

Accepted Manuscript

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PII: S0963-9969(14)00399-8
DOI: doi: [10.1016/j.foodres.2014.06.007](https://doi.org/10.1016/j.foodres.2014.06.007)
Reference: FRIN 5325

To appear in: *Food Research International*

Received date: 20 March 2014
Revised date: 2 June 2014
Accepted date: 4 June 2014

Please cite this article as: Jantathai, S., Sungsi-in, M., Mukprasirt, A. & Dürschmid, K., Sensory expectations and perceptions of Austrian and Thai consumers: A case study with six colored Thai desserts, *Food Research International* (2014), doi: [10.1016/j.foodres.2014.06.007](https://doi.org/10.1016/j.foodres.2014.06.007)

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**Sensory expectations and perceptions of Austrian and Thai consumers: A case study
with six colored Thai desserts**

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ABSTRACT

This work studied evaluations by Austrian and Thai consumers of their sensory expectations and perceptions of six Thai desserts, each made in three different colors (green, pink, yellow). The color variants differed only in color but not in their ingredients or taste. Expectation tests were performed by showing pictures of the desserts on a monitor and asking them to evaluate their expected overall liking and expected intensities of sweetness, bitterness, sourness and hardness. Results showed that colors of the products were important in predicting expected liking and taste intensity. For the perceived liking test, the samples were served so they could be tasted, and the perceived liking was scored on a visual analogue scale. Austrians expressed a strong preference for yellow products whereas Thais preferred green and pink products. Findings of this study can be used as a model for adapting colors of products for new markets and consumer demand.

Keywords: Sensory expectations; Expected and perceived Liking; Food color; Thai desserts; Cultural difference

INTRODUCTION

Expectations have been indicated as a determining factor in the acceptance of novel (Deliza & MacFie, 1996) and unfamiliar foods (Tuorila, Meiselman, Cardello, & Lesher, 1998). They play an important role in forming acceptance structures, which are key factors in the success of food products in the market. Sensory expectations have a powerful influence on food selection and purchase decisions (Ares, Barreiro, Deliza, Gimenez, & Gambaro, 2010). Consumers have a higher probability of choosing a product when the expectations promise positive quality attributes, and they will probably reject the product when it induces negative expectations (Almli, Verbeke, Vanhonacker, Næs, & Hersleth, 2011; Deliza & MacFie, 1996).

In general, expectations can be defined as hypotheses about future events, and perception itself is the testing of this hypothesis, resulting in new experiences, which then form the basis for further expectations. The dynamic feedback process of expectations, perception and memorable experience (Fig. 1), which is evocative of the scientific method, thus guarantees that our perceptual hypotheses are adjusted to reality. Brain science claims that our brain does not like surprises and therefore permanently creates hypotheses about future events in the form of expectations, with the intention to be able to act very quickly in the moment of confrontation with an actual stimulus (Alink, Schwiedrzik, Kohler, Singer, & Muckli, 2010).

Food expectations are based on former experiences or inborn evaluation patterns. Johansen et al. (2008) showed that sensory expectations are formed basically on prior experiences and familiarity with more or less similar products. The actual formation of an expectation starts with the subjective perception of the situation in which a food product stimulus is given. Already within the situation, there are cues that give indications to quality attributes, which are perceived when the product is consumed. Most of the cues will be in the product itself or

in the packaging. Sensory evaluation of food products is always a multi-modal process, meaning that it involves several sensory modalities. The evaluation process starts before the actual tasting by means of visual or acoustical distal perception and goes on proximally with the actually eating or drinking of the product, thus stimulating all of the chemical and physical sensory systems in the oral and nasal area. The product and the situation deliver so called quality cues, which are perceived prior to the actual consumption and give hints of the quality attributes that are perceived during the course of consumption (Steenkamp, 1989). Consumers will consume the product when quality cues give hope that the product will taste good, and they will refuse it when it is expected to taste poorly (Brunso & Grunert, 2007; Hurling & Shepherd, 2003).

Color plays an important role in the development of food preferences and sensory perception (Crozier, 1996; Spence, Levitan, Shankar, & Zampini, 2010). Colored products have a significant impact on perception thresholds. Many reports revealed that the color of aqueous solutions had an effect on taste thresholds, e.g., (i) “sour” was associated with green and yellow; (ii) “sweet” with pink, orange and red; (iii) green raised sweet thresholds but lowered thresholds for sour and bitter; (iv) violet, black and brown made people think of something bitter; and (v) white, grey and blue enhanced the salty taste (Bayarri, Calvo, Costell, & Duran, 2001; Cardello, 1996). Stummerer and Hablesreiter (2010) reported that colors such as red, orange, yellow or green are associated with ripe fruits or crunchy vegetables through references to natural products. In contrast, blue, black or dark colors were linked with attributes like bitter, unpalatable or even poisonous. Thus, it seems to be obvious that the food color preferences of consumers are based on past experiences, cultural habits, feelings, thoughts, and eating behaviors (Costell, Tárrega, & Bayarri, 2009; Shankar et al., 2009).

Additionally, color cues are interpreted differently in different cultures. For instance, red-colored food in China is, in general, associated with good taste (Grossman & Wisenblit,

1999). Consumers in Uruguay reject black packages of milk dessert because they seem to have negative associations with this color variant (Ares & Deliza, 2010).

There has been a growing interest in cross-cultural sensory studies in the recent years. The measurement of culturally caused differences in the sensory field is critical to obtain an understanding of hedonic acceptance differences for developing ethnic food products or adapting products for international markets (Buisson, 1995; Yeh et al., 1998). Additionally, Äström et al. (2006) stated that cross-cultural research is an essential step to help food manufacturers in optimizing food products for different markets. Several sensory studies have been conducted on cross-cultural preferences of breads and muffins (Mialon, Clark, Leppard, & Cox, 2002), jellies (Blancher et al., 2008), apple juice (Rodbotten et al., 2009), soy yogurts (Tu, Valentin, Husson, & Dacremont, 2010), salad dressing and beverages (Chung et al., 2012), and green tea products (Kim, Jombart, Valentin, & Kim, 2013). However, the number of investigations on ethnic food products is limited.

Although cross-cultural differences in food perception have been demonstrated, there has been little research about the influence of food color on the expectations and perceptions of consumers across cultures. In the present study, Thai desserts were selected 1) to understand consumers' expectations and hedonic perceptions of novel foods for Austrians and common foods for Thais, and 2) to investigate the effects of the different colors of dessert products on individuals from two different cultural backgrounds. The results of this study can be used as a model to enhance the ability to compete in a foreign marketplace by adapting the colors of products to market preferences.

2. MATERIAL AND METHODS

2.1 Sample Preparation

The following six Thai desserts, each one colored in green, pink and yellow, were used in this study: *Ar-lua* (AL), *Khao-neow-moon* (KN), *Kleeb-lum-duan* (LD), *Ka-nom-shun* (NS), *Pui-fai* (PF), and *Woon-krob* (WK). Artificial colors (*Winner brand*®, Bangkok, Thailand) were used at concentrations of 0.05 ml/kg for the pink and 0.1 ml/kg for the green and yellow colors. The color concentrations were investigated and defined in preliminary tests by twenty Thai people in Vienna, Austria. The ingredients of each product and cooking method are shown in Table 1.

2.2 Subjects

One hundred twenty subjects, including 60 Austrians and 60 Thais, participated in the experiment. All of the subjects had normal color vision, as indicated by self-reporting. Austrian subjects were recruited within staff members and students at the University of Natural Resources and Life Sciences, Vienna (28 females, 32 males; mean age 27.7 years). The Thai subjects who participated in this study were students and staff members at Maharakham University, Thailand (35 females, 25 males; mean age 25.2 years). Subjects were asked to complete a questionnaire after the evaluation of the products. The questionnaire consisted of questions about the following: (1) gender, (2) age, (3) familiarity with the Thai desserts used in this study, and (4) eating frequency of these desserts.

The study was performed in compliance with the ethical guidelines for scientific research of the University of Natural Resources and Life Sciences, Vienna. The subjects were informed about the testing procedure and were also asked to give written informed consent before the test.

2.3 Procedure

The effect of color variations on the expectations of overall liking and the intensities of bitterness, hardness, sourness, and sweetness were investigated before the actual sensory

acceptance test. For the expectation test, food pictures were taken with a Canon EOS 400D digital camera. One color variant of one product was shown on the monitor at a time. Subjects were asked to look at the food pictures and to rate their expected likability on visual analogue scales, line-scales from 0 to 100 mm. The anchor on the left end was described with “Dislike extremely” and the anchor on the right end with “Like extremely”. The subjects also evaluated the expected intensities of sweetness, bitterness, sourness and hardness using line-scales with anchor descriptions on the left end (“Not at all”) and the right end (“Extremely bitter (hard, sour, and sweet)”).

After the expectation test, the samples shown on the monitor were served, and the participants tasted them to rate how much they liked the samples overall as well as their color, flavor, taste, and texture on line-scales ranging from “Dislike extremely” to “Like extremely”. Six samples (two kinds of desserts with three color variations each) were served per day.

All products were served within 24 hours of preparation. The samples were presented in a randomized and coded way following a balanced incomplete block design.

2.4 Data Analysis

All statistical analyses were performed using SPSS version 21 for Windows (IBM Corporation, Armonk, USA). Repeated measurements of ANOVA (RM-ANOVA) with Bonferroni adjustment were performed with the cultural group (Austrian/Thai) as the main factor. The responses of consumers across the regions for each sensory attribute of the desserts were calculated, checking for significant differences at the $p < 0.05$ level. Independent sample t-tests were conducted to measure differences in the ratings of the expected and perceived sensory attributes between Austrian and Thai consumers and additionally, the results between the expected and perceived overall liking for each sample for both consumer groups. Principle Component Analysis (PCA) allows the recognition of quite

intuitive relationships between various factors, and we therefore used PanelCheck (Version 1.4.0; General Public License) to map the relationships among the various liking evaluations (expected and perceived), the dessert type, the dessert color and the culture group. Tables 2 and 3 list the factors and dimensions of the data set matrix used.

3. RESULTS

According to the questionnaire, all of the Austrian subjects were unfamiliar with the tested dessert products and had never eaten them before. Approximately 85% of Thai subjects reported that they consumed the investigated Thai desserts at least once a week.

3.1 Expectation rating

3.1.1 Expected overall liking

The comparison of the mean scores of Austrian and Thai consumers for their expected overall liking of the desserts is presented in Fig. 2. Overall, the expected overall liking scores of the green and pink desserts were higher for Thai participants than for Austrian participants. In turn, the Austrians had higher expected overall liking scores for yellow products than the Thai group.

Table 2 shows the significant effect of the cultural group on the expected overall liking ($F_{(1,118)} = 11.366, p = .001$). The following interactions were significant: *dessert x cultural group* ($F_{(5,590)} = 2.176, p = .050$), *color x cultural group* ($F_{(2,236)} = 43.964, p = .000$), and *dessert x color x cultural group* ($F_{(10,1180)} = 2.545, p = .005$).

3.1.2 Expected sensory perceptions

Fig. 2 shows the differences between the Austrian and Thai subjects in the mean scores of the expected liking and expected intensities of four sensory attributes of each sample. The

expected sweetness intensities for the green and pink desserts between the Austrians and Thais were significantly different ($p < 0.05$): green AL ($t_{(1,118)} = -2.302, p = .023$), pink AL ($t_{(1,118)} = 2.113, p = .037$), green KN ($t_{(1,118)} = 4.367, p = .000$), green LD ($t_{(1,118)} = 3.071, p = .003$), pink LD ($t_{(1,118)} = 3.063, p = .003$), green NS ($t_{(1,118)} = -5.923, p = .000$), pink NS ($t_{(1,118)} = -6.589, p = .000$), green PF ($t_{(1,118)} = -3.396, p = .001$), pink PF ($t_{(1,118)} = -6.942, p = .000$). With regard to the expected bitterness and sourness, Thais gave higher scores for all three colors of desserts compared to the Austrians, with the one exception being the KN dessert. The expected hardness intensities for all colors of PF were not significantly different.

Table 2 shows that two main factors, the dessert type and color, significantly affected the expected sensory intensities of sweetness, bitterness, sourness, and hardness. The cultural group factor had a significant effect only on the expected bitterness intensity ($F_{(1,118)} = 22.581, p = .000$). No significant effects were found for the *dessert x color* factor on the expected sweetness intensity ($p = 0.995$) and on the expected sourness intensity ($p = 0.441$). There were significant effects of the *dessert x cultural group* factor on the expected sweetness ($F_{(5,590)} = 18.364, p = .000$), expected bitterness ($F_{(5,590)} = 8.428, p = .000$), expected sourness ($F_{(5,590)} = 9.775, p = .000$), and expected hardness ($F_{(5,590)} = 25.913, p = .000$). The effect of the *color x cultural group* factor on the expected sweetness intensity was significant ($F_{(2,236)} = 7.597, p = .001$). Also, the interactions of the three main factors showed significant effects on all of the intensity attributes, including the expected sweetness ($F_{(10,1180)} = 5.508, p = .000$), expected bitterness ($F_{(10,1180)} = 2.189, p = .016$), expected sourness ($F_{(10,1180)} = 3.064, p = .001$) and expected hardness ($F_{(10,1180)} = 3.377, p = .000$).

3.1.3 PCA Biplot based on the expectation ratings

PCA was conducted to investigate the interrelationships between the three different color variables in six dessert types and the assessed expectations. For Austrian consumers, the PCA

of the data explains 84.8% of the variation, with 64.1% explained by PC1 and 20.7% by PC2 (Fig. 4). These results and additional correlation analyses (Table 3) revealed that for Austrian consumers, the expected overall liking has a significant weak positive correlation with the expected sweetness intensity and a weak negative correlation with the expected sourness intensity. The expected bitterness and hardness intensities do not significantly correlate with the expected overall liking of the Austrians. The PCA also shows that the dessert type influences the expected overall liking and all of the expected sensory intensities more than the color of the desserts.

The results of the Thai consumers are depicted in the PCA biplot in Fig. 5 (PC1: 40.2%; PC2: 33.6%). Thai consumers clearly had a higher expected overall liking for the pink and green products than for the yellow ones. Additionally, correlation analyses (Table 3) revealed that the expected overall liking has a weak negative correlation with the expected bitterness intensity and the expected sourness intensity but a weak positive correlation with the expected sweetness intensity.

3.2 Perception rating

Table 4 shows results from RM-ANOVA, which evaluated the effects of the dessert type, color, and cultural group as the main factors and their interactions on the overall liking, color liking, flavor liking, taste liking, and texture liking. Significant effects of the dessert type, color and their interactions with the cultural group were observed for all of the sensory attributes. The cultural group showed significant effects on the overall liking ($F_{(1,118)} = 8.917$, $p = .003$), color liking ($F_{(1,118)} = 8.568$, $p = .004$), and taste liking ($F_{(1,118)} = 9.713$, $p = .002$). The color x cultural group has significant effects on the overall liking ($F_{(2,236)} = 4.866$, $p = .008$), color liking ($F_{(2,236)} = 10.575$, $p = .000$), flavor liking ($F_{(2,236)} = 11.688$, $p = .000$), and taste liking ($F_{(2,236)} = 5.845$, $p = .003$) but not on the texture liking.

Regarding the rating scores, Austrians gave scores for overall liking ranging from 38.6 to 58.4 for green, 36.2 to 54.9 for pink and 40.1 to 58.9 for yellow, whereas the perceived liking scores of Thais ranged from 56.0 to 66.0, 42.3 to 61.5, and 47.5 to 58.3 for green, pink and yellow, respectively. T-tests were carried out to compare the overall liking mean scores of the two cultural groups for each of dessert type. In general, Thais gave higher color liking scores for green and pink products than Austrians. Most of the Thai desserts were highly preferred by Thais, while these samples were not as preferred by the Austrians. There are significant differences for AL, LD, NS, and WK but not for KN and PF (see Fig. 3).

3.3 Expected and perceived overall liking

Results in Table 5 show the Austrians' expected and perceived overall liking scores differed significantly for yellow KN ($F_{(1,118)} = 8.528, p = .004$), yellow NS ($F_{(1,118)} = 4.491, p = .036$), yellow PF ($F_{(1,118)} = 9.638, p = .002$), and yellow WK ($F_{(1,118)} = 4.132, p = .044$). In contrast, no significant differences between the expected and perceived overall liking ratings by the Thais were found for any colored dessert variant.

The differences between the expected and perceived overall liking scores for all of the products and color variants are shown in Fig. 6 for both consumer groups. Austrians had significantly higher overall liking expectations compared to their perceived overall liking of pink NS ($t_{(118)} = 3.812, p = .000$), yellow PF ($t_{(118)} = 3.515, p = .001$), green WK ($t_{(118)} = 1.972, p = .050$), pink WK ($t_{(118)} = 2.785, p = .006$), and yellow WK ($t_{(118)} = 2.292, p = .024$), whereas for green AL ($t_{(118)} = -2.893, p = .005$), green LD ($t_{(118)} = -2.324, p = .022$), green PF ($t_{(118)} = -2.530, p = .013$), and pink LD ($t_{(118)} = -4.117, p = .000$) the perceived overall liking ratings of Austrians were significantly higher than the expected overall liking ratings. Thai consumers showed a significantly higher expected overall liking for pink AL ($t_{(118)} = -2.421, p = .017$), pink KN ($t_{(118)} = -2.763, p = .007$), and pink NS ($t_{(118)} = -1.970, p = .050$), whereas

only yellow AL ($t_{(118)} = 2.255, p = .026$) was higher in perceived overall liking than expected overall liking for the Thai consumers. The results therefore indicate that for the Austrian subjects, there were many more discrepancies between expectations and perceptions than for the Thai consumers. For the Thai subjects, there were fewer and smaller differences between the expected and perceived overall liking, and only for pink AL, pink KN, and pink NS were the expected overall liking scores higher than the perceived overall liking scores.

3.4 PCA biplot based on the hedonic ratings of sensory attributes

Fig. 7 shows a PCA biplot of the expected and perceived overall and color liking of the six dessert types in three color variants. The results show that the origin of the subjects significantly influenced the liking ratings of the desserts with different colors. Austrians rated their expected and perceived overall liking of yellow desserts relatively high. Yellow PF and KN had the highest liking ratings. However, Thais rated the expected and perceived overall liking of green and pink desserts relatively high. Green KN, green PF, and pink NS had higher liking ratings than the other desserts. Additionally, color liking shows a significant positive correlation with the expected overall liking. For Thai individuals, color liking narrowly correlates with the expected overall liking and perceived overall liking. For the Austrians, only the expected overall liking and color liking correlate, and there is no narrow correlation between the color liking and perceived overall liking. This shows that the Thai consumers have clearer expectations of the tested dessert products than the Austrians, who are not very familiar with these products.

DISCUSSION

Sensory expectations in humans are mainly based on individual daily experiences, which link distal sensory and other quality cues with the real product performance (Ares & Deliza, 2010; Sakai, Imada, Saito, Kobayakawa, & Deguchi, 2005) by referring to familiar (Johansen,

Laugesen, Janhøj, Ipsen, & Frøst, 2008) as well as to unfamiliar products (Tuorila et al., 1998). Regarding the expectations of the Austrian subjects, *Kleeb-lum-duan* (LD), which looks like a cookie, was expected to be harder than any of the other investigated desserts, and *Pui-fai* (PF), which has the appearance of an Austrian muffin, was expected to be soft (see Fig. 4). An explanation for this finding might be that consumers' expectations toward food sensory properties are based on experiences, and if there is a lack of experience with the precise product the individuals are confronted with, they simply take a similar but familiar product to build up their expectations. According to the "liking by tasting" or "mere exposure" effect, individuals expect and perceive higher hedonic liking from products they are relatively familiar with. According to Kim et al. (2013), familiarity with the ingredients/composition might be one essential factor that affects consumers' attitudes towards food products.

Our results indicate that taste liking is related to the perceived overall liking of food products (see Fig. 3). This is in accordance with the findings of Brug et al. (1995), which showed that taste satisfaction was the primary motivating factor for food liking. Wan et al. (2007) stated that flavor and texture are often considered the most important attributes of foods as well.

This study shows that the subjects used the colors of desserts to evaluate their expected basic taste perceptions. A great deal of prior research suggests that color has a significant influence on food choice (Jantathai, Danner, Joechl, & Dürschmid, 2013; Stroebele & De Castro, 2004) and on the quality assessment of many food attributes (Clydesdale, 1991). In addition, food colors show correlations with increases and decreases in the expected intensities of sensory properties (Wei, Ou, Luo, & Hutchings, 2012a), which is in agreement with our results. An intense sweet taste was expected when the desserts were pink, and a bitter taste was expected when they were green. Yellow desserts were expected to be less sweet and less

bitter than pink and green ones, respectively. These results agree with the data of Clydesdale (1991) as well as with that of Stummerer and Hablesreiter (2010).

Sensory expectations elicited by seeing food images and sensory liking ratings given after tasting the dessert samples appeared to be weakly correlated. The liking scores regarding the food color of each dessert showed tendencies similar to the expected overall liking scores. This result is in line with the finding of Ares et al. (2010) that previous expectations of consumers affect their responses when actually tasting the samples. It is well known that previous experiences can change the hedonic acceptance of food products (Köster, Couronne, Leon, Levy, & Marcelino, 2002; Pliner, 1982; Zajonc, 1968) and expectations are able to influence the liking evaluations to a certain degree (Tuan, 2007). It is well known that consumers have a tendency to move towards higher hedonic acceptance when they consume food products several times (Tuan, 2007; Lange, Rousseau, & Issanchou, 1999; Pliner, 1982; Zajonc, 1968).

Moreover, familiarity with the colors of traditional foods might influence the evaluation of food liking. Wei et al. (2012b) stated that consumers tend to prefer the colors of products that match with their memories. Our results show that subjects in Vienna, Austria preferred the yellow dessert variants to the pink ones. A plausible explanation of this finding might be that yellow is a widespread “natural” food color, which is found in many food products in Austria, such as bread, cake, and cheese, primarily coding for Maillard reactions, egg yolk, lemon or vanilla. In contrast, pink is a color seldom found in Austrian food products. Some subjects claimed that pink products seem to be dangerous and toxic. This is in agreement with Hutchings (2003), who stated that consumers in Europe seem to show negative attitudes towards food additives in general and visible additives in particular, and they therefore often refuse to taste foods with additives. Moreover, the green product variants had the second highest acceptance as green is considered to be an appropriate color for foods. In accordance

with Stummerer and Hablesreiter (2010), consumers might like the color of edible things when they are perceived to be in a natural context.

On the other hand, the subjects from Mahasarakham, Thailand showed a clear preference for green and pink desserts compared to yellow ones. Thai consumers are used to the green color and flavor from pandan leaves, which are widely used in cakes and custards (Senklang & Anprung, 2010). In general, Thai consumers rated their liking of the pink-colored products higher than consumers in Austria, probably resulting from their daily use of pink food products.

Most of the Thai subjects rated their expectations and perceptions of the investigated desserts in the middle and higher part of the scale, whereas Austrians scored theirs more in the middle and lower part of the scale. The reason for this might be that the hedonic response of the subjects to the Thai desserts samples in this study depended on the nature of the specific dessert and the pleasurable experience of the desserts. Kim et al. (2013) indicated that consumers, who are more familiar with specific food products, tend to give those food products higher liking scores than consumers who are less familiar with them.

The culinary culture of consumers appears to be a complex but is a factor of significant influence on individual food preference structures. Köster and Mojet (2007) stated that people do not just eat products, but they eat what they like in a meaningful situation and that they forge themselves from a mixture of memory and intentionality. The products used in this work, Thai desserts, are usually served on very special occasions such as religious and traditional festivals and therefore have a specific meaning for Thai people. This cultural background of the Thai consumers is not available for the Austrian consumers and may contribute to the liking differences between the two ethnic groups. Moreover, personality differences between people may also influence food preferences (Shepherd, 2001).

LIMITATIONS

We used 60 people each from Austria and Thailand. A number of consumers of 60 is the lower limit for the valid statistical analysis of consumer data. The number of consumers in this work was therefore enough to perform statistical analysis regarding differences in the sensory expectations and perceptions of consumers in Austria and Thailand, but further work in this area should be performed with significantly higher numbers of consumer representatives for the defined target groups while also systematically varying the socio-demographic factors (e.g., education level, income, town size, etc.). As our samples lack representativeness, we should not overgeneralize and cannot make general statements about the two investigated cultural groups, Thais and Austrians. However, the results based on investigating 2 x 60 individuals at least give valuable evidence.

CONCLUSION

Food colors affected the sensory expectations and hedonic perceptions of consumers both from Austria and Thailand. These results have to be discussed considering cultural differences and familiarity with the food products. Consumers in Austria are not familiar with the Thai desserts used in this study, and they express a strong preference for the yellow dessert variants compared to the pink and green ones. Thai consumers preferred green to pink and yellow desserts. It is likely that the differences in food preference structures of the investigated consumers in Austria and Thailand are reflections of complex cultural differences. The effects of food colors on consumer expectations and hedonic perceptions were investigated to provide insight into the formation of preferences and to support the development of new food products. By understanding consumer expectations and the perception of colored Thai desserts in Austria, producers can enhance their ability to compete in a foreign marketplace by

adapting their products to market needs. Additional research measuring consumer behavior is needed to further explore differences and their roots in cultural peculiarities.

ACKNOWLEDGEMENTS

We are grateful to all the people who participated in this study and thanks to Department of Food Sciences and Technology, University of Natural Resources and Life Sciences, Vienna for funding support. We would like to acknowledge support of the Royal Thai government to providing a graduate scholarship.

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Table Captions

Table 1 List of Thai desserts used in this study

Table 2 The results from the Repeated Measure Analysis of Variance of the expectation test by Austrians and Thais: degree of freedom (df) of factors

Table 3 Pearson's correlation coefficients between the expected overall liking and all of the sensory intensities

Table 4 The results from the Repeated Measure Analysis of Variance of the perception test by Austrian and Thai subjects: degree of freedom (df) of factors

Table 5 Results of the differences in the rating scores of expected and perceived overall liking for colored desserts by the Austrians and Thais; $df = (1, 118)$

Table 1

Product	Characteristics	Ingredient	Cooking method
<i>Ar-Lua</i> (AL)	It should have a sugar crust, a soft crumb texture and the flavor of coconut milk (Lhieochaiphant, Jangchud, & Jangchud, 2011)	Wheat flour (100 g), coconut milk (300 ml) and sugar (400 g)	Wheat flour and sugar were mixed together. Then, coconut milk was added a little at a time, and the mixture was stirred frequently until the sugar dissolved. Cook on medium heat until the mixture looks clear, and then make it dry.
<i>Khao-neow-moon</i> (KN)	The appearance should be like glassy rice. Taste is sweet, salty and creamy.	Glutinous rice (170 g), coconut milk (80 g), sugar (90 g) and salt (1.5 g)	The glutinous rice was soaked in cold water overnight, transferred to a steamer tray lined with muslin and steamed over boiling water until done. The cooked rice was mixed immediately with coconut milk, sugar and salt.
<i>Kleeb-lum-duan</i> (LD)	It is a kind of cookie, named according to its appearance, which is similar to the <i>Kleeb-lum-duan</i> flower.	Wheat flour (250 g), icing sugar (200 g), baking powder (3.5 g), and vegetable oil (100 g)	It was prepared by kneading flour, icing sugar, baking powder, and vegetable oil. It was cut into small flower shaped pieces after resting for 20 min and baked at 170°C for 12-15 min.
<i>Ka-nom-shun</i> (NS)	It is similar to a layer pudding, composed of multiple layers of a non-colored and colored starch mixture alternately layered.	Tapioca flour (100 g), corn flour (30 g), rice flour (30 g), coconut milk (300 g), water (130 ml) and sugar (230 g)	Tapioca, corn, and rice flours were kneaded with some coconut milk and syrup and then left to rest for 15 min. The remaining coconut milk and syrup were added to make a uniform batter. Batter was divided into two parts; no color and color added. Then, the batter was steamed at 100°C for 15 min per layer. A total of 9 layers were used, alternating between colored and non-colored layers.
<i>Pui-fai</i> (PF)	It is a muffin-style dessert, which is very soft in texture.	Wheat flour (340 g), condensed milk (125 g), baking powder (10 g), water (180 ml), emulsifier (30 g), egg (30 g) and sugar (300 g)	Sugar, egg, leavening agent and some water were mixed well. Wheat flour and the rest of water were finally added and lightly mixed. The batter was proofed for 30 min, put into an aluminum tray, and then steamed for 20 minutes until done.
<i>Woon-krob</i> (WK)	It is crispy gelatin, which should have a hard skin, a soft filler, good shape and light color	Gelatin powder (125 g), floating jasmine water (250 ml) and sugar (400 g)	Gelatin powder was mixed with water. It was cooked over medium heat until the gelatin melted, and then sugar was added and the mixture was stirred until it was sticky and well done. Gelatin was poured into a tray and left to rest for 30 min. Gelatin was cut into small pieces and dried until its skin was hard.

Table 2

Source of variation		Overall liking		Sweetness		Bitterness		Sourness		Hardness	
Factor	df	<i>F</i> value	Sig.	<i>F</i> value	Sig.	<i>F</i> value	Sig.	<i>F</i> value	Sig.	<i>F</i> value	Sig.
Dessert (D)	(5, 590)	1.644	.146	20.533	.000	4.483	.001	8.674	.000	35.887	.000
Color (C)	(2, 236)	0.043	.958	26.703	.000	15.400	.000	12.283	.000	6.607	.002
Cultural group (CG)	(1, 118)	11.366	.001	2.198	.141	22.581	.000	1.365	.245	.353	.553
Dessert X Color	(10, 1180)	11.202	.000	2.412	.008	0.214	.995	3.447	.000	1.001	.441
Dessert X Cultural group	(5, 590)	2.176	.050	18.364	.000	8.428	.000	9.775	.000	25.913	.000
Color X Cultural group	(2, 236)	43.964	.000	7.397	.001	.901	.408	1.978	.141	1.062	.347
D X C X CG	(10, 1180)	2.545	.005	5.508	.000	2.189	.016	3.064	.001	3.377	.000

Table 3

Consumer origin	Attribute	Bitterness	Sweetness	Sourness	Hardness
Austria	Expected overall liking	$r = .004$	$r = .150^{***}$	$r = -.079^{**}$	$r = .020$
Thailand	Expected overall liking	$r = -.144^{***}$	$r = .185^{***}$	$r = -.081^{**}$	$r = -0.051$

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4

Factor	df	Overall liking		Color liking		Flavor liking		Taste liking		Texture liking	
		<i>F</i> value	Sig.	<i>F</i> value	Sig.	<i>F</i> value	Sig.	<i>F</i> value	Sig.	<i>F</i> value	Sig.
Dessert type (D)	(5, 590)	4.944	.000	9.495	.000	7.956	.000	4.856	.000	7.549	.000
Color (C)	(2, 236)	15.065	.000	3.806	.024	20.372	.000	14.542	.000	3.721	.026
Cultural group (CG)	(1, 118)	8.917	.003	8.568	.004	2.652	.106	9.713	.002	3.061	.083
Dessert type x Color	(10, 1180)	2.780	.002	5.977	.000	6.863	.000	3.165	.001	5.091	.000
Dessert type x Cultural group	(5, 590)	7.869	.000	4.155	.001	6.010	.000	8.134	.000	8.854	.000
Color x Cultural group	(2, 236)	4.866	.008	10.575	.000	11.688	.000	5.845	.003	2.060	.130
D X C X CG	(10, 1180)	3.922	.000	1.787	.049	2.681	.003	3.491	.000	4.719	.000

Table 5

Product	Austrians						Thais					
	green		pink		yellow		green		pink		yellow	
	F value	Sig.	F value	Sig.	F value	Sig.	F value	Sig.	F value	Sig.	F value	Sig.
AL	.001	.978	.308	.580	.601	.801	.010	.919	.162	.688	.764	.384
KN	2.490	.117	.310	.579	8.528	.004	.266	.607	.510	.477	.765	.383
LD	3.036	.084	.587	.445	.009	.925	.096	.758	.406	.525	2.790	.097
NS	.218	.642	3.317	.071	4.491	.036	.456	.501	1.826	.179	.399	.529
PF	.620	.433	.388	.535	9.638	.002	.306	.581	.214	.644	2.751	.100
WK	.197	.658	1.230	.270	4.132	.044	.007	.934	2.500	.116	.040	.842

Note: AL is *Ar-lua*, KN is *Khao-neow-moon*, LD is *Kleeb-lum-duan*, NS is *Ka-nom-shun*, PF is *Pui-fai*, and WK is *Woon-krob*

Figure Legends

Fig. 1. The dynamic feedback process of expectations, perception and experience

Fig. 2. Differences between the Thais' (TH) and Austrians' (AT) expected liking for each dessert type; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fig. 3. Differences between the Thais' (TH) and Austrians' (AT) perceived liking for each dessert type; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Fig. 4. PCA biplot for the expected overall liking and expected intensities of four sensory attributes by the Austrians (N = 60)

Fig. 5. PCA biplot for the expected overall liking and expected intensities of four sensory attributes by the Thais (N = 60)

Fig. 6. Differences between the expected and perceived overall liking scores for each color of the Thai desserts

Fig. 7. PCA biplot for the cultural groups obtained in the expectation and perception tests using color variation as the stimulus

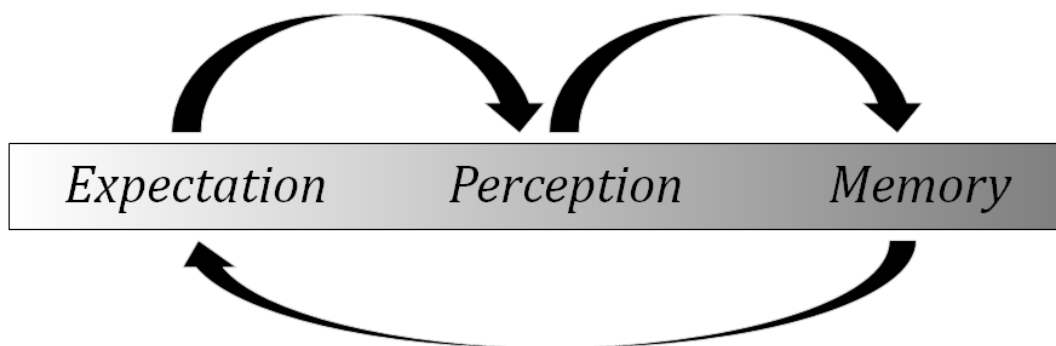


Fig.1.

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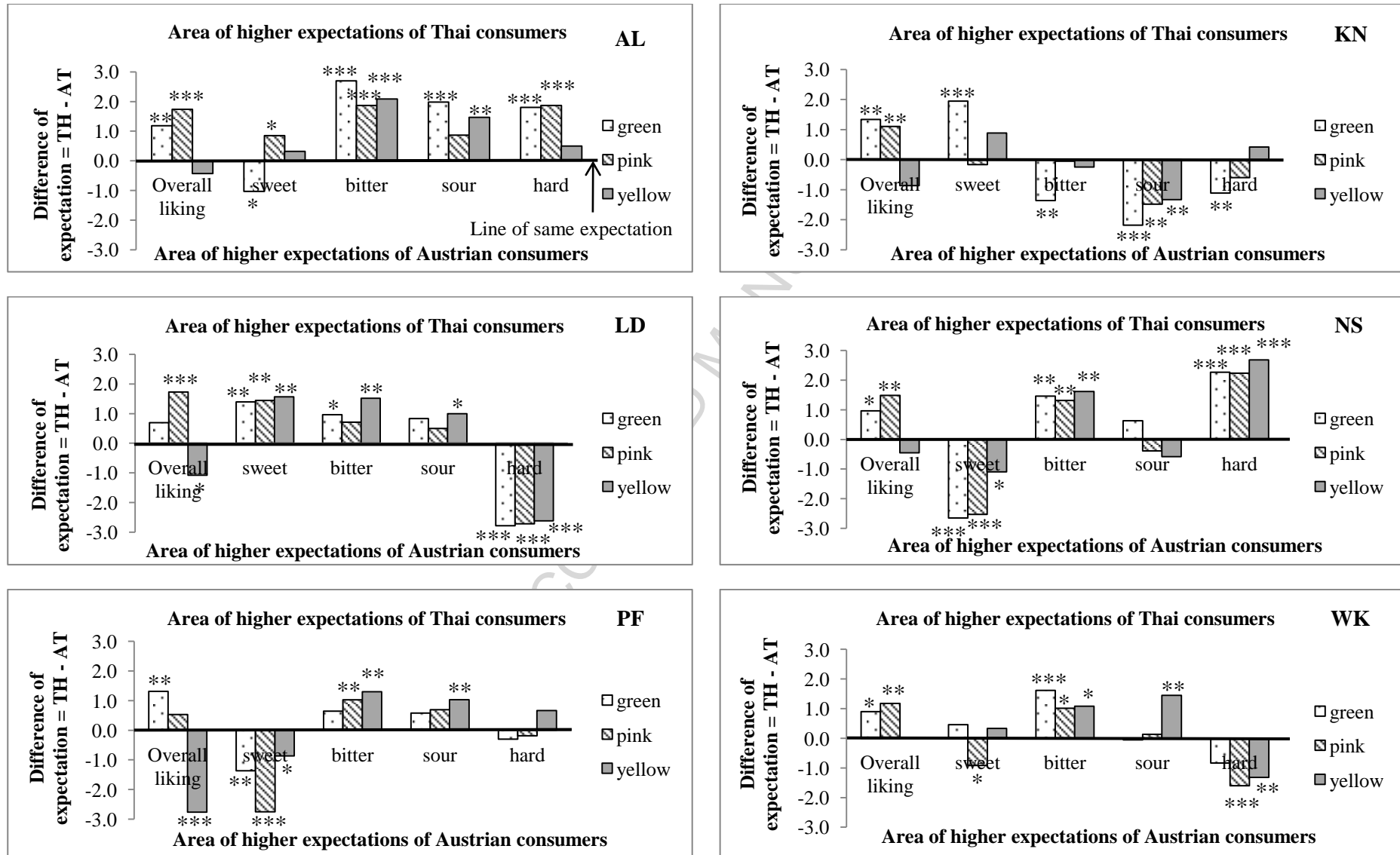


Fig.2.

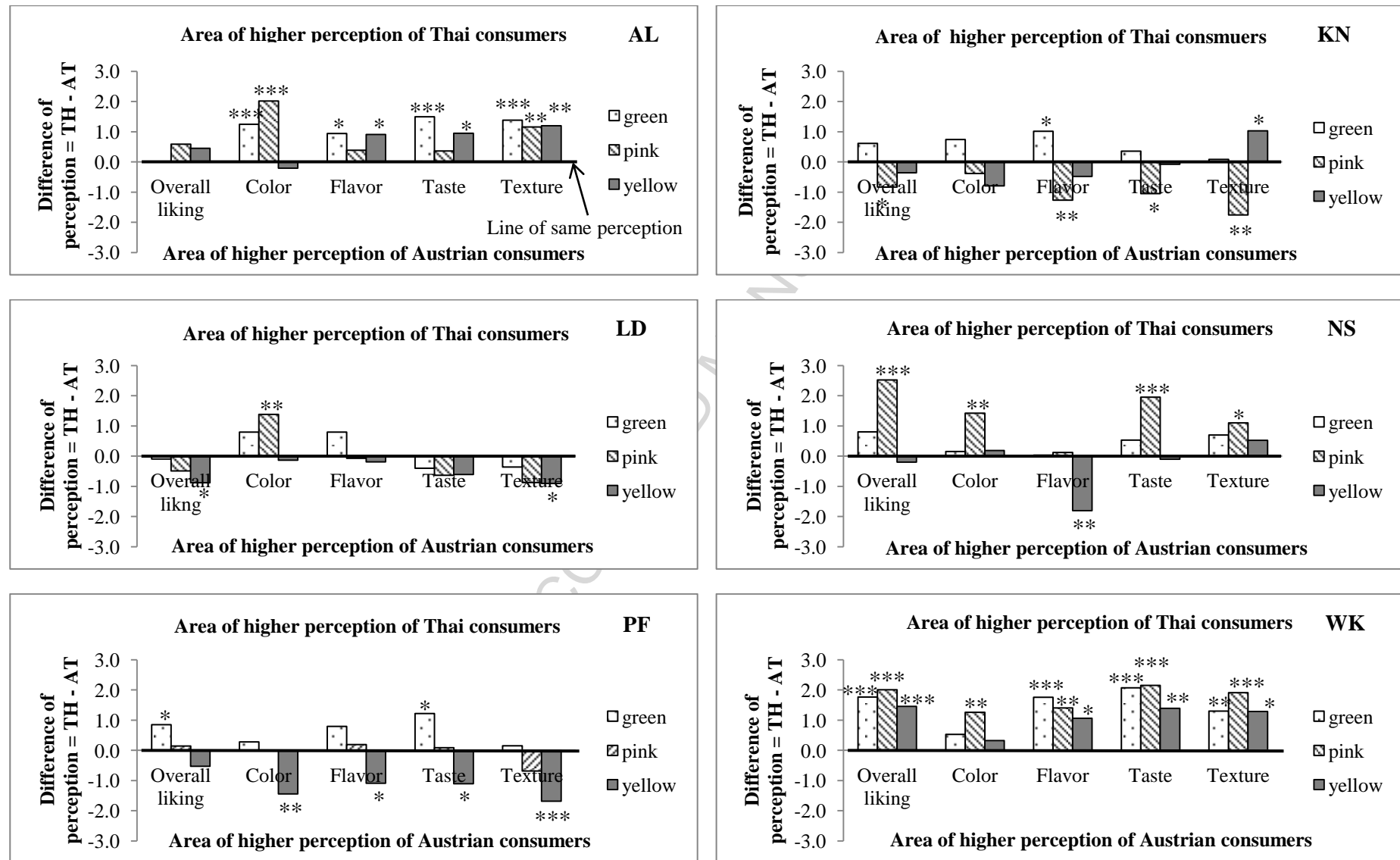
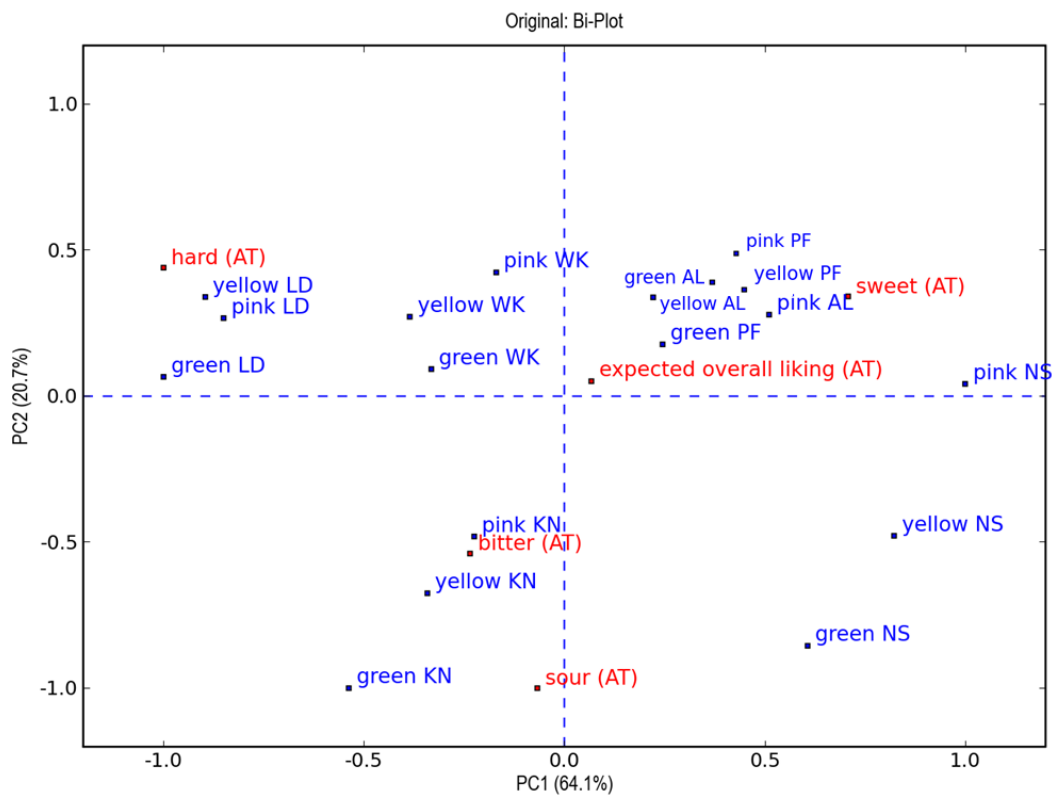
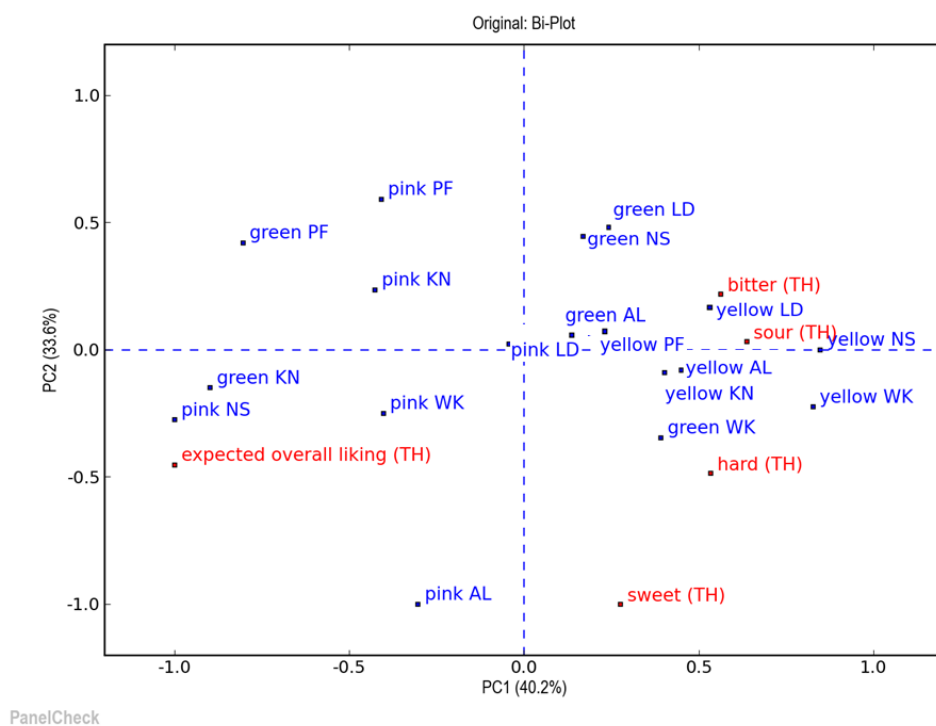


Fig.3.



PanelCheck

Fig.4.

**Fig.5.**

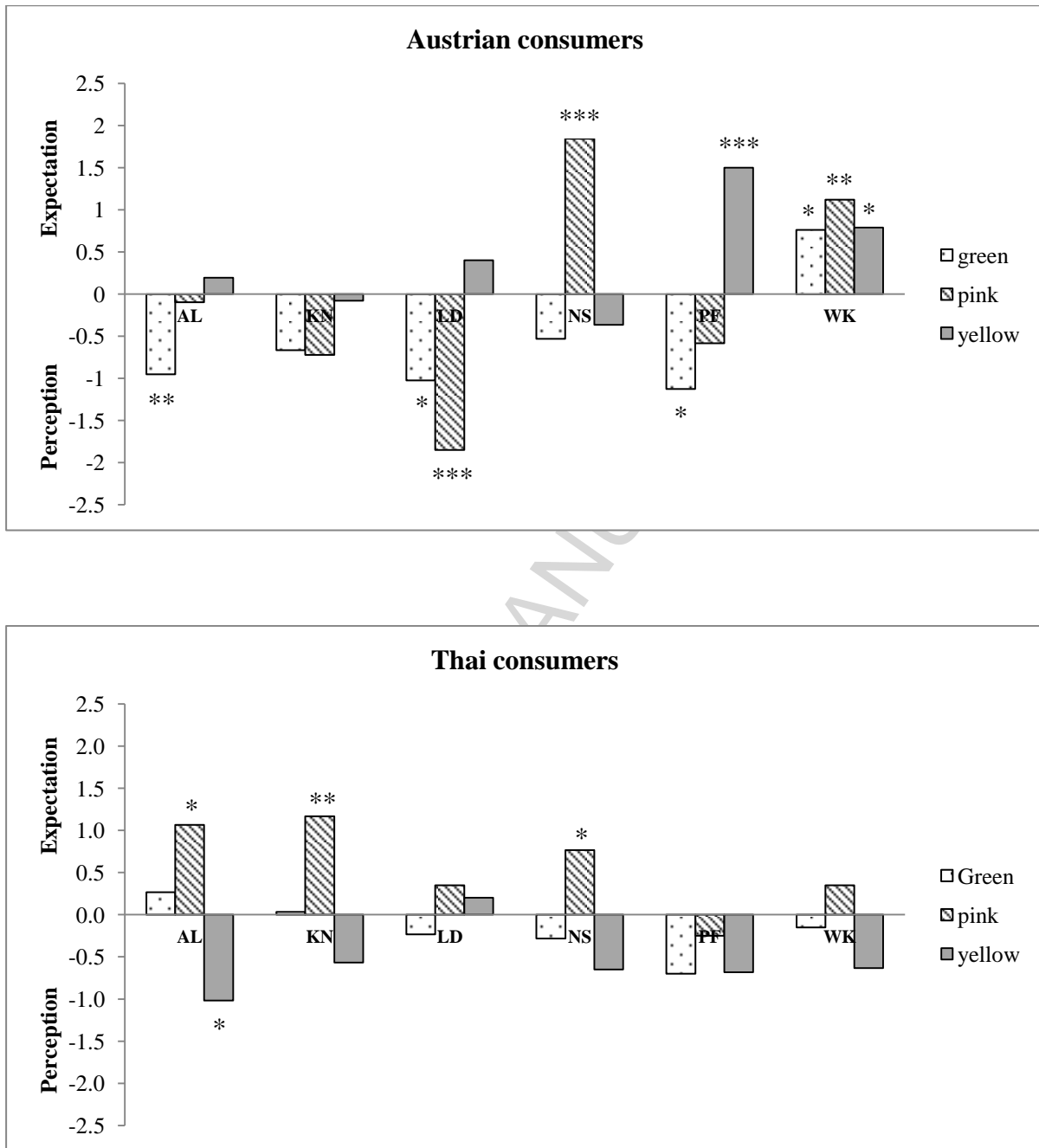
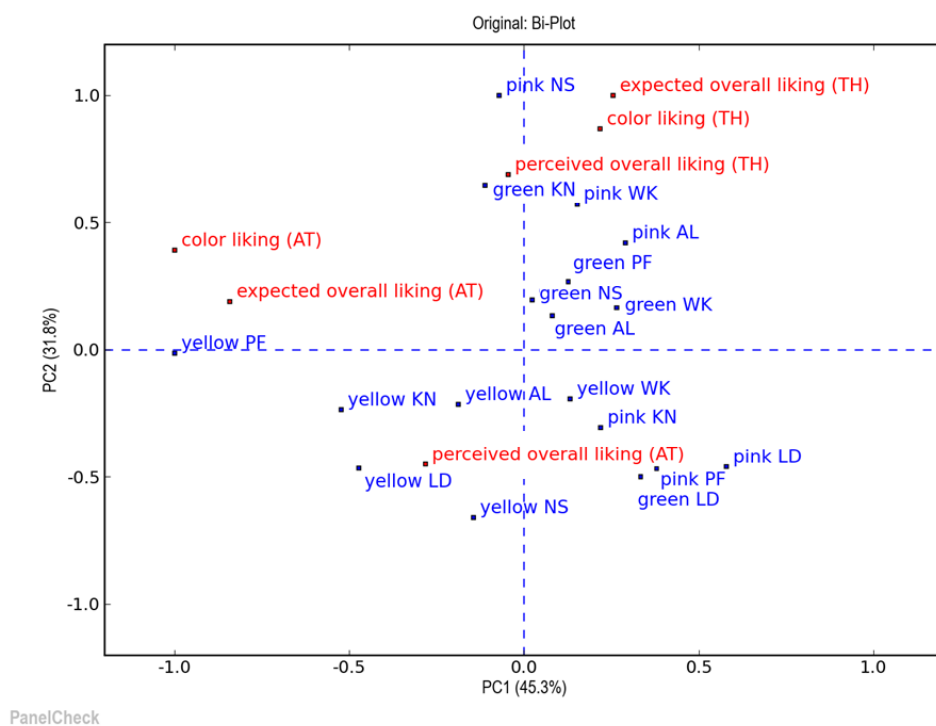


Fig.6.

**Fig.7.**

Highlights

- Expectations regarding colored Thai-desserts differ between Austrians and Thais.
- Expected and perceived liking of colored Thai-desserts differ between Austrians and Thais.
- Liking of the color correlated with familiarity of color for the product.
- Multivariate analyses showed the differences in sensory expectations and perceived liking between both groups.
- Austrians have a hedonic tendency towards yellow and Thais towards green and pink products.