SPISE 2007

SPISE2007 “New trends in sensory evaluation of food and non-food products” symposium aims to encourage implementing sensory evaluation techniques in Vietnam and neighboring countries. The symposium seeks to cross boundaries of specialization to allow sensory scientists, consumer researchers, psychologists, statisticians and industrials from different countries to meet and discuss the most recent developments in sensory evaluation and consumer research.

We have great confidence that we will be successful in our effort to strengthen sensory evaluation in Asia and develop new fruitful collaborations among the symposium participants.

We would like to take this opportunity to thank the sponsors who supported us for the organization of this symposium: Fizz Biosystems, LogicStream, HABECO, POLYCO, Hanoimilk, Tribeco. We extend our thanks to all who have worked so hard to make this event possible: Tâm Minh Lê, Khuong Thanh Nguyen, Hà Hai Nguyen, Xuân Uyên Thuy Phan, Thanh Ba Nguyen, Kim Hanh Thi Vu, Vu Tuấn Nguyen.

Dominique Valentin
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SOME NEW AND EASY WAYS TO DESCRIBE, COMPARE, AND EVALUATE PRODUCTS AND ASSESSORS

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Abstract

Recently, in response to industrial demand to develop faster and cheaper methods of descriptive analysis, several methods have been offered as alternatives to conventional profiling. We present three of these methods: sorting tasks, projective mapping, and flash profiling along with a new statistical method to analyze them. This new statistical method, called DISTATIS, is a generalization of classical multidimensional scaling (MDS) and takes into account individual differences. DISTATIS provides two MDS-like maps: one map for the assessors, and one (compromise) map for the products. The attributes used by the assessors can also be represented on the product map as well as the specific pattern of evaluation of each assessor. Using the same statistical method to analyze different methods of descriptive analysis will facilitate their comparison.

Keywords: descriptive analysis, sorting task, napping, flash profile, DISTATIS.

INTRODUCTION

Descriptive analysis is widely used in sensory evaluation for product development, quality control as well as market research. The goal of this method is to describe the sensory characteristics of a product, and to use these characteristics to quantify inter-product sensory differences (see, e.g., Lawless & Heymann, 1999, for a review). The most popular variations of descriptive analysis are the quantitative descriptive analysis or QDA (Stone, Sidel, Oliver, Woodlsey, & Singleton, 1974), the spectrum method (Meilgaard, Civille, & Carr, 1991), the texture profile (Muñoz, Szczesniak, Einstein, & Schwartz, 1992) and flavour profile (Keane, 1992). All these variations provide quantitative description of sensory attributes as perceived by a group of expert panellists. These expert panellists are selected for their sensory abilities and trained to describe and evaluate sensory differences among products. The panellists first elaborate by consensus a list of attributes with precise definitions and references for each attribute. Then, they are trained to develop their sensory acuity and to use the evaluation scales. The final evaluations—which are always performed in blind condition and replicated twice—give the positioning of the different products as well as their quantified sensory characteristics. The essential parts of this training process are the elaboration of precise consensual definitions of the attributes and the development of homogeneous scaling skills. These two conditions guarantee the success of descriptive analysis in providing detailed information as well as reliable and consistent results. Yet, as a counterpart of this success, classical methods of descriptive analysis require extensive training before the panel can become a reliable sensory instrument because the vocabulary and associated training must be adapted to each product space. It can take from few weeks to several months to perform a study and thus there is an obvious need for faster and cheaper methods.
And so, it is, maybe, not so surprising that several methods have been proposed in recent years as alternatives to classical descriptive analysis: free sorting task (Cartier, Rytz, Lecomte, Poblete, Krystlik, Belin, & Martin, 2006; Faye, Brémaud, Durand-Daubin, Courcoux, Giboreau, & Nicod, 2004; Saint-Eve, Paài, Kora, & Martin, 2003), projective mapping (Risvik, McEwan, & Redbotten, 1997) or tablecloth analysis (from the French “nappe” which is often directly translated as “napping,” Pagès, 2005), and flash profiling (Dairou & Siefermann, 2002; Delarue & Siefermann, 2004). These methods aim at providing a quick sensory positioning of a set of products and thus bypass the time-consuming steps of attribute and scaling alignment of classical methods. These new methods build on the idea of free choice profiling (Williams & Langron, 1984) that allows judges to use their own attributes.

In a free sorting task, assessors are asked to sort together the products based on the perceived similarity between these products. Assessors are free to make as many groups as they wish and to put as many products as they want in each group. When they have sorted the products, assessors are asked to describe each group of products with a few words. In the sensory domain, sorting tasks were used on a large variety of food products as well as on non-food products (see Abdi, Valentin, Chollet, & Chrea, 2007, for a review). Sorting tasks are well adapted to obtain a coarse characterization of products or to select a subset of products for conducting further descriptive analysis (Giboreau, Navarro, Faye, & Dumortier, 2001; Piombino, Nicklaus, LeFur, Moio, & Le Quéré, 2003). Despite a few differences, perceptual maps obtained with sorting tasks are globally comparable with those obtained from classical descriptive analysis (Faye et al, 2004; Saint Eve et al, 2004) and seem to be reproducible (Cartier et al., 2006).

In projective mapping, or tablecloth analysis (a.k.a, “napping”), an assessor is asked to position the products on a two-dimensional space (an A3 sheet of white paper which plays the rôle of a tablecloth or “nappe”), according to how he or she perceives them to be related to each other. Two products are placed very close to each other if they are perceived as identical and very far one from the other if they are perceived as very different. There are no instructions as to how the samples should be separated in this space (each assessor chooses his/her own criteria), but examples of two-dimensional geographical maps can be used for illustration. After they have positioned the products on the map, assessors can be asked to describe each product by writing a few words directly on the sheet near the products. Assessors are free to re-taste the samples as often as they want and they can take as much time as needed to complete the task. Projective mapping gives rise to perceptual maps comparable to those obtained with classical descriptive analysis for obvious aspects of the products (Risvik, McEwan, Colwill, Rogers, & Lyon 1994; Risvick et al., 1997; Perrin, Symoneaux, Maître, Asselin, Jourjon, & Pagès, in press) and to be reproducible (Risvik et al., 1994; Risvick et al, 1997). This method seems to be well adapted for obtaining coarse descriptions of the products.

Flash profiling involves two sessions. In the first session, assessors are asked to individually generate attributes, which should be sufficiently discriminant to allow for a
ranking of the samples. All the generated attributes are then pooled by the experimenter. In the second session, assessors are asked first to read the panel’s list and to update their own list if desired. Then, they are asked to rank order the products from least to most for each of the chosen attributes. Ties are allowed and assessors can re-taste the samples as much as they like and take as much time as needed to complete the evaluation. Flash profiling has been used to describe food products such as red fruit jams (Dairou & Sieffermann, 2002), fruit dairy products (Delarue & Sieffermann, 2004), chewing gum (Delarue & Loescher, 2004) and fruit jelly (Blancher, Chollet, Kesteloot, Nguyen, Cuvelier, & Sieffermann, 2007) and proved to be satisfactory (compared to conventional profiling) when products are relatively different (Dairou & Sieffermann, 2002; Blancher et al, 2007) but may give different results than conventional profiling for relatively similar products such as apricot fresh cheeses (Delarue & Siefferman, 2007).

Although sorting tasks, projective mapping, and flash profiling cannot replace conventional profiling, these new descriptive methods constitute very attractive ways to provide quick descriptions of products. In this paper, we present a new statistical method, called DISTATIS, which can be used to analyze data from all three descriptive methods. DISTATIS provides two multidimensional scaling (MDS) like maps: a map for the assessors, and a compromise map for the products. The individual assessor patterns as well as the descriptors used by the assessors can be projected on this compromise space. This method has been previously described for sorting tasks (Abdi et al., 2007) here we show how to adapt it to projective mapping and flash profiling.

**DISTATIS: GENERAL PRINCIPLES**

DISTATIS is derived from a generalization of PCA called STATIS (Escoufier, 1980; Lavit, 1988; Schlich, 1996; Abdi, & Valentin, 2007b) and has the advantage of taking into account individual differences. It is a generalization of classical MDS (see, e.g., Abdi, 2007a). Specifically, DISTATIS analyzes a set of distance matrices obtained on one set of stimuli. As in MDS, the first step is to transform each distance matrix into a covariance matrix (using double centering). The similarity between covariance matrices is first evaluated using the $R_v$ coefficient (Roberts & Escoufier, 1976, Abdi, 2007c), and this coefficient is used to create a between assessor similarity matrix. The analysis of this $R_v$ matrix reveals the similarity structure of the assessors (i.e., are there subgroups in the assessors?) and it also provides an optimal set of weights which is then used to compute a “compromise” matrix. This compromise matrix represents the best aggregate of the original covariance matrices. The PCA of the compromise gives the position of the stimuli in the compromise space. The position of the stimuli for each distance matrix can be represented in the compromise space as supplementary points and the original distance matrices can be represented as points in a multidimensional space. Also, the attributes used to describe the products can be represented as points in the compromise space. Finally, confidence intervals can be computed for the position of the products (and the assessors but we do not illustrate this point here). These confidence intervals complete the
descriptive analysis with an inferential component that identifies “significant” differences between products.

Statistical inferences with DISTATIS

A general problem with multivariate techniques such as MDS, PCA, STATIS, and DISTATIS is to complete descriptive analyses with an inferential step (it is, in general, easier to publish “significant” results due to the “magic” of the .05 and .01 significance levels, see Cohen, 1994). Because the sampling distributions of the parameters optimized by these methods are rarely known, standard analytic procedures based on the normal distribution (e.g., F-tests) cannot be used, but alternative non-parametric inferential methods can be implemented via computational cross-validation techniques. One very powerful recent technique for cross-validation is the bootstrap (Efron 1979; Efron & Tibshirani, 1993). The idea of the bootstrap is to derive sampling distributions from the distribution of a large set of samples drawn with replacement from the observed data set. The bootstrapped distribution obtained from these samples is then used to estimate the sampling distribution of interest. As an illustration, in the sorting task example (described in details later), eleven assessors sorted the data and we have one distance matrix per assessor. So, the data set is composed of eleven distance matrices labelled $D_1$ to $D_{11}$. A possible sample of 11 distance matrices obtained by sampling with replacement from our data could be the following set of 11 distance matrices:

\[
\{D_{11}, D_{11}, D_6, D_9, D_2, D_5, D_{11}, D_9, D_{11}, D_8, D_1\}
\]

From this set we can compute a compromise matrix.

We implemented this procedure (of sampling with replacement and computing the compromise) and repeated it 1000 times. We then projected all these 1000 compromise matrices onto the original compromise (using the projection operator defined in Equation 14 of Abdi et al, 2007) and computed for each category a confidence ellipsoid that comprised 95% of the projections of the bootstraped compromises for this category (See Figure 2). These confidence ellipsoids can be used to perform hypothesis testing: When the ellipsoids of two categories do not intersect, these two categories can be considered as statistically different at the $p = .05$ level; and when the ellipsoids of two categories intersect, these two categories cannot be considered as statistically different at the $p = .05$ level.

DISTATIS: AN ILLUSTRATION FOR SORTING TASK, PROJECTIVE MAPPING, AND FLASH PROFILING

To illustrate how to use DISTATIS for sorting task, projective mapping, and flash profiling, we fabricated a small example in which seven beers (A, B, C, D, E, F, G) are described by three groups of assessors. The first group includes eleven assessors who described the beers using a sorting task. Their data are presented in Tables 1 and 2. The second group includes seven assessors who described the beers using projective mapping / napping. Their data are presented in Tables 3 and 4. The third group includes six assessors who
Table 1. Sorting data, the beers. For each assessor, beers with the same number were sorted together

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Table 2. Sorting data, the vocabulary

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Table 3. Projective mapping / napping: the beers

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Table 4. Projective mapping / napping: the vocabulary

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</tbody>
</table>

Table 5. Flash profile, the beers

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Assessors</th>
<th>Assessors</th>
<th>Assessors</th>
<th>Assessors</th>
<th>Assessors</th>
<th>Assessors</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1 3 1 5 4</td>
<td>2 7 4 5 7</td>
<td>6 3 6 1 7</td>
<td>1 3 1 1 5</td>
<td>3 7 1 6 5</td>
<td>3 1 1 1</td>
</tr>
<tr>
<td>B</td>
<td>2 5 1 4 7</td>
<td>1 6 5 2 6</td>
<td>7 7 7 2 6</td>
<td>1 5 3 2 7</td>
<td>6 7 7 2 1</td>
<td>5 6 4 7 6 2</td>
</tr>
<tr>
<td>C</td>
<td>3 6 4 6 1</td>
<td>2 5 1 7 1</td>
<td>2 1 3 3 1</td>
<td>6 4 6 7 5</td>
<td>4 6 7 5 3</td>
<td>2 3 3 1 7</td>
</tr>
<tr>
<td>D</td>
<td>6 7 5 2 1</td>
<td>6 2 6 1 3</td>
<td>2 5 5 4 7</td>
<td>3 3 6 6 2</td>
<td>3 3 6 6 2</td>
<td>6 2 7 2 6 3</td>
</tr>
<tr>
<td>E</td>
<td>5 2 7 7 4</td>
<td>3 4 3 1 2</td>
<td>3 5 2 6 2</td>
<td>7 7 4 3 5</td>
<td>1 3 5 6 2</td>
<td>1 2 5 3 6 5</td>
</tr>
<tr>
<td>F</td>
<td>7 4 6 5 3</td>
<td>6 7 5 3 4</td>
<td>3 6 1 7 7</td>
<td>5 4 1 4 3</td>
<td>5 2 2 4 3</td>
<td>5 2 1 4 1 4</td>
</tr>
<tr>
<td>G</td>
<td>4 3 3 3 6</td>
<td>3 4 3 2 5</td>
<td>5 4 4 4 4</td>
<td>5 2 2 4 5</td>
<td>5 2 2 5 4</td>
<td>5 2 3 4 6 1</td>
</tr>
</tbody>
</table>

Table 6. Flash profile, the vocabulary

<table>
<thead>
<tr>
<th>Attribute #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 alcohol</td>
<td>alcohol</td>
<td>alcohol</td>
<td>coriander</td>
<td>ripe fruit</td>
<td>toasted cereal</td>
<td>malt</td>
</tr>
<tr>
<td>2 malt</td>
<td>citrus</td>
<td>lemon</td>
<td>bitter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 fruity</td>
<td>cereal</td>
<td>honey</td>
<td>sweet</td>
<td>alcohol</td>
<td>coriander</td>
<td></td>
</tr>
<tr>
<td>4 bitter</td>
<td>bitter</td>
<td>alcohol</td>
<td>alcohol</td>
<td>sweet</td>
<td>coriander</td>
<td></td>
</tr>
<tr>
<td>5 spice</td>
<td>floral</td>
<td>sweet</td>
<td>coriander</td>
<td>bitter</td>
<td>hop</td>
<td></td>
</tr>
<tr>
<td>6 hop</td>
<td>sweet</td>
<td>honey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 hop</td>
<td>hop</td>
<td>alcohol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
described the beers using projective mapping / napping. Their data are presented in Tables 5 and 6.

**Sorting task**

To analyze the sorting task, we derived one between beer distance matrix per assessor. In this distance matrix, rows and columns represent the beers sorted by this assessor. A value of 1 at the intersection of a row and a column means that this assessor did not sort together these two beers, a value of 0 means that this assessor put these two beers in the same group (see Abdi et al., 2007, for more details). Standard **DISTATIS** was performed on the set of distance matrices. The first two dimensions of the **PCA** of the compromise matrix explain 70% of the variance, and therefore, we limited the interpretation of the results to these two dimensions. The attributes generated by the assessors were then projected on the two-dimensional compromise map using a barycentric projection procedure (see Abdi, 2007d). Specifically, the factor coordinates of a given word were obtained by first identifying for each assessor the beer coordinates corresponding to this word, and then computing the average of these coordinates over the assessors. The results of the analysis provide three maps: One map for the assessors (Figure 1), one map for the beers with their confidence interval (Figure 2a) and the map of the attributes (Figure 2b).

The assessor map represents the **PCA** of the between-assessor similarity matrix (i.e., the $R_Y$ coefficient matrix). It provides an easy way to examine the relationships between the assessors. It can be used to reveal clusters of assessors and to detect atypical assessors. Here we can note two groups of assessors who seem to have behaved somewhat differently. This apparent separation in two groups of assessors could be validated using hierarchical cluster analysis or a $k$-mean algorithm on the coordinates of the assessors. In addition, the proportion of variance explained by the first component of the assessor map gives an indication of the quality of the compromise: The closer this value is to 100%, the better the quality of the compromise. Here the first dimension explains 70% of the variance and this reflects a relatively good consensus between assessors.

The beer and attribute maps represent the **PCA** of the compromise matrix. They can be interpreted as a standard **PCA**. Despite relatively large confidence ellipsoids the beers seem to be organized in four groups \{A,B\}, \{C,D\},\{E,F\}, and \{G\} with some overlap of the confidence ellipsoid for the beer D and E. The relatively large size of the confidence ellipsoids for groups \{C,D\},\{E,F\} is however probably due to the nature of the sorting task which uses 0/1 values only. The first dimension which explains 42% of the variance opposes beers A and B to beers C, D, E, F. The second dimension which explains 28% of the variance opposes beers C and D to beers E, F, G. Beers A and B are described as lemon, light, floral, acid, coriander, citrus spicy. Beers C and D are described as toffee, honey, toasted, coffee, and somewhat sweet and bitter. Beers E and F are described as heavy, alcohol, fruity, strong, and somewhat sweet and bitter. Finally beer G—which is in
Figure 1. Sorting task: Map of the assessors

Figure 2. Sorting task: a) The map of the beers along with their confidence ellipsoids and b) Barycentric projections of the attributes in the beer space.

between groups {A,B} and {E,F}—has characteristics of both groups, but is mostly characterized as dentist\(^1\) and spice.

**Projective mapping/napping**

Data were collected using a coordinate system placed in the lower right hand corner of the map. The coordinates of the products are obtained as their projections on the horizontal and vertical axes. For each assessor we used the coordinates of the beers to compute a

\(^1\) Our fake assessors were French and in France the attribute “dentist” refers to the odor of eugenol (clove), which was used by French dentists in dental fillings.
between beer distance matrix. For example, the second assessor placed Beer A at the coordinates (1,5) and Beer E at coordinates (7,9). Using these coordinates (and the Pythagorean theorem), we can compute the (squared) Euclidean distance (see, Abdi, 2007b) between these two beers as:

\[ d^2(A,E) = (1-7)^2 + (5-9)^2 = 6^2 + 4^2 = 36 + 16 = 52. \]

Standard DISTATIS was performed on the set of distance matrices. The first two dimensions of the PCA of the compromise matrix explain 91 % of the variance. Such a large value indicates that the interpretation of the results can be restricted to these two dimensions. The attributes were projected on the two-dimensional compromise map using a barycentric projection procedure similar to the one used for the sorting task.

Figure 3 represents the assessor map. The high proportion of variance explained by the first dimension (\(\tau=75\%\)) indicates that there is a good consensus among the assessors and that the compromise is a good representation of the whole group of assessors. Yet, we can note some segmentation in the group of the assessors on the second dimension. Assessors 6 and 3 seem to have behaved differently than Assessors 4 and 5. It could thus be interesting to look at the characteristics of the assessors to explain these differences.

![Figure 3. Projective mapping / napping: Map of the assessors](image)

Figure 4. Projective mapping / napping: a) The map of the beers along with their confidence ellipsoids and b) Barycentric projection of the attributes in the beer space.
Figures 4a and b represent respectively the beer and the attribute maps. The configuration of confidence ellipsoids in Figure 4a suggests that there are four groups of beers: {F,E}, {G}, {A,B}{C,D}. The first dimension—which explains 52% of the variance—opposes clearly Beers F and E characterized as sweet, strong, fruity, heavy, and alcoholic to Beers A and B characterized as lemon, light, floral, citrus, and sour. The second dimension opposes Beers C and D to Beer G. Beers C and D are characterized as toffee, honey, coffee, and toasted. Beer G is characterized as dentist and somewhat alcoholic and spicy.

**Flash Profiling**

For each assessor, we used the ranking of the beers to compute a between beer Euclidean distance matrix. For example, the first assessor ranked Beer A as (1,1,3,1,5,4) and Beer B as (2,5,1,4,7,7). Using these ranks (and the Pythagorean theorem), we can compute the (squared) Euclidean distance between these two beers as:

\[ d^2(A,B) = (1-2)^2 + (1-5)^2 + \ldots + (4-7)^2 = 1^2 + 4^2 + \ldots + 3^2 = 43. \]

Standard DISTATIS was performed on the set of distance matrices. The first two dimensions of the PCA of the compromise matrix explain 72% of the variance; we thus limited our analysis to these two dimensions. The coordinates of the attributes on the two-dimensional compromise space were obtained by computing the correlation of each attribute with the dimensions of the compromise (these coefficients of correlation are equivalent to loadings in factor analysis).

Figure 5 represents the assessor map. The very high proportion of variance explained by the first dimension (τ=89%) indicates a good consensus among the assessors and a good quality of the compromise. Yet, we can note some segmentation of the assessors on the second dimension. Specifically, Assessor 6 seems to have behaved differently from Assessor 3. The other assessors are very consensual.

![Figure 5. Flash profiling: Map of the assessors](image)
Figures 6a and b represent respectively the beer and the attribute maps. The configuration of the confidence ellipsoids in Figure 6a reveals four groups of beers: {C,D}, {A,B}, {E,F}, and {G}. Beer G is located in between the groups {A,B} and {E,F}. The first dimension, which explains 52% of the variance, opposes Beers C and D to Beers A and B. The second dimension, which explains 39% of the variance, opposes Beers C and D to the other beers. The characterization of the groups of beers is somewhat more difficult with flash profiling than with the other two methods as all the attributes of all the assessors are preserved and sometimes the same attribute used by different assessors might project on different locations of the space. This is the case, for example, of the attribute bitter. Bitter as used by Assessor 1, is opposed on the second dimension to bitter as used by Assessor 6. Nevertheless, in our example, we can characterize Beers C and D as sweet, toasted, malt, alcohol, and maybe honey; Beers E and F are fruity, sweet, alcohol; and Beers A and B are floral, lemon, citrus, hop, coriander, spicy, and honey. Beer G is more difficult to characterize.

CONCLUSION

The main objective of this paper was to present new and easy ways to describe, compare, and evaluate products and assessors. We showed how to use a new statistical method, DISTATIS, to analyze descriptive data obtained through sorting tasks, projective mapping, and flash profiling. The advantage of using the same statistical technique to analyze data collected from different methodology is to make it easier to compare these methodologies. Here, for pedagogical reasons, we presented only small fabricated examples, so the comparisons between the three methods would be meaningless and thus these comparisons remain to be performed on real data.
Because DISTATIS provides an easy way to look at the same time at assessors, products, and attributes, we used it as the common tool to analyze the results of the sorting task, projective mapping / napping, and flash profiling. But we could have used other techniques, such as plain STATIS (Abdi & Valentin, 2007b), multiple factor analysis (Escofier & Pagès, 1998; Abdi & Valentin, 2007c), or generalized procrustean analysis (Gower & Dijksterhuis, 2004). Empirical comparisons need to be performed to evaluate the respective qualities of these alternative statistical methodologies.

REFERENCES


IMPACT OF TRAINING ON STRATEGIES TO REALIZE A BEER SORTING TASK: BEHAVIORAL AND VERBAL ASSESSMENTS

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Abstract

Several studies have explored the influence of training on beer flavor perception. These studies showed that perceptual, verbal and memory abilities can be developed during sensory training. However, no study has explored whether trained participants elaborate, using their specific knowledge and memory abilities, particular strategies to realize sensory tasks. To apprehend this question we designed a new experimental approach in which verbal data were analyzed in conjunction with behavioral indicators.

Ten trained and 10 novice participants were presented with eight beer samples and were asked to group similar beers together according to their own criteria, using only taste and olfaction. At the end of the task, the participant commented his behavior on particular moments during the task. This phase was analyzed to extract the strategies the most frequently described by trained and novice participants.

The first result that emerges from the verbal and behavioral data is the difficulty of the task, especially expressed by novices who felt overwhelmed. Participants expressed difficulties to memorize the samples as well as sensory saturation problems. To limit these problems, trained participants expressed in their verbalizations and behavior the following strategy: realize the task as quickly as possible. As a consequence, they validated their groups more quickly than novices. For that they relied more on olfaction than novices did, they avoided wasting time on rinsing their mouths and tasted the samples only to confirm their groups. By contrast novices tended to start the sorting by using taste; they frequently used bread and water to rinse their mouths and frequently changed their group’s constitution. Finally, an MDS analysis of the sorting data showed that the strategy used by trained participants lead to a finer and more consensual categorization of the beers than that obtain by novices. To conclude, this study illustrates the advantages of conjointly using verbal and behavioral approaches to investigate experts’ strategies in sensory tasks and eventually to transfer these strategies to novices.

Keywords: retrospective reports, human ethology, sorting task, expertise, beer.

INTRODUCTION

Brewing industries develop expert panels to help them not only in product development but also in routine control to maintain product quality. Expert panelists are selected for their sensory abilities and trained to describe product characteristics, discriminate among beers and spot sensory defects. To some extend they can be considered as measuring instruments. Nevertheless, these experts have to be trained all year long and, by consequent, require time and money. The natural question that arises is: “Do trained subjects acquire interesting abilities during training and if so, which abilities?” In the past few years, several studies in the domains of beer and wine have re-explored the influence of training on perceptive, verbal and memory abilities.
Experts generally outperformed novices on verbal performance

The results seem relatively clear on verbal performance: experts have a specific and larger vocabulary than novices to describe the products and to communicate about them (Solomon, 1990; Chollet & Valentin, 2001, 2006; Valentin, Chollet & Abdi, 2003; Chollet, Valentin & Abdi, 2005). Desort & Beauchamps (1974) and Cain (1979) showed that trained participants enhanced their abilities to identify odorants. A short training (10 hours) appeared sufficient to have a positive effect on identification of learned flavors added in beer but also to match correctly beers with the descriptions made by other trained participants (Chollet & Valentin, 2006). After 75 hours of training, participants were also able to match correctly beers with trained participant descriptions on unlearned beers (Chollet & Valentin, 2006). If other authors (Lawless, 1984; Lehrer, 1975; Gawel, 1997) were less categorical on experts’ verbal abilities, we can say that most of the studies suggest that trained participants are better at describing their perception than novices. Globally, trained participants use more terms to describe a product than untrained participants. Moreover, it seems that trained participants’ description tend to be precise and concrete whereas novices use more ambiguous, redundant, and less specific terms (Clapperton & Pigott, 1979; Cholet & Valentin, 2001; Chollet et al., 2005 for beers and Lawless 1984; Sokolow, 1998; Chollet & Valentin, 2000 for other domains).

The difference between experts and novices is not clear on perceptive abilities

The difference between experts and novices on perceptive abilities appeared unclear in the literature. In wine domain, several studies have shown that there was no difference between experts and novices on detection threshold (Bende & Nordin, 1997; Parr, Heatherbell & White, 2002; Parr, White & Heatherbell 2004), but Chollet & Valentin (2006) found that, after training, the isoamyl acetate threshold in beer tended to decrease. Concerning discrimination abilities, Solomon (1990) on wine domain and Peron & Allen (1988) on beer domain showed that experts outperformed novices, but Chollet et al.(2005) showed that a long training was necessary (more than 75 hours). Moreover, trained participants outperformed novices only on products used during training (Chollet et al., 2005). The free sorting task, which consists in grouping together products on their similarity (Mac Rae, Howgate & Geelhoed., 1990; Bijmolt & Wedel, 1995), was also use as perceptive task to compare trained participants with novices. Using this task, Chollet & Valentin (2000) showed that experts and novices used similar dimensions when they sorted wines from the same grape variety. Ballester, Patris, Symoneaux, & Valentin (in press) showed that experts and novices also used similar dimensions when they sorted wines from two grape varieties, using grape varieties on first dimension, but Solomon (1997) who used wines from several grape varieties showed that experts used grape varieties to sort the wines but not novices. On beer domain, Chollet & Valentin, (2001) showed one more time that experts and novices used similar dimensions, and Nava Guerra et al. (2004) have also shown that novices were as reproducible as experts when they carried out a sorting task on beers.
Experts outperformed novices on memory tasks, but only with learned products.
Concerning memory abilities, we have previously noted the experts superiority on identification tasks but it has been also shown that experts outperformed novices on recognition memory task with wine odorants (Parr et al., 2002, 2004) or in beer domain (Chollet & Valentin, 2006) but only for products they had been trained on (Valentin et al., 2007).

Do expert used particular strategies on sensorial tasks?
Here we are interested in another possible difference between experts and novices. Do experts elaborate particular strategies, using their specific knowledge and memory abilities, to realize sensory tasks in their domain? In cognitive psychology, a strategy could be defined as a rule or a procedure which allow to select an option among those which are available, or to create a new one, to solve a problem. The subject in this case selects and organizes elementary acts in order to reach successive goals in accordance with environmental constraints (Sabah, 2002). Newell and Simon (1972) have popularized this approach using a method named “verbal protocol method” where subjects might express aloud what they were thinking about during the task. These studies have come to conceptualize software able to simulate high level of human thought.

So, to apprehend the question of expert’s strategies, we designed here an experimental approach in which verbal data were analyzed in conjunction with behavioral indicators. Behavioral indicators give quantitative information concerning the task realization, and verbal data allow to apprehend original part of the experts’ thought processes (Gufoni, 1996). Then, verbal data were analyzed in conjunction with behavioral indicators to reveal original information on trained and novices participants’ strategies in a sensorial categorization task.

MATERIALS AND METHODS
Ten trained subjects and 10 novices took part in the study. The trained participants (6 men, 4 women, aged from 24 to 51 and presenting varied educational level) were involved (1 hour per week) for two years in a beer training program in France (ISA, Lilles). They were trained to describe commercial beers, to detect and identify aromas added in beers and to evaluate the intensity of general beer characteristics (bitterness, astringency, sweetness, alcohol, hops, malt, fizziness, and persistence). At the time of the experiment, trained participants had received more than 50 hours of training and described more than 200 beers. They developed a consensual vocabulary and common knowledge. In contrast, novices were beer drinkers without any formal training to describe flavors in beer and were selected according to the same criteria than those of the trained participants on sex, age and educational level.
Samples

Eight beer samples (20 ml each) were presented simultaneously to the participants (Table 1). Two of them could be described as “beers without alcohol” (Tourtel, Buckler), two as “amber beers” (Killian’s, Amber Jenlain), and the others as “lager or blond beers” (Bud, Kronenbourg and two repetition of Heineken). Beers were served at 8 to 12°C in brown plastic cups coded with a letter (A to H).

<table>
<thead>
<tr>
<th></th>
<th>Type</th>
<th>Alcohol content</th>
<th>Particular taste or aroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buckler</td>
<td>Lager</td>
<td>&lt; 1.2 %</td>
<td>Bitterness, Honey, Fruity</td>
</tr>
<tr>
<td>Bud</td>
<td>Lager</td>
<td>5 %</td>
<td>Light in aroma and taste</td>
</tr>
<tr>
<td>Heineken</td>
<td>Lager</td>
<td>5 %</td>
<td>Bitterness, Fruity</td>
</tr>
<tr>
<td>Jenlain</td>
<td>Amber</td>
<td>7.5 %</td>
<td>Malted, Caramelized, Fruity</td>
</tr>
<tr>
<td>Killian’s</td>
<td>Amber</td>
<td>7.5 %</td>
<td>Malted, Caramelized</td>
</tr>
<tr>
<td>Kronenbourg</td>
<td>Lager</td>
<td>4.7 %</td>
<td>Acidity, Hop, Ripe fruits</td>
</tr>
<tr>
<td>Tourtel</td>
<td>Lager</td>
<td>&lt; 1.2 %</td>
<td>Citrus Fruit, Malted, Coriandre</td>
</tr>
</tbody>
</table>

Table 1. Description of the beers used in the sorting task

Procedure

The study was composed of two successive stages in the same experimental session.

Stage 1

Participants realized individually a free sorting task of the eight beer samples (Picture 1). They had to group together similar beers according to their own perceptive criteria, except visual information (experiment occurred in a dark room, beers were served in brown plastic cups and participants wore black glasses). We first asked the participants to smell or taste the eight samples one time each (from left to right) and then to smell or taste them again as many times as they needed to constitute their groups (from 1 to 8 groups). Beers were presented in the same order to all participants: from left to right, Bud, Tourtel, Killian’s, Heineken 1, Buckler, Kronenbourg, Heineken 2 and Amber Jenlain. Participants were also invited to use water and bread freely during the task. They were filmed during this task (Picture 1).

Stage 2

At the end of the first stage, the experimenter and the participant watched the video of stage 1 (Picture 2) and the participant commented his/her behavior on particular moments during the sorting task (retrospective reports). The participants could taste/smell again the samples at this stage. This stage was audio recorded.

Picture 1. A participant realizes a free sorting task of eight beer samples

Picture 2. A participant, watching the video of his sorting task, commented his behavior
Dependent variables and statistical analyses

Stage 1

Using the movies obtained in stage 1 we quantified 1) the duration of the task, 2) the number and duration of smell for each beer, 3) the number and duration of taste for each beer, 4) the number for bread and water consumptions, 5) all the beer associations during the tasks (when the participant took a beer during the task, we noted toward which beers he/she put it down and considered it as an association), 6) the final groups for each participants (output of the sorting task). The quantitative values of the five first behavioral variables were obtained with The Observer 5.0 (Noldus Information Technology, Netherlands). This software allows precise quantitative behavioral analyses in latency, frequency and duration.

To compare statistically trained and novice participants, we used a student t-test for the first and fourth variables, and a 2-ways ANOVA (Beers X Groups of participants) for the second and third variables (STATISTICA 6.1, Statsoft, France). The fifth (association of beers during the task) and sixth (final groups) variables permit to build independent co-occurrence matrices for trained participants and novices and to realize Multidimensional Scaling analyses (MDS), using ALSCAL algorithm (Non-metric Alternating Least-Square Scaling, STATISTICA). The observed stress values accepted a two dimensional representation in each case. Then, a hierarchical ascendant classification (HCA) was realized on the MDS dimensions and allowed to form groups of beers that were more often associated during the task or associated in the same final group by more participants at the end of the task.

Stage 2

The recorded interviews of stage 2 were transcribed to collect verbatim of participants and analyzed by three independent judges to explain their behaviors and their minds during the sorting task. Each judge had to extract the main themes for each group of participant (trained vs. novice participants) and to illustrate them with verbatim. Then, the three judges discussed to select the more consensual themes and verbatim. We presented here those who could illustrate the strategies and the difficulties that trained participants and novices encountered during a sorting task.

RESULTS

Which groups of beers emerge at the end of the sorting task?

The mean number of groups were quite similar between trained participants and novices (4.0 ± 0.9 and 3.8 ± 1.1). The HCA revealed that trained participants (Figure 1-a) were consensual in separately grouping the 4 lager beers (the Bud, the Kronenbourg and the repeated Heineken’s), the two amber beers and the two beers without alcohol. Regarding the novices (Figure 1-b), the HCA showed that only amber beers were consensually grouped together. So, the result of the sorting task showed that training lead to a finer and more consensual categorization of the beers.
How novices and trained participants realized the beer sorting task?

Trained participants and novices expressed the difficulty to realize the task

The first result that emerges from the verbal and behavioral data is the difficulty of the task, especially expressed by novices who felt overwhelmed. Participants expressed difficulties to memorize the samples as well as sensory saturation problems.

« …And then I felt that this would be a hard task because there aren't as many differences in the smells…. » (a novice)

« …So this... but I've had a lot of difficulty there. …. » (a novice)

« …it was a little bit because there was precisely a difficulty in telling the difference between the beers… » (a novice)

From a coarse sort to a finer one

Several verbatim from both groups of participants revealed that participants wanted to start with a coarse sorting before refining it, but novices expressed their difficulties to do it:

« …I start by putting them into big piles, then I go back to the piles and make smaller ones out of the ones I’ve already selected … » (a trained participant)

« …Now I want to see if there are groups and sub-groups in all that. » (a novice)

« …Yes, because in fact I have a really hard time making up sub-groups… » (a novice)

« …five of them and I suddenly realized that I couldn’t tell them apart … » (a novice).

Realize the task as quickly as possible: A trained participant strategy

To limit these problems, trained participants expressed in their verbalizations and behavior the following strategy: realize the task as quickly as possible. As a consequence, they validated their groups more quickly than novices;
« ...Yes, that’s the way I like to go about it, always do it pretty quickly... » (a trained participant)

« ..Five or six beers ... were a lot harder to place, that’s why I took so much more time ... » (a novice)

The MDS of the beer associations during the task showed that trained participants (Figure 2a) associated more often beers of the same family (amber beers, lager beers, beers without alcohol, repeated Heinekens) than beers of different families. Concerning novices (Figure 2b), the association of beers during the task did not reveal a sensory consensus between participants, except for amber beers.

Novices changed the groups constitution many times and, as a result, the task was significantly longer (t=2.17, p<.05) for novices than for trained participants (Figure 3). Verbatim revealed also that trained participants validated their groups and realized the task faster not because they found it easier but to be more efficient:

« ... If there is a substance that you smell first, after, progressively, as you’ve already smelled lots of things, it’s a little harder to distinguish. That’s why I go pretty quickly ... » (a trained participant)

![Figure 2. MDS analysis of the association of beers during the task (with HCA) for a) trained participants (N=10) and b) novices (N=10)](image)

![Figure 3. Mean duration (±SE) of the beer sorting task for trained participants and novices:* = p<0.05 student t-test](image)
Trained participants use more olfaction than novices

To be faster, trained participants relied significantly more on olfaction than novices, and tasted the samples only to confirm their groups:

« ... I classify them according to smell in fact. To classify the beers I only sort by smell ... » (a trained participant)

« ... It’s true that I didn’t really sniff the beers to classify them ... » (a novice)

As a result trained participants smelled all the beers significantly more often / min ($F_{1.18}=12.60$, p<.001) and for a longer time / min ($F_{1.18}=4.70$, p<.05) than novices (Figure 4), but no difference was observed concerning the duration / min and the number of occurrences / min that each beer was tasted (Figure 5).

Seven trained participants (out of 10) but only 1 novice started the sorting task by smelling all the beers and their verbatim gave some explanations:

« ...Yes, because right away from the smell, that’s what you notice right away. There are things you notice right away ... » (a trained participant)

« ...That way you can go quickly and get to the last one... you’ve got your classes right away ... » (a trained participant)

« ...By smelling first you also avoid saturating too quickly ... » (a trained participant)

---

**Figure 4.** a) Mean duration / min (±SE) and b) mean number of occurrences / min (±SE) that each beer was smelled by trained participants (black) and novices (white).

**Figure 5.** a) Mean duration / min (±SE) and b) mean number of occurrences/min (±SE) that each beer was tasted by trained participants (black) and novices (white).
Trained participants avoid wasting time on rinsing their mouths

To go faster, trained panelists also avoided wasting time on rinsing their mouths, contrary to novices which used significantly (t=2.28, p<.05) more often water to rinse their mouths (Figure 6). One more time, novices and trained participant verbatim explained these strategies.

« ...It’s funny, these sips of water, to feel the need to rinse your mouth if you really want to taste something … » (a novice)

« ... I taste one after the other without stopping to rinse my mouth ... » (a trained participant)

« ...No, because I have a hard time memorizing. I have to test again every time. I don’t remember what I tasted and that causes problems because then I have the taste of the next one in my mouth. That’s why I drink water between each one … » (a novice)

![Figure 6. Mean number of occurrences / min (±SE) that trained participants and novices drank water or ate bread:* = p<0.05 student t-test.](image)

Novices asked for methods

Finally, the reading of verbatim indicated that novice participants needed methods to realize the task:

« ...As for the task I was asked to do to make up the groups, I started to wonder how I was going to go about it, what criteria I was going to use to make up these groups … » (a novice)

« ...There I think I really ran into a problem of methodology. I had to find a way to … find my own methodology. How to determine parameters, criteria … » (a novice)

« ...Finally I did try to … maybe to sort of make up groups but at least to, I don’t know, give them a scale from one to ten. » (a novice)

DISCUSSION

The objective of this work was to study the impact of training on strategies, using behavioral and verbal assessments, during a sensory categorization task. The analyses of the sorting task showed that trained participants were more consensual than novices to group together beers on basic beer dimensions (lager beers, amber beers, beers without alcohol). Trained participants did so from the beginning of the task and validated quickly
their groups whereas novices changed their group constitution many times and, as a result, the task was significantly longer than for trained participants. It was also interesting to note that the verbatim of trained and novice participants confirmed these behavioral results: trained participants wanted to perform the task as quickly as possible and novices expressed their difficulties.

Concerning the trained subjects’ strategy - do as fast as possible - it was not because they have found the task easier than novices, but to be more efficient. Devevey & Sieffermann (1996) have already shown that in discriminative tasks, such as the triangular task, the delay between each perception decreased the performance because of memory limitations. Contrary to trained participants, novices wasted time to decide which criteria they could use to group the beers and they clearly asked for methods.

Trained and novice participant behaviors and verbatim revealed that both groups of participants wanted to start with a coarse sorting (one or two clear dimensions) before refining it, but novices expressed their difficulties to do it. Trained participants, but also novices, separated the two amber beers from the others. Then, participants report that they tried to create other groups, but only trained participants were able to do it in a consistent way (beers without alcohol, lager beers) whereas the six beers could not be grouped consensually by novices. This result suggests that if the sorting task is classified as a perceptive task, conceptual knowledge acquired during training could also influence the categorization process when differences between products are more subtle.

Trained participants, as in wine domain, have clearly used olfaction to sort the beers, and significantly more than novices. It is not intuitive for beer novice consumers, but not surprising for experts because they have learned to use olfaction during their training. The majority of trained participants smelled all the beers to start the task and some of them used principally olfaction to categorize stimuli. In their verbatim, trained participants expressed clearly that olfactory perceptions are primordial to discriminate between products and to rapidly analyze unstable components. Moreover, they could evaluate quickly a lot of products with olfaction and optimize the memory processes. Trained participants declared also that they used olfaction to avoid problems of saturation that appears rapidly when several beers are tasted.

Another unexpected result concerns the fact that trained participants rinsed their mouth significantly less often with water than novices. Yet, this behavior is clearly encouraged during training but one more time trained participants preferred to realize the task more quickly to avoid memory problems. It is also possible that novices, who needed more time to realize the task, have to rinse their mouth more than trained participants, but the difference were still significant in relative time (number of occurrences / min). To resume : novices took more time to acquire information on products, rinsed their mouth more often and, using too much time, forgot their perception on the first beers and needed to taste them again. It is important to remember that this task was not considered easy by experts, but they have nevertheless enough knowledge on beers to avoid successive evaluations and to make rapid decisions.
To enhance novice performance during the sorting task it could be efficient to transfer trained participant strategies. As previous studies on wines and beers have showed that experts and novices could used similar dimensions on sorting tasks (Ballester et al., in press; Chollet & Valentin, 2000, 2001), we could ask novices to do the task faster. More precisely we could suggest to novices to validate their groups more rapidly (validate their first intuitions), to make more use of olfaction, to only taste the beers to refine groups, and to use water with parsimony. The goal of these suggestions is to facilitate memory processes but it implies that novices have perceptive competences comparable to that of experts to discriminate and categorize products with subtle differences.

To conclude, this study clearly illustrates the advantages of conjointly using verbal and behavioral approaches to investigate expert strategies in sensory tasks and eventually to transfer these strategies to novices. This method allowed the discrimination of the two groups of participants on their behaviors and strategies, in a task where classically novice and expert results are comparable. Moreover, behavioral data have given quantitative variables that verbatim have described, and verbatim have given qualitative indications that behavioral variables have quantified. Ericsson and Simon (1993) underlined that conjoint analyses are heuristic because they increase the reliability and the validity of experimental results. Several studies on expertise, linguistic, education or reasoning, conjointly use verbal and behavioral approaches (Gufoni, 1996, 2003; Fayol, 1997; Piolat, 2004). In this work we have used this “mixed” method to apprehend the expert strategies in a sensorial task and it appeared that it could be efficient to increase the reliability and the validity of sensorial analyses.

ACKNOWLEDGEMENTS
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REFERENCES


USING GROUP FOCUS TO STUDY THE REPRESENTATION OF WINE IN VIETNAM

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Abstract

Wine consumption in Vietnam has been on the rise for the last five years. Due to westernization and health awareness, consumers living in urban areas tend to switch from beer and spirits to wine. We are interested in understanding how such a cultural context affects the way people perceive wine in this non viticultural country. Everyday thinking patterns in Vietnam related to wine are explored within the theoretical framework of representations. We used focus group techniques to explore consumers’ representations of wine in two cities in Vietnam (Hanoi and Ho Chi Minh-city) and compared them with the representations elaborated by consumers in a viticultural city in France (Dijon). In each country, focus groups were set up to explore the representations of wine among 20 connoisseurs, 20 novice-consumers and 20 non-consumers. Data from the focus groups were independently summarized by three readers to generate central themes.

Preliminary results indicate that, in Vietnam wine is not as associated with sensory pleasure as it is in France, but rather with social and health issues. Most Vietnamese participants declared not to like the taste of wine, but to find it valuable to exhibit bottles or to drink wine on important occasions. Drinking imported wine sounds fashionable and more prestigious than drinking other types of alcohol. Wine is also believed to be beneficial for digestion and virility and protective against the risks of heart attack. These results have several implications for wine marketing in Vietnam.

Keywords: representation, focus group, consumer, Vietnam, wine.

INTRODUCTION

Vietnam is a country of 80 million people located in South-East Asia. Contrary to wine-tradition countries, France for example, Vietnam does not produce wine and has no wine tradition. The alcohols commonly consumed include rice-alcohol in the countryside or beer and spirits such as cognac in the city. Nevertheless it seems that, due to westernization and health awareness, consumers living in urban areas have recently begun to switch from beer and spirits to wine. According to the statistics of the “mission économique” (French embassy), wine consumption in Vietnam is on the rise with a potential for annual growth of 7-10%. We can also observe through media communication a willingness on the part of authorities to develop wine. It is therefore important to understand how cultural context affects the way people perceive and think about wine and how Vietnamese differ from people from a wine tradition country. To answer these questions, we carried out an exploratory study in which Vietnam, newly interested in wine, is compared to France, a country considered as elite in matters of wine. That comparison will enable us to partially explain the link between practices and representations toward wine, a newly imported product in Vietnamese culture. Indeed, social representations are formed when given
abstract objects become problematic in a given social context (Clémence, 2001). In the field of food research, the social representation theory has been applied to the study of modern biotechnology (Wagner & Kronberger, 2001), genetic engineering of foods (Bauer & Gaskell, 1999), and word associations of food and eating (Lahlou, 1996; 2001), among others. The findings of this interdisciplinary study will be applicable both to the social representation theory and to the study of wine within food science.

According to Moscovici (1973), social representations can be defined as “a system of values, ideas and practices with a twofold function: first to establish an order which will enable individuals to orient themselves in their material and social world and to master it; and secondly to enable communication [...] by providing them with a code for social exchange.” By focusing on everyday communication and thinking, the social representation theory aims to establish a link between the psychological and the social (Moscovici & Vignaux, 2000). Social representations concern the contents of everyday thinking that give coherence to our beliefs, ideas, and connections we create. They enable us to classify persons, objects, and situations, to compare and explain behaviours, and to objectify them as parts of our social setting (Moscovici, 1998). Social representations enable lay people, who do not necessarily possess the theoretical and methodological scientific knowledge, to understand phenomena that would otherwise remain inaccessible (Wagner & Kronberger, 2001). Social representations are group specific in the sense that the objects of the representations are socially constructed, and that the object takes on group specific social characteristics. Groups are characterized by shared, consensual social representations. This consensus is seen to minimize uncertainty in interaction and facilitate communication between individuals and groups (Moscovici, 1981), and it distinguishes social representations from representations that are unique to only a few individuals.

Here, the everyday thinking patterns of Vietnamese participants, living in two Vietnamese cities (Hanoi and Ho Chi Minh-city), will be explored and compared with those elaborated by French participants from a viticultural city in France (Dijon): What do they think about wine, what do they expect from wine and what do they do with wine? We decided to use the group interview (focus group) method to explore the everyday thinking patterns of Vietnamese and French people. Twelve focus groups were conducted: six in France and six in Vietnam. The comparison between Vietnam and France should enable us to study the effect of culture on the perception of wine. We will also try to understand how wine drinkers’ degree of expertise could possibly influence their perceived representations of wine.

**MATERIAL AND METHODS**

**Participants**

Fifty-three Vietnamese and 56 French (aged 18-63) participants were recruited. The recruitment was based on a questionnaire which enabled us to classify participants into three categories: connoisseurs, novices and non consumers. The questionnaire included questions about actual consumption to distinguish consumers from non-consumers, and
questions about knowledge and interest in wine to distinguish connoisseurs from novices. Non-consumers were people who declared they did not drink wine. Connoisseurs exhibited a higher degree of knowledge about and interest in wine than novices. Six focus groups were conducted in each country, two for each category of participants. Details can be found in Table 1:

<table>
<thead>
<tr>
<th>FRANCE</th>
<th>N</th>
<th>Female</th>
<th>Male</th>
<th>Mean age</th>
<th>VIETNAM</th>
<th>N</th>
<th>Female</th>
<th>Male</th>
<th>Mean age</th>
</tr>
</thead>
<tbody>
<tr>
<td>connoisseurs</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>55,5</td>
<td>connoisseurs</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>32,8</td>
</tr>
<tr>
<td>connoisseurs</td>
<td>11</td>
<td>4</td>
<td>7</td>
<td>44,0</td>
<td>connoisseurs</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>31,7</td>
</tr>
<tr>
<td>Novices</td>
<td>9</td>
<td>4</td>
<td>5</td>
<td>44,2</td>
<td>novices</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>38,5</td>
</tr>
<tr>
<td>Novices</td>
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<td>4</td>
<td>5</td>
<td>44,2</td>
<td>novices</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>34,9</td>
</tr>
<tr>
<td>non consumers</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>30,0</td>
<td>non consumers</td>
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<td>6</td>
<td>5</td>
<td>21,0</td>
</tr>
<tr>
<td>non consumers</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>21,0</td>
<td>non consumers</td>
<td>11</td>
<td>4</td>
<td>7</td>
<td>24,1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>56</td>
<td>26</td>
<td>30</td>
<td>39,8</td>
<td>53</td>
<td>24</td>
<td>29</td>
<td>30,5</td>
<td></td>
</tr>
</tbody>
</table>

Procedure

One moderator conducted all the focus group sessions using a standardized protocol of questions and probes. In France, all the focus group sessions were conducted in a meeting room in the Centre Européen des Sciences du Goût (European Center for Taste and Smell, Dijon). In Vietnam, three sessions were conducted in a sensory evaluation room at Hanoi University and the three others in a classroom at the Food Industry College of Ho Chi Minh city. All focus groups were led through the following steps.

General Information

The moderator explained to participants that the aim of the session was to understand what they thought about wine and that the study was a part of a PhD thesis project. The moderator also insisted that participants should express their own ideas, that there were no right or wrong ideas and that all personal opinions were welcome. Finally, the moderator reminded the group that the discussion had to be related to wine.

Familiarization with the task

To make participants comfortable with the up-coming discussion, the moderator familiarized them with an example of the task. He asked participants “When I say ‘meal’, what comes spontaneously into your mind?” The moderator encouraged everyone to participate in the discussion.

Discussion about wine

As soon as the task was familiar to all participants, the moderator began the main task. He asked “Now, when I say ‘wine’, what comes spontaneously into your mind?” During the session, the moderator got the discussion back on track whenever it tended to derive from the topic or to boost the discussion by giving turns to participants who seemed to participate too little. Making sure that the discussion did not lag, he also used the following probes to start up the discussion whenever it slowed down: “What comes spontaneously
into your mind when you think of wine?”, “What do you associate with wine?”, “What images do you think of when you think about wine?” At the end of the session, to summarize the discussion the moderator asked, “To summarize what you just said before, what are the negative or positive points about wine?”

Each discussion session lasted approximately one hour and a half and was audio-recorded then transcribed to facilitate systematic analysis.

**Statistical analysis**

The transcribed focus group discussions were first thematically analyzed. Three independent researchers read the verbatim to extract items. An item is one sentence that summarizes an idea mentioned by participants in a focus group. In line with the social representation theory, natural expressions of the focus group members were used. All items from every focus group were compiled by country. We obtained a list of 75 items for France and another of 61 items for Vietnam.

To evaluate the similitude among items, a free sorting task was performed by ten participants from each country. Participants were asked to group together items that seemed similar. They were free to make as many groups as they wished and to put as many items in each group as they wanted. We then derived pairwise similitude estimates in each culture by counting the number of participants who sorted the two items of a pair together. The two resulting co-occurrence matrices were submitted to a correspondence analysis (CA). Using the rule that we retained only dimensions whose singular value was greater than the average value, we retained 20 dimensions in France (85% of the variance) and 15 dimensions in Vietnam (83% of the variance). The projection of the items on these dimensions was then submitted to a hierarchical cluster analysis (HCA) using the ward criteria. 12 groups of items or themes emerged from the French HCA and 10 from the Vietnamese HCA. In a given theme, there are items which were sorted together in the sorting task. Each theme was given a title that expresses the overall idea of all items grouped together in this theme.

<table>
<thead>
<tr>
<th>Specific themes of France</th>
<th>Common themes</th>
<th>Specific themes of Vietnam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terroir</td>
<td>Complex and difficult</td>
<td>Wine is nice and healthy</td>
</tr>
<tr>
<td>French culture</td>
<td>Alcohol</td>
<td>Fashionable, prestigious</td>
</tr>
<tr>
<td>Mediterranean civilization</td>
<td>Women</td>
<td>Urban, modern,</td>
</tr>
<tr>
<td>and Christianity</td>
<td>Money and luxury</td>
<td>higher social status</td>
</tr>
<tr>
<td>Wine cellar</td>
<td></td>
<td>Gift, decoration</td>
</tr>
<tr>
<td>Education, transmission</td>
<td></td>
<td>Positive perspective</td>
</tr>
<tr>
<td>Emotions</td>
<td></td>
<td>for wine in Vietnam</td>
</tr>
<tr>
<td>Democratization of the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>image of wine</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

We first classified the themes into three categories: themes that were mentioned only in Vietnam, themes that were mentioned only in France, and themes that were mentioned in both cultures (cf Table 2). We then analyzed these three categories separately.

Themes common to France and Vietnam

**Wine is a complex and difficult product**

In both cultures, wine was regarded as a complex product. It is complex for the diversity of its origins, its grape varieties, its tastes but also its long history. A French connoisseur said “Each wine has its own tastes, odors. And it even changes from one year to another. It is very complex.” And a French non-consumer: “It is a complex product. It is not the same between one wine and another or one bottle and another.” This complexity makes wine a difficult product to master. A Vietnamese novice related: “It is difficult to choose wine, to know about wine or understand and really be able to enjoy it.” A Vietnamese connoisseur concluded: “Another negative point is that it is so confusing to tell the difference between products. We already have a hard time distinguishing every brand and knowing from which countries they come. For wine, there are even fewer clues.” Along the same lines, a novice consumer said “I only know Bordeaux. And then, they are all Bordeaux. It is hard to know which ones are good. We therefore care especially about price and packaging.”

**Wine contains alcohol**

In France this theme was discussed mostly among novices and non-consumers and in Vietnam in all focus groups. In both countries participants mentioned that: “Wine is an alcohol and therefore dangerous”, “Wine induces euphoria” and “Wine makes you drunk.” Undeniably, for novices and non-consumers, wine is assimilated to other alcoholic drinks. As such, it is perceived at the same time as attractive “wine makes you feel light”, but also as dangerous, like other alcoholic beverages. It is important to know that in the Vietnamese language, there is no distinction between the word “wine” and all other “alcohols”, which are all called “rượu”. Wine is therefore naturally assimilated in the language to all alcoholic drinks. In France, in the past few years, anti-alcohol campaigns have been analyzed by communication specialists as being negative for the image of wine. A non-consumer explained in a focus group: “I don’t drink wine or any other alcohol. I don’t buy wine either. I only see negative aspects of it, like drunkenness and financial problems.” For a long time in France, wine was perceived differently from other alcoholic beverages that have the bad connotation of drunkenness or road accidents or social problems. Half a century ago, wine was still considered as an everyday drink in France. One French connoisseur testified: “Before, in the primary school of every village, there were series of lessons about the effect of alcohol...because it used to be a product of everyday consumption and in great quantity, but not of great quality...” In Vietnam, wine was assimilated to alcohol but a lighter one than traditional alcohol (rice alcohol, cognac): “Wine is light, not as strong as other alcohol.”
Wine and women

This theme was discussed in both cultures but from very different points of view. In Vietnam, wine is considered as more accessible to women than traditional alcohols because it is less strong. A Vietnamese woman explained: “I think wine is accessible to everybody. Some people like it, others do not but everybody can drink it. Easy drinking, not like strong alcohol, especially for women, wine seems an accessible alcoholic drink for everyone at parties or meals among friends. It does not make people drunk quickly but still keeps warming up the atmosphere throughout the event. Strong alcohols, on the contrary make people drunk and quarrelsome.” Another one said: “Actually, it is easier to drink wine than to drink strong alcohol. In a family, mother and daughter can also drink wine as my father and my uncle and men do, for it is not strong. With alcohols, even rice alcohols, it does not work that way.” This opinion was shared among Vietnamese participants: “In our country, people usually say alcohol is for men. In this way, drinking women are not easily accepted [...]. It seems that people can accept much more easily a woman drinking wine than strong alcohol. I don’t know, maybe for health awareness reasons or maybe because wine is chic and it is graceful to hold a glass of wine in your hands at parties. That appears modern and charming… ”

In France, traditionally, wine was perceived as a man’s drink: “You probably notice that before women did not drink wine.” But there has been an evolution in mentalities: “I still remember, about 30 years ago I went looking for wine with a friend of mine, a woman. We came to an estate in Burgundy. Many men stared at us: Who are these women coming wine shopping... nowadays, people do not care any more. It goes unnoticed. Yes, there has been an evolution”, “With the evolution in mentalities; wine has become a drink for both women and men.” Yet, despite this evolution some clichés seem to persist: “I think, as long as the tradition remains, wine is almost a drink for men. It’s men who go wine shopping, stock bottles, and take care of the cellar. Men drink and talk about wine among themselves. Somehow wine is for men, just like the kitchen, the cuisine, is for women”.

Wine is linked to money and luxury

In all focus groups, participants evoked the price of wine. Some participants, especially among the Vietnamese groups and the non consumers and novice French groups expressed the idea that for them wine was a luxury: “Wine is a deluxe product”, “Wine is an expensive pleasure”, “Wine is reserved to wealthy people.” Other participants, mostly among the French connoisseurs and novice consumers, indicated that it is normal that wine is expensive: “Wine requires laborious work and justifies high prices” and that “There is no need to be rich to drink wine. It’s a question of choice, of priority”, “There is pleasure not only in expensive wines.” The idea is that if you are interested enough in wine it is possible to find good wines that are not too expensive. As a connoisseur puts it: “That’s actually a job to do as there are also wines which are not expensive but absolutely fantastic.” French connoisseurs seemed to look for pleasure more than for high price and some indicated that the market was evolving toward a democratization of wine. On the other hand, some French novice consumers indicated their fear that the high price of wine
might lead them to drink standardized wines. “If a bottle is too expensive you may not want
to take the risk of trying it, you might rather go for a standardized product”. And also: “In
France, there are estates which adopt a strategy of producing cost-reduced wines by
methods that make every wine the same. We are not talking about globalization but we are
going somehow in that direction.”

Wine and events

Talking about wine made both Vietnamese and French participants talk about special
events; however, the nature of the events mentioned in France and in Vietnam is quite
different. Most French participants talk about friends and family events. Many of them
said: “A bottle of wine, I just cannot drink alone but only with my family or my friends”,
“The pleasure of drinking wine is drinking it with good friends to share the pleasure and
the good taste of wine.” Undeniably, in France, wine still preserves its connotation: the
drink of conviviality, of friendship, and of the family: “Wine marks family events. I stock
wines for anniversaries and the birthdays of my children.” The mark of family is strong in
wine drinking and wine appreciation. The know-how surrounding wine is something that
people said is transmitted within the family “Wine is a culture transmitted from father to
son.” In contrast, wine is associated in Vietnam with social events. “For me, wine is for
special occasions like parties, meetings, receptions. It is very unusual to drink wine in
normal time”, “Wine reminds me of evening parties, receptions with business partners,
especially foreigners”, “Wine is only for special occasions like year-end parties with
colleagues”. Wine is used in Vietnam for special occasions: receptions, meetings or
business parties, this differs from France where wine is said to be first of all for family
events like birthdays, Christmas, family meals or for drinking with friends.

Themes specific to France

Terroir, Mediterranean civilization and French culture

Among the themes specifically discussed in France, these three themes came up very early
in the discussion, especially during connoisseur focus groups. Wine was often associated
with its geographical origin, with the soil, the ground, the localization of the vineyard
where the vines grow. In this way, consumers distinguished a Bordeaux wine from a
Burgundy wine as well as a St-Emilion from a Médoc (wines from areas of the Bordeaux
region) or a Côtes de Beaune from a Côtes de Nuits (wines from areas of the Burgundy
region). Because wine is produced and drunk in almost every corner of France and that has
been the case for a very long time, wine was considered by French participants as “not
only a drink but a popular tradition derived from a long history” as well as “a culinary
art, a know-how.” On a larger scale, wine was said to be “originally from the
Mediterranean civilization and symbolically associated with Christianity.” Regarding
religion, some connoisseurs noted that thanks to Christianity, notably through “vin de
messe” (wine for prayer in a church), wine could reach such a high level of quality and
success in history. Wine was supposed by French connoisseurs to be a “know-how” that
originally belonged exclusively to a certain culture, possibly French or Mediterranean. A
kind of pride was clearly expressed by connoisseurs who were all living in Burgundy, famous for its long and prestigious history and tradition of wine “I must sound biased, but I think we are so lucky to be here in Burgundy, a region where we eat good food and drink good wine.” Yet, despite this long wine tradition, some French novice consumers mentioned that even though they associated wine with France, they were aware that France was not the only wine producer and that it is interesting to try wine from other countries as well. “In my opinion, it is better not to be too nationalist … one would rather taste wines from other places. Nowadays there are also very good wines elsewhere, I think…that helps us knowing them better and appreciate them more. That’s a good thing”.

**Wine cellar**

Along with the notions of history and tradition, connoisseurs discussed at length and with strong emotion the importance of having a good wine cellar. Some mentioned that it was an important criterion they had when they bought their house: “When we look at a house for sale, we care about the quality of the roof etc. In my case, I care about the quality of the roof but also the quality of the cellar.” Others invest a lot of time, energy, and passion into building their wine cellar: “Indispensable, when we settled into our house on la Côte, one of my very first preoccupations was building my cellar. I spent a year and a half with a digger to make my cellar.” The cellar, for a wine connoisseur, does not only serve as a place for storage but also as a place of pleasure, “the pleasure of looking at well racked bottles” or of pride: “Such a great pleasure having a nice good cellar. Showing visitors one’s cellar is an act of pride” or of affection: “The cellar reminds me of many family events: from the birthdays of my children to their communions etc…” Connoisseurs usually stock wine for their family events: “Wine marks family events. I stock wines for anniversaries and the birthdays of my children.” So the wine cellar seems to be a very important element in the organization of wine representations for French connoisseurs, which distinguished them from novice consumers and non consumers. There also seems to be a difference between men and women connoisseurs. Despite the fact that most French participants agreed on the equality between women and men as wine drinkers, they often gave a particular importance to men as the master of the cellar in the family: “as a respect for the tradition, choosing wine and taking care of the wine cellar still remain a man’s work, just like it is the man who chooses the wine at a restaurant.”

**Education and transmission**

Another important specificity of French focus groups is the link between family and transmission of wine appreciation. The know-how surrounding wine is something that people said cannot be learned without oral transmission. A novice mentioned: “One needs to learn from someone else to taste wines, it cannot be learned from a book”, a non consumer: “Wine requires initiation and education.” And this transmission generally occurs within the family. A connoisseur said “It was my father who had me try my first glass of wine, then little by little explained to me how to taste wine.” The know-how of wine appreciation is also like a skill to be transmitted from generation to generation, as participants from all categories seemed to agree. They said: “Wine is a culture transmitted
from father to son.” Among them, a female connoisseur was more detailed: “You cannot see people who start tasting wine at 25 years old to appreciate it, I mean. We all need long years to know about wine or should begin when a very young kid. Obviously, in France we have been in a wine culture since we were little kids and there is the familial notion that we have an approach to wine. We begin little by little with that notion and your palate, I mean your taste, is formed and one starts knowing how to appreciate a Grand Cru and... The history and experience of wine is...we learn to taste wine and we learn to love it and so on...I think in a family where the parents do not drink wine, there is little chance that the children will drink wine later.”

Emotions

Finally, French connoisseurs and to a lesser degree novice consumers indicated that for them wine was more than a beverage because, contrary to other beverages, they consider wine as a creation: “It is an object of creation, an object of color, of savors, of odors. And it is created, it is a creation!” or an art work: “A very beautiful wine is somehow an artwork, just like a good dish elaborated by a good chef, a painting, a piece of music.” As any creation or artwork, the vine evokes emotions: “When it is successful, it is beautiful in color, beautiful in savors, in tastes; just like the object we have in our glass”, “We are constantly surprised. We are not sure at all about what is waiting for us inside each bottle. We even get surprised when we buy the same wine but from the last year.” It needs some work “It can be compared to music. There is music that pleases immensely. It sounds good, it is nice but very quick, we get tired with...And on the contrary, other music requires listening to 36 times. At the beginning, we have to make an effort then little by little we end up loving it. These things require time to tame, then we will be rewarded”.

Finally, for some connoisseurs, wine is even a passion which leads them to collect bottles: “Pleasure, there is pleasure in tidying up bottles”, discovering new aromas “Puligny, Chassagne..., It was a discovery, I smelt aromas, extraordinary”, finding the perfect wine: “Last time, I opened a bottle, it was not OK. I opened another bottle and then another one, we talked about it, we criticized... Wine, that’s something.”

Themes specific to Vietnam

Nice and healthy

A first interesting theme that emerged from all the Vietnamese focus groups is that wine is perceived as something positive, something with a better image than beer or strong spirits such as rice alcohol or cognac. This positive image can be explained primarily in terms of health issues. A novice consumer explained: “Wine increases your lifespan; it is a nice gift from nature to man.” Another one told us: “I drink a little wine, above all because I think it’s good for my health. It’s true; a sip of wine gives me a good appetite and helps me digest my meals. I can eat more. We often hear people say that drinking red wine is good for the heart” and finally a connoisseur said: “I think we tend to drink too much beer when we eat out and when we invite friends to eat out. Beer is nice and popular but it fills the stomach. Now there is wine, it’s convenient for me. It is not as strong as alcohol, even
cognac or whisky. So, I drink some wine, it is light, it’s good like that.” A second explanation for wine’s positive image is linked to its appearance: “One thing particularly nice about wine is its red color”, “The red of wine is beautiful and warm and welcoming. It makes us feel like we are seeing a warm fire in cold winter, it makes you want to come closer”, its origin: “For sure, wine is associated with a chic refined style. When we go to a chic restaurant and we order European dishes, we order a glass of red wine. It’s like traveling, just like we were traveling abroad”, and its implications: “Wine means refined taste”, “Wine is intellectual”, “Wine is mysterious.” Finally, wine is perceived as more romantic than beer or spirits. A connoisseur said: “Wine is romantic too, a dinner together, a bottle of wine on the restaurant table” another one answered “That’s true, there is much less romanticism with beer. Beer is not romantic!”

**Fashionable and prestigious**

More than just nice and healthy, wine is considered by Vietnamese as fashionable and prestigious: “The chic characteristic [of wine] always makes us dream somehow. Maybe, also because of that, people will buy more and more till the day it will not be considered as a chic product anymore”, “Wine is an alcohol from abroad, so completely opposite to traditional alcohol”, “Drinking wine is snobbish”, “Imported wines are more stylish than local alcohol.” In fact, Vietnamese society, newly open to the world, often appreciates things from the West and wine is a good example: “I think Vietnam still stay under-developed compared to foreign countries. Maybe that’s the reason why we need to see things from the outside. Wine is something from abroad imported in Vietnam. It is good to know about modern things”, “When thinking of wine, we think first of foreign countries. Spontaneously, it is a sign from the exterior, France for example”. Wine, like other products from the West, seems to be a window open onto the world and the further away this world is, the more interesting it gets: “That’s true, I still remember once, about ten years ago, someone offered me a bottle of Bordeaux. At that time it was for me something from really very far away. Just thinking of the itinerary that bottle traveled around the Globe to arrive in my possession impressed me so much already. So I did not open it right away. I decided to keep it as people usually say the older a wine is, the better it gets. I kept it therefore for a long time in the kitchen.” Wine, like certain other typical products, provides an imaginative escape for the Vietnamese: “[Wine], that’s first of all France. When I hear someone say “wine from Europe” I think first of France, just like “tea from Asia” makes me think first of China. It seems that French have millenniums of wine history and there are thousands of instruction books about wine”, “In Europe, especially in France, it seems that they have created great specialties to match outstanding wines.”

**Modern, urban and higher social status**

Drinking wine is also considered modern: “The young people of our generation have certain open-mindedness and are interested in novelties like wine” and urban: “Very certainly, it’s urban people who appreciate wine. People from the countryside drink bottoms up. It’s not to taste or appreciate wine this way”. Further than that, wine gives people who drink it a higher social status. A young Vietnamese novice explained “I think
that knowing about wine, alcohol, luxury products, can help me in my job when I am in contact with people, colleagues, partners and customers who are from urban origins. They are very chic and have luxury oriented topics of discussion. The advantage of knowing about those kinds of topics makes me feel confident, people cannot take me for a guy from the country, cannot take me for granted. It is important to impress partners to be able to get in business contact later”.

**Gifts and decorations**

As wine is perceived as nice to look at, it can be used as decoration: “There are, among the people I know, some who like buying bottles of wine just to decorate or to be fashionable. However, wine has not become an everyday object yet” or as a gift “I think in Vietnam, we buy wines primarily to offer to our bosses” “For me, wine is a gift. Sometimes, we do not even care if the person drinks alcohol. No problem, we are actually nearly sure that it will please the person because it is not a question of utility; it is a question of image. Imported alcohol has a good image and prestige. It is used therefore as a gift, and then everyone can make use of it as he pleases. Some people drink it; some people give it in their turn to others”. Someone else agreed: “Honestly, I am pleased when I am given wines or spirits. I don’t really drink much, but I can give it to others, at least I won’t have to go shopping for alcohol when I need some.”

**Positive perspective for wine in Vietnam**

A traditional and cultural drink in France, wine still remains a new product in Vietnam. It is interesting to know what the Vietnamese, new consumers or potential future consumers with limited knowledge about the product, think about its future. This matter was discussed in all focus groups. Some participants hesitated ‘’Maybe wine, like many other things, is just a fashion phenomena.’’ On contrary, many participants were enthusiastic. One of them said ‘’I think wine is something positive culturally. Before, we didn’t know anything about this product and the main reason was economic. It is still expensive, but as a trend, the more our economy improves, the more modern life gets, the more people are interested in trying new, good things. Wine is one of them, I am sure that it will be much more popular in the future than it is nowadays.’’

**CONCLUSION**

As expected, results from this qualitative study showed that social representations of wine depend on culture. The main differences between France and Vietnam result from the status of wine in the two cultures. In France, wine is principally perceived as something people drink for sensory pleasure: “Obviously, we drink wine for the pleasure, that’s for sure!”,”Every wine has its own odors and its own tastes. Each one therefore gives a different kind of pleasure every time.” Besides the pleasure of taste, the French are also interested in wine for the emotions it brings: “Wine evokes emotions, just like an artwork”. Furthermore, wine is a very important part of French culture and a particular pride of the French people. There exists a kind of know-how around wine that requires education
which is given and received through an intergenerational transmission: “Wine is a culture transmitted from father to son”. In Vietnam, wine is not as associated with sensory pleasure as it is in France, but rather with social issues and health: “Wine is good for your health”. Most Vietnamese participants declared not liking the taste of wine “Wine does not taste good!” or “I don’t like the astringency of wine!” but they often found it valuable to exhibit bottles or to drink wine on important occasions. Drinking imported wine seems fashionable and more prestigious than drinking other types of alcohol: “Wine is elegant; it gives me the feeling of success in social life.” Wine can also be used as a gift “Colleagues offer me bottles of wine; I in turn use them to offer as gifts to other people” and is believed to be beneficial for digestion and virility and protective against the risks of heart attack: “Drinking wine is good for the heart. It can also reduce the risk of many diseases.”

The focus group methodology is an explorative tool. Here we used it to highlight aspects of everyday thinking about wine in Vietnam and in France. To validate the results reported in this paper, a questionnaire of social representations of wine has been developed based on the focus group discussions. The results provided by this questionnaire will enable us to quantitatively study the patterns isolated from the focus group discussions.

Despite the limitation of the focus group study presented above, our current results have several implications for wine marketing in Vietnam, as the country is considered as potentially emerging in terms of wine consumption. Understanding Vietnamese opinions, expectations and behaviour toward wine could help later in various aspects of wine marketing: packaging, communication, adapting the sensory profile of the products to local preference.

REFERENCES


THE EMOTIONAL POWER OF ODORS: IDENTIFYING THE DIMENSIONS REFERRING TO FEELINGS PRODUCED BY ODORS

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Abstract

There is broad literature on the emotional effect of odors but, so far, little concern with the precise mechanism underlying the elicitation of emotions via olfactory stimuli. One reason for this neglect might be the lack of answers to a major question that underlie any research on odors and emotions: What exactly are the emotions associated to odors and how are they organised? The major issue addressed in the present paper concerns the nature of the verbal labels that refer to the specific states produced by odors. We conducted a series of studies in order to examine which terms are best suited to describe the feelings associated to odors and autobiographical memories. In Study 1, the relevance of a broad list of candidate affect terms to describe odor-related feelings was examined by two groups of participants with different level of knowledge about odors. In study 2, the most relevant terms retained from study 1 were evaluated with actual odorant samples and the data were submitted to a series of exploratory factor analyses to reduce the set of variables to a smaller set of summary-scales and to get a preliminary sense of the differentiation of affects elicited by odors. The Study 3 replicated Study 2 with a larger and more representative sample of odorant samples and participants. Overall, the findings point to a structure of affective responses to odors that differs from the more traditional taxonomies of emotion such as posited by discrete emotion or dimensional theories and suggest that affective states elicited by odors are structured around few dimensions that clearly reflect the role of olfaction in social interactions, danger prevention and arousal/relaxation sensations.

Keywords: emotion, odors, feelings, affective response, consumer

INTRODUCTION

Identifying the determinants of food choice and preference has been the focus of interest of many disciplines such as anthropology, biology, history or psychology over the last decades. Consequently, this issue has been addressed using different types of approaches. Quite recently, sensory evaluation has become very influential in this area of research and has extended the focus to other products such as cosmetics. The tradition in sensory evaluation is to link sensory properties of diverse products, measured by instrumental or descriptive approaches, to preferences, measured by consumer subjective tests. Thus, this approach put the emphasis on the properties of the product as the main determinant of preference but does not take into account more complex aspects such as emotional aspects. However, we know that emotions play a crucial role in consumer behavior (Loken, 2006).
In fact, this may be particularly relevant when considering food or cosmetics since it has been well established that odor, important component in the perception of these kind of products, is a powerful elicitor of emotional reactions (see e.g. review by Ehrlichman & Bastone, 1992). For example, odors have been used in laboratory to induce mood changes which subsequently can influence cognition and behavior such as reaction time in a simple task (Millot et al., 2002), resolution of logical or reasoning tasks (Degel and Köster, 1999; Herz et al., 2004), memory performance (Ludvingson and Rottman, 1989), alertness (Ilmberger et al., 2001), and motivation (Eppe and Herz, 1999). Moreover, several authors showed that odors are impressively powerful to evoke autobiographical memories that are particularly emotional (Rubin et al., 1984; Chu & Downes, 2002; Herz, 2004).

Curiously, most research carried out in sensory evaluation has not yet directly addressed the emotional modulation of food or cosmetic preference via olfactory factors. We suggest that a paradigm change, integrating the measurement of emotional reaction to olfactory compounds, would enable researchers to study more systematically the determinants driving consumer choice and preference for food or cosmetic products. The remaining question is now: How to measure emotional reaction to odors?

While emotional reactions can be recorded by asking participants to describe in their own words their emotional experience, more often, for the purpose of highly-controlled paradigm, a forced-choice self-report questionnaire is preferred. This forced-choice measurement derives from two kinds of approaches: the discrete emotion approach, postulating the existence of a small number of so-called basic emotions (Ekman, 1984) or the dimensional approach that reduces the emotions to positions in a bi-dimensional valence by arousal space (Russell, Weiss, & Mendelsohn, 1989). These theoretical models that often serve as a framework for any empirical studies on emotional feelings may not be ideally suited to study the specific reaction to odors. Because odor stimuli produce a rich set of highly differentiated responses and feeling states, in many cases these do not match basic emotions such as anger, fear, sadness or joy. And while they can be projected onto a bi-dimensional grid of valence and arousal, such a characterization loses important qualitative differences between the affective effects of different types of fragrances.

For these reasons, we suggest that, instead of relying on well-established emotion models that have been elaborated to describe emotions occurring in broad contexts, more attention should be given to the nature and the organization of descriptors that refer to specific affective states elicited by odors. This was the main purpose of the present paper.

To do so, we carried out a series of interrelated studies in order to investigate which labels, in every day life, people find most appropriate to describe emotional effects of odors. We adopted an approach similar to the one used recently by Zentner, Scherer, & Grandjean (2005) for studying emotions elicited by music. This approach, relying on strictly empirical criteria and not on traditional emotion models as described above, consisted in two steps. The first step aimed at selecting the terms rated as the most appropriate to describe music-elicited feelings from a large list of candidate affect terms. In the second step, psychometric analyses were performed on several sets of emotion ratings made while
people were listening to widely different types of music. Using a similar approach, we conducted a series of three studies on odors and emotions. Study 1 was conducted to compile a list of odor-relevant affect terms. The aim of Study 2 was to examine emotion ratings that were provided when participants where exposed to actual odors and to get a preliminary model of the structure of affects elicited by odors based on Exploratory Factor analytic procedures. The Study 3 was a replication of Study 2 with a larger and more representative sample of odorant samples and participants in order to validate the preliminary model obtained in Study 2 by using Confirmatory Factor Analytic procedures.

**STUDY 1**

**Material and Method**

*Participants.* 96 undergraduate students (83 females) from the Faculty of psychology in Geneva and 121 Employees from Firmenich (71 females) took part in this study.

*Material.* A list of 480 candidate terms was established on the basis of several sources. Among the 480 terms, 147 came from the music studies because they were rated as relevant terms to describe affective feelings in broad contexts (Zentner et al, 2005). Three hundred three terms were added to this preliminary list, some coming from empirical data on odors and some from literature related to odor expert classification, descriptions and emotion.

*Procedure.* The experimental task consisted in a questionnaire in which participants rated the relevance of candidate terms by answering this question “According to you, how relevant is this term to describe an emotional feeling induced by odors?” Participants had to report the degree of relevance of each term on a continuous scale ranging from “not relevant at all” to “extremely relevant”.

*Results and discussion*  

The main goal of Study 1 was to select the most relevant terms to describe affective feelings related to odors. We decided of a selection criterion in sort that a substantial majority had to agree on the relevance of the term for it to be retained. Thus, only terms that were considered relevant (*i.e.* score over the middle of the relevance rating scale) by at least two-thirds of the participants (66%) were retained. Thus, we obtained a reduced list of 124 terms. Interestingly, were absent from this reduced list many affect terms used to refer to commonly experienced emotions such as guilt, shame, anger, sadness. Moreover, we found that the relevant emotions elicited by odors were mostly positive affects with the exception of some negative affects related mostly to disgust and displeasure.

**STUDY 2**

**Material and Method**

*Participants.* 38 undergraduate students (24 females) from the Faculty of Psychology in Geneva took part in this study.
Material. The inspection of the 124 relevant terms resulting from Study 1 indicated that some terms clearly reflected the intrinsic quality of the odors rather than the affective sensation they may elicit (e.g., sweet, feminine, spring-like) but some could also be evaluated as both affective or qualitative (e.g., fresh, clean, strange). Thus, based on judgments of ten experts on emotion, we split the initial list of 124 terms into a primary list of 73 affective terms and a secondary list of 60 qualitative terms with nine terms overlapping between the two lists.

24 odorants corresponding to everyday odors were selected in order to cover a large range of odor types. The odorants, provided by Firmenich SA, were diluted in odorless Di-propylène glycol (DIPG) in order to obtain an average intensity roughly similar for all odorants. The diluted solutions were presented in a pen-like odor dispensing device.

Procedure. Participants rated the odorants twice in two sessions separated by at least one day. One of the two sessions consisted in emotion ratings, where participants were asked to rate the intensity of their subjective emotional experience elicited by each odorant sample with the means of the 73 affect terms. The other session consisted in an odor quality rating, where participants rated the intensity of the descriptive quality of the odors using the 60 qualitative terms. In both sessions, answers were given on continuous scales ranging from ‘not intense at all’ to ‘extremely intense.’

Results and discussion

The individual data for the emotion ratings and the odor quality ratings were submitted to separate PCA Exploratory Factor Analyses, followed by VARIMAX rotation. The factor analysis on the emotion ratings yielded five main factors which were respectively interpreted as happiness-well being, awe-sensuality, disgust-irritation, soothing-peacefulness, energizing-refreshing. The factor analysis on the odor quality ratings yielded four main factors, which were respectively associated to the delicateness, heaviness, sweetness and healthiness feature of the odors.

In order to evaluate to what extend odor quality may predict the emotional response elicited, we performed a series of multiple regression analyses using the odor loadings on the odor quality factors as the predictors of the odor loadings on the affect factors. The results of these regressions suggested that some qualitative features of the odors can predict specific affective states. Thus, odors, described as sweet, elicited happiness and well being, heavy odors provoked disgust and irritation, delicate odors were associated to awe and sensuality as well as soothing and peacefulness feelings and healthy odors induced energizing and cooling sensations.

In sum, the findings point to a preliminary structure that clearly reflects the important role of olfaction in social interactions, danger prevention, well-being and relaxation/arousal sensations. Moreover, the results suggest that there is a close relationship between the affective states produced by odors and the intrinsic chemosensory quality of the odorant substances.
STUDY 3

Because one of the main limitations of Study 2 was the representativeness of both the odorant samples and the population sample, we replicated Study 2 in two distinct experiments conducted in important public fairs, namely La nuit de la Science (NDLS) and La cité des métiers (CDM).

Material and Method

Participants. 282 participants in the NDLS and 245 in the CDM took part in this study.

Material. A list of 36 terms was derived from Study 2 on the basis of internal reliability, loadings on the PCA factors and homogeneity among the different PCA factors.

56 odorants were selected to cover a large range of everyday odors for the NDLS. 24 commercial perfumes were selected to cover a large range of perfume classes for the CDM.

Procedure. Participants were recruited during their visit in the two public fairs. In both experiments, the instructions and rating procedure were similar to Study 2. Participants were asked to rate their emotional feelings elicited by the odors with the help of the 36 affect terms selected from Study 2.

Results and discussion

The main goal of Study 3 was to extend findings from Study 2 by examining the differentiation of odor affect ratings based on Confirmatory Factor Analytic procedures. This procedure provides a stronger test of the model’s validity because, unlike Exploratory Factor Analysis, the model is specified prior to data analysis.  

We first tested the preliminary model obtained in Study 2 that consisted of five factors. Then we tested this original model against alternatives models. For both stimuli conditions, we found that the model in five factors fit reasonably well with the set of new judgments made on everyday odorants and commercial perfumes (SRMR = 0.047, RMSEA = 0.048, CFI= 0.914 for the everyday odorants and SRMR = 0.058, RMSEA = 0.053, CFI= 0.878 for the perfumes). However, we found that the fit was improved by creating a 6th variable referring to sensory pleasure (SRMR = 0.047, RMSEA = 0.048, CFI= 0.914 for the everyday odorants; SRMR = 0.056, RMSEA = 0.052, CFI= 0.892 for the perfumes; significant Chi-Square Difference test for both everyday odorants and perfumes).

We tested alternative models with fewer latent factors (e.g. positive affects vs negative affects) but they gave rise to an inferior fit compared to the six factorial model (SRMR = 0.111, RMSEA = 0.068, CFI= 0.829 for the everyday odorants and SRMR = 0.062, RMSEA = 0.062, CFI= 0.845 for the perfumes).

For this analysis, three fit indexes were considered: the standardized root mean square residual (SRMR), the root-mean-square error of approximation (RMSEA) and the comparative fit index (CFI). A combination of an SRMR < 0.8 with RMSEA < 0.6 correspond to a good fit. Similarly, CFI values of .90 or greater indicate an acceptable fit.
Finally, below are the 6 dimensions emerging from the various psychometric analyses as the underlying structure to differentiate odor-elicited feelings:

- a dimension of pleasant feelings including well-being, happiness,
- a dimension of sensuality including desire and romanticism,
- a dimension of unpleasant feelings including disgust and irritation,
- a dimension of relaxation including soothing and peacefulness,
- a dimension of refreshment including invigorating and clean feelings,
- a dimension of sensory pleasure including the feeling of nostalgia, amusement and salivating sensation.

CONCLUSION

We conducted a series of three studies to select the verbal labels to be used in empirical research, by examining the knowledge showed by the general public about which terms are best suited to describe the feelings associated to odors and autobiographical memories.

These studies, conducted with various types of odorant stimuli and populations, suggest that six dimensions enable to represent the psychological structure of the fundamental dimensions required to describe olfactory-elicited feelings. These dimensions clearly reflect the important role of olfaction in bringing old autobiographical memories back to awareness, social interactions, danger prevention, well-being and relaxation/arousal sensations. In order to validate this empirical approach, the question is now to know whether this set of new scales is more appropriate to describe odor-elicited feelings than traditional models such as discrete emotion models or dimensional models.

To test this hypothesis, an ongoing study aims at comparing the olfactory-specific model emerging from the reported studies to the two well-known emotions models. From these new data, we will compare the reliability and the discriminability of the three models. We expect these two latter indicators to be higher for the olfactory-specific model compared to the two traditional models. If so, this new set of scales, based strictly on empirical data, will provide promising leads to study in a more applied fashion the emotional effects of food or cosmetic products.

REFERENCES


CONSUMER LIKING OF THAI MANGOES

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Abstract

Five Thai mangoes and one foreign variety were tested for their preferences by Japanese, Chinese, Hong Kong and Middle-East tourists in Thailand. The three preferred mangoes in overall liking of fruit were Nam Dok Mai Sri Thong, Rad and Mahachanok varieties and the three preferred mango in overall liking of flesh were Nam Dok Mai Sri Thong, Kinsington and Chokanan varieties. The trained panellists identified 11 descriptors for mango fruits and 17 descriptors for mango flesh. Japanese consumers and Hong Kong consumers considered “color of fruit skin and fruit length” for their liking towards mango fruits and “color of the flesh” for mango flesh. Chinese consumers considered “size, thickness, weight and smell of fruit” for their liking towards mango fruits and “firmness of the flesh” for mango flesh. The Middle-East consumers considered “color of the flesh” for their liking towards mango fruits and “color of the flesh” for mango flesh.

Keywords: consumer preference; descriptive analysis; Thai mangoes

INTRODUCTION

Thailand is a mango producing country and has potential to export Thai mangoes to the Asia and near by regions such as Japan, China, Hong Kong and the Middle East markets but the annual export volume of the mangoes is still very low compared with production volume. Mangoes have been promoted as promising export crop or a product “Champion”. There is many Thai mango varieties; among these are Ok Rong, Nam Dok Mai, Nam Dok Mai Sri Tong, Rad, Kaew, Mahachanok and Chok Anun. They are different in their fruits and flesh characteristics but all are yellow colored and very flavorful when ripe. These varieties have potential for export.

Differences among the individual culture of consumers as well as variations in their environment influence consumers food choice and their degree of liking of individual foods (Cardello, 1996, Schutz, 1988, Van Trijp & Meulenberg, 1996). If the sensory characteristics that drive the liking of Thai mangoes by the target consumers are identified, the most suitable variety of Thai mangoes could then be selected for exporting to targeted markets. This would help increasing the export volume of Thai mangoes.

The aim of this study was to determine the preference among selected Thai varieties of mangoes by Japanese, Chinese (from mainland), Hong Kong and Middle-East consumers as well as the sensory characteristics that drove these preferences. The outcome would provide information which could be used by growers, plant selectors and breeders, and exporters and marketers, to develop the Thai mango export industry.
METHODOLOGY

Mango samples

Five varieties of commercially grown export potential Thai mangoes were studied, along with one foreign introduced variety. The Thai varieties were Kaew (SK007), Chokanan, Nam Dok Mai Sri Thong, Mahachanok and Rad. The foreign variety grown in Thailand was Kinsington. Using the same batch of fully ripe mangoes, tests were carried on consumer preference and quantitative descriptive analysis.

Consumer preference test

The consumers were Japanese, Chinese (from mainland), Hong Kong and Middle-East tourists in Thailand. A 9-point hedonic scale was used to determine the degree of liking. The test was carried out in a central location in Bangkok and Nakorn Pratoom Province, Thailand. The sensory attributes used for the fruit of mangoes were skin color, skin appearance, fruit size, fruit shape, fruit aroma and overall liking. The sensory attributes used for the flesh of mangoes were flesh color, flesh flavor, flesh texture and overall liking. The questionnaire was translated into Japanese, Chinese and English languages for the Japanese, Chinese and Hong Kong and the Middle East respectively.

Quantitative descriptive analysis with trained panelists

Eleven panelists (5 males and 6 females) were selected using duo-trio tests for the selection process. They were staffs of Khon Kaen University, Khon Kaen Thailand. Sensory attribute descriptors were developed using the Repertory Grid Technique (Gains, 1993). They were then screened for the key sensory characteristics. Intensity line scales of 110 mm were used to evaluate the key sensory characteristics of the mango fruit and flesh of the six varieties of mangoes.

Data analysis and statistics

Results of the consumer preference test were submitted to ANOVA and Duncan New Multiple Range tests. Results of quantitative descriptive analysis were submitted to ANOVA and Principal Component Analysis (PCA). Multiple Linear Regression (Sanford, Gullet, & Roth, 1988) was used to investigate the relationship between consumer liking score and the important sensory dimensions of the six varieties of mangoes. All results were analyzed using SPSS for Windows, version 10 (SPSS, 1999).

RESULTS

Consumer preferences

Eighty two Japanese consumers evaluated fruit samples and 84 evaluated flesh samples, 17 Chinese consumers evaluated fruit samples and 30 evaluate flesh samples, 42 Hong Kong consumers evaluated fruit samples and 72 evaluated flesh samples, 39 Middle-East consumers evaluated fruit samples and 62 evaluated flesh samples. The results obtained showed the preference of different groups of consumers as followed:
Japanese consumers evaluated overall liking of Nam Dok Mai Sri Tong and Rad higher than others. The consumers liked fruit shape of Nam Dok Mai Sri Tong and Rad more than others. They liked skin color of Nam Dok Mai Sri Tong, Mahachanok and Rad more than others. They liked flesh texture of Nam Dok Mai Sri Tong most. They liked flesh color and flavor of Nam Dok Mai Sri Tong and Kensington more than others. They evaluated overall liking of flesh of Nam Dok Mai Sri Tong and Kensington more than others. The liking scores for fruit are listed in Table 1 and the liking scores for flesh are listed in Table 2.

**Table 1.** Sensory attribute rating of mango fruit by Japanese consumers (mean + standard deviation N=82, indices indicate Duncan subsets for alpha=0.05)

<table>
<thead>
<tr>
<th>Mango variety</th>
<th>Skin Color</th>
<th>Skin Appearance</th>
<th>Fruit Size</th>
<th>Fruit Shape</th>
<th>Fruit Aroma</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SK007)</td>
<td>5.18±1.831</td>
<td>5.45±1.661</td>
<td>6.11±1.761</td>
<td>5.80±1.741</td>
<td>5.53±1.701</td>
<td>5.61±1.651</td>
</tr>
<tr>
<td>Chokanan</td>
<td>4.94±1.591</td>
<td>5.28±1.661</td>
<td>6.34±1.391</td>
<td>5.98±1.641</td>
<td>5.88±1.551</td>
<td>5.82±1.331</td>
</tr>
<tr>
<td>Nam Dok Mai Sri Thong</td>
<td>7.17±1.801</td>
<td>7.06±1.723</td>
<td>7.18±1.652</td>
<td>6.93±1.692</td>
<td>6.21±1.613</td>
<td>6.79±1.712</td>
</tr>
<tr>
<td>Mahachanok</td>
<td>7.02±1.531</td>
<td>6.54±1.693,2</td>
<td>6.15±1.701</td>
<td>5.95±1.761</td>
<td>5.13±1.971,1</td>
<td>5.85±1.691</td>
</tr>
<tr>
<td>Rad</td>
<td>6.98±1.441</td>
<td>6.84±1.393</td>
<td>6.88±1.432</td>
<td>6.78±1.512</td>
<td>6.16±1.642</td>
<td>6.78±1.422</td>
</tr>
<tr>
<td>Kensington</td>
<td>6.45±1.692</td>
<td>6.15±1.742</td>
<td>6.02±1.861</td>
<td>6.09±1.821</td>
<td>5.89±2.132</td>
<td>6.13±1.871</td>
</tr>
</tbody>
</table>

Chinese consumers evaluated overall liking of fruit of Nam Dok Mai Sri Tong and Mahachanok higher than other varieties. The consumer liked skin color of Nam Dok Mai Sri Tong, Mahachanok and Kensington, skin appearance of Nam Dok Mai Sri Tong and Mahachanok. They liked fruit size of Nam Dok Mai Sri Tong most. They liked fruit shape of Nam Dok Mai Sri Tong and Mahachanok more than other varieties. They evaluated overall liking of flesh of Nam Dok Mai Sri Tong, Kensington and Chokanan higher than others. They liked flesh color of Nam Dok Mai Sri Tong, Chokanan, Kensington and Mahachanok more than other varieties. The liking scores for fruits are listed in Table 3 and the liking scores for flesh are listed in Table 4.

**Table 2.** Sensory attribute rating of mango flesh by Japanese consumers (mean + standard deviation N=84, indices indicate Duncan subsets for alpha=0.05)

<table>
<thead>
<tr>
<th>Mango variety</th>
<th>Flesh Color</th>
<th>Flesh Flavor</th>
<th>Flesh Texture</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SK007)</td>
<td>5.68±1.681</td>
<td>4.86±1.671</td>
<td>5.46±1.681</td>
<td>5.06±1.701</td>
</tr>
<tr>
<td>Chokanan</td>
<td>6.45±1.671,2</td>
<td>6.42±1.852</td>
<td>6.31±1.532</td>
<td>6.44±1.582</td>
</tr>
<tr>
<td>Nam Dok Mai Sri Thong</td>
<td>7.33±1.441</td>
<td>7.21±1.673</td>
<td>7.10±1.503</td>
<td>7.18±1.593</td>
</tr>
<tr>
<td>Mahachanok</td>
<td>6.63±1.663,2</td>
<td>6.10±2.002</td>
<td>6.48±1.382</td>
<td>6.23±1.702</td>
</tr>
<tr>
<td>Rad</td>
<td>6.31±1.592</td>
<td>6.36±1.852</td>
<td>6.45±1.352</td>
<td>6.26±1.622</td>
</tr>
<tr>
<td>Kensington</td>
<td>6.89±1.474,3</td>
<td>6.68±1.813,2</td>
<td>6.61±1.462</td>
<td>6.71±1.583,2</td>
</tr>
</tbody>
</table>
Table 3. Sensory Attribute Rating of Mango Fruit by Chinese Consumers

<table>
<thead>
<tr>
<th>Mango Variety</th>
<th>Skin Color</th>
<th>Skin Appearance</th>
<th>Fruit Size</th>
<th>Fruit Shape</th>
<th>Fruit Aroma</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SR007)</td>
<td>5.06±1.73&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>5.39±2.37&lt;sup&gt;1&lt;/sup&gt;</td>
<td>4.94±1.92&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5.29±2.23&lt;sup&gt;2,3&lt;/sup&gt;</td>
<td>5.76±1.23&lt;sup&gt;4&lt;/sup&gt;</td>
<td>5.18±1.91&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chokanan</td>
<td>4.06±2.03&lt;sup&gt;1&lt;/sup&gt;</td>
<td>4.92±2.04&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6.00±1.50&lt;sup&gt;1&lt;/sup&gt;</td>
<td>4.06±2.22&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5.35±1.87&lt;sup&gt;1&lt;/sup&gt;</td>
<td>5.24±1.82&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Nam Dok Mai</td>
<td>7.90±0.94&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7.82±0.81&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7.94±0.90&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7.76±0.75&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>6.76±1.20&lt;sup&gt;1&lt;/sup&gt;</td>
<td>7.47±0.72&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Su Thong</td>
<td>6.83±2.04&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>6.94±1.92&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>6.65±1.69&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6.76±1.44&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6.94±1.72&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6.76±1.70&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mahachanok</td>
<td>6.05±2.42&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>6.18±1.91&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>6.06±2.19&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>6.41±1.73&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>5.76±2.39&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>5.94±1.89&lt;sup&gt;2,4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Kensington</td>
<td>6.25±2.49&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>5.41±2.33&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>5.62±2.34&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>5.82±2.16&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>6.06±1.99&lt;sup&gt;1,3&lt;/sup&gt;</td>
<td>6.24±1.86&lt;sup&gt;1,3&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> Mean±Standard Deviation of Sample size = 17
<sup>2</sup> Duncan subset for alpha=0.05
Table 4. Sensory attribute rating of mango flesh by Chinese consumers (mean ± standard deviation
N=30, indices indicate Duncan subsets for alpha=0.05)

<table>
<thead>
<tr>
<th>Mango variety</th>
<th>Color</th>
<th>Flavor</th>
<th>Texture</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SK007)</td>
<td>4.93±0.20 (^1)</td>
<td>4.67±1.84 (^1)</td>
<td>4.69±1.98 (^1)</td>
<td>4.60±1.84 (^1)</td>
</tr>
<tr>
<td>Chokanan</td>
<td>5.52±1.93 (^1)</td>
<td>5.90±1.64 (^1)</td>
<td>6.31±1.42 (^1)</td>
<td>5.86±1.66 (^1)</td>
</tr>
<tr>
<td>Nam Dok Mai</td>
<td>7.14±1.24 (^1)</td>
<td>7.14±1.12 (^1)</td>
<td>6.88±1.45 (^1)</td>
<td>6.93±1.42 (^1)</td>
</tr>
<tr>
<td>Sri Thong</td>
<td>6.95±1.61 (^1)</td>
<td>6.29±2.00 (^1)</td>
<td>6.24±2.08 (^1)</td>
<td>6.43±1.85 (^1)</td>
</tr>
<tr>
<td>Mahachanok</td>
<td>6.81±0.92 (^1)</td>
<td>6.10±1.62 (^1)</td>
<td>6.45±1.37 (^1)</td>
<td>6.40±1.25 (^1)</td>
</tr>
<tr>
<td>Kensington</td>
<td>6.17±1.68</td>
<td>6.14±1.88 (^1)</td>
<td>6.19±2.02 (^1)</td>
<td>6.33±1.84 (^1)</td>
</tr>
</tbody>
</table>

Table 5. Sensory attribute rating of mango fruit by Hong Kong consumers (mean ± standard deviation
N=42, indices indicate Duncan subsets for alpha=0.05)

<table>
<thead>
<tr>
<th>Mango variety</th>
<th>Color</th>
<th>Appearance</th>
<th>Size</th>
<th>Shape</th>
<th>Flavor</th>
<th>Aroma</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SK007)</td>
<td>4.81±2.31 (^1)</td>
<td>3.94±2.09 (^1)</td>
<td>4.74±2.14 (^1)</td>
<td>4.06±2.03 (^1)</td>
<td>5.30±2.03 (^1)</td>
<td>6.69±2.30 (^1)</td>
<td></td>
</tr>
<tr>
<td>Chokanan</td>
<td>5.44±1.96 (^2)</td>
<td>5.26±2.13 (^2)</td>
<td>5.89±1.72 (^2)</td>
<td>5.29±2.07 (^2)</td>
<td>6.04±2.07 (^2)</td>
<td>7.26±2.30 (^2)</td>
<td></td>
</tr>
<tr>
<td>Nam Dok Mai</td>
<td>6.61±1.74 (^3)</td>
<td>6.36±2.13 (^3)</td>
<td>6.35±1.98 (^3)</td>
<td>6.26±2.12 (^3)</td>
<td>7.26±2.30 (^3)</td>
<td>8.69±2.30 (^3)</td>
<td></td>
</tr>
<tr>
<td>Sri Thong</td>
<td>5.53±2.33 (^4)</td>
<td>4.96±2.37 (^4)</td>
<td>5.29±2.26 (^4)</td>
<td>5.06±2.25 (^4)</td>
<td>6.04±2.07 (^4)</td>
<td>7.26±2.30 (^4)</td>
<td></td>
</tr>
<tr>
<td>Mahachanok</td>
<td>5.25±1.95 (^5)</td>
<td>4.69±2.03 (^5)</td>
<td>4.76±2.10 (^5)</td>
<td>4.68±2.01 (^5)</td>
<td>5.06±2.25 (^5)</td>
<td>6.04±2.07 (^5)</td>
<td></td>
</tr>
<tr>
<td>Kensington</td>
<td>6.54±1.73 (^6)</td>
<td>6.07±2.01 (^6)</td>
<td>6.43±1.90 (^6)</td>
<td>6.31±1.84 (^6)</td>
<td>7.26±2.30 (^6)</td>
<td>8.69±2.30 (^6)</td>
<td></td>
</tr>
</tbody>
</table>

Hong Kong consumers evaluated the overall liking of fruit of Nam Dok Mai Sri Tong, Mahachanok, Rad and Kensington equivalently and the results showed no differences in liking of any attribute of fruit of any variety except for the skin appearance of Nam Dok Mai Sri Tong that was preferred to the the appearance of other fruits. The consumers liked flesh color and flavor of Nam Dok Mai Sri Tong and Kensington more than that of other varieties and evaluated overall liking of flesh of Nam Dok Mai Sri Tong and Kensington higher than the other. The consumers liked flesh texture of Nam Dok Mai Sri Tong, Chokanan and Kensington more than other. The liking scores for fruits are listed in Table 5 and the liking scores for flesh are listed in Table 6.

Middle-East consumers evaluated overall liking of fruit equivalently for Nam Dok Mai Sri Tong, Mahachanok, Rad and Kensington and no difference in liking for skin color, skin appearance, fruit size and shape of these fruits. Results showed that overall liking of flesh of Nam Dok Mai Sri Tong and Kensington was higher than other and the consumers liked
Table 7. Sensory attribute rating of mango fruit by the Middle-East consumers (mean + standard deviation N=39, indices indicate Duncan subsets for alpha=0.05)

<table>
<thead>
<tr>
<th>Mango variety</th>
<th>Skin Color</th>
<th>Skin Appearance</th>
<th>Fruit Size</th>
<th>Fruit Shape</th>
<th>Fruit Aroma</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SK007)</td>
<td>5.31±2.05</td>
<td>5.38±1.99</td>
<td>5.36±2.22</td>
<td>5.77±2.13</td>
<td>5.77±2.36</td>
<td>5.28±2.06</td>
</tr>
<tr>
<td>Chokanan</td>
<td>6.46±1.80</td>
<td>5.97±1.93</td>
<td>6.31±1.85</td>
<td>6.26±2.06</td>
<td>6.51±1.87</td>
<td>6.05±2.01</td>
</tr>
<tr>
<td>Nam Dok Mai</td>
<td>7.41±1.35</td>
<td>7.31±1.34</td>
<td>7.41±1.31</td>
<td>7.18±1.47</td>
<td>6.18±1.92</td>
<td>7.21±1.22</td>
</tr>
<tr>
<td>Sri Thong</td>
<td>7.64±1.56</td>
<td>7.41±1.67</td>
<td>6.79±2.05</td>
<td>7.26±1.83</td>
<td>7.18±1.80</td>
<td>7.26±1.76</td>
</tr>
<tr>
<td>Mahachanok</td>
<td>7.28±1.49</td>
<td>7.13±1.78</td>
<td>6.82±1.62</td>
<td>7.00±1.73</td>
<td>6.56±2.12</td>
<td>7.26±1.25</td>
</tr>
<tr>
<td>Rad</td>
<td>6.92±1.78</td>
<td>6.69±1.89</td>
<td>6.87±1.84</td>
<td>7.08±1.87</td>
<td>7.15±1.51</td>
<td>6.95±1.86</td>
</tr>
</tbody>
</table>

Table 8. Sensory attribute rating of mango flesh by Middle-East consumers (mean + standard deviation N=62, indices indicate Duncan subsets for alpha=0.05)

<table>
<thead>
<tr>
<th>Mango variety</th>
<th>Flesh Color</th>
<th>Flesh Flavor</th>
<th>Flesh Texture</th>
<th>Overall Liking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaew(SK007)</td>
<td>5.76±2.27</td>
<td>5.19±2.39</td>
<td>5.26±2.25</td>
<td>5.50±2.46</td>
</tr>
<tr>
<td>Chokanan</td>
<td>5.95±2.35</td>
<td>6.11±2.33</td>
<td>6.39±2.33</td>
<td>6.32±2.24</td>
</tr>
<tr>
<td>Nam Dok Mai</td>
<td>7.32±1.69</td>
<td>7.35±1.78</td>
<td>6.94±1.92</td>
<td>7.21±1.70</td>
</tr>
<tr>
<td>Sri Thong</td>
<td>6.55±2.22</td>
<td>6.26±2.15</td>
<td>6.31±2.15</td>
<td>6.06±2.22</td>
</tr>
<tr>
<td>Mahachanok</td>
<td>6.08±2.26</td>
<td>6.06±2.27</td>
<td>6.27±2.13</td>
<td>6.11±2.31</td>
</tr>
<tr>
<td>Rad</td>
<td>7.13±2.04</td>
<td>6.79±2.04</td>
<td>7.00±1.98</td>
<td>6.84±2.10</td>
</tr>
</tbody>
</table>

The liking scores for fruits are listed in Table 7 and the liking scores for flesh are listed in Table 8. The results showed that the fruit shape, fruit aroma and skin appearance were more highly correlated with overall liking of fruit than other fruit attributes. The flesh flavor was more highly correlated with overall liking of flesh than other flesh attributes.

It was concluded that all the foreign consumers liked the sensory attributes of fruit and flesh of Nam Dok Mai Sri Tong most. The three top preferred fruits in sensory attributes of fruits were Nam Dok Mai Sri Tong, Rad and Mahachanok, and the three top preferred fruits in sensory attributes of flesh were Nam Dok Mai Sri Tong, Kensington and Chokanan.

Quantitative descriptive analysis

Eleven fruit sensory attributes and 17 flesh sensory attributes were generated. From PCA the 11 fruit sensory attributes were grouped into three groups. Group 1 included size, thickness, weight and fruit smell. Group 2 included skin smoothness, fruit length and firmness. Group 3 included skin color. The perception of the sensory attribute descriptors of the fruit of the six mangoes are shown in Figure 1a and b. From PCA the 17 flesh sensory attributes were grouped into five groups. Group 1 included smoothness and juiciness. Group 2 included stringy texture. Group 3 included odor strength. Group 4 included flesh color. Group 5 included flesh firmness and taste. The perception of the sensory attribute descriptors of the flesh of the six mangoes are shown in Figure 2a, b, and c.
Figure 1. A Perception of the sensory attribute descriptors of the fruit of the Six Mangoes on a) principal components 1 and 2; and b) principal components 1 and 3.

Figure 2. A Perception of the Sensory Attribute Descriptors of the Fruit of the Six Mangoes on a) principal components 1 and 2; b) principal components 1 and 3; and c) principal components 1 and 4.
Results indicated that the difference among these fully ripe mangoes was most pronounced on the perception of fruit size, weight, thickness and fruit odor strength. Generally, the fruits of Kensington mango are the biggest, heaviest, and most thick and provide the strongest fruit odor. The fruits of Rad, Kaew, and Nam Dok Mai Sri Tong mangoes were similar on these sensory characteristics. The size, weight and shape of these fruits were comparatively the smallest, lightest, and thinnest respectively. These fruits also provided the weakest fruit odor. The difference among the flesh of these mangoes was most pronounced on smoothness, juiciness and tenderness. The flesh of Nam Dok Mai Sri Tong mango was perceived as the smoothest, the juiciest and the tenderest. The flesh of Mahachanok, Rad, Kaew and Kensington mangoes were perceived respectively to be less smooth, juicy and tender than the flesh of Nam Dokmai Sri Tong mango. The flesh of Chokanan mango was perceived as the least smooth, juicy and tender.

**Consumer liking of sensory characteristics**

Results indicated that Japanese consumers considered “color of fruit skin and fruit length” as the most important concepts to formulate their liking towards fully ripe mango fruits and “color of the flesh” as the most important concept to formulate their liking towards fully ripe mango flesh respectively. Chinese consumers used the sensory dimensions designated as “size, thickness, weight and smell of fruit” to formulate their liking towards the whole mango fruits. The sensory dimension of “firmness of the flesh” was considered to be most important in determining their liking towards the flesh of the mangoes. Hong Kong consumers used the same concepts as Japanese consumers to determine their liking towards the whole mangoes fruit as well as liking towards the flesh of the mangoes. The Middle-East consumers considered “color of the flesh” as the most important concept to formulate their liking towards the flesh of fully ripe mangoes.

**CONCLUSIONS**

For the overall liking Nam Dok Mai Sri Thong variety was the most liked by all of the consumers. In ranking the three top preferred fruits for fruit sensory attributes were Nam Dok Mai Sri Thong, Rad and Mahachanok and the three top preferred fruits for flesh sensory attributes were Nam Dok Mai Sri Thong, Kensington and Chokanan.

Fruit shape, fruit aroma and skin appearance were more highly correlated with overall liking of fruit than other attributes of fruit. The flesh flavor was more highly correlated with overall liking of flesh than other attributes of flesh.

The sensory characteristics driving Japanese and Hong Kong consumers preference for Thai mangoes were color of fruit skin, fruit length and color of the flesh. The sensory characteristics driving Chinese consumers preference were size of fruit, fruit thickness, fruit weight, smell of fruit and firmness of the flesh, and the sensory characteristics driving Middle- East consumers preference was the color of flesh.
ACKNOWLEDGMENTS

The authors would like to thank the Thailand Research Fund for the financial support.

REFERENCES


SENSORY CHARACTERISTICS AND PREFERENCE MAPPING OF BREAST AND THIGH CHICKEN MEAT FROM COMMERCIAL BROILER AND CROSSBRED CHICKENS

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Abstract

The sensory profile of six samples of cooked breast and thigh meat from two commercial broilers and a Thai indigenous crossbred chicken was performed by 10 trained assessors, using 12 attributes of appearance, texture, flavor and taste. All samples were also assessed for overall liking by a consumer panel of 90 regular chicken meat consumers. Principal component analysis (PCA) indicated that sensory descriptors that best separated the chicken meat samples and closely related to the first principal component were brown color intensity, yellowness and whiteness. Smoothness, tenderness and stickiness were related to the second principal component and chewiness, juiciness and tenderness to the third component. The fourth dimension was defined by attributes: sweetness and greasiness. Breast meat samples were perceived to have lighter color as well as less smooth, tender, chewy and juicy texture than thigh meat samples. Both thigh and breast meat samples of Thai indigenous crossbred chicken were perceived to have similar characteristics as those of a commercial broiler. Cluster analysis of consumers’ overall liking data showed that four clusters of consumers with similar preference patterns could be formed. Each cluster preference data was regressed onto the first two principal components of a PCA of the sensory profile data to establish a preference map. Results indicated that consumers in cluster 1 (n = 37) like thigh more than breast meat. Chicken meat samples of moderate brown and yellow color but of very smooth and tender texture were preferred. Cluster 2 (n = 25) also seemed to like thigh more than breast meat samples. On the contrary, cluster 3 (n = 19) seemed to like breast more than thigh meat samples. However, drivers for liking were not conclusive. Cluster 4 (n = 9) seem to prefer thigh chicken meat of moderate brown and yellow color.

Keywords: sensory characteristics, principal component analysis, cluster analysis, preference mapping, chicken meat.

INTRODUCTION

Chicken meat is one of the most common white meats generally consumed and appreciated by large Thai consumer groups. Thailand is now one of the world largest chicken-producing countries and one of the largest exporters to Japan (Department of Livestock, 2006). Approximately 70% of chicken meat produced in Thailand is derived from broiler raised by independent commercial farms and contract growers. Thai indigenous chickens raised by small farming families account for about 30% of the national chicken meat (FAO 1989). Broilers are generally produced from breeding stocks which are raised mostly from imported chicks and used for both domestic consumption and export. Thai indigenous chickens are raised mainly for on-farm and domestic consumption (Department of Livestock, 2006).
Indigenous and broilers chickens are generally consumed at approximately the same commercial live weight. However, indigenous chickens generally have slower growth rate than commercial broilers (Wattanachant et al., 2005). Despite their slower growth rate, Thai indigenous chickens produce meat with a unique taste and texture which are preferred by a large Thai consumer groups. Their breast and thigh muscles have been reported to possess firmer textures, particularly after cooking than those of the commercial broilers (Wattanachant et al., 2004). Recently, the crossbred chicken from Thai indigenous sire and imported commercial dam has been introduced and raised as commercial broiler. The Thai indigenous crossbred chicken meat is now available on local market and has also been exported.

Little research was conducted to study sensory characteristics as well as consumers’ acceptance of commercial broiler and Thai indigenous crossbred chicken meat. Consumer acceptance of chicken meat depends on its eating quality, which is influenced by a number of factors ranging from the physical and chemical to the histological properties and processing and handling of meat (Alvarado and Sams, 2004). One of the textural properties, tenderness has been noted as the most important factor determining quality of meat products (Savell et al., 1989). Apart from that juiciness, flavor and color are the main eating quality characteristics that do influence the consumers’ overall judgment of quality (Wood et al 1995). By considering the relationship between sensory attributes and consumers’ liking of chicken meat samples, a producer may find it possible to manipulate the underlying factors that affect the meat sensory characteristics to maximize product acceptability.

The objectives of this study were to: (1) measure the sensory profile of cooked breast and thigh meat from two commercial broilers and a crossbred chicken with a trained sensory panel, (2) measure the sensory acceptability of the same chicken meat samples with a consumer panel and (3) apply preference mapping methodology to analyze the relationship between acceptability and descriptive data.

MATERIALS AND METHODS

Chicken meat samples

Fresh commercial broiler and crossbred of Thai indigenous chicken meat were obtained from local market. The broiler chicken meat samples were commercial products of two companies. The breast and thigh meat of the first company were designated as A and B and the second company as C and D respectively. The crossbred chicken breast and thigh meat produced by the third company were designated as E and F. Breast and thigh meat samples from each source were packed separately in polyethylene zip-locked bags and kept in plastic boxes covered with crushed ice and transported to Food Technology Laboratory, Faculty of Technology, Khon Kaen University. Immediately upon arrival in the laboratory all samples were unpacked and trimmed to remove skin, visible fat and connective tissue. They were then repacked and refrigerated at 4°C. After one week of storage at 4 °C
chemical and sensory evaluations as well as measurement of consumer’s degree of liking were performed.

**Chicken meat cooking**

Prior to sensory evaluation and measurement of consumer’s degree of liking the fresh samples were cut to the size 1.5 × 1.5 × 4 cm. and steamed at 100°C to the internal temperature of 85°C. The heating time required to attain a temperature of 85°C were determined beforehand by inserting thermocouples connected to a temperature recorder at the thermal centre of the samples. After heating, the samples were chilled in cold water to about 15°C. The cooked samples were then wrapped in aluminum foil and kept in water bath at the temperature of 40°C until used.

**Proximate analysis and pH**

Moisture, protein and fat contents of raw chicken meat samples were determined following the standard AOAC (1990) procedures. The pH of raw chicken meat was determined using a pH meter on a homogenate of 5 g raw sample in 50 ml distilled water.

**Sensory Evaluation**

Six cooked chicken meat samples (3 breast and 3 thigh meats) were evaluated by conventional profiling using a panel of 10 trained assessors. The quantitative descriptive analysis (QDA; Stone and Sidel, 1993) method was used as descriptive test. The assessors were selected and trained according the ISO Standard (1993). In a pre-tasting session the assessors were trained in developing sensory descriptors and the definition of the sensory attributes. The assessors developed a vocabulary by describing differences between extreme samples and agreed on a consensus list of attributes for profiling. A total of twelve 1-h sessions was used for sensory descriptor development, definitions and panel training. The consensus list of sensory attributes is shown in Table 1.

A semi-structured line scale of 100 mm with verbal expressions anchored at both ends was used for rating the intensity of an attribute. The anchored word on the left side of the scale corresponded to the lowest intensity of each attribute (value 0 mm) and the right side corresponded to the highest intensity (value 100 mm). Descriptive analysis of six chicken meat samples was carried out in triplicate over three sessions and each assessor evaluated six samples per session. The order of presentation of samples was randomized across sessions but was balanced across assessors within each session.

Tests were carried out in separate booths, in a sensory laboratory at room temperature of about 27 °C under normal white fluorescent illumination in morning sessions (10.00 – 12.00 am) every other day. Two pieces of each cooked chicken meat sample were served at room temperature in a white plastic cup coded with three-digit random numbers. The assessors were allowed to swallow the samples and rinsed their mouth with drinking water between samples to avoid residual flavor effects.
### Table 1. Definition of sensory descriptors used in profiling of breast and thigh chicken meat

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Low intensity</th>
<th>Definition</th>
<th>High intensity</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown color intensity</td>
<td>light</td>
<td>light intensity</td>
<td>dark</td>
<td>dark intensity</td>
</tr>
<tr>
<td>Yellowness</td>
<td>light</td>
<td>Yellow light intensity</td>
<td>dark</td>
<td>Dark yellow intensity</td>
</tr>
<tr>
<td>Whiteness</td>
<td>grey</td>
<td>Grey white intensity</td>
<td>white</td>
<td>White intensity</td>
</tr>
<tr>
<td>Chicken odor intensity</td>
<td>weak</td>
<td>Weak chicken odor intensity</td>
<td>strong</td>
<td>Strong chicken odor intensity</td>
</tr>
<tr>
<td>Sweetness</td>
<td>no sweet taste</td>
<td>Low sweetness</td>
<td>strong sweet taste</td>
<td>Strong sweetness</td>
</tr>
<tr>
<td>Aftertaste</td>
<td>low amount of chicken flavor left on palate</td>
<td>High amount of chicken flavor left on palate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stickiness</td>
<td>low feeling of adhesiveness when chewing</td>
<td>High feeling of adhesiveness when chewing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenderness</td>
<td>high force required for compression between the molars</td>
<td>Low force required for compression between the molars</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chewiness</td>
<td>take short time to deform when chewing</td>
<td>Take long time to deform when chewing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juiciness</td>
<td>dry feeling when chewing</td>
<td>Juicy when chewing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoothness</td>
<td>rough texture when chewing</td>
<td>Very fine texture when chewing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greasiness</td>
<td>low oil or fat covering when chewing</td>
<td>High oil or fat covering when chewing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Consumer tests

Consumers were recruited according to their responses to a brief screening questionnaire about sex, age, product usage and available time to perform the test. A group of 90 consumers, aged between 19 and 55 were selected. All of them were regular consumers of chicken meat who consumed chicken meat at least once a week or more often.

Each consumer evaluated the acceptability of each one of the six chicken meat samples, using a nine-category hedonic scale with ends labeled “dislike extremely (1)” and “like extremely (9)”. Testing was completed in one session and each consumer evaluated all six samples with a 10-minute break after three samples were tasted. The order of presentation of samples was randomized and balanced across assessors. Sample evaluation was conducted under the same conditions as for the sensory descriptive test.

### Statistical Analysis

One-way analysis of variance (ANOVA) was applied to proximate analysis and pH data. Minimum significant differences among samples were calculated by Tukey’s honestly significant difference test (HSD) ($\alpha \leq 0.05$).

For each individual sensory descriptor, a two-way analysis of variance was performed, considering assessors, samples and their interaction as sources of variation. Averages of samples were compared using Tukey’s test ($\alpha \leq 0.05$). To aid in the visual interpretation of the QDA results, covariance principal component analysis (PCA) on the sensory evaluation data averaged over assessors was performed. PCA also allows for inspection of descriptors that are correlated with each other.

Two-way ANOVA was also applied to acceptability data with sample as a fixed effect, and consumer as a random effect. Minimum significant differences were calculated by Fisher’s LSD method ($\alpha \leq 0.05$). To understand consumers’ responses further, the degree of liking...
ratings were also analyzed by Ward’s hierarchical clustering analysis with Euclidean distances on the unstandardized data (McEwan, 1998). This method assigns consumers that are close in the multivariate space or with similar preferences for the six chicken meat samples to the same cluster. The choice of number of clusters is somewhat subjective and usually depends on common sense. In this study, the number of clusters was considered to be adequate when (1) splitting the clusters did not provide new clusters with different acceptability patterns, and (2) when merging clusters meant loosing clusters with different acceptability patterns. The average preference rating for each of the consumer clusters, were related to the descriptive sensory data space by means of regression analysis resulting in a map revealing which attributes and samples were related to preferences of consumers in different clusters (extended internal preference mapping).

All statistical analyses were performed using SPSS 11.0 for Windows (SPSS Inc., Chicago, IL 60606).

RESULTS AND DISCUSSION

Chemical composition and pH values of chicken meat samples are shown in Table 2.

Table 2. Chemical composition of chicken meat samples. a, b

<table>
<thead>
<tr>
<th>Composition</th>
<th>Sample</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td></td>
<td>75.53</td>
<td>72.44</td>
<td>72.39</td>
<td>74.38</td>
<td>73.90</td>
<td>72.93</td>
</tr>
<tr>
<td>Fat (%)</td>
<td></td>
<td>0.96</td>
<td>2.96</td>
<td>0.61</td>
<td>1.74</td>
<td>0.79</td>
<td>3.09</td>
</tr>
<tr>
<td>Protein (%)</td>
<td></td>
<td>22.96</td>
<td>23.20</td>
<td>20.26</td>
<td>18.19</td>
<td>21.71</td>
<td>18.19</td>
</tr>
<tr>
<td>Ph</td>
<td></td>
<td>5.81</td>
<td>6.65</td>
<td>6.02</td>
<td>6.2</td>
<td>6.01</td>
<td>6.84</td>
</tr>
</tbody>
</table>

a Average value of three replicates and each replicate with three sub-samples.
b Within a row, means followed by the same letters are not significantly different.

Table 3. Mean sensory attribute scores (n = 12 × 3 replicates) and corresponding Tukey’s honestly significant difference (HSD) at α ≤ 0.05 for the six chicken meat samples. a, b

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Sample</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>HSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown color intensity</td>
<td></td>
<td>22.00</td>
<td>54.93</td>
<td>12.37</td>
<td>43.67</td>
<td>12.17</td>
<td>45.33</td>
<td>11.17</td>
</tr>
<tr>
<td>Yellowness</td>
<td></td>
<td>22.43</td>
<td>24.97</td>
<td>17.07</td>
<td>23.83</td>
<td>15.13</td>
<td>22.73</td>
<td>7.71</td>
</tr>
<tr>
<td>Whiteness</td>
<td></td>
<td>40.73</td>
<td>17.73</td>
<td>54.60</td>
<td>27.13</td>
<td>56.80</td>
<td>25.17</td>
<td>9.75</td>
</tr>
<tr>
<td>Chicken odor intensity</td>
<td></td>
<td>58.53</td>
<td>59.90</td>
<td>58.13</td>
<td>54.67</td>
<td>59.60</td>
<td>57.60</td>
<td>9.82</td>
</tr>
<tr>
<td>Sweetness</td>
<td></td>
<td>38.97</td>
<td>28.17</td>
<td>44.07</td>
<td>43.70</td>
<td>41.73</td>
<td>49.53</td>
<td>8.72</td>
</tr>
<tr>
<td>Aftertaste</td>
<td></td>
<td>47.50</td>
<td>51.90</td>
<td>49.10</td>
<td>47.97</td>
<td>48.93</td>
<td>51.77</td>
<td>8.25</td>
</tr>
<tr>
<td>Stickiness</td>
<td></td>
<td>51.97</td>
<td>48.63</td>
<td>44.60</td>
<td>28.03</td>
<td>31.70</td>
<td>28.00</td>
<td>10.00</td>
</tr>
<tr>
<td>Tenderness</td>
<td></td>
<td>44.97</td>
<td>42.00</td>
<td>47.03</td>
<td>64.27</td>
<td>59.27</td>
<td>65.17</td>
<td>12.55</td>
</tr>
<tr>
<td>Breakage</td>
<td></td>
<td>63.13</td>
<td>50.70</td>
<td>64.77</td>
<td>58.73</td>
<td>72.33</td>
<td>57.07</td>
<td>8.55</td>
</tr>
<tr>
<td>Juiciness</td>
<td></td>
<td>38.40</td>
<td>44.93</td>
<td>40.80</td>
<td>57.10</td>
<td>38.17</td>
<td>58.50</td>
<td>9.19</td>
</tr>
<tr>
<td>Smoothness</td>
<td></td>
<td>35.13</td>
<td>38.33</td>
<td>40.90</td>
<td>51.67</td>
<td>42.60</td>
<td>52.93</td>
<td>9.03</td>
</tr>
<tr>
<td>Greasiness</td>
<td></td>
<td>28.97</td>
<td>40.33</td>
<td>29.87</td>
<td>40.43</td>
<td>30.10</td>
<td>41.73</td>
<td>7.11</td>
</tr>
</tbody>
</table>

a Composition of samples are shown in Table 2.
b Within a row, means followed by the same letters are not significantly different.
Table 4. Two-way analysis of variance of sensory attribute ratings of cooked chicken meat samples. F-ratios when assessors are treated as fixed effect (F) and when assessors are treated as random effect (R).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Assessor (F)</th>
<th>Sample (F)</th>
<th>Assessor × Sample</th>
<th>Sample (R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown color intensity</td>
<td>28.30*</td>
<td>92.65*</td>
<td>2.66*</td>
<td>34.78*</td>
</tr>
<tr>
<td>Yellowness</td>
<td>68.84*</td>
<td>8.90*</td>
<td>2.75*</td>
<td>3.24*</td>
</tr>
<tr>
<td>Whiteness</td>
<td>74.15*</td>
<td>93.57*</td>
<td>4.41*</td>
<td>21.21*</td>
</tr>
<tr>
<td>Flavor intensity</td>
<td>61.69*</td>
<td>1.24 ns</td>
<td>1.70*</td>
<td>0.73 ns</td>
</tr>
<tr>
<td>Sweetness</td>
<td>87.85*</td>
<td>22.87*</td>
<td>2.30*</td>
<td>10.26*</td>
</tr>
<tr>
<td>Aftertaste</td>
<td>105.51*</td>
<td>1.75 ns</td>
<td>4.88*</td>
<td>0.36 ns</td>
</tr>
<tr>
<td>Stickiness</td>
<td>18.83*</td>
<td>39.46*</td>
<td>3.35*</td>
<td>11.79*</td>
</tr>
<tr>
<td>Tenderness</td>
<td>16.29*</td>
<td>22.68*</td>
<td>1.63*</td>
<td>13.95*</td>
</tr>
<tr>
<td>Ease of breaking</td>
<td>29.06*</td>
<td>25.19*</td>
<td>7.67*</td>
<td>3.28*</td>
</tr>
<tr>
<td>Juiciness</td>
<td>56.97*</td>
<td>33.93*</td>
<td>2.87*</td>
<td>11.81*</td>
</tr>
<tr>
<td>Smoothness</td>
<td>21.04*</td>
<td>21.43*</td>
<td>2.06*</td>
<td>10.40*</td>
</tr>
<tr>
<td>Greasiness</td>
<td>134.42*</td>
<td>25.26*</td>
<td>2.96*</td>
<td>8.55*</td>
</tr>
</tbody>
</table>

* The error term was used as the denominator for the F test
b The interaction term was used as the denominator for the F test
* Significant at $\alpha \leq 0.05$, ns = not significant

Sensory profile

Results of ANOVAs of the sensory attributes scores across the six chicken meat samples of 10 assessors are shown in Table 3. Table 4 summarizes the results of ANOVA on the 12 sensory attributes evaluated by the trained assessors. Main effects were tested first against the error term and, since significant sample by assessor interactions occurred, main effects were retested using the interaction mean square.

Table 3 indicated that there were significant differences between chicken meat samples for nearly all descriptors except chicken flavor intensity and aftertaste. This indicated that, the attributes selected by the trained assessors were useful descriptors for discrimination between samples. The two attributes that did not distinguish significantly among the samples, were excluded from subsequent PCA.

Results in Table 4 revealed that the assessor effect was also significant for the majority of the descriptors. Considering that individual differences between assessors are always present, some variation among assessors is considered acceptable in sensory profile analysis. The important thing to be aware of is whether these variations may have consequences in the estimation of sample differences. Plots of each assessor’s mean scores for each sample were examined for each sensory attribute. The plots revealed that for all the sensory attributes assessors were using different portions of the scales but placing most of the samples on the same relative order. The use of different portions of the scale was causing a large portion of the significant differences (Table 4) between assessors. F-ratios for assessor by sample interactions as tested against the error term indicated that significant assessor by samples interactions (Table 4) existed for all attributes. The assessor by sample interaction provided information about consistency among panelists (Stone and Sidel, 1993). Plots of assessor’s mean scores versus sample also revealed that: (1) interactions were not always associated with the same assessor or assessors; (2) there were few samples cross-over type interaction for some attributes. Despite this, the main sample effect for
majority of the attributes except chicken flavor intensity and aftertaste remained significant when tested against the assessor by sample interaction term (Table 4).

PCA indicated considerable redundancy in sensory descriptive attributes. A four component (PCs) extraction was obtained (Table 5). The PCA solution accounted for 74% of the variance among samples. Factor loadings (Table 5), which are the correlations between the factors and the variables, were examined to interpret the components. PC1 which accounted for 24.4% of the variance was interpreted as a color component due to high correlation with brown color intensity \((r = 0.89)\), whiteness \((r = -0.77)\) and yellowness \((r = 0.58)\). PC1 reflected mainly the difference in brown color intensity, whiteness and yellowness of chicken meat samples (Figure 1).

**Table 5.** Rotated factor loadings for each principal component for 10 sensory attributes evaluated by a panel of 10 trained assessors.

<table>
<thead>
<tr>
<th>Sensory Attribute</th>
<th>Principal Component (PC)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Brown color intensity</td>
<td>0.89</td>
</tr>
<tr>
<td>Whiteness</td>
<td>-0.77</td>
</tr>
<tr>
<td>Yellowness</td>
<td>0.58</td>
</tr>
<tr>
<td>Stickiness</td>
<td>0.09</td>
</tr>
<tr>
<td>Smoothness</td>
<td>0.26</td>
</tr>
<tr>
<td>Chewiness</td>
<td>-0.34</td>
</tr>
<tr>
<td>Juiciness</td>
<td>0.45</td>
</tr>
<tr>
<td>Tenderness</td>
<td>0.07</td>
</tr>
<tr>
<td>Sweetness</td>
<td>-0.12</td>
</tr>
<tr>
<td>Greasiness</td>
<td>0.54</td>
</tr>
<tr>
<td>Proportion of variance (%)</td>
<td>24.4</td>
</tr>
<tr>
<td>Cumulative % variance</td>
<td>24.4</td>
</tr>
</tbody>
</table>

It separated B, D and F which are all thigh meat samples from A, C and E which are breast meat (Figure 1). The assessors generally perceived that thigh meat samples had stronger brown color intensity, yellowness but lower whiteness than breast meat samples. Results also showed that Thai indigenous crossbred chicken meat samples (E and F) have similar color with broiler chicken meat samples of a company (C and D) (Figure 1). PC2 contributed an additional 18.7% to the explanation of the variance and split the samples on the basis of stickiness (feeling of adhesiveness when chewing), smoothness and tenderness of meat texture. Two thigh meat (F and D) and a breast (E) samples were perceived as having more smoothness and tenderness but less stickiness than the other two breast meat (A and C) and a thigh meat (B) samples (Fig. 1). PC3 accounted for 16.7% of the variance and it had high loadings for chewiness \((r = 0.79)\), juiciness \((r = 0.68)\) and tenderness \((r = 0.60)\). This component separated all samples into two main groups. A breast sample (E) and two thigh meat samples (F and D) were more chewy, juicy and tender than the other two breast meat (A and C) and a thigh meat (B) samples (Figure 2).
Figure 1. PCA loadings of PC1 and PC2 for sensory descriptors (a) and chicken meat samples (b). B1 and B2 are breast meat samples of broiler chicken and B3 is that of Thai indigenous crossbred chicken. T1 and T2 are broiler chicken thigh meat samples. T3 refers to a thigh meat sample of Thai indigenous crossbred chicken.

Figure 2. PCA loadings of PC1 and PC3 for sensory descriptors (a) and chicken meat samples (b). B1 and B2 are breast meat samples of broiler chicken and B3 is that of Thai indigenous crossbred chicken. T1 and T2 are broiler chicken thigh meat samples. T3 refers to a thigh meat sample of Thai indigenous crossbred chicken.
Figures 1 and 2 also revealed that Thai indigenous crossbred chicken meat was stickier, smoother and more chewy, juicy and tender than that of broiler chicken. PC4 which accounted for 14.4% of the variance, was interpreted as a flavor and mouth-feel component as evidenced by high loadings for the attribute *sweetness* \( (r = 0.86) \) and *greasiness* \( (r = 0.61) \). A broiler chicken thigh meat produced by a company (B) was perceived to have the least sweetness and greasiness among all samples (Figure 3). In spite of this, there was small difference in sweetness and greasiness between Thai indigenous crossbred chicken and commercial broiler meat.

**Extended internal preference mapping**

Extended internal preference map gave an overall picture of the chicken meat samples and the sensory characteristics that drove consumer preferences. The extended internal preference map was derived by regression technique. Factors scores for each chicken meat sample of PC1 & PC2, PC1 & PC3 and PC1 & PC4 were used as the two predictor variables and mean overall liking scores of all sample for each consumer cluster was used as the dependent variable.

The importance of individual PCs to consumer cluster acceptance can be assessed by examination of the standardized beta-coefficients. The larger the standardized beta-coefficient the more impact a change in the independent variable has on the dependent variable. Table 7, 8 and 9 showed that only PC1 & PC2 were significant predictors \( (p \leq 0.05) \) for the preference of consumer cluster 1 with the standardized beta-coefficient of 0.76 and 0.54 respectively. PC1 was also a significant predictor \( (p \leq 0.05) \) for the acceptance of consumer cluster 4 (Table 7, 8 and 9). The liking for chicken meat samples of consumer cluster 2 and 3 were not significantly related to any one of the four PCs.
Table 6. Mean overall liking scores of the six chicken meat samples a, b for overall consumers and for subgroups classified by hierarchical clustering analysis.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Overall Consumers (n = 90)</th>
<th>Cluster I (n = 37)</th>
<th>Cluster II (n = 25)</th>
<th>Cluster III (n = 19)</th>
<th>Cluster IV (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.89&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.40&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.16&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.22&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>B</td>
<td>5.74&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.86&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.84&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.32&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.22&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>5.31&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.35&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.00&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>6.32&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.44&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>D</td>
<td>6.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.70&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.08&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4.16&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.00&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>E</td>
<td>4.93&lt;sup&gt;c&lt;/sup&gt;</td>
<td>4.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.92&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>5.37&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.33&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>F</td>
<td>6.18&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.41&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>7.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.26&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.67&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* Within a column, means followed by the same letters are not significantly different (Tukey’s test, α ≤ 0.05).

b Within a column, bold figures correspond to significantly preferred samples.

Table 7. Coefficients generated in the regression of each consumer cluster liking scores onto factor scores of PC1 and PC2.

<table>
<thead>
<tr>
<th>Consumer cluster</th>
<th>Intercept</th>
<th>PC1</th>
<th></th>
<th>PC2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B&lt;sup&gt;a&lt;/sup&gt; coefficient</td>
<td>Beta&lt;sup&gt;b&lt;/sup&gt; coefficient</td>
<td>B&lt;sup&gt;a&lt;/sup&gt; coefficient</td>
<td>Beta&lt;sup&gt;b&lt;/sup&gt; coefficient</td>
</tr>
<tr>
<td>Cluster 1</td>
<td>5.20</td>
<td>1.33&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.76&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1.08&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.54&lt;sup&gt;*&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>6.95</td>
<td>0.07</td>
<td>0.15</td>
<td>0.44</td>
<td>0.82</td>
</tr>
<tr>
<td>Cluster 3</td>
<td>5.10</td>
<td>-0.81</td>
<td>-0.75</td>
<td>-0.12</td>
<td>-0.10</td>
</tr>
<tr>
<td>Cluster 4</td>
<td>3.13</td>
<td>1.50&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.92&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.04</td>
</tr>
</tbody>
</table>

a Unstandardized regression coefficient
b Standardized beta-coefficient
* Significant at p ≤ 0.05

Table 8. Coefficients generated in the regression of each consumer cluster liking scores onto factor scores of PC1 and PC3.

<table>
<thead>
<tr>
<th>Consumer cluster</th>
<th>Intercept</th>
<th>PC1</th>
<th></th>
<th>PC3</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B&lt;sup&gt;a&lt;/sup&gt; coefficient</td>
<td>Beta&lt;sup&gt;b&lt;/sup&gt; coefficient</td>
<td>B&lt;sup&gt;a&lt;/sup&gt; coefficient</td>
<td>Beta&lt;sup&gt;b&lt;/sup&gt; coefficient</td>
</tr>
<tr>
<td>Cluster 1</td>
<td>5.20</td>
<td>1.89&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1.09&lt;sup&gt;*&lt;/sup&gt;</td>
<td>3.29</td>
<td>0.54</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>6.95</td>
<td>0.27</td>
<td>0.60</td>
<td>1.19</td>
<td>0.73</td>
</tr>
<tr>
<td>Cluster 3</td>
<td>5.10</td>
<td>-0.93</td>
<td>-0.86</td>
<td>-0.77</td>
<td>-0.20</td>
</tr>
<tr>
<td>Cluster 4</td>
<td>3.31</td>
<td>1.44&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.88&lt;sup&gt;*&lt;/sup&gt;</td>
<td>-0.49</td>
<td>-0.08</td>
</tr>
</tbody>
</table>

a Unstandardized regression coefficient
b Standardized beta-coefficient
* Significant at p ≤ 0.05

Table 9. Coefficients generated in the regression of each consumer cluster liking scores onto factor scores of PC1 and PC4.

<table>
<thead>
<tr>
<th>Consumer cluster</th>
<th>Intercept</th>
<th>PC1</th>
<th></th>
<th>PC4</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B&lt;sup&gt;a&lt;/sup&gt; coefficient</td>
<td>Beta&lt;sup&gt;b&lt;/sup&gt; coefficient</td>
<td>B&lt;sup&gt;a&lt;/sup&gt; coefficient</td>
<td>Beta&lt;sup&gt;b&lt;/sup&gt; coefficient</td>
</tr>
<tr>
<td>Cluster 1</td>
<td>5.20</td>
<td>1.97&lt;sup&gt;*&lt;/sup&gt;</td>
<td>1.14&lt;sup&gt;*&lt;/sup&gt;</td>
<td>2.54</td>
<td>0.57</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>6.95</td>
<td>0.35</td>
<td>0.75</td>
<td>1.11</td>
<td>0.93</td>
</tr>
<tr>
<td>Cluster 3</td>
<td>5.10</td>
<td>-0.68</td>
<td>-0.63</td>
<td>0.64</td>
<td>0.63</td>
</tr>
<tr>
<td>Cluster 4</td>
<td>3.31</td>
<td>1.34&lt;sup&gt;*&lt;/sup&gt;</td>
<td>0.83&lt;sup&gt;*&lt;/sup&gt;</td>
<td>-0.65</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

a Unstandardized regression coefficient
b Standardized beta-coefficient
* Significant at p ≤ 0.05
Figure 4. Extended internal preference map of four consumer clusters on PC1 and PC2 of the chicken meat sensory descriptors indicating the position of (a) the sensory descriptors and (b) the chicken meat samples. The vector of each consumer cluster represents the direction of liking for the consumer cluster. B and T represent breast and thigh meat respectively. Number 1 and 2 represent broiler chicken from two different producers. The number 3 represents Thai indigenous crossbred chicken.

Because of this, the preference map of the four consumer clusters was generated in the spaces defined by only PC1 and PC2 as shown in Figure 4.

The vectors in Figure 4 indicate the direction and position of greatest preference for the four consumer clusters. If the vectors were extended in the opposite direction preference would theoretically decrease. Consumer cluster 1 (n = 37) showed strong preference for thigh meat samples of a commercial broiler and a Thai indigenous crossbred chicken. This could be accredited to their appearance with moderate brown and yellow color together with very smooth and tender texture. This group of consumers was the largest group and could be named as chicken thigh meat lover. Figure 4 also indicated that thigh meat of Thai indigenous crossbred chicken possess color and some textural characteristics similar or comparable to that of commercial broiler. Among the thigh meat samples, product produced from commercial broiler of company 1 was liked the least. This could be attributed to strong brown and yellow color as well as high sticky texture. Thigh meat of a commercial broiler and a Thai indigenous crossbred chicken had also particular appeal to consumer cluster 2 (n = 25) but the drivers of liking were not conclusive since there was no PC significantly correlated to the preference dimension (Table 6). Consumer cluster 3 (n=19) prefer breast more than thigh meat and could be designated as the chicken breast lover. This cluster seemed to like the breast meat of Thai indigenous crossbred chicken as similar as that of broiler chicken. However, the preference dimension of cluster 3 was not correlated to any sensory descriptor dimension. Consumer cluster 4 (n = 9) clearly like thigh meat more than breast meat samples and moderate brown and yellow color seem to reflect preferred choice. This cluster seemed to like thigh meat of broiler produced by company 1 the least, because of its strong brown and yellow color.
CONCLUSION

Extended internal preference mapping can be a valuable tool for detecting consumer clusters with different preference patterns. Relationships between consumer cluster liking scores and sensory attribute dimensions generated by a trained assessor panel inform about which sensory dimensions are drivers of product liking for each consumer cluster. In this work, the descriptive panel developed 12 sensory descriptors for evaluating six chicken meat samples. Consumer likings for 6 chicken meat samples were also evaluated. Principal component analysis of sensory attribute ratings identified 4 sensory dimensions. Cluster analysis identified four consumer clusters. Consumers in cluster 1 and 4 preferred thigh meat because of its brown and yellow color. They also preferred thigh meat samples with moderate brown and yellow color rather than samples with strong color. Apart from that, consumer cluster 1 also preferred thigh meat with very smooth and tender but low sticky texture. Consumers in the second clusters seemed to prefer thigh meat as well but seemed less concerned about sensory characteristics. Consumers in the third cluster preferred breast meat samples but sensory characteristics that drive their acceptability were not conclusive.

ACKNOWLEDGEMENTS

The authors are grateful to the Department of Food Technology, Faculty of Technology, Khon Kaen University for technical support.

REFERENCES


GREEN TEA FLAVOR DESCRIPTION: A FOCUS ON DIFFERENCES IN GREEN AND BROWN FLAVOR NOTES

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Abstract

Green teas have flavor characteristics that are both green (vegetative) and brown (often from processing). A description of the green and brown characteristics of green tea was developed to differentiate those flavor notes. Flavor descriptions for green and brown notes were based on testing over 100 green teas from nine countries. A highly trained descriptive sensory panel identified, defined, and referenced green and brown flavor attributes. “Green” attributes included terms that described specific vegetative notes: asparagus, beany, Brussels sprout, celery, green beans, green herb-like, mint, parsley, and spinach, while “Brown” notes included notes associated with processing: ashy/sooty; burnt/scorched; and brown or roasted products: brown spice, nutty, tobacco. A few teas had only green (n=10) or brown (n=29) notes, but most (n=109) had combinations of green and brown flavors. Processors and researchers can use these descriptors to better understand green tea and produce products with specific green or brown flavor notes.

Keywords: green tea, flavor, green, brown, sensory analysis

INTRODUCTION

Green tea has been consumed for centuries in some parts of the world because of its flavor and health benefits. It is becoming popular in other parts of the world in part because of increased interest in functional foods. As with most other natural products, green teas differ. Tea can be different because of bush species (Camellia sinensis var. sinensis or var. assamica), cultivating environment/region, differences in harvest times of tea leaves, and different processing methods (Jung, 2004).

Green tea flavor has been studied using descriptive sensory methods (Yamanishi, 1977; Park, Chung, Ki & Eun, 1996; Park, Choi & Park, 1998; Park, Jeon & Lee, 1999). Most of those researchers included terms associated with appearance, aromatic flavor components (acidic, acrid, burned, citrus, dimethyl sulfide-like, dried leaf, earthy, fermented, fresh floral, sweet floral, sweet fruity, green, fresh green, moldy, juice of motherwort, nutty, oily, resinous, roasted, seaweed, sweet), fundamental tastes (bitter, sweet, umami), and trigeminal or mouthfeel properties (astringent, biting/pungent). Togari, Kobayashi & Aishima (1995) evaluated and differentiated among green, oolong, and black tea using the16 sensory terms developed by Yamanishi (1977), however those researchers did not present references to help understand the attributes. Until a recent study by Lee and Chambers (2007) who examined a wide range of green tea samples, previous studies were conducted on a limited number of samples that may not represent the wide range of green teas available around the world.
The description of green tea is complicated by the fact that both “green” and “brown” notes are present, a combination that does not occur often in many other food products. Green notes are present from the vegetative source and brown notes either from the terroir or processing. Thus, to understand green tea, a sensory vocabulary must include and differentiate between green and brown flavor notes. In addition, the terms should be defined, have references for comparison whenever possible, and differentiate samples in the category (Drake & Civille, 2003). Various lexicons have been developed for products such as cheese (Drake, McIngvale, Gerard, Cadwallader & Civille, 2001; Retiveau, Chambers, & Esteve, 2005); soymilk (Day N’Kouka, Klein & Lee 2004; Chambers, Jenkins & McGuire, 2006) and flavor chemicals such as those responsible for “beany” (Vara-Ubol, Chambers & Chambers, 2004; Bott & Chambers, 2006), and more importantly for this study, “green” (Hongsoongnern & Chambers, 2007).

The objective of this research was to clearly differentiate the attributes associated with green and brown notes in green tea.

MATERIALS AND METHODS

Tea Samples
One hundred thirty eight green teas in leaf form were used to ensure that the green tea flavor description would include the widest array of flavor notes present in green teas, a principle proposed by Drake et al. (2003). Samples were from China (45), India (6), Japan (40), Kenya (3), Korea (32), Sri Lanka (4), Taiwan (4), Tanzania (1), and Vietnam (1). Two samples did not have country information. Those countries and areas within those countries represent nearly all of the major tea farming areas that produce green tea for profit. Variations in sample also included age of the leaf from very young buds to fully grown late season leaves; different processing methods included steaming and/or roasting, drying, hand processing, or machine processing; and newer samples (brewed within a few months of production) as well as older samples (close to expiration date which generally means the sample was aged up to 2 years after production). Specific leaf age, processing methods, and freshness of samples were not always available. Retail prices for green tea tested varied from approximately 2 USD per 100g to over 400 USD per 100g. Factors influencing price included time of picking leaves, processing methods, size of farms/manufactures, and location of tea grown.

Tea Preparation and Serving Procedure
Green tea sample preparation and serving procedure are given by Lee et al. (2007). To reduce build-up of flavors from one sample to another, carrots and bland cheese, followed by unsalted-top crackers and reverse osmosis, deionized, carbon-filtered water were used to cleanse the mouth between samples.
Panelists
Six highly trained panelists from the Sensory Analysis Center at Kansas State University served as a panel in this study. The panelists had completed 120 hours of general training and had a minimum of 1200 hours of general sensory testing including beverages, vegetables, and other food products with attributes similar to those that might be found in tea.

Development of Definitions and References
The panel was asked to describe samples of green tea as completely as possible. The panel was told to separate broad flavor attributes used in previous studies, such as brown and green, into more specific attributes to provide a better flavor description of the samples. The panelists were instructed to focus on the specific flavor of each individual sample. General procedures for developing definitions and references were adapted from the flavor profile method (Caul 1957; Keane, 1992).

In order to reduce potential biases, the panel was not given any information regarding the samples (product origin, age of tea leaf, production method, age of tea product, etc.) other than that they were tea samples. During evaluation, the panelists individually evaluated a green tea sample. After this independent evaluation, a discussion was led by the panel to reach consensus on descriptors for each sample. As part of that process, the panel defined each descriptor and suggested potential references that were representative and specific for each attribute as suggested by Piggott (1991).

RESULTS AND DISCUSSION

Description
A generalized lexicon for green tea flavor was given by Lee et al. (2007), but this current research focuses specifically on the notes associated with green and brown flavor attributes.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Definition</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREEN FLAVORS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Green</td>
<td>Sharp, slightly pungent aromatics associated with green plant/vegetable matter, such as asparagus, Brussels sprouts, celery, green beans, parsley, spinach, etc.</td>
<td>Fresh parsley water = 9.0 (flavor)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25 gram of fresh parsley, rinse, chop, and add 300 ml of water. Let it sit for 15 minutes. Filter and serve liquid part.</td>
</tr>
<tr>
<td>Asparagus</td>
<td>The green, slightly earthy aromatics associated with cooked green asparagus.</td>
<td>Asparagus water = 6.5 (flavor)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weigh 40 g of fresh asparagus, wash, dice, add 300 ml of water, cover, microwave for 3 minutes on high. Serve liquid part.</td>
</tr>
<tr>
<td>Beany</td>
<td>The green, somewhat musty earthy aromatics associated with cooked legumes such as garbanzo beans and lima beans.</td>
<td>Kroger Small Green Lima Beans = 5.0 (flavor)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measure juice out of can. Dilute: take 1 part of lima beans juice, and mix with 4 part of water.</td>
</tr>
<tr>
<td>Flavored</td>
<td>Description</td>
<td>Example Recipe</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
</tbody>
</table>
| Brussels Sprouts | The somewhat sharp, slightly sour, pungent aromatics associated with cooked cabbage, Brussels sprouts, and cauliflower. | Brussels sprout water = 6.5 (flavor)  
Weigh 20g, wash, dice, add 300 ml of water, cover, microwave for 3 minutes. Filter and serve liquid part. |
| Celery | The slightly sweet, green, slightly bitter aromatics associated with cooked celery leaves. | McCormick Celery Flakes water = 6.5 (flavor)  
Weigh 1.5g, add 300 ml of water, cover, microwave for 3 minutes on high. Filter and serve liquid part. |
| Green Beans | A viney, green, woody aromatic associated with processed green beans. | Del Monte Cut Green Beans (No Sodium) = 5.5 (flavor)  
Measure juice out of can. Dilute: take 1 part of green beans juice; mix with 4 part of water.  
Mixture of McCormick bay leaves, McCormick ground thyme, and McCormick basil = 6.0 (aroma)  
Mix 0.5 g of each herb. Grind using mortar and pestle. Add 100 ml of water. Mix well. Put 5 ml of herb water in a medium size snifter. Add 200 ml water. Cover. |
| Green Herb-like | The aromatics associated with dry green herbs such as bay leaves, thyme, basil. | |
| Mint | Aromatics associated with fresh mint; somewhat reminiscent of toothpaste. | Fresh crushed mint leaf = 7.0 (aroma)  
Weigh 0.1 g of mint leaves. Crush. Place in a medium snifter, cover. |
| Parsley | The clean fresh green, bitter, pungent aromatics associated with cooked parsley. | Parsley water = 5.5 (flavor)  
Weigh 15g, rinse, chop, put in 300 ml of water, cover, and microwave for 3 minutes on high.  
Filter and serve liquid part. |
| Spinach | The green, slightly musty, earthy aromatics associated with freshly cooked spinach. | Spinach water = 6.0 (flavor)  
Weigh 35g of spinach, rinse, chop. Add 300 ml of water, cover, microwave for 3 minutes on high. |
| **BROWN FLAVORS** | | |
| Overall Brown | A sharp, caramel, almost burnt aromatic. | Sethness AP100 Caramel color = 7.0+ (aroma)  
4 drops on a cotton ball in a medium snifter, cover. |
| Ashy/Sooty | The light smoky/ashy aroma associated with burning tobacco such as cigarette smoke. | Camel Filters (Turkish and Domestic Blend)  
Cigarette smoked filter = 7.0 (aroma)  
Place 0.02 gram of smoked filter in a medium snifter. Add 100 ml of water. Cover. |
| Brown Spice | Aromatics associated with a range of brown spices such as cinnamon, nutmeg, allspice. | Spice blend = 9.0 (aroma)  
Place ¼ teaspoon of McCormick Allspice, ¼ teaspoon of Cinnamon, and ¼ teaspoon of Nutmeg in medium snifter. |
| Burnt/Scorch-ed | The somewhat sharp, acrid notes associated with burned or scorched vegetables or grains. Nutty characteristics are: sweet, oily, light brown, slightly musty and/or buttery, earthy, woody, astringent, bitter, etc. Examples: nuts, wheat germ. | FMV Wheat Puffs Cereal = 7.0 (flavor)  
Diamond® Shelled Walnut = 6.5 (flavor)  
Grind for 1 minute on high using blender. |
| Nutty | | Camel Filter cigarettes (Turkish and Domestic Blend) = 7.0 (aroma)  
Break cigarette and place 0.2 gram of tobacco in a medium snifter. Cover. |
| Tobacco | The brown, slightly sweet, slightly pungent aromatic associated with cured tobacco. | |

* Intensity, 15-point scale, 0= none, 15= extreme. Intensities of references are not based on a universal scale and may be relevant only to green tea evaluation.
Table 2. Intensity distribution of green and brown attributes

<table>
<thead>
<tr>
<th></th>
<th>Threshold (Intensity 0.5 – 1.0)</th>
<th>Low (Intensity 1.5 – 4.5)</th>
<th>Moderate (Intensity 5.0 – 9.5)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Green</td>
<td>13</td>
<td>73</td>
<td>23</td>
<td>109</td>
</tr>
<tr>
<td>Asparagus</td>
<td>2</td>
<td>19</td>
<td>0</td>
<td>21</td>
</tr>
<tr>
<td>Beany</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Brussels Sprouts</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Celery</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Green Beans</td>
<td>3</td>
<td>20</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Green Herb-like</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>Mint</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Parsley</td>
<td>5</td>
<td>31</td>
<td>1</td>
<td>37</td>
</tr>
<tr>
<td>Spinach</td>
<td>1</td>
<td>55</td>
<td>2</td>
<td>58</td>
</tr>
<tr>
<td>Overall Brown</td>
<td>37</td>
<td>76</td>
<td>14</td>
<td>127</td>
</tr>
<tr>
<td>Ashy/Sooty</td>
<td>2</td>
<td>30</td>
<td>3</td>
<td>35</td>
</tr>
<tr>
<td>Brown Spice</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Burnt/Scorched</td>
<td>2</td>
<td>23</td>
<td>2</td>
<td>27</td>
</tr>
<tr>
<td>Nutty</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Tobacco</td>
<td>7</td>
<td>32</td>
<td>2</td>
<td>41</td>
</tr>
</tbody>
</table>

**Green flavors**

The flavor term “green”, used in previous research on a variety of different products (Baldwin, Goodner, Plotto, Pritchett & Einstein 2004; Vara-Ubol et al., 2004; Galan-Soldevilla, Ruiz-Pérez-Cacho, Serrano Jiménez, Jodral Villarejo & Bentabol Manzanares, 2005; Vilanova & Soto, 2005; Retiveau, Chambers & Milliken, 2004) was too broad for this study of green tea. Although an “overall green” note was included in this study, additional notes indicating the specific green note present were used. Those included various vegetative notes: asparagus, beany, Brussels sprouts, celery, green beans, green herb-like, mint, parsley, and spinach. Those green notes are more specific than the ones used by Hongsoongnern et al. (2007) to broadly classify “green” flavors into categories such as unripe, peapod, grassy/leafy, viney, or fruity. The green flavor notes for tea found in the current research generally would fall into the grassy/leafy classification of Hongsoongnern et al. (2007). Those researchers described green tea products with green-grassy/leafy attributes in their study.

One hundred and nine samples out of 138 green tea samples tested were perceived to have overall green flavor (Table 2). Twenty three samples had a moderate intensity of overall green flavor (5.0-9.5), 73 samples had low intensity (1.5-4.5) and 13 samples were perceived as having green flavor at threshold level (intensity 0.5 or 1.0). Spinach, parsley, green beans, and asparagus were found in green tea samples most often, generally at low intensity. In contrast, other green attributes, such as green herb-like, mint, celery, beany, and Brussels sprouts were present in fewer than 9 samples. These are characterizing flavor notes for limited number of green tea products and possibly differentiate from others.

Some samples had a single characterizing vegetable attribute (e.g. only spinach in 15 samples, parsley n=6, green-herb like n=5, green bean n=3 samples) and other samples had combination of these vegetable attributes such as parsley and spinach (n=15 samples), asparagus and spinach (n=9), green bean and spinach (n=8), green bean and parsley (n=5),
etc. Twenty one samples were perceived to have overall green, however specific characteristics of flavor could not be determined. Generally intensity of overall green was threshold to low with one exception.

Hongsoongnern et al. (2007) defined green-grassy/leafy as “A green aromatic associated with newly cut-grass and leafy plants; characterized by sweet and pungent character” and used fresh spinach and fresh parsley water for references. The overall green attributes found in this green tea study are part of this classification. More specific attributes were developed for this research. Most references were prepared by using processed canned products or cooking either raw or dried vegetable/herb in water and serving liquid part only, to reflect the nature of green tea – brewed in water, tea leaves dried, steamed, or roasted while processing.

While developing terms for green tea, panelists found most green tea samples resemble a specific vegetable. Spinach was one of them. However, spinach had to be cooked in water and only filtered liquid was served as reference to provide reference intensity as low as most green tea flavor intensity. Asparagus has been suggested as an indicator of high quality green tea. Both spinach and asparagus green and slightly earthy aromatics associated with their own characteristics. On the other hand, parsley was used to describe green tea having clean fresh green, bitter, pungent aromatics resembling cooked parsley. The green bean attribute was characterized by viney, green, woody aromatics of processed green beans.

**Brown flavors**

The flavor “brown” also has been used in previous studies on different products (Johnson & Civille, 1986; Smith, Chambers & Colley, 1994; Vara-Ubol et al., 2004; Chambers et al., 2006). In this study, the overall brown term was partitioned into ashy/sooty, brown spice, burnt/scorched, nutty, and tobacco. Ashy/sooty and burnt/scorched are most likely related to processing method. Ashy/sooty is a smoky aroma associated with burning tobacco/cigarette smoke, where burnt/scorched is flavor associated with burnt or scorched vegetables or grains. To present this difference, a smoked filter from a cigarette was used as a reference for ashy/sooty, and a piece of wheat puff cereal was used for burnt/scorched. Attributes such as brown spice, nutty, and tobacco are related to specific products that generally are dried before use. In addition, those products may have some further processing (e.g. roasting of nuts) that adds additional brown flavors to the product. For instance, tobacco from a cigarette was used for the ‘tobacco’ attribute to reference the slightly sweet, pungent aromatic associated with cured tobacco in green tea samples.

For brown notes in particular, references appropriate for green tea had to be reduced in intensity. For example, the filter from a smoked cigarette was most appropriate for ashy/sooty, but used as is, it was too strong. Thus, various weights of filter and water combinations were prepared to find the best combination of a tobacco water ‘tea’ to give an appropriate intensity.
Interestingly, 128 (92%) of the samples had some level of overall brown flavor (Table 2). That number of samples is higher than for overall green flavor even though these were green tea samples. Ashy/sooty and tobacco notes were present in more than 25% of the samples and burnt/scorched was present in nearly 20% of the green tea samples. Brown spice and nutty were found in fewer than 6 samples. Although brown flavors were found in more samples, the intensities generally were lower. Fourteen samples had a moderate intensity of overall brown flavor (5.0-9.5), 76 samples had low intensity (1.5-4.5) and 37 samples were perceived at threshold level (intensity 0.5 or 1.0). Samples that have ashy/sooty or burnt/scorched notes, especially when those notes are either moderate in intensity or at the higher end of the low intensity level, may have been roasted or processed either at too high a temperature or for too long a period of time. It also is possible that leaf age or other factors may produce a higher carbohydrate content that would be scorched or burnt in processing.

**Differences in green and brown flavors**

All samples had either a green or brown note and most had both notes present. Out of 138 green tea samples tested, 109 samples had both overall green flavor and overall brown flavor. Thus, only 10 samples had an overall green flavor without brown notes and 29 samples had overall brown flavor with no green flavor perceived.

Forty-five green tea samples from China were tested in this research, 43 samples had brown-related attributes and 33 samples had green-related attributes. Intensity for overall brown generally was stronger in Chinese teas, accounting for 2/3 of Chinese samples tested. In only one-third of the Chinese samples was overall green flavor intensity higher than overall brown. Intensity for green-related attributes also were low (the highest intensity was 4.0). This finding is different from the green teas from other countries where the green note generally was higher. There are various possibilities for this finding. The most logical reasoning is processing. It is possible that Chinese teas are processed at a higher temperature or longer than is done in other countries. Other options include differences in terroir, age, or handling after picking. This difference is manifested in some recommendations for differences in brewing conditions between Chinese green teas and many other teas. Chinese green tea often comes with a recommendation for brewing with boiling water (much like black or oolong tea) and discarding the first brew before drinking the second and subsequent brews. That was not done in this research. In order to provide consistent comparison among teas, researchers brewed all tea at 70 C for 2 minutes and the first brew was tested.

Forty green tea samples in this research were from Japan. Thirty eight samples presented green-related attributes and 32 samples were found to have brown-related attributes. Generally, overall green intensity in Japanese tea was moderate and character notes included mostly spinach, parsley, and asparagus. Other specific green attributes were noted only in a few samples. Most Japanese samples had very low brown flavor, with the highest score for brown being 2.0. When present, the specific brown note was either ashy/sooty or burnt/scorched. The Japanese samples with little or no green flavor were roasted green
teas, Hojicha. Hojicha and roasted samples showed low to moderate intensity for overall brown (range 4.5-8.0). Other brown-related attributes, brown spice, nutty, and tobacco, were not found in Japanese green tea.

All 32 Korean green teas had both green and brown flavor notes. Generally, the intensity for both overall green and overall brown attributes was low (most intensity below 4.5 with a few exceptions), and most samples had similar intensity for both attributes, although overall green flavor intensity tended to be slightly higher (0.5 – 1.0 points) than overall brown flavor.

The number of teas from other countries was too small to draw any conclusions about the dominant flavor notes present in green teas from that country.

**Attribute References**
In this research, a 15-point numerical scale with half-point increments was used with 0 meaning “None” to 15 meaning “Extremely Strong.” Because green teas have a weak flavor compared to many common food products in market, references were scored on a product specific scale to differentiate green tea samples on subtle flavor notes (Table 1). Muñoz & Civille (1998) compared product specific scaling to the universal scaling and pointed out that product specific scaling allows sample differences to become larger because it permits panelists to use a wider range of the scale. Thus, products outside the category of green tea should not be evaluated using references in this research. Intensities of references may need to be adjusted when non-green tea products are evaluated.

**CONCLUSION**
The flavor descriptions for green and brown notes of green tea were identified, defined, and referenced to differentiate those flavor characteristics commonly present in green tea. Green tea can be described objectively by using this set of sensory attributes rather than judged subjectively on quality. Furthermore, this set of descriptions can be used to describe, compare, and differentiate various green tea products around the world.

**ACKNOWLEDGEMENTS**
Authors appreciate generous donation of their green tea products of AmorePacific Co. (Seoul, Korea).

**REFERENCES**


LINKAGE BETWEEN AN ADAPTED FREE CHOICE PROFILING (FCP) METHOD AND INSTRUMENTAL ANALYSIS BASED ON A THAI CHILLI PASTE PRODUCT

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Abstract
Free Choice Profiling (FCP) was applied to measure consumer perception on attribute intensities of Thai chilli paste products. The FCP was adapted to include a ‘standardized’ session which was conducted in order to give panelists an idea of reference standards and their intensities on six key attributes related to product ingredients. After five chilli paste samples (including one repeated) were evaluated, GPA was applied, and revealed that judgments from 10 out of 14 panelists were reliable. The sensory consensus data from FCP was then linked to instrumental measurement data, such as water activity (a_w), moisture content, salt content, capsaicin content, acidity, pH, L*, a*, b*, stickiness and adhesiveness (measured by texture analyzer) and volatile compounds (detected by dynamic headspace sampling technique (DHS) with GC-MS). PCA and PLS graphs demonstrate that colour and brightness of the products were key attributes affecting product acceptance, and appear to be related to presence of ethanol and linalool. Hot sensation presents strong correlation with saltiness perceived by consumers and % salt content whereas acidity seems to be correlated with product texture.

Keywords: chilli paste, sensory attributes, GPA, FCP, volatile compounds

INTRODUCTION
A principle of Free Choice Profiling (FCP) is to give panelists freedom in generating their own individual attribute lists in describing product sensory profiles. The method main objective is quite different from other conventional descriptive analysis, as it measures what consumers perceive and reveals product attributes in consumer vocabulary while not requiring training sessions (William & Langron, 1984; Arnold & William, 1985). FCP is normally used as a tool to get product information for positioning the products in market place or adjusting formulation in relation to competitive product range. However, it has been applied recently to product quality development (Aparicio et al., 2007; Tang & Heymann, 2002), which raises questions regarding FCP reliability in generating product sensory profiles and in representing various consumer groups from different cultures. Saint-Eve et al. (2004) reported different outcomes when comparing FCP with Conventional profiling. It was found that FCP revealed impact of flavouring agent composition on texture perception, similarly to results from the sorting method, whereas the conventional profiling method did not reveal the effect.

Following on from this research, we attempt here to demonstrate and prove FCP outcomes by linking the product attribute intensities perceived by untrained panels with the attribute
intensities measured by objective methods including chemical and physical product indicators. Generalized Procrustes Analysis (GPA-XLSTAT 2006.5) is applied in order to combine data from individual sensory profiles to obtain a consensus data matrix by reducing panel scaling effects.

MATERIALS AND METHODS

Adaptation of Free Choice Profiling

Since FCP is highly dependent on the individual’s ability to generate their own attribute lists, an issue concerning panel analytical and expressive manner arises when dealing with eastern culture. A ‘Warm-up’ step is added to FCP as we have experienced that Thai panelists are generally shy and hesitant to express their feeling and perception. Several Thai herbal products and seasoning materials were provided to panelists as mock-up samples. Panelists were encouraged to observe and taste the mock-ups then made attribute lists for each sample. Panelists who could express only a few attribute items for the first mock-up were given thorough exposure through tasting a series of single herbal ingredients before moving on to herbal products. Participants who had difficulties in expressing the sensory attributes after 3 sessions (one hour each) were asked to terminate participation in the trial and received a half incentive. The maximum length of time for the warming-up step was set so that FCP still retains its advantage of time and cost benefits.

Another FCP adaptation step is setting reference standards for six key sensory attributes: Brownness, Redness, Stickiness, Saltiness, Spiciness, and Spicy odour. This step took five sessions (5 hours) for panelists to be able to identify various intensity levels of standards on six key attributes (within sd.+1.5). The purpose is to confirm whether consumer attributes obtained with standards could present a superior relationship to chemical and physical data than the attributes obtained without standards.

Consumer Panel

Consumers who regularly consume chili paste products (once a week or more frequently) were recruited via telephone. Seventy six consumers were interested in participating after the research recruitment was advertised by local radio for a week, out of which 28 had agreed on the research place and timing conditions (to participate at Department of Food Technology, Khon Kaen University for 10 to 12 hours within two weeks). Screening procedure for discriminating ability on basic tastes and herbal odours was applied, and as a result 17 potential subjects joined the FCP. After warming-up session, 14 panelists continued participating throughout the trial.

Data Analysis

Significance testing on GPA has been reported with different null hypothesis testing, for example, to test whether GPA consensus configuration is true (King & Arents, 1991), if the consensus is significant (Wakeling et al., 1992), or testing factorial effect (main effect and interaction) for GPA (Xiong et al., 2007). In this study we use the XLSTAT (2006.5)
package software in which a GPA null hypothesis is specified as ‘a consensus is reached after the GPA transformations’. Permutation of missing data from individual set of sensory attributes in GPA can be replaced by ‘0’ as not identified and hence no attribute intensity perceived.

PCA and PLS (XLSTAT 2006.5) are employed on consensus data from FCP together with other objective measurement data such as acidity, salt content and volatile compounds detected by dynamic headspace sampling technique (DHS) with GC-MS.

Sample and Designs
Thai chili paste product with fermented fish is a traditional chilli paste product in North Eastern part of Thailand and was used as a sample for this trial. The product samples are four most popular brands from the market selected for their high quality standard, and one research sample produced in a pilot plant at the Department of Food Technology at KKU. Thus, there were six samples served to panelists for evaluation with random serving plan. The balance order and carry-over effects design was not applied here since the experimental control for bias may violate GPA assumption. Null hypothesis on applying GPA permutation was under random ordering of treatments for each experimental unit (Xiong et al., 2007). Completely Randomized Design was then assigned as a serving plan for evaluating FCP on six samples of which KK is a replicated treatment of K sample.

Instrumental Measurement
The product physical and chemical properties measured in this research are based on Thai Community Standard 131/2546 (Ministry of Industry, 2002) and quality characteristics perceived from Thai chilli paste product preferred by consumers from previous studies. The test samples were analysed according to various tools and standards as follows.

1. Colour measured by Hunter Lab (Ultrascan XE, USA)
2. Water activity by Novasina (TH-2/RTD-33/BS, Switzerland)
5. pH by Mettler Toledo (SevenEasy)
7. Texture by Texture analyzer (TAXT2)
8. Capsaicin by Colorimetric method (Sadasivam & Manickam, 1997)
9. Volatile flavour compounds analysis by dynamic headspace sampling technique (DHS) with GC-MS (Agilent 6890 Plus GC/HP 5973 MSD).
Table 1. PANova from FCP on 14 panelists

<table>
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<th>Source</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean squares</th>
<th>F</th>
<th>Pr &gt; F</th>
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<td></td>
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<td>15.025</td>
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<tr>
<td>Residuals after rotation</td>
<td>195</td>
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<td>5.082</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotation</td>
<td>195</td>
<td>1471.105</td>
<td>7.544</td>
<td>1.726</td>
<td>0.000</td>
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<tr>
<td>Residuals after translation</td>
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<td></td>
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<tr>
<td>Translation</td>
<td>78</td>
<td>1808.528</td>
<td>23.186</td>
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</tr>
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<td>9.125</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. GPA consensus test on FCP data (n=14)

RESULTS AND DISCUSSIONS

The results contain three parts: 1) consumer panelist performances on FCP key attributes by GPA, 2) FCP results from 10 consumer panelists using 23 attributes in explaining product profiles, and 3) relationship of instrumental measurements on product attributes illustrated by PCA and PLS.

Panel performance on FCP key attributes

Fourteen consumer panelists tested six samples of which one was repeated, PANova (shown in Table 1) results performed on six standardized key attributes present significant residuals reduction by scaling, rotation and translation methods in GPA. Figure 1 shows Rc (0.553) and the quantile beyond the confidence interval, meaning that the GPA significantly reduces the variance and the fit is superior to a random fit. Two dimensions are required for the interpretation.

Subjects for whom residuals are high (J3), as shown in Figure 2a, and whose scores do not map well onto the GPA consensus were taken out of the analysis. Scaling factors across subjects J1, J4 and J10 contribute highly to the scaling effect (Figure 2b), hence their scores were removed from further analyses.
The samples seem to be equally fitted to the consensus in terms of residuals (Figure 3a). Note that the research sample (K) presents small residual which gets smaller when tested twice (KK). The repeated samples are close on the GPA map and thus were perceived as similar to each other (shown in Figure 3b). The projection of each individual configuration on the consensus first two dimensions is shown in Figure 4 presenting product positions perceived by 14 panelists. When four subjects were excluded, the configuration of product positions are clearly separated (Figure 5) and the repeated sample (K and KK) are described more similarly by the six key attributes as shown in Figure 6. It may be worth noting that subject J3 who has highest residual also gave fewer attributes than the others and used different attributes in describing the product profiles. Subjects J1, J4 and J10 had scaling patterns on extreme ends whereas the rest had dispersed attribute scores.
Figure 4. Scatter product positions described by 14 panelists.

Figure 5. Scatter product positions described by 10 panelists
Objects (axes F1 and F2: 75.94 %)

Figure 6. Consensus configuration of products on FCP key attributes (n=10)

Dimensions (axes F1 and F2: 64.89 %)

Figure 7. GPA illustration on 23 sensory attributes from FCP (n=10)
FCP product profiles

From the most frequent terms used in FCP, 23 sensory attribute mean scores from 10 panelists were processed and presented in GPA and PCA-biplots (Dimension 1-3) as shown in Figure 7 and 8. Generally this type of chilli paste is perceived as hot and salty. From FCP, the samples were perceived in two major characteristics–spice odours (chilli and others) and texture & taste (crude, moist and salty). The product was preferred when it contained less salt and more dried Thai chilli, which contributes to brighter red colour. The repeated experimental samples K-KK profiles are very similar and present strong galangal and dried fish odours as shown in Figure 8.

The consensus product profiles from the FCP are well related to the product formulation and the data derived from some instrumental measurements. However, only brownness, redness, stickiness, saltiness, spiciness, and spicy odour attributes were chosen from 23-FCP attributes to combine with the instrumental data in PCA (shown in Figure 9), providing standardization on similar attribute definitions and standard references.

Relationship of FCP and Instrumental measurements

Graphical PCA (Figure 9) demonstrate that several volatile flavour compounds, salt content, acidity, water activity (a_w) and moisture content are correlated with the panelists’ textural attributes. The main volatile flavour compounds are alcohols, acids and aldehydes which are from fermented fish (an ingredient in this type of chilli paste). The flavour characterization of fermented fish is primarily due to proteins and lipids degradation by autolytic and bacterial enzymes during fermentation process. The colour (brownness, redness and a*) and brightness (L*) of the product were found to be key attributes affecting product acceptance (Figure 10). The 1,8-cineole is normally found in both lemongrass and galangal. The limonene and linalool found in lemongrass contribute to overall herbal odour which is quite strong in U and K samples as far as the formulation is concerned.
Figure 8. Biplots on dimensions 1-3 from FCP-23 sensory attributes
Figure 9. PCA generated from FCP key attributes and instrumental data

Figure 10. PLS generated from instrumental and consumer data sets
CONCLUSION

In this research, our objective has been to investigate the relationship between the adapted FCP and instrumental data. The product chosen to carry out this investigation was a Thai chili paste product. We have found that the consensus product profiles from the FCP are well related to the ones derived from instrumental measurements. FCP results can be very different depending on the participants in the panel, some of whom may locate themselves on extremes of scales and have significant differences in product perceptions. The GPA reveals how 10 panelists perceived the chilli paste samples and how they liked the product in terms of its sensory properties. Colour, brightness, hot sensation and fermented fish odour (2,5 dimethyl pyrazine) of the products were found to be key attributes affecting product liking scores and appear to be related to presence of ethanol and linalool when the data is linked with instrumental measurement data by PCA and PLS. Hot sensation and saltiness perceived by consumers present negative relationship to amount of alcohol and limonene compounds. Saltiness also shows positive relationship to 2,5 dimethyl pyrazine found in fermented fish, whereas % salt content and acidity seems to be correlated with product texture.

In order to link sensory to instrumental data, we omitted panelists whom residuals in using scale are high and whose product sensory profiles did not quite fit the consensus profile. The drawback of this procedure is that, the number of panelists is small (n=17) and it may be possible that the target population could have a different sensory perceptual frame. In this case, however, the FCP sensory and instrumental data sets seem to complement each other and can be explained by the product ingredients and process.

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XLSTAT (2006.5) – www.xlstat.com
DESCRIPTIVE ANALYSIS OF MANGO GEL SNACKS

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Abstract
Mango gel snack samples were formulated using a three-factor Box and Behnken design. There were three independent variables (brix/acid ratio, hardness and colour) at three levels, resulting in fifteen samples overall. This experiment used a constant percent of mango flavour (0.2%) for all of samples. Generic descriptive analysis was used. Trained panellists (n = 23) identified 11 descriptors. As panellists could distinguish no difference between samples with regards to mango odour, pungent, mango flavour and mango flavour aftertaste, these descriptors were eliminated from further analysis. Three principal components were sufficient to model the results. Principle component 1 (PC1) included sweetness, sourness, sweet aftertaste and sour aftertaste descriptors and accounted for 50% of the total variance. Principal component 2 (PC2) included hardness and springiness descriptors and accounted for 35.8% of the total variance. Principal component 3 (PC3) included colour descriptor and accounted for 13.8% of the total variance.

Keywords: descriptive analysis; principal component analysis; mango gel snacks

INTRODUCTION
Mango is a tropical fruit appreciated worldwide. It is one of the most important fruits of Thailand economically speaking. In 2005, Thailand produced about 1.80 million tones of mangoes, which was the third country of production in the world (Food and Agriculture Organization of the United Nations, 2006). Among all Thai mango varieties, Nam Dok Mai which constitutes a third of all mango plantations in the country, is the most popular variety of mango because of its eating quality when ripe (Anonymous, 2001). Generally, ripe mangoes are processed for standardised pulp, mango slices, pulp based fruit drinks/beverages, mango leather and fruit bars. Mango processing industries usually follow a standardisation of Brix value of pulp to 14⁰-18⁰ without preservative. (Singh, Kulkarni & Sreedevi, 2003).

A new product made from mango puree is the mango gel snack. ThaiGrocer Company (2001) advertised that gel snacks, as ready-to-eat desserts, have natural flavour, natural colour, high fibre and fat free. A gel snack, having fruit puree as an ingredient, is a functional food, and is considered as healthy for consumers. In addition, rising interest for tropical fruits, both as a product and as a flavour, is seen in the “rapid growth of a semi-indulgent trend on dessert menus” (Sloan, 1999). Due to its unique flavour and nutrition value, mango puree may be an important ingredient for the snack food and dessert industries.
Descriptive analysis deals with the characterisation of products in terms of their perceived attributes (qualitative component) and intensities (quantitative component) (Munoz & Civille, 1998). The objective of this study was to obtain descriptive sensory data to differentiate among mango gel formulations.

MATERIALS AND METHODS

Mango gel snack formulations

The materials and methods for making mango gel snacks have been described by Ekpong, Ngarmsak & Winger (2006). Perceived sweetness was modified by altering the citric acid content (0.185, 0.240, 0.340% w/w), resulting in a brix/acid ratio of 80, 100 and 140, respectively. The colour was altered using β-carotene (Sensient Technologies (Thailand) Ltd.) at levels of 0, 50mg/kg and 100mg/kg. Hardness was modified using carrageenan (Thai Food and Chemical Co., Ltd.) at different concentrations to give objective hardness values of 500 gram force, 1000 gram force and 1500 gram force. Artificial mango flavour (0.2% w/w; Sensient Technologies (Thailand) Ltd.) was added to boost the mango aroma.

This experiment used three variables: brix/acid ratio, gel hardness and colour. Fifteen samples were prepared using a three-factor Box and Behnken design described by Gucula (1993), shown in Table 1. The levels of independent variables were coded as -1 and +1, representing the lowest and highest levels respectively; Zero (0) represents the center point of the design.

Sensory evaluation

Selection and training of the descriptive panellists was adapted from ISO 8586-1 Part 1: Selected assessors (1993). A total of 23 panellists (4 males and 19 females) were selected using the following criteria: students of Khon Kaen University, Thailand; normal colour vision; achieved 65% correct answers in both an odour and a texture description tests; being available for all sessions and willing to participate.

A generic descriptive analysis was used for this experiment (Lawless & Heymann, 1998). The training program was completed over a period of four weeks. Fifteen 1.5 h training sessions were conducted over that period of time. At the start of the training program, assessors were informed about the objective of this study, and received basic information about mango gel snacks and sensory evaluation. All assessors were trained to examine the attributes in the same way, starting from colour and appearance, odour, texture, flavour (comprising aroma and taste) and aftertaste, respectively. The training sessions included training in the use of unstructured 15 cm line scales. Panellists were then trained on mango colour, mango odour, sweetness and sourness using sucrose and citric acid solutions and texture using mango gels with varying concentrations of gelling agent. Panellists were advised of their performance in the previous training session before they started the next one.
Table 1. Experimental design for the mango gel snack sample preparation

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<th>Samples</th>
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<th>Decoded</th>
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Panellists were then introduced to profiling by being presented with a series of mango gel snacks. To generate a descriptive terminology, six samples from different formulations were presented to the panellists to provide a range of attributes of mango gel snacks (Table 2). The panellists individually examined the sample, generated descriptive terms and then discussed the results as a panel. An agreed list of eleven descriptors and their intensity terms (Table 3) was used in further training sessions. This experiment used product specific scaling method (Munoz & Civille 1998). This type of scale is based on the philosophy that attribute intensities are rated only within the boundaries of the product category being studied.

After the training sessions, all assessors evaluated all 15 samples in each of four sessions held over four days. The two batches of 15 samples were prepared. The first batch was evaluated in the first and second sessions. Then the second batch was evaluated in the third and fourth sessions. For each session, the fifteen samples were divided into 3 sub-sessions in random order. Five samples were presented at a time in each sub-session and a ten-minute break was taken before presenting the next set of five samples.

Data analysis

Analysis of variance with mean comparison tests (DMRT) was conducted using SPSS for Windows, version 12 (SPSS (Thailand) Co., Ltd.). Principal component analysis was performed to model the trained panellists’ rating with MINITAB® (Minitab Inc., State College, PA, USA).

RESULTS AND DISCUSSION

Twenty-three trained panellists evaluated 15 samples from two batches, each batch in duplicate. There was no significant difference identified for rating all attributes across the
Table 2. Composition of mango gel samples used for product training

<table>
<thead>
<tr>
<th>Sample</th>
<th>Brix/acid ratio</th>
<th>Hardness (gram force)</th>
<th>Beta-carotene (mg/kg)</th>
<th>Mango flavour (%)</th>
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Table 3. Attributes defined by trained panellists to describe mango gel snacks

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Definition</th>
<th>Intensity term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Light yellow to intense orange</td>
<td>light yellow-intense orange</td>
</tr>
<tr>
<td>Mango odour</td>
<td>Aromatic associated with artificial mango flavour</td>
<td>none-weak</td>
</tr>
<tr>
<td>Pungent</td>
<td>Irritating sharp sensation upon exposure to artificial mango flavour</td>
<td>none-weak</td>
</tr>
<tr>
<td>Hardness</td>
<td>The force required to bite through</td>
<td>soft-hard</td>
</tr>
<tr>
<td>Springiness</td>
<td>The degree of which sample return to original shape after depression is removed</td>
<td>no recovery-very springy</td>
</tr>
<tr>
<td>Sweetness</td>
<td>The taste on the tongue associated with aqueous solution of sugar</td>
<td>none-high</td>
</tr>
<tr>
<td>Soursness</td>
<td>The taste on the tongue associated with aqueous solution of citric acid</td>
<td>none-high</td>
</tr>
<tr>
<td>Mango flavour</td>
<td>Aromatic in mouth associated with artificial mango flavour</td>
<td>none-weak</td>
</tr>
<tr>
<td>Sweet aftertaste</td>
<td>The intensity of sweetness after swallowed the sample</td>
<td>none-high</td>
</tr>
<tr>
<td>Sour aftertaste</td>
<td>The intensity of sourness after swallowed the sample</td>
<td>none-high</td>
</tr>
<tr>
<td>Mango flavour aftertaste</td>
<td>The intensity of mango flavour after swallowed the sample</td>
<td>none-weak</td>
</tr>
</tbody>
</table>

four days of sensory testing. All trained panellists were able to distinguish the samples for each attribute (Table 4).

The mean values for the mango gel snack descriptive analysis is shown in Table 5. Results were predictable, given the known composition of the gel snacks. Most panellists could not distinguish any difference between samples with regards to mango odour, pungent, mango flavour, and mango flavour aftertaste. This experiment used a constant percent of mango flavour (0.2%) for all of samples, so this result was expected. Thus, the four descriptors associated with mango aroma (mango odour, pungent, mango flavour and mango flavour aftertaste) were eliminated from further analyses.

Therefore, data from the remaining seven attributes were subjected to PCA (Table 6). The results indicated that three components were adequate to model the data (eigenvalue greater than 1). Principal component 1 (PC1) included sweetness, sourness, sweet aftertaste and sour aftertaste attributes, and accounted for 50% of the total variance. Principal component 2 (PC2) included hardness and springiness attributes, and accounted for 35.8% of the total variance. Principal component 3 (PC3) included colour attribute, and accounted for 13.8% of the total variance.
Table 4 Ability of panellists to differentiate samples using key sensory attributes (*significantly different at $\alpha = 0.05$)

<table>
<thead>
<tr>
<th>Panellist</th>
<th>Significance of Attribute</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
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*Attribute for mango gel snack
A = Colour       B = Mango odour       C = Pungent
D = Hardness     E = Springiness      F = Sweetness
G = Sourness     H = Mango flavour   I = Sweet aftertaste
J = Sour aftertaste  K = Mango flavour aftertaste
Table 5. Sensory attribute rating by the trained panel (continue)

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Table 6. Principal component analysis of sensory attributes used to describe mango gel snacks.

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<td>-0.094</td>
<td>-0.990</td>
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<td>Sourness</td>
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<td>Sweet aftertaste</td>
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<td>0.077</td>
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<td>Sour aftertaste</td>
<td>0.461</td>
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<td>Eigenvalue</td>
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<tr>
<td>% of variance</td>
<td>50.0</td>
<td>35.8</td>
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CONCLUSION

Descriptive analysis is a powerful method to describe sensory characteristics of products. A generic descriptive analysis procedure, as described by Lawless & Heymann (1998), was used to obtain the sensory descriptors for mango gel snacks. A product specific scaling method was used, as it was the best method to evaluate a single product category. The panel provided 11 sensory descriptors to describe mango gel snacks, although the mango odour ones were not relevant for this particular study. The descriptors of taste which included sweetness, sourness, sweet aftertaste and sour aftertaste accounted for the highest of the total variance in the principal component analysis.

ACKNOWLEDGMENTS

The authors would like to thank the Ministry of Education, Thailand and the Postharvest Technology Innovation Center, Khon Kaen University, Thailand for the financial support.

REFERENCES


HOW DOES CULTURE AFFECT FOOD PERCEPTION AND DESCRIPTION?
CONTRASTING FRENCH AND VIETNAMESE PANELISTS ON SOY-YOGURTS

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\textsuperscript{c} Groupe ESC Dijon Bourgogne, 29 rue Sambin, 21000 Dijon, France
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Abstract
In-mouth perceptions including texture, taste and aroma of eight soy-yogurts and four milk-yogurts were assessed by one French trained panel and one Vietnamese trained panel, two cultures with important differences in soy and dairy product consumption habits, using a quantitative descriptive analysis (QDA) method. A Multiple Factor Analysis (MFA) showed that the two product spaces are highly similar. In contrast, the verbal description of the product set differs between the two panels. First, French panelists used more attributes than Vietnamese panelists (19 vs. 13). Second, a large difference was observed in aroma description: there was only one common attribute and French panelists used two times more attributes than Vietnamese panelists. While the attributes used by Vietnamese panelists are related to soy-based products (“raw soybean”, “soy milk” and “tofu”) the attributes of French panelists were more diverse and even included references to non food products (“woody”, “earthy”, and “chalky”). These results suggest that globally the perception of soy-yogurt characteristics is not influenced by culture, but that similar characteristics are described using different attributes, especially for aroma.

Keywords
Cross cultural; Soy-yogurt; Descriptive analysis; Perception; Description

INTRODUCTION
With increasing trading exchanges, the variety of food products in domestic markets is wider than ever before. Among factors influencing consumers’ food choice, familiarity plays an important role. For example, Prescott et al. (1997) found that Japanese and Australian consumers differed in their liking for salty and sweet products: Products judged as just about right in one country, were found too salty or too sweet in the other one. Yet, while cross-cultural differences in food preference are well established, there had been little researches on how perception and description of food products may vary across cultures. Moreover, the picture emerging from the few studies available is far from being clear. While some studies report that consumers perceive food characteristics similarly but described their perceptions differently (Andani, Jaeger, Wakeling & MacFie, 2001; Blancher, Chollet, Kesteloot, Nguyen, Cuvelier & Sieffermann, 2007; Follet, Lê, MacEwan & Pagès, 2006) other studies report cross cultural perceptual differences. For example, Kohno et al. (2005) using descriptive analysis found that Japanese panelists evaluated dried bonito stock as less greasy, without odd taste, weaker in fishy flavor, and with a more well-balanced taste than chicken bouillon, whereas Chinese panelists
evaluated dried bonito stock as less greasy, stronger in odd taste, stronger in fishy flavor, less well-balanced taste than chicken bouillon. Likewise, Prescott et al. (1997) report that an Australian and a Japanese panel differed on the perception of the fruitiness of orange and grapefruit juices and on the creaminess of ice cream.

The goal of our study was to further evaluate the role of culture and familiarity on the perception and description of food products. More precisely, we investigated how a newly introduced food product, soy-yogurt, would be perceived in a soy consumer (Vietnam) and in a non soy consumer (France) culture. For both French and Vietnamese consumers, soy-yogurt is at the same time a traditional and a new product. It is a traditional product because yogurts have been consumed for at least 4500 years in Europe and soy-based products have been consumed since 7th century B.C. in Asia. It is also a new product because consumption of dairy products including yogurt has just started in Vietnam and soy food consumption in France is still marginal.

MATERIALS AND METHODS

Products
Eight soy-yogurts and four milk-yogurts were used in this study (Table 1). Four soy-yogurts were bought from local supermarkets and four from organic health stores. Thirty grams yogurt samples were prepared in sealed plastic cups coded with three digit numbers. Samples were stored at 4°C and kept at room temperature (22°C) to equilibrate, one hour before serving. Panelists evaluated the products in standard sensory booths under red light.

<table>
<thead>
<tr>
<th>Product’s name</th>
<th>Product type</th>
<th>Supplier</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Soy-yogurt</td>
<td>La Vie Saine</td>
<td>SojadéliceBlancLVS</td>
</tr>
<tr>
<td>Sojadelice au Bifidus</td>
<td>Soy-yogurt</td>
<td>La Vie Saine</td>
<td>SojadéliceBifidusLVS</td>
</tr>
<tr>
<td>Sojade</td>
<td>Soy-yogurt</td>
<td>La Vie Saine</td>
<td>SojadeLVS</td>
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<td>Soja Douceur</td>
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<tr>
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<tr>
<td>Spécialité au Soja</td>
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<td>SojaChampion</td>
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<tr>
<td>Soja Nature</td>
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<td>Leader Price</td>
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<td>Velouté</td>
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<td>Perle de Lait</td>
<td>Milk-yogurt</td>
<td>Yoplait</td>
<td>PerleLaitYoplait</td>
</tr>
</tbody>
</table>

Panels
The Vietnamese panel was composed of nine subjects (6 women and 3 men between the ages of 23 to 26 years) and the French panel was composed of eight subjects (5 women and 3 men between the ages of 23 to 24 years). All panelists were recruited amongst the students of the University of Bourgogne, France. They attended two one-hour sessions each week for 10 weeks.
Procedure

Generation of attributes

A generation of attributes was conducted in each panel using the repertory grid method. Panelists were presented with three triads, the first triad consisted of two soy-yogurts and one milk-yogurt, the second triad consisted of three soy-yogurts and the last triad consisted of three milk-yogurts. For each triad, panelists were asked to find out the product that they considered different and to describe how this product was different from the two others. Then, they were asked to indicate how the two other products were similar. Attributes generated in each panel were compiled to form a preliminary list. In the next step, panelists were presented with two new products, one soy-yogurt and one milk-yogurt they had not been exposed to before, and were asked to describe them using the preliminary list of attributes. Panelists were free to add attributes to the list if necessary. During the next sessions, panelists were asked to rate every attributes on a 6-point intensity scale for 12 products. A reduction of the list of attributes was then performed following the ISO 11035:1994 norm.

Panel training

During training, panelists were presented at least once with each product of the final set plus some others. They agreed upon definitions, references and procedures for each attribute and were trained to rate the intensity of these attributes on 10 cm unstructured scales. At this step, flavor references were available at any time, as reminder for panelists.

Final profiling

The final profiling consisted of five one-hour sessions and was carried out on three consecutive days. Twelve products were evaluated in duplicate. In each replication, samples were presented in three blocks with random orders across subjects in each block.

Data analysis

Data of each panel were first analyzed separately using analysis of variance (ANOVA). Three-way ANOVAs were carried out for each attribute in each panel with the following model: \[ \text{Score} = \text{assessor} + \text{product} + \text{assessor} \times \text{product} + \text{session} + \text{product} \times \text{session} \]. When a significant \( \text{product} \times \text{assessor} \) interaction was found a principal component analysis (PCA) was performed to evaluate the consensus between panelists. The two panels were then compared using multiple factor analysis (MFA) (Abdi & Valentin, 2007; Escofier & Pagès, 1998). MFA is a generalization of PCA used when a set of observations (products) is described by several groups of variables (panels). In this procedure, a PCA is performed on the data of each panel then the normalized data of the two panels are merged to form a unique matrix and a global PCA is performed on this matrix. The individual panels are then projected onto the global analysis. The interest of this method is to uncover common sensory dimensions among the two panels. Similarities between the two sensory spaces were further assessed by the computation of an RV coefficient (Escoufier, 1973).
Session management and data collecting were conducted using FIZZ System. Data were statistically analyzed using SPAD version 5.5 and STATISTICA version 6.0.

RESULTS

Comparison of the attributes generated by the two panels

To describe the product set, French panelists used 19 attributes including five of texture, four of taste and 10 of aroma, while Vietnamese panelists used 13 attributes including five of texture, three of taste and five of aroma (Table 2). Some of the attributes used by the two panels are similar. For example the French “épais” and Vietnamese “dắc sệt” terms for “thick”; the French “gras” and Vietnamese “béo” terms for “fatty”; the French “fondu” and Vietnamese “tan” terms for “melting”; the French “farineux” and Vietnamese “mịn” terms for granularity; the French “sucré” and Vietnamese “ngọt” terms for “sweet”; the French “acide” and Vietnamese “chua” terms for “sour”; the French “lait” and Vietnamese “sũa” terms for “cow’s milk”.

Beside the similarities between the two panels some nuances can be brought. First, French panelists used more attributes than Vietnamese panelists (19 vs. 13). Second, a large difference was observed in aroma description: there was only one common attribute (“cow’s milk”) and French panelists used twice as much attributes than Vietnamese panelists (10 vs. 5). While the aroma attributes used by Vietnamese panelists are related to soy-based products (“raw soybean”, “soy milk” and “tofu”) the aroma attributes of French panelists were more diverse and even included references to non food products (“woody”, “earthy” and “chalky”). In contrast, among the five attributes of texture, four were the same (“granular”-“fine”, “sticky”, “fatty” and “melting”) and among the three taste attributes, two were the same (“sweet” and “sour”).

Comparison of the performance of the two panels

The product effect was significant for all the attributes at the 5% level for the French panel and 1% level for the Vietnamese panel. So, both groups of panelists were able to discriminate between the 12 products. The session effect was significant at the 5% level for only one descriptor (“salt”) of the French panel and for three descriptors (“thick”, “melting” and “umami”) of the Vietnamese panel. This indicates that there was no systematic difference from one session to another for both panels. A significant interaction assessor x product was found for 14 attributes with the French and nine attributes with the Vietnamese panel. However, PCA performed on each descriptor with assessors as variables, showed a good consensus between assessors in both panels.

Comparison of the characterization of the yogurts by the two panels

As the first two principal components of the MFA analysis explained 81% of the total variance, we limited our analysis to these components (Figures 1 and 2). In this subspace, the first two factors of separate PCAs (dotted lines on Figure 2) are well represented indicating a great similarity between the two panels. For both panels, the first principal
component clearly opposes the milk-yogurts to the soy-yogurts, whereas the second principal component opposes mainly retail brands to organic soy-yogurts. These similarities between the two panels are confirmed by the high value of the RV coefficient: 0.87. Despite the general similarity of product spaces between the two panels, some differences can be noted on the second principal component. French panelists tended to characterize milk-yogurt as rather creamy and fatty (especially VeloutéDanone and PerleLaitYoplait), whereas Vietnamese panelists characterized them as rather sour and melting (especially NaturelLeaderPrice and ActiviaDanone). Likewise some soy-yogurts tend to be perceived somewhat differently by the two panels. In particular, we can note that SojadéliceBlancLVS, Sojasun and SojadéliceBifidusLVS are more extreme on the second principal component for the Vietnamese panelists than for the French panelists. They tend to be characterized as stickier, thicker and sweeter by the Vietnamese panelists than by the French panelists who tend to perceive them as nutty and floury.

Finally we can note on Figure 2 that whereas most Vietnamese and French texture and taste attributes are very close (eg. “fatty”, “sweet”, “thick”) this is not the case for aroma terms with the exception of “cow’s milk”. The French terms “chalky”, “mushroom”, “earthy”, “water” and “woody” do not seem to coincide with the Vietnamese terms “raw soybean”, “soy milk” and “tofu”.

| Table 2. Descriptors in their original languages and translated into English |
|---------------------------------|-----------------|-----------------|-----------------|
| **Texture** | **French** | **English** | **Vietnamese** | **English** |
| Astringent | Astringent | Dính miếng | Sticky |
| Farineux | Granular | Mịn | Fine |
| Epais | Thick | Đặc set | Thick |
| Gras | Fatty | Béo | Fatty |
| Fondant | Melting | Tan | Melting |
| **Taste** | | | |
| Sucré | Sweet | Ngọt | Sweet |
| Acide | Sour | Chua | Sour |
| Salé | Salty | Ngọt lợ mỹ chính | Umami |
| Amer | Bitter | | |
| **Aroma** | | | |
| Lait de vache | Cow’s milk | Sữa | Cow’s milk |
| Farine | Floury/Starchy | Dầu nành sồng | Raw soybean |
| Bois | Woody | Sữa đậu nành | Soy milk |
| Craie | Chalky | Dầu phù | Tofu |
| Pâte à tarte | Pastry | Bột sắn | Kudzu starch |
| Eau | Water | | |
| Crème | Creamy | | |
| Noisette | Nutty | | |
| Terreux | Earthy | | |
| Champignon | Mushroom | | |
Figure 1. MFA plot - Product map including mean products (●) of French (■) and Vietnamese (▲) panel.

Figure 2. MFA plot - Circle of correlation French (Fr) and Vietnamese (Vn) panel
DISCUSSION

The aim of this study was to evaluate the role of culture and familiarity on the perception and description of soy-yogurts. The present work makes it possible to suggest some specificities of each culture. Considering the similarity of the two product spaces, the overall perception of soy-yogurts characteristics is not influenced by culture although some nuances were noted on the second principal component. With regards to the verbal characterization of the soy-yogurts, familiarity leads to some differences in the description of these similar characteristics: Vietnamese panelists - soy consumers - used less aroma attributes to describe the soy-yogurts than French panelists - non soy consumers. Vietnamese panelists seemed to have precise common references related to soy products (raw soybean, soy milk and tofu). In contrast, French panelists seem to have difficulties pining down the specific notes associated to soy, and thus had to use a large number of attributes to somehow characterize those notes. Moreover, as French panelists did not have relevant references in the food domain, they had to borrow from other domains to express their sensations (woody, earthy, chalky). However, these terms borrowed from other domains do not seem to express the same perception as raw soybean, soy milk and tofu, as they do not coincide on Figure 2. Another cultural specificity observed in the description of milk-yogurts was the utilization of the attribute “creamy” by French panelists - dairy product consumers. While French panelists have a precise reference (cream) to describe the aroma of the dairy products, Vietnamese panelists did not, the equivalent term does not even exist in Vietnamese. Thus, creamy aroma may be encompassed by the “cow’s milk” attribute for Vietnamese panel.

In contrast with the large difference observed between French and Vietnamese panelists for aroma attributes, almost no difference was observed for texture and taste attributes. In agreement with this result, Blancher, Le, Sieffermann & Chollet (2007) report in a recent study on fruit jellies a high similarity between two sensory profiles of visual appearance, texture by hand and texture by mouth established in France and Vietnam. In this study they also report that it was possible to translate and transfer texture attributes between the two countries with a good accuracy. This relative concordance between French and Vietnamese texture attributes might be related to the availability in both French and Vietnamese language, of abstract terms that refer directly to texture sensations (thick, smooth, melty…, for instance), whereas aromas are described by the name of an odorant (creamy: smell like cream, tofu: smell like tofu, and so on.). This higher level of abstraction for terms related to texture and tastes, may explain that their description is less impacted by culture than aroma which refer to objects present in our environment and we are familiar with. However, the polyglot list of texture published by Drake (1989) moderates this statement. It clearly indicates differences between tongues, especially for integrative terms such as crispness, for example. Thus, whereas similarities across cultures are evidenced for basic aspects of texture, some differences might be observed at a finer level.

Likewise the small number of basic taste attributes used to describe food taste might explain the similarity we observed between the French and the Vietnamese panels. The
only exceptions were the use of the attribute “umami” by Vietnamese panelists but not by French panelists and the use of the attribute bitter by French panelists but not by Vietnamese panelists. Previous work by O’Mahony & Ishii (1986) showed that American and Japanese people differed in describing the sensation of monosodium glutamate (MSG). Japanese people, consensually described MSG with the attribute “umami” but American people had difficulties to describe precisely and consensually the sensation elicited by MSG. In our study, French panelists did not use attributes that seemed to be associated with MSG, so it is possible that MSG-like tastants were present in soy-yogurt and were not perceived by French panelists. Alternatively MSG-like tastants might not have been present in soy-yogurt, but umami might be associated to the idea of soy-food for Vietnamese panelists through perceptive interactions.

CONCLUSION

Our objective was to assess the influence of culture and familiarity on the perception and description of soy-yogurts and milk-yogurts in France and Vietnam. Whereas, only a small cultural influence was observed on the perception of yogurts, a large difference appeared in the verbal description of aromas of the yogurts, particularly of those belonging to soy-yogurts. This is in line with previous studies on soymilks and tofu that also found cross-cultural differences on the intensity of specific aromas associated with “beany flavor” of soy-products (Torres-Penaranda & Reitmeier, 2001; Torres-Penaranda, Reitmeier, Wilson, Fehr & Narvel et al., 1998). Further works would be needed to understand these differences in perception as well as potential cultural difference in preference.

REFERENCES


HOW TO DESCRIBE THE HANDLE OF FABRICS?
A FOCUS ON GRAINY, HARSH, ROUGH AND RASPY PERCEPTION

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Fax: 0033 3 80 39 66 11

Abstract
Sensory techniques originally developed for food products, are nowadays applied to other fields such as cosmetics, car industry or fabrics. The French Institute of Textile and Clothing (Institut Français du Textile et de l’Habillement) works on the sensory characterisation of the handle of textiles i.e., the perceptive experience related to touch and handling of fabrics. A study run in 2003 (Soufflet, Calonier and Dacremont) underlined that the attributes harsh, rough, raspy and grainy were close to each others and opposite to soft. Do those four words refer to the same sensory concept? Classification studies run on fabric samples with non-trained assessors showed that grainy was a perception in its integrity. Harsh and rough/ raspy samples were differentiated as well. Moreover, the studies underlined that the discrimination between the samples is finer when the untrained assessors handled the fabric with their full hands (three-dimensional handling) rather than in a surface context, only with the five fingers of one hand (two-dimensional touch). When the samples were assessed with the surface context, harsh, rough and raspy seemed to constitute a sensory continuum. To check this hypothesis, untrained assessors assessed fabric samples on a non-structured linear scale labelled from ‘not soft at all’ to ‘very soft’ (randomised and monadic evaluation). After the evaluation, they were asked to put on the scale the labels harsh, rough and raspy. Raspy was the farest from soft, then harsh and finally rough but there is no significant difference between the last two. These results were compared with those obtained with a trained jury. The conclusion is that grainy, which is easily differentiated by the untrained assessors, is not used by the trained jury but they used relief instead. Harsh and rough are not exactly used in the same way by untrained and trained assessors and the difference of use is even more important for rough.

Keywords: sensory evaluation, fabrics, rough, harsh, raspy, novices

INTRODUCTION
Haptic perceptions, including both cutaneous and kinesthetic perceptions, guide consumers’ choice for clothes as well as textile manufacturers (weavers, finishers, fabricators, etc.) for technical decisions. The perceptive experience resulting from the manipulation of fabrics is called the “handle”. Its accurate description is essential for efficient communication of sensory specifications among manufacturers and also between manufacturers and consumers.

The pioneer approach to describe the handle of fabrics was based on instrumental measurements. The KES-F (Kawabata Evaluation System for Fabrics) was developed in Japan to measure various mechanical (comprressional, tensile, shearing and bending) and surface properties of fabrics using small deformations (Kawabata, 1980). These physical
parameters are combined to predict “primary hands” i.e., main attributes of the fabrics handle as defined by a panel of Japanese industrial experts. Although useful information is obtained, this approach shows some limitations. Recently, sensory approaches, stemming from methods widely used in the food-processing industry, were adopted to describe haptic properties of textile products. More particularly, the sensory profile has been adapted to the textile field (Civille & Dus, 1990; Robinson et al. 1997; MacKay et al., 1999; Giboreau et al., 2001; Griffiths & Kulke, 2002. Cardello et al., 2003; Philippe et al., 2003, 2004; Pense-Lheritier et al., 2006; Yenket et al., 2007).

In descriptive analysis, a lot of efforts during training are devoted to reach an agreement among panelists on the meaning of each attribute. This concept alignment (O’Mahony et al., 1990) leads sometimes panelists to elaborate a very specific meaning for the attribute. An example is given by Roudaut et al. (2002) who reported several definitions for “crispness” used by different panels. Obviously the same term “crispness” referred to different perceptions according to panels. From that, results the issue of communicative value of attributes. To be efficient, profiles must be communicable, outside the panel, and understood by professionals who make technical decisions based on such results. The importance of the communicative value was stressed as one of the requirements for attributes selection by Civille & Lawless (1986). Practically how attributes would be understood outside the panel, if the panel changed the meaning from the everyday language meaning to a specific and somehow different meaning? One way to solve this problem is to provide attributes’ definitions elaborated by the panel (Giboreau et al., 2007). A complementary approach is to choose highly consensual terms, spontaneously used by both novices and experts. Soufflet et al. (2004) found some “core attributes” for description of fabrics handfeel. Those terms are related to the most salient dimensions of the tactile perceptive space (Holins et al., 1993; Picard et al. 2003). The most salient dimension is probably the “soft” dimension. *Doux* (Soft) is the most often and spontaneously mentioned term when French people are prompted to describe touch perception (Picard et al., 2003; Giboreau et al., 2005). By contrast several terms are mentioned to refer to non-soft touch: *Granuleux* (Grainy), *Rêche* (Harsh), *Rugueux* (Rough), *Râpeux* (Raspy). The objective of the present work is to investigate the meaning and use of these four descriptive terms. The studies were carried out in France with French native speakers and the results are therefore related to French words. However, for readers’ convenience, English words are used in this text.

This work is organised in four experiments. In the first experiment, we checked whether the terms “Grainy”, “Harsh”, “Rough”, and “Raspy” referred to different perceptions. Experiments 2 and 3 focused on the relationship between those terms and their potential organisation along a perceptive continuum. Finally, we compared two methods of evaluation (surface or handling) and its impact on the use of the four terms.
EXPERIMENT 1: DO GRAINY, HARSH, ROUGH AND RASPY REFER TO THE SAME PERCEPTION?

The objective of the experiment was to determine whether the terms “Grainy”, “Harsh”, “Rough”, and “Raspy” referred to distinctive characteristics when spontaneously used by novices to describe the touch of fabrics.

Materials and methods

Subjects: 40 subjects (20 men and 20 women) were recruited on the Campus of The Université de Bourgogne. All of them were volunteers and novices (without any particular knowledge in either sensory science or textile field).

Samples: 29 samples of fabrics used for clothing were chosen to represent a wide range of both textile materials and technologies (weaving, knitting, non-woven processes, etc.). 24 samples were previously characterized as being grainy, harsh, rough or raspy and five as being soft (Soufflet et al., 2004). Two of these samples were duplicated in order to check the consistency of the results. Therefore subjects assessed 31 samples. Each sample measured approximately 21x30 cm.

Procedure: Subjects took part individually in the experiment in a single session. The experiment took place in a quiet and dimly lit room. Fabrics were coded with a three-digit number and put in a box to remove the influence of color on haptic judgment. Each subject assessed the samples randomly in a monadic way. The samples were evaluated in a two-dimensional context, called ‘surface’ context: the subjects were asked to put their hand palm on the fabric doing backward and forward motion with their fingers. Subjects had to evaluate each fabric and then to choose the most appropriate term among the following propositions: “Grainy”, “Harsh”, “Raspy”, “Rough” and “None”, according to what they perceived. Only one answer was allowed.

Results

Data obtained from the forced choice description task were summarized in a contingency matrix where the number of occurrence of the proposed terms was reported for each sample. Then, a correspondence analysis (CA) was performed.

When all data were included in the analysis, the CA space was essentially structured by the proposition “None” faced to the other descriptive terms. In order to eliminate this effect and to better interpret the differences between Harsh, Grainy, Rough and Raspy, fabrics mainly described as “None” were removed from the final analysis. This final analysis (Figure 1) was consequently performed with only 19 fabrics.

Grainy seems to be a distinctive perception, as this term was used by a majority of subjects to describe four samples (031, 856, 952, 901) and much less often for the other samples. The distinction between Harsh, Rough and Raspy seems less clear because for a large number of samples, two terms (Raspy/Rough or Rough/Harsh) were almost used an equivalent number of times.
Figure 1. Do Grainy, Harsh, Rough and Raspy refer to the same perception? CA "surface" context, 19 samples assessed

The U-shaped repartition of fabrics on the CA space (dimensions 1 and 2) could indicate that this space might account for only one dimension, with Harsh, Rough, and Raspy, and even Grainy, referring to different levels of a same perceptual continuum. This means that Harsh, Rough, and Raspy would be fuzzy and overlapping categories. Thus, subjects considered that both terms were appropriate to describe tactile properties of some products.

EXPERIMENT 2: FOCUS ON HARSH, ROUGH AND RASPY

The objective of the second experiment was to further investigate how Harsh, Rough and Raspy were used when subjects where free to use more than one adjective to describe each products. As ‘Grainy’ was used in a distinctive way in experiment 1, it was not considered in this experiment.

Materials and methods

Subjects: 45 subjects (35 men and 10 women) participated and were recruited according to the same specifications detailed in the first experiment.

Samples: the same samples of fabrics as the ones used in the first experiment were evaluated.

Procedure: the conditions of the experiment were the same as those described in the first experiment except that subjects had to evaluate each of the terms “Harsh”, “Raspy” and “Rough” according to “not adapted at all”, “relatively adapted” or “quite adapted”, for every fabrics. The fabric/term couples to be assessed were randomly presented.
Results

Assessments were transformed into scores as following: 1 for “not adapted at all”, 2 for “relatively adapted” and 3 for “quite adapted”. A Principal Component Analysis (PCA) was performed on mean scores. (Figure 2).

The first dimension (73.13 %) opposed the samples perceived as being very Harsh, Rough, and Raspy to the ones perceived as being less Harsh, Rough, Raspy.

The Pearson correlation coefficients between the three attributes (Tab. 1) showed a significant correlation between Rough and Raspy whereas Harsh was not significantly correlated with the two others. Thus, this experiment confirmed that Harsh was used somehow in a different way than the two others, Rough and Raspy being used overall in a similar way.
Table 1. Focus on Harsh, Rough and Raspy. Pearson correlation coefficient, "surface" context, 23 samples assessed, * significant at 5%.

<table>
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<tr>
<td>Rough</td>
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<tr>
<td>Raspy</td>
<td>0.60</td>
<td>0.79*</td>
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EXPERIMENT 3: ARE HARSH, ROUGH AND RASPY PART OF THE SAME SENSORY CONTINUUM?

If Harsh, Rough and Raspy referred to several levels of a same continuum, as suggested by experiment 1, how would they be sorted? The objective of the third experiment was to study how these three terms would be ranked on a “Soft” scale.

Materials and methods

Subjects: 45 subjects participated and were recruited according to the same specifications detailed in the first experiment.

Samples: A subset of 14 samples, perceived as being Harsh, Rough or Raspy in the previous studies, were selected.

Procedure: As in the previous study, subjects took part individually in the experiment in a single session. Fabrics were coded with a three-digit number and fixed on a rigid paper in an opaque envelope to remove the influence of color on haptic judgment. Before starting the evaluation, subjects were asked to handle all the samples to get familiar with them. Then, they had to evaluate the softness of each fabric on a 10cm non-structured linear scale, anchored from “not soft at all” to “very soft”, in a monadic way. The objective was to promote a proper context of use of the scale for the last part of the experiment. Subjects were finally asked to put the labels “Harsh”, “Raspy” and “Rough” on the “Soft” scale.

Results

The data obtained for the three labels were transformed into scores from 0 (not soft at all) to 10 (very soft). An analysis of variance (Score = Subjects + Attributes + Errors) showed a significant “attributes” effect.

![Figure 3. Are Harsh, Rough and Raspy part of the same sensory continuum? Comparison of the means.](image)
As expected, the scores were low (Fig. 3). However, “Raspy” and “Rough” were significantly different. “Hash” was not significantly different from the two others. Thus, when subjects are forced to put the terms on a soft scale, differences in intensity are observed: “Rough” seems to be the softest and “Raspy” the less soft, “Harsh” is in between.

EXPERIMENT 4: HARSH, ROUGH AND RASPY: COMPARISON SURFACE / HANDLING

In the first three experiments, subjects were instructed to touch the surface of the fabrics laid out on a rigid surface. However, in everyday life, we would rather evaluate fabrics’ tactile properties by handling, i.e. with three-dimensional solicitations. The objective of this last experiment was to evaluate if the context of evaluation (surface vs. handling) has got an impact on touch description.

Materials and methods

Subjects: 45 subjects (35 men and 10 women) participated and were recruited according to the same specifications detailed in the first experiment.

Samples: the same samples of fabrics as the ones used in the first experiment were evaluated.

Procedure: the conditions of the experiment were the same as those described in experiment 2. However the samples were evaluated in a three-dimensional context, called ‘handling’ context: the subjects were free to handle the fabrics with their two hands.

Results

The data were analysed in the same way as they were for the second experiment. The results are presented in Figure 4. Figure 4 shows that the first dimension (62.1%) opposed the samples Raspy and Rough to the ones perceived as being no Raspy and no Rough. Dimension 2 (33%) opposes the samples perceived as being Harsh to the ones perceived as no Harsh. Pearson correlation coefficients obtained are summarised in table 2:

<table>
<thead>
<tr>
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<th>Raspy</th>
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<td>Raspy</td>
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</table>

Table 2. Harsh, Rough and Raspy. Comparison Surface/Handling. Pearson correlation coefficient, “handling” context, 19 samples assessed, * significant at 5%.


The pattern of correlation was similar to the one obtained in experiment 1: Rough and Raspy were significantly correlated. But Harsh was more differentiated from Rough/Raspy when handled. This might mean that “Harsh” perception includes a kinaesthetic component.

GENERAL DISCUSSION

Overall the results indicates that the four terms Granuleux (Grainy), Rêche (Harsh), Rugueux (Rough), Râpeux (Raspy) refer to different tactile perceptions (for French native speakers) and are not used in an interchangeable way to describe handfeel of fabrics. Subjects used “Grainy” in a distinctive way: a very large majority of subjects described some fabrics as Grainy, when it was used only marginally for most of the other samples (Experiment 1). The distinction is less clear for the three other terms. In the surface context (two-dimensional exploration), these terms seem to refer to overlapping fuzzy-bounded categories arranged on a same perceptive continuum: from Raspy (closer to Grainy) to Harsh, with Rough in between. When subjects are instructed to rank the three labels on a “Soft” scale (Experiment 3), the picture is slightly different: Raspy is still the most distant
from the Soft end of the scale, but the position of Rough and Harsh are reversed. An explanation might be that Rough and Harsh are equivalent, as the difference in mean scores is not significant at the 5% level in Experiment 3. A second explanation might be related to the context of evaluation. In Experiment 3, the Soft context is explicitly mentioned, whereas any reference to Soft is made in Experiment 1. Words in everyday language are polysemy i.e., their meaning is context-dependant. For instance, in the three following sentences the meaning of “sweet” is quite different: “This fountain delivers sweet water”, “She prefers salty to sweet food”, and “James is a sweet boy”. We may face a shift of meaning of Rough and Harsh when used in the specific context of “Soft” scale in experiment 3. The impact of context may also explain the discrepancy observed between Experiments 1 and 2. In experiment 2, Rough and Raspy were used in a much more similar way than in Experiment 1. In Experiment 2 subjects assessed only one attribute at a time when they had to choose among several attributes in Experiment 1. The latter experimental design leads to narrow the meaning of each attribute because asking to choose among alternatives implicitly defines boundaries for each attribute. For instance, when subjects were instructed to pick up one term among Grainy, Harsh, Rough, Raspy, it implicitly define Rough as something that is not Grainy, Harsh or Raspy. However, when they had to assess whether a fabric was Rough, there is no indication of the boundaries of “Rough” and its meaning might be broader and encompass the meaning of Raspy. A similar phenomenon was observed in texture description with the attributes crispy, crackle, crunchy assessed all at once or one at time (Dacremont, 2006).

A third and last explanation is that Harsh might not be completely accurate to describe handfeel in the surface context. Actually, Experiment 4 would suggest that Harsh encompass a stiff component, requiring a three-dimensional exploration to be perceived. This may explain why the assessment of Harshness was less stable when assess in the surface context.

CONCLUSION

In the context of descriptive analysis, the results of the present study may help in the process of attributes selection. First, it seems useful to assess the samples in both 2- and 3-dimentional explorations depending on the attributes (Harsh being assessed by handling, for instance). In surface evaluation, Rough and Raspy seem close and may represent two levels on the same continuum. Thus, only one of them is needed for intensity assessment. Grainy may also belong to this same continuum. It is worth mentioning again, that this was obtained for the French attributes used by French native speakers. Any transfer to another language should be done carefully. From these results, the question of using a uni or a bipolar scale is also underlined. Bipolar scales are usually avoided in sensory profile. However, anchoring the scale at both extremities may help to narrow the meaning of the attribute and thus speed up the reach of consensus. Providing such a scale defines a genuine perceptual continuum.
REFERENCES


EVALUATING STABILITY OF RESTRUCTURED PORK ADDED WITH GINGER EXTRACTS BY MEANS OF CHEMICAL AND SENSORY ANALYSIS

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Abstract
The aim of the study was to examine the possibility to use ginger extract for stabilizing restructured pork. Ginger extracts were prepared by extraction with ethanol. The extracts were added to minced pork at concentration of 0.1%, 0.2%, 0.3% and 0.4% with regard to dry matter. The samples were then subjected to bake at 180°C and store at 4°C. During the storage, samples were taken for measurement of the malonaldehyde content and sensory evaluation of appearance, flavour and taste using 1-10 intensity scale. The results have shown ginger extracts retard the autooxidation of lipid and have a positive effect on the sensory quality of baked pork during the storage. In general, these effects increase with the concentration of the extract.

Keywords: ginger, spice, antioxidant, sensory analysis, pork, lipid oxidation.

INTRODUCTION
Lipids play an important role in technological, nutritional and sensory function of food. However they are liable to undergo autooxidation that leads to the formation of a number of undesirable compounds. In an effort to retard this process, various antioxidants are employed. The application of synthetic antioxidants has recently been restricted because there is suspicion that they are carcinogenic. For this reason a growing interest has been paid to the research of natural antioxidants, among which spices occupy an important position (Pokorny et al., 2001).

Ginger is a popular spice, grown everywhere in Vietnam. Thank to its pleasant taste and flavour, it has become an important ingredient not only in vietnamese cooking but also worldwide. Many papers have reported ginger antioxidant activity against the oxidation of lipid in various model systems such as lard, vegetable oils, oil /water emulsion etc (Takacsova, Nguyen, Kristianova, 2001; Yamazaki et al.,2007; Madsen & Bertelsen, 1995). This antioxidant effect was shown to be linked to the presence of gingerol related compounds and diaryl heptanoid (Kikuzaki & Nakatani, 1993).

Our work has been focusing on the antioxidative capacity of ginger grown in Vietnam. Results of our previous work had shown its antioxidant effect in lard (Dang, Takacsova, Nguyen, & Kristianova 2000). Thus, the aim of our current study was to examine the possibility to use ginger extract for stabilizing baked restructured pork.
MATERIALS AND METHODS

Chemicals
Tetrametoxypropane for synthesis, 30% acetic acid reag. Ph.Aur, 37% HCl for synthesis and Acetonitril HPLC grade from MERCK (Germany).

Preparation of ginger extract
Ginger was collected from Da Nang, Viet Nam. It was sliced and sun dried. The spice was then ground to fine powder by a vibration mill before using for experiments.

A slurry of 10% (w/w) ginger powder in ethanol (96%) was prepared. The slurry was then stored in dark for three days for occasional stirring. A supernatant after centrifugation of the slurry was used as ginger extract for application to pork samples.

Preparation of restructured pork for experiment
Fresh pork was trimmed to remove connective tissues, skin and visible fat. Pork meat contained 32.15% dry mass and 10.78% fat as determined by the Soxhlet extraction method. It was then minced and mixed thoroughly with NaCl (1.2%), water (20% regard to pork weight). The emulsion was divided into five lots: one without addition of ginger and the other four with ginger extract at concentration 0.1%, 0.2%, 0.3% and 0.4% (with regard to dry mass). Homogenized pork was packed in aluminum sheet and evenly spread to a thickness of 1.5 cm. Samples were baked at 180 °C for 40 min in an electric cooker. After cooking, restructured pork was ground to small lumps, homogenized and wrapped in PE bags to store in the refrigerator at 5 °C.

During storage, samples were taken for analysis of the malonaldehyde content and sensory analysis.

Analysis of malonaldehyde
Malonaldehyde is formed from the decomposition of lipid peroxide in pork. Its content indicates the extension of lipid oxidation in pork. Malonaldehyde was retrieved from meat samples by hydrodistilation. Twenty µl of distillate was injected to HPLC system. For evaluating the malonaldehyde content, the HPLC method according to Kakuda et al. (1981) was employed. The HPLC system was composed of HPP 5001 pump, UV detector (Laboratory Equipments Praha) and the column Nucleosil C-18, 250×4,6 mm (Phenomenex). The mobile phase was composed of acetonitril: 1% acetic acid (85:15). Conditions of HPLC analysis were as follows: flow rate: 2 ml/min; the wave length used in UV detection: 254 nm; injection volume: 20 µl. Analysis was carried out at room temperature and retention time was 1.4 min.

Determination of standard curve
Ten µl of tetrametoxypropane was diluted with 10 ml 0.1 M HCl in bruised tube. The solution was heated in a boiling water bath for 5 min. After that it was cooled quickly in
tap water. The basic solution was prepared with 1 ml hydrolyzed acetal diluted in water to fill 100 ml volumetric flask. This basic solution had the concentration of 6.07 \times 10^{-5} \text{ M} or 0.437 \mu \text{g/ml malonaldehyde}. From this solution, a series of standard solutions was made by dilution with water in ratio 1/10, 2/10, 3/10, 4/10, 5/10, 6/10.

The equation for standard curve for malonaldehyde gave the result of \( n = 0.234 + 0.00122 \times H \) (with a squared correlation coefficient \( R^2 = 0.993 \)), where \( n \) (10^{-11} \text{ mol}) is the content of malonaldehyde and \( H \) is the peak height. The content of malonaldehyde in samples was calculated as \( m \) (mg malonaldehyde/kg)=1.8 \( k \) \( n \), where \( k \) is the distillation yield (k=0.732).

**Sensory analysis**

Sensory analysis were carried out using five panellists from the faculty staff. The pork samples were heated for three min in microwave oven and immediately presented to the panellists. The analyses were conducted in isolated booths. In order to reach an accurate result, panellists were provided with distilled water to clean their palates after every tasting. The taste, flavour and appearance were determined using a 10-point scale (1 = like a lot, 10 = dislike a lot).

**Statistical analysis**

Statistical assessment was carried out with the software system Statgraphics Plus for Windows 4.0. The results of malonaldehyde content and sensory analysis were analyzed using two samples comparison t-test with significant level \( \alpha = 0.05 \).

**RESULTS AND DISCUSSION**

**The effect of ginger extracts on formation of malonaldehyde**

Due to oxidation of lipid in pork during the storage, peroxides were formed in the first stage of the auto-oxidation process. In the second stage, peroxides were decomposed and led to formation of various undesirable volatile compounds, among which malonaldehyde is an important indicator for extension of lipid oxidation.

The content of malonaldehyde was determined by mean of HPLC as mentioned above. Every two days from the beginning to the 8\textsuperscript{th} day of storage, samples of baked restructured pork were taken to measure. Analysis was done in triplicate and mean values were calculated. The result is shown in table 1 as mean ± standard deviation.

Results from table 1 show that ginger extracts inhibited the oxidation immediately after cooking (initial day). Due to the effect of temperature and oxygen during cooking, oxidation of lipid took place, leading to formation of peroxides and their decomposed products. It is known that meat contains hemoglobin that could catalyze lipid oxidation. Thus, in this case the pork samples could oxidize quickly and extensively. HPLC analysis showed the presence of malonaldehyde right after cooking. However, the value of malonaldehyde content in all samples added with ginger extracts at the beginning day were
significantly lower than those of control sample (p<0.05). Malonaldehyde is one of the volatile compounds formed during lipid oxidation, which are responsible for off-flavor of fat rich food. Therefore, it is possible to suppose ginger extracts have significant effect on inhibition of off-flavor formation in pork samples.

Results from Table 1 also show that the effect of storage time on malonaldehyde formation differed among samples without and with different ginger addition. While the malonaldehyde amount in control sample increased continuously (p<0.05), from the 2nd day of storage, samples added with ginger extracts did not show significant increase or decrease in malonaldehyde concentration. The level of malonaldehyde content in these samples always remained lower than in control samples. At the last day of analysis, the content of malonaldehyde in control samples was higher, approximately 2, 3, 5, 8 times than samples with 0.1%, 0.2%, 0.3%, 0.4% ginger extract.

<table>
<thead>
<tr>
<th>Samples</th>
<th>0 day</th>
<th>2 days</th>
<th>4 days</th>
<th>6 days</th>
<th>8 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.47±0.10</td>
<td>3.90±0.10</td>
<td>5.64±0.25</td>
<td>6.77±0.31</td>
<td>7.81±0.28</td>
</tr>
<tr>
<td>0.1% ginger</td>
<td>0.85±0.01</td>
<td>2.89±0.05</td>
<td>4.06±0.34</td>
<td>4.44±0.02</td>
<td>4.15±0.15</td>
</tr>
<tr>
<td>0.2% ginger</td>
<td>1.01±0.03</td>
<td>2.69±0.07</td>
<td>3.06±0.00</td>
<td>2.63±0.03</td>
<td>2.76±0.03</td>
</tr>
<tr>
<td>0.3% ginger</td>
<td>0.95±0.02</td>
<td>1.75±0.03</td>
<td>1.53±0.27</td>
<td>1.49±0.03</td>
<td>1.58±0.03</td>
</tr>
<tr>
<td>0.4% ginger</td>
<td>0.45±0.00</td>
<td>0.97±0.07</td>
<td>1.39±0.07</td>
<td>1.43±0.17</td>
<td>0.99±0.02</td>
</tr>
</tbody>
</table>

Therefore, it is possible to conclude that in general, the higher concentration of applied ginger extract, the less malonaldehyde was formed. The oxidative stability effect of ginger presumably was related to their gingerol related compounds. The higher concentration of these compounds could better inhibit lipid oxidation.

**Sensory analysis**

Sensory value is very important to any food, because it is the ultimate measurement consumers take to accept or reject a product. A spice extract could exhibit an excellent antioxidative capacity, but if it fails sensory test, it will not be accepted.

In order to check how the addition of ginger extract impacts the sensory value of baked minced pork, the appearance, flavor and taste of minced pork samples were evaluated using a 10-point intensity scale. Table 2 summarizes the result of evaluation as mean ± standard deviation of the five panelists' scores.

At the first day of storage, there was no significant difference in appearance and taste among all samples. However, it would be surprising that the control sample had the highest score of flavour. Paired t–test showed significant difference in flavor between control sample and sample with 0.1%, 0.2% ginger extracts, but there was no statistical difference among other samples. It is supposed that after cooking the off-flavor still didn't occure and control sample had an excellent odor, which was familiar to every panelist. Meanwhile, samples with addition of extract contained amount of ethanol which did not vanish completely after baking, so it could have been perceived as an unfamiliar odor to assessors.
who gave lower scores. If the concentration of ginger was high enough, ginger odor could hide the ethanol one. That could make the flavor of sample more pleasant.

After five days of storage, scores for all attributes were high, indicating that the sensory quality of all products was still very good. It is interesting to observe significant increase in flavor (p<0.05) of samples with 0.1% and 0.2% of ginger extract (about 42% and 24% respectively). This could be explained by the evaporation of ethanol during the storage.

The sensory quality of products, especially of the control sample, reduced remarkably after storing nine days. The control sample became unacceptable to panelists. All scores of appearance, taste and flavor were lower than 6. Comparing scores of 6th day to the 9th day, significant reductions of these values in control sample were observed (p<0.05).

Comparison t-tests failed to show significant difference in appearance between the control sample and samples with ginger extract (α=0.05). However, all samples with ginger extract had significant higher values of taste and flavor in comparison with control samples. This suggests that ginger extracted at concentration 0.1%, 0.2%, 0.3% and 0.4% had a stabilizing effect on sensory value of baked minced pork, stored at 5°C. In general, this effect increases with the concentration of spice.

Our results agree with those reported by El-Alim et al. (1999) and Takacsova et al (2000). In their research, El Alim et al. also studied the influence of ginger extract and other spices on the oxidation stability of fresh minced poultry stored in freezing conditions. Measurement of peroxide and TBARS values confirmed the antioxidative effect of ginger extract. A similar result was reported by Takacsova et al. in their study on the antioxidant activity of ginger extract in ground pork patties.

CONCLUSIONS

According to the present results, it is possible to confirm that ginger extracts at concentration from 0.1% to 0.4% has positive effect on oxidative and sensory quality of baked restructured pork. The spice extracts significantly reduce formation of malonaldehyde that is secondary product of lipid oxidation, causing off-flavors to meat products. Besides, the presence of these extracts also helps to stabilize taste and flavor of

Table 2. Effect of ginger extract concentration on results of sensory evaluation of baked pork samples.

<table>
<thead>
<tr>
<th>Storage</th>
<th>Descriptors</th>
<th>Control</th>
<th>0.1%</th>
<th>0.2%</th>
<th>0.3%</th>
<th>0.4%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 day</td>
<td>Appearance</td>
<td>7.6±1.7</td>
<td>6.6±0.9</td>
<td>7.6±1.7</td>
<td>8.4±1.7</td>
<td>7.6±1.7</td>
</tr>
<tr>
<td></td>
<td>Flavour</td>
<td>9.0±1.0</td>
<td>6.6±1.7</td>
<td>7.6±0.9</td>
<td>8.0±1.4</td>
<td>8.6±1.7</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>9.4±0.9</td>
<td>9.0±1.0</td>
<td>9.0±1.0</td>
<td>9.4±0.9</td>
<td>9.8±0.4</td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td>7.6±1.0</td>
<td>7.8±1.5</td>
<td>7.0±1.7</td>
<td>7.6±0.9</td>
<td>8.0±1.4</td>
</tr>
<tr>
<td>5 days</td>
<td>Flavour</td>
<td>10.0±0.0</td>
<td>9.4±0.9</td>
<td>9.4±0.9</td>
<td>8.6±0.9</td>
<td>9.8±0.4</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>9.0±1.0</td>
<td>9.0±1.0</td>
<td>9.0±1.0</td>
<td>8.0±0.0</td>
<td>9.0±1.0</td>
</tr>
<tr>
<td></td>
<td>Appearance</td>
<td>5.0±1.0</td>
<td>7.0±1.7</td>
<td>6.0±1.4</td>
<td>7.0±1.7</td>
<td>7.0±1.7</td>
</tr>
<tr>
<td>9 days</td>
<td>Flavour</td>
<td>5.8±0.4</td>
<td>6.0±2.0</td>
<td>6.0±1.4</td>
<td>6.6±0.9</td>
<td>7.0±1.7</td>
</tr>
<tr>
<td></td>
<td>Taste</td>
<td>4.6±0.9</td>
<td>6.6±0.9</td>
<td>7.6±0.9</td>
<td>7.0±1.0</td>
<td>8.6±0.9</td>
</tr>
</tbody>
</table>

After five days of storage, scores for all attributes were high, indicating that the sensory quality of all products was still very good. It is interesting to observe significant increase in flavor (p<0.05) of samples with 0.1% and 0.2% of ginger extract (about 42% and 24% respectively). This could be explained by the evaporation of ethanol during the storage.

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products, makes them still acceptable after nine days of storage at 5°C in refrigerator. However, further work should be carried out on the use of other forms of extracts, for example in powder form to eliminate the effect of solvent on sensory value. Our study demonstrates the possibility to use ginger extracts to extend shelf-life of meat without using synthetic antioxidants, which should be a safety concern.

REFERENCES


