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INtegrating SENSORY EVALUATION to PRODUCT DEVELOPMENT

An Asian Perspective

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INTEGRATING SENSORY EVALUATION INTO PRODUCT DEVELOPMENT

AN ASIAN PERSPECTIVE

Edited by

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Preface

SPISE 2012, "**Taste and Think. Integrating sensory evaluation into product development: An Asian perspective,"** the third symposium on sensory evaluation in ASEAN, was held on July 24–26, 2012 at Ho Chi Minh-City University of Technology, Vietnam. We had the great pleasure to welcome more than one hundred scientists from Vietnam, Korea, Singapore, China, Thailand, Japan, Indonesia, the USA, France, New Zealand, the Netherlands, and Denmark. The focus of this meeting was on sensory evaluation and product development.

There is widespread agreement in the food and beverage sectors that competitiveness in food markets relies in developing new, differentiated products that are adapted to the different and specific preferences of consumers or consumer segments. Yet, developing products that are successful is a difficult and time-consuming process. As competition is high and demand ever changing the rate of success might be very low. Knowing both consumers demand and product sensory properties is now essential to success because in order to survive products need to meet consumers' expectations. Therefore, it is necessary, when developing new products, to investigate and to consider factors influencing quality and their effect on sensory properties. The use of sensory evaluation in product development programs by food manufacturers is becoming a major tool to reach this goal.

Sensory evaluation is a science that measures, analyses and interprets the responses of people to products as perceived by the senses (see *e.g.*, Stone & Sidel, 1992; Lawless & Heymann, 2010). Human sensory data provide a better model of how consumers will react to food products than instrumental data as these data take into account both the product properties and the interpretation of these properties by consumers. The methods used in sensory evaluation can be divided into three categories: discriminative, descriptive, and hedonic tests.

Discriminative tests are used to evaluate whether any difference exists between two products. The most well known discriminative test is the triangle test. In this test, panelists receive three samples, two identical and one different. Panelists are asked to pick the odd sample among the three. Another well known test is the 2 or 3 alternative forced choice (2 or 3 AFC) which can be used when the main dimension of difference between the samples is known. Panelists receive 2 or 3 samples and are asked to indicate which one is the highest in the specified dimension (e.g., sweetness). Discriminative tests are generally conducted with about 30 untrained panelists who have been screened for sensory acuity and familiarized with the test procedure.

Descriptive tests aim at understanding product characteristics such as taste, texture, smell, and appearance in a controlled environment. The most well known descriptive test is the Quantitative Descriptive Analysis (QDA™, Stone *et al.*, 1974). QDA is performed by a small number of panelists (from 8 to 15) who provide intensity ratings for a set of selected attributes. It involves three main steps. The *first* step is product familiarization and development of a lexicon, which comprehensively and accurately describes the product space. The *second* step consists in training the panelists in order to align and standardize the sensory concepts of the panel. The *third* step is scoring of the products on the basis of each descriptive attribute on an intensity scale. The performance of the panel is monitored in terms of discrimination power, agreement between panelists, and reproducibility during training to achieve the most accurate, reliable, and consistent results as possible. But as training panelists is quite costly, some new methods will rely instead on untrained panelists (see, *e.g.*, Valentin *et al*. 2012, for a recent review).

Hedonic tests aims at understanding consumers. They are performed with large groups (> 100) of untrained panelists screened for product use. In product development, hedonic tests are usually used towards the end of the formulation process to evaluate which formulation is preferred. The easiest method to address this question is to ask panelists to rank the products in order of preference. This approach is known under the name of preference ranking and is quite useful to compare different formulations but does not provide information on the liking magnitude. An alternative is to ask panelists to indicate their liking of the products on a hedonic scale (hedonic scaling). Different types of hedonic scale can be used: semantic, numeric, unstructured line scale. Among those the most popular one is the so-called 9-point hedonic scale. This is a balanced semantic scale going from like extremely to dislike extremely with a central neutral category (Jones, Peryam, & Thurstone, 1955).

The chapters in this proceeding present some new developments in sensory testing or some applications in product development. They are organized into three topics which we used to organized this meeting sessions and themes:

1. New methods and research tools in consumer research
2. Food choices and consumer behaviour studies
3. Product development and food market
4. Cultural and social determinants of food choices

We would like to use this opportunity to express our gratitude to our two keynote speakers, Pr Harry T. Lawless (Cornell University, USA) and Mr Hajime Nagai (Product Development Center, Japan), for their great contributions. Our special thanks are due to our partners who participated to the organization of this meeting: the HCMC University of Technology, AgroSup Dijon, CSGA, AgroCampus-Ouest and Groupe ISA Lille. We would also like to thank, for their generous help, our sponsors: Fizz-Biosystems, LogicStream, Masan Consumer, Agrosup Dijon and CSGA. We extend our special thanks to those who have helped us so much and worked so hard to make this event possible: Phan Thụy Xuân Uyên , Nguyễn Bá Thanh , Nguyễn Thị Hằng , Trần Thị Cúc Phương , Nguyễn Thị Thu Hà , Nguyễn Quốc Cường, Nguyễn Quốc Dũng, và Lê Minh Tâm.

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Table of Contents

PART 1

New Methods and Research Tools in Consumer Research

THE IDEAL PROFILE ANALYSIS: FROM THE FORMULATION TO THE OPTIMIZATION OF SKIN CREAMS

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Abstract

The Ideal Profile Method (IPM) is a descriptive analysis in which consumers are asked to rate products on both their perceived and ideal intensities on a list of attributes. In addition, overall liking is asked. At the end of the test, each consumer provides a sensory profile of the products, hedonic ratings and the ideal profile. From a theoretical point of view this information is of utmost importance as it is used to formulate an ideal product. Still lots of things are asked to the consumers and the information is fragile. Does such methodology work in practice?

Eight skin creams were created varying in four main factors: the quantity of coemulsifier MF and VE, and the quantity and nature of the vegetal oil used. Seventy two women tested them according to the IPM, and rated the products on 13 attributes. After performing the Ideal Profile Analysis (IPA) consisting in checking for the consistency of the ideal data and guide on improvement, two "ideal products" were estimated and created. These two newly developed creams were tested with six of the eight original products using the same methodology.

This second test showed that the optimization procedure worked well since the two newly developed products were rated higher on liking than the original products.

Keywords*: Ideal profile method, ideal profile analysis, consumers, consistency, optimization.*

1. Introduction

For the Food and Cosmetics industry, optimization and innovation are important steps in product development. This requires a good understanding of the products, both from a sensory and hedonic point of view. In other words, we need to understand how the products are perceived and how the products are appreciated. Taken separately, this information is not sufficient for product improvement. But combined, it is: we can determine which sensory characteristics drive the hedonic judgments. This relationship is usually defined using statistical methods (Daillant-Spinnler, MacFie, Beyts, & Hedderley, 1996). Once the relationship between sensory characteristics and the hedonics is set, the industry can focus on these sensory characteristics for product optimization (Moskowitz, 1995; Moskowitz, & Krieger, 1998).

First we need to gather the sensory and hedonic descriptions of the products. Current practice consists of first asking subjects to describe the products according to a list of sensory attributes. This practice is known as "descriptive analysis" (such as *QDA*®, Stone, Sidel, Woosley, & Singleton, 1974; Spectrum™, Meilgaard, Civille, & Carr, 2006) and results in "sensory profiles". In descriptive analysis, subjects are asked to evaluate the presented products in a monadic sequence and to rate the perceived intensity for each of them according to the pre-established list of sensory attributes (MacFie, Bratchell, Greenhoff, & Vallis, 1989). In general, the subjects who participate in these tests are either specialists who know the family of products tested well, and hence are qualified as "experts" (*e.g.* oenologist tasting wine), or people who are trained accordingly in order *(1)* to understand the sensory attributes used, *(2)* to detect the differences between the products (discrimination of the products) and

(3) to rate them adequately (consensus between subjects) and repeatably (repeatability of the ratings) on the scale of notation used.

In parallel to the descriptive analysis to obtain the sensory profiles of the products, another test is performed. During this test, subjects are asked to rate the same products on overall liking. In order to have successful products, they must satisfy consumers. Hence, we need the judgments of the consumers about their liking or acceptance of the products (*i.e.* consumers' hedonic judgments).

After collecting the sensory and hedonic descriptions of the products they are linked in order to define which sensory characteristics drive the hedonic judgments (Rivière, Monrozier, Rogeaux, Pagès, & Saporta, 2006). For this, we often use the preference mapping techniques (Carroll, 1972; Greenhoff, & MacFie, 1995). In practice, two types of preference mapping techniques exist: internal preference mapping (MDPref, Carroll, 1972) and external preference mapping (PrefMap, Carroll, 1972). A comparison of these two techniques is done by van Kleef, van Trijp, and Luning (2006).

In order to get closer to the market, more importance should be given to the consumer. In this case, we would prefer to use the sensory descriptions of the products obtained from consumers over the sensory descriptions of the products obtained from experts or trained panelists. Thus, we would ask to the same consumer to perform both tasks simultaneously, which results in sensory profiles and the hedonic judgments. This procedure has the advantage that we can link the appreciation to the sensory perception of the products directly for each consumer. This link hence seems more direct.

The "intensive" use of consumers for sensory tests is not accepted by everybody in the sensory community. In the literature, numerous critics concerning the use of consumers for tests other than hedonic have been formulated: *(1)* "…as with any untrained panel, beyond the overall acceptance judgment there is no assurance that the responses are reliable or valid" (Stone, & Sidel, 1993) and *(2)* "…consumers can only tell you what they like or dislike" (Lawless, & Heymann, 1999). According to these authors, the use of consumers for sensory descriptive tasks is not appropriate as consumers lack two major qualities: consensus and repeatability to which we should add the uncertainty of the good comprehension of the meaning of the sensory attributes. Moreover, Earthy, MacFie, and Hedderley (1997) showed that associating sensory and hedonic questions can have an inconvenient halo effect. Although this effect is not always verified in practice (Popper, Rosenstock, Schaidt, & Kroll, 2004), the long and thoughtful perception of the products can affect the hedonic judgment of the consumers. This seems to be the price to pay if we wish to obtain sensory profiles from consumers.

Other authors are more optimistic concerning the use of consumers to obtain sensory profiles. Moskowitz (1996); Husson, Le Dien, and Pagès (2001) and more recently Worch, Lê, and Punter (2010) have shown through different studies that consumers can describe the sensory characteristics of the products with a precision comparable to the one obtained from experts. In that case, the larger size of the consumer panel counterbalances the lack of training. On the other hand, the use of consumers puts a restriction on the choice of sensory attributes used in the test. With consumers, only "simple" sensory attributes can be used, we cannot use technical or chemical terms.

Although the sensory and hedonic descriptions are obtained from the same consumers, we still need to link them together. However, it can happen in some cases that the sensory descriptions and the hedonic judgments are "independent". This would correspond to the situation where the major sensory differences which are detected do not influence the appreciation of the products for those consumers. In this case, the user will not be able to find links between the hedonic and the sensory descriptions of the products (Faber, Mojet, & Poelman, 2003). For that reason, extra questions linking the perception of each attribute with the appreciation of the products are asked. Since this task involves hedonic judgment, consumers are required.

A first way of doing so consists in asking consumers to describe the perceived intensity of the products in function of the representation they have of their ideal (Moskowitz, 1972). In this case, the consumers mention whether the product is *too much, just about right* or *too little* for each of the attributes considered. The scale of notation used is known as *JAR* scale (Rothman, & Parker, 2009). In this case, the difference between the perceived intensity and the ideal intensity is measured. However, the notion of "*just about right*" can be confusing. Indeed, for the consumers, does the *jar* level refer to

the acceptance of the product or to a preference (Gacula, Rutenbeck, Pollack, Resurreccion, & Moskowitz, 2007)?

A second method which links the perception of each attribute to the hedonic judgments consists in asking the consumers directly to describe their ideals, thus gathering the hedonic and descriptive aspects of the products simultaneously (Szczesniak, Loew, & Skinner, 1975). In practice, during such test, the consumers are asked to rate both the perceived and ideal intensity of the products on a list of predefined attributes. In this case, the consumers are asked to rate their ideal product on the same attributes and the same scale of notation as the tested products.

This technique, known as the Ideal Profile Method, is used by several professionals in industry. Nevertheless, only few articles in the literature concerning the analysis of these particular data can be found. Moreover, those articles only describe the testing protocol used and the final analysis of the data gathered. From a practical point of view, these studies show that the use of ideal data brings useful information for the optimization of products (Hoggan, 1975; Moskowitz, Stanley, & Chandler, 1977; Cooper, Earle, & Triggs, 1989). However, the methodology of the *IPM* can be questioned. Indeed, the ideal profiles are fragile data since they are provided by consumers who are describing fictive (ideal) products. So, which value can be granted to these data? To which extent can the use of ideal profiles guide product optimization?

In order to answer these questions, we propose a methodology for the analysis of these particular data. The methodology used is referred to the Ideal Profile Analysis (*IPA*). It gives insight about the consistency of the data and the procedure to use to improve the products. In this study, the *IPA* is applied to skin creams in order to both optimize the products and validate the methodology. To do so, a first sensory test is performed on skin creams. According to the results of the *IPA*, more optimal skin creams are formulated (according to the guidance on improvement proposed during the *IPA*) and tested during a second sensory test in order to see whether these more optimal products would be more appreciated than the original ones.

2. First sensory test: Use of the Ideal Profile Analysis (*IPA*)

2.1. Material

2.1.1. Products

During a preliminary study, 18 skin creams have been created according to an experimental design involving 4 factors: *(1)* the quantity of MF coemulser (ranging from 0.5% to 10%), *(2)* the quantity of VE coemulser (ranging from 0.5% to 10%), *(3)* the quantity of vegetal oil (ranging from 10% to 30%) and *(4)* the type of vegetal oil (sesame or macadamia). Through this procedure, we have a good knowledge of the products and the possibilities we have in terms of formulation, by still creating a large and realistic (*i.e.* matching what we could find on the market) product set.

In a second step, eight skin creams have been selected from these 18 in order to test the products according to a complete design. Each consumer's arm was divided into four areas where to apply the cream. Hence, each consumer can provide the ideal profiles of each of the eight creams,four creams being tested on each arm. This selection of eight out of the 18 products has been done according to a preliminary study (not presented here) which aimed at creating the product space of the 18 skin creams. This product space was obtained according to the Napping® method (Pagès, 2005). From this space, we selected 8 skin creams by taking care of maintaining both a large variability between products within the product space and keeping an optimal design between factors within the eight products selected.

2.1.2. Consumers

The eight skin creams were applied by 72 women aged between 18 and 52 years old. These women were recruited among the students and teaching staff of Agrocampus Ouest, Rennes, France.

By following the IPM, the consumers rated both the perceived and ideal intensity of the eight selected creams according to a list of 13 attributes. These attributes were defined according to what seemed important to us. This list is given Table 1. Additionally, four acceptance questions related to visual, texture before and after application and overall liking were asked. The eight products were presented to the consumers in a monadic sequence according to a complete design.

Table 1: List of the 13 attributes (*english*).

Visual	*Texture during application*	*Sensation after application*
Compact	Onctueux	Effet filmogène
compact	*smooth*	*film-forming effect*
Aspect gras	Etalement	Doux
fatty aspect	*sprawl*	*soft*
Jaune	Texture grasse	Frais
yellow	*fatty texture*	*fresh*
Brillant	Epais	Sensation de gras
shiny	*thick*	*fatty feeling*
	Pénétrant	
	penetrating	

2.1.3. Preliminary study of the sensory product space

Before studying the ideal profiles and the relationship they have with the sensory and hedonic descriptions of the products, let's first take a look at the sensory space of the products provided by the consumers. This product space of the 8 skin creams is obtained by PCA performed on the averaged sensory profiles of the products (table with 8 rows and 13 columns, each row corresponding to one cream and each column corresponding to one sensory attribute). This product space as well as the corresponding correlation circle are given in Figure 1.

In this space, the first dimension of the PCA explains around 65% of the total variance. It opposes the creams *1* and 3 (*aspect* and *texture gras*, *compact*, *épais* and *jaune*) to the cream *8* (*frais*, *étalement* and *brillant*). This first dimension can be interpreted as a dimension of texture opposing the products which are rather fatty to the products easily applicable on the skin. The second dimension corresponds to the particular case of the attributes *pénétrant*, *doux*, *effet de filmographie* and *sensation de gras*. This dimension opposes to some extent the products *8* and *13*. The products being mainly projected along the first dimensions, we can conclude that the sensory space is one-dimensional.

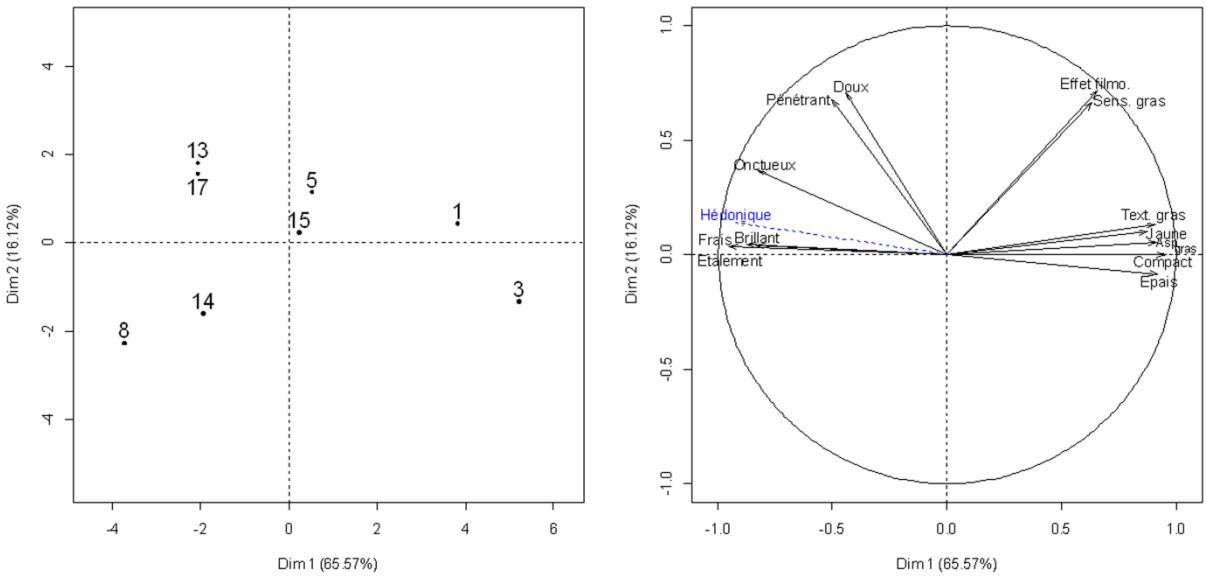

Figure 1: Sensory space of the skin creams (a, left) and correlation circle associated (b, right).

If we also focus on the hedonic aspects by considering the averaged hedonic score provided by the entire panel as a supplementary variable, it appears that this variable is strongly correlated to the first

dimension (*r(11)* = -0.92), the products easily applicable (*8, 13, 14* and *17*) being more appreciated than the fatty ones (Table 2). Hence, we can notice that the majority of the sensory attributes are strongly linked to the averaged hedonic scores.

Table 2: Averaged hedonic scores of the creams.

	1	***3***	***5***	***8***	***13***	***14***	***15***	***17***
Averaged hedonic scores	2.47	1.79	3.02	3.38	3.44	3.61	3.33	3.32

2.1.4. Preliminary study of the ideal product space of the consumers

Let's focus now on the ideal product space. This space is obtained by performing a standardized PCA on the corrected averaged ideal profiles $\tilde{\boldsymbol{z}}_{\boldsymbol{j}..}$ (table with 72 rows and 13 columns, each row representing the averaged ideal profile from a consumer after correcting from the use of the scale and each column representing one ideal attribute). This ideal space and its corresponding correlation circle are given in Figure 2.

The first dimension of this space opposes the ideal products from the consumers *30* and *54* which described their ideal as rather fatty (*jaune, épais, texture* and *sensation de gras*) to the consumers *44* and *53* which described their ideal as more easily applicable and fresh (*étalement, pénétrant, onctueux* and *frais*). Hence, the first dimension of the ideal product space can be interpreted as a dimension of texture opposing ideal products which are rather fatty to ideal products easily applicable on the skin. The second dimension opposes the ideal product from the consumer *35* which has a fatty aspect to the ideal products from the consumer *61* which is glossier.

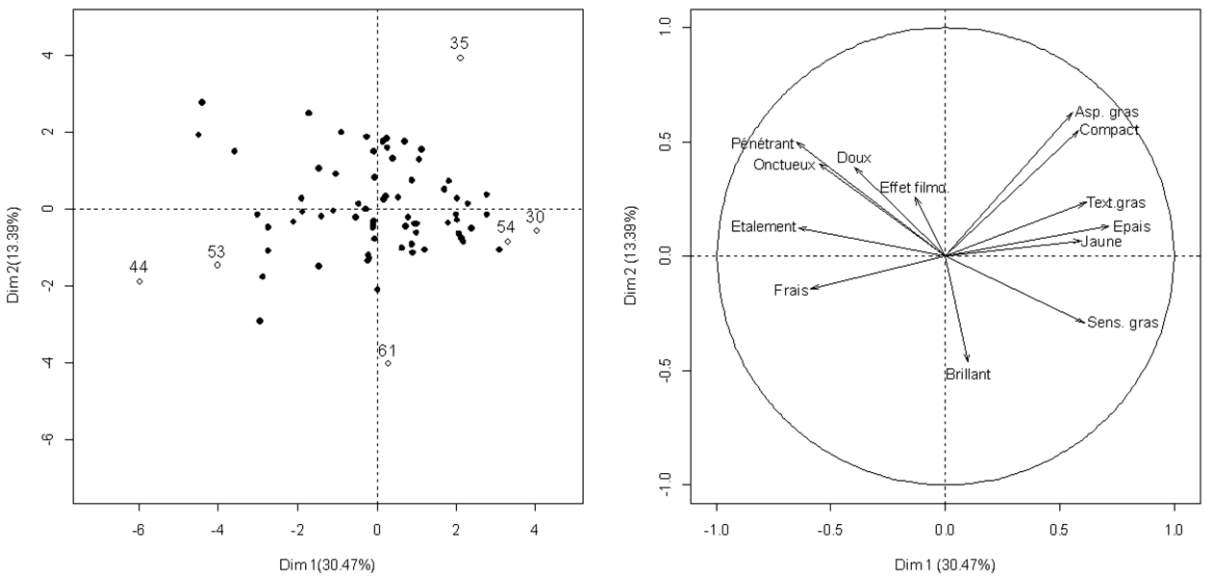

Figure 2: Ideal product space (left) and its corresponding correlation circle (right).

We can notice that the sensory space (Figure 1) and the ideal product space (Figure 2) are structurally similar, the first dimension opposing products which are rather fatty to products which are more easily applicable and fresh in both cases. From the sensory attribute point of view, the major direction of variability between ideal products seems to be related to the major direction of variability between products (in terms of sensory description). Theoretically, this relationship between the two spaces is not expected. This astonishing relationship between dimensions of variability can be interpreted in different ways. In our example, the attributes used to discriminate the products are strong drivers of liking or disliking. Since the ideal attributes referred to the hedonic by definition, the relationship between the two spaces will be justified by the strong link to the hedonic in both cases.

2.2. Methodology of the IPA

The IPA is defined in four steps: (1) checking for the sensory and hedonic consistency of the data, (2) checking for a segmentation of consumers and single ideal assumption, (3) defining the sensory profile of the ideal product used as reference (ideal reference) and (4) guide on improvement based on the sensory profile of the ideal reference.

2.2.1. Consistency

Sensory consistency. The ideal data provided by a consumer are consistent from a sensory point of view if the sensory profiles associated to the averaged ideal product have similar sensory characteristics as the tested product which she appreciated the most. From an attribute point of view, this means that the consumers who said they have a higher appreciation for the products perceived as more intense for an attribute *a* should also rate their ideals as rather intense for *a*. Hence, if a consumer says she has higher appreciation for the products she perceived as sweeter, we can expect her to have an ideal product rather sweet. This consistency is measured both at the consumer and panel level (Worch, Lê, Punter, & Pagès, 2012a).

In practice, at the panel level, this consistency can be checked graphically within the corrected averaged ideal product space (72 rows and 13 attributes, each row representing the averaged ideal product corrected of one consumer and each column representing one ideal attribute) in which are projected the sensory profiles of the products as supplementary entities (8 rows and 13 columns, each row corresponding to the averaged sensory profile of one tested product and each column corresponding to one sensory attribute) and the hedonic scores of the products as supplementary attributes (72 rows and 8 columns, each row corresponding to the centered hedonic scores provided by one consumer to the products and each column corresponding to one product). The sensory consistency of the ideal profiles is measured at the consumer level by the relative position of the tested products projected as supplementary entities in the sensory space of the products with the liking scores of the products projected as supplementary variables in the ideal attribute space.

Hence, the averaged ideal profiles of the consumers (after correcting from the different use of the scale) are consistent at the panel level if they are projected close to the tested products they said they appreciated the most. This can be seen graphically by the correspondence between the double projections as illustrative of the products. For a consistent panel, we can expect that each product *p* considered as a supplementary hedonic variable points in the direction of the product *p* projected as a supplementary entity in the sensory space.

In order to simplify the interpretation of the results, we match the sensory space and the ideal product space by centering the tables. In practice, we make sure that the center of gravity of the tested products cloud coincides with the center of gravity of the corrected averaged ideal products cloud. The interpretation of the space thus obtained is as follows: the ideal product of a consumer *j* is close to the tested product *p* if the sensory characteristics (relative to the panel of consumers) of the ideal product provided by consumer *j* are similar to the sensory characteristics (relative to the product set) of product *p*. In other words, the consumers who rated their ideals as more intense for the attribute *a* are projected close to the product which are more intense for *a*. In the cream study, this means that the consumer who has an corrected averaged ideal product as fattier and less applicable (relatively to the rest of the panel of consumers) will be projected close to the fattiest and less applicable product tested (relatively to the entire set of products).

Hedonic consistency. The ideal data are consistent from a hedonic point of view if they correspond to ideal products which would be more appreciated than the tested products. The hedonic scores of the ideal products cannot be obtained from consumers directly, so they are estimated. We will refer to those as the estimated liking potential of the ideal profiles. In this study, the $\mathcal{M}_{PCR}$ model is used (Worch, Lê, Punter, & Pagès, 2012b).

At the panel level, this consistency is estimated by comparing the distributions of the hedonic scores given to the tested products on one hand and of the estimated liking potential of the ideal products on the other hand.

At the consumer level, it is measured by comparing the estimated liking potential of the ideal products to the hedonic scores of the tested products. To simplify the interpretation of the results; this comparison is done based on an indicator called standardized liking potential which is positive if this estimation is larger than the averaged hedonic score provided by the consumer to the tested products. This threshold (averaged hedonic score) will be considered as a lower threshold (horizontal red line). More strictly, we could consider the quantile at 95% of the standardized normal distribution as a threshold. In this case, the estimated liking potential should be larger than 1.64. The quality of the individual models being also of great importance in the estimation of the liking potential, the standardized liking potentials are represented as a function of the adjusted R^2. An adjusted R^2 coefficient larger than 0.5 is considered here as large enough (vertical red).

2.2.2. Optimization

Segmentation and multiple ideals. In order to check for consumer segmentation, the classical procedure of hierarchical clustering can be used. However, in order to have an overview of the differences in behavior between consumers, a PCA is performed on the sensory profiles (*8* rows and *13* columns) where on one hand all the ideal products are projected as supplementary entities (72*8 rows, 13 columns) and on the other hand, the consumers' liking ratings are projected as supplementary variables (8 rows, 72 columns). The dispersion of the variables (*i.e.* the consumers liking behavior) give an overview of the clusters.

In order to check whether the consumers associated the product set to one unique ideal (we would then say that the products belong to one unique category), the averaged ideal profiles provided according to each tested product by the entire panel of consumers (8 rows, 13 columns) are projected as supplementary entities in the sensory space (8 rows, 13 columns). Based on the between-consumers variability of the ideal products, confidence ellipses are constructed around each averaged ideal product (Husson, Lê, & Pagès, 2007).

Definition of the ideal reference. In order to determine the ideal reference for the optimization procedure of the products, the ideal mapping technique is used (Worch, Lê, Punter, & Pagès, 2012c). For the construction of the ideal map, we consider that consumers associated to a large confidence ellipse have a larger ideal. Hence, the ideal mapping technique considered does not standardize the individual ellipses. In other words, the *IdMap* is preferred over the *wIdMap* here.

Optimization procedure. In order to guide on improvement, the attributes to change in priority, the "Fishbone Method" (Worch, Dooley, Meullenet, & Punter, 2010) is applied on our data by using the solution obtained with the *IdMAp* as ideal reference.

2.3. Results

2.3.1. Consistency

Sensory consistency. In the ideal product space, the double projections of the sensory profiles as supplementary entities (8 rows and 13 columns) and of the hedonic variables associated to the products as supplementary variables (72 rows and 8 columns) are represented in Figure 3. These double projections show that consumers who described their ideal as rather fatty and less applicable than the rest of the panel have a higher appreciation for the products *3* and *5* than the rest of the panel. Consumers who described their ideal as more applicable have a higher appreciation for the products *8* and *14* than the rest of the panel.

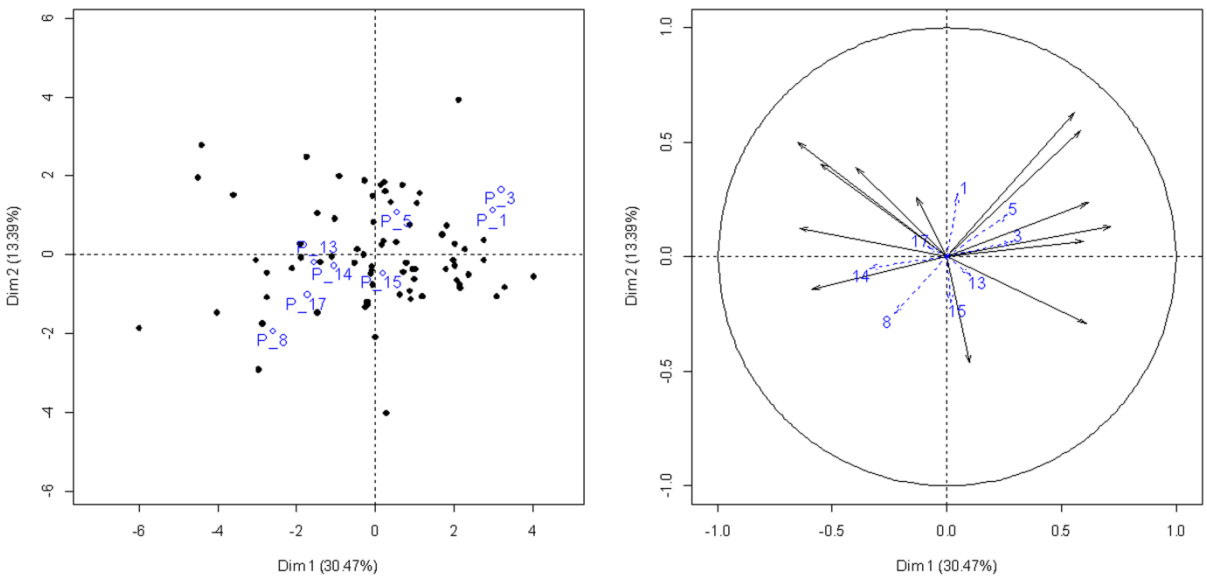

Figure 3: Projections of the sensory profiles (left) and the hedonic scores (right) of the creams in the ideal space.

At the panel level, the consistency of the ideal data is measured through the correspondence of similar products seen both through the sensory ("P_1" for example) and hedonic descriptions ("1" for example) within the ideal space. In this case, correspondances can be found between identical products: the consumers who have a higher appreciation for product *3* than the rest of the panel also seem to describe her ideal with similar relative characteristics as the product *3* (*i.e.* a fattier product). Similarly, the consumers who have a higher appreciation for product *8* rated their ideal with similar relative characteristics as the product *8* (*i.e.* an ideal product more easily applicable). This correspondence is not clear for all products. The consumers who said they have a higher appreciation for product *5* than the rest of the panel described an ideal with relative sensory characteristics closer to the one of product *1* or *3* than of product *5*. Similarly, the consumers who have a higher appreciation for product *14* than the rest of the panel described an ideal more intense for the attributes *étalement, frais, pénétrant* than is suggested by the characteristics of product *14*.

Although the correspondence of the projections is not perfect, a general tendency can be observed. The correlation coefficient measured between the scores of the supplementary entities (sensory profile of the products) and the loadings of the supplementary variables (hedonic scores of the products) along the first dimension of the ideal product space is 0.64 (corresponding to a *p-value* = 0.087). Hence, one would say that the ideal data are consistent from a sensory point of view, at the panel level.

The ideal data gathered from a consumer are consistent if the averaged ideal profile corrected has the same characteristics as the product appreciated the most. At the consumer level, this consistency is measured by the link between the ideal intensity measured on one hand and the vector of linear drivers of liking for this consumer on the other hand. These vectors of linear drivers of liking are obtained by measuring the correlation between the perceived intensity for each attribute and the hedonic ratings provided by the consumer considered. A consumer being consistent if she rates her ideal product with similar characteristics as the ones of the products she appreciates the most, one can expect that the link is strong, meaning that the correlation coefficients are high.

The distribution of the correlation coefficients measured for each consumer is presented in Figure 4. It shows high correlation coefficients (the majority is higher than 0.47, corresponding to the critical value at 5% for a one tailed test). Hence, we can conclude that the ideal profiles are consistent at the consumer level from a sensory point of view.

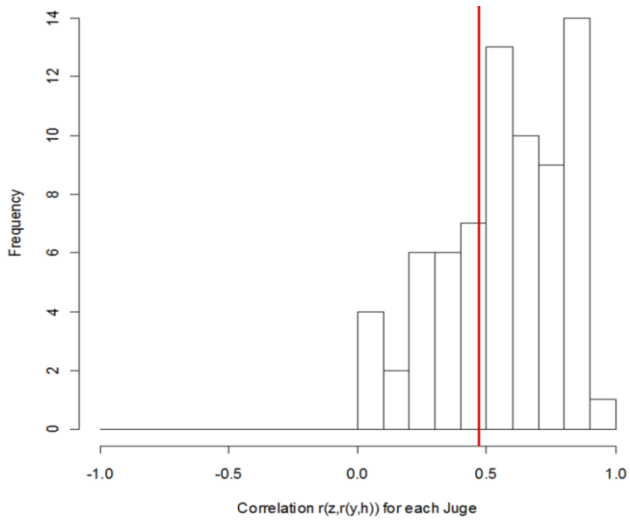

Figure 4: Distribution of the correlation coefficients measuring the individual sensory consistency of the ideal profiles.

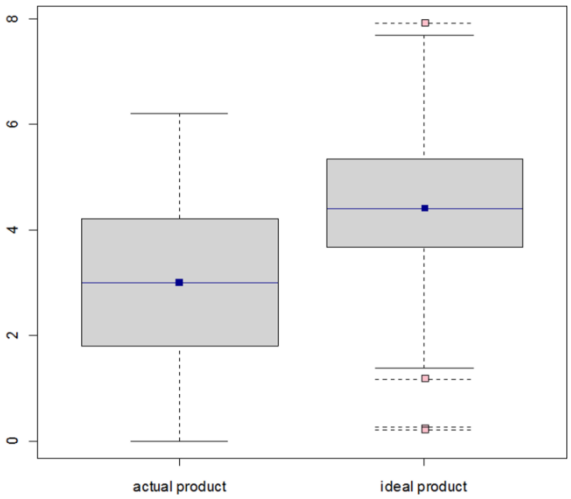

Figure 5: Distribution of the hedonic scores provided (product tested) and of the estimated liking potential (ideal product).

Hedonic consistency. For the hedonic consistency at the panel level, the distributions of the liking scores (products tested) and of the potential liking (ideal products) are represented in Figure 5. For the $\mathcal{M}_{PCR}$ model, the median related to the estimated liking potential of the ideal products is higher than the one related to the hedonic scores of the tested products. Hence, the ideal data seem consistent from a hedonic point of view at the panel level.

At the consumer level, Figure 6 shows that the majority of the consumers is located on the right upper part, meaning that the standardized liking potentials are positive and the adjusted R^2 of the corresponding individual model is high (the individual models explaining the hedonic ratings based on the sensory descriptions provided by the same consumer). Compared to the lower limit defined previously, the majority of the consumers are consistent. In the contrary, in the skin cream example, only 10 consumers (out of 72) are consistent according to the upper limit (standardized normal distribution).

Since the majority of the consumers are located between the lower and upper limits, we propose to compare the averaged liking potentials with the larger hedonic score given to the tested products (Figure 7). In this case, only 31% of the consumers have an averaged ideal product for which the corresponding estimated liking potential is larger than the maximal hedonic rating provided to the

products. Rather than associating each consumer to her averaged ideal product, one could consider associating her to an ideal area. This assumption is made in the Ideal mapping technique when each consumer is associated to an ideal confidence ellipse constructed around her averaged ideal product (§2.2.2.). In this case, each consumer could be associated to the ideal product which belongs to that ideal area and which is associated to the largest estimated liking potential. We can then compare the largest hedonic score provided to the tested products to the largest liking potential estimated of each consumer. Figure 7b shows that 54% of the consumers have an ideal for which the maximal liking potential is larger than the maximal hedonic score given to the products. For the remaining 46%, the maximal liking potential is close to the maximal hedonic score.

From these results, one can say that the ideal data are consistent from a sensory and a hedonic point of view, both at the panel and consumer level. The ideal data can be used to guide on improvement.

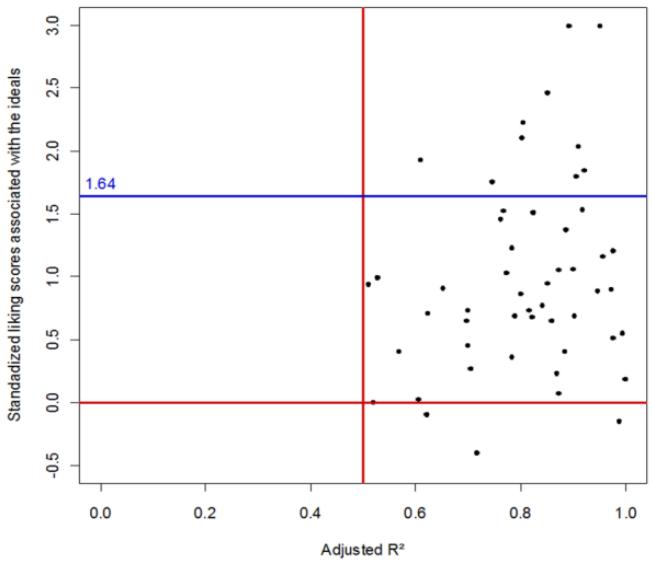

Figure 6: Representation of the individual standardized liking potential as a function of the adjusted R^2 associated.

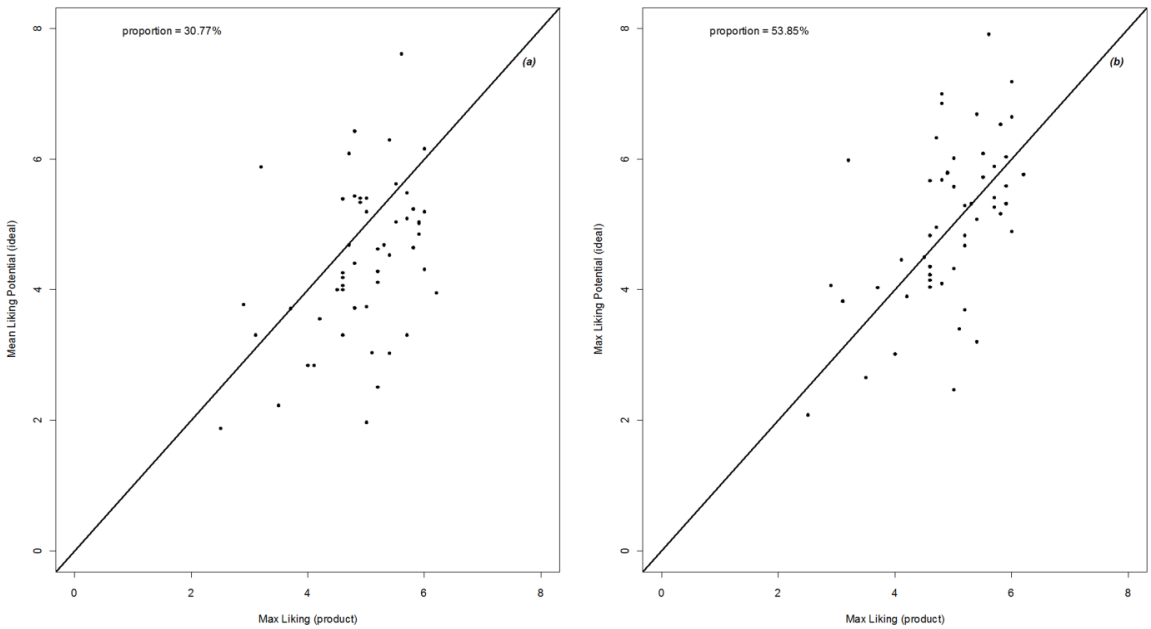

Figure 7: Comparison of the maximal hedonic score provided by each consumer with the averaged (left) and maximal (right) estimated liking potential.

2.3.2.Optimization

Segmentation and multiple ideals. The projection of the averaged ideal products (72 rows and 13 columns) or of the individual ideal products (72*8 rows and 13 columns) in the sensory space (8 rows and 13 columns) shows a similar consensus between the ideal products provided by the consumers (Figure 8). Indeed, the panel of consumers described an ideal more easily applicable and less fatty. On the opposite, we can note however that the variability between the ideal products is larger than the variability between the tested products. This difference can be observed through the difference of the size of the ellipses in Figure 8a (blue ellipse for the averaged ideal products, light blue for the individual ideal products and black for the tested products). The projection in the space of the sensory attributes of the individual hedonic scores provided by the consumers as supplementary variables (8 rows and 72 columns) shows a strong consensus between consumers (Figure 8b).

This double projection puts forward a strong consensus between consumers, both in their hedonic judgment and in the representation of their ideal products. Hence, no segmentation of the panel is considered. And, further investigation of clusters is not necessary here.

In this example, it seems that considering the averaged ideal product for the entire panel of consumers as reference to match in the procedure of optimization is a good solution. However, in order to follow the methodology of the *IPA* presented previously, the solution obtained from the ideal mapping is used. But before defining the sensory profile of the ideal reference, one has to be sure that the consumers associate the set of products to one unique ideal product. Since all the ellipses are superimposed, one can conclude that in this study, the entire panel of consumers associated the set of tested products to one unique ideal (Figure 9).

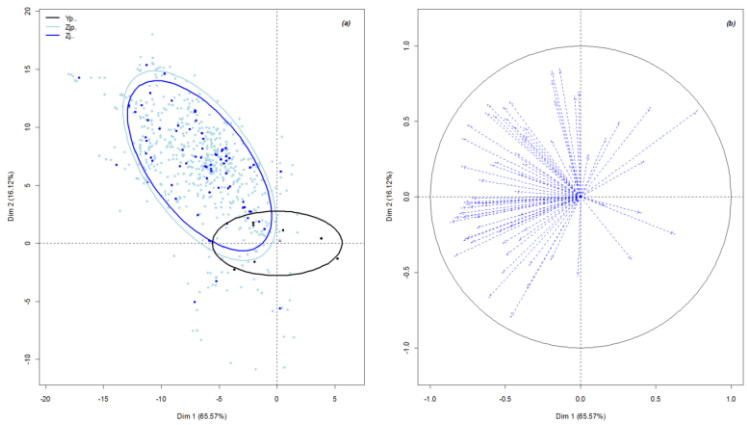

Figure 8: Projection of the averaged and individual ideal profiles (left) as supplementary entities in the sensory space of the products and projection of the hedonic scores (right) as supplementary variables in the corresponding variable space.

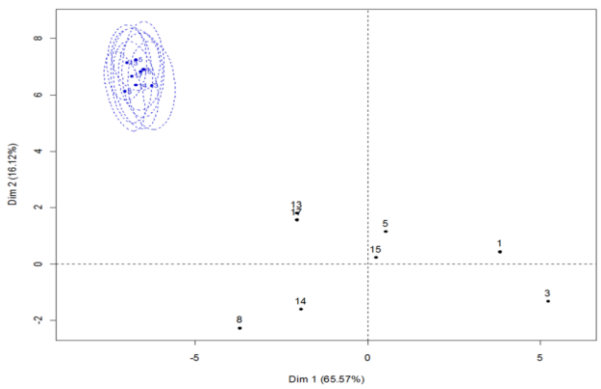

Figure 9: Confidence ellipses checking for the uniqueness of the ideal at the panel level.

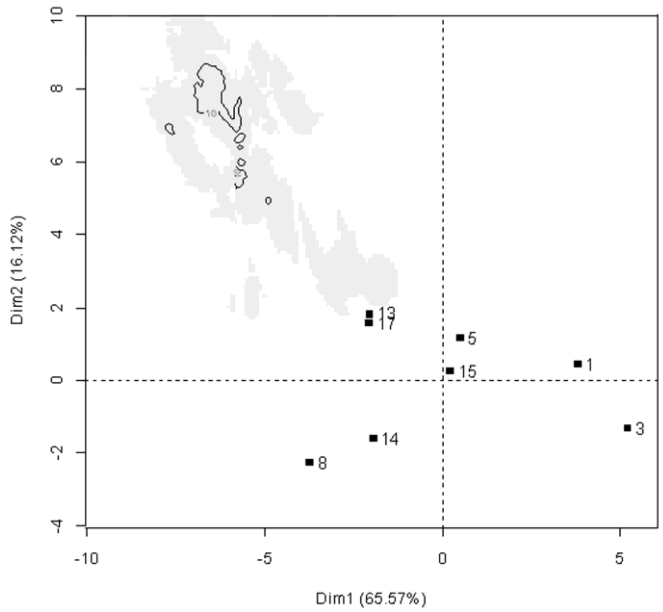

Figure 10: Results of the *IdMap*.

Ideal of reference. The map obtained according to the *IdMap* is presented in Figure 10.

In this ideal map, the profile of the ideal product common to a maximum of consumers is defined. As expected, it is located on the negative part of the first dimension, and on the positive part of the second dimension. Hence, we can expect that the ideal reference will be more easily applicable on the skin (more *étalement* and *pénétrant*) and less fatty (less *sensation* and *perception de gras*) than the tested products. This is confirmed in Figure 11 in which the profile of the ideal product used as a reference to match is compared to the sensory profile of products *3* (the product the further from the ideal) and *17* (one of the closest-to-the-ideal product).

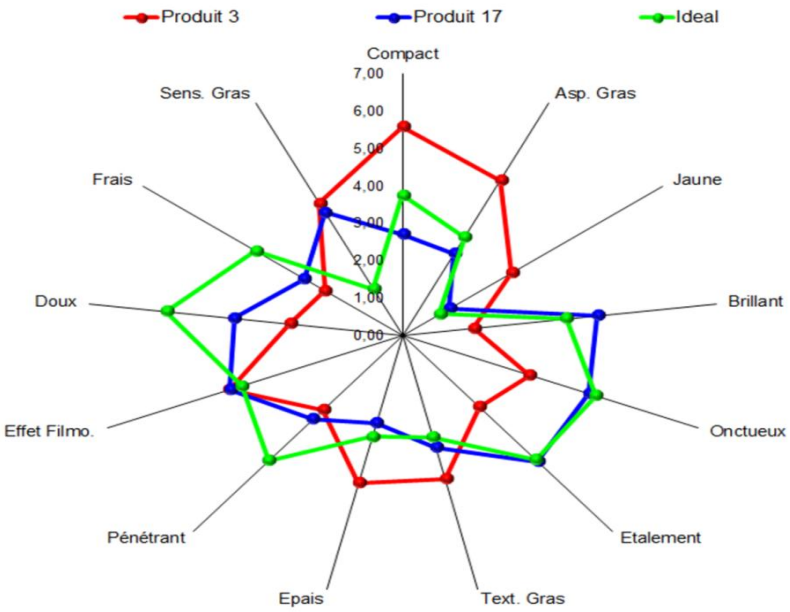

Figure 11: Sensory profiles of the products *3* and *17* compared to the profile of the ideal product obtained from the *IdMap*.

Optimization procedure. The comparison of the sensory profiles of products *17* and *3* with the one of the ideal product used as reference confirms that product *17* has a sensory profile closer to the ideal than product *3* (Figure 11). As expected, the principal differences observed between the sensory profiles of these products with the one of the ideal product considered as a reference to match concern the attributes *frais*, *doux*, *pénétrant* (intensity to increase) and the attributes related to the perception of fat (intensity to decrease). The optimizations (performed according to the *Fishbone* methodology) indicated for products *3* and *17* are shown in Figure 12a and 12b.

For product *3*, the entire set of attributes has to be improved. In priority, the attributes *frais*, *doux*, *brillant* and *étalement* should be intensified since they would have a larger impact on liking. On the opposite, the attribute *sensation de gras* should be decreased. From a hedonic point of view, the potential gain in liking would be more important if the attributes *frais* and *doux* were at their ideal level.

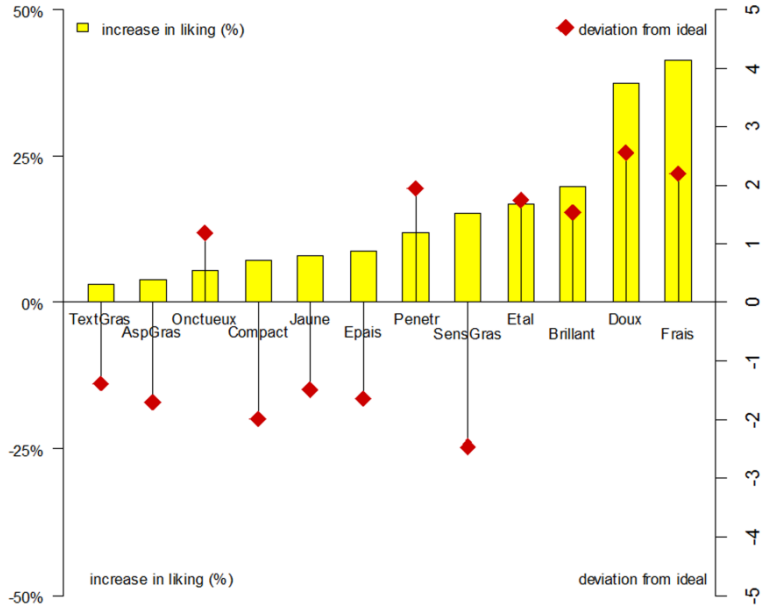

Figure 12a: Optimization of the product *3* according to the *Fishbone method*.

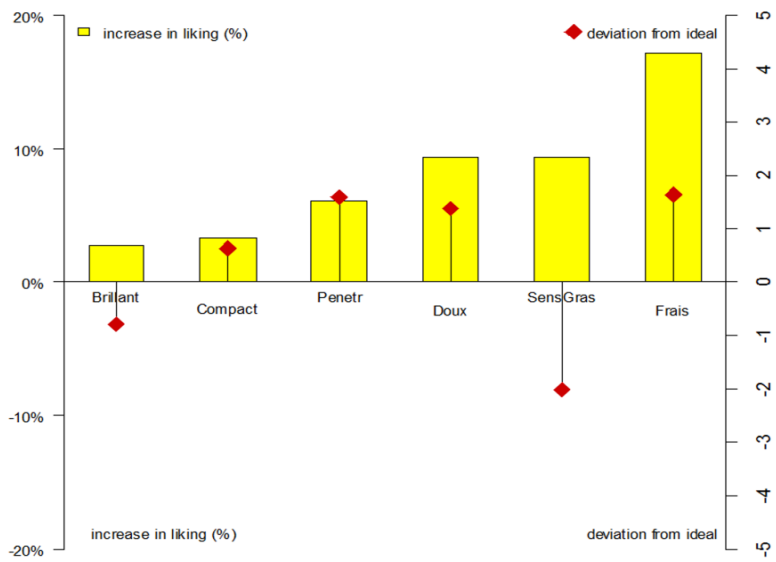

Figure 12b: Optimization of the product *17* according to the *Fishbone method*.

For product *17*, the attributes *frais*, *doux* and *pénétrant* should be intensified. On the opposite, the attribute *sensation de gras* should be decreased. From the hedonic point of view, the gain in liking would be more important if the attributes *frais*, *sensation de gras* and *doux* were at their ideal level. In that case, the gain in liking would be of around 18% for the attribute *frais* and 10% for the attributes *sensation de gras* and *doux*.

3. Second sensory test: Validation of the IPA

Although this procedure seems to improve the products, it has to be validated. To do so, new improved products have to be created and compared hedonically to the products of interest. This is the next step of the validation study.

3.1. Material

Among the 18 products originally created, there were two products (the products *2* and *9*) which had sensory characteristics close to the one of the ideal product (*i.e.* the products are more easily applicable and less fatty). Hence, a second study integrating these two products is realized. In order to keep the same total number of products in this new study (*i.e.* 8), these two new products were added to six out of the eight previous products. These six products were selected according to the D-optimality criteria (Ben Slama, Heyd, Danzart, & Ducauze, 1998). This second set of eight products includes the products *1, 2, 3, 5, 8, 9, 15* and *17*, the products *13* and *14* being discarded. This new set of 8 products was tested following the same procedure as before (IPM on the same 13 attributes and acceptance questions) by 65 of the 72 previous consumers.

The sensory profiles of products *2* and *9* are presented in Figure 13. These two profiles are compared to the profile of product *17*, as it was the product the closest to the ideal reference in the previous study. Products *2* and *9* have sensory profiles which are different from the one of product *17*. These differences are mainly related to the attribute *sensation de gras*, *texture grasse*, *épais* and *effet de filmographie* for which the perceived intensity is lower (Figure 13).We can also notice a difference in the perceived intensity between products *2* and *17* for the attributes *étalement* and *frais* (product *2* being less intense). These differences are not observed between the products *9* and *17*. Hence, the comparison of the sensory profiles of products *2* and *9* suggests a better improvement for product *2* than for product *9*, the attributes being closer to the ideal level.

Products *2* and *9* have sensory profiles closer to the ideal reference defined in the previous study. The attributes which are drivers of liking/disliking have been modified in the direction of an improvement.

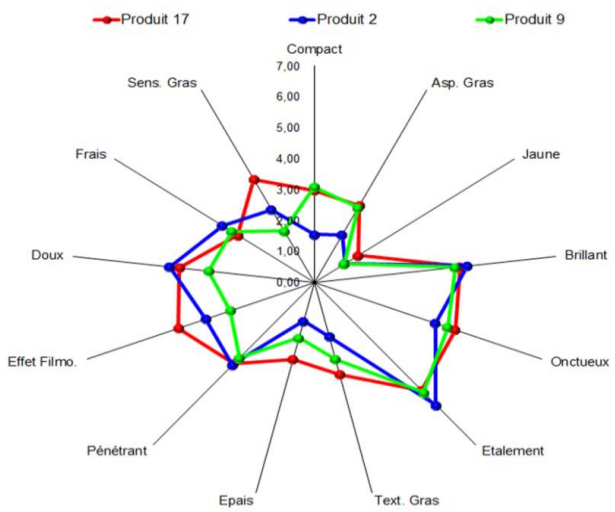

Figure 13: Comparison of the sensory profile of product 17 with the sensory profiles of the new products.

3.2. Method

3.2.1. Validation of the optimized products

Before checking that the two new products created according to the optimization procedure are more appreciated than the other products, we first need to check that the sensory space obtained in this second study is still similar to the previous one. This sensory space is obtained by performing a PCA on the sensory profiles of the products (8 rows and 13 columns). This space is presented in Figure 14.

The first dimension thus obtained opposes products *2*, *8* and *9* (*étalement*, *pénétrant*, *frais* and *brillant*) to products *1* and *3* (*compact*, *jaune*, *aspect* and *texture gras*). Hence, the first dimension opposes the products easily applicable to the products perceived as fatty. This dimension corresponds to the one obtained previously in the first test performed (Figure 1), hence showing a stability of the sensory spaces obtained from the consumers across tests. We can notice that products *2* and *9*, which correspond to the optimized products, are positioned on the negative extremity of the first dimension (which corresponds to the products more easily applicable and less fatty). This would correspond to the position of the ideal products in the previous space. However, we can notice that product *9* is less extreme than product *8* along that dimension.

The validity of the *IPA* methodology is measured through the hedonic judgments of the optimized products. One can expect here that these optimized products are more appreciated than the other products. For that reason, we project the averaged hedonic score for the entire panel as a supplementary variable in the sensory attribute space. The correlation circle presented in Figure 14 shows a strong and positive correlation with the sensory attributes *frais*, *étalement* and *brillant*, and a strong and negative correlation to the attributes *compact*, *jaune*, *épais*, *aspect* and *texture de gras*. This result confirms the one obtained in the first test, the more easily applicable and less fatty products being more appreciated. Hence, products *2*, *8* and *9* seem to be the most appreciated products.

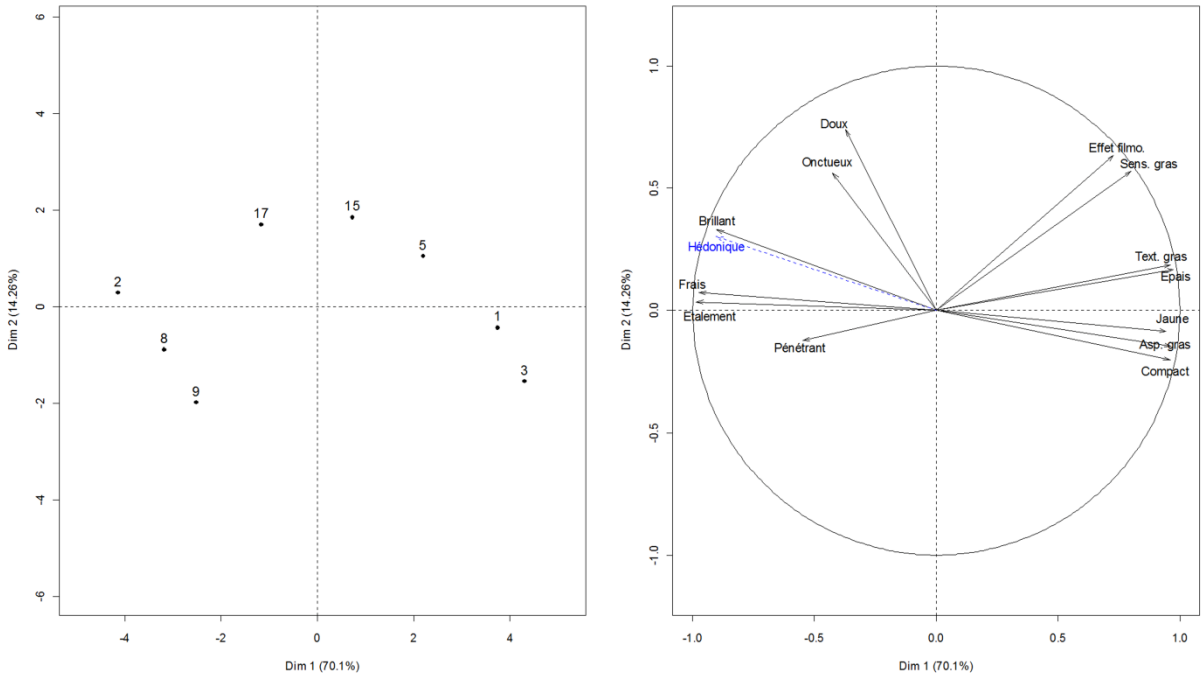

Figure 14: Sensory space and corresponding correlation circle obtained in the second sensory test.

3.3. Results

In order to validate the methodology, let's focus more particularly on the hedonic judgments. Indeed, the optimization of the products is measured through the differences in liking of the products. To do so, a two-way analysis of variance (measuring the *product* and *consumer* effects) is performed for

each of the four acceptance variables. For the overall liking and for the texture after application, the *t*-test confirms that product *2* is the most appreciated product. It is not the case for product *9*. However, concerning the visual aspect and the texture during application, the product *9* is the second most appreciated product, right after product *17* (Table 3).

Table 3: Results of the *t*-test related to the *product* effect obtained for each acceptance question.

	Visual		*Texture during*		*Texture after*		*Global*	
	Coeff	**P-value**	**Coeff**	**P-value**	**Coeff**	**P-value**	**Coeff**	**P-value**
Product 1	-0,829	0,000	-0,599	0,000	-0,199	0,204	-0,495	0,001
Product 2	-0,012	0,935	-0,187	0,239	**0,670**	**0,000**	**0,492**	**0,001**
Product 3	-1,194	0,000	-0,503	0,002	-0,664	0,000	-0,904	0,000
Product 5	-0,111	0,470	0,004	0,979	-0,018	0,910	-0,019	0,900
Product 8	0,377	0,014	0,363	0,022	0,430	0,006	0,415	0,007
Product 9	**0,620**	**0,000**	**0,415**	**0,009**	-0,015	0,926	0,219	0,151
Product 15	0,471	0,002	0,013	0,932	-0,215	0,171	0,193	0,205
Product 17	**0,680**	**0,000**	**0,493**	**0,002**	0,010	0,949	0,099	0,515

The methodology of the *IPA* helped us creating better products. This remark is particularly true for product *2* as it was more appreciated globally than any other product. Indeed, the closer a product is to the ideal and the larger its liking score. However, it is not the case for product *9* for which the optimization was not sufficient. Indeed, product *9* has a sensory profile which is closer to the one of product *17* than to the one of the ideal product to match. However, from a “visual” and “texture during application” point of view, product *9* is the second most appreciated product (Table 3).

To conclude, this study validates the optimization procedure according to the *IPA*. In this example, the products, which have the closer to the ideal profiles, were the most appreciated products. Although it was expected, these results were not guaranteed as the sensory, ideal and hedonic data were measured “independently”.

4. Conclusion

The Ideal Profile Method combined with the Ideal Profile Analysis is a useful tool for product optimization. Compared to the classical procedure involving experts or trained panelists for the product profiles and consumer for the hedonic description of the products, all the information is gathered from the same consumer. A direct link between the way the products were perceived and were liked exists. Moreover, by asking directly the ideal description from the consumers, this important information is directly actionable for guidance on improvement, whether or not the ideals belong to the sensory product space (compared to external preference mapping where extrapolation is not possible).

Additionally, by asking many times the ideal (one time per product), the ideal information gathered allows the user to check if the product set tested belongs to one unique category of product (*i.e.* all the products are associated to one unique ideal). As far as we know, this property is unique to this methodology, all the other Ideal Point Modeling methods assuming a single ideal solution.

Still, this entire methodology would only make sense if the ideal data provided by the consumers is consistent. For that purpose, an indirect methodology which checks for the consistency both from a sensory and a hedonic point of view has been proposed. These methodologies check whether the ideal information is in agreement with the sensory and hedonic descriptions of the products, both at the panel and consumer level.

Acknowledgements

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QUESTION ON IPM: A CASE STUDY ON LEMON JUICE

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Abstract

In food product development, using consumers to obtain ideal products is becoming more frequent in recent years. Despite being an economical way of optimizing products, relying on consumers is, however, not yet widely accepted in the sensory community. The main objectives of this study were to evaluate (1) whether the stability of ideal intensities and ideal products could be improved by providing a frame of references when consumers perform the Ideal Profile Method (IPM) and (2) the effect of the order of the questions on consumers' responses.

In the present study, sixty participants conducted two tasks: (1) rating the perceived and ideal intensities of attributes and (2) reporting the overall liking. They were randomly divided into four groups. Group G1 and G2 used references in rating intensity, whereas group G3 and G4 did not. Concerning the order of question, group G1 and G3 answered the overall liking question before rating the intensity, whereas G2 and G4 followed the inverse order. The experimental design included six lemon juice samples, and four attributes *(pulp, lemon odor, sweetness, and sourness)*. A three-way ANOVA was conducted on the ideal intensities of attributes and overall liking with reference and order as a between-subject factor and product as a within-subject factor.

Results showed that providing a frame of references improved the stability of the ideal attribute *pulp*, but not of the other ideal attributes. Besides, the order effect was without influence on overall liking. For ideal intensities, an order effect was observed on the ideal attribute *pulp* between groups G3 and G4 (without reference), and was not observed between groups G1 and G2 (with references). Several possible modifications to improve the IPM are discussed.

Keywords: *Ideal Profile Method; order effect; food product development*

1. Introduction

Product development plays an important role for all food companies. There are two approaches to develop a food product: the process-oriented approach and the consumer-oriented approach.

The process-oriented approach originally refers to a process in which various ingredients are systematically varied to create a number of different products. These products are then rated by a sample of category users, with each respondent rating overall liking as well as various sensory attributes of the products. The resulting data are then analyzed by analysis of variance (ANOVA), regression and/or response surface analysis in order to obtain the optimal product formulation. The advantage of the process-oriented approach is to control the technical parameters and therefore to set up an optimal formulation. However, this approach has also some limitations. First, consumers' demand is not given special importance even though, after all, the consumers are the buyers (Moskowitz *et al.*, 2006). Second, this approach takes time and resources (Lewis *et al.*, 2010). To overcome these limitations, the consumer-oriented approach focuses on the expectations of potential buyers, and then uses this information to modify a product to satisfy consumers' demand. In the last decades, three consumer-oriented methods (preference mapping, just about right scale, and ideal profile) have been described in the literature.

Preference mapping includes internal preference mapping (Chang & Carroll, 1969) and external preference mapping (Schlich, 1995; Meullenet *et al.*, 2008; Carbonell *et al.*, 2008). Internal preference mapping analyzes overall liking data to give the directions of preferences and to identify consumer segments. External preference mapping relates the overall liking data to sensory attributes generated by trained panelists. Despite their current popularity among sensory scientists, preference mapping techniques have some limitations. The main limitation is that training a panel to describe products is time-consuming, as it takes normally about 4 to 6 months to perform. To overcome this limitation, there has been an increasing interest in the past years in obtaining both sensory and overall liking data directly from consumers. New methods such as Just About Right (JAR) scales and Ideal Profile Method (IPM) have been developed.

JAR scales are commonly used to determine the optimal level of products' attributes. The scales combine intensity and overall liking judgments (Rothman & Parker, 2009); they typically consist of five or seven points, ranging from *too little* to *too much* for a given attribute (Meullenet, Xiong, & Findlay, 2007). The center point can be labeled "just-right" or "just-about-right." Consumers are asked to indicate whether the intensity of each attribute of the food product is *too high*, *too low* or *just about right* in addition to their overall liking. Data analysis is performed by computing the percentage of consumers who evaluated the attributes as *too high*, *too low* or *just about right*. Limitations of JAR scales occur when they are used without asking any additional intensity-related questions. For example, two groups of consumers might both mark a product as "just about right." However, one group might think the product is very strong (the level they prefer), whereas the other group thinks the product is fairly mild (the level they prefer). Thus, the results might mislead product developers into thinking that the participants are from a homogeneous population, while they are really from two different consumer segments (Lawless & Heymann, 1998). Moreover, the task is rather complicated for the consumers as they have to evaluate the intensity of attributes of an actual product and subtract it from the intensity of the same attributes in their ideal product (Punter & Worch, 2009). According to Punter and Worch (2009), it might be simpler to explicitly ask consumers to evaluate both the perceived intensities of the product and the ideal intensities for this type of product as it is done in the Ideal Profile Method (IPM).

IPM has been proposed recently as an alternative to both preference mapping and JAR scales (van Trijp *et al.*, 2007). In addition to evaluate their overall liking of the product, consumers are asked to rate, for a number of attributes, both the perceived intensity of the attribute and the intensity of that attribute if it was ideal. The deviation from the ideal product is then computed and related to overall liking. The IPM presents several advantages. First, absolute intensity information is obtained as well as the position of the ideal product. Second, individual scores can be expressed as deviations from the ideal score. So the directional information that helps to adjust the concentrations of attributes can be obtained. However, like other methods, IPM has its own limitations.

Despite being an economical way of guiding product development, relying on consumers is not yet widely accepted in the sensory community. For instance, Lawless and Heymann (2010) question the ability of untrained consumers to act in an analytical way when they taste products and to precisely understand some specific attributes. Popper *et al.* (2004) pointed out that overall liking of consumers could be altered when analytical questions on specific attributes were involved. Finally, an "ideal product profile" can be constructed only if the samples of consumers are reasonably homogeneous (van Trijp *et al.*, 2007; Punter & Worch, 2009; Lawless & Heymann, 2010).

The main objective of this study was to evaluate whether the stability of ideal intensities and ideal product can be improved by providing a frame of references when consumers perform IPM. Besides, we were also interested in evaluating whether the order of overall liking and intensity questions had an influence on consumers' responses.

2. Research procedure

A three-step procedure *(see Fig.1)* was used in this study. The first step consisted of constructing a product space. The second step consisted of generating the attributes and selecting the samples for the main experiment using Flash Profile (Delarue & Sieffermann, 2004). Finally, the third step included

preparing a frame of references and measuring consumers' ratings in IPM. In the third step, the *reference* factor effect was evaluated by comparing the rating data obtained in two experimental conditions: with references and without references. To evaluate the *order* factor effect, half of the participants began by the liking question and the other half by the intensity question.

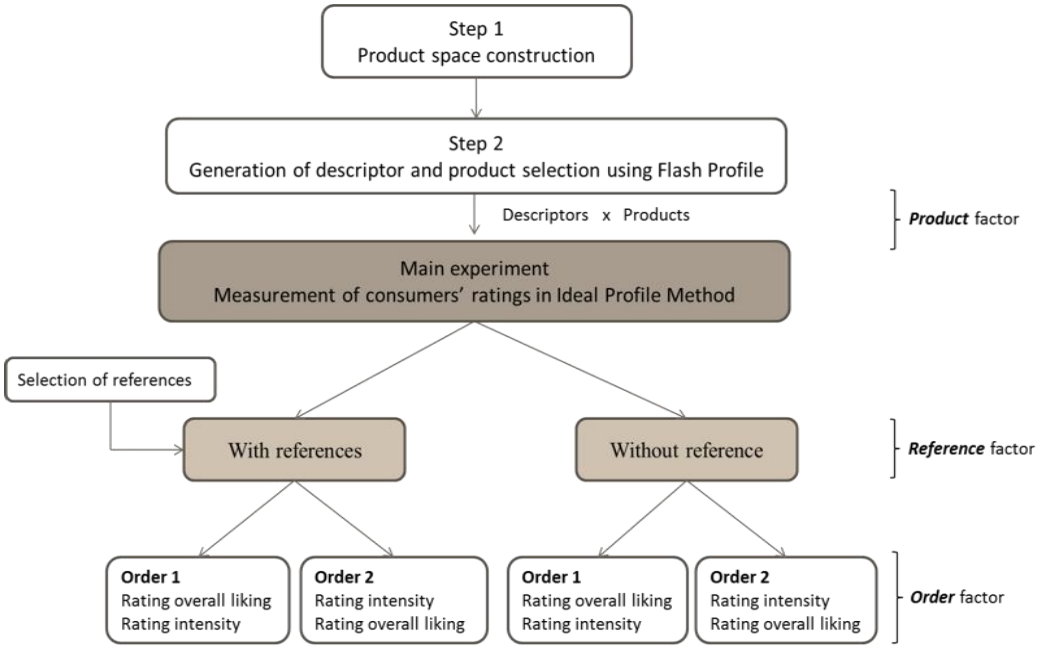

Figure 1: Three-step procedure used to evaluate the effect of *reference* and *order* on overall liking and intensity judgment in IPM.

The goal of the study was to test the two following hypotheses. *Hypothesis 1* – If providing a frame of references improves ideal product stability, we expect a significant *reference* effect and a *reference* by *product* interaction; *Hypothesis 2* – If the order of question (presentation of intensity and overall liking) has an effect on ideal product stability, we expect a significant *order* effect, a *reference* by *order* interaction, and an *order* by *product* interaction.

2.1. Step 1 - Product space construction

2.1.1. Samples

The base product was made by diluting one part of "Pulco Citron Vert" with six parts of water. Two series of samples were then made by adding either sucrose (sweet samples) or citric acid (sour samples) into the base product. The amounts of sucrose added in the base product were 5, 10, 15, 20, and 25 grams per one liter of base product, to make the sweet samples. The added amounts of citric acid were 0.7, 1.4, 2.1, 2.8, and 3.5 grams per one liter base product, to create the sour samples.

2.1.2. Participants

Twenty four staff members (12 men, 12 women, 24 to 40 years old) were recruited from the "*Centre des Science du Goût et de l'Alimentation"* (CSGA).

2.1.3. Procedure

Two series of triangle tests were carried out, one with the *sweet* samples and the other with the *sour* samples. Half of the participants received the *sweet* samples and the other half received the *sour* samples. Each participant was asked to do five triangle tests. For each triangle test, three samples were

prepared from two products: the base product plus one of the products from *the sweet (or sour)* series. All samples were presented in plastic cups coded by 3-digit numbers and were served at ambient temperature (22^0C to 24^0C). Participants tasted the samples from left to right and were asked to chose the odd sample. They were requested to rinse their mouth with water after each test, but not between samples in each test. All sessions were conducted at the sensory laboratory in CSGA.

2.1.4. Data analysis

The number of correct answers for each triangle test was counted. It was then compared to the critical value of the binomial distribution at α risk 0.1%.

Table 1: The 8 samples were varied from 3 factors *product, sourness* and *sweetness.*

Sample	*Product*		*Sourness*		*Sweetness*	
	Pulco Vert	Pulco	C_0	C_1	C_0	C_1
F1	X		X		X	
F2	X		X			X
F3	X			X	X	
F4	X			X		X
F5		X	X		X	
F6		X	X			X
F7		X		X	X	
F8		X		X		X

Pulco citron vert: a lemon juice product of Orangina Schweppes France with the ingredient: water, lemon juice 40%, pulp of lemon 4%, and acidifying. Pulco citron: a lemon juice product of the same company with the ingredient: water, lemon juice (35.5%) and orange juice (4.5%), pulp of lemon 4%, acidifying.

C_0: the concentration of citric acid (and/or sucrose) in base product, C_1: the concentration of citric acid (and/or sucrose) chosen in step 1.

2.1.5. Results

We selected the minimum concentration at which the number of correct answers was more than the number corresponding to the critical value for and alpha level of .05 (equal to 10 in this case). Over a total of 12 answers, the selected concentrations used to vary *sweetness* and *sourness* were 15.0g/l and 3.5g/l respectively. These concentrations were noted as C_1. To formulate samples, a factorial design was constructed with three factors *product*, *sourness* and *sweetness*. Each factor had two levels. For the *product* factor, two lemon juice products were used. For the *sweetness* and *sourness* factors, two concentrations C_0 and C_1 were prepared. Table 1 presents the eight formulated samples.

2.2. Step 2 - Generation of attribute and product selection using Flash Profile

2.2.1. Samples

The eight samples prepared from step 1 were used.

Table 1: The eight samples were varied from three factors *product, sourness* and *sweetness.*

Sample	*Product*		*Sourness*		*Sweetness*	
	Pulco Vert	Pulco	C_0	C_1	C_0	C_1
F1	X		X		X	
F2	X		X			X
F3	X			X	X	
F4	X			X		X
F5		X	X		X	
F6		X	X			X
F7		X		X	X	
F8		X		X		X

2.2.2. Participants

A panel of seven judges (3 men, 4 women, 24÷40 years old) was recruited from the staff at CSGA. The judges were not trained to evaluate lemon juice products before, yet they had participated in descriptive tests.

2.2.3. Procedure

The Flash Profile method was used to generate attributes of lemon juice products. This method was carried out in a single session of one hour including three steps. In the first step, the whole set of products was presented simultaneously to the judges. Each judge observed, smelled, and tasted all samples in order to generate attributes. In the second step, each judge read the lists of other judges to update his/her own list. In the third step, judges ranked all eight samples from “least” to “most” according to their list of attributes (Figure 2).

Attribute : *sweetness*

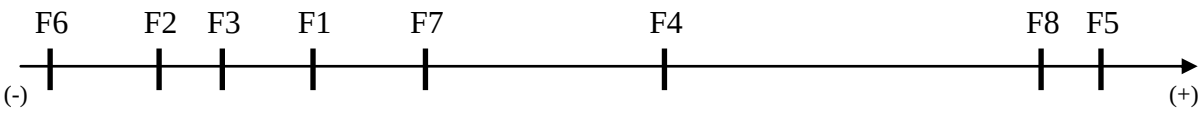

Figure 2: An illustration of ranking the *sweetness* of eight formulations using Flash Profile.

2.2.4. Data analysis

First, the number of citations for each attribute was counted. Second, the ranked data for each attribute were analyzed using Friedman test, with a *p*-value set to $\alpha = 0.10$. Third, Multiple Factor Analysis (MFA) (Pagès, 2005) was used to analyze the data matrix obtained from the samples scored on the individual attributes by the judges. The results of this analysis gave a map of the samples and a map of the attributes generated by each judge to describe the samples. The analysis was conducted by using the R software (R Development Core Team 2011) with the package SensoMineR 1.14 (Husson *et al.*, 2011).

2.2.5. Results

Each judge used between six and seventeen attributes to describe lemon juice products. Fourteen attributes were used by more than two judges (Table 2). The Friedman test showed that six attributes were discriminant at $\alpha = 0.10$. These attributes were *pulp, lemon odor, sourness, sweetness, astringency,* and *pungency*.

The first two dimensions of the MFA accounted for 37.36% and 25.16% of the total variance of the data set (Figure 3). Dimension1 was primarily a function of *pulp* and *lemon odor*, and Dimension 2 opposed *sourness, astringency and pungency* to *sweetness*. All samples were organized in six groups (F1,F4), (F5,F8), (F2), (F6), (F3), and (F7). The samples prepared from product Pulco (F5, F7, and F8) were characterized by *pulp* and *lemon odor*. The F3 and F7 were characterized by *sourness, astringency*, and *pungency*; whereas F2 and F6 were characterized by *sweetness*.

Table 2: Usage frequency and p-value of Friedman test of 14 attributes generated in Flash Profile.

Manner	Attribute		Frequency of citation	p-value
	French	English		
Appearance	*Pulpe*	*Pulp*	5	*0.04*
	Opaque	*Opaque*	5	0.4395
	Jaune	*Yellow*	4	0.7243
Odor	*Citron pressé/ naturel*	*Pressed/ natural lemon juice*	4	*0.07*
	Citron	*Lemon*	2	_
Taste.sensation	*Acide*	*Sour*	7	*8.19e-05*
	Sucré	*Sweet*	6	*8.62e-05*
	Astringent	*Astringent*	5	*0.06*
	Piquant	*Pungent*	4	*0.007*
	Citron	*Lemon*	3	_
	Amer	*Bitter*	2	_
	Salé	*Salty*	2	_
	Gratte la gorge	*Rasp the throat*	2	_
After taste	*Persistant*	*Persistent*	2	_

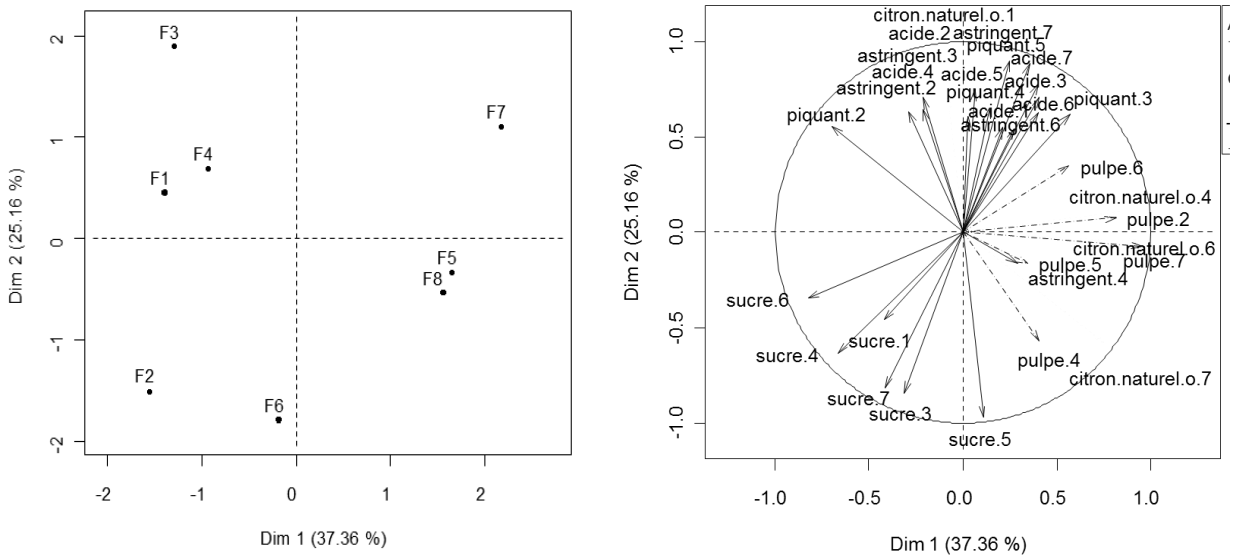

Figure 3: Representation of samples (left) and attributes (right) by the first two dimensions of MFA. Appearance is represented by dotted lines and Taste sensation by solid lines.

2.2.6. Product selection

The attributes used in the main experiment need to be understood by most of consumers. The first criterion to select the attributes for the main experiment was that the attributes were used by more than 50% of judges (3/7 judges). The second one was that the attributes should have the ability to discriminate the samples (Friedman test at p = .10). Six attributes met both criteria. Among these

attributes, four were selected for the main experiment: *pulp*, *lemon odor*, *sweetness* and *sourness*. Moreover, to prevent consumers from adaptation and fatigue, the number of samples was set at six. Samples F1 and F5 were not used in the main experiment because their sensory characteristics were close to that of samples F4 and F8.

2.2.7. Selection of references

References for attributes pulp and lemon odor. As mentioned in the result of step 2, the samples prepared from product Pulco were characterized by the attributes *pulp* and *lemon odor*. Concerning the two references of these attributes, Ref.1 (minimum reference) was prepared from product Pulco Vert and Ref.2 (maximum reference) was prepared from product Pulco citron (Table 3). The same procedure as in Step 1 was used. Two series of dilution were prepared, and each series had five ratios. To make the *weak* series, Ref.1, the dilution ratios of water to product were 6.5, 7.0, 7.5, 8.0 and 8.5 parts of water to 1 part of product. To make the *strong* series, Ref.2, the ratios were 5.5, 5.0, 4.5, 4.0 and 3.5 parts of water to 1 part of product. Six participants received one series and performed five triangle tests.

The correct responses were counted and compared to the critical value of binomial distribution at the level of $p = .01$. With six correct responses, the dilution ratio of Ref.2 was 1:4, and the dilution ratio of Ref.1 was 1:8. The dilutions of Ref.1 and Ref.2 of attribute *odor* were determined in the same way.

References for attributes sweetness and sourness. Concerning the attribute *sweetness*, the sample F1 was used as Ref.1 for the attribute *sweetness*. Ref.2 was prepared from product Pulco from which a *sweet* series with five dilutions was prepared by adding concentrations of sucrose 20, 25, 30, 35, 40 g/l gradually. Three samples for the triangle tests were also prepared from two products: one product at concentration C_1 and one of 5 products from the *sweet* series. Based on the triangle test results, Ref.2 concentration was prepared by adding 30g/l sucrose to base product of Pulco.

Concerning the attribute *sourness*, the sample F5 was used as Ref.1. The pH value of product Pulco Vert was smaller than the pH value of product Pulco. Product Pulco Vert was then varied at 5 concentrations to make a *sour* series to determine concentration of Ref.2 by adding gradually 4.2, 4.9, 5.6, 6.3 and 7.0 g/l of citric acid into the base product. Three samples of triangle tests were also prepared from two products: one product at concentration C_1 and one of five products from the sour series. Based on triangle test results, Ref.2 was prepared by adding 7.0g/l citric acid into the base product of Pulco Vert.

Table 3: Concentration of the two references for attributes *pulp*, *lemon odor*, *sweetness*, and *sourness*.

Manner	Attributes	Minimum reference Ref.1	Maximum reference Ref2
Appearance	*Pulp*		
Odor	*Lemon*	Pulco vert (1:8)	Pulco (1:4)
	Sweetness	Pulco vert (1:6)	Pulco (1:6) + 30g/l sucrose
Taste	*Sourness*	Pulco (1:6)	Pulco vert (1:6) + 7.0g/l citric

3. Main experiment: Measurement of consumers' ratings in IPM

3.1. Materials and methods

3.1.1. Samples

The six samples F2, F3, F4, F6, F7, and F8 were used and noted as P1, P2, P3, P4, P5, and P6 in this experiment.

3.1.2. Participants

Sixty participants (27 men, 33 women, 19 to 60 years old) were recruited. To participate in this study, the participants had to consume lemon juice products at least once a month. They were informed that the study was on lemon juice.

3.2. Procedure

Participants were randomly divided into four groups of 15 participants each (Table 4). Group G1 and G2 received references for intensity ratings, whereas group G3 and G4 did not. Concerning the order of question, group G1 and G3 answered the overall liking question before rating the intensity of attributes, whereas G2 and G4 rated the intensity before answering the overall liking question.

Table 4: Experimental design.

Experimental condition	Overall liking, then intensity rating	Intensity rating, then overall liking
With references	G1	G2
Without reference	G3	G4

To rate the intensities of attributes, participants in groups G1 and G2 were asked to observe, smell, and/or taste the references (Figure 4). They were instructed that the concentration of Ref.1 was anchored at 1/3 of the scale, and the concentration of Ref.2 was anchored at 2/3 of the scale; the endpoint labeled (-) indicates the weak intensity, and the endpoint labeled (+) indicates the strong intensity. After observing/smelling/tasting the references, participants rated the intensities of attributes. For each attribute, they were asked to rate the perceived intensity and then the ideal intensity. After rating the intensity of the four attributes and answering the overall liking question, they went to the next sample.

Figure 4: Illustration of the experimental set up.

Participants of G3 and G4 followed the same procedure as participants of G1 and G2 did; however, they were not provided with the references. Participants were instructed that the scale was marked at 1/3 and 2/3, the endpoint labeled (-) indicated the weak intensity, and the endpoint labeled (+) indicated the strong intensity.

A 150 mm unstructured line scale (marked at 50% and 100%) was used in rating intensities and a 9-point scale was used in rating overall liking (Figure 5)

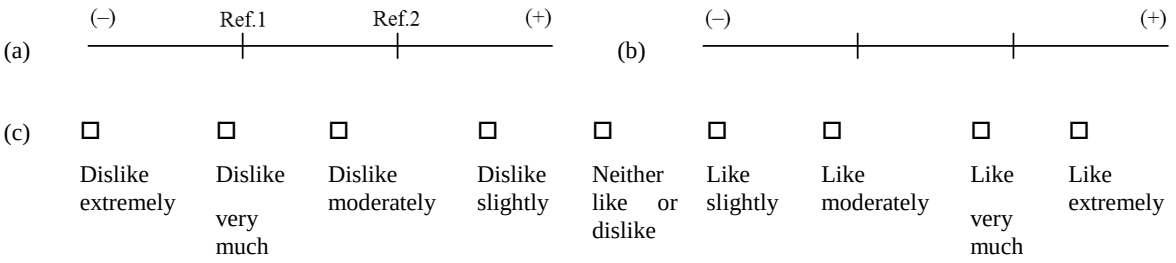

Figure 5: Illustration of the 150mm unstructured line scale used in the two experimental conditions with references (a), without reference (b); and of the overall liking 9 point scale (c).

3.3. Data analysis

3.3.1. Assumptions of IPM

First, the homogeneity of consumers' preference was verified by performing a PCA on the matrix of samples by overall liking score. Second, the differences of overall liking between the samples, as well as the differences of perceived intensities by attributes between the samples were tested using a three-way ANOVA with *reference* and *order* as between-subject variable, and *product* as within-subject variable. Third, if a significant *product* effect was observed, a mean comparison between the samples were performed using TukeyHSD *post hoc* test at p =.05.

3.3.2. Verifying the hypothesis

A three-way ANOVA was conducted on the ideal intensity of the four attributes. In this model, *reference* and *order* were defined as between-subject variables, and *product* as within-subject variable. Besides, the coefficient of variation (CV)[1] of each attribute in each experimental condition was calculated. The analysis was conducted with R software v.2.12.2 (R Development Core Team 2011), with package SensoMineR 1.14 (Husson *et al.*, 2011).

4. Results

4.1. Assumptions of IPM

4.1.1. Are participants taken from a homogeneous population?

Figure 6 presents the first two dimensions of the overall liking PCA. These two dimensions accounted, respectively, for 43.71% and 20.23% of the variance of the data set. Vectors toward the right space of the map represented the responses of participants who liked most samples P1, P3, P4, and P6; whereas vectors S4.10 (participant 10 in G4) and S1.11 (participant 11 in G1) in the lower-left quadrant represented two participants who preferred sample P2. In general, most participants had the same direction of preference with lemon juice samples.

4.1.2. Are all products different in overall liking?

The result of ANOVA showed a significant effect of *product* on overall liking *($F(df=5) = 22.08$, $MSe = 44.33$, $p < .001$)*. A mean comparison showed that samples P1, P3, P4, and P6 were liked more than samples P2 and P5 (Table 5).

[1] The coefficient of variation (CV) is defined as the ratio of the standard deviation to the mean. This parameter represents the ratio of noise/signal. In the context of this study, the CV value characterizes the variation within each group. The smaller the CV value was, the more consensual the participants were.

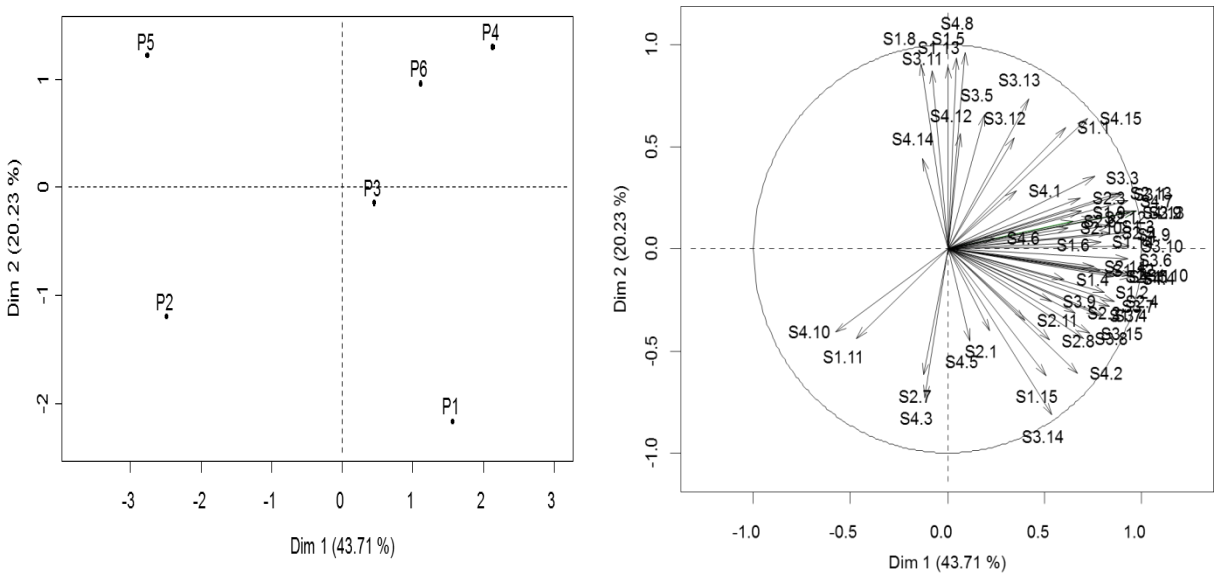

Figure 6: Direction of the preference for the six lemon juice samples.

Table 5: Average scores of overall liking and perceived intensities of the six samples.

Rating question	Samples					
	P1	P2	P3	P4	P5	P6
Overall liking	5.58[b]	3.92[a]	5.15[b]	5.93[b]	4.03[a]	5.60[b]
Pulp	48.15[ab]	46.93[ab]	44.58[b]	70.13[c]	61.13[ac]	56.36[bc]
Lemon odor	69.60[a]	77.93[a]	67.65[a]	68.25[a]	68.45[a]	72.3[a]
Sweetness	59.70[b]	32.31[a]	55.35[b]	64.55[b]	35.92[a]	53.78[b]
Sourness	67.21[bc]	99.88[a]	83.70[ab]	64.85[c]	97.21[a]	77.97[bc]

Correspond to each attribute, share a common letter do not differ significantly from one another (p<.05).

4.1.3. Are all products different in perceived intensities?

A significant effect of product was observed on attributes *pulp (F(df=5) = 11.79, MSe = 5853, p < .001)), sweetness (F(df=5) = 23.93, MSe = 10312, p < .001)*, and *sourness (F(df=5) = 18.49, MSe = 12996, p < .001)*. A mean comparison showed that the *pulp* in sample P4 was larger than that in samples P1, P2 and P3; the *sweetness* of samples P2 and P5 was weaker than the *sweetness* of other samples, whereas the *sourness* of samples P2 and P5 was stronger than that in other samples. No *product* effect was observed on the attribute *lemon odor (F(df=5) = 1.06, MSe =917.5, p = .38)*.

4.2. Stability of ideal product evaluation.

4.2.1. Does the frame of references influence on ideal intensity?

Table 6 presents the *p-value* of a three-way ANOVA performed with *reference*, *order*, and *product* on ideal intensity of attributes. There was no significant effect of *reference* on attributes *sweetness.id*[2] *(F(df=1) = 0.005, MSe = 11, p = .94)*. However, a significant effect of *reference* was observed on attributes *pulp.id (F(df=1) = 5.20, MSe = 14314, p = .026), lemon odor.id (F(df=1) = 8.99, MSe = 16430, p = .004))*, and *sourness.id (F(df=1) = 3.58, MSe = 9996, p =.06)*. This result indicated that for the attributes *pulp.id*, *odor.id* and *sourness.id*, the ideal intensities obtained in the experimental condition with references were different from those obtained in the experimental condition without reference.

[2] *id*: ideal attribute. For example: *sweetness.id* is the ideal attribute *sweetness.*

Table 6: The *p-value* of three-ways ANOVA test on ideal intensity of four attributes.

Source of variance	Ideal Intensity			
	Pulp.id	*Lemon odor.id*	*Sweetness.id*	*Sourness.id*
Reference	*0.0263**	*0.0040***	0.9459	*0.0636.*
Order	0.2390	0.9589	0.6304	0.3725
Reference:Order	*0.0380**	0.9062	0.5152	0.6192
Product	0.3111	0.6262	*0.0085***	0.7185
Reference:Product	0.1609	0.8234	0.8214	0.8450
Order:Product	0.9081	0.8139	0.4650	0.2095
Reference:Order:Product	0.9613	*0.0475**	0.5163	0.5535

Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table 7: Coefficient of variation between the two experimental conditions.

Attribute	Experimental condition	
	With references	Without reference
Pulp.id	0.32	0.38
Lemon odor.id	0.29	0.24
Sweetness.id	0.30	0.28
Sourness.id	0.39	0.36

4.2.2. Does providing a frame of references make ideal intensity more consensual?

The CV of each attribute in each experimental condition was calculated and presented in Table 7. The smaller CV was, the larger the consensus between participants was. A difference in consensus was observed only for the attribute *pulp.id*. A higher consensus was observed in the frame of reference condition.

4.2.3. Is the ideal product unique?

A significant effect of *product* was observed for the attribute *sweetness.id* $(F(df=5) = 3.16, MSe = 669.3, p = .008)$. However, a mean comparison showed that there was no significant difference on attributes *sweetness.id* between the samples. Besides, the effect of *product* was not observed on ideal attributes *pulp.id*, *lemon odor.id*, and *sourness.id*. In general, the four attributes of the ideal profile of lemon juice product were not differently perceived between the products.

4.3. Order effect

4.3.1. Is there an order effect on overall liking?

The *order* effect was without influence on overall liking $(F(df=1) = 0.13, MSe = 0.62, p = .71)$. Besides, the result showed that there was no significant interaction of *reference* by *order* $(F(df=1) = 0.49, MSe = 2.33, p = .48)$, and *order* by *product* $(F(df=5) = 0.97, MSe = 1.95, p = .43)$ on overall liking.

4.3.2. Is there an order effect on ideal intensity?

A significant *reference* by *order* interaction was observed for the attribute *pulp.id* $(F(df=1) = 4.51, MSe = 12414, p = .038)$ (Table 6). The difference between the four groups G1, G2, G3, and G4 was determined by TukeyHSD *post hoc* comparison and illustrated in Figure 7. Result showed a significant difference between the group G3 and G4 (without reference), but not between groups G1 and G2 (with references).

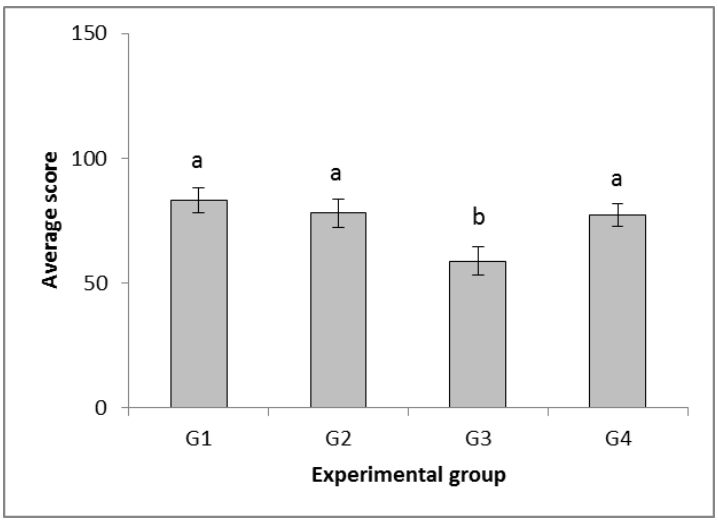

Figure 7: Illustration of *reference* by *order* interaction on attribute *pulp.id*. G1: with references, overall liking/intensity, G2: with references, intensity/overall liking, G3: without reference, overall liking/intensity, G4: without reference, intensity/overall liking.

4.4. Effect of product on reference by order interaction

A three-way interaction *reference* by *order* by *product* was also observed for the attribute *lemonodor.id [F(df=5) = 2.77, MSe = 717.4, p = .0475]* (Table 6). The three-way interaction implied that *reference* by *order* interaction was affected by *product*. However, a mean comparison failed to show any significant difference between groups by *product*. For other attributes, no significant three-way interaction was observed.

5. Conclusion

The issue of experts versus consumers is a strong debate in the sensory community. Some authors are sensitive of the reliable capacities of consumers' rating (Worch *et al., 2010;* Moskowitz, Muñoz, & Gacula, *2003*), whereas others express doubt in it (Lawless & Heymann, 2010). This study addressed a small part of this complex question in the framework of IPM.

The results showed that providing a frame of references could improve the stability of only one attribute *pulp.id*. Popper *et al.* (2004) and Earthy *et al.* (1997) pointed out the effect of question *order* on overall liking. However, in the present study, no effect of question *order* was observed. The data showed that, for ideal intensities, this effect was observed on the attribute *pulp.id* between groups G3 and G4 (without reference), but not between groups G1 and G2 (with references).

Although we attempted to offer a frame of references for all studied attributes, this frame of references proves useful for attribute pulp.id, but not for the other attributes. This suggests that, references might be more efficient for visual attributes than for chemical stimulus. This might be due to the fact that contrary to olfactory or gustatory references, visual references do not need to be memorized. For sensory modalities requiring some memory storage some training might be necessary for references to be efficient. However, additional work is needed to verify this hypothesis.

Concerning the methodological aspect, the Ideal Profile is a quick and easy method to meet industrial needs in food product development. However, it also has some limitations. The implication of this study is to propose two modifications to improve the Ideal Profile.

With references, participants can have a better understanding of attributes. However, using references is time consuming (i.e., to select and prepare the references), and required participants to taste more samples than in classical IPM. To overcome these disadvantages, experimenters might use some pre-tests to better understand their product space. This step could help in choosing attributes needing references.

Ideal attributes should be evaluated only once after the participants rate all samples for the two following reasons. First, if each ideal product is obtained for each formulation, and a final ideal product is obtained by computing the average of all ideal products, it may pose a risk. From a statistical point of view, the concentrations of ideal attributes of the final ideal product may be the average of all ideal products. Hence, we can get an imprecise lead in optimizing intensities/product. Second, from an empirical point of view, generating only one ideal product can decrease the demand on participants and, hence, save time for tasting additional samples.

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APPLICATION OF CHOICE-BASED CONJOINT ANALYSIS FOR CONSUMER PREFERENCE ON DOG'S PET FOOD PRODUCT IN THAILAND

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Abstract

This research was to study consumer preference on dog's pet food products in Thailand by using choice-based conjoint analysis. The empirical analysis used consumer-level questionnaire to elicit information regarding four attributes (formation, price, quality-brand and nutrition) with three elements of dog's pet food (canned, pouch, dry for formation; with pricing 85, 135, 165 baht per kilogram; unbranded, commercial, premium for brand-quality; fulfilled nutrition, silky hair and skin condition, dog preference for nutrition). The results showed that the important attributes were "formation", "quality", "nutrition" and "price". However, when we considered within elements of each attribute the result from coefficient values of condition logistic regression analysis by using the R program demonstrated that "dry" element from formation attribute had the most effect on the utility score. Followed by elements of "pouch", "can", "premium", "dog preference", "unbranded", "commercial", "silky and hair condition", and "85 baht per kilogram" respectively. The application of choice-based conjoint analysis from this research provided useful insights, high-potential product identification and consumer preference trends.

Keywords: *Choice-based conjoint analysis, preference measurement, utility score, pet food*

1. Introduction

The dog's pet food is one of the important products in Thailand. In recent year, the Bank of Thailand has reported the increased consumption of pet food in Thailand in 2010 compared to the previous year from 23,986 to 25,402 million baht or equaled to 5.90 percent. Furthermore, in 2011 the frequency of consumption dramatically increased to 10.81 percent or grew to around 28,148.80 million baht annually (BOT, 2012). However, many studies about pet food products in Thailand are not developed enough for product development researches. This result showed the importance of studying attitudes and preferences of Thai consumer toward dog's pet food products. This is especially true in Bangkok, the capital Thailand, one of the largest targets of consumers who buy dog's pet food for reasons of convenience to use (Konthip, 2006).

Most researches about dog's pet food have focused on questions related to consumer perception on qualities of dog's pet food in order to improve the understanding and prediction of product choices and to provide inspiration to consumer-oriented new product development (Jaeger, & Hal, 2010). Thus, evaluation of consumer preferences on products provides product developers useful insights, identifies high-potential products and explains gross trends in attribute influencing consumer preferences. Furthermore, it is also allows to improve product characteristics that respond to consumer's needs. Thus, the insight into how quality expectation is formed and how consumers experience the quality after purchase are vital inputs in product development and innovation process (Jaeger, & Hal, 2010).

The aim of this research was to study consumer preference on dog's pet food products in Thailand by using choice-based conjoint analysis. The conjoint analysis is a method or technique for studying the utility of a product and decomposed it into attribute utilities and levels or elements. By choosing alternative profiles, the preferences were measured to estimate utility functions, which explain its cross-disciplinary interest (Helme, & Markku, 2011).

2. Conjoint analysis (CA)

Conjoint analysis is a technique for measuring psychological judgments. It is used frequently in marketing research to measure consumer's preferences. It is also called trade-off analysis (Raz *et al.*, 2008). CA has been used in various fields such as new product planning for determining the preference effect of innovation, improving existing products, pricing policies, advertising and distribution fields (Gustafsson *et al.*, 2007). This method is extensively used in marketing research to evaluate industrial products and services and is being increasingly used in the study of food choice by consumers (Raz *et al.*, 2008). The reasons for this growth are the introduction of efficient, easy-to-use, reliable, and commercially available software and estimation approaches that produce estimates on an individual level (Halme, & Markku, 2011).

The objectives of CA are (Raz *et al.*, 2008):

1. to measure the importance for consumers of various attributes for the development of a product (i.e. the formulation, the brand or the type of packaging)
2. to measure the respective utilities of the levels or elements taken by a given attribute for the consumers. The level of an attribute is either a degree of intensity or an option (i.e. the valorization of a brand compared to others considered to be less attractive)
3. to describe and quantify the prospect customers for a given product
4. to determine the characteristics of an ideal product for a group of consumers.

CA has been a marketer's favorite methodology for eliciting consumer preferences. Ranking, rating and choice-based types of CA have been developed as well as different techniques to estimate part-worth utilities (Meißner, & Decker, 2009). After identifying relevant attributes from consumer's interviews, the basis of CA approach is to define realistic elements (or levels) for each of these attributes, combining them into a factorial design. The attribute combinations derived from the factorial design define a set of product concepts or profiles to be tested. Then a survey is conducted, where respondents are confronted with the product profiles in the form of a verbal description and/or pictures and ask to indicate their preferences (Jaeger, & MacFie, 2010). The preferences will be explained and predicted by estimating all product concepts in which specific attributes varied. The products are evaluated by respondents to evaluate the consumer's preferences. Accordingly, each product profile is assigned with a specific overall benefit value. The estimation of each attribute (partial benefits) that make the overall preference is done by using a logistic regression approach considering product attributes, which will be estimated for utility score (Haaijer, & Wedel, 2007).

The Conjoint analysis method produces two important results (Chee, 2004) :

1. Utility of attribute: an expression of how consumer places the numerical value of the attribute levels or elements. It represents the relative "worth" of the attribute. Low utility indicates less value, high utility indicates more value.
2. The relative importance of attribute which can be calculated by examining the difference between the lowest and highest utilities across the level or element of the attribute.

Two different conjoint analysis methods can be used depending on the data requirements (Jaeger, & MacFie, 2010). The traditional method is called conjoint analysis (CA). This method needs the

respondents to rate the product profiles on a metric scale or rank them in term of preference. The second method is called choice-based conjoint analysis (CBC). In this method, the respondents are required to choose the most preferred choice among alternative choices in order to provide consumer' preferences.

CBC approaches have recently increased in popularity (Halme, & Markku, 2011) because CBC was created to overcome several critical assumptions inherent in the CA design that could lead to incorrect predictions. The CBC seems to be more realistic and natural for respondents including ability to modeling interaction, cross-elasticity and multiple constant alternatives (Kallas, *et al*., 2011). Moreover, the CBC has some advantages when it is compared with traditional conjoint analysis (CA). The choice sets of CBC are more realistic than the ranking or rating task of CA, so respondents can evaluate a large number of profiles (Haaijer, & Wedel, 2007). Because of its realism in mimicking individual choice processes, CBC is most often used in market simulations to predict market shares and used to develop pricing strategies (Meißner, & Decker, 2009).

3. Choice based conjoint analysis (CBC)

As mention above, the CBC is one of the most frequently used methods in the exploration of individual preferences. This method has been applied to "complex goods", *i.e*., goods that comprise several parts or attributes, such as food products (Kallas *et al.*, 2011). In CA, all profiles are presented to the respondents while in the choice approach, the total set of profiles is divided into several choice sets and respondents can choose their most preferred alternative choice from each choice set (Haaijer, & Wedel, 2007). Choice sets are constructed from product attributes and their levels or elements. The choice-based approach offers two or more "choice sets" to respondents.

CBC has some advantages when compared with CA. It seems to be more realistic and natural for respondents when they make a decision to buy products. There are no differences in response scales between individual respondents. The choice tasks are more realistic than the ranking or rating tasks and respondents can evaluate a large number of profiles. The choice probabilities can be directly estimated (Haaijer, & Wedel, 2007).

Another advantage of the CBC compared to the CA method as mentioned by Elrod and Keith (2008) is the information obtained from decision-making. The CBC method can show what consumers really do when buying the product, which is the type of behavior that marketers usually seek to predict. An important benefit of CBC method is that models commonly used to explain combination of attributes might be fully described in terms of relative importance of the attributes and elements**.**

As mentioned above in the CA method. The utility represents the value the consumer places in an attribute level or element. Then, the contribution of an attribute level or element to the total utility is called a "part-worth" and the total utility of the profile is equal to the sum of the part-worth. (Haaijer, & Wedel, 2007; Kallas *et al.*, 2011). In order to set total utility model for the CA method, we define random utility maximization for each element as followed:

$$U_n = e_k + \sum_k \beta_k X_k \qquad (1)$$

Where : is the total utility of element from individual

U_n is the total utility of element from individual n
: X_k is a set of elements k in profile
: β_k is a coefficient value of each element
: e_n is an error term
(adapted from: Haaijer, & Wedel, 2007; Kallas *et al*., 2011)

The CBC is a technique based on an application of the characteristic Lancaster's theory of value (Lancaster, 1966), which proposed that utilities for products can be de composed into separable utilities for their attributes and Thurstone's Law of Comparative Judgment between pairs of offerings characteristic choice (Thurstone, 1927)), the random utility model approach to explain gross trends in decisions of individual n (Haaijer, & Wedel, 2007).which assume d that an event that the individual n will choose the alternative i rather than j when the utility of alternative i is greater than utility of alternative j . In the CBC method, each respondent had to choose one alternative from a choice set, containing product profiles. The choice set is constructed by varying the sets of product profiles (Haaijer & Wedel, 2007).

In order to determine the weight coefficient value of each element, a condition logit model has been applied in various researches. It also has been used for the statistical analysis in CBC studies. In CBC method, the probability of an alternative choice is related to its utility. The form of utility function in Eq. (1) must be redefined. The most common assumption of this function is separable, additive, and linear (Aizaki, Kazushi, 2008; Kallas *et al*., 2011). The CBC model can be expressed as:

$$U_{in} = ASC + \sum_k \beta_k X_{ki} \qquad ; \quad i = 1, \dots, I \quad (2)$$

Where : U_{in} is the utility of alternative i from individual n
: ASC is an alternative specific constant for alterative
: β_k is a set of coefficient value in element k
: X_{ki} is a set of elements k in alternative i

As an alternative within CBC method, a based-alternative called "no-choice" can be added to each choice set. An advantage of the CBC method is having this based-alternative for determining product which under qualified. However, the inclusion of a "no-choice" alternative in a choice set provides no information on the alternatives and attributes. Then, it must be noticed another potential problem when consumers choose the "no-choice" option. The respondents may choose it because of some attributes or elements, for instance, brand or prices that they are interested in are not available in the choice set. Another reason to choose the "no-choice" may be that respondents are not interested at all in doing the task. Finally, respondents may find that the choice is too difficult and choose the "no-choice" to spend less time on the choice task and avoid the difficult decision making. In these cases, researchers need to be careful how to interpret the estimated no-choice probability (Haaijer, & Wedel, 2007). Moreover, the number of attributes and levels play an importance role in experimental design. Gao *et al.* (2010) and Kallas *et al*. (2011) mentioned that using more attributes leads the number of choices set that respondents face grows exponentially and the design of CBC becomes too complicated to reflect real-life choices. In our study, we used the CBC method with two alternatives. Each alternative had four three-level attributes and the total combination of attribute levels or choice sets was 81 (3^4) for each alternative.

In order to maintain a reasonable number of alternatives in the choice set , a fractional factorial design was as described by Aizaki and Kazushi (2008). In this study had considered the impact of "price" and "quality-brand". The main attributes price and brand can be used in the CBC method. However, the inclusion of brand may lead to complications because it may represent implicit attributes such as quality. Furthermore, having price as a separate attribute may lead to unrealistic profiles (Haaijer, & Wedel, 2007). However, unrealistic price-brand in the profiles may occur. Then, after identifying the relevant attributes, the basis of approach is to define the reasonable elements (or levels) for each of these attributes in product profile before creating the choice-set in CBC.

Many studies had demonstrated the feasibility of using the CBC method in order to better understand consumer's behavior and to design effective market strategies. In 2008, Aizaki and Kazushi studied the consumer preferences on milk products by using CBC. The results showed that the relative importance of attributes affects consumer's preferences. Their studies also investigated consumer preferences with a demographic variable of gender and the variable of price, they found that there was

no significant interaction between the female consumer and price. In 2012, Tempesta and Vecchiato studied how individual preferences on milk territorial factors affect milk purchase in Italy by using the CBC method. The results showed the relation of that the important attributes relative to the consumer's preferences. Furthermore, their study also demonstrated the feasibility of using the CBC method in estimating willingness to pay (WTP) of consumers while considering the interaction between prices and quantity attribute.

Some studies had an aim to study individual preference by using choice-based conjoint analysis in consumer decisions on their preferences compared to the analytical hierarchy process (AHP) method. Many results from these such as the study of individual preference on coffee brewers using CBC (Meißner, & Decker, 2009) showed important attributes to the consumer preferences were "Price of a cup of coffee: 34%", "Price of machine: 22%", "Material: 20%", "Brand: 9%", "Design: 8%", and "System: 7%" subsequently. The study demonstrated that the results from using CBC compared with using the AHP approach were quite similar on the aggregate level. The study also indicated that CBC was a good alternative method for estimating values of individual attribute outperforming choice-based approach in market share predictions.

4. Methodological background creating choice sets in experiment and data generation

In the empirical application of choice-based conjoint analysis, the first step was to ensure a valid representation of attributes and elements. All attributes should be included within the hypothetical products in a balanced and equilibrated way (Kallas, & Gil, 2011).

The empirical analysis of this research used consumer-level questionnaires to elicit information regarding to four attributes (formation, price, quality-brand and nutrition) with three elements of dog's pet food(can, pouch, dry for formation; 85, 135, 165 baht per one kilogram for price; unbranded, commercial, premium for brand-quality; fulfilled nutrition, silky hair and skin condition, dog preference for nutrition).Conjoint measurement referred to a set of procedures that investigated responses to the mixtures of independent stimuli in an attempt to understand the contributions of these stimuli to the mixture (Moskowitz, & Matthias, 2006).

The attributes and their respective factor levels of choice-based conjoint analysis used in this research are shown in Figure 1. It demonstrates the attributes of dog's pet food in hierarchical structure. Three attributes of dog's pet food were qualitative variables for "formation", "quality-brand' and "nutrition" attributes and a quantitative variable for "price" attribute. Each attribute can be decomposed into three sub-level or elements.

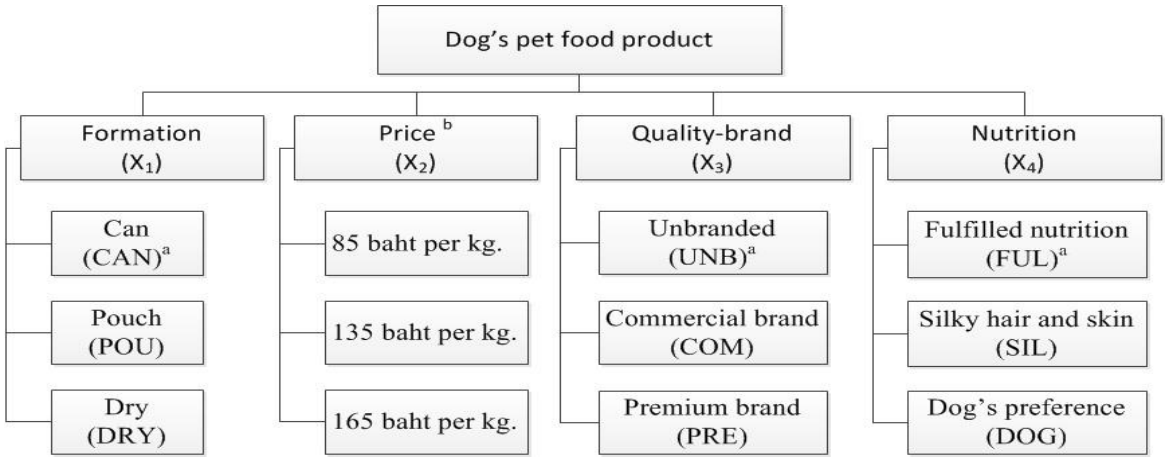

Figure 1. Attributes and elements of dog's pet food products in hierarchical structure [a] Based elements for condition logit model, [b] Price is a quantitative variable

Among the available experimental designs, the "factorial design" is one of the most used. The full factorial design has the advantage, from a statistical point of view, of ensuring that all main and

interaction effects among attributes and levels are independently estimated (the orthogonal property). Despite of this advantage, it also suffers from the problem of the generated number of choice sets increasing exponentially with the number of attributes and elements, reaching numbers beyond the capacity and the ability of a respondent to choose among them. As a solution to this difficulty, a fractional factorial design is used for this research to select some choice sets from the all possible combinations. The identification of the orthogonal fractional factorial design allows creating different and independent choice sets.

The total choice sets could be created by using the "gen.factorialfunction" of Algdesign package (Wheeler, 2011a) as a package of R program (R Development Core Team, 2010). Regarding the four attributes with three elements (3^n; n =4) from Figure 1, there were (3 x 3 x 3 x 3) or 279 possible combinations of profiles that could be selected by respondents. In order to avoid an overload effect for respondents, the choice sets were designed by using "optFederov function" of the Algdesign package (Wheeler, 2011b). This package was also used for generating the fractional factorial design from full factorial design to reduce the number of choice sets from 279 to 27. How to generate choice sets in this research was guided by Aizaki and Nishimura (2008), who designed choice sets by using R Program. The Table 1 shows an example of questions and a choice set using for survey procedures. After that respondent selected one choice set among three alternative choice sets.

The final sample size of respondents consisted of 41 Thai respondents located in Bangkok, Thailand, who always purchase dog's pet food available in Thai market. The design consisted of 27 choice sets with two product profiles and a no-choice option. Each profile featured four attributes with three elements including the price (Figure 1).

Table 1. Example of questions and a choice set of this research

If you were in the market to buy dog's pet food these were your only option, which would you choose?

Attributes	Alternative "A"	Alternative "B"	Alternative "C"
Formation	Dry	Pouch	Neither dog's pet food A nor B is preferred
Price per 1 kg	135 baht	165 baht	
Quality Brand	Unbranded	Commercial Brand	
Nutrition	Fulfilled nutrition	Dog preference	
	□A	□B	□C

Consumer data were collected using face to face interviewing with questionnaires. This survey was carried out during 20–22th April 2012. For each questionnaire, each respondent had to provide his or her characteristics and perceptions toward dog's pet food and respondents were briefly explained about definitions of product attributes and elements that they considered when purchasing products by using photos of sample products as the stimulus items (Figure2.)

Can □ Pouch 1.3 Dry

Figure 2. Photos of the three dog's pet food products used as samples

Using the attributes and elements of dog's pet food products shown in Figure 1 and the relation of "part worth" described in equation (2), the utility model for dog's pet food was computed as:

$$\text{Utility} = ASC^* + \beta_{11}(X_{11}) + \beta_{12}(X_{12}) + \beta_2(X_2)^* + \beta_{13}(X_{13}) + \beta_{31}(X_{31}) + \beta_{32}(X_{32}) + \beta_{33}(X_{33}) + \beta_{41}(X_{41}) + \beta_{42}(X_{42}) + \beta_{43}(X_{43}) \quad (3)$$

where : ASC is an alternative specific constant

βi_s are the coefficient values of elements

X_2 is a quantitative variable.

To estimate the part-worth utilities of dog's pet food products, we considered only the attributes that can partially explain utility (Kallas *et al.*, 2011). Thus, attributes and elements of dog's pet food products of this research (Figure 1) were created from the utility function in the CBC model from equation. (3) by transforming variables into element codes given by:

$$\text{Utility} = ASC^* + \beta_{can}(CAN) + \beta_{pou}(POU) + \beta_{dry}(DRY) + \beta_{unb}(UNB) + \beta_{com}(COM) + \beta_{pre}(PRE) + \beta_{ful}(FUL) + \beta_{sil}(SIL) + \beta_{dog}(DOG) + \beta_{pri}(PRI) \quad (4)$$

*Noted that : ASC was an alternative specific constant for dog's pet food

PRI" was a quantitative variable comprised of 85, 135 and 165 baht per kg.

: βi_s; ($\beta i_s = \beta_{can}, \beta_{pou}, \beta_{dry}, \beta_{unb}, \beta_{com}, \beta_{pre}, \beta_{ful}, \beta_{sil}, \beta_{pri}$) were coefficient values of elements

Data analysis was performed using the survival package (Therneau, & Thomas, 2011) in R program version 2.13.0 to achieve the conditional logit model.

5. Results

Table 2 shows the statistical values of variables giving the conditional logit model for reporting coefficient values. According to likelihood ratio test, we can reject the null hypothesis that presented "all coefficients were equal to zero". The ASC variable in the conditional logit model was an alternative specific constant for each type of dog's pet food. In this study, positive coefficients were associated with the elements "dry", "premium", "fulfilled nutrition", and "silky hair and skin condition" indicating that higher utility score were associated with these elements. On the other hand negative coefficients were associated with the elements "commercial", "unbranded", "dog's preference", "can", and "pouch" indicating that lower utility score were associated with these elements. Moreover, a negative coefficient value was associated with the quantitative variable "price" indicating that the utility score would increase when the level of "price" decreased. We can conclude that a product profile containing the elements "dry", "premium", "fulfill nutrition", and "85 baht per kg." will be preferred by most Thai consumers.

The coefficient values shown in Table 3 indicate that the important attributes were "formation", "quality", "nutrition" and "price". However, when considering each element of attributes, the result from coefficient values of condition logistic regression indicated that the "dry" element of formation attributes had the largest effect on utility score, followed by "pouch", "can", "premium", "dog's preference", "unbranded", "commercial", "silky hair and skin condition", and "85 baht per kilogram" respectively.

When we considered only the formation of dogs' pet food, it was found that respondents preferred the "dry" aspect (Figure 1) of dogs' pet food (coefficient value = 2.28242). This result was similar to the study of Konthip (2006) reporting that consumers who lived in Bangkok considered "convenience to

use" attribute of dog's pet food as the first priority when they feed their dogs. Then, pet food in can and/or pouch formation had lower utility values than "dry" formation. The high utility score of "dry" formation should come from "saving time when preparation", "hygiene of preparation", "easy to buy", and "no cooking by themselves" (Konthip, 2006). Furthermore, when we considered only the nutrition attribute, we found that the "fulfill nutrition" had more effect on the utility score than "silky hair and skin condition" and "dog's preference". This result was similar to the brand-quality attributes that showed higher effect on the utility score when having "premium" than having "commercial" and "unbranded" of brand-quality in profiles.

Table 2. Results of the choice-based conjoint analysis

Variables	Coefficients	Standard error	p-value
ASC	2.80995	0.24693	0.00000
Can	-1.03691	0.12243	0.00000
Pouch	-1.24551	0.13686	0.00000
Dry[a]	2.28242[b]	NA	NA
Price	-0.00334	0.00146	0.02200
Unbranded	-0.39265	0.12131	0.00120
Commercial	-0.14936	0.12749	0.24000
Premium [a]	0.54201[b]	NA	NA
Fulfilled nutrition	0.38251	0.10021	0.00014
Silky hair and skin condition	0.14234	0.11832	0.23000
Dog's preference[a]	-0.52485[b]	NA	NA
Summary Statistic			
No. of observations		3318	
No. of missing data		3	
Likelihood ratio test = 34.5 on 8 df, p-value =1.87e-06			

[a] Based element of attributes,
[b] Coefficient of the reference element (β_0) were calculated as : β_1 x (-1) + β_2 x (-1) following the effect coding procedure.
NA : variances and p-values can be obtained by re-estimating the model by changing the based element of the attributes.

Table 3 Relative importance of the attributes and element from choice-based conjoint analysis

CBC results		Relative importance
Elements	Coefficients	
Dry	2.28242	1
Premium	0.54201	2
Fulfill nutrition	0.38251	3
Silky hair and skin condition	0.14234	4
Price[a]	-0.00334	5
Commercial	-0.14936	6
Unbranded	-0.39265	7
Dog's preference	-0.52485	8
Can	-1.03691	9
Pouch	-1.24551	10

[a] price was qualitative variable as attribute in this study

When using a CBC method to study consumer decision making, the result from Table 3 showed some noticeable values from the estimation. “Dry” element seemed to be the most distinguished when compared to the other elements. The positive value of “Dry” element made consumers choose the product. Showing a “Dry” element in profiles of choice sets, causes respondents to pay more attention to it, and ignore the remaining attributes in a profile. This fact was already mentioned by Kallas *et al.*, (2011) that CBC estimates may tend to be overestimated when valuing complex goods. Moreover, Table 4 showed that the lowest important elements for consumer preference were “pouch” followed by “can” and “dog’s preference”. The negative sign indicate that Thai consumers do not show interest in buying the product when these elements are available in the profile. As mentioned above, the advantage of the CBC method is that it can show consumer’s decision making behavior, which marketers usually seek to predict and explain combination of attributes in terms of the attribute and element.

6. Conclusion and recommendation

In order to deal with evaluation of consumer preferences relating to product by using choice-based conjoint analysis, the study used dog’s pet food available in market Bangkok, Thailand as a case study. The results illustrated that relevant attributes and trends in each element influenced consumer’s preferences on dog’s pet food. These results are useful not only for product developers when they want to have insight into key attributes used by consumers to buy the product in the market, but also to help product developers to explain how the consumer trade-off between attributes. Furthermore, the CBC method allows product developers to identify high potential products that trigger consumer’s preferences. For the future study of CBC method on dog’s pet food preferences, we recommend that the researchers focus on “dry” formation of pet food in size and shape of product and “fulfill nutrition” in functional pet food for dog including health conditions and sport competition. Finally, this research has demonstrated that the CBC method is an applicable method for measuring Thai consumer’s preferences.

This study demonstrated that the CBC method is an interesting and a good practical method to be applied in food science for creating useful models of preference. This method seemed to be more realistic and natural for respondents when they make decisions. However, there are some constraints in using CBC method for determining consumer’s preferences. As mentioned above, as the CBC method relies on fractional factorial design for creating choice sets, there are more attributes and levels leading to a more complex decision making due to the size of the experiment, so the design of choice-set often become more complicated. This causes over assumption when respondents makes decision in CBC questionnaires. Thus, in order to gain better insight into consumer preference for complex goods, we recommend that CBC method can be used together with the other methods such as the analytical hierarchy method to assess individual preferences or using the CBC method together with a nine-point hedonic scale in order to understand consumer preferences with sensory information. In the future, our study will aim to apply the analytical hierarchy process on dog’s pet food in Thailand.

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PART 2

Food Choices and Consumer Behaviour Studies

EFFECTS OF GERMINATED RICE BEVERAGES ON CONSUMERS'STRESS REDUCTION

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Abstract

This study aimed to test the effects of germinated rice beverage on consumer's stress reduction in comparison to drinking water. The Visual Analogue Stress Scale (VASS) was applied to construct the scale for stress evaluation with 50 subjects (test twice per a sample). Scale reliability in measuring stress was tested by internal consistency. The results showed that after drinking the 100% germinated drinks for 30, 60 and 90 minutes, stress and blood pressure mean scores were reduced more than those obtained from drinking water and 50% germinated drinks ($p < 0.05$). But heart rate mean scores were reduced after drinking the 100% germinated drinks only for 90 minutes, more than those obtained from both drinks ($p < 0.05$). The VASS shows high reliability. In addition, the 100% germinated drinks received higher consumer liking, willingness to pay and pricing mean scores than drinking water and 50% germinated drinks ($p < 0.05$).

Keywords: *Stress, germinated rice beverages, visual analogue scale, scale reliability, physiological changes*

1. Introduction

Stress is a negative mood (Parncharoen, 2005), leads to mental and physical problems (Hinthong, 2008). Stress can come from any events or pressures and lead to frustrated, angry or nervous (Green, 2012). It causes depression, anxiety or concern, can be short or long-term, is perceived as outside of our coping abilities, feels unpleasant and decreases performance (Thanirath, 2009). Anxiety can bedefined as a state of nervousness, fear, worry, unease or apprehension (Green, 2012).

Rogers (1996) reports that the effects of food on mood are mediated by physiological mechanisms and may feedback influence food preference and consumption. The beneficial effects of mood are believed to affect food and drink choice (Smit, & Rogers, 2002). There has been substantial interest in the effects of food or drink on mood (Christensen, 2001; Appleton and Rogers, 2004). There are related studies such as the effects of drinks on fatigue reduction by Khajarern *et al.* (2010). If an individual believes that consumption of a particular food or drink has advantageous effects, it seems reasonable they should be more willing to pick out that product and when a product has unpleasant effects then that should lead to product avoidance (Roger *et al.*, 1994). Identifying the effects of food or drink on mood may be of important commercial value in product development and marketing.

Many researchers have attempted to construct and develop self-report scales in order to measure stress subjectively. A single item scale can be insensitive in estimating the multidimensional phenomenon that is stress. Thus, the multidimensional stress scale is of interest because this type of scale includes a pool of stress items which is suitable to measuring the complexity of stress (Leung *et al.*, 2010). The most popular format of self report scale is the Visual Analogue Scale (VAS) for clinical measurements (Lee *et al.*, 1991). There are two tools to monitor a scale: and validity. Reliability is defined as the extent to which results are consistent over time and are an accurate representation of the total population under a study (Lee *et al.*, 1991). Validity of scale is focused on the criterion related validity which refers to instrumental validity as in physiological change analysis (Nakamura *et al.*, 2009).

Generally, people take drugs or alcohol drinks when they have a feeling of stress (Sayette, 1999). These reagents lead to several health problems such as drug allergies, neurosis or illness

(Chatbunchachai, 2001). This is an important reason to treat stress with food or drink to avoid drug and alcoholic drink usage (Thanalertkul, 2005). Hence, this research focuses on reducing stress by drinking germinated rice drinks as an alternative to drugs. Lyman (1989) and Shiebler (2004) pointed out that consumers use beverages to increase energy more than food because fluids pass through and are absorbed by the body more easily and faster.

There is a relationship between food acceptance, food choice as well as food intake and the food's effects on mood (Rogers, 1996). This research aimed to test this relationship and to determine whether germinated rice drinks can reduce stress, increase product's acceptance, stimulate consumer usage and a willingness to purchase the product.

One hundred ninety millitres of a germinated rice drink (Sirichai brand; product of Thailand) was pasteurised. It was selected for this study because it contained Gamma Aminobutyric Acid (GABA) and was controlled for the quality and standard of process consistency by manufacturer. This drink is advertised as having an effect on stress reduction (Nongkhai rice research center, 2010) and contained 37.2 milligrams GABA per 100 grams. It is formulated by Rice department, Ministry of Agriculture and Cooperatives, Thailand. Some researches reported that GABA help reduce stress and control blood pressure (Abdou et al, 2006; Tungtrakul et al, 2006; Nakamura et al, 2009) as it is the primary inhibitory neurotransmitter in the central nervous system. It plays role on balance in brain inducing a state of relaxation (Martmhan *et al*., 2009). Tea institute of Mae Fah Laung University in 2012 recommended GABA dosing for stress reduction from 20 to 30 milligrams per day. However, there are different dose recommendations of GABA for children often respond to doses as little as 10 mg to 100 mg per day and for adults who often take dose anywhere from 250 mg to 1,000 mg per day and up to 3-4 grams per day (Andreeva *et al*., 1998). Pharrna Foods International Co., Ltd. intends to market GABA as a food ingredient in the United States in a variety of beverage products at the usage of 0.04 to 4% GABA per serving (30 to 200 mg GABA serving) (Yoshikuni, 2008).

2. Objectives

The objectives of this study were two-fold:

1. To test the effects of germinated rice drinks in comparison to bottled drinking water on stress reduction and to explore relationships between the stress levels, consumer acceptance and Willingness To Purchase (WTP) scores.
2. To evaluate the reliability and validity of the VASS based on the effects of the germinated rice drinks and bottled drinking water on stress reduction.

3. Materials and Methods

3.1. Samples

There were three samples for this study.

1. 100 % of germinated rice drink (Sirichai brand of Mahboonkrong 888 Co., Ltd. Product of Thailand; containing GABA 37.2 milligrams per 100 grams),
2. 50 % of germinated rice drink diluted from (1), and
3. Bottled spring drinking water used as a control sample.

All samples were served in a transparent plastic container with a lid cover and encoded with random three digit numbers. The temperature of the samples was set at 4 ^{o}C before serving (Brouns, & Kovacs, 1997). The serving quantity was 190 ml (Equal quantity of commercial germinated rice drink).

"Sirichai" Name of product

Germinated rice drink

Contain GABA 37.2 mg./100 g.

Nutrition facts: per 100 grams

Energy 221.91 Kilocalories

Dietary fibre 0.29 Grams

Vitamin B1 0.03 Milligrams

Calcium 3.66 Milligrams

Iron 0.32 Milligrams

Fifty Thai participants (Seaton *et al.*, 2005), of which 30 females (mean age = 20.8 ± 2.0, mean BMI = 20.4 ± 1.0 kg/m^2) and 20 males (mean age = 21.5 ± 2.2, mean BMI = 22.1 ± 1.4 kg/m^2) were recruited using the purposive sampling, in a sensory laboratory at the Food Technology Department, Khon Kaen University, Nongkhai Campus, Thailand.

The participants were in good health, based on an exercise demonstration and their recorded health interview, and were willing to participate in this study.

3.2. Stress questionnaire using VASS

A VASS was constructed and developed for this study. It is a 100 mm horizontal line with descriptive phrases, or anchors, representing extremes of sensation placed at either end. For example, '*not at all*' could be placed on the far left of the scale, and '*extremely*' on the far right of the scale. It consisted of 12 stress items; I feel worry, I feel moody, I want to be alone, I feel uncomfortable, I feel unable to think clearly, I feel serious, I feel relieved, I feel relaxed, I feel good, I feel happy, I feel clearheaded and I feel hopeful. These items were created using focus group discussions. The VASS showed the Cronbach's alpha α was 0.84. Participants used the VASS as a tool for self reporting their stress perceptions. Each subject was asked to rate the perceived intensity of each item on the VASS by placing a vertical line across the scale, at the point reflecting best the intensity of their feeling.

3.3. Experimental design

The fifty participants were required to report their stress using the VASS before testing. They then were induced a state of mild stress (reading some serious articles) for 30 minutes and had to report their stress again, after reading, using the VASS. The main objective of the reading was to induce a state of mild stress (Smit, & Rogers, 2002). Next, participants were asked to drink 190 ml of a sample and immediately report their stress after drinking the sample, and also after resting for 30, 60 and 90 minutes [as suggested in the fatigue measurement by Khajarern *et al*. (2010)]. Then, the participants came back for a replicated test after a few days, during the same week (each participant was tested twice a week, for 3 weeks). A Randomized Complete Block Design (RCBD) was used to arrange the test replications (Meilgaard *et al*., 1999).

All particispants were asked to avoid consuming food and drink before and during each test. The sensory laboratory were arranged to include facilities for the participants such as a test area and a relaxation zone. Air conditioning was used to control the room temperature at 25°C.

To test the criterion-related validity of the scale, physiological changes such as heart rate and blood pressure (systolic and diastolic) (Burish *et al*., 1982; Hjortskov *et al*., 2004; Nakamura *et al*., 2009; Gasperin *et al*., 2009) were gauged each time the participants were about to finish reporting their stress using the VASS. A digital wrist meter [Omron HEM-629 Portable Wrist Blood Pressure Monitor, Omron Healthcare, Inc. Illinois, USA] was given to each participant with instructions to measure and self-record their heart rate and blood pressures after they had just finished scoring their self-report scale.

3.4. Liking and willingness to pay (WTP) tests

After finishing drinking 190 ml of a sample (one sample per session), participants were asked to rate their liking and WTP for the drink on a line scale. The scale consisted of a horizontal line 100 mm in length. In addition, participants were also asked to rate their willingness to purchase the drink by answering the question 'How much money would you be willing to pay for the drink?' There were five choices of 10, 15, 20, 25 and 30 Thai Baht for the WTP test according to marketed prices on similar cereal drink groups.

3.5. Data analysis

The stress scores derived from the partiocipants, during the six testing situations were analyzed by various statistical parameters. Descriptive statistics of the individual's demographic data were also summarized for stress, liking and WTP. Cronbach's alpha and Pearson's correlation coefficients of the 12-item VASS for each sample were used to analyze the internal consistency (Lee *et al*., 1991) and test-retest reliability using SPSS/PC for Windows Version 16.0 developed by SPSS Inc., Chicaco, USA in 2007. Multiple correlation coefficients between stress levels measured by the VASS and physiological change measurements were used to analyse the criterion related validity of the scales (Dagneli *et al*., 2006) an Analysis of Variance (ANOVA) was used to detect differences between sessions. The level of significance for all statistical analysis was set at 0.05.

4. Results and Discussion

Figure 1 shows the effects of the beverages on the mean scores of stress, blood pressure and heart rate. During each session of the beverage test, the levels of stress, blood pressure and heart rate markedly increased transiently after reading then decreased immediately after drinking each beverage sample and after resting 30, 60 and 90 minutes. Stress scores before stress inducing of each session were not equivalent at the baseline measure. This could come from the fact that participants rushed and get excited (running and walking fast) to this test. However, the score differences observed before and after drink sessions indicate effect of drinks on stress reduction.

Stress scores measured with the VASS, after drinking the germinated rice drinks and drinking water in each session were compared in Figure 1. The highest possible scores on both scales are 10. The mean stress scores after stress inducing (reading) from each treatment (5.15 from drinking water, 6.61 from 50% germinated rice drink, and 7.5 from 100% germinated rice drink) were significantly different ($p < 0.05$). The stress after reading reaches a 'moderately stress' to 'very stress' level. After drinking each beverage, the mean stress scores reduced to 5.15 (drinking water), 5.15 (50% germinated rice drink), and 5.33 (100% germinated rice drink) which were not significantly different ($p < 0.05$). The mean stress scores for both before and after drinking tests were significantly different ($p < 0.05$) on germinated rice beverages. This means that only the germinated rice drink samples reduced stress immediately after drinking. However, the only stress mean scores after drinking recorded 100% germinated rice drink for 30 to 90 minutes of rest decreased more than the stress mean scores recorded after drinking water and 50% germinated rice drink ($p < 0.05$). Nakamura et al, 2009, showed the effects of GABA supplementation in chocolate products on arithmetic-induced stress reduction. After volunteers taking chocolate containing 0.28 mg GABA, their overall stress was reduced after 45 and 50 minutes of rest.

The mean stress scores were related to physiological changes such as blood pressure (r range between 0.32-0.42) and heart rate (r range between 0.67-0.72). The mean blood pressure was compared in each session of germinated rice drinks and drinking water tests (Figure 1). The mean blood pressure after reading in both germinated rice drink condition was not significantly different (107.3 from 50% germinated rice drink and 107.5 from 100% germinated rice drink, $p > 0.05$) but were higher than the meqan blood pressure recorded after drinking water (103.5; $p < 0.05$). After drinking each beverage, the blood pressure mean scores reduced to 102.7 (drinking water), 104.2 (50% germinated rice drink), and 100.2 (100% germinated rice drink). The mean blood pressures before test and after drinking test were significantly different in each beverage condition ($p < 0.05$). Therefore, it seems that the

beverages used in this study helped to reduce the blood pressure. The blood pressure mean scores recorded after drinking 100% germinated rice drink for immediately to 90 minutes of rest decreased more than the blood pressure mean scores recorded after drinking water and 50% germinated rice drink ($p < 0.05$).

According to the blood pressure chart presented by Vaughn (2008), the blood pressure after reading were in the range of 'blood pressure after strenuous activity' (systolic; 100-110). After drinking 100% germinated rice drink, the blood pressure decreased to the range of 'low normal blood pressure' (systolic; 90-100). The blood pressure decreased even more but remained in the range of 'low normal blood pressure' after resting for 90 minutes. Vaughn (2008) indicated that 'low-normal blood pressure' is the normal level of blood pressure for athletes and children. Although the blood pressure after drinking water and 50% germinated rice drink decreased, the levels remained in the range of 'blood pressure after strenuous activity'.

The heart rate mean scores after drinking both the germinated rice drinks and the drinking water were also compared in each session (Figure 1). The heart rate mean scores after reading during each treatment were significantly different ($p < 0.05$) (80.5 for the drinking water, 87.8 for 50% germinated rice drink and 89.4 for 100% germinated rice drink). After drinking each beverage, heart rate mean scores reduced to 87.4 (50% germinated rice drink), and 84.7 (100% germinated rice drink) but not for drinking water (82.6). Drinking water tests were set at the first time of the tests thus using of digital wrist meters may be problem for most of consumer panels. The heart rate scores before the test and after drinking 100% germinated rice drink was significantly different ($p < 0.05$) clearly. The scores reduced less than the drinking water and 50% germinated rice drink, $p < 0.05$).

4.1. Reliability and validity of scale

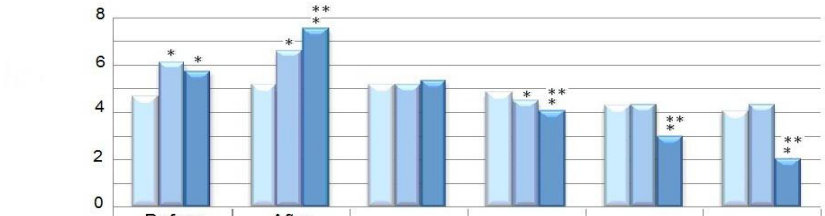
To test the reliability of the VASS for stress measurement, total-item internal consistency (Cronbach's alpha) was used. The results showed that the total-item Cronbach's alpha of the scale were not different in the water, 50% and 100 % germinated rice drinks conditions ($\alpha = 0.84$). These results indicate that the total-item internal consistency of the scale was high (George and Mallery, 2003; Glaim and Glaim, 2003 stated that the range of α between 0.8 - 0.9 was highly reliable).

Another parameter test for scale reliability used in this study is the test-retest reliability which refers to measurement of the scale stability over time. The test-retest reliability of the VASS for each beverage was tested by computing at each level of Pearson's correlation coefficient between the two replications in each session. The results showed the scale stability in high levels (the total item correlations between replications were 0.87 for the drinking water, 0.84 for 50% germinated rice drink and 0.85 for 100% germinated rice drink).

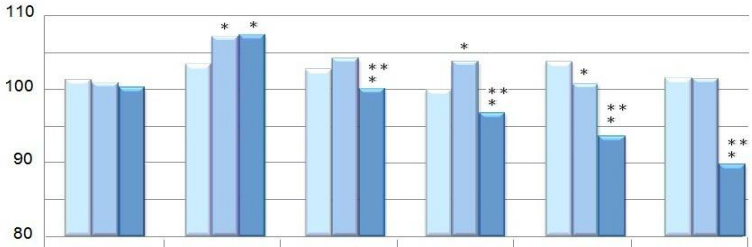
Although the reliability of the scale is important, it is not enough in determining the efficiency of measurements. Therefore, the criterion related validity of the scale was tested and considered together with the reliability test.

In order to test the criterion related validity of the VASS, multiple correlation coefficients were computed to estimate the relationships between the total stress scores of the VAS and each physiological factor (heart rate and blood pressure levels) using a multiple linear regression analysis (Hayes, 1998; Tangugsorn *et al.*, 1998).

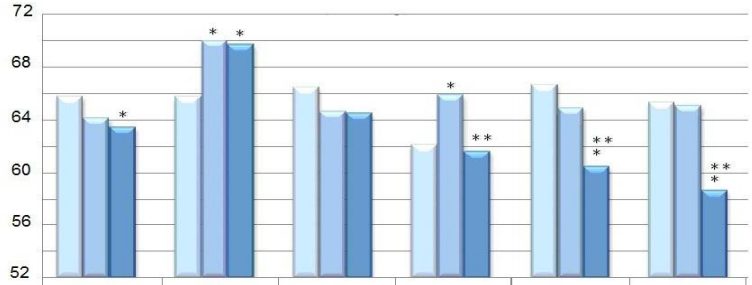
Blood pressure scores were correlated with stress itemized scores of the VASS (r range between 0.42-0.45), ($r \geq 0.30$ were considered significant for establishing validity, Emery, 2007). In addition, the results of the VASS measurements were alsohighly correlated with the results of heart rate measurement (r range between 0.72-0.74). The multiple correlation coefficients between each physiological factor and stress scores of all items from VASS for consumer panels were high.



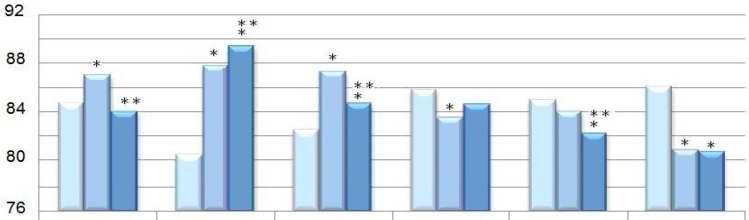
STRESS	Before stress inducing	After stress inducing	After drinking	30 minutes of rest	60 minutes of rest	90 minutes of rest
Drinking water	4.65	5.15	5.15	4.85	4.28	4.045
50% Germinated rice drink	6.095	6.61	5.145	4.5	4.315	4.305
100% Germinated rice drink	5.73	7.535	5.33	4.08	2.975	2.01



SYSTOLIC	Before stress inducing	After stress inducing	After drinking	30 minutes of rest	60 minutes of rest	90 minutes of rest
Drinking water	101.465	103.495	102.73	100.03	103.795	101.565
50% Germinated rice drink	100.93	107.26	104.23	103.83	100.795	101.53
100% Germinated rice drink	100.3	107.46	100.2	96.895	93.73	89.86



DIASTOLIC	Before stress inducing	After stress inducing	After drinking	30 minutes of rest	60 minutes of rest	90 minutes of rest
Drinking water	65.83	65.795	66.53	62.16	66.66	65.395
50% Germinated rice drink	64.165	70.03	64.66	65.93	64.965	65.1
100% Germinated rice drink	63.5	69.73	64.55	61.695	60.56	58.76

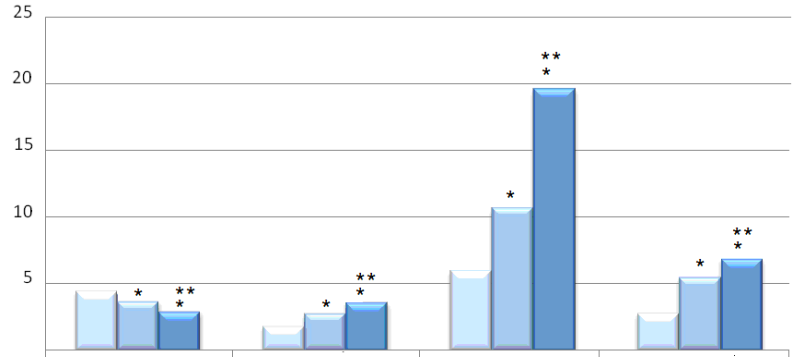


HEART RATE	Before stress inducing	After stress inducing	After drinking	30 minutes of rest	60 minutes of rest	90 minutes of rest
Drinking water	84.73	80.495	82.595	85.83	85.0	86.095
50% Germinated rice drink	87.06	87.8	87.36	83.595	84.1	80.9
100% Germinated rice drink	84.1	89.45	84.73	84.66	82.26	80.765

Figure 1 Mean scores on 'Stress', 'Systolic', 'Diastolic' and 'Heart rate', * = significantly different from drinking water, $p < 0.05$**,** **= significantly different from 50% germinated rice drink, $p < 0.05$

4.2. Liking and WTP test results

Liking scores measured by the line scale, after drinking the germinated rice drinks and water were compared (Figure 2). The liking mean scores were 1.8 (drinking water), 2.8 (50% germinated rice drink) and 3.6 (100% germinated rice drink). The liking of each drink was in the 'dislike very much' to 'dislike slightly' ranges. The low liking scores of all samples could come from the fact that all drinks were tasteless. However, liking mean scores of both germinated rice drinks were significantly different ($p < 0.05$). The liking mean score of 100% germinated rice drink was higher than the liking score of drinking water and 50% germinated rice drink ($p < 0.05$). Both germinated rice drinks received higher liking scores than drinking water.



MEAN SCORES	Stress	Overall liking	Expected price	Willingness to pay
Drinking water	4.85	1.83	6.0	2.8
50% Germinated rice drink	4.5	2.8	10.67	5.5
100% Germinated rice drink	4.08	3.6	19.67	6.87

Figure 2 Mean scores on 'Overall liking', 'Willingness to pay', 'Expected price' and 'Stress score', * = significantly different from drinking water, p < 0.05**,** **= significantly different from 50% germinated rice drink, p < 0.05

The WTP mean scores were 2.8 (drinking water), 5.5 (50% germinated rice drink) and 6.9 (100% germinated rice drink). The WTP mean score for 100% germinated rice drink was higher than the WTP mean scor for drinking water and 50% germinated rice drink ($p < 0.05$). Both of the germinated rice drinks received higher WTP mean scores than the water.

From the results, liking and WTP scores of drinking water seems unusually low. This could come from the fact that participants were not used to drink spring water.

The expected mean prices were 6.0 Thai Baht (drinking water), 10.67 Thai Baht (50% germinated rice drink) and 19.67 Thai Baht (100% germinated rice drink). The expected mean price of 100% germinated rice drink was significantly higher than the expected mean price of the water and 50% germinated rice drink ($p < 0.05$). Both of the germinated rice drinks received higher expected mean prices than the water.

The hypothesis on the effects of the beverages on stress level, consumer liking, and the WTP scores have now been verified. Figure 3 describes the interrelationships between stress, consumer overall liking and the WTP scores after drinking the beverage samples. After drinking each beverage, the stress mean scores decreased. 50% and 100% germinated rice drinks seemed to reduce stress more than drinking water, and, were preferred more and received a higher willingness to pay score as well.

The stress mean scores showed a negative relationship to the liking mean scores ($r = -0.21$, $p < 0.01$) and WTP ($r = -0.23$, $p < 0.01$) [Emery (2007) interpreted that these levels were likely to be useful] but no correlation with the expected price. From this negative relationship, it could be assumed that the drink which reduced stress more was preferred more and given a higher WTP score. The expected mean prices of 50% and 100% germinated rice drinks were 10.7 and 19.7 Thai Baht (THB) respectively, and were close to the price of Thai marketed green tea drinks. The expected price of the drinking water was 6.0 THB per 190 ml, and is the same price as the 500 ml of natural drinking water.

The expected prices could be estimated from participants' experiences with the relevant products. However, the stress mean scores were not significantly related to the expected price scores.

These results are in line with Rogers *et al*. (1994) and Rogers (1996) studies showing that the drinks influence our likings and WTP. The germinated rice drinks reduced stress more than the drinking water, and participants preferred and were willing to pay more for them than for drinking water. A research of Khajarern *et al.* (2010) support this statement because banana drinks which were significantly preferred more by consumer panels, were found to reduce fatigue more than drinking water. From this point, not only the sensory quality of the drink should be considered as an important key factor in making a drink choice, but also the effectiveness of the drink's ingredients on stress reduction. Since the germinated rice drinks had sweeter taste and flavor than drinking water, perhaps participants preferred them and were willing to pay more for them than the drinking water.

5. Conclusions

The germinated rice drinks had a positive effect on stress reduction more so than the spring drinking water, when considering the decreasing stress scores, decreasing blood pressure and decreasing heart rate. The blood pressure levels from this study were compared with the 'low normal stage' on the blood pressure chart presented by Vaughn (2008). After drinking the germinated rice drinks and resting for 90 minutes, the systolic and diastolic blood pressures decreased from the range of 'blood pressure after strenuous activity stress' to the range of 'low normal blood pressure'.

Results from the preference and WTP tests showed that both germinated rice drinks received a higher preference and WTP scores than the spring drinking water. This finding is in line with Rogers's work in 1996 stating interrelationships between diet and behaviour. Since our diet has influences on moods (such as stress or fatigue) and is mediated by physiological mechanisms. The mood can then feed back to influence food preference and consumption. The germinated rice drinks effectively reduced stress more than the drinking water, and led to greater product acceptance (in terms of consumer preference and a willingness to pay them). From this point, the effects of germinated rice drinks on stress reduction may be of interest for their commercial value in product development and marketing.

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IDENTIFYING DRIVERS OF CONSUMERS' CHOICE TO DEVELOP NEW COOKING DEVICES

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Abstract

This study aimed at investigating the influence of attitudes, perceived characteristics of cooking devices and the choice environment on food choices. Two conditions were created. In the first condition, participants assessed their attitudes General Health and Taste subscales in a laboratory before choosing devices from pictures, awhereas in the second condition, participants assessed their attitudes during a real lunch. In each experimental condition, 101 participants chose a dish presented in three cooking devices: a pressure cooker (presumed the healthiest), an innovative electric steamer (presumed the least familiar), and a sauté pan (presumed to cook the tastiest food). Later, participants were asked to evaluate the three cooking methods for health, cooking tasty food, and novelty characteristics. Results showed that the environment significantly affected cooking device choices. The sauté pan was the preferred choice in the cafeteria. The electric steamer cooker was the preferred choice in the picture condition. And, the original pressure cooker was the least often chosen device. Moreover, our results demonstrated that cooking method choices were related to perceived characteristics but not to health and taste attitudes. Participants scored higher the health and taste values of the cooking device they chose compared to participants who chose the other devices. These results are discussed in regard of the literature on attitudes and social desirability, as well as in terms of "a context effect." This work has several implications in the understanding of consumers' behavior.

Keywords: *Food behavior, health and taste attitudes, cooking methods, devices, environment*

1. Introduction

Because it is related to health, nutrition, and product development, food choice is in the core of societal debates and food market matters. Taking into account these issues has resulted in an increasing number of studies on the determinants of food choices and eating behaviors. According to Shepherd and Raats (1996), food choice is the outcome of the interrelations of a tripartite system that includes the food product, the broad environment (social, physical, governmental, etc.), and the consumers' characteristics. A noticeable point is that these groups of factors are likely to be mediated by individuals' attitudes, beliefs, and ideals as well as by the social framework and the characteristic of the food itself (Ajzen, 1991; Furst *et al.*, 1996). Although the impact of these factors has been well documented in the past decades, only few studies focused on cooking method choices. Yet, cooking processes play an important role on sensory and nutritional properties of foods. This paper was then devoted to evaluate whether the predictive power of taste and health attitudes could be generalized to cooking device choices, in regard to the environment in which those choices were made.

Determinants of food choices are multiple but it is worth highlighting the huge influence of psycho-social considerations. This influence includes notably beliefs, attitudes and values on food (Dreezens, Martijn, Tenbült, Kok, & de Vries, 2005). In particular, the role of attitudes toward healthy eating on food choices reflects a contemporary societal matter in regard to the introduction of "junk-food" and

the development of organic as well as functional food products. Many examples give evidence that healthy attitudes related to low-fat foods were good predictors of healthier food consumption (*e.g.*, Zandstra, de Graaf, & Van Staveren, 2001; Roininen, *et al*. 2001). Interestingly, attitudes may be experimentally conditioned in such a way that healthy food choices will be more important. Indeed, Hollands, Prestwich and Marteau (2011) used an aversive images paradigm to enhance the negative effects of snack foods on health. After seeing aversive pictures, implicit attitudes toward snack food appear to be more negative, especially in participants who were initially favorable to snacks. Additionally, changes in implicit attitudes led to a greater tendency in choosing fruits rather than snack foods.

Since health attitudes regulate food choices and eating-dietary behaviors, it is astonishing to notice the very small number of studies dealing with health and nutrition related to cooking methods. It is well-known that cooking changes the chemical composition of the product and that heat conditions affect the product taste and nutritional properties. According to Pelligrini *et al*. (2009), boiling vegetables increase the Total Antioxidant Capacity (TAC) of vegetables whereas pan-frying is associated with a decrease of vegetable TAC. Also, deep-frying seems to produce adverse effects as it is related to a higher TAC with some vegetables such as potatoes or artichokes, but a decrease of TAC with other vegetables such as mushrooms and onions. The role of cooking methods has also been showed on taste of meats (Dzudie, Ndjouenkeu, & Okubanjo, 2000). As an example, Braghieri *et al*. (2012) developed a descriptive training program for meat sensory evaluation. Interestingly, meat references were prepared with different methods to influence odor/flavor intensities, chewiness/tenderness intensities, and juiciness intensity. The boiling method would give low odor/flavor intensities; micro-waving would lead to medium intensity and electric grill would be associated with high intensities. Meats tenderness and juiciness would be related to grill temperature and cooking duration. It is then assumed that consumers' knowledge of the benefits of cooking methods on health and nutrition as well as health attitudes will modify their food choices.

Beyond the psychosocial influences on food choices, it is essential to focus on other environmental or contextual factors. As reviewed by Larson and Story (2009), environmental factors include macro-level policies (governmental positions on health, agriculture and food), the social-environment (relations with peers, friends, and family members) and the physical environment (different settings and places in which people choose, cook and eat). For the latter, findings by Marshall and Bell (2003) suggested that foods are selected according to location and space constraints. As an example, "snack food" was privileged in constrained eating spaces such as a car, or an office desk, whereas main meal type was preferred in mid-priced restaurant or in airplane. Results from other experimental studies suggest that eating in a natural location such as at home, in a full-restaurant or in a cafeteria provides higher ratings in the appreciation and acceptability of foods as well as a greater number of terms while describing it, compared to laboratory settings (*e.g.*, Cardello, Schutz, Snow, & Lesher, 2000; Meiselman, Johnson, Reeve, & Crouch, 2000; Petit, & Sieffermann, 2007). Natural eating locations are ideal situations to understand underlying processes of food choices as consumers have a real opportunity of choosing between products, associating dishes and eating it. Plus, social interactions are not limited.

In the present study, we were interested in evaluating whether taste and health attitudes and perceived characteristics of cooking devices may predict cooking choices, as a function of the choice context. To address this issue, we designed an experiment in which participants had to choose a dish cooked with different devices and rate the healthfulness, tastiness, and novelty of the cooking techniques. Three devices were used: (a) a pressure cooker that was expected to be the healthiest as it refers to a boiling method, (b) a frying pan that was supposed to be the tastier as it refers to the roast and grill method, and (c) an innovative electric steamer as an unfamiliar device. Health and taste attitudes were rated before the experiment at home. Perceived characteristics of the cooking methods were assessed in two conditions: (a) in a laboratory environment by looking at cooking device pictures, and (b) in a natural environment by choosing among dishes cooked with the different devices and having it for lunch in a cafeteria. We hypothesized that the cafeteria condition would be more involving than the picture condition, and as such, we expected this set up to better reveal food behavior and its link with attitudes.

2. Materials and methods

2.1. Participants

Two groups of participants were recruited, most of them worked in the vicinity of the University of Burgundy. The first group included 103 participants recruited for the test in the cafeteria condition. Among these participants two were dropped because of insufficiently filled forms. The second group included 101 participants recruited for the test in the picture condition. In both conditions, participants were roughly matched in the two groups according to gender, age, and socio-professional category as shown in Table 1. Participants signed an informed consent form before the study began. They were not paid for this study.

Table 1: Participants' characteristics in the two experimental conditions

Category	Number in Cafeteria condition (N=101)	Number in Picture condition (N=101)
Gender		
Male	29	26
Female	72	75
Age group		
≤35 year old	41	47
36-55 year old	50	48
≥55 year old	10	5
Socio-professional category		
Middle ranking/ senior executive	28	27
Foreman	29	37
Employee	21	21
Workman	3	0
Retired people	2	1
Non working people	18	13

Chi square between Cafeteria condition and Picture condition: Gender: $p=0.62$; Age: p =.40; Economic Condition: p =.35.

2.2. Devices presentation and dishes preparation

Three cooking methods were represented in our experiment: the boiling method, the frying method and the steaming method. Each method was operationalized with the use of a specific cooking device. The boiling method involved the use of an original pressure cooker, estimated as the healthiest way to cook. The frying method basically involved the use of a classic sauté pan, judged as the tastiest method. Finally, the steaming method involved the use of an electric steamer with a new design, judged as the less familiar.

Each device was used to cook two different dishes “spring chicken” and “cod and its veggies” which included a mix of vegetables (green beans, fava beans, and pepper) with either chicken or cod. All raw ingredients were purchased deep frozen from a local store. In total, six different main dishes: chicken/pressure cooker, chicken/sauté pan, chicken/electric steamer, fish/pressure cooker, fish/sauté pan and fish/electric steamer were evaluated in the study.

Because it is a cultural habit to add seasoning in dishes to make it tastier, when cooked with the electric steamer or the frying pan, the “cod and its veggies” was seasoned with a Thai-Chili sauce and the “spring chicken” was seasoned with a Provencal sauce. A few pieces of onion either steamed or

fried were added to dishes cooked in the electric steamer and the frying pan, respectively. Finally, a light spray of olive oil was added on top of the dish cooked in the frying pan. No seasoning was added when the dishes were made with the pressure cooker as the device does not allow it.

Portions sizes of dishes were determined by local staff to reflect custom and practice.

3. Procedure

3.1. Step 1: Health and Taste attitude scales

At home, participants had to complete the Health and Taste Attitude Scales (HTAS) developed by Roininen, Lähteenmäki and Tuorila (1999). It consisted of three health sub-scales (a total of 20 items) and three taste sub-scales (a total of 18 items). All items were rated on seven-point Lickert scales ranging from "strongly disagree" to "strongly agree".

The three health sub-scales were:

1. *General health interest* (8 items) dealing with an interest in eating healthily
2. *Light product interest* (6 items) related to an interest in eating reduced-fat foods
3. *Natural product interest* (6 items) related to an interest in eating foods that do not contain additives and are unprocessed.

The three taste sub-scales were:

1. *Craving for sweet foods* (6 items) describing the strength of craving for chocolate, sweets and ice-cream
2. *Using food as a reward* (6 items) considering food as a reward
3. *Pleasure* (6 items) related to the importance of obtaining pleasure from food.

A French translation of all items was achieved by means of forward/backward translation by a professional translator society (Tradoc, Lyon, France).

3.2. Step 2: Dish and Device choice

3.2.1. Cafeteria condition

Participants were invited to have a lunch meal in the cafeteria of the research center (CSGA) on campus in Dijon. It was designed to mimic a self-service cafeteria.

One dish was served per day, participants were informed of the dish that was served on each day and registered according to their preference for the "spring chicken" or the "cod and its veggies".

Participants came at the research center and were informed about the course of the lunch upon their arrival. After being instructed, participants entered individually in the cafeteria and were asked to choose their main dish among the three versions of the dish of the day ("spring chicken" or "cod and its veggies"). The three versions were presented within their cooking devices (sauté pan, pressure cooker, and electric streamer) on the stand. Explanations of the devices were orally given by the stand attendant:

1. *Classic sauté pan:* "Vegetables were quickly fried and the dish was stewed with seasoning"
2. *Original pressure cooker:* "The dish was pressure steamed, vegetables at first then chicken (cod)"
3. *New electric streamer:* "The dish was cooked with automatic release of seasoning during cooking."

The devices were presented in a random order different for each participant.

After participants had picked up the main dish, they proceeded to a second stand, where they could choose three side dishes between the following possibilities:

1 *Starter :* tabbouleh or raised crust pie;

2 *Cheese:* blue cheese, camembert, cream cheese, or tartare® cheese;

3 *Dessert:* milk chocolate mousse, dark chocolate custard, strawberry yoghurt, stewed apple, apple, or orange.

As in a standard cafeteria after choosing their main dish and side dishes, participants sat at a table with their colleagues, friends or family members to eat their meal.

3.2.2. Picture condition

Participants were received individually in an office of the research center. They were told to think of a meal situation and asked to indicate which dish they would like the best to eat between "spring chicken" or "cod and its veggies". Once they had chosen the dish they would like to eat, the experimenter showed them three pictures representing the cooking devices, filled with the dish they had chosen.

The same explanations as in the cafeteria condition were given orally to the participants for each of the cooking device.

3.3. Step 3: Assessment of perceived characteristics of cooking devices

At the end of the test, participants were asked to fill out a questionnaire concerning the perceived characteristics of the cooking devices used in the study. This questionnaire included three affirmations designed to assess respectively 1) health (this cooking device is healthy), 2) taste (this cooking device optimizes the taste of food), and 3) novelty (this cooking device is a novelty) values of the cooking devices. Participants indicated their degree of agreement with the three affirmations for the three cooking devices on seven-point Likert scales, ranging from 1 (strongly disagree) to 7 (strongly agree).

In the cafeteria condition, the questionnaire was administered at the end of the meal. Participants were seating in groups at a table but were asked to fill out their questionnaire individually. The experimenter explained orally to each group of participants how to fill the questionnaire and check that participants answered individually. In the picture condition, participants were asked to fill out the questionnaire after the dish choice, and had also oral explanations in addition to the written ones.

4. Results

4.1. Consumers' choices

4.1.1. Choice of dishes

The number of participants who chose the cod or the chicken differed between the cafeteria and the picture condition ($\chi^2 = 21.78$, $df = 1$; $p < .001$). Chicken was most often chosen in the cafeteria condition whereas the cod was privileged in the picture condition (Figure 1).

4.1.2. Choice of devices

The number of participants having chosen each device in each condition was first computed. Globally, the classic sauté pan was the most often chosen device followed by the electric steamer. Om the opposite, the pressure cooker was the less chosen device. A Chi-square test was then carried out to test for independence between participants' choices and experimental conditions.

Participants' choices differed between the cafeteria condition and the picture condition (Figure 2). The sauté pan was chosen more often in the cafeteria condition than in the picture condition (χ^2 (1) = 5.83, $p < .01$). The pressure cooker was privileged in the pictures condition compared to the cafeteria condition (χ^2 (1) = 7.1, $p < 0.001$). No significant difference was observed for the new electric steamer.

A finer analysis showed that the choice of cooking device depended on the choice of dish (Figure 3). The superiority of sauté pan observed in the cafeteria condition holds only when the presented dish was chicken ($\chi^2(1) = 6.61$, $p < 0.01$). No difference was observed when the fish was presented. Inversely the lack of difference observed for the electric steamer holds only when the presented dish was chicken. When the fish was presented, the electric steamer was chosen significantly more often in the picture condition than in the cafeteria condition ($\chi^2(1) = 24.03$, $p < 0.0001$). Although the number of pressure cooker choices is too low to allow for statistical analysis, the difference observed for the classic pressure cooker seems to hold only when the presented was fish.

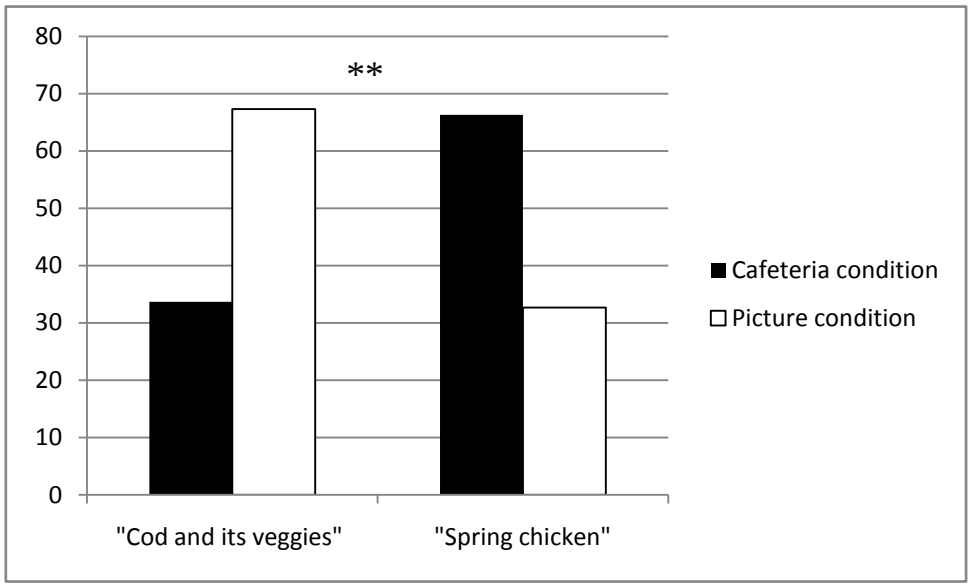

Figure 1. Participants' dish choices in regard to the "cafeteria or picture" condition.

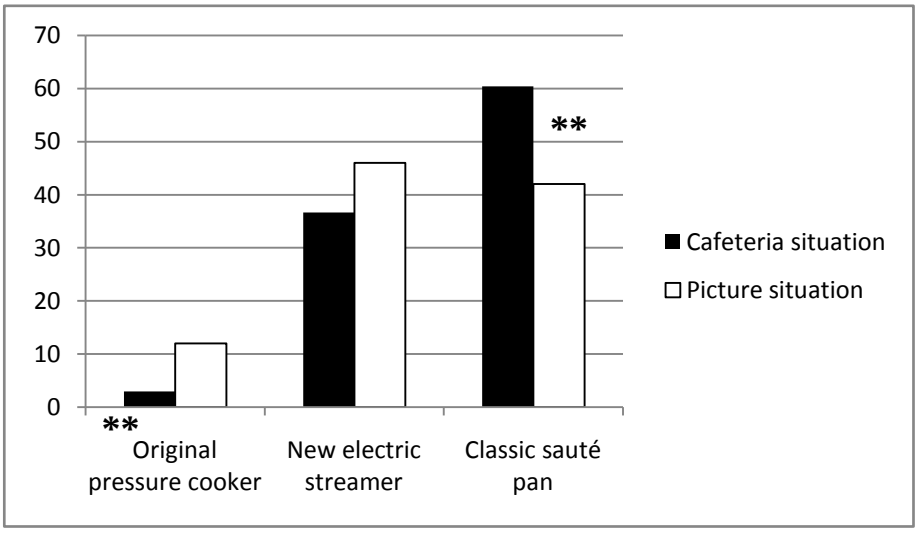

Figure 2: Participants' device choices in the two experimental conditions.

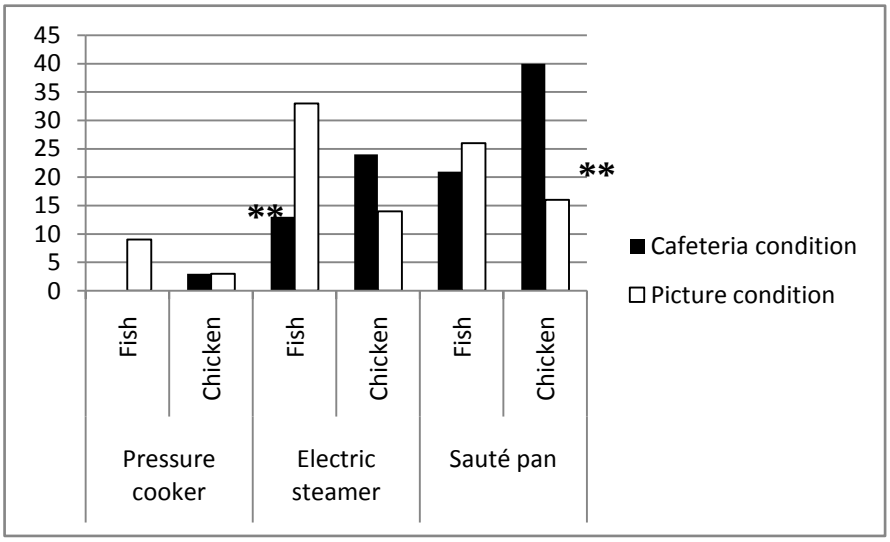

Figure 3. Participants' device choices considering the type of dish and the the "cafeteria vs. picture" condition.

4.2. Consumer patterns for health and taste of food

4.2.1. The Health and Taste Attitudes Scales : Health and Taste subscales

We first observed the distribution of participants for scores of the Health and Taste subscales (structured from 1 to 7 points). For the two sub-scales, distributions were globally similar in the two experimental conditions, with a large proportion of medium interest (3-4; 4-5) and relatively low proportion of low (1-2; 2-3) or high interest (5-6; 6-7), (Figure 4a and 4b). Besides this general pattern, some differences can be noted. For the health subscale, the proportion of low and high interest is significantly larger among participants recruited for the test in the cafeteria condition than for those recruited for the test in the picture condition (χ^2 (1) = 7.02, $p < 0.01$ for low interest, $\chi^2(1)$ =6.18, $p < 0.01$ for high interest). Inversely, the proportion of medium interest is larger among participants recruited for the test in the picture condition than among those recruited for the test in the cafeteria condition (χ^2 (1) = 13.19, $p < 0.001$).

The same pattern of results is observed for the taste subscale with the exception of low interest scores. As for the health subscale, a higher proportion of high interest and a lower proportion of medium interest was observed among participants recruited for the test in the cafeteria condition than among those recruited for the test in the picture condition (χ^2 (1) = 25.10, p <0.001 for medium interest, χ^2 (1) =23.81, $p < 0.001$ for high interest). In both conditions almost no participant had low interest in taste (χ^2 (1) = 7.02, ns).

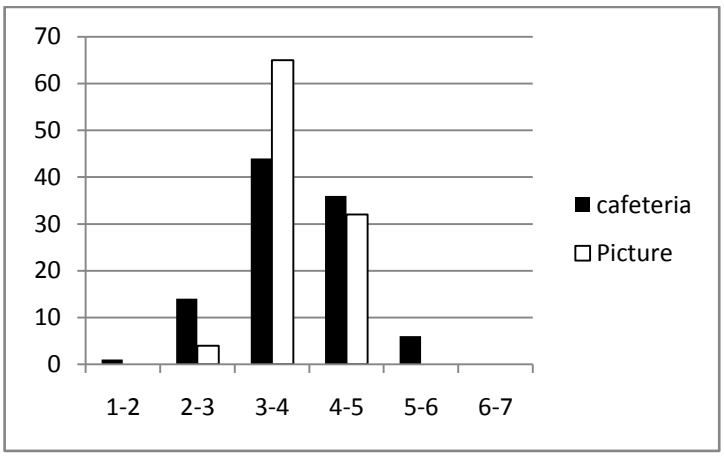

Figure 4a. Distribution of participants for the Health subscale ranging from 1 to 7.

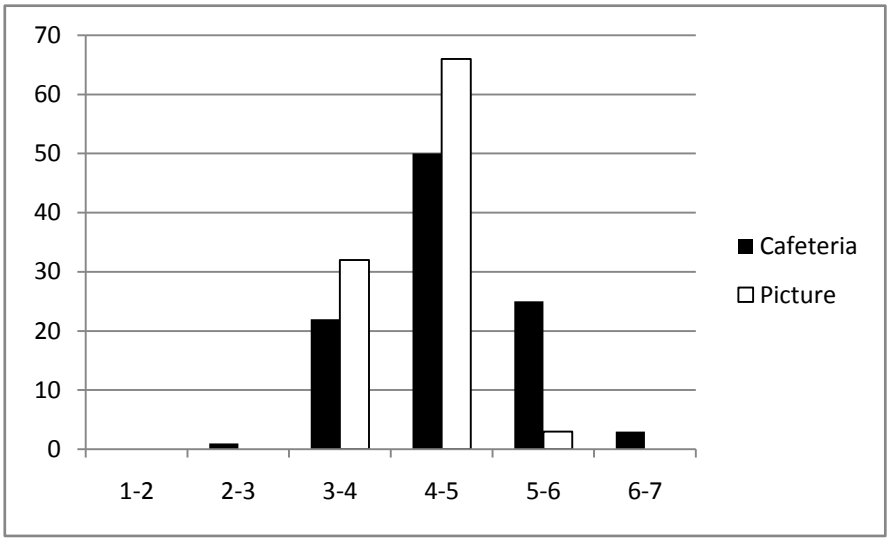

Figure 4b. Distribution of participants for the Taste subscale ranging from 1 to 7.

4.2.2. Discriminant Analysis

A discriminant analysis was used in each experimental condition to evaluate whether participants' cooking device choices could be predicted from the food attitude questionnaire (HTSA) and the health, taste and novelty scales for each device. The analysis was performed with SAS statistical software package (Proc Discrim, SAS Institute Inc., 1990). Because of the small number of pressure cooker choices, the discriminant analysis was carried out only on electric steamer and sauté pan choices (Table 2). The Wilks' lambda value was 0.75 ($p < 0.05$) in the cafeteria condition and 0.54 ($p < 0.0001$) in the picture condition. A cross validation using a leave-one-out jackknife technique yielded 37% of error in the cafeteria condition and 24% of error in the picture condition.

As shown in Table 2, perceived characteristics of health and taste of electric steamer and sauté pan could predict participants' device choices. Figure 5 showed that participants attributed a higher health rate to the device they chose in both experimental conditions. The same pattern of results was observed for taste (Figure 6).

Table 2 also points out that the HTAS did not predict participants' device choices.

Two additional discriminant analyses were carried out after separating the data according to dish choice (chicken vs. fish). The patterns of results were similar to those obtained in the global analysis.

Table 2. Discriminant analysis in the cafeteria and picture conditions, considering attitudes to Health and Taste subscales, as well as perceived characteristics related to health, taste and novelty in cooking devices.

		Cafeteria condition *without* pressure cooker (N=98)		**Picture condition** *without* pressure cooker (N= 89)	
		F	*p*	*F*	i
Food Attitude	Health	0.26	.6100	0.14	.7000
	Taste	0.38	.5400	1.13	.2900
Perceived characteristics related to *health*	Sauté pan ratings	***3.90***	***.0500****	***5.39***	***.0200****
	Electric steamer ratings	***11.63***	***.0009*****	***5.58***	***.0200****
Perceived characteristics related to *taste*	Sauté pan ratings	***8.89***	***.0036*****	***21.91***	***<. 0001*****
	Electric steamer ratings	***13.47***	***.0004*****	***35.65***	***< .0001*****
Perceived characteristics related to *novelty*	Sauté pan ratings	0. 90	.4400	2.11	.1500
	Electric steamer ratings	0.31	.5700	3.39	.0700

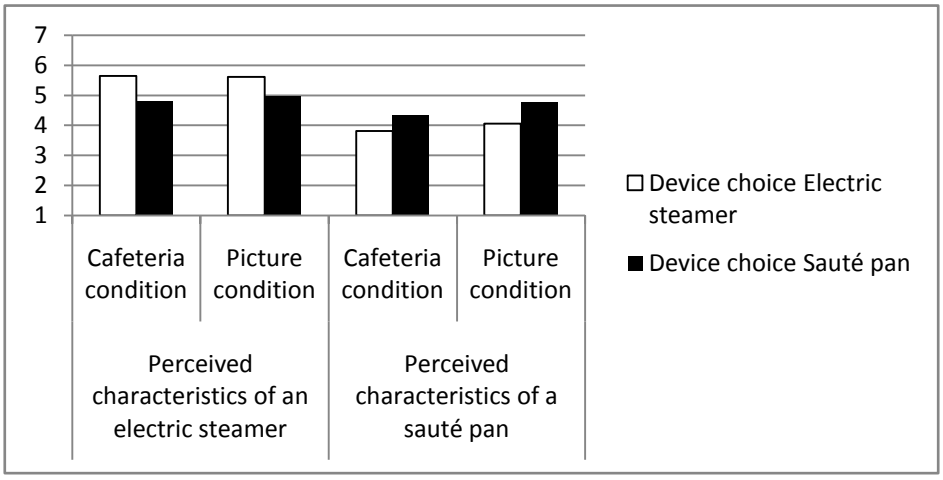

Figure 5. Mean scores of the perceived characteristics of health for the electric steamer and the sauté pan as a function of the experimental conditions (cafeteria vs pictures) and particpant's device choices.

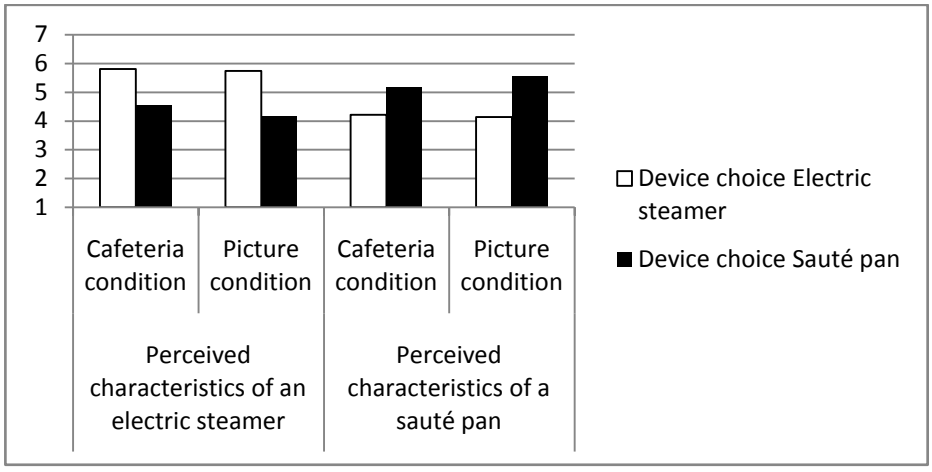

Figure 6. Mean scores of the perceived characteristics of taste for the electric steamer and the sauté pan as a function of the experimental conditions (cafeteria vs. pictures) and participant's device choices.

5. Discussion

This paper aimed to explore the role of contextual factors and the predictive value of attitudes on food choices. It was hypothesized that general Health and Taste attitudes on food would be good predictors of the cooking device choice. Additionally, it was assumed that the environment in which the choice was made, cafeteria vs. laboratory, would play a role on how consumers chose the devices and the dishes.

Contrary to our expectations, results firstly indicated that cooking device choices were not predicted by general Health and Taste attitudes but rather by perceived characteristics on health, taste and novelty of those cooking devices. The fact that we did not replicate Roininen and Tuorila (1999) results may originate from the presented alternatives. In our experiment, the two most often chosen alternatives (sauté pan and new electric steamer) corresponded to two dishes with subtle differences in term of taste and nutritional value. The dishes were prepared from the same ingredients with the same seasoning, thus with similar taste although the dish presented in the sauté pan was expected to be tastier because of the added oil and roasted onions. However the two dishes were undoubtedly less contrasted compared to the case of the "apple vs. chocolate bar," the two alternatives offered to participants in the Roininen and Tuorila's experiment. The same stands for the healthiness value: the dish presented in the sauté pan was also expected to be less healthy because of the added fat compared

to the dish presented in the electric steamer and the difference in perceived healthiness was about one point on a 7-point scale. In the Roininen and Tuorila's study, the difference in healthiness scores was about four on a 7-point scale. Failing to predict choice from health and taste attitudes with moderately contrasted alternative indicates that if these attitudes are predictive of choices, choices are under the control of other drivers as well. As a matter of fact, Sutton (1998) in a meta-analysis of researches based on Theory of Reasoned Action or Theory of Planned Behavior, reported that such experiments explain 19% to 36% of the variance in behavior. Thus, the HTAS questionnaire could reveal the link between attitudes and behavior when the alternatives are highly contrasted, but may failed to predict more subtle differences, such as choosing a cooking device for the same dish.

Also, the impact of health attitude in food behavior seems culture dependent. For example, Rozin, Fischler, Imada, Sarubin, & Wrzesniewski (1999) contrasted four countries: U.S.A., Japan, Flemish Belgium, and France, found substantial country differences in health attitudes. They reported that French people were less concerned about diet and health compared to American people and that they were inclined to define healthy eating more in terms of balance, variety and freshness. Cultural variables may then affect food perception and choices. In the future, we will have to be careful on the fact that the use of tools such as the HTAS questionnaire, originally developed and validated with Finnish people (Roininen & Tuorila, 1999; Roininen, Lähteenmäki, & Tuorila., 1999), may not tap into the relevant dimensions for French people and may require cultural adaptation.

A third explanation would be that the items addressing health issues are not totally relevant for French consumers. But the cross-cultural study carried out with Finnish, Dutch, and British consumers (Roininen *et al.*, 2001) does not support this explanation, because the overall health and taste attitudes revealed by the HTAS questionnaire were similar in the three countries. However, the study did not extend to French consumers and there is still the possibility that some sub-scales would be less discriminant because some items are less relevant in the French culture. For instance, in the Craving for sweet food sub-scale, several products are mentioned: chocolate, sweets, and ice-cream, but, Zellner, Garriga-Trillo, Rohm, Centeno, and Parker (1999) found differences in food products craved by American and Spanish people. Thus, the provided examples of craved foods might be less relevant for French participants and the corresponding items might not optimize attitude assessment. This could explain why a marginal proportion of participants scored high on the HTAS scales.

In our study, cooking device choices were better predicted by the perceived characteristics of taste, health and novelty of the cooking methods. Participants that rated one cooking device as giving healthier and tastier food were also more prone to choose the dish cooked in the corresponding cooking device. This is partially in line with previous results from Roininen and Tuorila (1999). In their study, participants who chose an apple preferentially to a chocolate bar as a snack, also rated apples as more pleasant than participants who chose the chocolate bar. But the same pattern was not observed for healthiness ratings of the two food products. However, the link between behavior and perceived pleasantness / healthiness has to be considered with caution. In our study as well as in Roininen and Tuorila (1999), participants assessed health and taste values of the choice alternatives, shortly after making their choice. Thus, the relationships between perceived values and choice may result from rationalization: participants justified their choice a posteriori by reporting the chosen alternative as tastier and healthier. This may just reflect social desirability and cultural convention (Köster, 2009) as healthy eating behaviors are valued and promoted through the French National Program for nutrition and Health (PNNS) campaigns.

Another important result in our study dealt with the role of the choice environment. Although the discriminant analysis did not demonstrate the predictive power of general attitudes and perceived characteristics of devices on device choices, in regard to the two conditions, we observed a main effect of the context on device and dish choices. Indeed, the pressure cooker was selected more often in the picture condition than in the cafeteria condition. There was no difference between conditions for the electric steamer. And the classic frying pan was more often chosen in the cafeteria. This finding is not astonishing when considering the fact that in many European countries, cafeteria or refectory are good alternatives to expensive restaurants with healthy and tasty products and fast-foods with tasty but not healthy foods. So, cafeteria menus are mostly composed with grilled, roasted or fried products. In respect with Marshall and Bell (2003) who found that cafeteria/refectory and mid-price restaurant

were clustered with fried or grilled foods such as steak, chicken breast, cod, bacon, sausage, pizza; privileging the fried pan device in the cafeteria condition could be perceived as a sign of consumer's habits in a cafeteria.

Plus, ones could argue that the cafeteria condition was more involving than the picture condition because it required eating the product after selecting it. It that sense, it reflected an actual choice for consumers, in contrast to the picture condition, which would be predicted by intended behavior (Louis, Davies, Smith, & Terry, 2007). Weijzen, de Graaf, and Dijksterhuis (2009) observed a discrepancy between intended and actual choices at an individual level. When comparing intended vs. actual choices for healthy vs. unhealthy snacks, about one fourth of the participants changed their mind when faced to the actual choice compared to their intended choice. However, this proportion is of the same order than the proportion of participants who switch from one alternative to another when faced twice with the same actual choice (Roininen, & Tuorila, 1999). These authors found that about 17% of participants (N = 174) switched from apple to chocolate or vice-versa when choosing a snack one week apart. In regard to those different results, it is complementary and of great relevance to consider both actual and intended behaviors when studying behaviors related to cooking method choices.

Choice environment was also shown to affect dish choices. More participants chose the fish dish in the picture condition compared to the cafeteria condition. This may be explained by the fact that in the cafeteria condition, participants registered for the meal with friends, family members or colleagues. Thus, their choice (fish vs. chicken) had to appeal to the whole group. In the picture condition, the choice was individual, leaving larger latitude for choosing the preferred dish. Moreover, there is an interaction between the dish and the condition on choices: the frying pan is preferentially chosen when the chicken dish was presented in the cafeteria condition but not in the picture condition, whereas the electric steamer was preferentially chosen when fish was presented in the picture condition but not in the cafeteria condition. However, as patterns of choice predictions from attitudes and cooking method characteristics are similar whatever the dish, this discrepancy did not impair the comparison between the two experimental conditions.

As a conclusion, this experiment showed that the environment in combination with perceived characteristics of health and taste related to cooking methods and devices indirectly affect food choices. More precisely, our results give evidence that in a cafeteria, consumers tend to choose fried-pan cooking whereas in a laboratory, they privilege a new cooking steamer. In opposition with our assumptions, general Health and Taste attitudes did not predict food choices. Moreover, it seems that participants tend to justify their choices of the cooking devices in terms of health and taste. Further research will be required to better understand this relation between the environment, the perceived characteristics of cooking methods and consumer's behavior. Finally, this work may offer promising issues for food markets in the elaboration of ergonomic cooking devices that helps in cooking healthy and tasty foods.

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USING DESCRIPTIVE SENSORY DATA TO PREDICT TEENAGE GIRLS ACCEPTABILITY OF MILK

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Abstract

Milk is a major source of calcium intake but milk consumption among teenage girls is especially low and one suggested reason is that milk leaves an aftertaste. Having a low calcium intake during such a critical bone building period may put young women at risk of developing osteoporosis. The objective of this study was to relate consumer liking to the descriptive sensory evaluation of flavor and aftertaste in milk, in order to provide information on how to modify the attributes of milk to make it more acceptable to teenage girls.

The seven milk samples included in this study were from dairies in the Midwest region of the United States and were acquired from a local grocery store, a school lunch program purveyor, and from a university dairy plant. The milk samples were evaluated by five highly trained panelists and 101 female teenage consumers from Kansas, USA. Analysis of variance of both the descriptive and consumer data was conducted to determine differences among milk samples. The data from both tests were correlated to determine the relationship of flavor, texture, and the aftertaste of milk samples to teenage women consumers' acceptability. Consumers liked a control milk sample, which possesses higher dairy characteristics (overall dairy, dairy fat, and dairy sweet) and sweetness (sweet and sweet aromatics) without musty/earthy, light oxidized, butyric acid, or lacks freshness. In general, liking of milk negatively correlated to descriptive attributes such as lacks freshness and bitterness.

Keywords: *milk flavor, descriptive, acceptability, teenage girl*

1. Introduction

There is a sharp decline in the amount of milk that teenagers drink. Nelson et al. (2009) showed that milk consumption decreased significantly from mid to late adolescence (high school to post high school). Research has also shown that for girls especially, the consumption of milk falls as the girls' ages rise (Yen, &Lin, 2002; Storey, Forshee, & Anderson, 2004; Economic Research Service, 2006). The consumption of milk among girls decreased from the 4-8 years old age group to the 9-13 years old age group and fell markedly for the 14-18 years old age group. This resistance to the consumption of milk by teenage girls has been found to be a significant health risk. The consumption of milk and milk products had a high relation with calcium intake (Storey *et al.*, 2004) and without this much needed calcium, teenage girls are more susceptible to weak bones. About 10% of female adolescents consumed the recommended adequate intake for calcium (Greer, Krebs and Committee on Nutrition, 2006). Another group of researchers found that insufficiencies in calcium intake early in life may be responsible for a 5% to 10% difference in peak adult bone mass (Sandler *et al.*, 1985). Based on this accumulation of research, a significant portion of young women do not receive the nutrition and bone strengthening advantages of milk at the most critical time for the maximum skeletal growth (National Osteoporosis Foundation, 1997).

Researchers have found that pleasure in drinking milk may result in higher calcium intake. Women who consumed less calcium tended to agree more with statements such as "soft drinks taste better with hamburgers than milk does" and disagreed more with "milk tastes good with snacks" indicating that these women are more likely to consume alternative beverages instead of milk (Susiyanti, Chambers, Pearson, & Lewis, 1996). In research on diets of children and adolescents, soft drinks replaced milk and fruit juices, especially at higher levels of soft drink use (Harnack, Stang, & Story, 1999). In contrast, a study by Shi and van Meijgaard (2010) showed that the decline in sugar-sweetened beverage (soda or other sweetened drinks) consumption did not correlate with an increase in milk consumption for children in California. In a survey, 42% of milk-avoiding children refused to drink milk because of its perceived "bad" taste (Black, Williams, Jones, & Goulding, 2002). The most common reason listed by non-milk drinkers for not drinking milk was the aftertaste (Midwest Dairy Association™, 2003) and milk aftertaste contributed to aversion of milk among milk dislikers (Porubcan, & Vickers, 2005). Understanding why milk taste and aftertaste are perceived as "bad" is necessary to increase the milk consumption of teenage girls by improving milk flavor.

Milk flavor (Claassen, & Lawless, 1992; Chapman, Lawless, & Boor, 2001; Frøst, Dijksterhuis, & Martens, 2001; Frandsen *et al*., 2003; Francis *et al.*, 2005) and milk aftertaste (Francis *et al.*, 2005; Porubcan, & Vickers, 2005) were studied using sensory descriptors. Milk taste and flavor notes such as astringent, bitter, chalky, cooked, fat, fatty mouthfilm, overall sour, and overall sweet at 15 seconds and 90 seconds after swallowing/expectorating milk were studied (Francis *et al.*, 2005). Milk aftertaste was suggested as a blend of tastes, flavors, textures, and feelings and used the following descriptors as milk aftertaste attributes: sweet, sour, bitter, umami, cream, cooked, buttery, fruity, cardboard, barny, dairy sour, astringent, fatty mouthcoat, lingering dry mouthcoat, urgency to clear the throat, time until all flavors clear the mouth, and time until all textures clear the mouth (Porubcan, & Vickers, 2005).

Researchers have shown that aftertaste contributed to the disliking of milk for milk dislikers. However, it is not clear which descriptive attributes contributed the most for the U.S. consumers' disliking. Studying milk aftertaste can help identify the characteristics of milk aftertaste and may help identify aftertaste properties that relate to consumer liking.

The objective of this study was to relate consumer liking to the descriptive evaluation results of flavor and aftertaste of milk in order to provide information on how to modify the attributes of milk to make it more acceptable to teenage girls.

2. Materials and methods

2.1. Samples

Seven 2% reduced-fat milks were obtained and tested (Table 1): one store brand milk, one school lunch milk, and five milk samples produced at the Kansas State University dairy plant. Milk samples from the Kansas State dairy plant included the control and four test samples: light-oxidized 1 hr, light-oxidized 3 hrs, lacks freshness, and high-acid (Table 1). All samples were processed, purchased, or delivered one day before the day of testing and stored in a walk-in refrigerator at 4±1°C.

Table 1. Selected 2% reduced-fat milk samples – source, treatment, and package[1].

Samples	Source/treatment	Package
Control	Kansas State University dairy plant	3.8 L plastic[2]
Light-oxidized 1 hr	Control milk under 200 lx[3] for 1 hour	3.8 L plastic[2]
Light-oxidized 3 hrs	Control milk under 200 lx[3] for 3 hours	3.8 L plastic[2]
Lacks freshness	Control milk processed 10 days earlier	3.8 L plastic[2]
High acid	Control milk plus 52 mL of buttermilk[4] added 24 hours prior to use	3.8 L plastic[2]
Store brand milk	Retail milk, purchased at local retail store, Manhattan, KS	3.8 L plastic[2]
School milk	Retail milk, served in school lunch program, Manhattan, KS	236 mL cardboard

[1]All holding and storage occurred at 4°C
[2]Containers were made by Kansas State Plastics, Inc., Hutchinson, KS, USA.
[3]GE fluorescent light 3500 K 15 W, Sylvania, Inc., Danvers, MA.
[4]Hiland cultured low-fat buttermilk, Hiland Dairy Co., Springfield, MO, USA.

2.2. Sample Preparation

For the descriptive evaluation, 120 mL of milk was poured into 240 mL Styrofoam cups (James River Corp., Easton, PA) and labeled with a 3-digit random code. The milk was poured approximately 14 minutes prior to serving and was allowed to temper at room temperature until the milk reached the serving temperature of 7°C. Samples were covered with a layer of clean waxed paper and a piece of thick cardboard to avoid light oxidation while tempering.

For the consumer hedonic test, 60 mL of milk was poured into 240 mL Styrofoam cups approximately eight minutes prior to serving. The milk was tempered and served at 7°C, with the same preparation as the descriptive testing.

2.3. Panelists

Five highly trained descriptive panelists from the Sensory Analysis Center at the Kansas State University (Manhattan, KS, USA) participated in the study. Each panelist had completed 120 hours of training in descriptive sensory evaluation of food; had more than 2000 hours of testing experience with a variety of food products including fresh dairy products. Other researchers have used highly trained panelists to describe the flavor of dairy products (Heisserer, & Chambers, 1993; Francis *et al*., 2005; Retiveau, Chambers, & Esteve, 2005; Talavera-Bianchi, & Chambers, 2008; Oupadissakoon, Chambers, & Chambers, 2009; Thompson, Chambers, & Chambers, 2009).

2.4. Descriptive Orientation Sessions

As a guide, panelists began orientation with attributes, definitions, and references previously developed in other studies for milk flavor (Claassen, & Lawless 1992; Chapman et al., 2001; Frøst *et al.*, 2001; Frandsen *et al.*, 2003; Francis *et al*., 2005; Porubcan, &Vickers, 2005). Panelists spent five 2-hour sessions reviewing and developing a lexicon appropriate for this study (Table 2). The general procedures for attribute determination and description were adapted from the Flavor Profile Analysis (Caul, 1957) and other works for attribute development for flavor, texture, and aftertaste of beverage products (Chambers, Jenkins, & McGuire, 2006; Lee, & Chambers, 2007; Oupadissakoon *et al.*, 2009).

Panelists evaluated each milk sample for flavor and aftertaste at 15 sec and 90 sec after the sample was swallowed or expectorated. Sweet, sweet aromatics, sour, sour aromatics, and fat feel cannot be measured as aftertastes, so panelists agreed to measure overall sweet, overall sour, and fatty mouthfilm instead. Testing time for aftertaste was determined during the orientation session. Panelists agreed on evaluating aftertaste at 15 sec for peak aftertaste (data not shown) and at 90 sec for residual aftertaste flavor. An interval scale was used with 0.5 increments where 0 meant no intensity and 15 meant extreme intensity (Francis et al., 2005).

Table 2. Descriptive terms for milk attributes and references used for testing.

Attribute	Definition	Reference(Intensity[a])
Flavor		
Brown	Aromatics that are brown and create a rounded, full-bodied impression. This is brown not related to the cooked attribute.	Carnation evaporated milk (4.0) flavor
Butyric acid	An aromatic that is sour and cheesy and slightly buttery — reminiscent of baby vomit.	Kraft 100% grated Romano cheese = 6.0 (aroma) Butyric acid (in propylene glycol) = 13.0 (aroma)
Cooked	The combination of brown flavor notes and aromatics associated with heated milk.	Dillons whole milk (2 min heated) = 4.5 (flavor) Carnation evaporated milk = 12.0 (flavor)
Overall dairy	A general term for the aromatics associated with products made from cow's milk.	Carnation non-fat dry milk = 4.5 (flavor) Kroger Half & Half = 10.0 (flavor)

Dairy fat	Aromatics associated with dairy fat.	Carnation non-fat dry milk = 0.0 (flavor) Land O'Lakes fat free Half & Half = 5.0 (flavor)
Dairy sweet	The sweet aromatics associated with fresh dairy products.	Kroger Half & Half = 6.0 (flavor)
Lack of freshness	Suggests the loss of fine taste qualities typically noted in good milk. May be a precursor to other, more objectionable, flavors.	*
Light-oxidized	Flavor caused by light-catalyzed oxidation. Characterized by aromatics that may be described as burnt feathers, slightly sour burnt protein, tallowy, and/or medicinal: may include increased astringency or metallic mouthfeels.	Light-oxidized skim milk = 2.0 (flavor)
Musty/earthy	Humus-like aromatics that may or may not include damp soil, decaying vegetation, or cellar-like characteristics.	Kroger butter beans (canned) = 5.5 (flavor)
Bitter	The fundamental taste factor of which caffeine in water is typical.	0.01% Caffeine solution = 2.0 0.02% Caffeine solution = 3.5
Sweet aromatics	Aromatics associated with the impression of all sweet substances.	Dillons whipping cream = 5.0 (flavor)
Sweet	The basic taste sensation of which sucrose in water is typical.	1% Sucrose solution = 1.0 2% Sucrose solution = 2.0 4% Sucrose solution = 4.0 5% Sucrose solution = 5.0
Sour	Fundamental taste factor of which citric acid in water is typical.	0.015% Citric acid = 1.5 0.025% Citric acid = 2.5 0.050% Citric acid = 3.5
Sour aromatics	Slightly pungent aromatics similar to those found in slightly fermented products such as sour cream, buttermilk, and yogurt.	Kraft Philadelphia cream cheese = 8.0 (flavor) Kroger lima beans = 3.5 (flavor)
Texture		
Chalky	A measure of a dry, powdery sensation in the mouth.	Kroger non-dairy coffee creamer = 4.5 Carnation non-fat dry milk = 7.5 Eagle brand sweetened condensed milk = 13.0
Fat feel	Related to the perceived fat content. Refers to the intensity of the oily feeling in the mouth when the product is manipulated between the tongue and the palate.	Carnation non-fat dry milk (reconstituted) = 0.0 Land O'Lakes fat-free Half & Half = 8.0
Viscosity	The measure of the flow as the product moves across the tongue.	Water = 0.0 Dillons 2% milk = 1.0 Dillons Half & Half = 2.0 Dillons whipping cream = 4.0 Hershey's chocolate syrup = 9.0
Astringent	Dry and puckering mouthfeel associated with an alum solution in the mouth.	0.5% Alum solution = 2.5
Aftertaste[b]		
Overall sweet	A combination of sweet aromatics and sweet taste.	*
Overall sour	A combination of sour taste and sour aromatics.	*
Brown	The aromatics that are brown and create a rounded full-bodied impression. This is brown not related to the cooked attribute.	*
Butyric acid	An aromatic that is sour and cheesy and slightly buttery — reminiscent of baby vomit.	*
Cooked	The combination of brown flavor notes and aromatics associated with heated milk.	*
Overall dairy	A general term for the aromatics associated with products made from cow's milk.	*
Dairy fat	Aromatics associated with dairy fat.	*
Dairy sweet	The sweet aromatics associated with fresh dairy products.	*
Fatty mouthfilm	The amount of residue left on the surfaces of the mouth after swallowing.	Carnation non fat dry milk = 0.0

Light-oxidized	Flavor caused by light-catalyzed oxidation. Characterized by aromatics that may be described as burnt feathers, slightly sour burnt protein, tallowy, and/or medicinal: may include increased astringency or metallic mouthfeels.	*
Astringent	Dry and puckering mouthfeel associated with an alum solution in the mouth.	*
Bitter	The fundamental taste factor of which caffeine in water is typical.	*

a Intensity was rated on a 15-point scale with 0.5-point increments.
b Technique: Take 3 sips of milk, at the end of the 3rd sip, begin timing.
* No reference used.

2.5. Descriptive Testing Sessions

Samples were evaluated one at a time, labeled with 3 digit numbers. Fifteen minutes elapsed between finishing one sample and beginning another sample. The flavor attributes were evaluated first, followed by the aftertaste. Panelists cleansed their palate using unsalted cracker tops (unsalted tops, Premium Saltine crackers, Nabisco, East Hanover, NJ, USA); reverse osmosis, deionized, carbon-filtered water; and baby carrots.

2.6. Consumer Liking Test

One hundred one teenage girls between the ages of 13 and 18 years old who were willing to be involved in milk testing were recruited to participate in this test. Consumers evaluated a total of seven milk samples in a 2-day period. To measure the consistency of consumers' rating between the days, control milk was evaluated on both days.

The samples were served one at a time. Consumers were asked to drink the entire sample of milk provided before rating the sample. Consumers evaluated the milk for overall liking, liking of sweetness, and liking of milk aftertaste using a hedonic type scale with 9 boxes labeled at one end with dislike extremely and at the other end with like extremely. To determine the amount of sweetness, amount of aftertaste, and amount of off-flavors perceived by consumers, they were asked to use a 9-point interval scale with 1 meaning none and 9 meaning extreme intensity. Ten minutes were allowed for evaluating each sample. Consumers were instructed to cleanse their palate between samples using crackers with unsalted tops and reverse osmosis, deionized, carbon-filtered water.

Demographic information was collected at the end of evaluation on the second day. Age, milk consumption frequency, type of milk consumed, and type of food consumed with milk were asked.

2.7. Data Analysis

Analysis of variance of both the descriptive and consumer data was conducted using PROC MIXED in SAS® version 8.2 (SAS Institute Inc., Cary, NC, USA) to determine differences among milk samples. Correlation analyses were conducted on the means of specific terms in the descriptive and consumer data using PROC CORR in the SAS® system.

3. Results

3.1. Descriptive Analysis

The results from descriptive sensory evaluation of milk samples are presented in Table 3 (initial evaluation) and Table 4 (aftertaste at 90 sec). The control milk had sensory attributes that were similar to the desired milk flavor described by Bodyfelt, Tobias and Trout, (1988), 'whole milk should have a pleasing sweetness, with no foretaste or aftertaste other than that provided by the natural richness of the milk fat and other milk solids.' The control milk had no off-flavors such as musty/earthy, light-oxidized, and butyric acid and was rated higher for overall dairy, dairy sweet, and sweet aromatic attributes than other milk samples (Table 3 and 4).

Table 3. Analysis of variance; means of descriptive analysis data[1] at initial evaluation.

Product	Control	Light-oxidized 3 hrs	Light-oxidized 1 hr	High-acid	Lacks freshness	School milk	Store brand milk	LSD[2]
Chalky	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	0.56 a	0.52 a	0.20
Fat Feel	5.58 a	5.52 a	5.41 ab	5.57 a	5.44 a	5.13 b	5.39 ab	0.28
Viscosity	1.23	1.26	1.20	1.28	1.20	1.19	1.20	n/a
Astringent	0.69 b	0.43 c	0.70 b	1.04 a	1.00 a	1.02 a	0.93 ab	0.23
Brown	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	0.80 a	0.00 b	0.23
Butyric Acid	0.00 b	0.00 b	0.00 b	1.78 a	0.00 b	0.00 b	0.00 b	0.21
Cooked	0.56 bc	0.00 c	0.67 b	0.72 b	0.57 b	1.26 a	0.69 b	0.33
Overall Dairy	7.54 a	7.54 a	7.37 ab	6.91 de	7.24 bc	6.72 e	7.00 cd	0.26
Dairy Fat	5.16 ab	5.31 a	5.17 ab	5.06 b	5.11 ab	4.93 b	5.07 ab	0.25
Dairy Sweet	4.09 ab	4.15 a	4.07 abc	3.39 e	3.87 bcd	3.63 de	3.81 cd	0.27
Lack of Freshness	0.00 c	0.00 c	0.00 c	0.83 b	0.72 b	0.65 b	1.30 a	0.30
Light-oxidized	0.00 c	0.00 c	0.00 c	0.00 c	0.61 b	0.00 c	0.91 a	0.29
Musty/Earthy	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	0.56 a	0.00 b	0.19
Bitter	0.89 bc	0.87 c	0.83 c	1.06 a	1.04 ab	1.11 a	1.15 a	0.15
Sweet	1.62 ab	1.63 a	1.52 ab	1.46 b	1.63 a	1.48 ab	1.54 ab	0.16
Sweet Aromatics	3.69 ab	3.81 a	3.59 ab	2.74 e	3.46 bc	3.13 d	3.22 cd	0.28
Sour	1.05 c	1.17 bc	1.17 bc	1.70 a	0.98 c	1.17 bc	1.30 b	0.20
Sour Aromatics	1.45 d	1.46 d	1.57 cd	2.57 a	1.50 cd	1.67 bc	1.80 b	0.19

[a-e] Means with the same letter designation in the same row are not statistically significantly different ($\alpha = 0.05$).

[1] Ratings used a 15-point linear scale with 0.5-point increments, where 0 = none and 15 = extreme,

[2] LSD = Least significant differences.

Table 4. Analysis of variance; means of descriptive analysis data[1] at 90 sec evaluation.

Product	Control	Light-oxidized 3 hrs	Light-oxidized 1 hr	High-acid	Lacks freshness	School milk	Store brand milk	LSD[2]
Overall Sweet	1.97 ab	2.09 a	1.96 ab	1.43 d	1.80 bc	1.70 c	1.93 ab	0.20
Overall Sour	1.74 c	1.70 c	1.80 bc	2.22 a	1.78 bc	1.91 b	2.07 a	0.16
Butyric Acid	0.00 b	0.00 b	0.00 b	0.63 a	0.00 b	0.00 b	0.00 b	0.14
Cooked	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b	0.57 a	0.00 b	0.24
Overall Dairy	2.49 abc	2.61 ab	2.63 a	2.41 bc	2.44 abc	2.37 c	2.43 abc	0.22
Dairy Fat	1.96 bc	2.22 a	2.04 ab	1.89 bc	1.81 c	1.78 c	1.83 c	0.19
Dairy Sweet	1.86 abc	1.96 a	1.93 ab	1.37 e	1.72 bcd	1.59 d	1.69 cd	0.21
Fatty Mouthfilm	1.70 ab	1.80 a	1.72 ab	1.63 ab	1.47 ab	1.57 b	0.67 ab	0.20
Astringent	0.95 bc	0.81 c	0.80 c	1.20 a	1.09 ab	1.11 ab	1.09 ab	0.22
Bitter	1.08 c	1.09 c	1.17 bc	1.41 a	1.28 ab	1.41 a	1.31 ab	0.18

[a-e] Means with the same letter designation in the same row are not statistically significantly different ($\alpha = 0.05$).
[1] Ratings used a 15-point linear scale with 0.5-point increments, where 0 = none and 15 = extreme.
[2] LSD = Least significant differences.

The two light-oxidized milk samples did not have appreciable light-oxidized flavor, according to descriptive evaluation. Both light-treated samples differed only slightly from the control milk and those differences were not significant. It is possible that the two treated milks were not exposed to a strong enough light sources for long enough duration to elicit the usual flavors associated with light-oxidized milk.

The high-acid milk was the only milk to have any butyric acid flavor and was rated higher for bitter, astringent, and sour attributes than the control and the light-oxidized samples. This was probably a result of adding cultured buttermilk to the sample. High quality cultured buttermilk should have a delicate, pleasant, diacetyl, and acid flavor derived from lactic acid. Cultured buttermilk contains about 0.9% total acid (lactic acid) and is similar in composition to skim milk except for its higher acidity (Bodyfelt *et al*., 1988). The high-acid milk sample was rated as one of the lowest in overall dairy, dairy sweet, sweet taste, and sweet aromatics. The 90-sec aftertaste evaluation of the high-acid milk was the highest in overall sour, astringent, bitter, and butyric acid among milk samples in the study and only in high-acid milk was the butyric acid attribute evident in the aftertaste evaluation.

The lacks freshness milk sample was rated similarly to the control milk except it was higher in astringent, lack of freshness, and light-oxidized and lower in overall dairy. Only bitterness aftertaste was different in comparison with the control.

The school milk had no light-oxidized flavor, probably because it was packaged in opaque 240 mL cardboard cartons. This sample was rated higher in brown, cooked, musty/earthy, and bitter attributes, and lower for fat feel, overall dairy, dairy sweet and sweet aromatics than other samples. At the 90-sec evaluation, the school milk was rated higher in cooked, astringent, and bitter, and lower in overall sweet, overall dairy, and dairy fat than other samples. The school milk was rated as being low in milk characteristics like dairy fat, overall dairy, and dairy sweet. Because the milk is intended for children, the school milk might have been pasteurized at a slightly higher temperature and/or for a longer time, than other milk samples, which may explain the increase in cooked intensity.

The store brand milk was rated the highest for lack of freshness, light-oxidized, bitter, and had lower ratings for overall dairy and dairy sweet when compared to the control sample. Notably, store brand milk was rated higher ($p < 0.05$) for the lack of freshness attribute than the lacks freshness milk sample. At the 90-sec evaluation, the store brand milk was rated higher than the control and the light-oxidized 3 hrs milk samples for overall sour and bitter. Those aftertastes such as bitter, acid/sour, and astringent are considered to be off-flavors (Bodyfelt *et al.*, 1988). The store brand milk was rated the lowest in the dairy fat attribute among all the samples.

Some texture attributes, such as chalky, fat feel, and viscosity, as well as fat-related flavor attributes (dairy fat and fatty mouthfilm) were similar among samples, probably because all samples were 2% reduced-fat milk. Fat content is important in milk, because the sensory properties of milk are strongly influenced by the fat content (Frøst *et al.*, 2001). In addition, the viscosity of milk is closely related to the percentage of milk fat (Chapman *et al.*, 2001).

3.2. Consumer Liking Test

The seven milk samples showed significant differences ($\alpha = 0.05$) for some characteristics (Table 5). Teenage consumers liked control milk, light-oxidized 3 hrs milk, and light-oxidized 1 hr milk significantly ($p < 0.05$) more than school milk, high-acid milk, lacks freshness milk, and store brand milk. Of all the milk samples, the store brand milk scored the lowest. The patterns for liking of sweetness and liking of aftertaste were very similar to that of overall liking. This relationship of sweetness and overall liking is also seen in a study by Chung (2009) where the sensory attribute sweet is positively correlated with consumers' liking of milk. Vickers, Mullan,and Holton, (1999) conducted a milk liking and consumption study that showed that a difference of about 1 point on a 9-point hedonic scale had little impact on milk consumption in a dormitory food service setting. In our study, the store brand milk was more than two points lower than control milk on a 9-point hedonic scale indicating that it may negatively affect milk consumption. There may be a corresponding impact on

milk consumption as a result of low liking scores of the store brand milk considering that store brand milk is what most teenage girls have access to. This issue should be further investigated.

Table 5. Analysis of variance: consumer data[1].

Product	Control	Light-oxidized 3 hrs	Light-oxidized 1 hr	High-acid	Lacks freshness	School milk	Store brand milk	LSD[4]
Overall Liking[2]	5.57 a	5.50 a	5.48 a	4.35 b	4.33 b	4.31 b	3.50 c	0.53
Liking of Sweetness[2]	5.39 a	5.45 a	5.15 a	4.29 b	4.39 b	4.32 b	3.52 c	0.50
Liking of Milk Aftertaste[2]	4.64 a	4.96 a	4.66 a	3.95 b	3.73 b	3.70 b	3.09 c	0.51
Amount of Sweetness[3]	4.41 a	4.18 abc	4.24 ab	3.90 bc	4.18 abc	4.33 ab	3.69 c	0.50
Amount of Aftertaste[3]	4.63 cd	4.51 d	4.70 cd	4.90 bcd	5.50 a	5.07 abc	5.32 ab	0.54
Amount of Off-flavor[3]	3.63 c	3.70 c	3.87 c	4.79 b	4.95 ab	4.90 ab	5.42 a	0.57

[a-d] Means with the same letter designation in the same row were not significantly different ($\alpha = 0.05$).
[1] A 9-point scale was used, with 1-point increments.
[2] For liking questions, 1 represented dislike extremely and 9 represented like extremely.
[3] For amount questions, 1 = none and 9 = extreme.
[4] LSD = Least significant differences.

The samples that the teenage participants perceived as sweetest in descending order, were control milk and school milk, followed by lacks freshness milk, light-oxidized 1 hr milk, light-oxidized 3 hrs milk, high-acid milk, and the store brand milk. Statistically, the control milk and school milk were rated higher than the store brand milk for the amount of sweetness.

Lacks freshness, school milk, and store brand milk were not significantly different from one another for amount of aftertaste and off-flavor perceived by teenage girl consumers. However, the store brand milk was the least liked for overall liking, liking of sweetness, and liking of milk aftertaste.

Of 101 teenage girls, 79 said that they liked to drink milk. Milk consumption, however, varied among consumers: four or more glasses/cartons a day (16%), 2 glasses/cartons a day (23%), one glass/carton a day (16%), more than three glasses/cartons a week (14%), one to two glass(es)/carton(s) a week (17%), less than once a week (11%), and never (3%). Two percent fat milk was consumed by the highest portion of teenage girls who participated in this study (54%) followed by flavored milk (41%), skim milk (31%), 1% milk (19%), and whole milk (14%).

Food that consumers said they ate while drinking milk varied, but the highest consumption of milk was with sweet foods or snacks. Sixty-one consumers answered that they drink milk when eating donuts and 87 consumers indicated they drank milk with chocolate chip cookies. The participants also said that they liked to drink milk with Oreo™ cookies (79). This result, illustrating the popular consumption of milk, with cookies confirmed the results of Auld et al. (2002), who reported that milk was often associated with consumption of cookies/cakes/brownies. And about two-thirds of participants in research conducted by Susiyanti *et al*. (1996) agreed that 'milk is good with snacks.' A little over than half of the respondents (57) answered that they would drink milk with peanut butter sandwich. However, only 30 girls in this current study selected milk to drink with chili. Again, these results support those of Auld et al. (2002), who found that milk was not usually consumed with spicy foods or pizza. It is apparent that the type of food consumed greatly affects the choice of beverage to accompany the meal. In Han and Kim's focus group study (2002), one teenage girl said that she drank soda whenever she ate hamburgers, since those items always tasted good together. Some consumers in that study suggested that soda aided digestion if consumed with greasy foods. Susiyanti *et al.* (1996) found similar result: 65.6% of participants who received high calcium (greater or equal to 100% recommended dietary allowance) agreed to the attitude statement of 'No milk with hamburgers.'

3.3. Relationship of Sensory Descriptive Data and Consumer Data

Correlation analysis was conducted using mean scores from descriptive sensory analysis and consumer acceptability study of seven milk samples. Overall liking from the consumer test was negatively correlated with the lack of freshness (r = -0.99) and bitterness (r = -0.96) attributes of descriptive sensory analysis. Also, overall liking was negatively correlated with astringent (r = -0.81) and bitter (r = -0.81) in the 90 sec-aftertaste descriptive test. Therefore, it may be that these attributes were factors in the reduced liking of milk expressed by these teenage girls. These findings generally confirm the results of Bodyfelt *et al*. (1988), who found that undesirable flavors in milk included acid, astringent, bitter, barny, cooked, flat, lacks freshness and light-induced oxidation.

The amount of aftertaste rated by consumers also was positively correlated with light-oxidized (r = 0.80) and lack of freshness (r = 0.82) attributes, and negatively correlated with dairy fat (r = -0.85) attribute at 90-sec aftertaste.

The amount of off-flavor rated by consumers was positively correlated with lack of freshness (r = 0.97), bitter (r = 0.95), and astringent (r = 0.84) attributes and negatively correlated with the overall dairy (r=-0.81) attribute. The amount of off-flavor, like astringent (r = 0.82), bitter (r = 0.84), and dairy fat (r=-0.81) correlated with aftertaste attributes at 90 sec. Consumers tended to dislike the flavor when the milk had lack of freshness, astringent, or bitter attributes or when the milk lacked dairy or dairy fat flavor. Generally, the consumer ratings were higher for the amount of off-flavor when descriptive panelists rated the sample higher for lack of freshness, astringent, and bitter attributes.

In summary, the control and light-oxidized milk samples in this study were liked by consumers. These samples were scored higher than other samples for attributes that contributed dairy characteristics: overall dairy, dairy fat, and dairy sweet. Consumers slightly disliked high-acid, lack of freshness, school milk, and store brand milk samples. Generally, these samples were rated lower for dairy characteristics than the other samples, and some also were rated higher for butyric acid, sour, sour aromatics, and bitter attributes. In these samples, lack of freshness and light-oxidized attributes were present to a slight degree. The high-acid, the lacks freshness, the school milk, and the store brand milk samples had several off-flavors that were appreciated as aftertastes.

4. Conlusion

The trend in milk consumption has changed from whole milk to primarily low-fat milk over the years. Light oxidation associated with milk fat and its associated taste attributes are perhaps a lower priority to consumers as a result. This study indicated that liking of milk correlated negatively with lack of freshness, astringent, and bitter attributes. Some attributes, such as astringent, bitter, and light-oxidized, may result from protein degradation. In order to encourage increased consumption of milk, milk producers should strive to keep milk as fresh as possible and control extensively for these types of off-flavors to maintain both quality and consumer acceptance of the product.

The variety of milk samples used in this study did not cover the full range of commercially available milks. Therefore, further research is needed to examine the issues of off-flavors and aftertastes in commercially available milk and the effects of these substances on milk consumption patterns in children and teenagers, as well as others who need to improve their calcium intake.

Because lack of freshness correlated negatively with teenage girls' liking of milk, further research may be able to estimate the liking score of a particular kind of milk by conducting additional descriptive tests on a variety of samples. To modify milk taste or to keep milk from developing the lack of freshness attribute, knowing which volatile flavor compounds appear as milk loses freshness will be helpful. Instrumental analysis, coupled with descriptive analysis using different sources of milk providing different degrees of lack of freshness should be performed on a variety of commercially available milks in order to find what volatile compounds are related to lack of freshness.

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NATIONAL IDENTITY, PERCEIVED VALUE AND WINE CONSUMPTION: A STUDY OF DALAT WINE IN VIETNAM

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Abstract

This study explores the relations between national identity and functional judgment of Dalat wine and consumer ethnocentrism. It then investigates how the product judgment and consumer ethnocentrism affect the perceived value of Dalat wine, which in turn predicts the consumer willingness to buy this product.

Empirical results based on SEM analysis show that national identity has a significant impact on product judgment and consumer ethnocentrism. These two factors together, in turns, explain 58 % variance of consumer's perceived value which is the key predictor (67 %) of willingness to buy. The study thus confirms the roles of national identity (*ie.*, cultural homogeneity, national heritage, and belief system) and consumer ethnocentrism in explaining wine consumption behavior. It also indicates that emotional and social values are important motivators of Vietnamese consumers towards Dalat wine.

Keywords*: National identity, Vietnam, consumer ethnocentrism, emotional value, social value, willingness to buy, wine consumption.*

1. Introduction

Wine is a typical example of a product for which consumption behavior is influenced by consumers' social-cultural factors (Aizenman, & Brooks, 2007; Cohen, d'Hauteville, & Sirieix, 2009), and their attitude towards the product's country of origin (Balestrini, & Gamble, 2006; Hu, Li, Xie, & Zhou, 2008). In Vietnam, local wine accounts for 23 % of the total market in 2010, in which Dalat wine is the dominant brand. To many Vietnamese consumers, this France-origin brand has a mixed image of the "French elegant", the "French colonist" and the "Vietnamese-made" product. This multi-facet background leads to the question of which social-cultural framework and factors are capable of explaining Dalat wine buying and drinking motivation.

Given this context, this research attempts to address three objectives. Firstly, it employs the concept of national identity (Keillor, Hult, Erffmeyer, & Babaku, 1996) to explain the consumer's functional judgment of the Dalat wine and the extent of consumer ethnocentrism. Secondly, it investigates how the product judgment and consumer ethnocentrism are capable of explaining the consumer perception on the value of Dalat wine. Thirdly, it tests the impact of consumer perceived value on consumer willingness to buy this product.

This research is expected to contribute to the literature in different ways. Firstly, it is among few empirical studies on the relations between consumer behavior and national identity, a concept which received scant attention in the marketing area (Dinnie, 2002). Secondly, this research suggests a theoretical distinction between the concept of consumer ethnocentrism and ethnocentrism in which the former is only a domain - specific application of the latter. Thirdly, in addition to culture, other

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dimensions of national identity, (*i.e.*, national heritage and belief system) are also capable of explaining wine consumption behavior. Fourthly, this study indicates that emotional and social values are key motivators of wine consumption. Finally, by providing the empirical evidence from the emerging market of Vietnam, the current study contributes to filling a gap. In literature, the existing body of research suffers from an important limitation as most of it has been conducted in high income, industrialized countries (Burgess, & Steenkamp, 2006). According to Burgess and Steenkamp (2006, p. 337). "emerging markets are natural laboratories in which theories and assumptions about their underlying mechanisms can be tested, generalizations derived and boundary conditions identified"

2. Theoretical background and proposed hypotheses

In response to the research objectives set forth above, this theoretical review provides basic understanding of the meanings of major constructs in this research and explanation of the hypothesized conceptual links among these constructs.

2.1. Perceived value

From the consumer perspective, perceived value is defined as the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given (Zeithaml, 1988). Chen and Hu (2010) suggest that value can be formed by functional utility and non-functional utility. Functional utility refers to tangible needs such as quality and price, while non-functional utility refers to intangible aspects relating to reputation, social and emotional needs. In the case of wine consumption, the functional utility is investigated in terms of physical product judgment and non-functional utility is considered under the construct of perceived non-physical value.

Based on various eating and drinking motivators suggested in the literature (Renner, Sproessor, Strohbach, & Schupp, 2012; Somogyi, *et al.*, 2011) and the value framework proposed by Williams and Soutar (2009), the current study focuses on two reflective components of perceived value when a consumer drinks wine, namely emotional value and social value.

Emotional value is a social-psychological dimension that reflects a product's ability to arouse feelings or affective states (Sheth, Newman, & Gross, 1991). In wine consumption, emotional value represents the extent of pleasure, indulgence, and relaxation or cheer a consumer may feel while drinking it (Renner *et al*., 2012). Social value is defined as "the perceived utility acquired from an alternative's association with one or more specific social groups" (Sheth, *et al.*, 1991, p. 161). Consumer choices of goods to share with other people like wine are often driven by social value (Williams, & Soutar, 2009). In a collectivistic culture like Vietnam, most people drink wine with other people in a group. In these circumstances, wine is an important means for them to socialize (Renner *et al.*, 2012). Therefore, social value is an important utility of wine consumption. Between the two components, emotional value is to reflect the fulfillment of internal need for stress release, relaxation, pleasure, fun, etc. In contrast, social value is associated with external need when consuming wine. It relates to the practice of social relationships with others like social gathering, business events, etc. (Renner *et al.*, 2012; Brunner, & Siegrist, 2011).

2.2. National identity

National identity is defined as the extent to which a given culture recognizes and identifies with a set of focal elements that set it apart from other cultures by exhibiting greater variations in the institutions of those aspects than others (Clark, 1990; Keillor *et al.*, 1996). The main strength of the construct of national identity against the construct of culture is that it minimizes the relevant distinction between "culture" and "nation", and avoids the ambiguity between the two concepts (Cui, & Adams, 2002). According to Keillor *et al.* (1996), national identity is conceptualized as a high-order construct which embraces four dimensions, namely national heritage, belief system, cultural homogeneity and consumer ethnocentrism. National heritage reflects the importance of historical figures and events in the history, which is regarded to reflect a given culture's sense of their own unique history. Belief

system refers to the extent to which individual beliefs, in a religious sense, play a role in facilitating individual cultural participation and solidarity. Cultural homogeneity is closely related to national heritage. This dimension characterizes the sense of cultural uniqueness in the context of national heritage. Consumer ethnocentrism reflects the importance placed on maintaining culturally centered consumption patterns. Strong preference for domestically manufactured products to foreign-made ones is an indication that a culture has a high degree of national identity.

Keillor *et al.* (1996) suggest that these four components reflect how strongly individuals in a given nation identify with religious, historical, cultural, and social aspects of their national identity. However, while national heritage, belief system and cultural homogeneity fully capture the religious, historical and cultural aspects, consumer ethnocentrism is a domain-specific construct which reflects only one part of ethnocentrism (Vinson, Scott, & Lamont, 1977). The conceptual domain of consumer ethnocentrism is confined within the economic exchange of consumers which is only one aspect of the general social exchange. Therefore, this study adopts three former reflective components.

The model we used to describe the hypothesized relations between national identity, perceived value and attitude towards wine consumption (*i.e.*, willingness to buy) is presented in Figure 1.

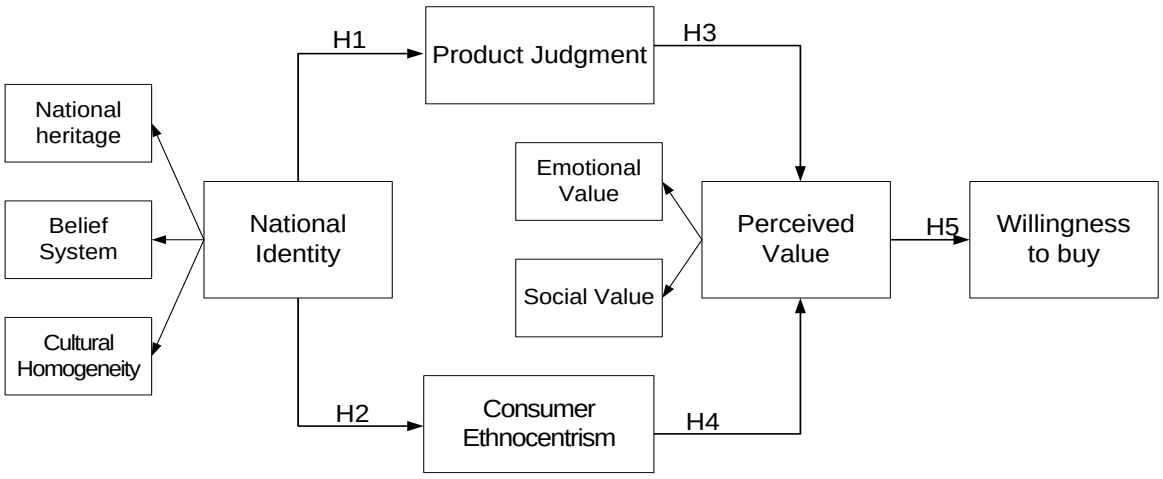

Figure 1. The research model

2.3. National identity and product judgment

Product judgment represents the rational evaluation of a consumer towards a physical product. In the current study, product judgment is reflected by perceived quality and perceived price of Dalat wine. Perceived quality refers to the consumer's judgment about a product's overall excellence or superiority (Zeithaml, 1988). For consumers in developing economies like Vietnam, perceived quality is perhaps the most meaningful attributes of a product because they tend to have experienced low quality products manufactured by local firms (Nguyen, Nguyen, & Barrett, 2008). On the other hand, perceived price reflects what is given up or sacrificed to obtain a product (Zeithaml, 1988). In this study, it is the perception of consumers on how fair the amount of money they pay in exchange for the functional quality they get from the product is. Perceived quality and perceived price together represent the consumer's cognitive response to the product offered, which is termed product judgment.

The association between national identity and product judgment can be explained by the personal value system of consumers (Schwartz, 1992). National identity is the extent that a consumer adhere to a "typical value system" of a country. It provides a shared cultural and social value system, based on which its members develop their own personal value framework to judge a product/service they consume (Thuy, & Hau, 2010). Therefore it is expected that:

H1. National identity has a positive association with the consumer's judgment of Dalat wine.

2.4. National identity and consumer's ethnocentrism.

Keillor *et al*. (1996) identified close relations between national identity and consumer's ethnocentrism. However, the inequivalence in abstraction level and conceptual domain as mentioned above suggests that consumer ethnocentrism should be an attitudinal result of national identity in the economic domain. Research has pointed out that national identity is an important antecedent of consumer ethnocentrism, and characteristics associated with a sense of national identity are capable of explaining the existence of consumer ethnocentrism (Sharma, Shimp, & Shin, 1995; Cui, & Adams, 2002). Thus, it is hypothesized that:

H2. National identity has a positive association with consumer's ethnocentrism.

2.5. Product judgment and perceived value

In the consumer's cognitive process, the relationship between product judgment and perceived value can be explained by means-end chains theory (Gutman, & Alden, 1985; Zeithaml, 1988) and cognitive appraisals. Accordingly, product judgment has lower level of abstraction than that of perceived value. That is, the physical product judgment must precede the perception of value that the product offers. Empirically, previous studies support that product judgment, which comprises perceived quality and perceived price, is the key antecedent of perceived value (Chen, 2008; Chen, & Tsai, 2008). Therefore, it is hypothesized that:

H3. Product judgment has a positive effect on the perceived value of Dalat wine.

2.6. Consumer ethnocentrism and perceived value

Consumer ethnocentrism stems from the concept of ethnocentrism in socio-psychology. This concept is developed specifically within marketing domain which indicates the "belief held by consumers about the appropriateness, indeed morality, of purchasing foreign-made product" (Shimp, & Sharma, 1987, p.280). Ethnocentric consumers are likely to value highly products belonging to their own group and to devalue products which do not belong to their group, leading to a bias in their perception of the utility of a product (Nguyen *et al.*, 2008). This is particularly relevant to the consideration of Dalat wine consumption because it is a local product but has a French origin. The bias perception of Vietnamese consumers on local products was empirically found by Nguyen *et al*. (2008). In this study of wine, it is expected that consumer ethnocentrism exerts a positive influence on the consumer's perception of wine value because the main utility of this product is based on non-physical aspect (*i.e.*, social and emotional value). Consequently, it is hypothesized that:

H4. Consumer ethnocentrism of Vietnamese has a positive impact on the perceived value of Dalat wine.

2.7. Perceive value and willingness to buy

Willingness to buy represents the extent to which a consumer has positive attitude towards purchasing a product. The marketing literature has established that perceived value of a product/brand leads to behavior intentions towards that product/brand (Nguyen *et al*., 2008; Williams, & Soutar, 2009; Whittaker, Ledden, & Kalafatis, 2007). Therefore, the willingness to buy which reflects consumer's attitude towards buying wine is expected to be strongly linked to its perceived value. Thus:

H5. Perceived value has a positive influence on customer's willingness to buy Dalat wine.

3. Method

The proposed hypotheses were tested using survey data obtained from respondents who were customers of Dalat wine. The sample comprised 251 cases. Data were collected by means of a

structured questionnaire employing a convenience sample of face-to-face interviews at various points of purchase in HoChiMinh city, the biggest city of the country.

In terms of measurement scale, national heritage, belief structure, cultural homogeneity and consumer ethnocentrism were measured by 12 reflective items adopted from Keillor and Hult (1999). Perceived quality, perceived price, emotional value and social value and willingness to buy were measured by 15 reflective items adopted from Sweeney and Soutar (2001). All measures employed five-point Likert scales (Table 2).

4. Results

The sample characteristics are summarized in Table 1 which indicates that the sample was reasonably distributed in terms of gender, age, education, and income level.

Table 1. Sample characteristics (n = 251 cases)

Characteristic	Frequency	%		Characteristic	Frequency	%
Gender:				Education:		
- Male	142	52.6		- Below university	63	23.3
- Female	128	47.4		- University	207	76.7
Age group:				Income: (USD/month)		
20-29	99	36.7		Less than 200	70	25.9
30-39	104	38.5		200 – 400	138	51.1
40-49	60	22.2		Over 400	62	22.9
50-over	7	2.6				

4.1. Validity and reliability of measures

The 27 items measuring nine constructs were submitted to confirmatory factor analysis (CFA) using AMOS software program (Arbuckle & Wothke, 1999) to assess the measurement model representing relations among all constructs and associated items. The kurtosis values of all variables were within -0.74 to +0.86 and their skewness values ranged from -0.94 to -0.06. Although the data exhibit slight deviations from normal distribution, it was appropriate for maximum likelihood (ML) estimation to be applied (Kline, 1998).

Refinement was made by eliminating 6 items (Table 2) due to low loading or high covariance of error terms. Finally, CFA of the measurement model with the remaining 21 items yielded the following measures: Chi-square $\chi^2(153) = 209.77$; $p < 0.002$; Normed chi-square $\chi^2/df = 1.37$; Goodness-of-fit index GFI = 0.93; Tucker-Lewis index TLI = 0.97; Comparative fit index CFI = 0.98; Root mean square error of approximation RMSEA = 0.04. It was also noted that no offending estimates (*i.e.*, no negative error variances or Heywood cases) were found (Hair, *et al.*, 2010). All these statistics showed that the measurement model fited the data set in this empirical study.

As shown in Table 2, all item loadings on their designate constructs range from 0.64 to 0.95. Correlation coefficients between the 36 pairs of constructs range from 0.12 to 0.73 which are well below 1.00. Composite reliabilities of the nine scales range from 0.60 and 0.93 which are acceptable for exploratory research (Kline, 1998). Thus, convergent validity, discriminant validity and reliability of scales are satisfactory.

4.2. Structural model estimation

The structural model was estimated using maximum likelihood (ML) estimation. In this model, national identity, product judgment and perceived value were specified as multidimensional reflective constructs, while customer ethnocentrism and willingness to buy were unidimensional constructs. Model estimation yielded a good fit: Chi-square $\chi^2(177) = 261.74$; $p = 0.000$; Normed chi-square $\chi^2/df = 1.48$; Goodness-of-fit index GFI = 0.912; Tucker-Lewis index TLI = 0.963; Comparative fit index CFI = 0.969; Root mean square error of approximation RMSEA = 0.044.

The resulting standardized estimates (Table 3) indicate that national identity has a significant effect on product judgment (β = 0.66; p < 0.001). National identity also has a significant direct effect on consumer ethnocentrism (β = 0.30; p < 0.002). Then, product judgment has a significant effect on perceived value (β = 0.68; p < 0.002). Consumer ethnocentrism also has a significant effect on perceived value (β = 0.24; p < 0.010). Taken together, product judgment and consumer ethnocentrism explain 58 % of the variance in perceived value. In turn, perceived value is the key predictor of consumer willingness to buy Dalat wine (β = 0.82; p < 0.002), which explains 67 % of its variance. It is, thus, concluded that all five hypotheses are supported by the data in this empirical study.

Table 2. Scale items

Item wording	Std. loading
National heritage: (Comp. reliability = 0.71 AVE = 0.55)	
Important people from the country's past are admired by people today	0.75
One of the country's strengths is that it emphasizes events of historical importance	0.74
The country has a strong historical heritage	eliminated
Belief system: (Comp. reliability = 0.60 AVE = 0.43)	
Religious education is essential to preserve the cohesiveness of Vietnamese society	0.67
A specific religious philosophy is an important part of being Vietnamese	0.64
A true Vietnamese would never reject their religious beliefs	eliminated
Cultural homogeneity: (Comp. reliability = 74 AVE = 0.59)	
Vietnamese in general feel that they come from a common cultural background	0.76
Vietnamese are proud of their national culture	eliminated
People frequently engage in cultural activities that identify them as Vietnamese	0.78
Consumer ethnocentrism: (Comp. reliability = 0.84 AVE = 0.64)	
Buying foreign products hurts Vietnamese business	0.70
Vietnamese people should not buy foreign products as it causes unemployment	0.87
Buying foreign products lets other countries getting rich off us	0.83
Emotional value: (Comp. reliability = 0.79 AVE = 0.65)	
In comparison with the money, time and effort I spend…	
Dalat wine is one that I would enjoy	0.83
I would feel relaxed about using Dalat wine	eliminated
Dalat wine would give me pleasure	0.78
Social value: (Comp. reliability = 0.90 AVE = 0.81)	
In comparison with the money, time and effort I spend…	
Dalat wine would help me to feel acceptable	0.88
Dalat wine would give me social approval	0.95
Dalat wine would improve the way I am perceived	eliminated
Perceived quality: (Comp. reliability = 0.93 AVE = 0.82)	
Dalat wine has consistent quality	0.87
Dalat wine is well produced	0.95
Dalat wine has an acceptable standard of quality	0.91
Perceived price: (Comp. reliability = 0.87 AVE = 0.69)	
Dalat wine is reasonably priced	0.77
Dalat wine offers value for money	0.87
Dalat wine is a good product for the price	0.86
Willingness to buy: (Comp. reliability = 0.76 AVE = 0.61)	
I would be willing to buy Dalat wine if it is available at the store	0.72
I would recommend Dalat wine to friends or relatives	eliminated
I would buy Dalat wine even if there is another brand at the same quality and price	0.84

The results show further that national identity (second-order construct) is reflected substantially and equally by its three components (first-order constructs), namely national heritage (β = 0.80; p < 0.002), belief system (β = 0.81; p < 0.002) and cultural homogeneity (β = 0.89; p < 0.002). Moreover, perceived quality and perceived price have satisfactory loadings on its second-order construct of product judgment, in which perceived quality has higher loading (β = 0.85; p < 0.002) than perceived price (β = 0.62; p < 0.002). Emotional value and social value load satisfactorily on perceived value of the product, in which emotional value is more substantial (β = 0.86; p < 0.002) than social value (β = 0.66; p < 0.002). It is, therefore, concluded that all first-order constructs in the model have substantial loadings on their designated second-order constructs.

Table 3. AMOS estimation results

Path			Std. Coeff.	p value	Hypothesis test
National identity	→	Product judgment	0.66	0.001	Support H1
National identity ethnocentrism	→	Consumer	0.30	0.002	Support H2
Product judgment	→	Perceive value	0.68	0.002	Support H3
Consumer ethnocentrism	→	Perceived value	0.24	0.010	Support H4
Perceived value	→	Willingness to buy	0.82	0.002	Support H5
National identity	→	National heritage	0.80	0.002	
National identity	→	Belief system	0.81	0.002	
National identity homogeneity	→	Cultural	0.89	0.002	
Product judgment	→	Perceived quality	0.85	0.002	
Product judgment	→	Perceived price	0.62	0.002	
Perceive value	→	Emotional value	0.86	0.002	
Perceive value	→	Social value	0.66	0.002	

5. Discussion

The discussion of results is organized around three key points. Firstly, this study attempts to tackle the question of how a Vietnamese consumer's adherence to national identity can help explain his/her perceived value of Dalat wine, a French-origin-Vietnam–made product. By broadening from culture-based to nation-based consideration of consumer behavior, the results of this research indicate that national identity has a positive impact on the perceived value of Dalat wine. It can explain 58% of the variance on perceived value. However, it is found that national identity does not have a direct impact on perceive value. It influences perceived value through the mediation of product judgment and consumer ethnocentrism. This means national identity is a highly abstract construct which resides within individual consumer as a base for the personal framework of reference to judge the physical product quality in relation with its price. National identity also forms the level of consumer ethnocentrism which in turns, influences the consumer's perception of Vietnamese wine value.

Secondly, the current study departs from previous studies by drawing a distinction between ethnocentrism and consumer's ethnocentrism. While Keillor *et al*. (1996) consider ethnocentrism as a component of national identity, the operationalization of this construct captures business/economic exchanges only. Given that consumer ethnocentrism is a domain-specific construct, it should be a consequence of ethnocentrism, and thus national identity should be reflected by three components (*i.e*., national heritage, belief system and cultural homogeneity). Empirical results of the current study totally support this interpretation by showing that national identity has a much smaller regression

coefficient on consumer ethnocentrism (β = 0.30, below the threshold of 0.50) than on national heritage (β = 0.80), belief system (β = 0.81) and cultural homogeneity (β = 0.89). In fact, the same pattern was also found in the empirical results of previous studies (Cui, &Adams, 2002; Thelen, & Honeycutt, 2004). Moreover, additional tests reveal that none of the three components (*i.e,* national heritage, belief system and cultural homogeneity) had significant direct effect on perceived value, while consumer ethnocentrism had a significant direct effect on perceived value (β = 0.24, p < 0.010).

Thirdly, it is found in this study that perceived value of wine consumption is mainly related to emotional value and social value, meaning that non-physical motives drive people to drink Dalat wine. The strong positive link between emotional value and wine consumption is consistent with previous study in Switzerland (a European country with a traditional wine culture). However, while the current study finds a positive association of social value and wine consumption in Vietnam, social motive was negatively related to wine consumption in Switzerland (Brunner, & Siegrist, 2011). This different result may be attributed to the impact of national aspects like culture, belief and national heritage, which together form the national identity of each country.

6. Conclusion

This study is an attempt to respond to the need for knowledge of food consumption behavior under different social and cultural configurations (Cohen et *al.*, 2009; Yaprak, 2008). It provides empirical evidence for a special case of wine consumption in Vietnam and its predictive factors. Apart from the multiple influences of France due to historical connection between the two countries, the consumption behavior of this local product is also linked to the context of an emerging economy in the South East Asia region under the trend of globalization. This multi-facet indigenous research setting certainly provides special value to the global knowledge of food consumption behavior (Tsui, 2004). It is, in fact, a necessary step before the global knowledge can be claimed (Burgess, & Steenkamp, 2006).

From the managerial perspective, the knowledge obtained from this study serves as a basis for wine marketers in Vietnam to invest their firm's limited resources and effort on designing and implementing communication programs for Dalat wine. Particularly, in their communication messages, marketing managers should emphasize the emotional and social values of the product which adhere to Vietnam national identity.

As with many other studies, the current research cannot avoid a number of potential limitations, based on which further research is suggested. First, regarding the conceptualization of key concepts, this study specified national identity and perceived value as second-order reflective constructs. With due conceptual consideration, an alternative approach is suggested to apply formative specification to these two constructs to fully understand the relative contributions of each component of national identity and perceived value in this research setting. Secondly, further research should investigate the moderating effect of factors like consumption occasions (i.e., private, public), consumer knowledge of wine and other social demographics (Ritchie, 2009; Cohen et *al.*, 2009). Finally, further research is also suggested to revalidate the inclusion of ethnocentrism as a dimension of national identity and to develop its own measurement scale in replacement of the scale used by Keillor et al. (1996) and many other authors afterward, which actually measures consumer's ethnocentrism, rather than ethnocentrism.

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MOTIVES UNDERLYING VIETNAMESE CONSUMER FOOD CHOICE: A MEANS-END CHAIN APPROACH

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Abstract

In this study, we used Mean-Ends Chain (MEC) to explore and characterize the motivations underlying food choice of Vietnamese consumers. Specifically, we identified and described the differences in cognitive structures between consumers who actually used green tea products (considered as traditional products) and those who consumed milk products (considered as new products). Eighty-two consumers (18-65 years old) participated in this study. Forty-two were green tea consumers and forty milk consumers. Using the "soft laddering" technique, we asked participants to provide the reasons for choosing their preferred product. The results showed that the cognitive structure of green tea consumers was constructed around abstract attributes *(taste and flavor, knowledge, and understanding about products...*), functional consequences (*alertness*), psychological consequences (*social interaction, comfortable feeling, alertness, to make exciting*), and values (*good for work*). By contrast, the cognitive structure of milk consumers incorporated abstract attributes (*calcium, preference, components in milks*) and functional consequences (*height growth, nutrition supply*). Family concerns and knowledge affected both cognitive structures. The term "*good for health*" and "*good for work*" were mentioned in both structures. These results help understand the motivational cognitive structure of both green tea and milk consumers.

Keywords*: Laddering technique, means-end, Vietnamese consumers, food choice*

1. Introduction

Food choice, like any complex human behavior, is influenced by many interrelated factors (Prescott, Young, O'Neill, Yau, & Stevens, 2002) but Rozin (2000) argued that culture provides the strongest determinant. To some extent, the effects of culture reflect different dietary histories, determine which foods are acceptable in terms of sensory properties, and create culturally specific "flavor principles" (Rozin, & Rozin, 1981, Prescott, 2002). These principles help understanding the attachment to traditional foods and the often mentioned resistance towards new foods. However, the choice of food products is a complex decision process that is influenced by many factors such as: convenience, price, production technology, personal health, branding, and societal issues (Jaeger, 2006). This complexity is particularly apparent when traditional foods are contrasted with new foods (that can be traditional foods from another culture). An example of such an opposition can be found in Vietnam when comparing a very traditional product such as green tea with a new product such as milk based

beverages. Here two complex cultural systems of cultural values and motivations interact and underlie consumers' food choice decisions.

The exploration of these complex process requires adequate tools. For example Steptoe, Polland, and Wardle, (1995) developed the food choice questionnaire (FCQ) that investigates nine factors influencing food choice*: Health, mood, convenience, sensory appeal, natural content, price, weigh control, familiarity and ethical concern.* To better understand how consumers integrate these factors decision mean-ends chain (MEC) has been developed. MEC is, actually, a complete cognitive model of consumer behavior to reveal the cognitive structure relevant to the buying behavior, as indicated by Grunert and Grunert (1995). As a basic assumption of the model, the consumers' values play a dominant role in guiding consumer choice patterns (Gutman, 1982). MEC approach is based on this fundamental assumption. In food research, MEC theory and laddering technique were applied in defining motives of consumers' purchase of organic foods, French consumers' wine (Fotopolus, Maglaras, & Pagiaslis, 2009), and trade coffee in France (Ferran, & Grunert, 2007). This method was also used to explore the perception of beef in different cultures (Grunert, 1997), vegetable oil in different countries (Nielsen,Bech-Larsen, & Grunert, 1998), differentiation of meat perception (Lind, 2007; Barrena & Sánchez, 2009), and motives to choose Ready-to-eat meals (Costa, Schoolmeester, Dekker, & Jongen,, 2007), GMO products (Bredahl, 1998), functional foods (Urala & Lahteenmaki, 2003), meat consumption in Islamic contries (Bonne & Verbeke, 2006), acceptance of GMO in yogurt products (Boecker, Hartl,, & Nocella, 2007), and high pressure food products (Sorenso, & Henchion, 2011). MEC is used to determine cognitive structure of consumers in order explain their decision-making process. MEC builds hierarchical value maps (HVM) that show the link between attributes, consequences, and values of consumers' choice.

To sum up, in this paper, we compared consumers' cognitive structures for a traditional (green tea) and a non-traditional new food (milk) product. We also evaluate the effects, on food buying decisions, of these cognitive structures and of other consumers' characteristics such as gender and age.

2. Materials and methods

2.1. Participants

A total of 82 consumers (age 18 – 65 years) living in Ho Chi Minh City participated in the individual laddering interview. Forty-two consumers who actually used green tea products (considered as traditional products) and the others (40) consumed milk products (considered as non-traditional products) participated in this study.

2.2. Procedure

We followed closely the guidelines for research application of MEC theory (Grunert, & Grunert, 1995; Reynolds, & Gutman, 1998). A soft laddering interview technique was chosen because participants may use unwanted strategic processes, and the degree of knowledge about the product category is either low or high (Grunnert, & Grunnert, 1995). Direct elicitation was chosen. The subject was told that there would be two main questions the researcher was investigating related to her or his green teas or milk usage or consumption habit, namely *''Why do you consume green tea/ milk product*?'' and ''*Why did you choose green tea/ milk product to use right now*?'' For each attribute elicited by the subject, an additional questions was asked: "Why is that (Attribute) important to you?" Each answer that followed was also further elaborated, continuing the laddering process until the participant

had no more information to give. Furthermore, we also collected demographic data such as age and gender.

2.2.1. Data collection

Data were collected from individual interviews lasting approximately thirty minutes per person. All interviews were conducted in the surroundings chosen by the participant. Participants were first explained the purpose of the research and were told that there were no right nor wrong answers and that the interviewer was only interested in the participants' opinion. Participants were also informed that the interviewer had no affiliation with any of the brands mentioned during the interview.

2.2.2. Data analysis

Content analysis regroups the large numbers of individual responses into subcategories of three larger categories: Attributes, Consequences and Values. This was obtained using the online version of Ladderux ®. This software also produced an implication matrix that shows the number of associations between different categories in the interview. This could be in direct connection A – C, or in indirect connection A- C– V. The sum of different connections indicates the strength of a given association. This Iimplication matrix creates basis for constructing HVM with a chosen threshold level (*cut-off level*)[3].

3. Results and discussion 3.1. Milk products- Attributes- Consequences-Values

The content analysis of the 40 interviews provides 25 subcategories regrouped in 8 attributes, 14 consequences, and 3 values. All these are listed in Table 1 along with the number of respondents in each segment..The attribute mentioned most by every respondent was "nutrition" and "calcium supply." The consequence mentioned most by every respondent was "good for health." The value was "good for work.".

3.1. Green teas products- Attributes- Consequences-Values

Most of consumers are using green tea product frequently. The age of participants is from 18 to 68 years-old ((37.5+16.2) including 25 males and 17 females. The content analysis of the 42 interviews being registered and categorized under 43 labels including 21 attributes, 15 consequences, and 7 values, which are listed in Table 2 along with the number of respondents in each segment..The attribute mentioned most by every respondent was "*taste and flavor*" and "*knowledge and understanding*." The consequences mentioned most by every respondent was "*alertness*," "*good for health*," "*comfortable feelings*;" value was "*good for work*." Sensory perception was attracted by green tea consumers.

Consequences include functional consequences (*good for health, thristy decrease, dispose a poison*) and psychological consequences (*comfortable feelings, pleasant, social interaction*). Values explored in green tea consumers are "*Good for work*," "*Happiness*" and "*Efficient in*

[3] The cut-off level is defined by Skytte and Bove (2004) as *"the minimum number of times two elements must have an indirect link to be mentioned in the hierarchical maps".*

work" when consumers used green teas. "*Good for work*" is considered the most important value in consumers' decision-making.

Table 1- Attribute, consequences and values elicited in the laddering interviews- milk products.

Attributes (*)	Consequences	Values
I Concrete Attributes	III Functional Consequences	V Values
II Abstract Attributes	9 Saving time (1/0)	23 Success (2/0)
1 Calcium (16/0)	10 Good for skins (5/0)	24 Enjoy life (1/0)
2 Taste and flavor (2/0)	11 Energy supply (16/0)	25 Good for work (14/0)
3 Ingredients in milks (2/0)	12 Help bone strong (5/0)	
4 Advertisement (1/0)	13 Good for health (32/0)	
5 Habit (5/0)	14 High growth (7/0)	
6 Preference (5/0)	15 Weight gain (1/0)	
7 Quality (2/0)	16 A full stomach (1/0)	
8 Convenience (2/0)	17 Easy to sleep (1/0)	
	18 Good for digestion (3/0)	
	19 Nutrition supply (18/0)	
	IV Psycho-social Consequences	
	20 Comfortable feelings (4/0)	
	21 Effective in work (2/0)	
	22 More intelligence (1/0)	

(*) the numbers in brackets are the frequency of factors in MEC

Table 2- Attribute, consequences and values elicited in the laddering interviews- green tea products

Attributes	Consequences	Values
I Concrete Attributes	III Functional Consequences	V Values
1 Color (6/0)	22 Good for digestion (4/0)	37 Good for work (26/0)
II Abstract Attributes	23 Good for teeth (2/0)	38 Mutual understanding (3/0)
2 Traditional beverage (1/0)	24 Anti-cancer (5/0)	39 Happiness (1/0)
3 Traditional factor (6/0)	25 Thirsty decrease (8/0)	40 Life more significant (3/0)
4 Knowledge, understanding (12/0)	26 Dispose a poison (2/0)	41 Efficient in work (4/0)
5 Taste and flavor (31/0)	27 Good for health (25/0)	42 Good and safe for one's.. (2/0)
6 Strongness (2/0)	28 Fat decrease (1/0)	43 Long life (1/0)
7 Habit (17/0)	IV Psycho-social Consequences	
8 Preference (17/0)	29 Social interaction (11/0)	
9 Drink for thirsty (8/0)	30 Alertness (18/0)	
10 Mineral component (4/0)	31 Pleasant (9/0)	
11 Oxidize component (8/0)	32 Stress decrease (4/0)	
12 Quality (5/0)	33 Make exciting (12/0)	
13 Typical of greentea (13/0)	34 Comfortable feelings (14/0)	
14 Natural beverage (2/0)	35 Relaxation (3/0)	
15 Price (2/0)	36 Make friends (2/0)	
16 Antiseptic (1/0)		
17 Get rid of fishy (1/0)		
18 Astringent (3/0)		
19 Deliciousness (2/0)		
20 Familiarity (2/0)		
21 Taste adaption (2/0)		

3.3. Hierarchical Value Maps for milk products

Hierarchical value maps (HVM) describe the link between attributes, consequences, and values. The HVM of the milk products (Figure 1).shows that the relation of the structure of energy *supply-good for health-nutrition supply* is the strongest relation. In general, consumers paid attention to *calcium content, important ingredient in milk* products. Functional consequences were important when consumers chose milk products. By contrast, the psychological consequences found in this structure *(e.g.*, comfortable feelings) were less important. The values mentioned in this structure was "*good for work*" and showed the highest motivation of consumers in their lives

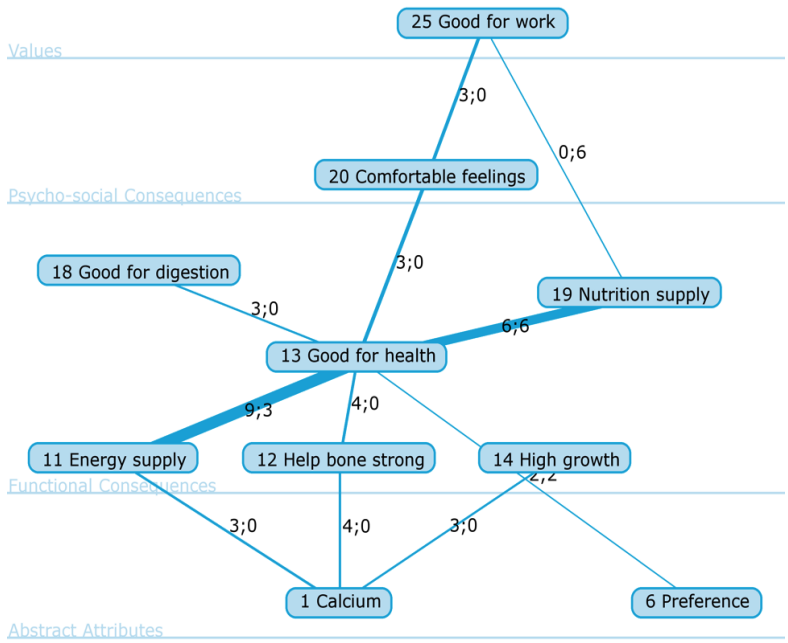

Figure 1. Hierachical Value Maps of milk products (cut-off=3)

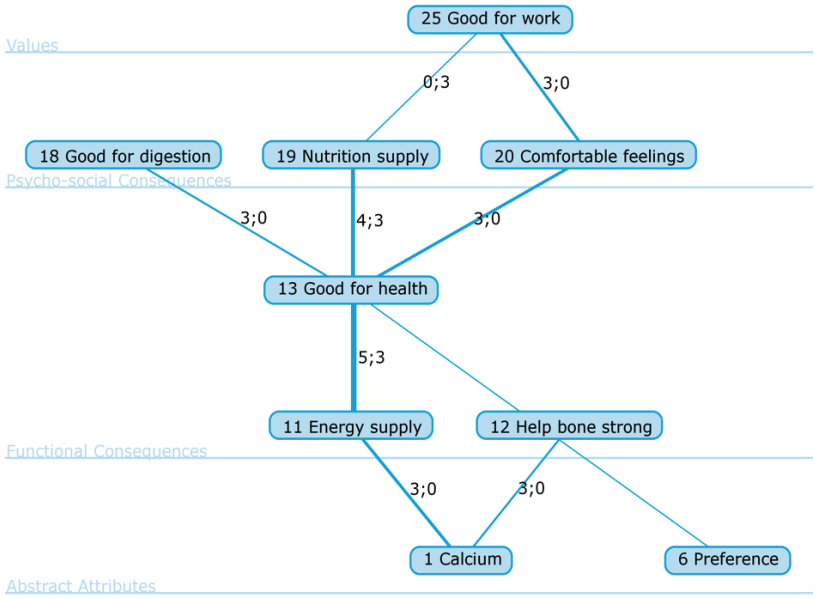

Figure 2. Hierachical Value Maps of milk products (cut-off=3) for female consumers

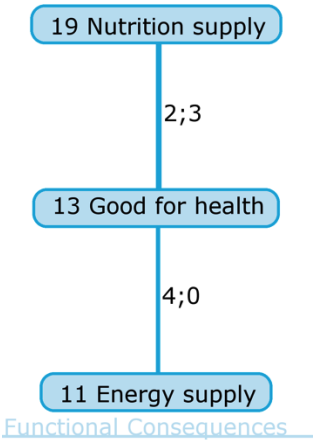

Figure 3. Hierachical Value Maps of milk products (cut-off=3) for Male consumers

Female consumers are more likely to use milk products than male and this was expressed as a gender's effect in the cognitive structure. Figures 2 and 3 show the different results for male and female participants.

Male consumers like to drink milk products and they paid attention to calcium (attributes). The male consumers' structure shows link attributes-consequences-values while the male consumers' structure indicate only the relations between *energy supply-good for health-nutrition supply* (functional consequences).

Besides gender's effect, the results showed in Figures 4 and 5 showed clearly the difference between the older (over 35 years old) and the younger consumers (under 35 year old). The older consumers's structure was more complex than the young consumers. Specifically, the attributes, psychological consequences, and values were found in the older consumers' motivations while only functional consequences were found in the young's ones. However, in both structures, "*good for health*" was expressed as the reason for choosing milk.

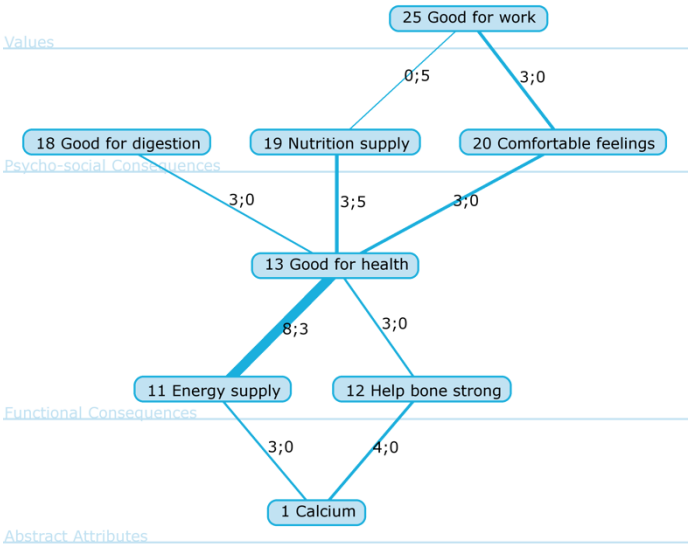

Fig 4 Hierachical Value Maps of milk products (cut-off=3) to consumers over 35

3.4. Hierarchical value maps for green teas

HVMs built on the link between attributes, consequences and, values are shown Figure 6. In this HVM (cut-off=3), the relation between "*taste and flavor -typical of green tea"* and "*knowledge, understanding"- "good for health*" constitute the strongest structure. In general, consumers paid attention to sensory properties (*taste and flavor*) and the useful chemical ingredients to consumer's health. The "*traditional factor-social interaction-good for work"* link, found in this structure, indicate the cultural effect in consumers' cognitive structure of the traditional products. In this structure, psychological consequences (*social interaction, alertness, make exciting, pleasant and comfortable feelings*) affected consumers' choice. The value mentioned in this structure was" *good for work*" showed the highest motivation of consumers in their lives.

Green tea products are considered as traditional products of Vietnamese consumers and are used more by men than women. In men's structure, the results showed more psychological consequences than women's structure, while functional consequences in women consumers' structure were higher than in men's structure. *Color and drink for thristy* and use of green tea were found in women's structure. *Traditional factor and habit* were in men's structure. In those structures, we found that the relations between the value "*good for work*" linked strongly to *social interaction, make exciting, pleasant and comfortable feelings*, while the links of value, "*good for work*" to "*alertness"* and "*good for health"* were not strong.

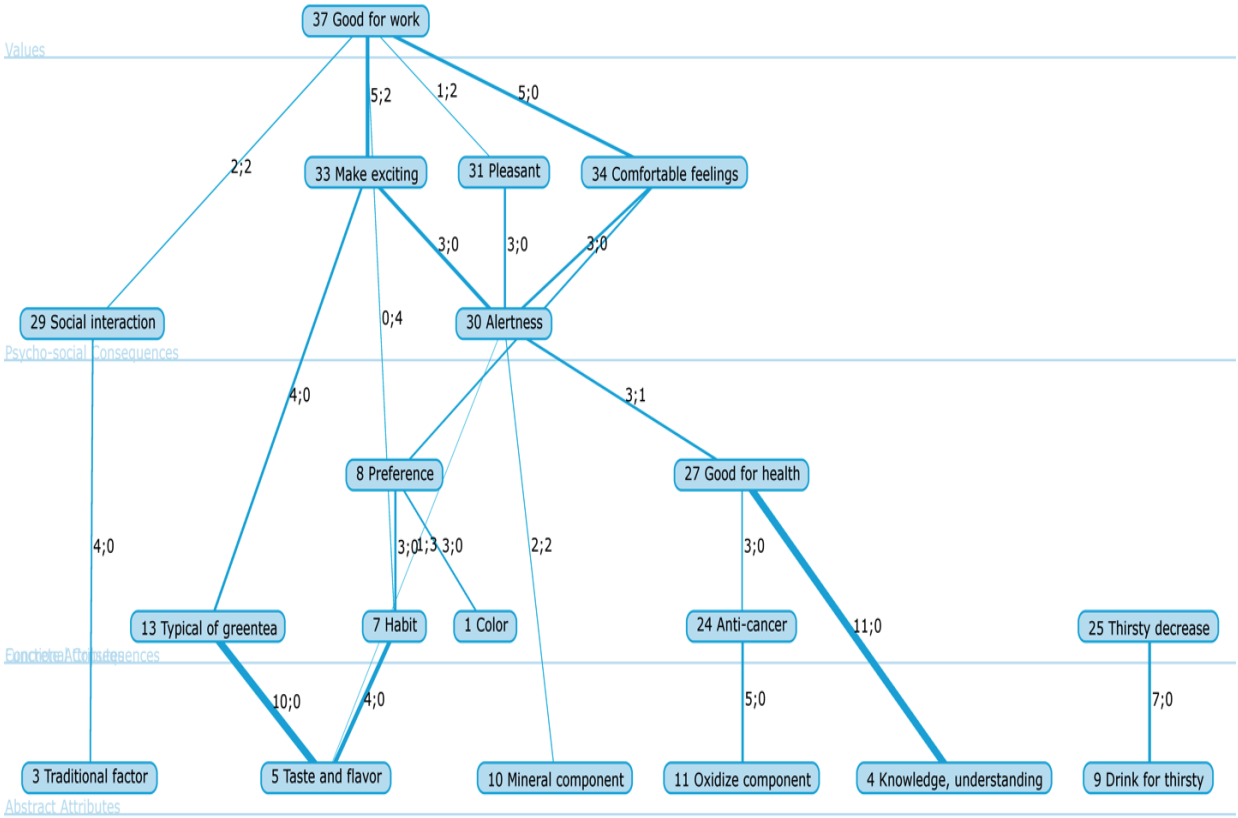

Figure 6. Hierachical Value Maps of green tea products (cut-off=3)

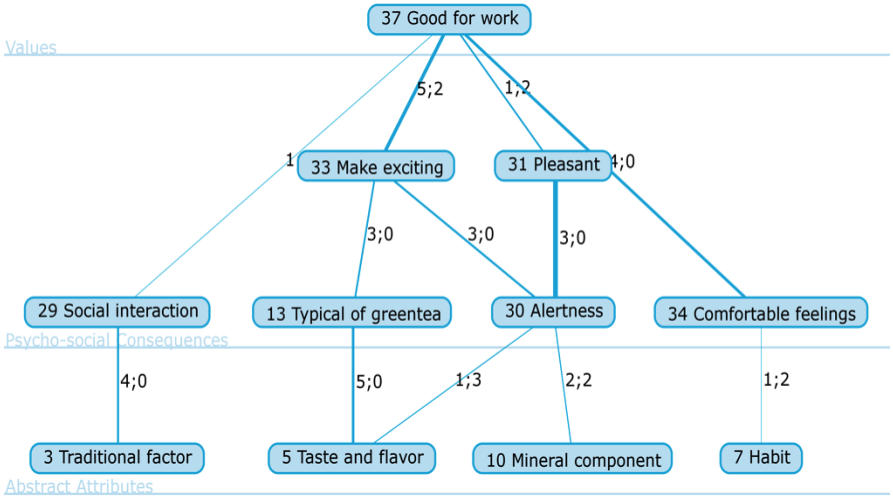

Figure 7. Hierachical Value Maps of green tea products (cut-off=3) for male

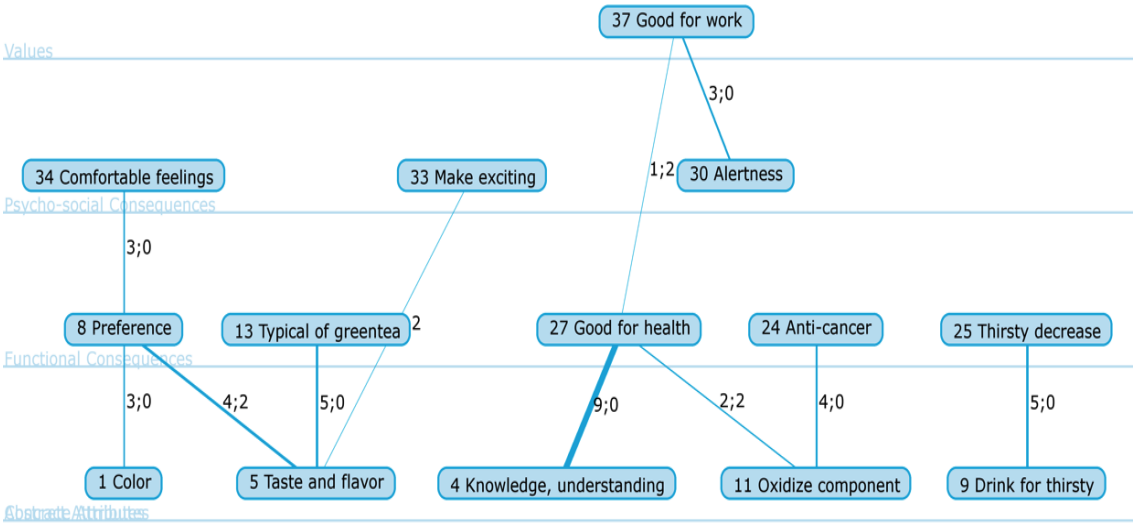

Figure 8. Hierachical Value Maps of green tea products (cut-off=3) for female

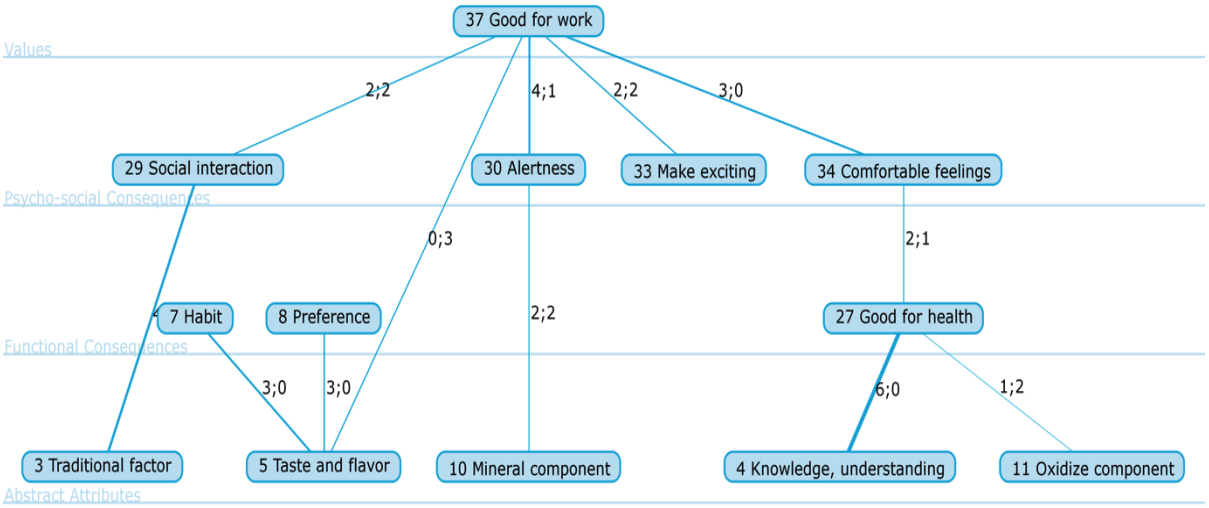

Figure 9. Hierachical Value Maps of green tea products (cut-off=3) for over 35

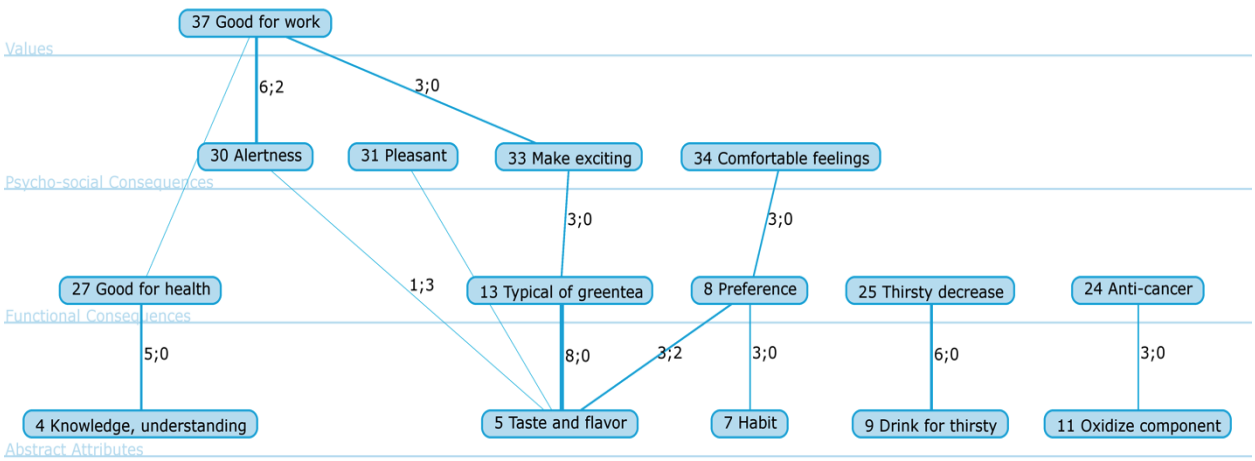

Figure 10. Hierachical Value Maps of green tea products (cut-off=3) for under 35

We found an age effect in the maps of cognitive structure of consumers using green. Figures 9 and 10 show the maps of the older and younger consumers. In the cognitive structure of the older consumers, the *traditional factor-social interaction-good for work* link is clear, while this linkage was not found in the structure of the younger consumers.

3.5. Implication for food product development and food choice motives

Milk products and green tea products are beverage products with equivalently complex sensory properties. The consumer sample from two kinds of products is also very similar. By contrast the attributes, consequences and values of consumers of green teas were very different from those of milk products' consumers. Specifically, the links of A-C-V of green teas' consumers are higher than milk products' (Table 3).

Table 3. The links in MEC of green teas's consumers and milk products'

Green tea products		Milk products	
Direct links	194	Direct links	97
Indirect links	125	Indirect links	75
Total links	319	Total links	172
Respondents	42	Respondents	40
Ladders	111	Ladders	52
Ladders enabled	111	Ladders enabled	52
Ladders disabled	0	Ladders disabled	0
AVG elements/ladder	2.75	AVG elements/ladder	2.87
AVG ladders/respondent	2.64	AVG ladders/respondent	1.30
Datapoints	305	Datapoints	149

4. Conclusion

In our MEC approach, the link between A-C-V represented the cognitive structure of consumers when they chose specific food products. The A-C-V links were the essential parts of the consumers' cognitive structure. This approach not only showed the cognitive structures but also reveal the important factors for consumers. Those results can be of particular significance for food marketers, consumer behaviorists, manufactures but also to the consumers thenselves.

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PART 3

Product Development and Food Market

THE PRODUCTION OF WINE FROM THE SAP OF SUGAR PALM (*ARENGA PINNATA)*

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Abstract

Sugar palm or *Arenga pinnata* is a feather palm native of tropical Asia. In Vietnam, it is named Búng Báng or Đoác and grown only on the highlands in the central or northern part of Vietnam. It is utilized for many purposes, especially for making a unique wine from its sap, sometimes called "The Wine of the God", regarding to its natural fermentation and its unique characteristics. However, such product possesses inconsistent quality and short self-life. The aim of this study was to develop a new approach for making wine from the sap of *Arenga pinnata* that enable larger production of the wine.

The sap was analyzed for the solid content, pH, the titratable acids and sugars. After pasteurization, the sap was added to the ethanol extract of the bark from Ceylon ironwood (*Mesua ferrea* L.) and subjected to fermentation using *Saccharomyces cerevisiae* from the yeast isolated from the old wine. In another attempt, the sap was supplemented with sugar for increasing the alcohol level of the final product. The final wine products were analyzed for the sugar residue, the alcohol content, the pH and the acidity. Sensory analysis was employed to check consumers' preference of the products. The results showed that the most suitable adjusted solid content and applied ironwood concentration to make product most favored were 25% and 2-3% respectively.

Keywords: *Arenga pinnata, alcohol fermentation, Saccharomyces cerevisiae, Celon ironwood, Mesua ferrea L.*

1. Introduction

Sugar palm or *Arenga pinnata* belongs to the kingdom *Plantae*, order *Arecales*, family *Arecaceae*, genus *Arenga*.It is a feather palm native of tropical Asia. In Vietnam, it is named Búng Báng or Đoác and grown only on the highlands in the central or northern part of Vietnam.

It is a perennial plant which has flowers at age of three to six years. The palm sap is usually extracted at the peduncles of flowers. Every peduncle of flowers can produce five liters of sap every day during a period of one to two months. The palm is utilized for many purposes. Its most important product is the sap, which is used as a drink, to make sugar, vinegar and alcohol [see internet websites 1, 2, 3].

The Co Tu ethnic minority in the central part of Vietnam developed a simple process of making wine from the sap with unique flavor. This wine is called "The wine of the God" and is part of the culture of the Co Tu minority. According to this method, before gathering the sap, few pieces of the bark from Ceylon ironwood (*Mesua ferrea* L.) are put into the container. The collected sap is let ferment naturally in few days before use. Such product carries an interesting characteristic flavor of sap, bark and fermentated products that please consumers.

However, this product possesses inconsistent quality and very short self-life, making it difficult to produce at larger commercial scale. So, the aim of this study was to develop a new approach for making wine from the sap of *Arenga pinnata* that enable larger production.

2. Materials and methods

2.1. Materials

The sugar palm which was used in the study was grown in A Luoi part of the Thua Thien-Hue province, Viet Nam. The sap was collected from the palm into small cans which were cooled by ice cubes. The cans were then frozen to store before being used in experiments.

The bark of the Celon ironwood used in experiments was collected at A Luoi region of Thua Thien-Hue province, Viet Nam.

The *Saccharomyces cerevisiae* culture which was previously isolated from the old palm wine was donated by the Microbiology Laboratory of the Department of Resource and Environment, Quang Nam Province, Viet Nam.

2.2. Methods

1) *Analysis of titratable acidity:* according to Vietnamese Standard *TCVN 1273-86*
2) *Determination of reducing sugars:* according to *Lane &Eynon methods AOAC Official Method 923.09*
3) *Determination of total sugar:* according to *AOAC Official Method 925.35*
4) *Determination of total soluble solids:* using refractometer RUDOLPH J357
5) *Determination of alcohol content*: according to Vietnamese Standard *TCVN 1273-72*
6) *Preparation of ironwood extract:*

   100 g of dried broken pieces of the bark from ironwood was soaked with 400 ml ethanol 30% (v/v) for seven days. This extract was used for experiments.

7) *Fermentation of palm sap:*

   The fermentation took place anaerobically in 1.5 l and 3.5 l glass containers. The prepared sap was added with the ironwood extract and maybe sugar for adjusting Bx and heated to 70 ^{o}C for 10 minutes. The medium was then cooled to ambient temperature and inoculated with *Saccharomyces cerevisiae* culture with the ratio 1% (v/v). Every two days, samples were taken for chemical analysis.

3. Results and discussion

3.1. The chemical composition of the sugar palm sap

There is little information about the chemical composition of the sap from *Arenga pinnata* available in the literature. Obviously this composition depends on many factors. In this study, we collected samples in April. This is the season which is considered as the most suitable for collecting the quality sap from the tree. Using the methods previously described, we determined some characteristics of the sap. The results are shown in Table 1.

Table 1. The characteristics of the sap from *Arenga pinnata*

Bx (%)	pH	Titratable acidity (g citric acid/l)	Reducing sugar (g/l)	Total sugar (g/l)
12.6±0.7	4.20±0.05	2.06±0.21	56.7±9.6	107±14

According to the values in Table 1, the Bx which represented the soluble solids in the sap is low in comparison with the Bx of grape juice used for wine production (Alan, 2011, Philip, 2005), which suggests that the fermented product from this sap should have lower alcohol content than grape wine. On the other hand, this Bx of the palm sap is higher than that of the juice from various fruits like

orange, apple, lemon, strawberry (Phili, 2005). The low value of pH indicated the presence of some kinds of acids, but thank to high amount of total sugar, the overall taste of the sap was sweet.

3.2. The effect of the soluble solids (Bx) on the alcohol level and consumers'preference

From the result of Bx determination, it is supposed that the alcohol level of the palm wine product should be lower than of the standard grape wine. The purpose of this experiment was to produce palm wine with higher alcohol content and to evaluate the preference of new products in comparison with the "normal" palm wine.

The medium for fermentation was prepared as mentioned above with the ironwood extract level of 2% (v/v). The Bx of the fermentation medium was adjusted to the level of 15%, 20% and 25% by adding sugar. The results of measurements of alcohol content of the fermented products are shown in Table 2.

Table 2. Changes of alcohol content (% v/v) and total sugar of the palm wine during fermentation at different starting Bx level

Days	Alcohol (% v/v)				Total sugar (g/l)			
	Bx 12.6	Bx 15.0	Bx 20.0	Bx 25.0	Bx 12.6	Bx 15.0	Bx 20.0	Bx 25.0
0	-	-	-	-	97,92	126,18	170,0	242,85
2	6,0	8,0	10,8	10,8	9,68	19,23	45,43	84,22
4	9,0	11,8	11,6	13,4	8,42	13,90	17,87	46,14
6	7,8	10,2	12,2	14,6	6,54	9,78	12,48	21,76
8	-	-	13,0	14,6			10,69	18,16

According to the result of table 2, the alcohol level increased with the increased values of starting Bx, meanwhile the total sugar decreased rapidly right after the beginning of fermentation. The maximum alcohol level of the palm wines at starting Bx 12.6%, 15%, 20% and 25% were 9%, 11.8%, 13.0% and 14.6% respectively. Whereas the residual sugar in the final day of fermentation at starting Bx 12,6%, 15%, 20% and 25% were 6.54 g/l, 9.78 g/l, 10.69 g/l and 18.16 g/l respectively. These levels of alcohol could be suitable for the final wine product, but the sugar residue at Bx 25% was rather high, which makes the product sweet.

In order to choose the best Bx level, we carried out a ranking test, using a judge board including 19 students from the Department of Food Technology of Da Nang University of Technology. Position 4 represented the best product and position 1 depicted the worst one. The results were then processed according to Fischer and Yates method (Ha 2006). Position 1, 2, 3 and 4 were attached with values -1.03, -0.30, 0.30 and 1.03 respectively.

The results of analysis of variance showed significant difference between mean values with p = 0.0000. Using the procedure of least significant difference, the preference of 4 products could be ranked as shown in Table 3.

Table 3 Average ranking score for the four products

Sample	Bx 12.6	Bx 15.0	Bx 20.0	Bx 25.0
Mean	-0.66^{a}	-0.19^{b}	0.16^{b}	0.69^{c}

* Different indices mean statistical significant difference between values at α=5%.

This result suggests that the higher the Bx, the the more the product is prefered.

3.3. The effect of the ironwood extract on the liking of the product

The scientific information about the ironwood bark is very rare in literature. It is supposed to have some kind of antimicrobial activity, because according to the local palm wine maker, the sap should spoil without its addition. On the other hand, it apparently gives the characteristic bitterness and

astringency to the wine. The purpose of this experiment was to find out the suitable concentration of the ironwood extract for the product.

The samples were prepared similarly as previous experiment with the Bx of 25%. The ironwood extract was applied to the fermentation medium at the level (v/v) of 0%, 1%; 2%, 3% and 4%. The samples were analyzed for alcohol content and residual sugar during the fermentation. The results are presented in Table 4.

Table 4 Changes of alcohol content (% v/v) and total sugar of the palm wine during fermentation at different ironwood extract concentration

Days	Alcohol (% v/v)					Total sugar (g/l)				
	0%	1%	2%	3%	4%	0%	1%	2%	3%	4%
0	-	-	-	-	-	250,0	250,0	250,0	250,0	250,0
2	8,5	9,4	8,8	10,8	10,4	109,8	95,6	88,4	89,8	94,8
4	9,2	11,2	11,8	11,8	11,8	83,4	93,3	84,8	84,8	93,3
6	11,4	12,0	13,0	14,0	13,8	77,7	66,7	59,6	55,2	59,6
8	11,6	12,4	13,0	13,2	13,0	75,5	57,0	50,6	50,6	53,6
10	12,2	13,0	13,0	13,2	13,0	74,7	55,8	47,9	48,7	48,7

Except the sample without extract addition which has fermented slower, all other samples had a similar course of fermentation. The alcohol content of the products ranged from 13.0 to 13.2, whereas the total sugar remained in products at level ranging from 47.9 g/l to 55.8 g/l.

In order to find out the most suitable amount of ironwood extract to add to the sap, a ranking test was employed. The judge board consisted of 15 students from the Department of Food Technology of Da Nang University of Technology. Position 5 represented the best product and position 1 denoted the worst one. The results were then processed according to Fischer and Yates method. Position 1, 2, 3, 4 and 5 were attached with values -1.16, -0.50, 0, 0.50 and 1.16 respectively.

The analysis of variance showed significant differences between mean values with p = 0.0072. Using the procedure of least significant difference, the preferences of five products could be ranked as shown in Table 5.

Table 5 The means of score for ranking the products

Sample	4%	1%	0%	2%	3%
Mean	-6.80^{a}	-2.50^{ab}	-2.48^{ab}	5.32^{bc}	6.46^{c}

* Different indices mean statistical significant difference between values at α=5%.

The result showed that the lowest score belonged to the sample with 4% extract. This may be due to the excess bitterness of the product that was unpleasant. Samples with no addition and 1% addition got the next lowest scores that could be caused by the absence of apparent taste from the bark of ironwood. However, the differences of liking between samples without addition, with 1% addition and 4% addition were not statistically significant at level α = 5%. On the other hand, the sample with 3% addition was prefered, although the difference of scores between it and the sample with 2% was not statistically zignificant. So, it could be concluded that the addition of ironwood extract at concentration ranging from 2-3% was most suitable.

4. Conclusion

The sap from the sugar palm (*Arenga pinnata*) is an important product. The result of our study has shown that it contained high amount of sugar that could be fermented to make wine. In our first attempt to make the wine have consistent quality, we tried to pasteurize the sap before inoculation of

S. cerevisiae, to control the content of soluble solid and to add active compounds from the bark of ironwood. We finally found out the suitable content of soluble solids was 25% and the most favored concentration of extract of the ironwood bark was 2-3%.

However, the nature of sugars, acids, polyphenols or other chemical components presented in the sap was not resolved in this study. These should have great effect on the final sensory quality as well as the other benefits of the product. And furthermore, other sensory analysis methods should be employed to understand the liking of different groups of people better. Finally, in order to produce commercially, further study should also be designed to find out the appropriate method for preserving and packing product.

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DEVELOPMENT OF A LOW-FAT, LOW-SALT PORK BALL PRODUCT FOR THE SINGAPORE MARKET

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Abstract

One of the most popular processed meat products in Singapore is the pork ball. There are, however, no low-fat and/or low- salt pork balls available commercially in Singapore, with most products containing about 12 g/100 g of fat and 860 mg/100 g of sodium. In order for a product to be labelled either low-fat and/or low-salt it must have < 10 g/100g of fat and/or < 450 mg/100g of sodium (Singapore Health Promotion Board guidelines).

The objective of the current research was to evaluate the effect of partial replacement of fat and sodium on the sensory properties and acceptability of pork balls. A balanced incomplete blocked design was used for the sensory work undertaken by 48 untrained panellists with samples from 16 formulations.

Results indicated that replacement of some of the fat by 1.5% of carrageenan and sodium by 0.4% of potassium chloride achieved the most acceptable score in the pork product as assessed by a consumer panel. Cooking yield and moisture retention were improved by 15.9 % and 6.4%, respectively, relative to low-fat, low-salt pork balls when carrageenan and potassium chloride were used as ingredients. Based on the trained panel, it was indicated that lower levels of NaCl decreased brothy aroma, cuttlefish aroma and salty taste. Increased carrageenan had no effect on sensory characteristics alone, but in conjunction with KCl, the higher level of carrageenan increased chewiness, cohesiveness, hardness, and aftertaste at high KCl levels. The fat and sodium content of the healthy version of pork ball was 7.7 g/100g and 431 mg/100 g, respectively.

Keywords: *Pork, low-fat, low-salt, taste, carageenan, potassium chloride*

1. Introduction

Processed meat products often contain higher amounts of saturated fatty acids and sodium than recommended for a healthy diet. Reduced dietary fat and sodium are recommended because of their association with obesity, heart disease and high blood pressure (Dahl, 1972; Law *et al*., 1991; Davies *et al*., 1999). Direct reduction of fats and sodium can lead to technological difficulties, however, as they perform important technological, microbiological and sensory functions.

Fat replacers and salt substitutes (the term “salt” is used here to mean sodium chloride) are widely used as ingredients in the formulation of low-fat and low-salt meat products. Fat imparts a desirable appearance, and improved flavour, aroma, texture and mouthfeel in foods. Most of the currently available fat replacers are either protein-based, carbohydrate-based or fat-based. Salt substitutes like potassium chloride and tetrapotassium pyrophosphate have been used to replace sodium chloride for low salt meat products. The biggest challenge is cost, as salt is one of the cheapest food ingredients available. Also, consumers may have grown accustomed to salt through processed foods so it may be difficult to reduce it without a decrease in acceptability. The effects of reduced salt are most often minimised by substituting with potassium chloride or flavour enhancers.

Currently, one of the most common processed meat products in Singapore is the pork ball which is a popular ingredient for steamboats where they are cooked in a pot of simmering broth. There are, however, no low-fat and low-salt pork balls available commercially in Singapore (as at mid 2011), with most products containing about 860 mg of sodium per 100 g, which is almost double the Singapore Health Promotion Board healthy guidelines. In order for a product to be labelled as low fat and low salt, the amount of fat and sodium cannot exceed 10 g/100g and 450 mg/100g, respectively (HPB, 2010). It has been reported (Goh, 2006) that two in five Singaporeans (42.7%) exceeded the recommended fat intake, and that the average Singaporean consumes 3527 mg of sodium a day; whereas an average healthy adult requires no more than 2000 mg per day (Singapore Heart Foundation, 2009). Therefore, the availability of a low-fat and low-salt pork ball product would be one of the ways of limiting the fat and sodium intake by Singaporeans.

The objective of the current research was to use consumer and trained sensory panellists to assess the overall acceptability and sensory parameters of pork balls varying in the content of fat, salt, carrageenan (as a fat substitute), and potassium chloride (as a salt substitute).

2. Material and methods

2.1. Pork used and experimental design

Chilled Australian pork loins with fat from a supermarket (Fairprice), were separated into lean and fat. These were minced separately through a 6 mm plate (Sammic Mincer, USA), and then stored at 4°C until used to make pork balls within 24 hours. The 16 formulations involved the use of carrageenan (CP Kelco, Singapore) as the fat replacer and potassium chloride as the sodium chloride substitute are shown in Table 1.

Table 1. The composition of the 16 pork meatball formulations in Experiment 1 and their sodium content[2]

Formulation	Pork	Fat (%)	NaCl (%)	Carrageenan (%)	KCL (%)	Sodium (mg/100g)	NaCl : KCL
F1	79.35	12.5	1.0	0	0	603	100 : 0
F2	81.85	10.0	1.0	0	0	605	100 : 0
F3	79.75	12.5	0.6	0	0	446	100 : 0
F4	82.25	10.0	0.6	0	0	448	100 : 0
F5	81.25	10.0	0.6	1.0	0	447	100 : 0
F6	80.75	10.0	0.6	1.5	0	447	100 : 0
F7	81.15	10.0	0.6	1.0	0.1	447	86 : 14
F8	80.65	10.0	0.6	1.5	0.1	447	86 : 14
F9	81.05	10.0	0.6	1.0	0.2	447	75 : 25
F10	80.55	10.0	0.6	1.5	0.2	450	75 : 25
F11	80.95	10.0	0.6	1.0	0.3	450	67 : 33
F12	80.45	10.0	0.6	1.5	0.3	450	67 : 33
F13	80.85	10.0	0.6	1.0	0.4	447	60 : 40
F14	80.35	10.0	0.6	1.5	0.4	446	60 : 40
F15	80.75	10.0	0.6	1.0	0.5	447	55 : 45
F16	80.25	10.0	0.6	1.5	0.5	446	55 : 45

[1] The other ingredients found in all 16 formulations were water (5.00%), corn starch (1.20%), salt (1.00%), sodium tripolyphosphate (0.30%), cuttlefish flavour (0.30%), soy sauce seasoning (0.20%) and white pepper (0.10%)

[2] Sodium chloride contains 39.33% sodium while sodium tripolyphosphate contains 31.24% sodium. Pork is taken to contain 63 mg of sodium per 100 g.

2.2. Processing of pork balls and physical measurements

Pork balls were prepared using the method shown in Figure 1.

The pH of an homogenate of 10 g of sample (after the 1st cooking) and 90 mL of distilled water was measured in duplicate using a pH meter, (pH 211, Hanna, England) standardized at pH 4.0 and 7.0 (Pexara *et al.* 2002).

After the 1st cooking and cooling to room temperature (25°C+3°C), three whole pork balls per group were assessed in triplicate for hardness on a Texture Analyzer (Model TA XT plus, Stable Micros System, Surrey, England) using a 6 mm diameter probe that compressed the sample to 80% of its original height at a cross head speed of 2.0 mm/s. Hardness (N) is the peak force required (Ranganna, 2008).

Cooking yields were calculated over the first cooking as a percentage of the uncooked weight, and over the second cooking as a percentage of weight after the first cooking. Moisture after the first and second cookings was measured in duplicate in 3 g of ground samples by a halogen moisture analyser (model HR73, Mettler Toledo, Greifensee, Switzerland). Moisture retained over the first cooking was expressed as a percentage of the uncooked moisture, and over the second cooking as a percentage of the moisture present after the first cooking.

The Soxhlet system (Model: Soxtec 2050, FOSS, Sweden) was used (AOAC 991.36) to measure fat in duplicate 2 g samples (after the 1st cooking) of freeze-dried, homogenised material.

For elemental analysis, samples preparation was performed as followed: Minced samples (2.0 g ±0.01 g) were weighed into a teflon vessel. Then 7 ml of nitric acid (65%) was added followed by 1 ml of hydrogen peroxide (30%). Digestion took place in a microwave digestion system (model: Ethos 1600, Milestone, USA). After digestion, the samples were topped up with ultrapure water to 100 mL. An inductively coupled plasma emission (ICPE) spectrometer (Shimadzu model ICPE-9000) was used for the analysis using Argon as a cooling plasma, and carrier gas at flow rates of 14.0, 1.2, 0.7 L/min respectively. The sample was introduced via a coaxial nebulised.

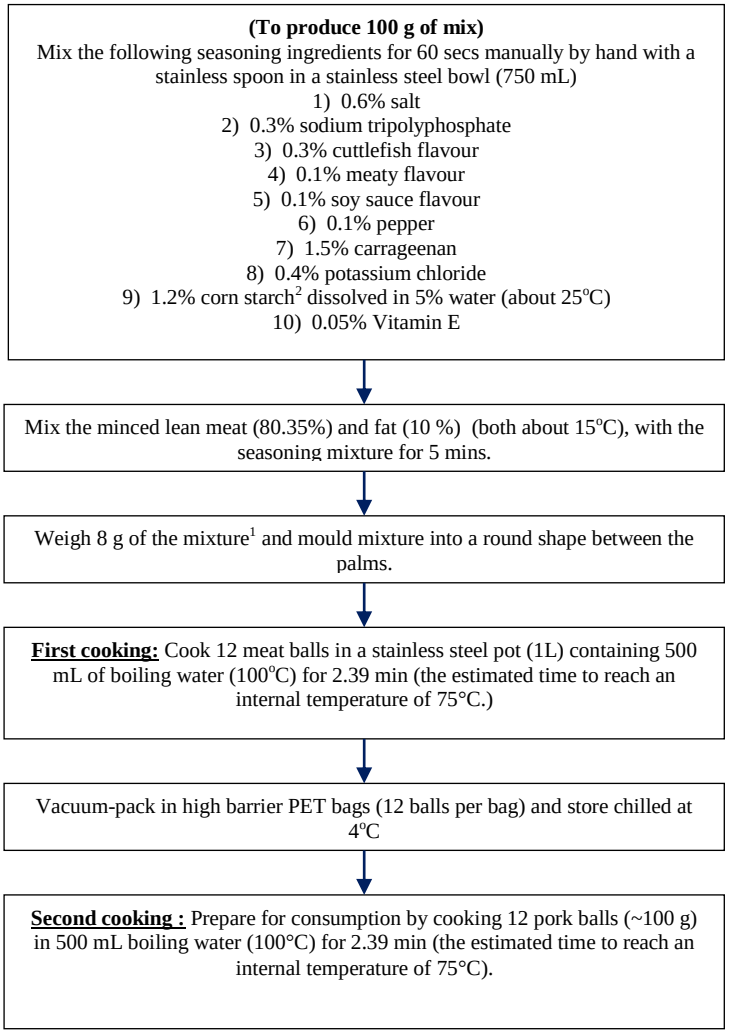

Figure 1. A flowchart showing the steps followed for producing pork balls

2.3. Sensory evaluation

A balanced incomplete blocked design (BIBD) was used for the sensory evaluation of pork balls by the 48 untrained consumer panellists with samples from the 16 treatment groups evaluated by a separate set of 16 panelists during each of three tasting sessions over two consecutive days, with four samples assessed per panellist in each session. The panelists ranked the aroma, flavour, texture, and overall acceptability of the four samples from 1 to 4, where 1 was "Least acceptable" and 4 the "Most acceptable". Thus, with pork balls of each formulation being assessed 24 times, the maximum possible rank sum score was 96 when all scores were 4, and the minimum was 24 when all scores were 1.

An 8-member (3 male, 5 female aged from 21-30yr) panel experienced in sensory evaluation of pork was trained according to AMSA (1978, 1995) procedures. All had participated in sensory evaluation of pork or pork products for one to two years. The trained panel testing was conducted at the Food Quality and Sensory Evaluation Laboratory of the Singapore Polytechnic. Quantitative descriptive analysis (QDA) was used with trained panellists who were screened based on their sensory acuity, liking for pork, and their commitment to taste pork for eight sessions over a period of two days. Triangle tests using different concentrations of sucrose, sodium chloride, citric acid and caffeine were used to perform the screening and ultimately the eight panelists selected participated in five discrimination trials over a period of two days. Under the direction of the panel leader, the panellists developed a sensory language to describe the sensory properties of the products. They grouped the attributes by modality order and then within a modality developed definitions for each attribute. There were three 1.5 hour training sessions. During training, panellists became more confident with scoring the sensory attributes of pork by having samples presented at least two times per session to allow them to re-familiarise themselves with the typical flavour associated with each attribute. The attributes are described in Table 2 and were scored using 150 mm line-scales with anchor points at the ends. In the actual testing, each sample was presented twice to the panel.

Table 2. Definitions of the sensory attributes of pork developed by the trained panellists during training, together with the anchor points at each end of the scale

Sensory attributes	Interpretation	Anchor points
Aroma/flavour/taste attributes		
Meaty aroma/flavour	Aromatic and sensation associated with cooked meat[1]	None / Strong
Brothy aroma/flavour	Aromatic and sensation associated with pork cooked in water[1]	None / Strong
Cuttlefish aroma/flavour	Aromatic and sensation associated with dry preserved cuttlefish[1]	None / Strong
Metallic aroma/flavour	Aromatic and sensation associated with presence of iron ions (blood)[1]	None / Strong
Acidic aroma/flavour	Aromatic and sensation associated with presence of citric acid[2]	None / Strong
Mutton aroma/flavour	Aromatic and sensation associated with presence of mutton[2]	None / Strong
Stale odour/flavour	Atypical aroma/taste generally associated with deterioration of quality[2]	None / Strong
Salty taste	Taste on the tongue associated with sodium chloride[2]	None / Strong
Bitter taste	Taste on the tongue associated with caffeine[2]	None / Strong
Aftertaste	Sensation of lingering taste on the tongue after ingestion[2]	None / Strong
Texture attributes		
Cohesiveness	Degree of resistance to breakdown[2]	None / Strong
Chewiness	Amount of work to chew the sample for swallowing[1]	None / Strong
Hardness	The force required to bite through using molars[1]	None / Strong

[1]Definitions as developed by the panellists
[2]Meilgarrd *et al*. (1999)

3. Statistical analysis

3.1. Physical measurements

The results were analysed in three groups to answer specific questions as follows:

Formulations 1 to 4 were analysed as a 2 x 2 factorial design to assess the effects of fat level (12.5 vs 10%) and NaCl level (1.0 vs. 0.6%) on the characteristics measured in the absence of any fat or NaCl substitutes (Table 3).

Formulations 4, 5 and 6 were analysed together to assess the effects of three levels of carrageenan (0, 1.0, 1.5%) on characteristics measured at constant levels of fat and NaCl, and without any KCl (Table 4).

Formulations 5 to 16 were analysed as a 2 x 6 factorial design to assess the effects of 2 carrageenan levels and 6 KCl levels (0, 0.1, 0.2, 0.3, 0.4 and 0.5%) on the characteristics measured (Table 5).

ANOVA was used to measure the effects of batch, sodium, fats and their interactions as well as potassium chloride, carrageenan and their interaction. Orthogonal polynomial contrasts were used to evaluate the potassium chloride effect with linear, quadratic and cubic components. The significance of differences between means of the physical characteristics was assessed using Fisher's Least Significant Different (LSD) test.

3.2. Sensory evaluation

3.2.1. Untrained panel

Results of the untrained panel assessment of overall acceptability were analysed using a BIBD design. The Friedman-type statistic was used to rank the data (Durbin, 1951).

The formula was:

$$T = [\frac{12}{p\lambda t(k+1)} \sum_{j=1}^{t} R_j^2] - [\frac{3(k+1)pr^2}{\lambda}] \qquad \text{[Equation 1]}$$

where: T = Friedman-type statistic

t = total number of treatment groups (t= 16 for the current panel)

k = Number of samples evaluated by each panellist (k = 4 for the current panel)

r = Number of times a sample is evaluated within a replication (r = 4 for the current panel)

b = Number of blocks (with one block per panellist) to complete a single replication (b = 16 for the current panel)

p = Number of replications of the fundamental design (p = 3 for the current panel)

λ = Number of times pairs of treatment groups are evaluated within each replication (λ = 1 for the current panel)

R_j: Rank sum of the j'th sample

j = j'th treatment group within the total of t treatment groups.

If the results for equation 1 exceeded the upper-α critical value of a χ^2-statistic with 15 degree of freedom ($\chi^2_{15,\ 0.05}$ = 25.0), then a multiple comparison procedure was performed using the nonparametric analog to Fisher's Latin Square Designs for rank sums from a BIBD (Durbin, 1951). Terms used in Equation 2 are the same as those used in Equation 1.

$$LSD_{rank} = z_{\frac{\alpha}{2}} \sqrt{p(k+1)(rk-r+\lambda)/6} \qquad \text{[Equation 2]}$$

where: $z_{\frac{\alpha}{2}}$ = upper $\alpha/2$ critical value of a z distribution

3.2.2. Trained panel

For the data from the trained panel, scale marks from QDA questionnaires were converted to intensity scores from 0 to 100 for each descriptor. The significance of the differences between means of the sensory profiles was assessed using the LSD test. Panel performance was tested in relation with reproducibility, repeatability, and interactions panelist-sample and discriminant power of panellists.

4. Results and Discussions

4.1. Physical measurements

Table 3 shows that sodium chloride levels did not affect the fat contents of the pork balls (p = 0.45), possibly because of the small difference in NaCl levels. It has been reported that myofibrillar protein solubilisation requires a minimal ionic strength (0.15M NaCl) and increases when salt concentration is higher than 0.5M (Xiong *et al*., 2000; Liu, & Xiong, 1997; Prusa, & Bowers, 1984). This increased protein extractability and protein solubilisation results in fat globules that are physically entrapped within a protein matrix (Barbut, 1998) which increased fat retention and reduced fat loss during cooking. As expected fat content was significantly reduced in pork balls (p = 0.003) when less back fat was used (Table 3); and sodium content significantly increased (p < 0.001) when more sodium chloride was used.

When carrageenan was present (Table 4) in the formulation, fat contents were lower compared to when carrageenan was absent. This could be due in part to slightly less lean meat (which contains intramuscular fat) in the formulation.

Carrageenan had no effect on moisture retention, but was associated with a higher cooking yield for the second cooking (Table 4). Candogan and Kolsarici (2003) also noted that low-fat sausages, with carrageenan had a higher cooking yield, and an increased cooking yield with carrageenan was also observed in studies on frankfurters by Cierach *et al*., (2009) and Candogan and Kolsarici (2003).

Cooking yield and moisture retention after the first and second cookings increased as KCl increased but the KCl effect was not significant (Table 5). Protein extraction is enhanced by high ionic strength which leads to increased solubilisation of myosin in the water phase and ultimately giving a better binding and higher water holding capacity (Hamm, 1971; Shults, & Wiebicki, 1973).

Hardness was higher for 1.5% carragennan than 1.0% at some of the higher levels of KCl (p = 0.027) (Table 5), and hardness increased with increasing KCl levels in a linear manner (p < 0.001). Frye *et al.*, (1986) showed that a 50% replacement of NaCl with KCl gave superior bind for cooked ham, but Collins (1997) found that 30% replacement with KCl had no effect on tenderness.

Table 3. Effects of levels of fat (10% vs 12.5%), and sodium chloride (0.6% vs 1.0% and their interaction on fat, sodium and potassium content of pork balls as determined by ANOVA based on a 2 x 2 factorial design. Measures of the overall goodness-of-fit for the model include the coefficient of determination, R^2(%) and the residual standard deviation, RSD.

Physical characteristic[1]	Fat level %	NaCl%		Effects (p value)			R^2%, RSD
		0.6	1.0	Fat	NaCl	Fat x NaCl	
Fat (%)	10	7.37	6.01	**0.003**	0.45	0.07	92.6, 0.59
	12.5	9.08	9.75				
Na (mg/100g)	10	450	690	0.66	**<0.001**	0.95	97.6, 264
	12.5	442	680				
K (mg/100g)	10	275	260	0.19	0.14	**0.005**	90.2, 58.3
	12.5	259	290				

[1]No significant fat and sodium chloride effect on hardness, pH, moisture retention (1st and 2nd cooking), cooking yield (1st and 2nd cooking)

Table 4. Effects of levels of carrageenan (0%, 1.0% and 1.5%) without KCl on cooking yield(2nd cooking) and fat% of pork balls (fat=10% ; sodium=0.6%) as determined from type I ANOVA. Measures of the overall goodness-of-fit for the model include the coefficient of determination, R^2(%) and the residual standard deviation, RSD.

Physical characteristic[1]	Carr. Level			Carr. Effect (p value)	R^2%, RSD
	0	**1.0**	**1.5**		
Cooking yield (2nd cooking) %	76.69	81.65	80.50	**0.014**	92.6. 0.74
Fat (%)	7.37	5.67	5.62	**0.003**	92.6, 0.59

[1]No significant carrageenan effect on hardness, pH, moisture retention (1st and 2nd cooking), cooking yield (1st cooking), sodium and potassium concentration

Table 5. Effects of levels of carrageenan (carr. 1% vs 1.5%), potassium chloride (KCl, 0.1% , 0.2% , 0.3%, 0.4% and 0.5%) and their interactions on least squares means of hardness, fat, potassium content of pork balls after the first cooking as determined from ANOVA based on a 2 x 6 factorial design. Measures of the overall goodness-of-fit for the model include the coefficient of determination, R^2(%) and the residual standard deviation, RSD.

Physical characteristic[1]	Carr. level	KCl conc.(%)						Effects (p value)			R^2%, RSD
		0.0	**0.1**	**0.2**	**0.3**	**0.4**	**0**	**Carr.**	**KCl**	**Carr x KCl**	
Hardness (N)	1.0%	8.89	8.16	8.10	10.29	9.97	1 .85	**0.027**	**<0.01**	**0.035**	70.9, 0.91
	1.5% .	8.48	7.85	10.75	9.39	10.68	1 .14				
Fat (%)	1.0%	5.67	4.95	4.10	5.05	6.89	6 89	0.16	**0.002**	0.73	78.7, 0.67
	1.5%	5.62	5.25	5.46	5.58	6.96	7 12				
K (mg/100g)	1.0%	266	387	501	627	760	8 56	0.39	**<0.01**	0.92	99.6, 185
	1.5%	272	371	483	609	751	8 59				

[1]No significant carrageenan and potassium chloride effect on pH, moisture retention (1st and 2nd cooking), cooking yield (1st and 2nd cooking) and sodium concentration.

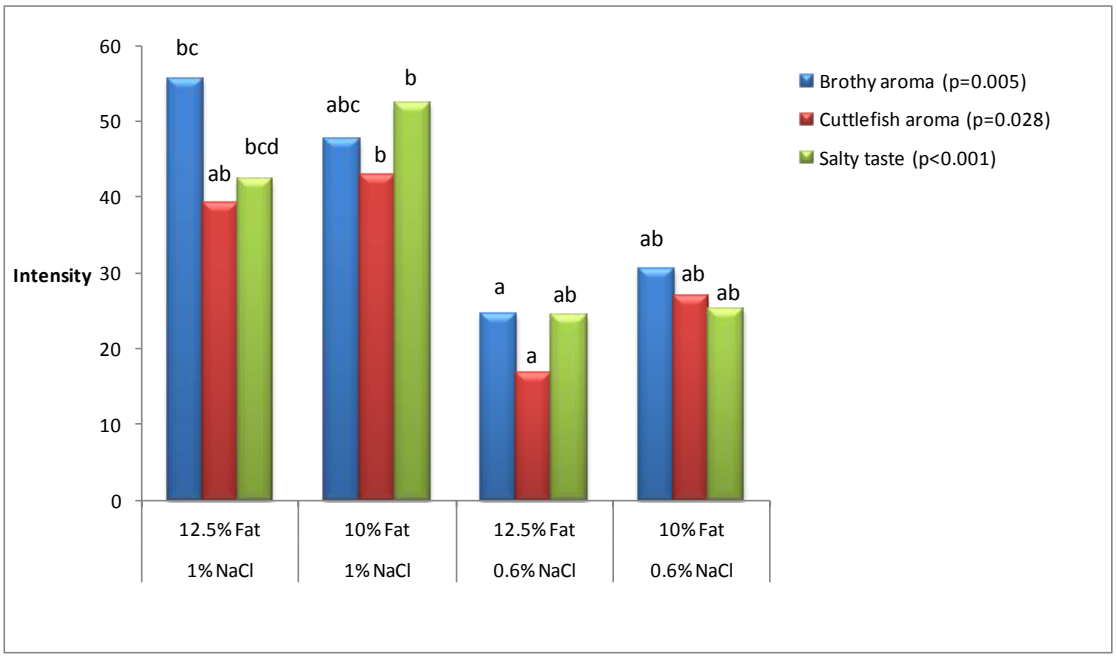

Figure 2. Effects of levels of sodium chloride (NaCl, levels) on least squares means of brothy aroma, cuttlefish aroma and salty taste of pork balls[1] following the second cooking in Experiment 1 as determined by a trained panel (n=8) using type I ANOVA based on a 2 x 2 factorial design. Means of intensity of same colour with no letters after them or with a common letter after them do not differ significantly (*p* >0.05) as determined by Fisher's least significance difference (LSD) mean separation test

Table 6. Effects of levels of carrageenan (carr), potassium chloride (KCl) and their interaction on least squares means of selected sensory attributes of pork balls 1 following the second cooking as determined by a trained panel (n=8) using an ANOVA based on a 2 x 6 factorial design.

Sensory Attributes	Carr.	KCl concentration (%)						Effects (P values)		R^2%, RSD
		0.0	0.1	0.2	0.3	0.4	0.5	Carr.	KCl	
Salty flavour	1.0%	17.5	24.3	25.3	30.1	26.7	39.4	0.53	**0.031**	55.2, 26.2
	1.5%	24.9a	26.3a	23.0a	29.1ab	26.5a	48.7b			
Bitter flavour	1.0%	0.157a	0.228a	0.543ab	1.03b	1.83c	4.20d	0.22	**<0.001**	78.9, 0.79
	1.5%	0.214a	0.257a	0.671a	1.71b	2.13b	4.29c			
Chewiness	1.0%	62.5a	57.2a	69.7ab	80.8b	70.7ab	69.9ab	0.04	**0.030**	57.6, 18.2
	1.5%	66.7a	70.4ab	74.8ab	75.6ab	79.5b	76.5ab			
Cohesiveness	1.0%	61.7	63.7	65.6	69.5	59.7	71.0	**0.03**	0.50	52.9, 22.1
	1.5%	68.9	69.1	74.6	73.4	74.6	67.6			
Hardness	1.0%	39.7	46.6	56.7	53.2	57.3	55.0	**0.03**	0.05	74.2, 24.3
	1.5%	52.2a	47.9a	67.9b	64.9ab	58.2ab	77.1b			
Aftertaste	1.0%	31.9	27.0	24.7	23.3	24.2	38.4	**0.04**	**0.03**	72.3, 23.4
	1.5%	17.9a	22.4ab	24.0ab	27.1ab	30.6ab	41.9b			

[1] Means in the same row with no letters after them or with a common letter after them do not differ significantly (P >0.05) as determined by Fisher's least significance difference (LSD) mean separation test.

4.2. Sensory evaluation

4.2.1. Trained panel

As experienced assessors for meat and meat products, the panel performed satisfactorily although a few panellists needed training to improve reproducibility in order to achieve efficiency in profiling the pork balls.

Lower levels of NaCl decreased brothy aroma, cuttlefish aroma and salty taste as assessed by the trained panel (Figure 2). Increased carrageenan had no effect on sensory characteristics alone, but in conjunction with KCl, the higher level of carrageenan increased chewiness, cohesiveness, hardness, and aftertaste at high KCl levels (Table 6). The main effect of increased levels of KCl was a more bitter flavour (Table 6), but they were also associated with a greater saltiness, chewiness, and hardness, and with inconsistent changes in aftertaste.

At the highest levels of KCl the saltiness scores were similar to those for formulations containing 1% sodium chloride (Figure 2), but the bitterness ($p < 0.001$) and aftertaste ($p=0.03$) scores were appreciably higher (Table 6). It was shown that at higher levels, potassium chloride has been reported to elicit a bitter/metallic taste (Van der Klaauw, & Smith, 1995). When potassium chloride is used in high concentrations the bitter/metallic taste dominates over the salty taste, thus limiting the use of potassium chloride as a salt substitute (Ainsworth, & Plunkett, 2007).

The increase in cohesiveness, chewiness and hardness at higher levels of KCl (Table 6) could have been due to the increase in myofibrillar protein extraction, particularly myosin, which in turn would have led to increased water binding and ultimately to increased binding between adjacent pieces of meat (Hamm, 1986). Frye et al. (1986) reported for cooked hams that a 50% replacement of NaCl with KCl gave a superior bind in the meat.

Table 7. Rank sum of acceptability scores for sensory attributes of the 16 formulations of pork balls following the second cooking in Experiment 1 using an untrained panel

Formulation	Variable ingredients (%)				Colour	Aroma	Flavour	Texture	Overall Acceptability
	Fat	NaCl	Car.	KCl					
1	12.5	1.0	0	0	49ab	63cd	58ab	58ab	55ab
2	10.0	1.0	0	0	47a	65cd	65bc	53a	53ab
3	12.5	0.6	0	0	50ab	47a	51a	55a	53ab
4	10.0	0.6	0	0	53ab	46a	54ab	59ab	59ab
5	10.0	0.6	1.0	0	58ab	48ab	62ab	61ab	62b
6	10.0	0.6	1.5	0	67c	55ab	67bc	60ab	62b
7	10.0	0.6	1.0	0.1	61c	53ab	70bc	74b	63bc
8	10.0	0.6	1.5	0.1	64c	61c	62ab	70b	50a
9	10.0	0.6	1.0	0.2	66c	62cd	70bc	69b	57ab
10	10.0	0.6	1.5	0.2	64c	67cd	70bc	70b	62b
11	10.0	0.6	1.0	0.3	61c	70cd	68bc	69b	70bc
12	10.0	0.6	1.5	0.3	65c	67cd	69bc	69b	64bc
13	10.0	0.6	1.0	0.4	48ab	69cd	63b	69b	66bc
14	10.0	0.6	1.5	0.4	58ab	73d	75c	69b	74c
15	10.0	0.6	1.0	0.5	59bc	58bc	65bc	71b	67bc
16	10.0	0.6	1.5	0.5	60bc	64cd	66bc	69b	65bc
					p<0.05	p<0.01	p<0.05	p<0.05	p<0.01

[1]Means within a column followed by a common letter are not significantly different at the 5% significance level (LSD rank = 11.72)

4.2.2. Untrained panel

For the untrained panel results (Table 7), there were significant differences in the acceptability for aroma, flavour and overall acceptability for the 16 formulations. The overall acceptability score of 74 for F14 was 22.3% higher than the average score for all other formulations (60.5). F14 (1.5% carrageenan; 0.4% KCl) had the highest rank scores for aroma, flavour and overall acceptability, and had scores that were significantly different from six samples for aroma and flavour acceptability and

nine samples for overall acceptability. This suggests that the panellists found the extra bitterness of the formulations with moderately high KCl levels (40% of NaCl replaced with KCl) quite acceptable. In addition, this formulation met the low-fat and low-sodium criteria. Thus, F14 was used for all subsequent pork ball batches. Lilic et al., (2008) reported that sausages with 20% and 40% replacement of NaCl with KCl were acceptable, while those with 60% of NaCl replaced were at the limit of acceptability, and products with 80% KCl were unacceptable. The current results are also in accordance with those of Askar *et al*. (1994) in showing that between 20% and 40% replacement of NaCl by KCl had no significant influences on taste. As each formulation was being assessed 24 times, the above results indicated a general trend and as such it was recommended to use more panellists to validate the results.

5. Conclusion

A low-fat, low-salt pork ball has been developed for the Singapore market with fat and sodium levels below the recommended maximum levels of 10 g/100g and 450 mg/100 g, respectively, and without any loss in sensory acceptability or deterioration in cooking yield or other physical characteristics of the pork balls. Carrageenan 1.5% was used to replace some of the fat in this product and KCL replaced 40% of the NaCl. These ingredients improved the cooking yield and moisture retention. It is concluded that it is possible to produce low-fat, low-sodium pork balls without a decrease in acceptability for Singapore consumers.

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PART 4

Cultural and Social Determinants of Food Choices

BROWN RICE: CULTURAL EFFECTS ON CONSUMER PERCEPTIONS AND BELIEFS

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Abstract

This study examines perceptions, behaviors, and beliefs across Caucasian-American and Vietnamese (with US residence 1-5 years) rice consumers by using focus groups. The concepts investigated were cultural differences in rice product awareness, cultural use and preparation of rice, and overall interest in value-added brown rice product concepts incorporating health related language.

Caucasian-American participants showed higher awareness and interest in health related language for brown rice products than their Vietnamese counterparts. Caucasian participants were more accepting of brown rice products because health benefits associated with brown rice are considered important to them. For acceptability of new rice products, Vietnamese consumers in this study did not consider health benefits important; therefore, it requires specific language to address new product flavor and texture as compared to traditional white rice before Vietnamese consumers will try a new brown rice product. This study found that despite numerous health benefits in a brown rice product concept, it was not readily accepted by Vietnamese participants due to culturally negative associations of brown rice with poverty, aging, and illness. Because new products must often overcome cultural preconceptions value-added brown rice product concepts require further research.

Keywords: *Culture, rice, focus group, perception, belief*

1. Introduction

After the release of Dietary Guidelines for Americans in 1980, most United States (US) consumers gradually have become more aware of healthy eating habits. Recently, health related issues such as obesity, being overweight, and having a poor diet have come to light as threatening the wellbeing of many Americans. Among healthy food products in the US, grain-based food has become a fast growing market, and the term “whole-grain” is considered marketable. However, the United States Department of Agriculture (USDA) reports that most Americans do not consume enough whole grains while consuming too much refined grain foods (Lin, & Yen, 2007). The marketing company Freedonia Group reported that US consumers would not sacrifice taste for good health in relation to grain-based foods (2011). Trends in the grain-based food industry for product development focus on alternatives to traditional products by offering better tasting healthy foods.

Kapsak *et al*. (2011) adopted the functional food definition from the American Dietetic Association describing functional foods as providing added health benefits that may assist in lowering risk of certain diseases and contribute to better overall health (Hasler, & Brown, 2009). Siró *et al.* (2008) recognized the concept of consumer acceptance of functional foods as key success factors for market orientation, consumer-led product development, and successful market negotiation. The authors were aware of determining roles played by different factors (e.g., primary health concerns, consumer familiarity with ‘‘functional food’’ concepts and ingredients, nature of the carrier product, manner of health effect communication, etc.) in consumer acceptance of functional foods. From an economic perspective, promoting and developing functional food products in the US can provide important benefits because the US has an established health conscious population. Furthermore, Americans have taken steps to encourage lower caloric intake, higher physical activity, and making health conscious food choices (USDA & HHS, 2010). The grain-based food market continues to expand because population growth motivates it with trends in healthy consumer consumption. This behavior

influences the demand for products made with whole grain, high-fiber, natural, and organic items. Demand for these items will allow a market value increase, thus causing desire for the development of a food product from a new grain (Freedonia Group, 2011).

The US contains diverse ethnic populations that create diversified and competitive markets with different demands and expectations. Caucasian, Asian, Hispanic, and African populations have diverse perceptions and acceptability of the same food product, therefore for new food products introduced into the market to be successful overcoming hurdles associated with cultural assumptions of that product would be required.

This study investigated the cultural barriers that a new rice product would need to overcome to thrive in the US market. Two target populations were Caucasian-American and Vietnamese residing less than five years in the US. Researchers chose rice because the two cultures of interest use it differently. For example, US culture considers rice as simply a product in the market, whereas, Vietnamese culture considers rice a "traditional" commodity. These interpretations lead to perception and belief differences that create various obstacles in the two markets. This study also will help in the understanding of how perceptions change for Vietnamese individuals living 1-5 years in the US from when they lived in their home country.

2. Materials and Methods

2.1. Participants

Researchers recruited focus group participants from two populations in the US (Caucasian-American) and recent Vietnamese immigrants (Vietnamese). Sixteen Caucasian-American participants (eleven females and five males, ages 18-64 years) were recruited and divided into two focus groups (eight per group). The Vietnamese counterparts included twelve participants (six females and six males, ages 18-44 years) who had lived in the US for at least one year but less than five years. The Vietnamese participants were divided into two groups, with eight in one group and four in the other based on scheduling. Mini focus groups, consisting of four to six participants, are becoming popular because they are easier to set up and participants are more comfortable sharing their opinions (Krueger, & Casey, 2000). Other researchers have conducted focus groups consisting of five to eight or four to seven participants (Wan, Lee, & Lee, 2007; Lee, & Lee, 2007).

The current study's researchers scheduled group discussions based on participant availability, and participants were compensated for their time. To qualify for this study, participants had to consume grain and rice products at least twice per month, be older than 18 years, and have no knowledge or professional training related to food science, product development, marketing, and health.

2.2. Focus group

This study used focus groups where participants engaged in open discussion about rice product awareness, cultural use and preparation of rice, and overall interest in value-added brown rice product concepts incorporating health related language. Focus groups are the most versatile type of qualitative research (Chambers, & Smith, 1991) and often are used in the early stages of product development to generate ideas or probe consumer responses about a new product concept (Wan, Lee, & Lee, 2007). Researchers use focus groups to give insights into consumer attitudes, opinions, concerns, and beliefs in various topics such as food, healthcare and politics (National Democratic Institute for International Affairs, 2006; Lee, & Lee, 2007; Fox, Philliber, McManus, & Yurkiewicz, 2010).

2.3. Procedure

A total of four 90-minute focus groups were conducted at the Sensory Analysis Center at Kansas State University, Manhattan, Kansas. The focus group discussions took place at a round table in a room facilitated with a two-way mirror for audio and video recording, observing, and note taking. The discussions were guided by a trained focus group moderator (RIVA Institute, Bethesda, MD, USA).

The moderator used guides specifying general and specific questions and activities. General questions explored consumer awareness and perception of rice and rice products, usage and preparation of rice, and factors underlying purchasing/consuming rice. The focus groups carried out in-depth discussions exploring consumer interests, attitudes, and concerns toward new brown rice product ideas.

Focus groups started with an introduction about the general topic of discussion, followed by disclosure of video recording and note taking, and participant guidelines (e.g., having one speaker at a time, respecting others' opinions, avoiding side conversations, and needing honest opinions from all participants). After the introduction, the moderator began the discussion with warm-up questions followed by two activities to explore awareness, usage, and preparation of rice and rice products. Then the moderator introduced the participants to two product ideas for a new brown rice with health-related benefits. Participants were asked to share their interests, attitudes, and conceptions for this new product. The group discussed in-depth their responses. Figure 1 illustrates the moderator's guide.

Focus groups including Vietnamese participants were conducted in both English and Vietnamese providing a comfortable atmosphere for participants to share their opinions. Researchers offered translation assistance during the discussion portion of the focus groups. Vietnamese participants also responded to additional questions about their food habits and rice consumption changes as compared to when they resided in their home country.

INTRODUCTION

1.1 Greetings and acknowledgment.
1.2 Disclosure of videotaping and observers
1.3 Guidelines
  a. Speak only one at a time
  b. Be honest in your opinions and share them freely
  c. Respect each group members' opinion
  d. Give everyone a chance to speak
  e. Avoid side conversations with your neighbors.
1.4 Self introduction: Please introduce yourself to the group and tell us
  f. First name and where you are from
  g. Tell us one of your favorite things to eat

WARM-UP – You all filled out a questionnaire previously that asked about the foods you typically eat.

2.1 So tell me about a typical (evening meal) dinner for you
2.2 Tell me some things you consider/think about when deciding what you will have for a meal.
2.3 How have the things you eat here (US) compare to what you ate when you lived in Vietnam? Specifically, products you buy at the supermarket. *
2.4 You've mentioned several foods you typically eat, one food in particular we will be discussing tonight is rice. When I mention "rice", what do you think of first?

ACTIVITY 1 – Group activity - Awareness of rice/rice products

I would like to have you break up into two groups. Each group will think of any products that contain rice and list it on the flip chart. The products can be rice itself or a product that contains rice.

3.1 What rice do you eat/cook (here in U.S.)? *
3.2 Is it the same as the rice you cooked when you lived in Vietnam? *
3.3 Are these types of rice different to you? Tell me about those differences.
3.4 Do these rice types offer you different things?

ACTIVITY 2 – Individual Activity – Actual usage of rice products

I would like you to use the paper you have to write down the products you eat on a regular basis that contain rice and when you typically eat it (time of day).

4.1 Help me understand some of the reasons you purchase/eat the rice products you wrote down.
4.2 Tell me, are these rice products similar or different than the rice products you ate when living in Vietnam? *

PREPARATION OF RICE AT HOME

We have been talking about products you use that contain rice, now let us discuss rice itself (whole grain form), and how it is prepared.

5.1.If you were to prepare rice at home, tell me the way you would go about preparing it.
5.2. Do you prepare rice more often, about the same, or less often since you moved to the US? *
5.3. Help me understand if you are serving rice for a meal at home, what things led to your decision to prepare and serve rice. +
5.4. In the meal you have prepared with rice, how much of the plate does rice take up?

Figure 1. (continued)

NEW PRODUCT IDEAS DISCUSSION – ATTITUDES AND BELIEFS

Product Idea #1

This new brown rice comes from the process of bringing regular brown rice into germination. The new rice, therefore, is softer and contains higher amounts of vitamins B1, B6, E, dietary fiber, minerals as well as anti-oxidants. Moreover, a significant quantity of Gamma-Amino Butyric Acid (GABA) is also found in this rice. GABA is known for its calming effect on the nervous system, and its benefit in fighting insomnia, depression and other neurological conditions. A regular intake of GABA helps improve kidney function, lower blood pressure and reduce sleeplessness.

6.1 What caught your attention in the product idea?
6.2 The idea mentions brown rice. What are your thoughts about brown rice?
6.3 Where would you expect to learn this kind of information (package, commercial, friends, article)?
6.4 Was there anything in the paragraph that you did not understand or that confused you?
6.5 What else do you want to know about the product?
6.6 What changes would you make to this product description to make it better for you?

Product Idea #2

This new brown rice is known for its superior nutritional value. It contains dietary fiber, various vitamins, and anti-oxidants. This rice also contains GABA, an amino acid known for its soothing effect on the nervous system, fighting depression, lowering blood pressure, and reducing sleeplessness. This rice can be cooked and digested easily thanks to its surprisingly soft texture for a brown rice. This product combines the health benefits of brown rice with a softer texture similar to white rice.

7.1 Tell me how this product idea compares to the first product idea
7.2 Was there anything in the paragraph that you did not understand or that confused you?
7.3 What changes would you make to this product description to make it better for you?
7.4 Who would you expect to be most interested in this product?

CLOSURE

8.1 Today we talked about rice, what products you eat with rice, when you eat it, and how you prepare it. We also discussed two new product ideas and I heard from you that …
8.2 Please do not discuss the product ideas you have seen today with anyone outside of this room. We appreciate your help in maintaining confidentiality.
8.3 Thank you again for your participation!

[*] Questions only for Vietnamese groups
[+] Questions only for Caucasian-American groups

Figure 1. Moderator's guide used in the focus group on healthy rice product

2.4. Data analysis

Upon completion of each focus group, the moderator and observers held a debriefing session to summarize key points from the discussion. Following the discussion guide, notes from the moderator and observers were reviewed one point at a time. Researchers used the summaries to form an overview of what was learned from the focus groups. All focus group videotapes were transcribed with comments and discussions grouped into main "themes" identified in the debriefing sessions. Researchers used flip charts and written ballots from the sessions to explore trends in participant responses.

3. Results

3.1. Cultural differences in rice product awareness, usage, and preparation

A typical dinner for Caucasian-American participants contains little rice. Typical dinners for these participants included hamburger, beef, grilled meats, or pasta. The word *rice* reminded Caucasian participants of particular dishes or products containing rice. "Mexican rice", "stir-fry", "minute rice", "ready rice", and "rice and beans" were some examples of products they thought of for rice. One participant instantly mentioned "soy sauce" as his response to the question, and he also thought of different rice varieties. Convenience and availability were the driving factors for choosing food in this

group. The group named “alternative to potato”, “versatile”, “cheap”, and “everyone (in family) likes it (rice)” as the main reasons to prepare and serve rice.

However, Vietnamese participants reported rice as the main item in their dinner meal; they also eat rice noodles (a rice product) occasionally. Vietnamese participants perceived rice as “Asian”, “familiar”, “everyday”, “filling”, “smelling good”, and “white”. The word *rice* also reminded them of typical Vietnamese rice products; however, similar to Caucasian-American participants, convenience and availability were considered the most influencing factor on this group’s choice of food items that go with rice.

Caucasian-American participants were well aware of products that contain rice and different types of rice (long, medium, short, basmati, brown, white, and rice in Asian foods). They personally consumed a wide variety of rice products, such as ready-to-eat rice cereal for breakfast, steamed white rice and brown rice, instant rice for lunch and dinner (e.g., Chinese dishes, Mexican dishes, processed rice product such as Rice A Roni, Hamburger Helper, or Minute rice), and rice products for dessert (e.g., rice pudding, rice cakes). Most participants employed microwave cooking, boiling, and steaming as common methods to prepare rice. Some participants also used rice cookers. On their plate, except for in casserole, the portion of rice never exceeded one third.

However, Vietnamese participants did not know any processed rice products in the US market, thus they did not consume any processed rice products. They listed only traditional rice products from their home country, and they all personally cooked (using a rice cooker) and consumed rice (mostly white rice) at home for every meal; rice always takes up the largest portion on their plate.

3.2. Changes in food habits and rice consumption of Vietnamese participants

Responding to the question “How have the things you eat here (in the US) compared to what you ate when you were in Vietnam?” Vietnamese participants stated that the greatest difference existed in the ratio between meat and fresh vegetables. They ate more vegetables and less meat in Vietnam but consumed the exact opposite in the US. They also consumed fewer dairy products (mostly milk) in Vietnam on a daily basis than in the US. The reason for these changes was cost. Fresh vegetables were cheaper in Vietnam but more expensive in the US; meanwhile, meat and milk were expensive in Vietnam but were considered “cheap” for Vietnamese consumers in the US. Expressing that she could not find good vegetables and ingredients to cook dishes similar to what she used to eat in Vietnam, a participant stated, “(Vietnamese) foods I cook here are less tasty than foods I used to cook in Vietnam.” Participants claimed that breakfast held the most differences for them after coming to the US. In Vietnam, they usually ate noodles and other rice dishes for breakfast, but the most common breakfast items in the US for them were cereal milk, and bread. Grocery shopping habits illustrated another change for this group. In Vietnam, participants typically shopped every day, but in the US they commonly shopped only once per week. Therefore, this difference caused the amount of groceries purchased during one grocery shopping trip to change (i.e., in Vietnam small amounts for one day’s use were purchased, while in the US groceries were bought for use throughout the entire week). Because fresh vegetables are perishable and difficult to keep fresh in fridge, Vietnamese participants preferred buying them less than other groceries that they can refrigerate or freeze.

This group’s rice eating habits did not change. Their meals always contained white rice as the main item. Rice cookers were often used to make rice in both places; however, participants reported the use of different rice cultivars. After living in the US, Vietnamese participants switched from using Vietnamese rice to Thai, Korean, or Japanese rice. Participants stated that, “Rice here (US) is better. It is cleaner and has a better flavor” or “Rice here (US) is better in quality”.

Vietnamese participants claimed that rice consumed in the US differed in texture and flavor from rice in Vietnam. Participants preferred Thai and Korean rice to American rice because they consider American rice dry. “Soft” and “sticky” describes the two properties of rice that most Vietnamese participants liked.

When discussing the rice portion on their plate, Vietnamese participants, except for one, reported, "They eat more rice than other types of food". Only one participant said that she ate less rice than vegetables and other foods; she used age as an explanation.

3.3. Perception of brown rice

Both groups perceived brown rice as different in taste and texture from white rice. Brown rice was said to be tougher than white rice. Two Caucasian-American participants said it contained a nutty flavor. Another said brown rice had a better taste than white rice. She could not name the taste difference, but she explained it as containing something else in flavor that white rice does not have. Caucasian-American consumers also were aware that brown rice takes longer to cook than white rice. One woman said she would like one-minute brown rice. However, Vietnamese participants claimed that the brown rice did not taste as good, and that it contains a stronger flavor than white rice. One female concluded that brown rice is crunchy, which she liked and it did not need the softness of white rice; although she desired it to be stickier.

Both consumer groups expressed awareness that brown rice contains more nutritional value (e.g., vitamins and fiber) than white rice. Brown rice reminded one Caucasian-American participant of "whole grain." Therefore, Caucasian-American participants considered brown rice as "healthy" and were conscious that healthy things often do not taste good. To Caucasian-American consumers, brown rice did not evoke any inferior perceptions, and they perceived it as a product with pros in health benefits and cons in taste and texture. Vietnamese participants, on the other hand, had negative perceptions about brown rice because they associated it with a period of poverty in Vietnamese history. One participant explained that most Vietnamese know that brown rice includes vitamins and health benefits but they do not want to use this product because they are uncertain of how the product should be used. Another shared her negative experiences with brown rice, and a male panelist remarked "Not familiar" when he thought of brown rice. All Vietnamese participants agreed that brown rice was for old people.

3.4. General interest and attitudes toward value-added brown rice product ideas

3.4.1. Caucasian-American participants

Caucasian-American participants indicated high interest in both product ideas (Figure1 – New product ideas discussion: Attitudes and beliefs). Nutritional compositions and health benefits were reported to catch their attention. Gamma Amino Butyric Acid (GABA), described in both ideas, also caught their notice, but only because they had not heard of it previously. The Caucasian-American participants found germination and GABA as the most confusing words in the first description (Figure 1 – Product Idea #1). They wanted to know at what level the rice would be germinated. One participant thought of a bean sprout and its texture when he heard germination and wondered if the new rice would be similar to bean sprouts. Another participant was afraid the rice would be too soft due to the germination process. The same participant expressed less interest in the second idea, which mentioned soft texture, than the first idea.

All Caucasian-American participants suggested excluding germination from the description. One female participant explained that germination sounded like dirt, therefore all participants, except one, said they preferred the second description. Most participants did not care about specific vitamins contained in the product; instead they wanted to know only that the product contained vitamins. One participant had a different opinion stating that specifying vitamins remained important because different people may seek different vitamins; she wanted to keep the vitamins in description. In general, participants perceived the second idea (Figure 1 – Product Idea #2) as easy for the public to understand. The participants classified the first idea as more technical, and therefore more suitable for those in the medical and health fields.

Caucasian participant concerns focused mostly on whether GABA was a natural part of or injected into the product. GABA's health benefits were considered attractive, but participants requested more

information about the production process. Caucasian participants also expressed other concerns, *e.g.*, product effectiveness (has it been tested or not), preservation and preparation methods to maintain all benefits from the rice, intake amount, or interactions with other medications.

This group also requested more specific product information (*i.e.*, price, availability, taste, and shelf life). They expected this product to be more expensive than white or regular brown rice. Participants agreed that they would need to taste the product, but it did not need to necessarily taste good because they accepted the fact that healthy foods do not taste good. Therefore, if the product taste better than regular brown rice, it would be acceptable to them.

Caucasian participants desired more information on the product from various forms: commercial ads, product package, Internet, Facebook, celebrity endorsements, nutritionist, or dietician. They believed "moms" and "people who are stressed out" would be interested in this product. However, they considered this product for them as well. Regarding products made from this rice, they suggested it depended on flavor within different product types, but they agreed the rice should be sold in regular type.

3.4.2. Vietnamese participants

The first new brown rice product idea (Figure 1 – Product Idea #1) did not gain much interest from this group. The variation in responses reflected concerns over this idea. Similar to Caucasian-American participants, Vietnamese participants indicated strong concerns about the germination process. They wanted to know how far the rice would be germinated. One participant also associated the rice germination process with bean sprouts. They also expressed curiosity about GABA and whether GABA was natural or artificial, similar to Caucasian- American participants. Their interest included concerns over taste, texture, health benefits, and functional effects, but taste of the product was the top concern because of previous negative experience with the taste of brown rice. They also doubted the product's functional effect, thus the functional effects must be tested to convince them. This group expressed other concerns about the new rice product (*e.g.*, package size, preparation methods, and availability).

Similar to Caucasian-American participants, all Vietnamese participants liked the second description (Figure 1 – Product Idea #2) better because it was easier to understand. They all indicated being interested to very interested. The "soft texture similar to white rice" attracted Vietnamese participants to the idea, and they expressed that rice tasting similar to white rice would be acceptable.

Vietnamese participants thought this new rice product was for health conscious people, diabetes patients, professional athletes who need to take good care of their bodies, elderly, and people with digestion problems. They would like to have information about the product on the package and information boards near their residence.

4. Conclusions

Caucasian-American participants showed the strongest interest in the new brown rice product. They expressed their interests by enquiring about more information on the product, especially the cost, and product availability on the market; whereas Vietnamese participants were not as interested in the product ideas. They asked for more information, but more out of suspicion about the rice product and its effect than interest in the product. While Caucasian-American participants were ready to compromise cost and taste for health benefits, Vietnamese participants insisted on taste and texture as preference for rice. Caucasian-American participants had a neutral perception, but their Vietnamese counterparts showed negative attitudes towards brown rice. Health benefits were attractive to both groups but not enough to change Vietnamese participants' expectation for taste; however, Caucasian participants expressed willingness to compromise taste. Researchers concluded that it would take more effort to convince Vietnamese consumers, living in the US for a short time, to accept the new product than Caucasian-American consumers.

Further study should focus on exploring perceptions and beliefs of rice and brown rice of Vietnamese consumers in Vietnam and Vietnamese consumers who have been living in the US for more than 15 years.

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HOW CAN WE COMMUNICATE SENSORY CHARACTERISTICS OF FOOD IN DIFFERENT LANGUAGES AND CULTURES: THE CASE STUDY OF COOKED RICE?

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Abstract

International trade in food is growing and this leads to the development of single markets on a global scale. Associated with this trend, there is a growing demand for standards to describe products. Sensory characterization of food is one way to reach this goal, but such an approach poses many methodological problems. The main one is that a panel of assessors is used as an analytical instrument but, unlike many conventional instruments, it can be highly variable, a problem exacerbated by differences in languages and cultures. For a better communication between countries, it is essential to understand how people in different languages and cultures describe the same product. This study aimed to address this issue, using rice as a model product. Rice was chosen because of its importance as a staple food in many countries in the world. Lexicon for cooked rice was developed in four countries with important differences in rice consumption habits and languages (Korea, Japan, Thailand, and France). The same procedure was applied in each country. First, naive panelists were asked to taste white, brown, and germinated brown rice and generate descriptors. Second, the descriptors were selected using ISO 11035. And third, lexicon was created by writing definition for each descriptor and selecting references. Ten 1 hour sessions were conducted in each country by native one panel leaders. The global comparison showed that the same key sensory concepts were identified in the four countries. Specificities were also identified in each country, implicating an important role of dietary experience. More descriptors for aroma and taste were generated in Japan and Korea and these descriptors were applied to the food products which are eaten frequently by them (*e.g.*, rice-cake, azuki bean, barley malt). More texture terms were generated by Thai panelists. Our results suggest some critical questions when building a universal lexicon.

Keywords: *Cross-cultural study, sensory analysis, description, rice*

1. Introduction

As a result of the expansion of international trade in food, food industries carry out consumer and sensory tests, such as sensory profiles in different cultures. Unlike the physical sciences, where data are collected using instruments calibrated in internationally standardized units, sensory evaluation uses human subjects who must be verbally instructed concerning the attributes of the food that they have to evaluate and for which they must then give qualitative or quantitative responses that require further language interpretation. Basic sensory protocol can be transferred from country to country, but is not always easy to develop appropriate descriptive terminologies for attributes that are indicative of characteristics perceived by different ethnic groups that have different food experiences (Karahadian, 1995). For example, Daget (1992) reports that panels in different countries may associate the same descriptor with different attributes. For

example, the word 'fruity' was connected with sugar content in the USA but with volatile content in Spain and Switzerland, this pattern suggests a different interpretation of "fruitiness" by these cultures. Speaking different languages is another barrier for the international sensory evaluation community (Cardello, 1993). Prescott (1998) discussed that in some cases an important sensory concept for one culture does not have equivalents in another culture. For example, Korean sensory concept *kusu*, an important and desirable flavor attribute for Koreans, does not have an exact translation in English, but is expressed (in English) as a conglomeration of attributes into a single concept.

An important question then is: how can we import the results of a sensory profile from one culture to another? To address this question, many studies were carried out with various methodological approaches. One group of studies allowed laboratories from different countries to choose their methodology to describe the products and compare the results (de Jong, van der Knaap, & van der Knaap, 1998; Drake *et al*., 2005; Follet, Lê, S., McEwan, & Pagès, 2006; Mojet, & de Jong, 1994; Nielsen, & Zannoni, 1998). A second group of studies set the attributes in one country and then use this list of attributes in another country (Daget, & Collyer, 1984; Hirst, Muir, & Naes, 1994; Risvik, Colwill, McEwan, & Lyon, 1992). Then a third group of studies aimed to build a set of common attributes across the countries so they can compare the results more easily and reduce the variability between countries (ESN, 1996; Hunter, & McEwan, 1998). Regardless of the method chosen, there are still open issues when dealing with panels from different cultures.

For a better communication between cultures, it is essential to understand how people with different languages and cultures describe the same product. The objective of this study was to compare the sensory characterization of products generated in four different countries with differences in eating habits and languages: Japan, Korea, Thailand, and France. We chose to study rice because it is globally consumed with important differences of consuming patterns in the investigated countries.

2. Materials and methods

2.1. Stimuli

White rice, brown rice and germinated brown rice (Koshihikari variety and Chu-chung variety harvested in 2010) were used in this study. Samples were stored at 5 degrees C. in a single location and sent in each country before sensory evaluation.[4]

Four rice cooking procedures varying soaking period (short/long), heating intensity (low/high), type of rice (white/brown), and brown rice germination (yes/no) were used in each country. Rice (600g of white rice and 572g of brown rice) was rinsed following a standardized procedure and then mineral water (Evian, 700g for white rice and 850g for brown rice) was added. A rice cooker (CRP-HNXG1010FB, CUCKOO) was used to prepare the samples. Germinated brown rice was prepared two days before the experimental session. The germination procedure included two steps. First, brown rice was germinated in water during two hours using the germination program built in the rice cooker and after, it was germinated in the air during 48 hours at room temperature.

The middle part of the cooked rice was slightly stirred and scooped into isolated Styrofoam cup (about 45 g per cup). The cups were kept in an isotherm bag until they were given to the panelists. The serving temperature was between 45 to 55 degrees C.

2.2. Panels

Seven or eight native panelists (women aged between 22 to 53 years) in each country participated in this study. They were screened according to their ability for conducting sensory profiling task and rice consumption frequencies. All participants had not participated in any sensory profiling of cooked rice before. They attended two one-hour sessions each week for five weeks.

[4]Because of some incidents, in Japan, only the Koshihikari and in Thailand, only the Koshihikari and white Chu-chung varieties were used.

2.3. Procedure

2.3.1. Generation of descriptors

A generation of descriptors was conducted in each country. The panelists generated the descriptors during the first two initial one-hour sessions. Each panelist was given 12 samples, six per session, and was asked to write down terms which described the similarities and differences between the samples. During the first session, rice samples were presented simultaneously to help panelists compare the samples. During the second session, rice samples were presented one at a time to help panelist focusing on each sample. In both sessions, panelists were asked to generate as many descriptors as they could to describe the samples. At the end of each session, the panel leader compiled the descriptors generated by all participants and started a discussion with the panelists to establish an initial lexicon. During the discussions, the panelists eliminated any redundant descriptors such as hedonic, quantitative and irrelevant terms. They also grouped synonyms together and eliminated redundant descriptors. The panelists discussed and reached an agreement for each descriptor on the initial list before the subsequent sessions.

2.3.2. Selection of descriptors

Two one-hour sessions (Sessions 3 and 4) were conducted to rate the perceived intensity of each descriptor in the initial list for 12 rice samples (eight and six samples in Thailand and Japan, respectively). Six samples (labeled with 3-digit codes) were tested in each session. Perceived intensity was scored on a 6-point scale from 0 (none) to 5 (strong). The panelists were asked to rinse their mouth between each sample with water.

Following the ISO 11035 norm, geometric means (Dravnieks & Bock, 1978) were computed for each descriptor. Descriptors with a mean less than 10% were discarded. Remaining descriptors were submitted to a Principal Component Analysis (PCA) to check for synonymous and antonymous. The results of the PCA were discussed with the panelists at the beginning of session 5 to keep only non-redundant descriptors.

Two one-hour group discussions (session 5 and 6) were then conducted to define the descriptors in the final list and select references for the inferior and superior anchors. To facilitate the discussion, six rice samples were presented simultaneously (four and three samples were presented in Thailand and Japan, respectively) during this step.

2.3.3. Final evaluation to validate the lexicon

Twenty-four samples were examined (16 and 12 samples were examined in Thailand and Japan) in four one-hour sessions (Sessions 7-10). Each attribute was rated on a 10cm line scale. Rice samples were coded with 3-digit random numbers and presented monadically. Six samples were tested in each session, and were presented following a William Latin square design. Water was provided for rinsing during the sessions.

2.4. Data analysis

All descriptors and definitions were translated into English by native panel leaders. Generated descriptors from the four countries were compared in terms of definition and reference samples. As the Chu-chung rice variety was not evaluated in all countries, only Koshikari rice variety samples were kept for final analysis. The four panels were compared using multiple factor analysis (MFA).

3. Results

3.1. Comparison of the attributes generated by the four panels

To describe the rice samples set, Korean participants used 28 descriptors, Japanese participants 19 descriptors, Thai participants 24 descriptors, and French participants 20 descriptors (Table 1). Chi-square tests showed that Korean and Japanese participants generated more terms related to odor ($\chi^2(3)=6.0$, $p < 0.10$). Comparison of definitions and references samples showed that six sensory attributes were similar in the four countries. For example, appearance attributes ‘color/brown’, ‘uniformity of grain/homogeneity/variedness of grain’, and ‘glossiness/glossy/shininess’, and texture attributes ‘degree of

separation/parting grains/grain separate/dispersible', 'adhesiveness/sticky/stickiness', and 'residual feeling/husk/fiber' appear similar among the four panels.

Nine attributes were similar in three countries. For example, 'length/shape' 'size/degree of swelling', 'intactness of grain/entirety of grain/integrity of the grain', and 'chewiness/slipping/ability to swallowing' by Korean, French, and Thai panels; 'sweet taste' and 'burnt rice flavor/cereal/roasted and pleasant flavor' by Korean, French, and Japanese panels; 'rice bran odor/husk/bran', 'moistness/wetness/watery', and 'firmness/softness/hard' by Korean, Thai, and Japanese panels appeared similar based on definitions and references.

Fourteen attributes were similar in two countries. For example, 'sprout/germ' 'roughness/crunchy', and 'mucous/runny' by Korean and French panels; 'embryo bud of rice/ amount of germ', 'diameter/thickness', and 'springiness' by Korean and Thai panels; 'roasted barley odor/roasted and pleasant', 'bitter taste', and 'cohesiveness of mass/rice cake like (bolus)' by Korean and Japanese panels; 'uniformity of color', 'husk/membrane,' and 'layer in mouth/slimy' by French and Thai panels; 'astringent/acrid and astringent taste' by French and Japanese panels; 'hard outside and soft inside/feeling of burst' by Thai and Japanese panels appeared similar based on definitions and references.

Besides these similarities across countries, some differences were also found. First, the number of attributes used to describe the rice samples was different. Korean panelists used more descriptors than the other panelists. Second, large differences were observed in aroma and taste/flavor descriptors. Korean and Japanese panels developed their own unique attributes to describe the aroma and taste/flavor of rice samples. These aroma and taste/flavor attributes used by Korean and Japanese panelists are associated with food products which are frequently eaten in Korea and Japan (e.g., "rice-cake", "azuki bean", "barley malt", "roasted barley", and "burnt rice"). Third, more texture terms were generated by Thai panelists. In Thailand, participants used more than a single texture term to express similar texture sensations. For example, while 'slippiness' appears similar to 'slimy' based on the definition and 'rice bran' appears similar to 'fiber', Thai panel left these terms separated and gave different references. Fourth, some overlapping terms between appearance and texture or aroma and flavor were observed within the countries. For example, the appearance attribute 'compact' and the texture term 'parting grains' by French panels; the appearance attribute 'wet' and the texture term 'wetness' by Thai panels; the flavor attribute 'husk flavor' and the aroma attribute 'husk' by Thai panels; the flavor attribute 'roasted and pleasant' and the aroma attribute 'roasted and pleasant' by Japanese panels.

3.2. Comparison of the usage of attributes by the four panels

The first two principal components of the MFA explained 77.91% of the total variance (Figure 1 and Figure 2). The usage of attributes shows great similarity between the four panels. For all panels, the first component opposed the white rice samples to the brown rice samples, whereas the second principal component opposed mainly germinated brown rice samples to non-germinated brown rice samples. Although rice samples were perceived similarly by the four panels, some differences can be noted on the second principal component. French and Korean panelists tended to characterize germinated brown rice with a rather runny appearance and sticky texture. On the other hand, Thai and Korean panelists tended to characterized brown rice as having a rather firm and dispersible texture.

Table 1. Descriptors generated four countries (Translated into English)

	KOREAN	FRENCH	THAI	JAPAN
Appearance	Thickness		Diameter	
	Length	Shape	Length	
	Size	Size	Degree of swelling	
	Intactness of grain	Entirety of the grain	Integrity of the grain	
	Uniformity of grain	Uniformity of the grain		Variedness of grains
	Color	Color	Color	Brown
		Color uniformity	Uniformity of color	
	Transparency			
	Embryo bud of rice		Amount of germ	
		Husk	Membrane	
	Sprout	Germ		
	Glossiness	Shininess	Glossy	Glossy
	Mucous	Runny		
			Wet	
		Compact		
Odor	Rice bran odor		Husk	Bran
	Roasted barley odor			Roasted and pleasant
	Corn odor			
	Barley malt odor			
				Azuki bean
				Roasted soy bean
				Rice cake
Flavor/	Sweet taste	Sweet		Sweet taste
Taste	Bitter taste			Bitter taste
		Astringent		Acrid and astringent taste
	Burnt rice flavor	Cereal		Roasted and pleasant flavor
	After taste			
			Husk flavor	
Texture	Degree of separation	Parting of grains	Grain separate	Dispersible
	Cohesiveness of mass			Rice cake like (bolus)
	Springiness		Springiness	
	Adhesiveness	Sticky	Stickiness	Sticky
	Firmness		Softness	Hard
			Hard outside and soft inside	Feeling of burst
	Moistness		Wetness	Watery
	Chewiness	Slipping	Ability of swallowing	
			Slippiness	
	Roughness	Crunchy		
			Homogeneity	
		Layer in mouth	Slimy	
	Residual feeling	Husk	Fiber	Fibrous
			Rice bran	

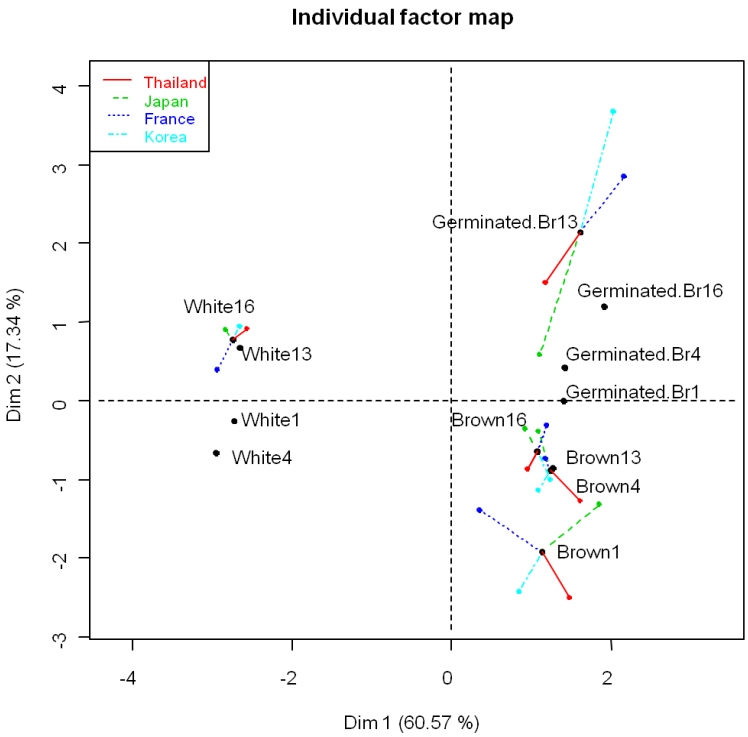

Figure 1. Product map of MFA plot. Numbers in the product names indicate heating intensity and soaking length (1, low heating intensity and short soaking length; 4, low heating intensity and long soaking length; 13, high heating intensity and short soaking length; and 16, high heating intensity and long soaking length

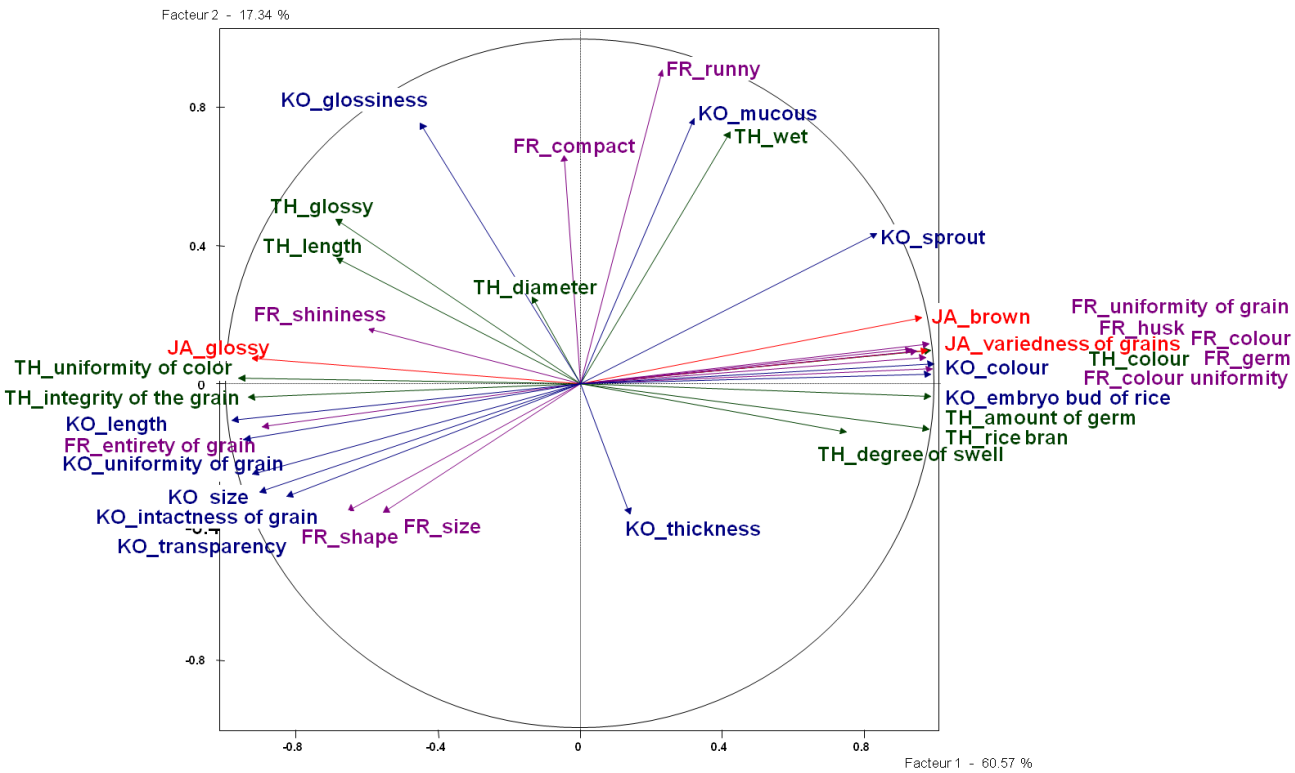

Figure 2.a. Appearance descriptors.

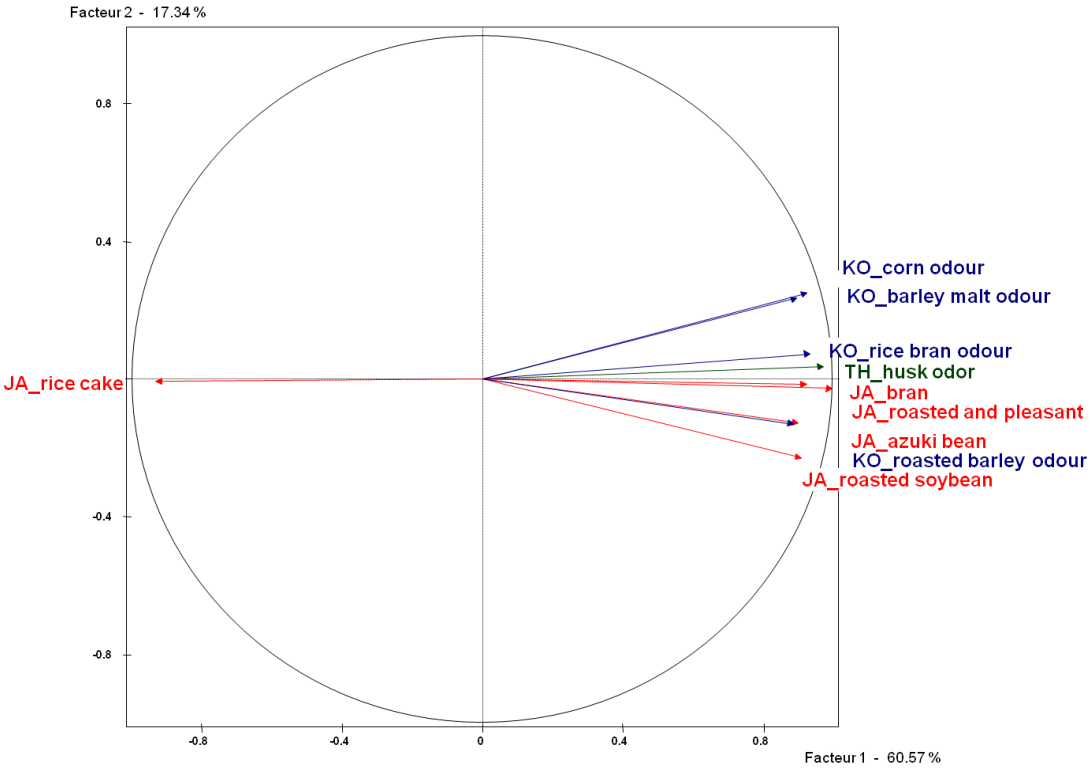

Figure 2.b. Aroma descriptors

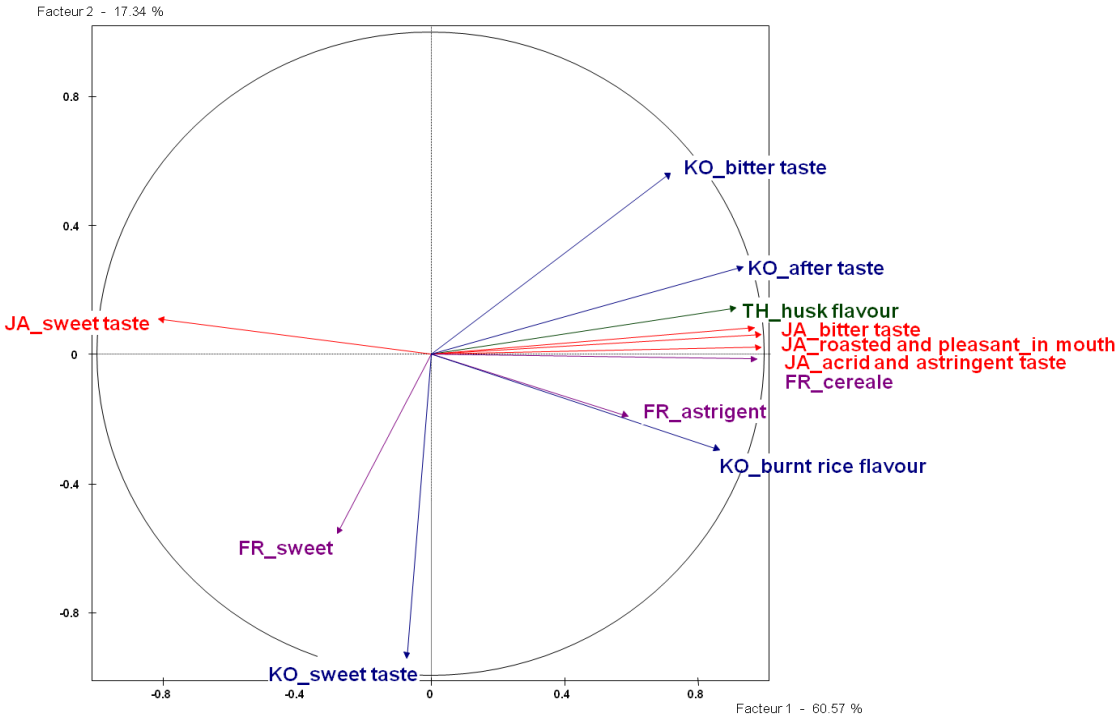

Figure 2.c. Taste/Flavor descriptors

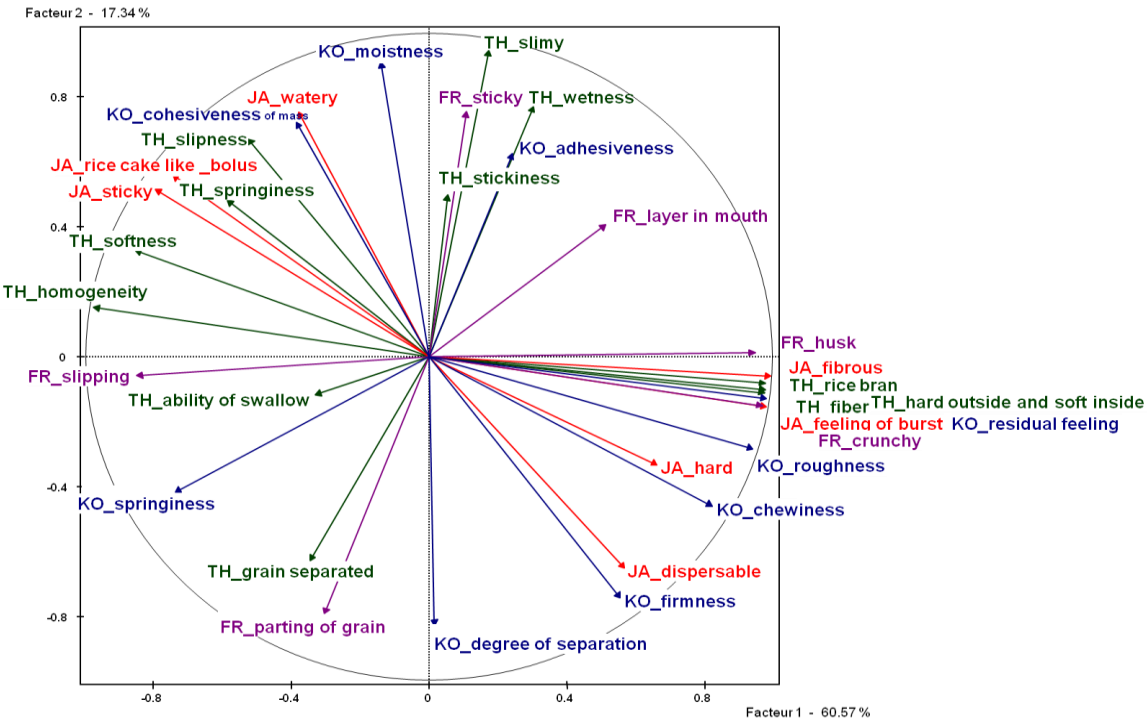

Figure 2.d. Texture descriptors

4. Discussion

The aim of this study was to provide a better understanding of how descriptive attributes of a food product can be communicated between countries with different culture and familiarity to rice. The overall perception of rice samples was not strongly influenced by culture; however, how samples were described differed among the cultures.

The agreement between countries for 'aroma' was less than for 'appearance' and 'texture'. Korean and Japanese panels used more aroma attributes than Thai and French panels. This confirmed previous studies which showed a high similarity between French and Vietnamese panels for visual appearance and texture descriptors but not for aroma descriptors of fruit jellies (Blancher, *et al*., 2007) and soy-yogurts (Tu, Valentin, Husson, & Dacremont, 2010). This could be generated by differences in the richness of sensory words derived from familiarity. In other words, Thai and French panels, who rarely consume short-grain rice variety, might also recognize a sensory concept and differentiate the samples, but did not find an appropriate word to express it. The aroma terms generated by Korean and Japanese panels refered to traditional food, such as "rice-cake," "roasted soybean," "roasted barley," and "barley malt" which are often used by them as descriptive aroma terms in sensory analyses of various foods (Hayakawa, et al., 2010). These aroma terms are specific of the Japanese and Korean culture and language.

The problem of translation was also addressed in this study and we found some three important results: 1) More texture terms were generated by Thai panelists and some of these texture terms were semantically very similar when translated into English. Indeed, some cultures use more than a single word to express some sensory sensations that are, in other cultures, expressed with a single word, as is the case of the Malay which have three words for what we call "bitter" sensation (O'Mahony, & Alba, 1980). 2) Unique expressions which reflect culture and language were also observed in the Japanese panel, for example "roasted and pleasant (こうばしい)" is an expression in Japanese and is often used by Japanese participants to describe the roasted and pleasant aroma of various foods. Some concepts which come from a specific view of reality, typical of a culture, are related to specific words which exist only in one language (Martinet, 1969). 3) Some sensory sensations which are common to Japan and Korea were translated differently into English. Based on the definition and reference samples, "roasted and pleasant (こうばしい)" by the Japanese panel and

"roasted barley (구수한)" by the Korean panel refers to the same sensation. Indeed, "こうばしい" is translated into "구수한," and vice versa, with Japanese-Korean/Korean-Japanese dictionary. This indicates the necessity to have a deep knowledge of each culture and language because terms that are culturally-specific should be understood within this context.

The product map in our study suggests some critical points which need to be discussed when developing a universal lexicon. As the rice samples used in our study, white, brown, germinated brown rice, have quite distinctive sensory characteristics, the descriptors and reference samples generated to describe the attributes were good enough to represent general attributes and to separate various categories of rice. However, it was not precise enough to understand detailed differences within a single category. For example, the inferior and superior anchors for the appearance term 'color/brown', white and brown respectively, were too extreme to explain subtle differences among white rice samples or among brown rice samples. The scales with two extreme anchors developed from global category might not be very useful for a single category with high similarity. One way to overcome this problem can be to use more than two anchors. This way, the developed lexicon can be used for a single product category by adjusting the scales (*i.e.*, to use only part of the scale up to the product space of interest). This methodology needs to be checked in further studies.

5. Conclusion

This study has provided important insights to set the universal lexicon for international market. The overall perception of rice samples was not very different across cultures; however, the use of descriptive vocabulary to characterize the samples was highly influenced by cultures. Especially the richness in vocabulary for aroma and texture terms was different across cultures. Different languages and translations are fundamental difficulties in cross-cultural sensory studies. Thus, it is essential to have deep knowledge of each culture and language. Furthermore, the selection of sample products, when developing universal lexicon, should be carefully considered so the lexicon can be useful for each product category. Further refinement should be continued on an international scale with inherent cultural differences presented. The task will be not easy but it is necessary to develop standardization for a growing international market.

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USING SENSORY TECHNIQUES IN A CROSS CULTURAL STUDY OF KOREAN AND AMERICAN FOOD SAFETY HABITS

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Abstract

People older than 65 years generally are considered a risky group for food safety purposes. Little research was found that reported elderly consumer food safety behavior from a cross-cultural perspective. The objective of this study was to identify food safety behavior of female elderly in different rural and urban settings of two countries, the United States and Korea. Eight focus groups, four in the U.S. and four in Korea, with two in each country being in an urban area and two in a rural area, were conducted by trained moderators. All participants were elderly females over 65 years old. Korean participants indicated that foods that were stored for a long time and rotten foods can cause food poisoning. Participants from higher socioeconomic groups indicated they threw out food earlier than did those from lower socioeconomic groups. Some participants remembered difficult times and felt they needed to conserve food. More rural Korean participants, compared to urban Korean, mentioned experiencing food poisoning symptoms, possibly because they ate food although the smell of the food was "not right". Elderly Koreans indicated not using soap to wash hands in the kitchen because it could change food flavor. US elderly participants were more specific on reasons why food could "go bad". However, several US participants mentioned eating foods (e.g. applesauce) with mold by removing the mold and eating the remaining portion. US participants gave more details about food safety than Korean consumers. US rural elderly indicated more interest and potential knowledge than any other group. Few recalled symptoms of food poisoning and indicated they thought they were more aware of food because many came from farm backgrounds. Overall, knowledge of food safety was high by all groups, but food safety practice was mixed and appeared to be slightly higher in Korean urban and US rural consumers.

Keywords: Food safety, focus groups, Asia, US

1. Introduction

Food poisoning is a common problem, but the incidence of food poisoning can be reduced with proper education and awareness of consumers. It is estimated that 48 million Americans experience food poisoning each year, and about 3,000 of those cases end in death (Scallen, *et al*., 2011*a, b*). People older than 65 years old are generally classified as a risky group for food safety purposes (Office for National Statistics, 2006). The elderly are more susceptible to food poisoning than younger people and often takes a longer time to recover (Smith, 1998; Centers for Disease Control and Prevention, 2012). Some food safety-related outbreaks may lead elderly near death, for example, an outbreak of *Escherichia coli* O157:H7 in a nursing home led to further health complications for many and the death of 17 residents (Carter, *et al*., 1987). Despite this risk, in a Mintel Group study elderly consumers were less concerned about food poisoning in general than younger participants (2002).

Internationally, several researchers have studied food safety behavior, including the behavior of children (Kim, & Kim, 2004), Chinese consumers (Wang, Mao, & Gale, 2008), consumers on the island of Ireland

(McCarthy, Brennan, Ritson, & de Boer, 2006), European consumers (van Rijswijk & Frewer, 2009), gardeners (Pivarnik, Patnoad, Leydon, & Gable, 2006; Pivarnik, *et al*., 2008), Indian mothers (Sudershan, *et al.*, 2008), and Japanese consumers (Kim, 2008). A study conducted in England revealed that many elderly people were keeping their refrigerators too warm, putting themselves at risk for food-related illnesses (Johnson, et al., 1998). In the United States, researchers have studied food safety behavior of adolescents (Pedigo, et al., 2009), college students (Byrd-Bredbenner, et al., 2007), residents of Kentucky (Roseman, & Kurzynske, 2006), adult/elderly caregivers in Nebraska (Wilson, Babu, & Omaye, 2009) and Puerto Rican residents of the United States (Bermudez-Millan, *et al*., 2004).

Although there is a large body of research on food safety behaviors, we were not able to locate any research on food safety of elderly Koreans. Most studies involving Korean elderly researched older populations' health, food perceptions and food habits (Chung, & Kang, 1996), their knowledge on nutrition and attitude (Yang, Lee, & Chae, 1998), the effect of a nutrition education program for the elderly (Kang, & Lee, 2005), the effect of a low income food supplementary program for elderly (Park, Lim, & Kim, 2007), and the effect of age and education on food and nutrient intakes (Kim, 2001).

The objectives of this study were to identify food safety behavior of elderly females in rural and urban settings of two countries, the United States and Korea, using a focus group technique and to determine areas for improvement in their food safety behavior, knowledge, or awareness.

2. Materials and Methods

2.1. Participants

A total of eight focus groups were conducted; four in the United States and four in Korea. The participants were all elderly women 65 from the United States and Korea. In the United States, the city of Manhattan, Kansas was chosen to represent the urban area whereas Utica and Wakeeney, also in Kansas, were chosen to represent the rural area. In Korea, Busan was chosen to represent the urban area and Suncheon was selected as the rural area. Table 1 presents general demographic characteristics of locations where focus groups were conducted. Participants were recruited for 90-minute group discussions and were compensated for their time. The focus groups were conducted to compare living environment (rural vs. urban) of the two countries. The focus groups were conducted by Riva-trained moderators who spoke English or Korean as their native language.

Table 1. General demographic characteristics of focus group locations

	Population	Population Density[a]	Females older than 65[b]
United States			
Urban:			
Manhattan, KS	44,831	1152.4	2,116 (4.7%)
Rural:			
Utica, KS	223	358.8	24 (10.8%)
Wakeeney, KS	1,924	434.4	325 (16.9%)
Republic of Korea			
Urban:			
Busan	3,596,063	4,695.0	214,501 (6.0%)
Rural:			
Suncheon	269,348	299.7	18,474 (6.9%)

[a] Number of people per km^2
[b] Number of female older than 65 years (percentage)

2.2. Discussion guide

A moderator's guide was developed to collect food safety-perceptions, food safety knowledge, and knowledge on refrigerator use using real life situations (Figure 1).

I. Rapport/Reconnaissance (15 minutes)

1. What is your favorite food? [List on chart I-1]
2. What is it about this food that you like most?
3. What do you like least about this food?
4. How long do you keep _____ [pick food from list in chart II-1]?
5. Close your eyes and tell me what is in your refrigerator right now. [list on Chart I – 5].
6. Do you have anything in your refrigerator right now that should already have been discarded? [Probe issues: How is it that this food is still in the refrigerator?]

7. Have you ever thrown _____[pick food from list in chart I-1] away?
8. Several of you mentioned spoilage, how do you store this food [pick food from list in chart I-1] to keep it from spoiling?
9. How do you decide when food is no longer safe to eat?

II. In Depth Investigation (50 minutes)

A. Food Safety Perceptions

1. What do you think causes food to make us sick?
2. How concerned are you about food safety?
3. Have you ever gotten sick from eating a food?
4. How did you know if a food had made you sick?

B. Food Safety Knowledge

1. Name some foods for me that you think would make a person sick.[List these on chart II, B-1.]
2. What is it about these foods that makes them more likely to cause a person to be sick than other foods?[In chart II, B-1]
3. What do you think you could do to help prevent this food from making someone sick? [Talk about specific foods from list in chart II, B-1.] [List ways on chartIII, B-3]

Real Life Situations

One: It is the Aprons' family reunion and they are going to have a picnic with the following as part of the menu: macaroni salad, sliced meats, and lemon meringue pie.

1. What should the Aprons do to keep the food safe until it is eaten at the picnic site 20 miles away? [Write list on chart II, B-4.]

Two: The Opossums' have a mealtime ritual that everyone gathers for the dinner hour at 6:00 P.M. However, today Mr. Opossum called to say he would be about 2 hours late. Mrs. Opossum prepared his plate, covered it with a napkin and left it on the table for him to eat when he came in.

1. Does anyone here do something similar to this?
2. What do the rest of you do if someone is not there for the meal but you want to save them some food?

A. Thawing Practice:

One: Michelle shops at a well-known food store across town. On her way home from shopping she stops at the bank where there is an unexpected long line. When she arrived at home, her ice cream was liquid, her frozen green beans, her frozen corn and her frozen broccoli had become soft.

1. If you were Michelle, what would you do with the foods?
2. What could Michelle have done to prevent this from happening?

Two: It is 4:00 P.M. in the afternoon and you have a taste for pork chops for tonight's dinner at 6:00 P.M. But the pork chops are frozen.

1. Tell me about the ways you would thaw them.

Three: It is two days before a big fiesta and you have just purchased 20 pounds of frozen meat for the upcoming special dinner.

2. Tell me how you will prepare your meat.

B. Knowledge of Refrigerator Temperature:

One: Ms Smith works out of the home and prepares chili for her evening meal for her family of six before she leaves for work.

1. List ways Ms Smith could keep her food of chili safe until dinnertime. [Put on chart II, D-1[1].]

Two: A tornado hit your area. You had to leave your house for five days. You have just returned home and found out that the electricity was out the entire time you were gone.

1. What do you do with the food that is in your refrigerator?
2. What do you do with the food that is in your freezer?

Three: Ms Tisdale thought she got a great bargain on a new freezer until she discovered that it wasn't frost-free. Now she has 2 inches of ice built up. What should she do to defrost her freezer?

1. How many of you have frost-free freezers?

C. Barriers to Using Proper Refrigeration:

[Refer back to Chart II-5. Read this list again] You have stated that you have (read list) in your refrigerator right now. Is there anything else that you usually have in your refrigerator that you don't happen to have right now? [List these on chart II, E-1.]

1. Where do you store your eggs?
2. Thinking about the [pick food from chart II, E-1] in your refrigerator (if you have any now), how long have (has) it (they) been there?
3. Does anyone have refrigerators with adjustable temperatures for different foods?

D. Refrigerator Temperature:

1. Can you tell me what the temperature is inside your refrigerator?
2. What do you use to tell it is that temperature?
3. What temperature should the refrigerator be?
4. Does any one have a thermometer similar to this one in their refrigerator or does yours look anything like this one? [Show thermometers]
5. How do you know if your refrigerator is keeping the food cold enough or not?
6. If you don't think your refrigerator is cold enough, what do you do?
7. What might keep a refrigerator from being cold?
8. How many of you have been reminded or reminded someone else to close the refrigerator doorr?

E. **General Questions:**

1. Where do you get most of your food safety information? [Put on chart II, G-1.]
2. Who is most likely to get sick from eating unsafe foods?

Figure 1. Discussion guide for focus group (in English), [a] Focus group in Republic of Korea was conducted in Korean. Moderator's guide was translated into Korean and real life situations were modified to suit Korean life style.

3. Results and Discussion

3.1. Korea, Urban area

About half of Korean participants in the urban area lived with their children. Most lived with their son's family, while a few lived with their daughter's family. These individuals were not involved in cooking. The other half of the participants was either living alone or with an unmarried child and was actively involved in cooking.

All participants agreed that foods that were stored for a long time and rotten foods can cause food poisoning. However, participants reported differing behaviors about stored food. The participants who lived in developed condominium complexes reported that they waste about half of foods in the refrigerator because the foods go bad before they are consumed. A reduced family size was one of the reasons for food waste. In contrast, the participants who lived in underprivileged apartment complexes reported that they conserved foods and consumed almost everything they purchased. A few participants mentioned the history of Korea, specifically when they did not have enough foods and felt that conserving grains was important for future generations. They also suggested that the younger generation (those in their 50's) would behave differently from them and would not try to conserve grain as much.

Some participants had experienced food poisoning because they consumed food even though the smell of the food was not right. The participants understood that it was easier to get sick from rotten foods. The participants often smelled foods to decide if the foods were still safe to consume, in addition to evaluating the appearance. To prevent food poisoning, the participants from the urban area agreed that they needed to be cautious, clean well, avoid rotten foods, and, interestingly, eat less. It appeared that the participants believed that food poisoning and indigestion were interchangeable.

The Korean urban participants did not know the proper temperature of the refrigerator. They used the dial settings of 'strong', 'medium', and 'weak' to adjust cold air. A few mentioned that when there are more foods than normal, they changed the setting to 'strong' from 'medium.' Another practice they used to keep the refrigerator cold was cooling cooked foods before they put it in the refrigerator.

The Korean urban participants who lived in the privileged area differed in their hand washing practice from the participants who lived in the unprivileged area. Although they all wash their hands when they return home, before cooking and eating, and other occasions, the participants who lived in the privileged area answered they would use soap occasionally, whereas the participants from the unprivileged area only wash their hands under running water.

3.2. Korea, Rural area

About half of the Korean rural area participants were living with their spouses and the participant was the main cook in the household. The other half of the participants were widows and they either lived alone or with their son's or daughter's family.

The Korean participants from the rural area generally agreed that rotten foods or foods that were stored a long time may cause food poisoning. However, some consumed expired foods such as milk because they felt bad about wasting food. Even though they generally thought that weak people can get sick easily from food poisoning, they excused themselves from the weak people group because they were working in the field. About half of the participants reported that they experienced food poisoning and started to avoid the foods that caused the incidence, which is probably because rural participants were consuming expired or stored foods.

The participants from the rural area also did not know the proper temperature of the refrigerator. They also had 'strong', 'medium', and 'weak' to adjust the cold air. Participants commented that they visually inspected the temperature and would know if any of their foods in the refrigerator freeze.

For hand washing, all the Korean participants from the rural area agreed that they used soap to wash their hands when they returned home. However, they did not like using soap in the kitchen because they thought that the fragrance of the soap may influence the flavor characteristics of foods they prepared.

Overall, the elderly Korean participants shared their experience and behavior regarding food safety in the focus group setting with peer elderly women. However, some of senior elderly participants dominated the

conversation several times, often asking others to agree with her opinion, and tended to summarize the discussion at the end of small topics. Another challenge was the culture and language. In Asian countries, including Korea, talking back to the elderly is considered to be rude. The moderator spoke Korean in to participants and managed to obtain the information that was needed. Perhaps one-on-one interview may be better in Asian countries, especially when the participants are much older than the moderator.

3.3. United States, Urban Area

Most participants from the U.S. urban area lived with their spouses. Only one participant mentioned living with grandchildren. As Korean elderly females commented, U.S. elderly females also thought that overeating and foods that were not stored properly could cause people to become ill from eating foods. However, American participants were much more specific about the reasons why foods go bad. The reasons included bacteria, foods stored at room temperature, and foods stored for too long in the refrigerator. Appearance (e.g. firmness and color of vegetables), smell during cooking, and date on the packages were often mentioned as an indication that foods may be spoiled. However, some participants said that when they see mold in an apple sauce jar, they removed the portion with mold and consumed the remaining food. The others commented that they buy smaller containers of foods because it ended up saving them money, since they may not consume the whole amount from a larger container. Some of the American participants from the urban area went grocery shopping more than three times a week to keep fresh vegetables and fruits in stock. They bought fresh products in small quantities and stored it in the refrigerator. Whenever the fruits and vegetables did not look fresh, they discarded them. A few mentioned that foods in the back of the refrigerator shelf got thrown out because they were hard to reach, easy to forget, and went bad. One participant cleaned her refrigerator every two days so she did not have any bad foods in her refrigerator. Participants were not worried about how long they kept condiments in the refrigerator. Some participants mentioned that whenever they got a new bag or container of the same food, they threw older foods regardless.

To prevent foodborne illness, participants agreed that preparing foods properly, maintaining proper hand washing technique, keeping raw meat and fresh products separately, and keeping foods at proper temperatures were important.

Most participants knew the correct temperature of the refrigerator was between 3.3 and 4.4°C (38 to 40°F) because they had a thermometer in their refrigerator. They stored foods in the refrigerator to keep them safe rather than letting food sit out at room temperature. For food storage in the refrigerator, participants in the current study were very particular. Some washed all products before storing it in the refrigerator, believing it would extend the storage period. Many stressed that meat should be stored or thawed in the bottom shelf of the refrigerator and should not be in contact with fresh products.

Although about half of the participants experienced foodborne illness accompanying stomach ache, vomiting, and diarrhea, they were not concerned about food safety of home prepared food or when eating out. However, it was clear that participants were aware of food safety. A few participants mentioned that they read restaurant reviews concerning proper food handling and food safety practice in general and limit their restaurant choices to locations where they are clean and handle foods properly.

U.S. participants from the urban area obtained food safety information from articles in the local newspaper, magazines, internet, reading, and product extension lines. They thought phone extensions from products provided information on various topics.

3.4. United States, Rural Area:

United States participants from the rural area generally lived with their spouses. A few lived with extended family. They tended to have many food items in the refrigerator, except for participants who ate at the senior center. Participants did not worry about condiments getting old. As long as the food did not smell bad, most consumed the product.

Participants from the U.S. rural area kept the temperature of the refrigerator below 4.4 °C (40°F). A few of them had opinions for where each food item should be stored in the refrigerator. For example, milk was best

to be stored in the lowest shelf in the back to keep it away from warm air exposure occurring when the door is open.

Participants used appearance, smell, and taste to judge if a food item was safe to consume. When the safety of a food item was questionable, they discarded the food because seeing a doctor cost more than the food item. Some strictly used 'best-by' date to determine safety, even though some were still acceptable in terms of appearance and smell.

Again, American participants thought bacteria, improper hand washing, and mistakes during food handling, and cooking malpractice were the reasons for foodborne illness. Only a few participants experienced food poisoning, thus, they were not worried about it. They considered different aspects in relation to the food safety of a restaurant. For example, clean floor of the restaurant indicated safer restaurant.

U.S. elderly participants from the rural area talked about specific cooking practices that would prevent food from spoilage. Rapid cooling and storage at the appropriate temperature were mentioned as such methods.

5. Conclusion

Generally, both elderly females from both South Korea and United States were aware that they are in the risk group for food borne illness. Korean elderly females who were actively involved in cooking followed appropriate food safety practice, except they washed their hands without soap. Korean elderly females who were not actively involved in cooking did not seem to care about food safety. Food poisoning experience led to more cautious behavior, and sometimes to avoidance of the food product that caused the illness. Most participants had habits of conserving food and even consuming foods when they know it may not be safe. Reasons for continued consumption included knowledge of the effort that was put into farming and previous experiences of extreme hunger during the Korean War. Korean elderly females learned proper food handling techniques from experience.

American participants also identified overeating and improper storage habits as potential causes of food-related illness, but they were more specific about food safety practices and problems than Korean participants. Both groups of U.S. participants did not think condiments under long-term storage were a concern. American participants were more aware of the proper refrigerator temperature and kept the temperature at the proper level. The U.S. rural elderly had high knowledge of food safety matters and expressed interest in learning about food safety.

Korean and American elderly women from urban and rural areas were found to have high knowledge of food safety, but all groups had room for improvement. The information obtained from these focus groups can be used to develop food safety programs for rural and urban elderly females in South Korea and the United States.

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