}	**4.9**^{abcde}	6.0^{abc}	4.4^{bcd}	5.7^{bcd}	5.3^{ab}
NK	**6.4**^{ab}	**6.2**^{abc}	**4.4**	7.7^{ab}	4.8^{bcde}	**6.1**^{a}	5.7^{abc}	6.0^{ab}	6.4^{abcd}	5.5^{ab}
RE	**6.1**^{abc}	5.8^{abc}	**5.0**	7.0^{ab}	4.1^{cde}	**5.1**^{abcd}	6.2^{ab}	6.3^{ab}	7.4^{ab}	5.9^{ab}
SN	**6.2**^{ab}	**6.6**^{ab}	**5.1**	7.7^{ab}	5.6^{abc}	5.2^{abc}	6.9^{a}	5.4^{ab}	6.8^{abcd}	6.2^{a}
SK	**6.3**^{ab}	4.9^{cd}	**5.5**	5.3^{cde}	4.0^{cde}	4.3^{bcdef}	6.4^{ab}	6.2^{ab}	6.3^{abcd}	5.7^{ab}
SR	5.0^{bcd}	**6.5**^{abc}	**4.9**	6.4^{bcd}	5.1^{bcd}	**5.1**^{abcd}	6.3^{ab}	4.8^{abc}	5.8^{abcd}	5.9^{ab}
UB	**5.4**^{abcd}	5.2^{bcd}	**5.9**	4.1^{efg}	4.5^{cde}	3.2^{ef}	4.9^{bc}	5.6^{ab}	5.6^{cd}	4.9^{abc}
UD	**6.0**^{abcd}	5.5^{abc}	**5.0**	7.2^{ab}	3.9^{cde}	5.5^{ab}	7.0^{a}	6.6^{a}	6.6^{abcd}	5.5^{ab}
YT	**6.2**^{ab}	6.3^{abc}	**4.6**	5.1^{def}	5.5^{abc}	**4.8**^{abcde}	6.3^{ab}	5.7^{ab}	6.2^{abcd}	5.8^{ab}

Means with different superscript letters are significantly different (p<0.05) between sources in each sensory attribute.
Bold letter for sensory attributes = no different significantly;
Bold letter with underline for sources = all sensory attributes were highest;
Bold letter for sources = all sensory attributes were highest but there was only one sensory attribute low.

Table 2 Loading of sensory attributes response on three principal components which was defined as their underlying dimensions, evaluated by ten trained panels on a range of twenty cooked Thai jasmine rice samples

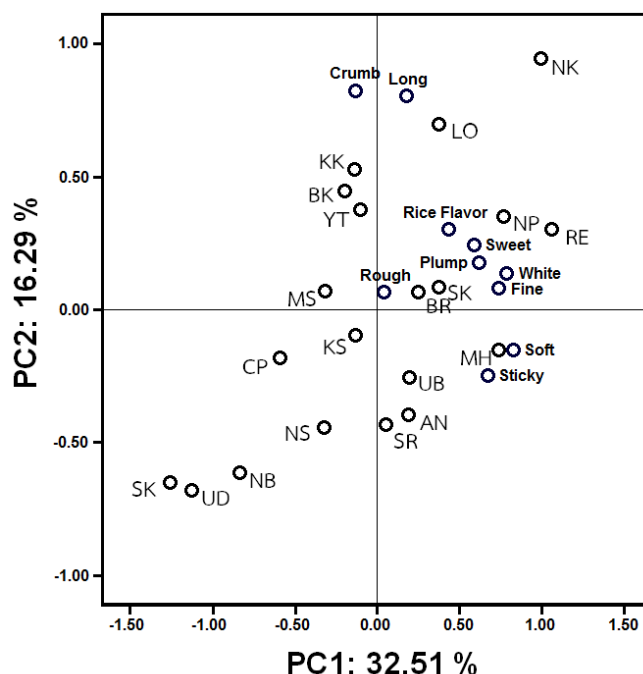| Sensory Attributes	PCs		
	1	2	3
Plump	0.531		
Long		0.806	
Rough			0.888
White	0.789		
Crumb		0.826	
Sweet	0.615		
Rice flavor			0.496
Sticky	0.668		
Soft	0.823		
Fine	0.737		
Percentage of variance	32.507	16.286	13.304
Cumulative percentage	32.507	48.793	62.097

Figure 1 The perceptual map of the sensory attribute descriptors of twenty cooked Thai jasmine rice samples on first two principal components (PCs) 1 and 2.

Table 3 Mean scores of hedonic response on four main items evaluated by fifty consumer panels on a range of twenty cooked Thai jasmine rice samples

Sources	Appearance	Flavor	Texture	Overall liking
AN	2.95[f]	2.48[jk]	3.73[i]	3.33[hi]
BK	4.63[de]	4.95[defgh]	5.30[bcdefg]	5.22[def]
BR	5.90[bc]	5.90[abc]	5.33[bcdefg]	6.20[abc]
CP	1.48[g]	1.88[k]	1.83[k]	1.98[j]
KS	2.75[f]	2.85[j]	2.80[i]	3.00[i]
KK	5.40[bcd]	5.18[bcdefg]	5.48[bcdefgh]	5.65[bcde]
LO	5.20[cd]	5.03[cdefgh]	4.65[fg]	5.38[cde]
MS	4.78[de]	3.80[i]	3.65[i]	3.98[gh]
MD	3.95[e]	4.53[fghi]	4.70[fgh]	4.78[efg]
NP	4.63[de]	5.28[bcdefg]	5.83[abcde]	5.68[bcde]
NS	5.80[bc]	**6.08[ab]**	5.88[abcd]	5.70[abcde]
NB	5.83[bc]	5.30[abcdef]	4.93[efgh]	5.30[cde]
NK	**6.98[a]**	**6.15[a]**	**6.58[a]**	**6.58[a]**
RE	5.03[d]	5.18[bcdefg]	5.02[cdefg]	5.35[cde]
SN	5.58[bcd]	5.70[abcd]	6.00[abc]	6.03[abcd]
SK	5.33[cd]	5.53[abcde]	5.63[bcdef]	5.23[def]
SR	4.08[e]	4.60[efghi]	5.00[cdefg]	5.05[ef]
UB	4.00[e]	4.18[hi]	4.55[g]	4.38[fg]
UD	**6.30[ab]**	**6.18[a]**	**6.20[ab]**	**6.48[ab]**
YT	4.83[de]	4.33[ghi]	5.10[cdefg]	4.98[ef]

Means with different superscript letters are significantly different (p<0.05) between sources in each hedonic item.

Bold letter for sensory attributes = no different significantly;

Bold letter with underline for sources = all hedonic items were highest;

5. Conclusion

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For the overall liking, Nong Khai's jasmine rice was the most liked by all of the consumer panels. Nong Khai jasmine rice was the highest of most sensory attributes when all attributes were considered together especially for sweet. Texture and flavor were more highly correlated with the overall liking of jasmine rice than appearance. Thus, the sensory characteristics driving consumer preference for Thai jasmine rice were soft, fine, sticky and sweet, respectively. This result may be used to identify the quality of Thai jasmine rice of Thailand Northeastern. In addition, the map result may access the business cluster and network of Thai jasmine rice producers for the increasing potential of Thai jasmine rice commercial and export in the future.

6. Acknowledgements

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