SPISE 2009

SUMMER PROGRAM IN SENSORY EVALUATION 2009

Vietnam, August 7-9, 2009

PROCEEDINGS

FOOD CONSUMER INSIGHTS IN ASIA

CURRENT ISSUES & FUTURE

Edited by

Hervé Abdi, Dominique Valentin, Dzung Hoang Nguyen

Vietnam National University-
HoChiMinh City Publishing House

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SPISE2009, the second symposium on sensory evaluation in ASEAN, was held on August 7–9, 2009 at Ho Chi Minh-city University of Technology, Vietnam. Besides the former purpose of encouraging the implementation and development of sensory evaluation in Vietnam and in neighboring countries, this year SPISE aimed to capitalise on and to encourage further collaborations among Asian food scientists. The focus of SPISE2009 was on "Food Consumer Insights in Asia: Current Issues and Future." We had the great pleasure to welcome more than one hundred of scientists from (among other countries) Vietnam, China, Thailand, Singapour, the USA, France, Australia, the Netherlands, and Denmark.

The present proceedings are organised into four topics which we used to organised this meeting sessions and themes:

1. New methods and research tools in consumer research
2. Food choice and consumer behaviour studies
3. Applications in the food industry/Product development
4. Sensory-instrumental relations

The presenters who submitted papers came from a wide range of disciplines, partly because sensory evaluation so often depends on interdisciplinary collaboration for successful implementation. We also feel that these papers reflect the wide range of interests and methods of the field and that they give an accurate image of the state of the art of sensory evaluation practices and theoretical concerns in the Asian countries. As such, this document should be of interest for anyone interested in consumer research in Asia.

Our special thanks are due to our partners which participated to the organisation of this meeting: the HCMC University of Technology, AgroSup Dijon, CESG-Dijon, and AgroCampus-Ouest. We would also like to thank our sponsors for their generous help: VITAGORA, Fizz-Biosystème, LogicStream, Vinamilk, and Saoviet. We extend our special thanks to those who have helped us so much and worked so hard to make this event possible: Le Minh Tam, Phan Thuy Xuan Uyen, Nguyen Thi Hang, Vu Thi Thanh Phuong, Lam Minh Thuy, Truong Thi Xuan, Vu Thi Phuong Mai.

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Part 1: New methods and research tools in consumer research

THE IDEAL PROFILE METHOD: COMBINING CLASSICAL PROFILING WITH JAR METHODOLOGY

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Abstract

In order to make competitive and successful products, companies need to know what consumers really want. They need detailed insights in the perceived product characteristics and their contribution to consumer liking. Traditionally, sensory information is collected by the R&D department and liking information by the market research department. These two disciplines use very different methodologies and subjects to obtain this information. For the sensory information, experts or trained panellists are used and for the acceptance data consumers from the target population are used. The sensory professional in R&D is employed by the food company, for the collection of consumer preferences companies will use their own market research department or rely on outside market research agencies. In recent years, there has been an increasing interest in obtaining both sensory and hedonic information from the target consumers. Market researchers have been doing this for many years using the JAR methodologies. But when consumers can answer JAR questions about sensory characteristics, they should also be able to rate the perceived and ideal intensities directly. The Ideal Profile (IP) method combines both JAR and classical profiling methodology: consumers are requested to rate the perceived and ideal intensities for the relevant product characteristics and to give acceptance ratings. The resulting data are used to compute the effect of the difference from ideal for each individual attribute on overall liking and to guide R&D in product optimisation.

Keywords: *profiling, consumer, product optimisation*

1. INTRODUCTION

The success of a food product depends to a large extend on consumer liking: The higher the liking, the more successful the product. Most methodologies applied in product optimisation work from the implicit assumption of the existence of an "ideal" product. A key challenge in product development and optimisation is to modify and redefine the existing product closer to this ideal. A core assumption underlying this thinking is that consumer's loss in liking (A_p) of a product is a weighted linear combination of the absolute attribute level deviations from the ideal product. More formally this can be expressed as:

$$A_p = \sum_{j=1}^{n} b_j |\bar{X}_{p,j} - I_j|$$

where A_p is the consumer's loss in liking for product *p*, b_j is the relative importance of deviations on attribute *j* for consumer's overall liking judgment, X_{pj} is the consumer perception of product *p* on attribute *j*, and $\bar{I}_j$ is the ideal level of attribute *j* (averaged over all products of reference) that would generate maximum liking (Engel, Blackwell, & Miniard, 1995). When all attributes have the ideal level, $A_p = 0$, there is no loss in liking and liking is maximised: The larger the deviations from ideal, the higher the loss in liking and the lower the liking for that product.

The classical sensory approach is to obtain a sensory profile of the different products from trained assessors, to obtain liking ratings from target consumers and to find out which sensory aspects drive liking through regression modelling (Lawless & Heymann, 1999; Stone & Sidel, 2004; Meilgaard *et al.*, 2006; Greenhoff & MacFie**,** 1999) market research has a different approach to this problem: Just-About-Right (JAR) scaling. Since market research has no access to trained assessors, they have to extract the necessary information directly from consumers (Epler *et al*., 1997; Popper *et al*, 2004; Popper & Kroll, 2005; ASTM E-18, Moskowitz *et al*., 2004). In JAR scaling, consumers give a liking rating for a specific product and rate it on a series of sensory attributes. In contrast to standard sensory profiling, they do not simply state their perceived sensory intensity but make an assessment of the difference between their perceived sensory intensity and their ideal intensity for that aspect. For each sensory attribute, they indicate whether the intensity is "just about right", "too weak", or "too strong". From a psychological point of view, this is a complex task and the only output is the result of the mental arithmetic. This task could be made more explicit by asking the consumers to give both the perceived and ideal intensity instead of asking them the result of the subtraction. This is actually the procedure in Ideal Profiling (IP). Consumers rate the products on a set of relevant sensory attributes (both perceived and ideal intensity) and on hedonic aspects.

Comparison of sensory profiles from consumers and experts show that the results do not differ (Moskowitz, 1996; Husson *et al.*, 2001; Worch *et al*., 2009). The final recommendations for product improvement based on expert, consumer, or JAR profiles also suggest a high degree of convergent validity between the various methods in terms of the order of ideal points (van Trijp *et al*., 2007).

A number of alternative profiling methods have been developed in the past years which allow the use of naïve consumers. Most are based on the assumption that consumers should not be asked attribute questions and use ranking procedures with free choice profiling (Delarue & Sieffermann, 2004) or use "Napping®" (Pagès, 2005).

Since the results from these different methodologies lead to similar conclusions, the choice for one particular method can be made on practical grounds.

From a business point of view, presenting product developers with quantitative sensory and ideal profiles and information about the effect of deviations from ideal on liking is more efficient than showing them a product map or the results of a ranking. The IP method provides accurate sensory and ideal spider webs, drivers of liking and suggestions for optimisation, as will be shown in this paper with an example for eight different fruit yoghourts.

2. MATERIALS AND METHOD

2.1 Samples

The following eight commercially available fruit yoghourts have been tasted:

Raspberry/Peach	***Orange***
Fruit mix	Mandarin
Cherry/Orange	Maracuja
Mango	Dades

2.2 Consumers

A total of 130 consumers participated in the test, 78 females and 52 males. They ranged in age between 19 and 65 years (median age 42 years). All users fruit yoghurt, 49% is heavy user (several times a week) and 51% light user (at least once every two weeks). They have been recruited by telephone from the OP&P consumer database.

2.3 Questionnaire

The questionnaire consisted of six acceptance questions including overall liking (rated on the 9-point hedonic scale), buying intention (5-point scale) and 28 intensity questions (both perceived and ideal intensity has been asked on 100 mm line scales with anchors at 10% and 90%.).

Acceptance (9-point category scales)	*Intensity and ideal (100 mm line scales)*		
appearance	gloss	fruity taste	Thick in mouth
odour	colour intensity	freshness fruit	smooth in mouth
taste	amount fruit	sweetness	watery/thick
mouth feel	recogn. fruit	sourness	airy mouth feel
aftertaste	thick appearance.	bitterness	firmness fruit
overall liking	odour intensity	astringent	amount fruit mf
buying intention (5-p)	fruity odour	creamy taste	aftertaste intensity
	sweet odour	mild taste	aftertaste length
	sour odour	fresh taste	
	taste intensity	off taste	

The questionnaire has been administered by computer (EyeQuestion software, 2005).

2.4 Procedure

The consumers were invited to the sensory facility (a sixteen booth tasting room) on two consecutive days for two 60-minute sessions. They were paid for their participation. On each day, they tasted four of the eight variants. The variants were presented one after another at 12

minute intervals, according to a balanced presentation design (MacFie *et al.*, 1989). The participants received 125 gram of each variant in a plastic cup with plastic spoons. Between the presentations, they were advised to clean their palate using crackers and water.

2.5 Statistical analysis

The acceptance and intensity ratings for the different products were analysed by ANOVA (repeated measurements ANOVA, each subject has tasted all products) and LSD post hoc analysis. A significant product effect shows that the eight products are rated differently, the post hoc test shows which individual product differs from which other products. To see if there is an effect of gender, age class or cluster membership a factorial design with block-treatment confounding (split-plot design) has been carried out. The consumer panel has also been segmented on the basis of their liking ratings (Clustering around latent variables, Vigneau *et al.*, 2001).

For the multivariate analysis of the intensity ratings, a principal component analysis (PCA) on the correlation matrix for product × panellist with varimax rotation has been carried out. Liking is regressed on the extracted principal components (this method is also called Principal Component Regression). All analyses have been carried out using Senstools.NET (beta version, OP&P product research, 2009).

3. RESULTS

3.1 Acceptance aspects

Comparison of the overall liking ratings show that the eight variants differ significantly from each other (figure 1). Fruit mix and Cherry/Orange are liked most; Dades and Mango are liked least. There is no effect of user type (heavy or light users) or gender on overall liking but there is a significant effect of age class (consumers between 34-49 give higher ratings than the younger and older consumers, but there is no interaction with yoghourt). Furthermore, the consumers can be divided into two clusters of 85 and 45 consumers respectively with different liking patterns (figure 2).

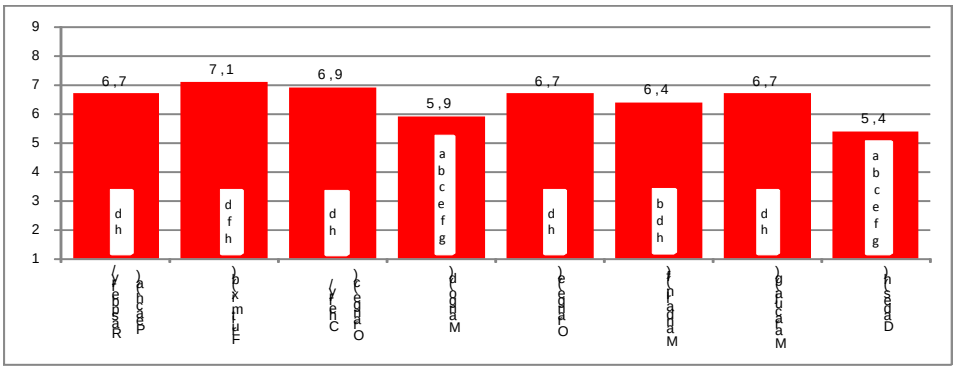

Figure 1: Overall liking for the different yoghurts and post hoc significances (LSD). The letters in a bar indicate from which other product this specific product differs significantly

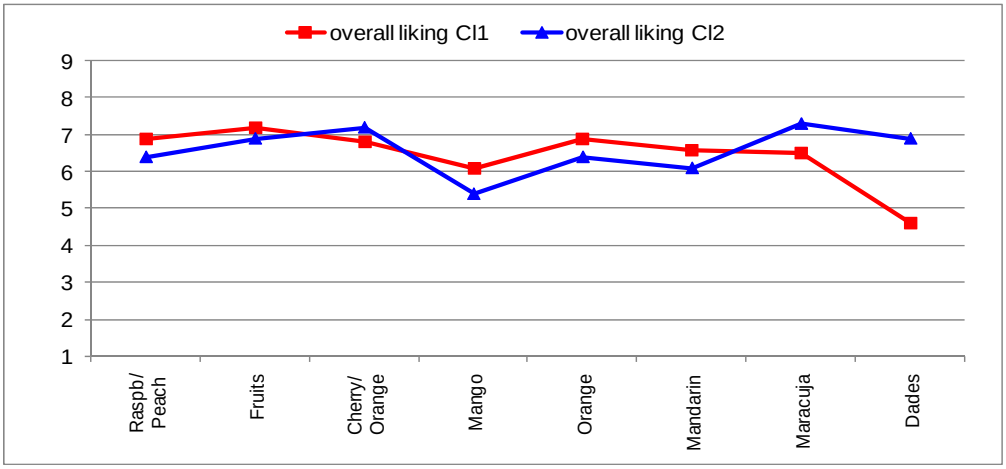

Figure 2: Overall liking for Cluster 1 (n = 85) and 2 (n = 45).

The two clusters differ mainly in their appreciation for the Dades yoghourt. Cluster 1 clearly dislikes Dades but Cluster 2 likes them. The clusters differ in usage frequency: Cluster 1 has more light users and Cluster 2 has more heavy users.

Besides overall liking, participants rated several other aspects on liking. Table 1 shows the averaged acceptance ratings (9-point scales) and buying intention (5-point scale).

Table 1: Average acceptance ratings and buying intention for the eight yoghourts

	Rasp/ Peach	*Fruit mix*	*Cherry/ Orange*	*Mango*	*Orange*	*Mandarin*	*Maracuja*	*Dades*
appearance	6,7	6,5	7,0	6,7	6,6	7,1	6,5	5,6
odour	6,6	6,6	6,7	6,4	6,8	7,1	6,4	5,9
taste	7,1	7,2	7,0	6,1	7,0	6,6	6,9	5,2
mouth feel	6,8	7,1	6,9	6,4	6,9	6,5	6,7	5,5
aftertaste	6,6	6,9	6,7	6,0	6,6	6,2	6,6	5,3
overall liking	6,7	7,1	6,9	5,9	6,7	6,4	6,7	5,4
buying	3,7	3,9	3,7	3,0	3,7	3,3	3,6	2,6

The eight yoghourts differ significantly from each other for every aspect.

3.2 Sensory and ideal profiles

The eight products differ significantly from each other at each aspect except sour odour. Table 2 presents the ANOVA results (F-ratio's and p-values).

Table 2: Results of the ANOVA for the intensity attributes (model main effects for product and subject without interaction)

	F-Ratios products	*p-values products*	*F-Ratios subjects*	*p-values subjects*
gloss	7.57	<.01	10.88	<.01
colour int.	67.20	<.01	4.94	<.01
amount fruit	22.99	<.01	5.03	<.01
recogn. fruit	25.56	<.01	5.75	<.01
thick app.	3.99	<.01	8.39	<.01
odour int.	10.93	<.01	7.38	<.01

fruity odour	18.66	<.01	6.05	<.01
sweet odour	3.76	<.01	9.59	<.01
sour odour	1.02	0.42	10.40	<.01
taste int.	14.45	<.01	7.62	<.01
fruity taste	19.09	<.01	5.01	<.01
freshness fruit	6.22	<.01	6.00	<.01
sweetness	35.85	<.01	5.44	<.01
sourness	12.03	<.01	6.51	<.01
bitterness	11.05	<.01	8.64	<.01
astringent	10.46	<.01	7.19	<.01
creamy taste	9.31	<.01	9.21	<.01
mild taste	3.93	<.01	6.88	<.01
fresh taste	18.82	<.01	6.90	<.01
off taste	5.32	<.01	8.70	<.01
thick in mouth	2.24	0.03	8.85	<.01
smooth in mouth	9.65	<.01	8.48	<.01
watery/thick	2.14	0.04	6.40	<.01
airy mouth feel	5.57	<.01	9.08	<.01
firmness fruit	24.71	<.01	4.02	<.01
amount fruit mf	11.77	<.01	6.35	<.01
int. aftert.	7.16	<.01	7.22	<.01
length aftert.	4.61	<.01	7.14	<.01

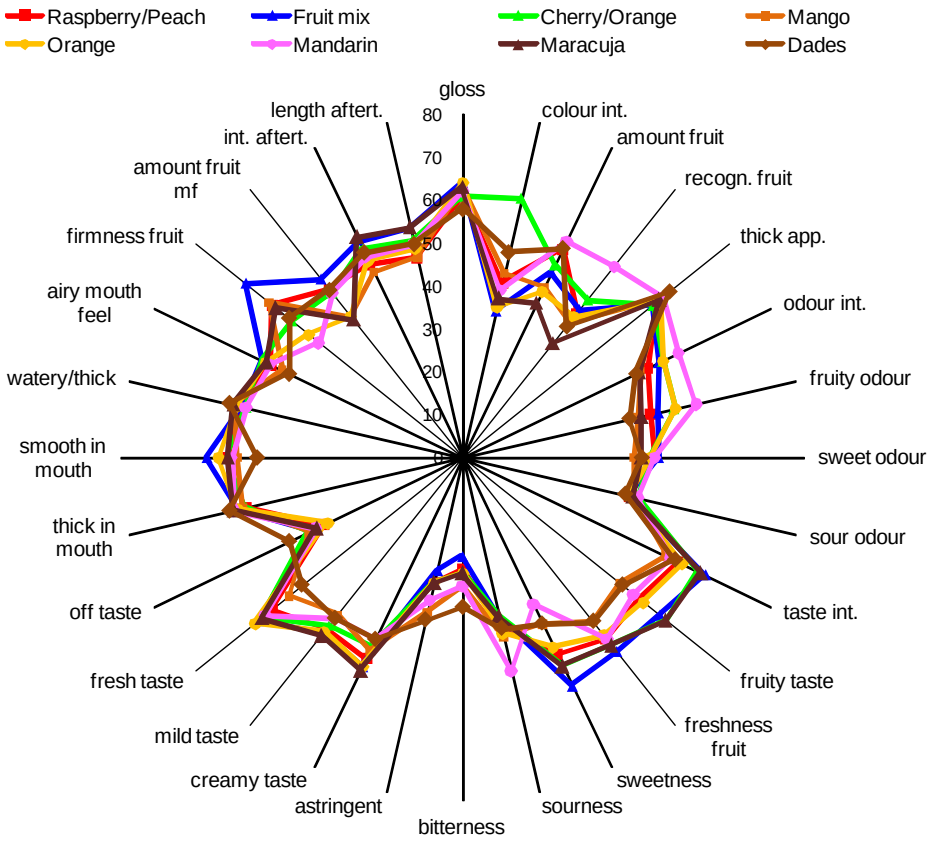

Figure 3: Sensory profiles of the eight variants (n=130)

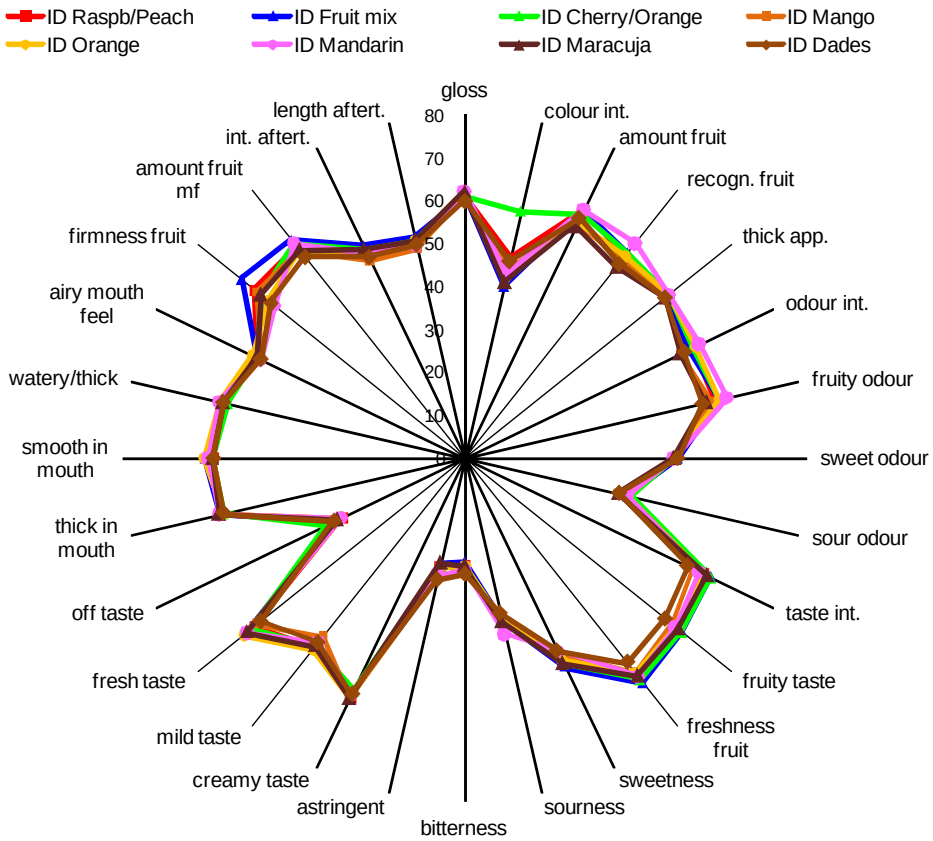

Figure 4: Ideal profiles of the eight variants (*n*=130)

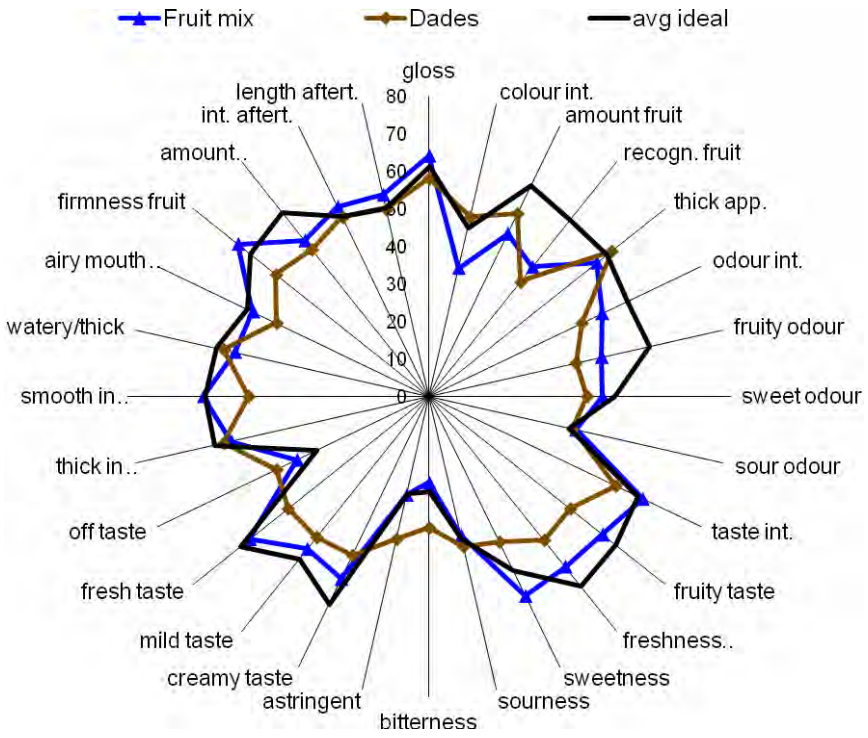

Figure 5: Sensory and average ideal profiles of Fruit mix (liking 7.1) and Dates (liking 5.4) *n* = 130.

Comparison of the sensory and ideal profiles of the most liked and least liked variant shows that they clearly differ in their deviation from ideal (figure 5). They both lack recognisable fruit, Fruit mix lacks more fruit than Dades, both lack fruity odour and taste, odour intensity and the fruit lacks freshness (more so for Dades). Fruit mix is ideal on the basic tastes, Dades clearly deviates from ideal on these aspects. Dades has too much off taste and it lacks mildness and freshness and the mouth feel lacks smoothness and airiness.

4. DRIVERS OF LIKING

First, a PCA is carried out to extract the underlying sensory dimensions (PCA on the product × consumer × attributes matrix with varimax rotation). The 28 sensory attributes can be summarised into the following eight underlying factors or dimensions (67% variance accounted for).

Table 2: Extracted factors

F1 Fruity/fresh	***F3 Thickness***	***F6 Smooth/mild***
fruity taste	watery/thick	smooth in mouth
taste int.	thick in mouth	airy mouth feel
freshness fruit	thick app.	mild taste
firmness fruit	creamy taste	fresh taste
sweetness	**F4 Odour aspects**	gloss
F2 Fruit aspects	fruity odour	**F7 Aftertaste**
amount fruit	odour int.	length aftert.
recogn. fruit	sweet odour	int. aftert.
amount fruit mf	**F5 Bitter/off taste**	**F8 Sourness**
colour int.	off taste	sourness
	bitterness	sour odour
	astringent	

Since the analysis has been carried out on the product × consumer matrix we can also estimate the amount of variance which is explained by differences between the products and which can be attributed to differences between consumers. Table 3 shows the ratio between the product and consumer variance for each dimension.

Table 3: Variance ratio by dimension

	Variance between products	*Variance between consumers*	*Ratio*
F1 Fruity/fresh	24.6	2.8	8.2
F2 Fruit aspects	17.6	3.0	5.87
F3 Thickness	5.7	4.3	1.32
F4 Odour aspects	11.9	3.8	3.16
F5 Bitter/off taste	7.4	4.7	1.55
F6 Smooth/mild	4.5	4.3	1.05
F7 Aftertaste	3.4	4.0	0.85
F8 Sourness	6.9	4.3	1.59

For most dimensions, the variance explained is mainly due to product differences and not to subject differences.

Regression of liking on the factor scores (with backward deletion) shows that liking can be explained by seven of the eight factors (multiple correlation coefficient 0,63). Figure 7 shows the standardised beta weights.

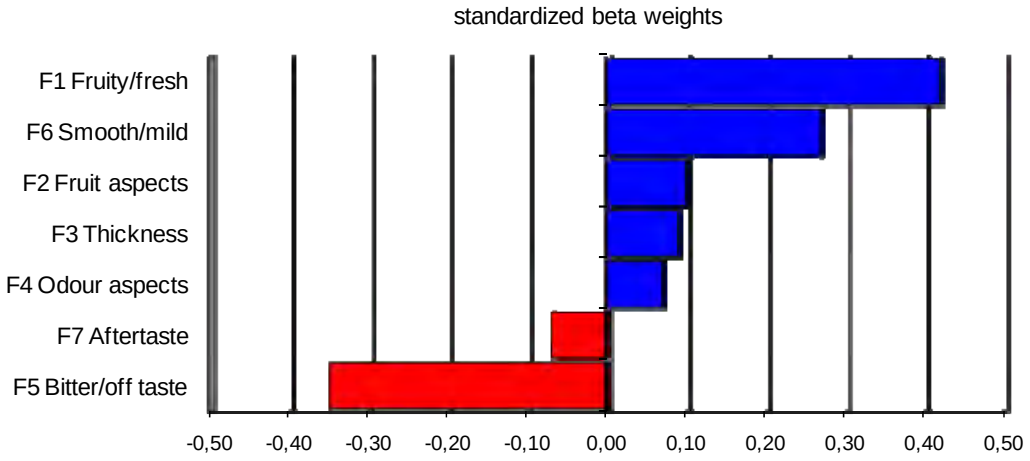

Figure 6: Standardised regression weights (standardised beta) for the significant factors (blue bars contribute positively to liking and red bars negatively).

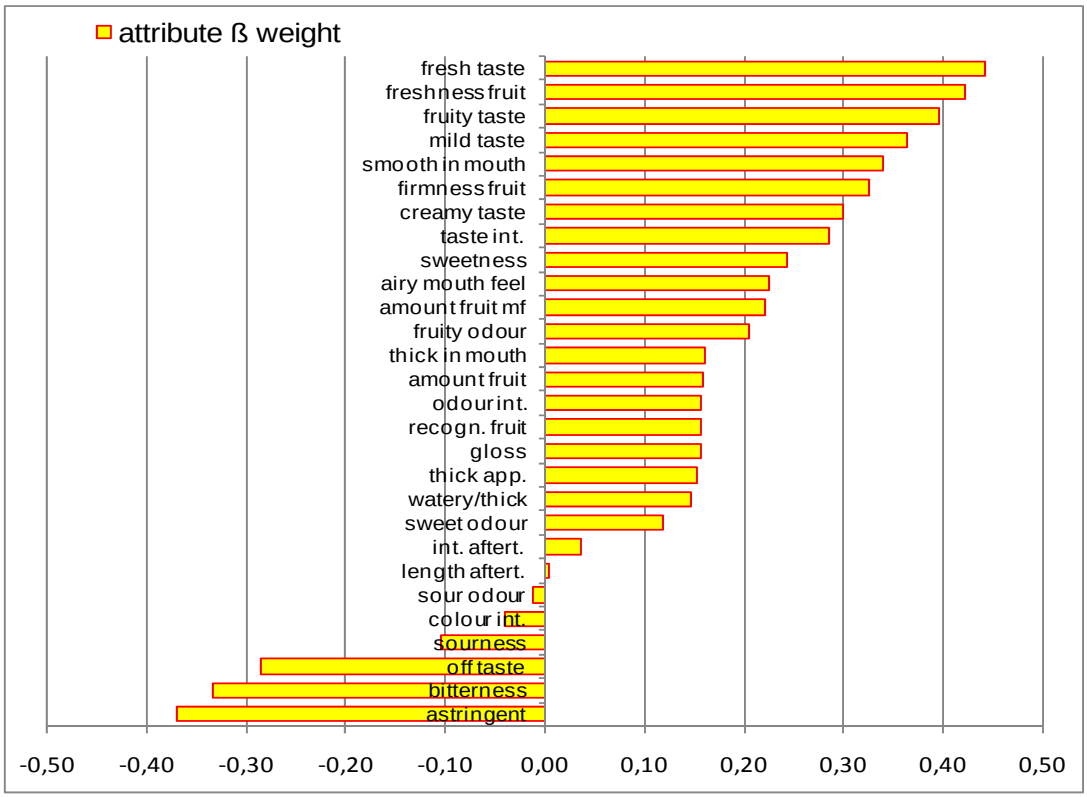

Figure 7: Attribute beta weights (standardised).

To obtain the "attribute beta weights," the factor loadings for each attribute within a factor have been multiplied with the standardised beta weight and the resulting values have been summed for each attribute. Figure 7 shows these values.

The values indicate the relative contribution to overall liking for that specific attribute. Here, it appears that the "fresh" attributes have the largest positive contribution to overall liking. On the other side, astringent is equally important, but contributes strongly to disliking (strong negative contribution). In the final step, the deviations from ideal are weighted by these attribute betas and the impact on liking when the specific attribute would be ideal is computed.

5. OPTIMISATION

For each attribute, the relative effect on overall liking is computed provided that this attribute would be rated ideal (the assumption is that liking will be rated 9 on the 9-point scale when the product is ideal).

The final result is presented as a fishbone plot in which the potential increase in overall liking and the deviations from ideal are shown. Only attributes which show a relative improvement of 2% or more are shown in the plot, the attributes are ordered according to the improvement (attributes on the right have the highest impact).

Figure 8 shows the results for Fruit mix. The yellow bars show the potential increase in liking if that attribute would be ideal (in percentages, left axis) and the red diamonds show the absolute deviations from ideal (right axis).

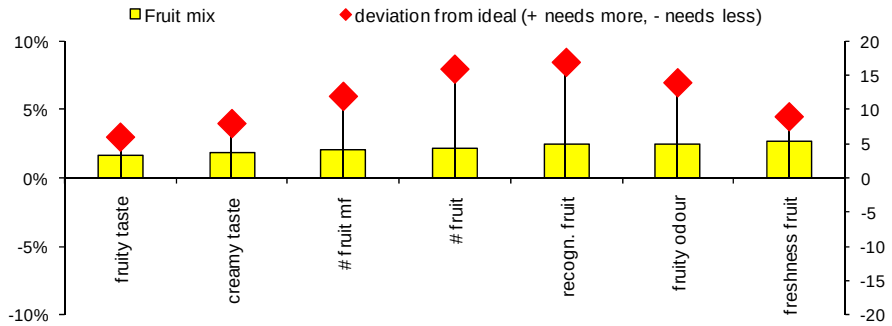

Figure 8: Optimisation or fishbone plot for Fruit mix.

Since Fruit mix already has a high liking rating (7.1) there is little room for improvement. Increasing the freshness and making the fruit more recognisable and increasing amount of fruit will increase liking (Note that the increase in liking is not directly related to the amount of change: for recognisable fruit, the deviation is larger than for freshness Fruit, but the possible gain in liking for freshness is higher than that for recognisable Fruit, not every deviation is equally important).

For the Dades variant more improvements are needed. As can be seen on the right side of the graph, increasing fresh and fruity taste and decreasing astringency have a large effect on liking. Increasing creamy and smooth mouth feel and decreasing bitterness and off taste also will improve liking.

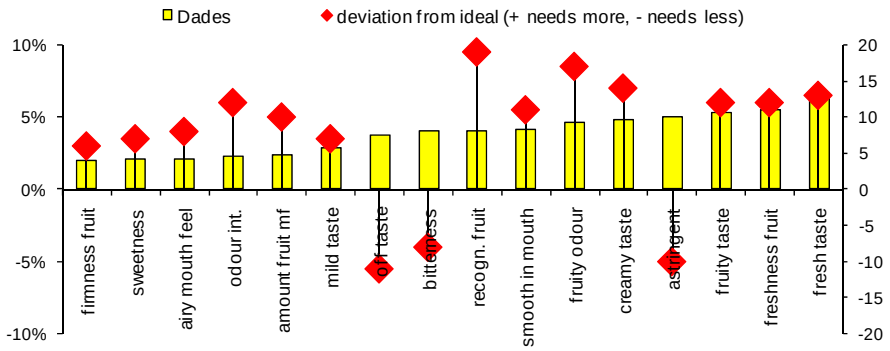

Figure 9: Optimisation or fishbone plot for Dades.

6. DISCUSSION AND CONCLUSIONS

Compared to the classical procedure (expert panel for the sensory profile and consumers for liking) the IP method is faster and more efficient because all information is obtained in one test. The final results are the fishbone plots which show for each attribute how much it deviates from ideal and the relative effect on liking when it would be made ideal. In contrast to expert panels, consumers do not use a specific language and cannot tell R&D which ingredient is missing. The final translation has to be made by the expert. For the translation of the results, a knowledgeable researcher is indispensible. Identical conclusions with respect to all methods of product improvement were reached by van Trijp *et al*. (2007): "…….*the results therefore show that statistical criteria only are an inadequate basis to decide on product adjustment or not and that this criterion needs to be complemented by managerial judgment as to whether the deviation from ideal is large enough to justify product adjustment..*" and with respect to JAR scaling by Popper (2004): "….*Nevertheless,* JAR *scales in the hands of knowledgeable researchers and along with the appropriate analysis can do a just-about-right job* ….".

Compared to the JAR procedure, flash profiling and napping, the IP method provides more detailed information. It shows not only how the different products are perceived (the sensory profiles), but also the ideal profiles and it shows estimates of the effect on overall liking when an attribute would become ideal.

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APPENDIX

The average intensity and ideal rating are shown in table 4 and 5

Table 4: Average intensity ratings for the different products:

	Raspberry/Peach	*Fruits*	*Cherry/ Orange*	*Mango*	*Orange*	*Mandarin*	*Maracuja*	*Dades*
gloss	61	64	61	63	64	62	63	58
colour int.	42	35	62	44	36	40	38	49
amount fruit	54	48	50	44	43	56	40	54
recogn. fruit	43	44	47	40	42	57	34	39
thick app.	58	57	57	60	59	60	59	62
odour int.	48	51	52	46	52	56	46	45
fruity odour	45	47	51	42	51	56	43	40
sweet odour	45	46	44	40	44	45	42	42
sour odour	40	40	42	41	40	42	41	39
taste int.	56	63	61	53	57	54	62	55
fruity taste	53	59	61	47	54	51	61	48
freshness fruit	54	58	56	49	53	54	56	49
sweetness	51	59	54	43	49	38	54	43
sourness	40	38	38	43	42	51	38	41
bitterness	26	23	27	30	27	30	27	35
astringent	30	27	30	37	30	34	30	39
creamy taste	52	54	49	50	54	47	55	47
mild taste	51	52	50	47	52	48	53	48
fresh taste	57	61	60	52	62	59	60	48
off taste	36	39	40	40	35	38	38	45
thick in mouth	52	54	52	53	54	55	55	56
smooth in mouth	55	60	55	53	57	54	55	48
watery/thick	53	53	52	55	54	52	55	56
airy mouth feel	50	52	52	47	51	50	51	45
firmness fruit	57	65	51	58	46	43	56	52
amount fruit mf	50	53	49	42	42	49	41	50
int. aftert.	50	56	54	48	51	52	57	53
length aftert.	48	55	52	48	50	51	55	51

Table 5: Average ideal ratings for the different products.

	Raspberry/Peach	*Fruits*	*Cherry/Orange*	*Mango*	*Orange*	*Mandarin*	*Maracuja*	*Dades*
ID gloss	61	61	61	61	62	62	62	60
ID colour	48	41	59	45	43	44	42	47
ID amount fruit app.	64	64	63	61	61	64	60	62
ID recogn fruit	60	61	61	59	60	64	57	58
ID thick app	61	60	61	60	61	61	60	60
ID odour int	59	58	59	56	60	61	56	57
ID fruity odour	60	61	61	59	61	63	58	57
ID sweet odour	49	50	49	49	49	49	49	50
ID sour odour	38	39	40	37	39	39	37	37
ID taste	62	64	64	59	62	61	63	58
ID fruity taste	64	65	65	62	63	63	64	60
ID freshness fruit	65	67	66	64	64	65	65	61
ID sweet taste	51	54	53	50	52	50	53	50
ID sour taste	38	39	39	38	39	42	39	37
ID bitterness	25	24	25	26	25	26	25	27

ID astringent	26	25	26	28	26	28	25	29
ID creamy taste	62	62	60	62	62	61	62	61
ID mild taste	56	56	56	53	57	55	56	55
ID fresh taste	63	66	64	62	66	65	65	61
ID off taste	32	34	36	33	32	32	33	34
ID thick mf	59	59	58	58	58	59	59	58
ID smooth mf	59	61	59	59	61	60	59	59
ID watery/thick	58	58	57	58	59	59	58	58
ID airy mf	54	54	54	53	55	53	54	53
ID firmness fruit	63	67	61	62	59	57	61	58
ID amount fruit mf	63	65	64	62	62	64	62	60
ID int aftert.	53	55	54	51	53	53	54	52
ID aftert	51	53	52	50	52	51	52	51

CONSUMER PREFERENCES FOR VISUALLY PRESENTED MEALS

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Abstract

The aim of the present study was to develop methods to model preferences at the individual—or even contextual—level. Such model may increase the explanatory power of the data and thereby be a stronger tool for understanding the consumer variation, the contextual variation and the cultural variation. A better understanding of these variations may replace the concept of "best product" by a portfolio of good products and give input to new product development. As the study object we applied ready meals, the appearance of such products being very important for our choices of convenient food products. A conjoint layout using 32 pictures as a 2^5 design was constructed: Collation (modern/traditional), Meat cutting (medallions or pieces), Vegetables (wok or root fruits), Herbs (with or without), and Sauce (with or without). A Total of 880 consumers were interviewed in three different towns in Denmark and at two different stores. The method of scoring the pictures makes it possible to analyse the results as an analysis of variance (ANOVA). The statistical analyses showed that is it possible to estimate the variability of preferences according to the five different aspects in the conjoint layout and furthermore to estimate trade-offs between different aspects. Finally, the analyses indicated the amount and type of products in a product portfolio.

Keywords: conjoint layout, analysis of variance, multilevel models, product portfolio

1. INTRODUCTION

The overall aim of the study was to investigate consumer preference for the appearance of a meal in a situation of buying convenience food. These products are sold at a rather low and stagnant rate in Denmark compared to, for example, the rest of Europe where they are sold at a high and increasing rate. The meals can be targeted at various consumer groups.

When we buy a ready meal, the appearance is very important for our choice. However, the knowledge of how the plates should be arranged is scarce and mainly empirical. The preferred appearance may depend on geographical location, gender, age, and many other factors. This knowledge can be used in product development and in the design of the meal according to consumer groups: The busy high income family who do not have time to cook themselves, but still want some well tasting food; the singles who do not want to cook for themselves; the family with children who do not have time to cook in everyday life etc.

However, often it is in practice impossible to connect preferences to segments and one has to consider the distribution of preferences in the targeted market to decide the characteristic of products, price level of products and marketing strategies.

Visually based preferences

Visual surveys are an inexpensive and quick method for assessing preferences and the potential of these surveys have expanded with recent computer and visually based techniques in fields such as consumer preference research, convenience meal development, package labelling, and advertising.

Visual surveys are increasingly being applied to methods such as discrete choice analysis (Louviere, Hensher, Swait, & Adamowicz, 2000; Train, 2003), which is used to predict preferences for goods or services according to choices made between distinct alternatives with varying attributes.

A conjoint design can be used to determine the value placed on attributes by having respondents choose between strategically included alternatives characterised by a limited number of different attributes, each at levels, which are evenly distributed between the alternatives (*i.e.*, orthogonal design). In conjoint design, it is assumed that choice is governed by the maximisation of preferences for the attributes (Moskowitz & Silcher, 2006). The use of conjoint design in a discrete choice analysis makes it possible to determine the value placed on attributes through decomposition of the choices and trade-offs made between alternatives. The validity and discriminatory power of using visual surveys instead of real products has previously been established for conjoint design in the sense that there is no difference between preferences of food products determined by choices made between pictures versus tangible food products (Jaeger, Hedderley, & MacFie, 2001). However, it is important that alternatives investigated are realistic. Consequently, meal attributes should be well known, well-liked, properly organised, and appear palatable to respondents. Despite this, most visual surveys investigate relatively few distinct attributes. A visual survey based on multiple combinations of attributes might vastly reduce effort and costs associated with investigating various attributes. Furthermore, visually-based choices can be rapidly made and used to infer preferences and thereby help improve food product development and institutional food services. In the present study, the meals seemed to closely resemble each other, but were in fact strategically organised with varying attributes as based on a conjoint design

Since visual working memory has a limited capacity and the perceptual workload of our task was high, it was deemed very unlikely that the results would be based on either short-term working memory or long-term visual memory between sessions. Rather, choices were more likely to be based on subjects' previous meal experience (Humphreys & Bruce, 1991; Repovs & Baddeley, 2006). Hence, we investigated the reliability of the method by conducting the experiment twice.

2. MATERIALS AND METHODS

The investigation was carried out by means of a computerised questionnaire in shopping centres in three middle-sized Danish towns: Amager, a suburban part of the Danish capital, Copenhagen; Naestved, a town situated on the isle of Zealand about 75 km from Copenhagen; and Kolding, situated on the peninsula of Jutland about 225 km from the Danish capital.

The sample comprised 880 respondents, 542 women and 338 men, who completed the questionnaire. Respondents were recruited in shopping centres on location, adjacent to supermarkets of interest for the investigator Bilka a relatively large and cheap supermarket (three stores), and "Irma," a small supermarket with a reputation for high-quality food (two stores).

The program was written in microsoft access and functioned interactively, forcing the respondents to pick their choice to any question posed by pressing the key marker on one of the displayed response options. Consequently, the respondents were allowed progression onto the next question that appeared on the interface once the former question had been answered and registered in the computer database.

The program was divided into a pictorial part, which was followed by the regular questionnaire that included a total of 26 questions that focused mainly on geographic, demographic, sociological and lifestyle variables. The 32 photos were divided into four series, and each series of eight photos were displayed on the screen. The series each consisted of eight unique pictures of randomised food dishes. For each screen display, respondents were instructed to pick their most preferred choice, second most preferred choice and least preferred choice, respectively, from eight pictorial variations of a meal presented in randomised series (blocks). Having pressed the key marker, the most preferred image was removed from the display, and similarly, for the second most preferred choice. When the respondent had selected the least preferred image of the displayed series, the sequence was terminated, and the screen display shifted with emergence of a new series of another eight photos until all of the series had been displayed.

Figure 1 displays the first of four series that respondents were presented within the program. The screen display thus consisted of a 3 × 3 array in which the questions were posed in the centre square. In order to obtain an indication of respondents' degree of overall liking of the visually presented stimuli, they were asked to rate two images that were diametrically opposed to each other with respect to variations of the component. We chose the first photo randomly from a pile of images and subsequently paired it with its opposite. In this way the majority of meal components used in the experiment was subjected to a hedonic evaluation. We used a hedonic 5-point scale, with values ranking from "like very much the look of the meal" to "don't like the look of the meal at all".

Figure 1: One of four series consisting of eight photos.

2.1 Meal Components

The five meal components and their corresponding levels (in brackets) were defined in the following way:

Dish: modern or traditional level; this component denotes the mode of presentation.

Vegetable mix: root mix or wok mix.

Meat: slices or pieces of tenderloin pork; this component represents the carving of the meat.

Sauce: dishes with or without sauce.

Herbs: dishes with or without parsley.

When selecting the stimuli we were cautious to meet popular Danish choices of meat, vegetable mixes, and sauce, this insured that the stimuli reflected Danish cultural aspects. Moreover, the energy contents and constitution of macronutrients of the meals largely were in accordance with guidelines from Nordic Nutrition Recommendations, NORDEN 2004.

Three base ingredients were used for all photos: tenderloin pork, potatoes (either white and cooked, or fried, brown boats) and vegetables.

Dish was presented in a modern and traditional collation, respectively. The former was defined as a dish with fried potato boats, and glasses were used if the component sauce was present. For the component variant meat in pieces, the meat pieces were arranged on spears

and whole leaves of parsley were used. The traditional dish was arranged with cooked white potatoes and the sauce was arranged in a small puddle, and the parsley had been chopped and poured over the potatoes. Two different *vegetable mixes* were used; root mix and wok mix.

Regarding *meat*, the pork tenderloins were cut in 1-cm-thick pieces and weighed 50 g on average. The smaller pieces of meat were approximately 1 × 1 cm in size, weighing 10 g on average. The slices were fried for 4 min. and the pieces for 3 min, respectively. Averages of 10 g of virgin olive oil were used for each pan. The meal components, *sauce* (whisky sauce) and *herbs* (parsley), varied in the series by being either present or absent. The dishes were arranged placing the vegetables on the plate approximately between 6:00 and 10:00 a.m., the potatoes approximately between p.m., and the meat covering the rest of the plate.

2.2 Experimental design

The applied design was a 2^5 conjoint layout combining a balanced block design and an incomplete ranking test. In this factorial design, 2^5 = 32 photos were allocated into four blocks (fractionals, series) of eight, so that each level of each of the five meal components appeared equally often on the screen, and at various positions. The same layout was repeated for all respondents. Thus, the main and two-way effects were balanced with respect to the block, thereby enabling estimation of the main effects and two-way interaction effects of the meal components, irrespectively of the block on the individual level as well as on the aggregate level. The variable position described the position of the items in the 3 × 3 array used for all blocks.

2.3 Data Analyses

The study presented a conjoint layout and was analysed by analysis of variance (ANOVA). The position of the photos on the screen influenced respondents' choices and the effect has been corrected for as "design" variables. Likewise, respondents were shown only eight photos at a time, which resulted in a series effect that has also been corrected for. Age and gender were regarded most important variables, and effects related to these variables have been corrected for in the analyses of data as categorical variables (factors) in the analysis.

The five treatment factors (meal components) may be represented as dummies X^C ~ the factor dish, 0 = traditional and 1 = modem; X^V ~ vegetable mix, 0 = wok mix of vegetables and 1 = root mix of vegetables; X^M ~ meat. 0 = tenderloin meat in pieces and 1 = tenderloin slices; X^S ~ sauce, 0 = without sauce and 1 = with sauce; X^H ~ herb, 0 = without herbs and 1 = with herbs.

The 32 photos consisted of the 32 combinations of the five factors and may be indexed by *i, j, k, l, m*. We defined a factor Block (*B: b* = 1,2,3,4) allocating the 32 photos to the four blocks *b* = *b*(i, *j, k, l, m*) indicating to which of the four blocks a photo belonged.

D_{ijklm} was a dummy indicating the position of the photo (on the screen): 0 = lower right comer, 1 = upper left comer, including the diagonal. For convenience, *position* has been

reduced to a two-level "design" factor (level 1 ~ position 1, 2, 3, 4 and 6; and level 2 ~ position 5, 7 and 8) because more than 95% of the variation between the eight positions was explained by these two levels. As such, the core of the analysis of variance model—with only main actions—looked like this:

$$E(Y_{ijklms}) = \mu + \gamma_b^B + \delta D_{ijklm} + \beta_C X_i^C + \beta_V X_j^V + \beta_M X_k^M + \beta_S X_l^S + \beta_H X_m^H$$

in which $E(Y_{ijklms})$ denoted the expected response of subject s to photo *i, j, k, l, m* corrected for the effect of photos displayed and the effect of the block. The 32 photos were the explanatory variables/factors. To fit a model to all the data, each of the 32 photos must have a response. Thus, the method used had to take into account the photos not chosen, representative of "missing values" in this context.

The values for the hedonic scores within a block were: 2, 1, 0 and –1, where 2 represented the score of the most preferred choice, 1 represented the score of the second most preferred choice and –1 represented the score of the least preferred choice. Finally, 0 represented the score of each of the five images of a block with no mutual ranking. To calculate the main effect of a factor, the difference between the means of the 16 scores on each of the two factor levels was used as the sufficient statistic. As the blocks are orthogonal to the (treatment) factors, this calculation could be performed across blocks.

Because of the central limit theorem, therefore, the sufficient statistics for each subject are approximately normal. Calculating means across subjects would make the approximation to normality even better. Furthermore, the sum of scores for a specific factor level is the fraction of times this level is present in the most preferred photo with weight 2 plus the fraction of times this level is present in the second most preferred photo with weight 1 plus the fraction of times this level is present in the least preferred photo with weight 1. This means that although the scores are (incomplete) ranks, the sufficient statistics are means of weighted ranks (or smoothed ranks). By using the ranks as scores one theoretical difficulty arose: for each subject and each block the rating or scores of the eight photos comprising the block are given by the numbers 2, 1, 0, 0, 0, 0, 0, –1. Thus, the mean of the scores in each block is 0.25 and thereby the mean of the 32 scores given by a subject is also 0.25 (and the grand mean of the 32 scores given by the 768 subjects is also 0.25).

Furthermore, for each subject and each block the SSQ is $(2 - 0.25)^2 + (1 - 0.25)^2 + 5 \times (0 - 0.25)^2 + (-1 - 0.25)^2 = 5.5$. For each subject, therefore, we have the total SSQ = 4 × 5.5 = 22.

This means that the grand mean is fixed (and no degrees of freedom are used to estimate it). Furthermore, the total SSQ is fixed being number of subjects × 22 = 768 × 22 = 16,896. Thus, the data can be considered as standardised, having for each respondent the same mean (equal to 0.25) and the same SSQ (equal to 22). This implied that from a theoretical point of view the usual *F*-test in the ANOVA is not valid. However, the numerator is still chi-square distributed and the usual *F*-test should have been replaced by a chi-square test. As the number of degrees

of freedom in the denominator in the present case is large, the chi-square test and the *F*-test are approximately equal and therefore. We use the *F*-test as usual.

3. RESULTS AND DISCUSSION

Data can be analysed at different levels. Table 2 shows the result of the analyses of variance at the aggregated level, assuming, that respondents are randomly drawn from a homogeneous population. The most important meal component is *Dish* and in general the modern collation is preferred. This means that the "mean respondent" prefers modern collation just a little bit over traditional collation, however, the variation of preferences is very high and therefore very few respondents are close to "the mean consumer." The meal component *Dish* account for only 6 % of the total variation of the preferences. If the other four meal components are included in the analyses the explanatory power increases to R^2 = 7.2 %. Including all order interactions makes the explanatory power increases to 8.3 %, Table 2.

The remaining variation, 91.7 %, is what is sometimes called the biological variation – variation of consumer preferences – and with a remaining biological variation as big 91.7 % it has hardly any meaning to talk about a mean consumer.

Table 2: Main effects – Aggregated level.

Source of Variation	*Most preferred*	*Sum of Squares*	*p*
Main effects			
Collation	Modern collation	997.1	< 0.0001
Vegetables	Wok-like vegetables	21.7	< 0.0001
Meat	Meat in Pieces	11.3	< 0.0001
Sauce	With sauce	27.0	< 0.0001
Herbs	With herbs	133.5	< 0.0001
R^2 = 7.2 %			
Main effects + all order interactions			
R^2 = 8.3 %			

To reduce the biological variation we can try to segment the consumers according to, for example, gender, age, etc. The idea of segmenting is that the consumers are clustered into "groups" (*i.e.*, segments) and that within segments the consumers are considered as a random sample from a homogeneous population and the variation is due to differences between segments. The effect of segmenting after different factors is shown in Table 3. It is seen that segmenting the consumers increase the explanatory power of the model to at most 10 % of the total variation.

Table 3: Main effects – Segmented.

Model	R^2
Main effects at aggregate level	7.2 %
Main effects segmented by gender	7.5 %
Main effects segmented by gender and age	8.7 %
Main effects segmented by gender and age and geography	8.8 %
Main effects segmented by gender and age and geography and …	~ 9.5 %

At the individual level we can estimate the main effects of the meal component of each individual. As the number of respondents is high we can illustrate the distribution of each of the main effects - illustrating the unexplained individual variation. The explanatory power of main effects estimated at the individual level is R^2 = 45.8 %.

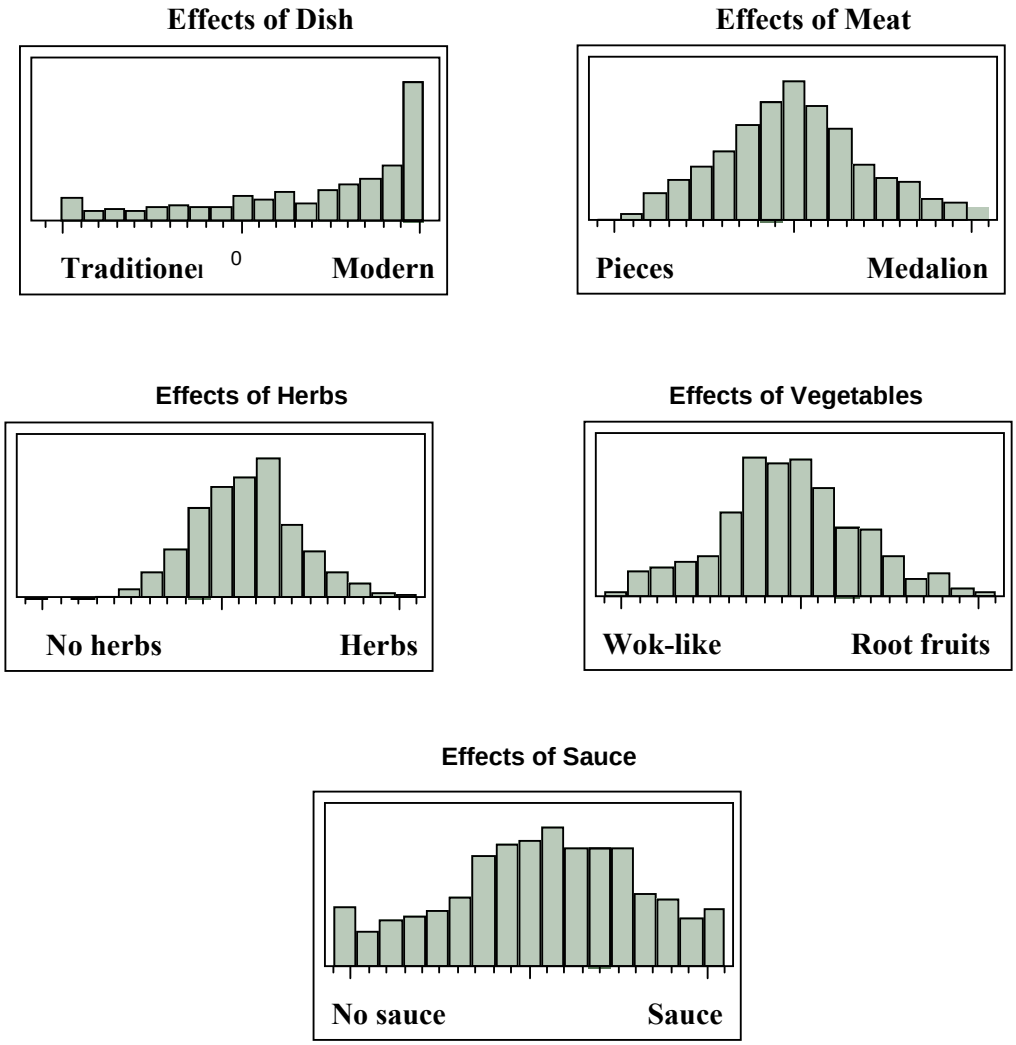

Figure 4: Main effects of meal components.

Figure 4 shows the distribution of the estimated main effects for the five meal components *Dish, Meat, Herbs, Vegetables and Sauce.* The variability of all of the meal components is large: it does not seem possible to produce a ready meal which satisfies all consumer preference concerning the five meal components. The meal component with the most interesting distribution of preferences is *Dish*, where many consumers prefer *Modern* collation; however, there is a long tail of preference towards *Traditional*. The preference of *meat* is concentrated in the middle of the distribution meaning that most people have no preferences concerning the meat being in *pieces* or *medallion*. Also the distribution of preference of *Herbs* is concentrated a little towards *Herbs,* and there is no outspoken preference for *any Herbs.*

Many consumers have no outspoken preferences concerning *Vegetables*, however, there are consumers who prefers *Wok-like* and consumers who prefers *Root fruits*. The distribution of the preference of *Sauce* is heavy tailed in both ends, meaning that there are many consumers who prefer *sauce* and there are many consumers who prefer *no sauce.* Therefore, it is not possible to develop a ready meal satisfying all consumers and an approach in that direction will result in a product satisfying the "mean consumer:" "what fits everybody fits none". One way of approaching this problem is to segment the consumers. However, as seen from Table 3 the segmenting factors do not reduce the variations very much, which means that we have a variation which is not explainable by the usual factors (*e.g.*, lifestyle). A solution, therefore, is to develop a portfolio of products each product satisfying some consumers and hope that consumers can find the products themselves.

One way the consumers segment themselves is by the store where they choose to shop. The distributions of preferences of Dish segmented into costumers in Bilka and IRMAS, respectively, is shown in Figure 5, where it is seen that consumers in IRMA concerning preferences on *Dish* is rather concentrated on *Modern* being homogeneous whereas the costumers in Bilka is more heterogeneous.

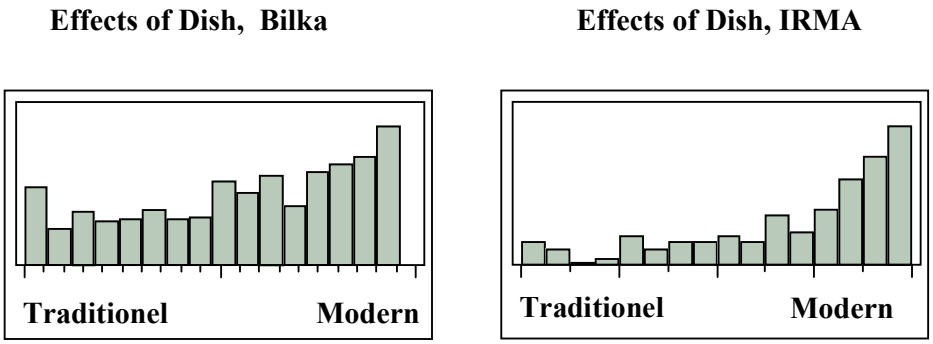

Figure 5: Effect of Dish segmented after store.

4. CONCLUSION

From a methodological point of view in market research it is important to distinguish between measurements error, market variation, and biological variation. The purpose of a market research is to explore variations of "preferences," and, if possible, to determine sources of variation of preferences. The sources of variation may be related to, for example, lifestyle, culture and family but may also be contextual: "we do not eat the same every day." The market research should involve both product variation and biological variation and make it possible to measure, model and compare both types of variations. One way to achieve this is to use a conjoint layout; it can include many objects attributes (meal components) many consumer attributes (gender, lifestyle etc.) and by use of a reasonable design it is possible to separate different kinds of variation. Furthermore, data can be analysed at different levels

(individual level, family-level, neighbourhood level, country level) such that the variations can be attributed to the right level. Often it is appropriate to determine preferences by asking respondent to choose between objects (*e.g.*, discrete choice, best / worth). In these cases it is often reasonable, if possible, to replace respondent's choices by respondent's scores of objects. Furthermore, it is important that the research can be performed cheap and fast. Often it is possible to use the internet, and to determine the preference for visually presented objects/meals or one can use Hall-test.

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OBSERVATIONAL RESEARCH: A TOOL FOR COLLECTING BEHAVIORAL DATA AND VALIDATING SURVEYS

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Abstract

Observational research is an underused technique that involves the direct observation of people in a natural setting or in surroundings that closely resemble a natural situation. This differentiates it from survey research which may be completed in almost any location. Observational techniques can be an effective method for collecting behavioural data and for validating information we obtain from individual surveys. It measures behaviour directly, rather than reports of behaviour or intentions. Thus, observational research is a direct approach to collecting data, as contrasted to a survey where people are asked what they do or would do in different situations, and we assume that they reported actual behaviours. In our studies we use observational research for many purposes including designing better surveys by knowing what choices need to be put on the questionnaire. Additionally, we use "casual observation" to assist us in developing a "formal" observation process where the observer will know what types of behaviours to watch for and how they should be recorded. In addition, behavioural research also allows for the flexibility of recording things that were seen but were not expected. Examples of using observational research in recent studies such as watching for specific food safety behaviours as people prepared a meat dish in their own kitchen and research where observational data was used to validate diet surveys will be presented. The reliability of the observations can be increased by training observers, practicing recording observations and reaching agreement between the observers during the training.

Key words: observational research; survey validation

1. INTRODUCTION

Consumer research is conducted to obtain many types of information including preference, liking, attitudinal, and behavioural information. Behavioural information, such as what people eat, how they store or prepare food, how they use particularly products, and other types of data often are collected with surveys.

Research methods, such as surveys, that rely on self-reported data are valuable in many situations. However, for behavioural data, self-reported information may be biased and show incorrect information because there can be a substantial difference between what people say they do and what they actually do. In addition, people forget what they do, people tend to answer with what is considered appropriate, and people tend to say what they think the

interviewer would like to hear (Herzog, 1996). Because self-reported data essentially are second hand information and relevant behaviour is not being observed directly by the researcher, the accuracy of the data may be questionable (Herzog, 1996; Pike & Agnew, 1991).

Taylor-Powell and Steele (1996) state that direct observation is a valuable and underused technique for collecting data. In addition, those authors point out that observational data can take various forms from simple check-lists and counting to complex anthropological and sociological methods. Moskowitz, Beckley, and Resurreccion (2006) suggested that observational research is the most common form of research in many fields, but it only recently has become popular in food and product research. Lee and Broderick (2007) state that technology can revolutionise observational research through such techniques as video, internet, tracking, and neuroimaging.

2. OBJECTIVES OF OBSERVATIONAL RESEARCH

Observational research can be used to achieve many objectives. It can be used to:

- Understand what the product or service means in the lives of consumers
- Learn how a product actually is used
- Uncover in-use motivations
- Uncover unmet needs
- Understand selection and purchase behaviour
- Document real benefits in-use
- Understand the category
- Assess actions in various situations

Observational research is the careful, planned, systematic watching, with attention to detail, of various types of phenomena in order to learn new facts or test theories. Notice that this definition is, in fact, virtually identical to that of any type of research.

3. OBSERVATIONAL RESEARCH ADVANTAGES

Direct observation methodology has two potential advantages over self-report and anecdotal methods: observation captures actual behaviour and behaviour is captured in context (Gittelsohn *et al.*, 1997). Redmond and Griffith (2003) suggest, "*Observational studies provide a more realistic indication of the food hygiene practices actually used in domestic food preparation.*" Thus, direct observation research is believed to yield valid and reliable information upon which to base educational efforts, or decisions regarding acceptance of new items.

Observational data are best used when you need direct information to determine who people are, what people actually are doing, when trying to understand on-going behaviour or process such as how people prepare certain types of foods or interact with various product types, when physical evidence needs to be observed such as how products turned out when they

were made or how much food people left on the plate, and when other types of data collection are incapable of capturing the data needed such as eating patterns or shopping behaviour (Taylor-Powell & Steele, 1996).

Observational data is essential when people cannot accurately give information. Chambers, Godwin, and Vecchio (2000) and Godwin and Chambers (2003) noted in studies of dietary intake that people cannot estimate what never went into memory in the first place. Thus, in those situations, alternative methods, including observational research, may be necessary to track how much people actually eat.

Similarly, in a recent study on food storage habits that we conducted (unpublished data), we asked people what the temperature was in their home refrigerator. More than half the respondents had no idea what the temperature was and another fourth of the respondents indicated they were guessing. In addition, many people did not have a thermometer in their refrigerator so even asking them to check the temperature would be impossible. To obtain that type of information, in home observation, where thermometers can be placed in the refrigerator and temperatures tracked is necessary.

4. EXAMPLES OF STUDIES CONDUCTED USING OBSERVATIONAL RESEARCH

Anderson *et al*. (2004) assessed food-handling practices during food preparation in the home and compared them with Fight-BAC recommendations. Before conducting a similar study at Tennessee State University (Godwin, Chen, & Kilonzo-Nthenge, 2009), we used observational research during the preliminary phases of the study to assist with development of structured check sheets for use during the actual research project.

The accuracy with which people report what and how much they eat during dietary recalls was investigated by Godwin, Chambers, and Cleveland (2004) in a study comparing recall to actual consumption. In general, people were able to recall the foods they ate, but they did not do as well estimating how much they ate. In fact, some people gave estimates that were off by more than 50%. In that case, observational data showed that the methods used for portion size estimation of food were inadequate and needed further development.

Shopping behaviour was examined by Sinha and Uniyal (2005). Those authors found that observational data provided some similar segmentation of shoppers as did attitudinal or psychographic surveys, but additional segments were noted in the observational research. They suggested that this type of research could augment other methods and could provide needed practical information that could be used by retailers.

5. COLLECTION OF OBSERVATIONAL DATA

Observational data can take many forms including information about the people, the physical environment, ways of functioning, timing, amounts, behaviours, and reactions among other things. Some of these types of data may be able to be measured quantitatively such as

temperatures in refrigerators, amounts of food eaten, numbers of people or objects, or time in shopping. Other information may need to be measured semi-quantitatively, such as approximate ages of people, relative time people spend in lines or eating a particular food on a plate, and estimates of amounts eaten. Still other information is qualitative in nature including observations of people's reactions to products or services, ways in which people do things, or clarity of explanations.

A key aspect of observational research is the requirement that the measurement be observable. While this seems like an obvious aspect, the number of studies that indicate observation of attitudes or liking is surprising. While it is possible to make inferences about those aspects they generally are not observed phenomena. For example, a researcher decides that asking about liking is too direct and instead decides to watch people as they eat at a buffet. Based on eating patterns of various people at the buffet, the researcher concludes that green salad is a well liked food. Unfortunately, the researcher fails to consider other explanations for why salad was selected so frequently (habits, customs, health aspects, other options at the buffet). The researcher infers liking when, in fact, many people selected the salad not because they liked it, but because it was not disliked and they chose it for other reasons.

6. ISSUES ASSOCIATED WITH OBSERVATION

Observational research is not without problems. As with any type of research, a clear objective is essential. Knowing the information that is needed and careful planning together that information is essential. Observation is only as good as the consumers that you target to observe and the behaviours or other targeted information that is noted. Selecting the wrong set of consumers has the same problems as with any consumer research, a lack of ability to project the results to a larger population. Observing the wrong things results in the same issues as asking the wrong questions in a survey, and results in the inability to meet the objectives of the study.

Unfortunately, biases are a well-known possibility in observational research and have resulted in it sometimes being treated as unreliable. Grimes and Shulz (2002) state that "*selection bias, information bias, and confounding are present to some degree in all observational research*." However, those authors go on to state that such biases can be overcome and may have little effect on the information gathered. Considering they were discussing medical research, where the potential for incorrect information truly can be a matter of life and death, the idea that bias is not a reason for eliminating observational research from the repertory of research techniques is an important concept.

Biases often are thought to be personal, that is to say noting behaviours through a screen based on personal beliefs; perception vs. reality, where the behaviour is observed to be one thing when, in fact, it is another; or objective *vs.* subjective, where interpretation (*e.g.* motives

for purchasing) is necessary to the observation. All of those biases are potentially real, but can be reduced with training.

A commonly forgotten aspect of direct observation is the time required to observe the phenomenon. Godwin *et al.* (2007) reported on the direct observation of food storage habits for ready to eat foods in 210 respondent homes. To collect the observational data, five researchers spent more than 1000 hours in travel and interview time, in addition to the time required to analyse the large volume of data. A survey of 210 people would require much less time, but would not result in the same quality of data.

Myllyluoma and Buck (2009) found that there was excellent inter-observer reliability when single quantitative variables had to be assessed, but there was less reliability when noting "multiple complex features" or when semi-quantitative estimates were reported. This may suggest that observers should attempt to track fewer details or that more training of observers is important.

7. TRAINING OF OBSERVERS

Careful and thorough training of the observer(s) is critical for the success of observational research; however it can also introduce bias into the observations if not designed correctly. Explaining the purpose of the research, and taking the observer through the issues that need to be explored during the observation are critical components of the training process. Taylor-Powell and Steele (1996) state that training and practice are essential for standardisation of observation. Further, they suggest that observers must be trained to look for the same information, record data similarly, and use similar vocabulary and meanings. Training in observation and the use of field notes can help observers become more consistent within themselves and among other observers. The development and use of checklists or other simplified observational data collection tools can help to standardise observation, but the overuse of such systems can result in losing the spontaneous, unique information that can be provided by observational research.

8. ANALYSING AND INTERPRETING DATA

Although recognised as a valid method for obtaining data, the interpretation of the data must be completed with some caution. Other than the obvious potential biases of people knowing they are being watched, it is essential that the analysis of the data used unbiased procedures whether those analyses are qualitative or qualitative.

Myllyluoma and Buck (2009) used various estimates of inter-reliability depending on the data that was collected. Scarsellone (1998) suggested that typical reliability estimates were inadequate and proposed using generalisability theory as an appropriate framework for evaluation.

9. CONCLUSIONS

Observational research provides an alternative to surveys and other types of consumer research that can enhance the information we gather about products and services. In some cases observational research is the only way to collect valid data. Because observational research is subject to potential biases it is essential that training be provided to those who will collect the data and that the analysis and interpretation of the data be considered carefully.

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Part 2: Food choice and consumer behaviour studies

HEDONIC RESPONSE TO THE TASTES OF WINE IN VIETNAM: DOES THE REGION OF ORIGIN OF CONSUMERS MATTER?

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Abstract

Recent surveys showed that the consumption per capita of sugar in Vietnam is higher in the South than in the North. Do these different food habits lead to differences in liking for a new food or beverage? To address this question, a consumer test was conducted in Hochiminh city in the South and Hanoi in the North of Vietnam. In the two cities, consumers evaluated three series of red wine. In the first series, fructose was added to a base wine to manipulate sweetness. In the second series, sourness was manipulated by adding tartaric acid into the base wine. In the last series, bitterness and sweetness were manipulated by adding quinine and fructose into the base wine. Results suggest that "frequency of consumption" matters more than "city of origin." Our initial hypothesis that people from Hochiminh city (South) might like wine to be sweeter than people from Hanoi (North) did not hold. In contrast, our results suggest that bitterness liking might be somewhat affected by city of origin and gender. However further work is needed to confirm this last point.

Keywords: Vietnam, tastes, food habits, wine, liking.

1. INTRODUCTION

Consumer's hedonic responses to tastes depend generally on environment except for sweetness for which the liking may be innate (Beauchamp, Cowart, & Schmidt, 1991). Environment concerns notably the effect of exposure and the familiarity of the tastes (*e.g.* ; Bertino & Chan, 1986; Moskowitz *et al*., 1975; Prescott *et al*., 1992; Prescott & Khu, 1995; Laing *et al*., 1994). For instance, Japanese consumers tend to give higher hedonic responses to umami taste than Australians ones do, because this taste is much more familiar in Japan than in Australia (Prescott *et al*., 1992). Differences in hedonic responses seem thus to exist between consumers having differential food habits.

Consumers from the South and the North of Vietnam appear to have differential food habits (Figure 1). For example, surveys of the Centre for International Economics of Canberra and Sydney (2003) and General Statistics Office of Vietnam (2006) reported that the consumption per capita of sugar in the South of Vietnam (including Mekong river delta and the South-East) was higher than in the North of Vietnam (including the Red river delta, the North-East and the North-West). Yet, there is little scientific understanding of how hedonic responses to a taste component might vary across these two regions. The answer to this question is important for

professionals who want to formulate a food for Vietnamese consumers from both the South and the North, especially for consumers from the biggest cities of these two regions: Hochiminh city and Hanoi.

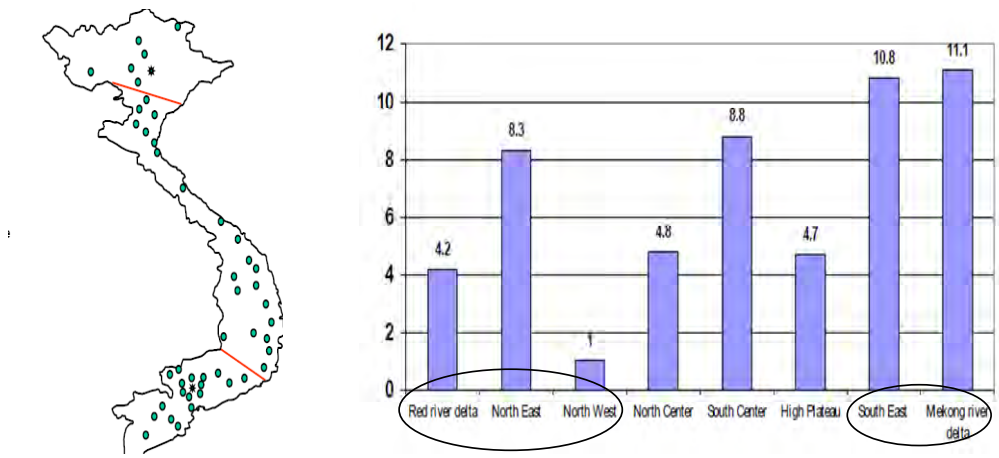


Figure 1: Average consumption of sugar by ecological regions in g/capita/day (General Statistics Office of Vietnam, 2006).

As sugar consumption is higher in Hochiminh than in Hanoi, consumers from Hochiminh are more exposed to sweetness than consumers from Hanoi. Does that lead to a differential liking for sweet foods? It is difficult to address this question within the context of a familiar food for which people have already strong existing expectations. For this reason, our study was performed with wine, a non-familiar drink in Vietnam (*cf.* Do, Patris, & Valentin, 2007). We hypothesise that consumers from Hochiminh city appreciate sweet wines better than consumers from Hanoi. To verify this hypothesis, two experiments were carried out. The first experiment permitted us to select a base wine. In the second experiment, we added sweet, sour and bitter tastants into the base wine to evaluate the difference of appreciation between consumers from Hochiminh city and Hanoi.

2. EXPERIMENT 1: SELECTION OF THE BASE WINE

The objective of this experiment was to select a base wine having little overall in-mouth intensity.

2.1 Material and methods

Participants. Nine staff members from the national university of Hanoi (four women, five men, average age: 31.3) were trained during three two-hour sessions. During the training sessions, the panellists performed the following tasks:

- Identify sweetness, sourness, bitterness, astringency alcohol and overall in-mouth taste in water and wine mixtures.
- Rank the perceived intensity of the solutions and wine samples for each of the above mentioned sensory attributes.

- Rate the sweetness, sourness, bitterness, astringency and alcohol of wine samples using a six-point scale (0 = absence of the sensation, 1 = very weak, 2 = weak; 3 = in the middle, 4 = strong and 5 = very strong).

Stimuli. We first chose two Vietnamese wines that we judged, *a priori*, having a neutral overall in-mouth taste. They were both red wines from the Dalat wine company, Vietnam. The first wine was made exclusively from cardinal grapes. Cardinal is a variety of table grape that Vietnamese producers often use to produce wine. The second wine was made exclusively from syrah grapes. Syrah is a worldwide popular variety of grape which has been recently imported in Vietnam from Australia. Both wines were produced using the same technology.

Procedure. During the final evaluation, the nine trained panellists rated respectively the sweetness, the sourness, the bitterness, the astringency and the alcoholic sensation of each candidate wine using six-point scales going from 0 (absence of the sensation) to 5 (very strong).

2.2 Results and discussion

The mean intensity rating of each sensory attribute (sweetness, sourness, bitterness, astringency and alcohol sensation) is shown Figure 2. Five bilateral student *t*-tests were conducted to compare the intensity of the two wines in sweetness, sourness, bitterness, astringency and alcohol sensation.

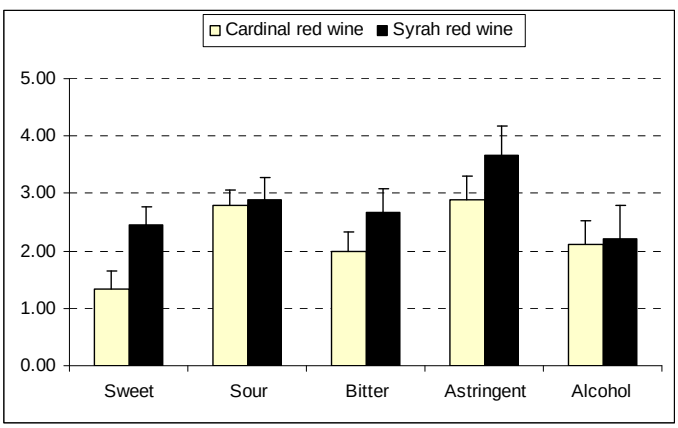


Figure 2: Mean intensity of each sensory attribute obtained from the rating given by nine panellists. Bars represent confidence interval at 95%

Results showed a significant difference between the two wines for sweetness, $t(8) = -4.6$, $p<.01$), for bitterness, $t(8) = -2.83$, $p < .05$) and for astringency, $t(8) = -2.68$, $p < .05$) but no significant difference for sourness and alcohol sensation. The cardinal wine was judged less sweet, less bitter and less astringent than the syrah wine. By consequence, we selected the cardinal wine as the base wine for experiment 2. This base wine contained no residual sugar, 3.98 g/l tartaric acid, and 11.8 v/v ethanol, according to information given by its producer.

3. EXPERIMENT 2: CONSUMER TEST

3.1 Material and methods

Participants. The experiment was conducted in Hochiminh city in the South and Hanoi in the North of Vietnam. A total of 211 consumers were recruited in the two cities; all of them were volunteers. The recruitment was performed using the snowball method. First, five frequent wine consumers and five non-frequent wine consumers from different ages were recruited in each city. The five frequent consumers declared drinking wine more than two times per month and the five non-frequent consumers up to two times per month. Then these ten volunteers from Hochiminh city and ten volunteers from Hanoi were in charge of asking people of their age at their work places to participate to the experiment. In both cities, the proportion of men and women was roughly equal. Details about participants can be found in Table 1.

Table 1: Characteristics of the consumer test participants in Ho Chi Minh City (HCMC) in the south and Hanoi in the north. Frequent consumers (FC) declared drinking wine twice per month or more; non frequent consumers (NFC) declared drinking wine less than twice per month.

HCMC	Mean age	Women	Men	N	Hanoi	Mean age	Women	Men	N
NFC	26.5	32	30	64	NFC	29.4	24	18	42
NFC	32.2	20	24	44	FC	30.6	29	32	61
TOTAL	*28.6*	*52*	*54*	*108*	*TOTAL*	*29.9*	*53*	*50*	*103*

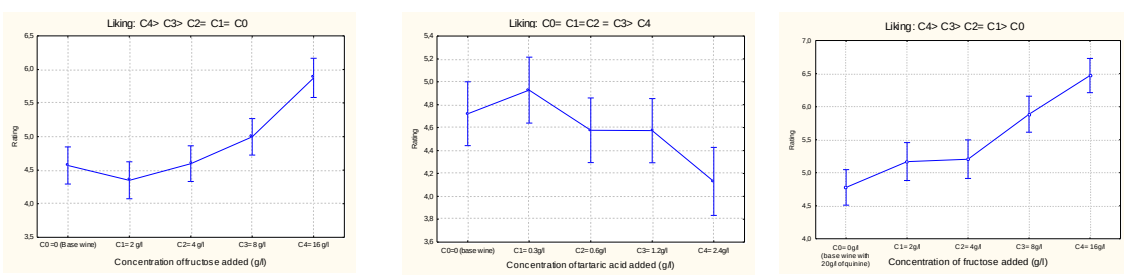
Stimuli. The stimuli were made from the base wine selected in Experiment 1. To limit bias due to between-bottles effect, before each session of the consumer test, the base wine was obtained by mixture of all bottles needed for the preparation. Then, fructose, tartaric acid and quinine (Rectapur, France) were added into the base wine to obtain three series of wine. The first series (A) included the base wine (C_0) and four samples of the same wine in which four concentrations of fructose C_1 = 2 g/l and C_2 = 4 g/l and C_3 = 8 g/l and C_4 = 16 g/l were respectively added to manipulate sweetness. In the second series (B), sourness was manipulated by adding tartaric acid into the base wine (C_0) at four concentrations C_1 = 0.3 g/l and C_2 = 0.6 g/l and C_3 = 1.2 g/l and C_4 = 2.4 g/l, respectively. The last series (C) included the base wine boosted in bitterness by addition of 20 mg/l of quinine and four samples of the same wine with sweetness manipulated like in series A. Concentration steps were determined by preliminary triangular tests performed on ten wine consumers to ensure that the difference between two consecutive concentrations was perceived by more than 70% of the participants. The preparation was carried out 24 h before the consumer test. Prepared samples were stored at 21°C, temperature of the tasting room.

Procedure. Consumers were requested not to smoke or eat and drink for 1 h prior to the consumer test. The wines were served 15 min before the consumer test. Each sample contained 20 ml of wine in a 40-ml plastic cup. During the consumer test, the 15 samples of wine were tested. The samples of each series were presented in a randomised order. To separate the two series of sweetened wines (A and C), the series A was presented first, then the series B and the series C at last. The test was conducted in separate booths in 21°C air-conditioned rooms, under the day light. Participants were requested to rate their liking for each sample of wine using a nine-point scale going from "I totally dislike it" to "I like it very much." They could swallow or spit out the wines at their convenience but they had to rinse their mouth between each sample with water and crackers.

3.2 Results and discussion

Our main hypothesis was that the appreciation of consumers from Hochiminh city and from Hanoi differs according to the concentration in tastants. To verify this hypothesis, three two-way ANOVAs with "city of origin" as a between-subject factor and "concentration in tastant" as a within-subject factor were carried out, one ANOVA for each series of wine. Contrary to our hypothesis, none of the ANOVAs showed a significant interaction "city of origin" × "concentration in tastant" at the 5% level. The only significant effect observed at this level was a main effect of "wines" for each series.

In the series A (Figure 3, left panel), the appreciation increased with the sweetness, $F_{(4, 836)} = 32.67$, $p < .001$). The LSD test showed the order of the preference given to each concentration of fructose added was $C_4 > C_3 > C_2 = C_1 = C0$. In the series B (Figure 3, middle panel), the appreciation decreased with sourness, $F_{(4, 836)} = 7.53$, $p < .0001$). The LSD test showed the order of the preference given to each concentration of tartaric acid added was $C_0 = C_1 = C_2 = C_3 > C_4$. In the series C (Figure 3, right panel), the appreciation increased with the sweetness, $F_{(4, 836)} = 38.15$; $p < .0001$). The LSD test showed the order of the preference given to each concentration of fructose added was $C_4 > C_3 > C_2 = C_1 > C_0$.



Figures 3: Effect of "wine" ($p < 0.001$) on hedonic responses to the series A, B and C respectively.

Bars represent confidence interval at 95%

To better understand the appreciation of the consumers we carried out a Principal Component Analysis (PCA) with the 211 "participants" as individuals and the 15 "wines" as active variables. The "city of origin," "gender," and "frequency of consumption" were projected as

nominal illustrative variables. Only the first two factors of the PCA having an eigen-value higher than 1 were taken into account for interpretation (Figure 4). The first principal component, which explains 36% of total variance, is positively correlated with all the variables. This dimension opposes participants who tended to like the wines to participants who tended to dislike them. This dimension seems to be linked to the frequency of consumption. Consumers who liked the wines the best tend to be the most frequent consumers. The second dimension, which explains 10% of the variance opposes participants who tended to prefer the series C (wines boosted in quinine) over the series A (wines not boosted in quinine) to participants who tended to prefer the series A over the series C. This dimension seems to be somewhat linked with the participant's "city of origin" and "gender". Participants from Hochiminh city (South) and women tended to prefer the bitter sweetened wines (series C) over the sweetened wines (series A). Inversely, participants from Hanoi (North) and men tended to prefer the sweetened wines (series A) over the bitter sweetened wines (series C).

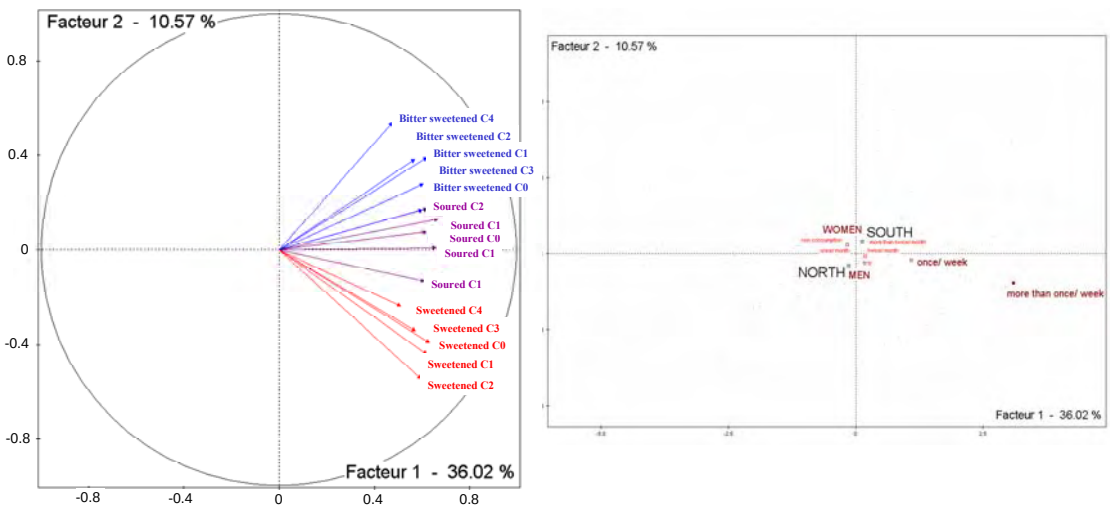


Figure 4: Factors 1 and 2 of the PCA

4. CONCLUSION

All together our results, suggest that the "frequency of consumption" matters more than the "city of origin" of the participants. Our initial hypothesis that participants from Hochiminh city (South) might like wine to be sweeter than participants from Hanoi (North) is thus not confirmed. In contrast, our results suggest that there might be a difference in bitterness liking between Hochiminh city and Hanoi, and also between male and female consumers. However further work is needed to confirm this trend. From an applied point of view, this experiment suggests that when professionals formulate a wine for the Vietnamese market, they should take into account the "frequency of consumption" of the consumers that they want to target.

Acknowledgment. *We would like to express our special thank to Dalat wine company for giving us the wines used in this experiment.*

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COFFEE OR MARGARITA: IMPACT OF AMBIENCES ON BEVERAGE CHOICES IN A BAR.

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Abstract

Two approaches are classically used to perform consumer tests: "central location" tests favouring experimental condition control or "at home" tests favouring ecological validity. We describe an alternative approach (based on immersion combining both approaches) which was implemented to study beverage consumption in bars. In a cultural manifestation, two pub-like ambiences were created with a few pieces of furniture: A traditional pub ambiance with raw wood furniture and yellow lights and a modern ambience with blue translucent furniture. In both ambiences, five video clips evoking different warmth levels were displayed successively and participants had to choose what they would like to drink among a drink list. Hot drinks were predominantly chosen when watching a clip depicting icebergs; Mexican drinks were predominantly chosen when watching a clip depicting a desert, probably because of the South-American style music that accompanied it. The three abstract clips (red, white and blue on a black background) also impacted the drink choices but in a less extent.

Keywords: consumer test, context, drink choice, bar

1. INTRODUCTION

Hedonic tests are widely used in the food industry to get insight into consumers' preferences and identify the products that will perform best on the market. However, consumer tests still need further developments. The difficulty of consumers' testing originates from an inherent contradiction: the objective is to gain information regarding the products whereas their appreciation is context dependant by nature. Food behaviour is determine or influence by numerous factors related to 1) consumers (physiologic, socio-economic or cultural factors), 2) intrinsic properties (organoleptic characteristics) as well as extrinsic properties (origin, nutritional claims, convenience, price, etc.) of products, and 3) contexts of consumption (Rozin & Tuorila, 1993). For instance, the same food product will be more appreciated in a restaurant than in a student cafeteria (Meiselman, Johnson, Reeve, & Crouch, 2000). Food acceptability is related to food accessibility, time of consumption, eating location, social interactions, and ambience (for a review, see Stroebele & de Castro, 2006). However, the actual impact of these factors is not completely elicited and the effect of a given factor on a specific food is still difficult to predict (King *et al*., 2007).

For consumers testing, two approaches are classically used: central location tests (CLT) and at home tests (ATH). CLT are run in a sensory room to standardise the contextual parameters; the experimental conditions are strictly controlled to insure that all products are evaluated in comparable ways. ATH favour ecological validity by allowing consumers to use or consume products as usual. But then, experiential conditions may vary considerably from one product to another decreasing the validity of products comparison. The few studies comparing CLT and ATH did not demonstrate any superiority of one approach over the other (Boutrolle, Arranz, Rogeaux, & Delarue, 2005; Bouterolle *et al*., 2007). An alternative approach to carry consumers' tests would consist in evoking a contextual situation in a controlled set up as suggested by Köster (2003, 2009). This would combine advantages of both CLT and ATH by insuring ecological validity of the tests through the evocation of a situation but still insuring comparison among products by controlling testing conditions. However, an efficient evocation may not be easy to implement. Petit and Sieffermann (2007) set up a sensory room with some contextual element such as pictures, odour, and music to evoke a "warm ambiance." But, the appreciation of drinks tested in this situation was not different from appreciation of drinks tested in a classic sensory room. This lack of effect may come from the fact that a situation is not only a set of elements, but rather reflects the meaning that consumers associate to the overall set up (Köster, 2009). A situation of consumption is related to a specific pattern of elements including the food, the time of the day, the location, the social environment, the activities in which consumers are involved, the mental processes (emotions) and the recurrence of the episode (Bisogni *et al*., 2007). All these elements have to be taken into account to evoke efficiently a situation of consumption.

The objective of the present study was to explore whether a consumption situation could be evoked using contextual elements. We implemented this idea to study beverage consumption in bars. We carried out the experiment during a cultural manifestation to match the appropriate activities (going out with friends), the time of the day (evening), and the recurrence (special occasion) of the situation. Two bars were materialised using a few pieces of furniture. We manipulated the ambiance of the bars (traditional vs. modern) through the furniture material (wood vs. plastic) and the lights (orange vs. blue). In each bar the warmth of the ambiance was modified through short video-clips projected in the room. People were allowed to participate with their friends and settle down at the same table. They received a drink list offering a large choice of drinks comparable to what can be found in bars and their task was to indicate which drink they feel like to drink for each ambiance. We hypothesised that modification of the ambiance would lead to different choices from the participants.

2. MATERIAL AND METHODS

2.1 Participants

Individuals who attended a cultural manifestation dedicated to beer on the campus at the University of Bourgogne took part in this experiment. They were allowed to attend both or

only one of the two experimental bars; a majority of them attended both bars. Overall 92 and 82 participants completed the questionnaires in the traditional and modern bars respectively.

2.2 Material

Five video-clips combining video and music were specifically designed for this experiment. Two figurative videos were chosen to evoke two contrasted ambiences: icebergs slowly drifting in the sea and a road in a desert landscape. Three abstract videos pictured moving coloured shapes on a black background. These videos were selected from a set of 20 videos on the basis of their perceived warmth assessed by a group of about 30 students on a 10-point scale anchored with cold at the left end and warm at the right end. The three selected videos were white, blue, and red coloured leading to different levels of warmth from the coldest (white) to the warmest (red). The same approach was adopted to select music from an array of specifically composed tunes. Videos-clips combined videos and music according to their warmth level and their tempo, especially for abstract videos were shapes move at a specific pace. The duration of video-clips was from 1.5 to 2 min each.

2.3 Experimental setup

Two bars were settled in two adjacent rooms. In each room, one wall was white and was used as a screen to project video-clips. The other walls were draped with black curtains and the room was kept in dim light. A few pieces of furniture: three tables each surrounded by three bar stools and a small counter, were dispatched in the room to evoke a bar. In one room, the bar and tables were made from raw wood. Orange lights displayed on each table and on the counter created a “traditional” ambiance. In the other room, the bar and tables were made from a white translucent plastic material retro-lighted with blue light providing a rather “modern” ambiance. The five video-clips associating video and music were displayed in loop in the bar in a fix and predetermined sequence: blue, desert, white, iceberg, and red.

Participants who entered one of the bars where welcomed by an attendant, who explained the task, provided them with the questionnaire and settled them down at a table. Participants were also offered a drink to drink during their stay in the bar. This was aimed at enhancing the situation by reproducing actual activity in a bar (*i.e.*, having a drink). Participants were offered either a glass of orange juice or of non-alcoholic beer, as they wished.

Participants were instructed to wait for the beginning of the next video clip, to take a moment to enjoy the ambiance and then fill out the questionnaire. First, they were asked to choose among a drink list (Figure 1) what they would like to drink at the moment. Second, they were asked to assess the ambiance of the bar on 10-point scales regarding overall appreciation (from disagreeable to agreeable), warmth (from cold to warm), arousal (from calm/relaxed to excited/stressed) and harmony of the ambiance (from not harmonious to very harmonious). Participants performed the same task (choosing a drink in the list and assessing the ambiance) for each of the five clips consecutively.

Hot drinks	**Fruit juices**	**Cocktails**
☐ Coffee	☐ Orange juice	☐ Bloody Mary
☐ Déca coffee	☐ Grappefruit juice	☐ Electric Blue
☐ Tea	☐ Pineapple juice	☐ Margarita
☐ Hot chocolate	☐ Grappe juice	☐ Pina Colada
	☐ Apple juice	
Water & Soft drinks		
☐ Still water	**Beers**	**Alcohols**
☐ Perrier	☐ Heineken	☐ Whisky
☐ Coke	☐ Desperado	☐ Vodka
☐ Diet coke	☐ Leffe blonde	☐ Gin
☐ Seven up	☐ Leffe brune	☐ Cognac
☐ Ice tea	☐ Hogaarden blanche	
☐ Schweppes	☐ Kreik	
☐ Orangina	☐ Chimay rouge	
	☐ Guiness	

Figure 1: drink list.

2.1 Data analysis

Ambiance ratings were converted into scores from 1 to 10. Liking, warmth, arousal, and harmony scores were submitted to 3-ways ANOVA (furniture, clips, participants (in furniture)). Whenever a furniture × video-clip interaction was observed, *t*-tests were performed to compare the two furniture types for each video-clip. Drink choices were assessed by counting the number of choices observed for each drink in each bar and each ambience. The distributions of the choice in each condition were then analysed using χ^2 tests.

3. RESULTS AND DISCUSSION

3.1 Ambience assessments

The warmth of the ambience is driven by the video-clips only, $F(4, 687) = 222.86$, $p < .0001$) as there is no significant furniture effect nor furniture × clips interaction. As expected the iceberg landscape was assessed as the coldest and the desert landscape as the warmest. The abstracts clips are assessed with intermediate levels of warmth and with significant differences among the three clips.

Table 1: Mean warmth scores.

Video-clips	Warmth scores
1-Blue	5.0 b
2-Desert	8.2 a
3-White	4.1 c
4-Icebergs	3.7 d
5-Red	7.9 a

Liking and arousal evoked by the ambiences are driven by the video-clips only as no significant furniture nor furniture × clips interaction was observed. Table 2 shows the mean scores obtained for each video-clip. For abstract videos there is a relation between liking and

warmth scores. However, this link does not hold for figurative videos as icebergs and desert landscapes are much contrasted in term of warmth but were equivalently liked.

Table 2: Mean liking and arousal scores.

Video-clips	Liking scores	Arousal scores
1-Blue	6.5 c	4.2 c
2-Desert	7.2 ab	5.9 b
3-White	5.0 d	6.6 a
4-Icebergs	6.8 bc	3.6 d
5-Red	7.4 a	4.1 cd

The furniture type did not impact the evaluation of warmth, liking nor arousal. But, the furniture was not completely ignored by the participants. A significant furniture × clips interaction was observed for harmony scores, $F(4, 687) = 4.10$, $p < .01$). It is worth noticing that the interaction was significant for the abstract video-clips but not for the figurative ones (Table 3).

Table 3: Mean harmony scores.

Video-clips	Wood furniture	Plastic furniture	t-test (Pr)
1-Blue	5.79	6.38	1.60 (.11)
2-Desert	6.64	6.68	0.13 (.90)
3-White	4.36	5.39	2.88 (.004)
4-Icebergs	6.68	6.62	-0.18 (.86)
5-Red	7.16	6.37	-2.35 (.02)

3.2 Drink choices

Some beverages were pooled as they showed similar choice profiles: tea and hot chocolate were pooled as “hot drinks”; still water and Perrier were pooled as “water”; coke, diet coke, seven up, ice tea, Schweppes, and orangina were pooled as “soft drinks, and all fruits juices were also pooled.

Figure 2 shows the number of choices for different drinks for each bar and each ambience. The ambience and more specifically the video-clips had a clear impact on drink choices. The video-clip depicting icebergs led to choose preferentially hot drinks; more than half of the participants chose a hot drink in this ambience. It was even more pronounced in the wood bar although the difference is not significant. The video-clip depicting a desert landscape led to choose more desperado, margarita and pina colada than in other ambiences ($\chi^2 = 96.6$; p $p <$ .001). These three drinks are typically link to South-America at least for French people. These choices were probably oriented by both the video and even more the music that evoked South-America. Abstract video-clips also induced some specific choices. The white video-clip led to choose significantly more spirits (vodka and in a lesser extent gin and whisky) than in other ambiences ($\chi^2 = 87.3$, $p < .001$). The blue video-clip led to choose significantly more fruit juices than in other ambiences ($\chi^2 = 11.0$, $p < .001$). Finally, the red video-clip led to choose significantly more stout beer than in other ambiences ($\chi^2 = 36.9$, $p < .001$).

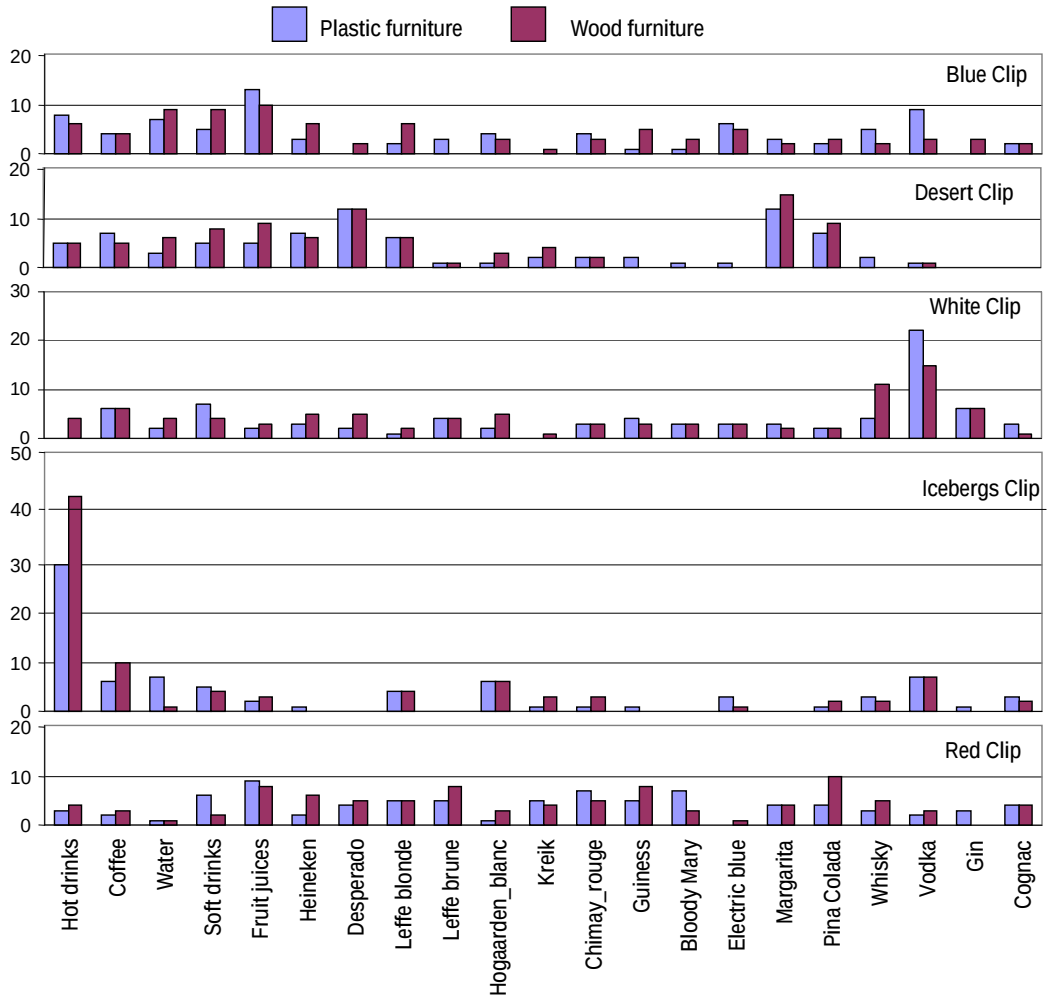

Figure 2: Number of drink choices according to bars and video-clips

4. CONCLUSION

This experiment showed that it is possible to evoke a bar situation and to impact the drink choices by modifying the ambience inside the bar. As expected, figurative video-clips very contrasted in term of temperature evocation clearly induce some specific drink choices. But, abstract video-clips were also efficient to direct choices. This experiment is a preliminary study demonstrating the potential of an immersive approach to credibly evoke a consumption situation. However, in this experiment, we only recorded declarative choices, participant were well aware they will not actually get the drink. A further step will be to confirm the interest of this approach to study actual behaviours.

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THE SOUPE DU JOUR EFFECT: LANGUAGE AS A COUNTRY-OF-ORIGIN CUE AND ITS IMPACT ON PRODUCT PERCEPTION

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Abstract

This research investigated the effect of language as a proxy of country of origin on people's perception of a new food product and their purchase intention. A primary study has shown that "to which country a food is thought to belong could influence whether or not people would be willing to try it". This effect was named the "soupe du jour" effect. It was verified, firstly, by a survey conducted in Taiwan. In this study, participants read a cover story of a new tea product and its advertising bilingual description (traditional Chinese Mandarin combined with either simplified Chinese Mandarin or English or Japanese or Vietnamese and Chinese traditional by itself). They were asked to indicate the prices and whether they were willing to buy the tea products on a 5 point scale. The "Soupe du jour" effect was also confirmed by an experimental study. The stimuli were five bona-fide tea boxes with labels written in one of the five languages mentioned above. The participants were asked to choose one and only one tea box to taste. They also indicated the price of each tea box in comparison with the rest. The findings suggested that, depending on the types of products and the cultures, language could serve as proxy of country of origin cue and elicit a positive or negative "soupe du jour" effect.

Keywords: Country of Origin, product perception, language effect, culture difference

1. INTRODUCTION

Eating is a basic physiological need (Maslow, 1943), but its psychological, social and cultural dimensions are undeniable (*e.g.*, Rozin & Vollmecke, 1986; Rozin, 1996). During this time of globalisation, foods from other countries are crossing the traditional borders of food cultures. Even though encountering new foods is becoming all the more common, relating to novelties in everyday life may be ambiguous. Relating to new foods evokes ambivalent thinking, as people eat "*with their mind as much as with their mouth*" (Beardsworth & Keil, 1997). Food choice entails not only decisions based on conscious reflection, but also automatic, habitual, and subconscious decisions (Furst *et al*., 1996). Therefore, people are not as rational in food choice as they think they are. Factors such as price, brand name, trademarks, promotion appealing, or even foreign words in the commercials are able to drive people to consume things.

Explanations and predictions of people's choices are often founded on the assumption of human rationality. In food context, it is often that one has to make a choice from many different options of a food product category without tasting it first. This happens everywhere, at anytime, in supermarkets, in restaurants, in food stores or in open markets. Without the help of sensory tasting, people acquire other cues to justify their choice. Take food context in a restaurant as an example, instead of "Seafood filet", "Succulent Italian Seafood Filet" was found to increase sales by 27 percent (Wansink *et al*., 2001). It is also common to find restaurants with foreign names such as "Le Village" whose food has nothing to do with French cuisine. Another example is the packed coffee "La gauche de La Seine - Café au Lait" of Uni-President Enterprises Corp. – the biggest food company in Taiwan. It seems that foreign languages have an effect on consumers; otherwise, restaurants and food companies

would not have used them in their business. However, is it true that foreign language could induce people to consume a new food product? What is the process underlying it? And how does it work? Is the language effect a product-specific effect?

In previous work we explored the existence of a language effect, named "soupe du jour effect", on inducing people to try a novel food product. Our hypothesis was that the country to which a food was thought to belong could influence whether or not people would be willing to try it. We showed that Taiwanese and Vietnamese participants was influenced differently by the information linked to the country to which the food was though to belong: expensiveness was weighted more by Taiwanese, and familiarity was weighted more by Vietnamese (Phan & Sheu, 2007; Phan, 2008)

The goal of the current study was to investigate further the effect of extrinsic cues, languages and country of origin, on people perception of price and willingness to try (purchase) a new food product. Our approach was twofold. First we used a survey to examine the effect of country of origin images and its interaction with languages on people willingness to buy a new tea product, and price perception. Then we carried out a behavioural experiment to validate the results of the survey.

2. QUESTIONNAIRE SURVEY

2.1 Material and methods

Stimuli. A cover story of a new tea product was created. This cover story included a description of the tea in the form of a commercial advertisement. The description gave participants general information about the flavour of the tea without any specific information such as the kind of tea, health information, and so on. In the description, the country where the tea leaves came from was explicitly stated. Two factors were explicitly manipulated: the country where the tea leaves were supposed to come from, and the language in which the cover story was presented.

- Country of Origin: Five country names were used: Taiwan, China, Vietnam, Japan and England. Those countries were all tea producing countries but differed in term of economic development: China and Vietnam are developing countries, Japan and England are developed countries and Taiwan is a new developed country.
- Language: Five languages were used: traditional Chinese Mandarin, simplified Chinese Mandarin, Vietnamese, Japanese, and English.

Participants. A total of 700 people participated in the survey: about 30 in each COO and language combination. Participants were tea consumers (aged from under 25 to over 60, sample's ratio of female/male about 1/1, from different professions).

Procedure. Participants were first asked to rate their willingness to purchase the tea product on a scale of 1 to 5 (1 - least likely to buy, and 5 – most likely to buy). Then they were asked to select a market price for the tea product from five different prices provided. The price options were chosen based on data from a previous survey of the market prices of different kind of teas, both domestic and imported products, in several main supermarkets in Taiwan.

The survey was conducted in different places (university campus, public parks, offices, department stores, hospitals). This was a self-administrated survey, and the participants were approached by the interviewer directly. They were introduced to the survey and its scientific purpose. Half of the participants did the task of rating their willingness-to-buy the new tea first. The other half did the task of choosing the market price first. Participants were allowed to take as much time as they wanted to complete the task.

Data Analysis. Analysis of variance (ANOVA) was used for comparing the mean scores of price choices and "willingness to buy" (WTB) in different languages and COO conditions.

Multiple comparison using Tukey's adjustment were conducted on the mean scores of all paired-wise combinations of languages and COO. The prices were converted to an ordinal scale going from1 to 5.

2.2 Results and discussions

Taiwanese sample: Two two-way ANOVAs were used to test the effect of COO direct (country name) and indirect (language) cues on price perception and WTB (Table 1 and 2). Country name had a strong effect on both price-perception and WTB. Although the main effect of language was just marginal for price-perception, its effect is reflected through the interaction with country-name. In contrast, there was no main language effect on WTB and its interaction with country-name cue was marginal.

Table 1: ANOVA of country and language effect on price perception

Source	Df	SS3	Mean square	Value	Pr > F
Country	4	21.72	5.43	**4.82**	**0.0008**
Language	3	8.92	2.97	2.64	0.0489
Country*Language	12	35.03	2.92	**2.59**	**0.0024**
Residuals	533	601.06	1.13		

Table 2: ANOVA OF Country and Language Effect on WTB

Source	Df	SS3	Mean square	Fvalue	Pr > F
Country	4	19.75	4.94	**4.29**	**0.0020**
Language	3	8.05	2.68	2.33	0.0731
Country*Language	12	24.19	2.01	1.75	0.0533
Residuals	537	618.04	1.15		

Simple effects were run to examine the country by language interaction for both price perception and WTB. Results showed that the interaction effect of country name by language came mainly from the country name "Taiwan" and language "Japanese". Traditional and simplified Chinese Mandarin did not have any interaction with the country names. Regardless of where the tea was from, if its description was in Chinese, Taiwanese consumers perceived its price in the same way. The same situation was found for the country names of Japan, Vietnam, and China. If the tea was from these three countries, no matter what language was used to describe it, people perceived the price of the product in the same way.

We assumed that participants perceived the tea described as Taiwan tea in traditional Chinese Mandarin to be the tea product marketed in Taiwan only. At the same time, they thought of Taiwan teas with foreign languages as a product marketed in foreign countries. Besides, if the tea product was described only in traditional Chinese Mandarin, no matter where it was told to be from, people would perceive it as a product sold only in Taiwan.

There was no difference in price perception between tea from Taiwan and teas from other countries if they all were thought to be sold only in Taiwan (see Table 3). Meanwhile, Taiwan tea should be advertised in Japanese to gain the best price in people perception (see Table 4). Chinese simplified, and English could not make the product be perceived more expensive than the one just advertised in traditional Chinese.

Table 3. Difference in price perception between Taiwan tea and tea from other countries which were described in traditional Chinese Mandarin

Difference between Country of Origin (Chinese traditional description)	Difference between the means of price choice
Taiwan – Vietnam	- 0.35
Taiwan – China	0.01
Taiwan – England	0.07
Taiwan – Japan	- 0.52

Table 4. Difference in price perception between Taiwan tea marketed in Taiwan and Taiwan tea sold in different countries (* significantly different at α=.05)

Taiwan tea, difference in languages of description	Difference between the mean of price choice
Chinese Traditional – Chinese simplified	- 0. 48
Chinese traditional – English	- 0. 47
Chinese traditional – Japanese	**- 1.09** *

Besides, as the simple effect analysis revealed strong effects of Taiwan COO and Japanese language, it drew our interest in comparing Taiwan tea in different conditions of languages with each other to reveal the effect of perception of markets, as well as comparing Taiwan tea with other countries' teas in the condition of traditional Chinese only to reveal the effect of COO.

Table 5. Difference in price perception and WTB between Taiwan tea and other teas, with description in Japanese (* significantly different at α=.05)

Difference between Country of Origin (Japanese description)	Difference between Means of Price choice	Difference between Means of WTB
Taiwan – Vietnam	1.007 *	**0.88** *
Taiwan – China	1.02 *	0.53
Taiwan – England	0.40	0.13
Taiwan – Japan	0.70	**0.74** *

Though Japanese was found to have a strong effect in inducing people to perceive the tea product more high-end and show high purchase intention, it could suppress the COO effect linked to countries with a low image. An advertisement in Japanese would not be enough to bring Vietnam and China tea to the same class as Taiwan tea. However, Japanese language was not found to increase people purchase intent for Japan tea in comparison with Taiwan tea. Japanese gave the most effective effect on Taiwan tea, but not on Japan tea (Table 5).

2.3 Conclusion

The results of this survey were consistent with the findings of our previous study. Languages could serve as COO to elicit price and familiarity perception in people about food from different countries. The "made-in" effect was also found to have a strong effect on participants' perception of product. Above all, Taiwanese had strong preference for tea "made in Taiwan." This demonstrated a strong home-country selection bias, which was consistent with many previous studies on COO effect, such as Levin *et al*. (1993), Good and Huddleston

(1995), or Baker and Michie (1995). In Taiwan, drinking tea has developed to an art or tea ceremony, which was adapted much from Chinese and Japanese tea cultures. Therefore, to Taiwanese drinking tea is sort of sacred. Thus, a familiar taste may be desirable. An unfamiliar imported tea could not satisfy people needs in this aspect.

However, Taiwanese people seemed to have desires of high-class products. If they could have a similar taste in a high class tea product, it would be the best choice ever. Therefore, nothing could be better than a tea made in Taiwan but supposed to sale in Japan. Despite all the fame Japan earns in the world market for other kinds of products, just the fact that Japanese tea ceremony has a worldwide reputation was enough to be a secure for a perception of a high class level of any tea product which was sold in that market. This could be a reason why Japanese language emerged as the most effective language to influence Taiwanese consumers' purchase intent to a new tea product. This finding stabilized the "Soupe du jour" effect, for the fact that it existed even on a special product category like tea.

Yet this first study used a direct and self-administrated questionnaire survey method to approach people perception. This methodology was based on the implicit idea that people are "reasonable" and make rational choices. Unfortunately, psychological theories show that many decisions are irreflexive, and that people simply rationalise because they do not know the true reasons for their choice. It means that they think up an answer to any question, even unanswerable question, instead of saying they don't know. That's why the fallacy of conscious choice becomes particularly dangerous in sensory science and consumer research (Köster, 2003). Knowing this fallacy is especially important in consumer survey research, in which the investigators use questionnaires to interact with consumers. Several studies showed that in that case, using indirect methods is more efficient than direct methods. Behavioural frequency questions are used to imply liking. Asking indirect questions always gets more reliable answers than direct questions, for instance, "*Have you ever hesitated to invite friends to your garden at home because of the pollutio*n" prove to be a much better question to estimate the pollution in an area than "*How bad is the odour pollution in this neighbourhood*?" (Köster, 2003). Therefore, the validity of the findings of our first study needs to be confirmed using behavioural data.

3. BEHAVIOURAL EXPERIMENT

3.1 Materials and methods

Stimuli. Fake tea boxes were made from ordinary bamboo-style tea boxes. The original labels of the boxes were removed, and replaced by experimental labels. To control for unexpected factors which could affect the results, the stimuli labels were made with the same image, logo, expiration date, and distributor company. The content of the labels were kept similar, too. Only languages of the labels were different. Five languages were adopted from the precedent survey. They were traditional Chinese Mandarin, simplified Chinese Mandarin, Vietnamese, English and Japanese. Figure 1 showed the stimuli and the English labels. Other labels had the same picture and content, but different languages. Those designed tea boxes have gone through a pre-test to verify their convincibility as real products before they were used in the main experiment.

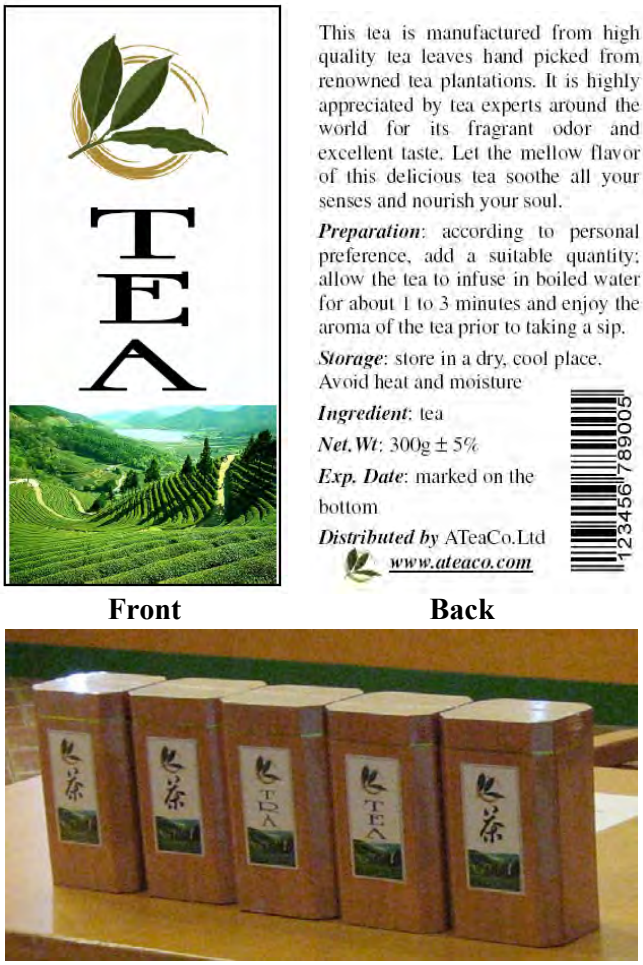

Figure 1. Tea stimuli used in behavioural experiment

Participants. A total of 148 college students (aged from18 to 25 years old) and 2 faculties (30 to 45 years old) from the Department of Baking Technology and Management in National Kaohsiung Hospitality College in Kaohsiung participated in the experiment.

Procedure. The experiment included four tasks carried out in the following order (1) language recognition test, (2) tea label forced choice, (3) price estimation and (4) demographic information. The language recognition test was performed in the waiting room. The last three tasks were conducted in the testing room, which was decorated as a tea shop. There were five separate tables in the room. These tables were arranged to diminish the contact between participants. A set of five experimental tea boxes was available on each table.

Participants received a cover story about a tea distributor who wanted to market five different new tea products in Taiwan and foreign markets. Before officially doing the market launching, the company wanted to conduct a consumer test to examine the promising success of their new products. The distributor would like to invite them to join the test.

In the *language recognition test*, participants received a questionnaire containing five slogan sentences written in either traditional Chinese Mandarin, simplified Chinese Mandarin, Vietnamese, English or Japanese, and five names tags corresponding to those languages. They were asked to match each sentence with one language. If they could not answer all correctly in this task, they would be ineligible to the experiment.

In the *label forced choice task*, participants were asked to examine the tea boxes in front of them (label, logo) and decide which tea they wanted to taste later (Figure 2).

No: .....

Please take a careful look at five different tea products in front of you. Their labels are written in five different languages:

Mandarin Traditional Mandarin Simplified
Vietnamese Japanese English.

Indicate which one you like to try. Make a choice by circling the name of the label above. The tea you chose will be served to you in 10 mins.

Figure 2. Label forced choice task

After completing the label choice task, participants moved on to the *price estimation task*. In this task, subjects were randomly divided into five groups of 30 persons each. Each group was assigned into a COO of the tea product condition. In the five different conditions of COO, participants were given a scenario saying that all five tea products came from one of five countries of Taiwan, China, Vietnam, England and Japan. Depending on what country the tea was told to be from, the anchoring price corresponded to the tea box whose label was written in the language of that country. Based on the anchoring price, participants had to estimate the price of the other four tea products, indicated by their labels' languages (Figure 3).

No:…….

All of the tea products are manufactured in different parts of Japan. The product with the label written in Japanese has the market price of 550 NT for a box of 300 grams. Please estimate the price of the other tea boxes at the same weigh.

Box with Vietnamese label: ……

Box with Traditional Mandarin label …….

Box with English label: …….....

Box with Simplified Mandarin label: …….

Figure 3. Price estimation task in the condition of Japan COO. The tea was told to be made in Japan, and the tea box with Japanese label was the anchor product to estimate the other prices

When participants have completed this task, they received a questionnaire of 11 *demographic questions* and a cup of tea. This questionnaire included questions on participants' tea habit and preference, personal information, and reason of their choice in the label choice task

Data Analysis. Data of label choice task was analysed using the proportion test (Wilson, 1927; Newcombe, 1998 a and b). Participants' reasons of choosing the label were classified into three main groups: extrinsic product characteristics (packaging, language), socio-cultural factors (cultural, economical influence, trust in industry, habits) and psychological factors (emotion, previous experiences, personality traits, belief, and perception). Price estimation data were analysed by one-way ANOVA model for each COO. Other demographics information was collected to help explaining the results of label choice and price estimation tasks.

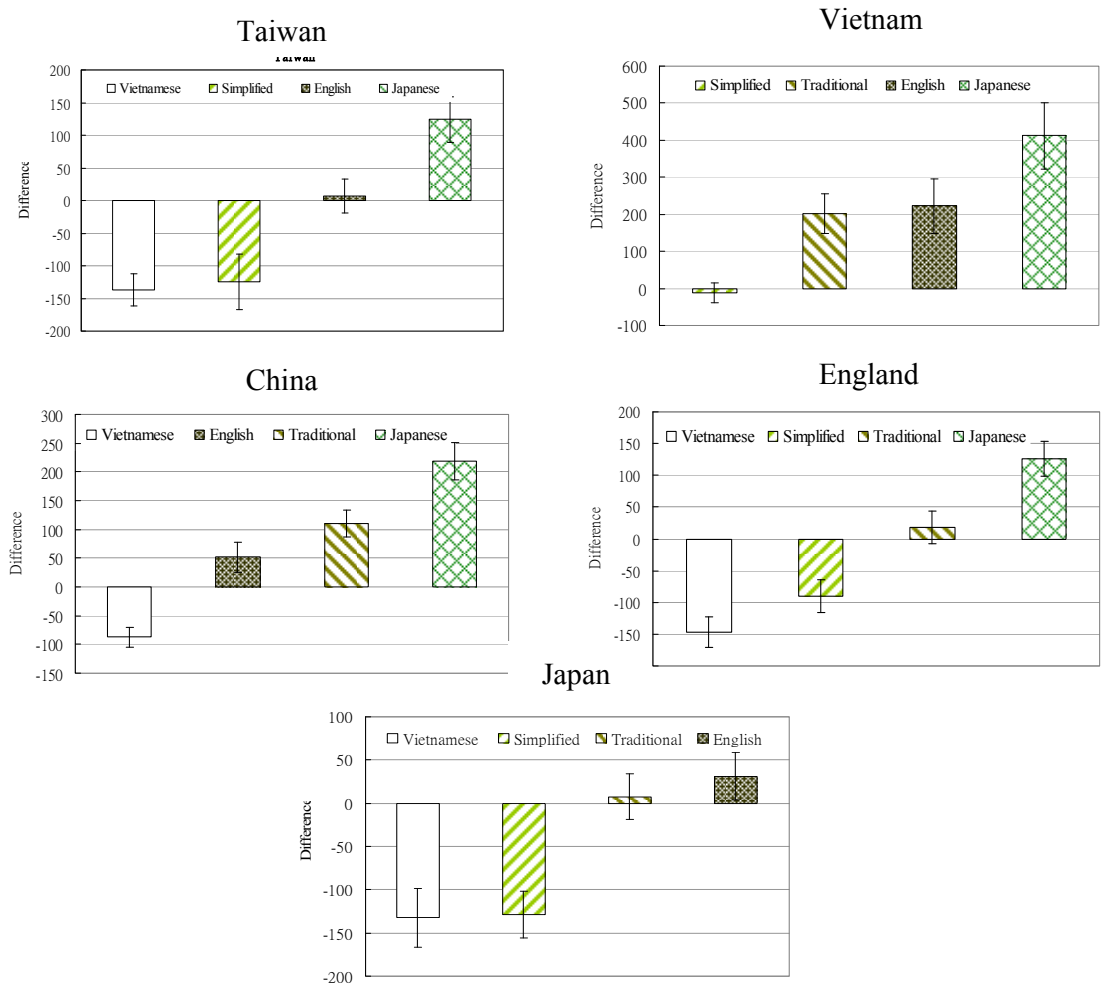

Figure 4. The differences between the estimated price scores of experimental language labels and the anchoring price in the five countries of origin conditions.

3.2 Results

Label choices. The observed proportions of label choice were: 52% for Japanese, 36% for Traditional Chinese, 6% for English, 4% for Vietnamese and 2% for simplified Chinese. These observed proportions were significantly different, $\chi^2(4) = 192.75$, $p < 2.2e\text{-}16$. The Japanese label was the most chosen among the five labels even when compared with the

second-most-chosen label (traditional Chinese Mandarin). Significant differences were also found between the Chinese traditional label and the other labels.

Price estimation. Figure 4 shows the differences between each condition of labels' languages with the anchoring language condition for each "made-in" country. Results showed that only Japanese language increased price for a tea made in Taiwan. Japanese also increased the price of Chinese and English tea. Traditional Chinese Mandarin, English and Japanese all increased the price of Vietnam tea. In case of Japan tea, no increase in price was found in all conditions of languages.

3.3 Conclusion

This behavioural experiment verified the language effect or "soupe du jour" effect on product perception in two important indicators: price and choice. Japanese language was found to be the most effective language to increase the price of tea. Vietnam gained the most benefit, followed by China. Taiwan and England had the same gain from Japanese language for their tea products.

All participants highly valued the tea with Japanese labels, regardless from the origin of the tea. They associated Japan with price, high class and high quality, and they showed high desire for Japanese label.

4. CONCLUSIONS

The survey and behavioural experiment demonstrated the existence and magnitude of a "soupe du jour" effect on perception of two key characteristics of a tea product: price and purchase intention. Language was shown to be an indirect way of communicating "made-in" concept. First, language activates the image of the country it represents. Then, the country image activates people's perception of its representative products, national characteristics, economic background, history, and tradition. Finally, this activated knowledge influences how people evaluate the food product which is presented in that language.

We also found strong interaction effects between COO and language on people perception of price and purchase intent of a new tea product. This result was inconsistent with Lim *et al.* (1994). These authors have demonstrated that when other product information cues are provided at the time of exposure to the COO information, such product information lessened the effect of COO. But our findings showed the reinforcement of language cue and COO effect when they were presented together. Furthermore, Taiwan COO and Japanese language proved to be the best combination between COO and language to increase price perception and purchase intent.

To sum up, this study has shown how irrational people could be. No one would realise that they were easily manipulated just by a simple factor as language. People always tried to be rational in their choice by acquiring information to justify their choice. To do that, people need cues to guide them. The "soupe du jour" effect provides a language cue, which was automatically associated to country image. This process was somewhat unavoidable. In other words, foreign language in a description does more than just getting attention from consumers. It is an alternative way to elicit COO effect and influence the perceived price of a food product and people's willingness to purchase the product.

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ATTITUDES AND SPENDING BEHAVIOURS FROM A MIDDLE CLASS POINT OF VIEW DURING THE CURRENT ECONOMIC RECESSION IN VIETNAM

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Abstract

The objective of this study was to investigate attitude and spending behaviour of members of *middle class* in the current economic recession period in Vietnam. Two experiments were carried out: a focus group and a consumer survey. The focus group results provide a description of the general profile of the economy of Vietnam: "*this economic situation is not in crisis period,*" *"it is a downturn as a consequence of domino effect from the recession of capitalistic countries";* and describe the concept of recession as "*difficult life*", *"bankruptcy"*, *"unemployment",* and *"rise of social evils"*. Facing the recession situation, the reactions of the participants were to *"work harder", "study more", "recruit/select superior sale managers", "satisfy the outside and inside clients",* and *"manage expenses in a planned way"* The questionnaire survey focused on the consumer expense distribution patterns and on forecasting consumer spending behaviours. The proportion of expenditures showed that the five items on which consumers spent the most were *food at home* (20.56%), *savings* (15.29%), *food services* (8.72%), *payment for rent* (5.61%), and *party expenditure* (5.34%). Moreover, a new trend in spending behaviour was discussed. Eleven items of expenditures were highlighted in this discussion: *food at home, alcoholic beverage, clothing, jewellery, travelling, private transportation, telephone, party expenditure, home equipment (with and without motors),* and *payment for rent*.

Keywords: Vietnam economic, recession, spending behaviour, income distribution

1. INTRODUCTION

Erupting in US financial declination, the current recession has spread rapidly and wrecked many countries all over the world. The global recession was revealed via some obvious signs such as: increasing prices of basic food and fuel, increasing unemployment, decreasing retail turnover, decreasing actual revenue and the gradually weakening industrial growth index (IMF, 2009, Shimelse *et al*., 2009). All of these extraordinary changes imply a global economy shrinking. This recession has affected consumer spending. According to Jena (2009), 73 % of Americans planned to cut back on spending in the next 12 months, and 26% of Chinese were likely to trim their expenditures. Like consumers all over the world, Vietnamese consumers also have to prepare for an economic emergency, with consequences such as: losing jobs, cutting costs and changing spending habits. The objective of this study was to explore the attitudes and behaviours of middle class consumers in Hochiminh city

towards the current recession. Hochiminh city is a region that has Gross Domestic Product (GDP) per capita at the highest level in Vietnam. Its GDP per capita reached 2,534 USD in 2008 (Song, 2009) and the middle class has income about 5-15 million VND/month (equal 294-882 USD/month).

2. METHOD

This research included two studies: a focus group study and a market survey. The objective of the focus group study was to obtain information about concepts, attitudes and reactions of Vietnamese consumers in a recession period. And the purpose of the market survey was to investigate the behavioural changes in spending patterns.

2.1 Focus groups

A total of five focus groups were held in Hochiminh city. Numbers of participants in each group were between 3 to 9 persons, with a total of 27. The main characteristics of focus group are presented in Table.1.

Table 1. Main characteristics of focus group

	G1	G2	G3	G4	G5
Participants	6	9	4	3	5
Age (years)	25-34	25-34	35-44	35-44	45-55

Participants were selected based on their income (5-15 million VND/month) and age (25-55 years old). They worked in banking, information technology, retailers (food, construction materials), logistics, and bureaucratic government. All focus group sessions were conducted in a room large enough to accommodate 10 persons comfortably. The room was equipped with fluorescent lights, video and audio recorder, blackboard, and a round table to allow free discussion. The protocol guide was based on a semi-structured interview (Barrios, 2008; Ives, 2003). All focus group sessions were operated by one moderator and two assistants. The moderator was responsible for facilitating the group discussions and the assistants controlled the audio equipment and took notes. When the participants sat around the table, the moderator started the discussion by introducing himself. Then he informed participants that there were no correct or incorrect answers to each question, but rather just personal point of views concerning their professionals and social positions. Subsequently, the participants were asked to briefly introduce themselves, and the discussion started around the following questions:

1. What do you think about Vietnam's current economic situation? How to get this information?
2. Thinking about economic recession, what is your first impression?
3. How does this recession affect your job?
4. Which solutions were found by your firm?
5. How does this recession affect your life?

6. What do you do in recession period?
7. When will the recovery begin?

Each session lasted approximately 90 minutes, and the interviews were recorded.

2.2 Market survey

The survey was conducted in March 2009 on 200 inhabitants who have an income in the range of 5-15 million VND/month in HoChiMinh city. The questionnaire focused on their main spending categories (*i.e.* food, beverages and tobacco, clothing products, tools, health-care services, cultural activities, sport, recreational facilities, transportation, post, medical care, education, communicative relationship, home equipments, housing, building, materials and saving). For each item, respondents were asked to indicate their expenditures at two periods (before and during recession).

3. RESULTS

3.1 Focus group

The moderator and the two assistants analysed the notes taken and the transcript tapes. Results were summarised by the following themes: a) Vietnam's current economic situation; b) Effect and reaction to recession on their jobs/lives; c) Forecasting the ending time of recession.

Vietnam's current economic situation: The focus groups revealed both positive and negative aspects of the recession period. Most participants mentioned that Vietnam's economy was influenced by domino effect from global economic recession through opinions such as: *"this economic situation is not in crisis period"*, *"we are living in recession period, not crisis one"*, and *"it is a downturn as a consequence of domino effect from the recession of capitalistic countries"*. for these participants, the concept of recession was defined by *"difficult investment environments"*, *"bankruptcy risks"*, *"slackness of import-export activities"*, *"unemployment"*, *"price increase"*, and *"consumer spending declination"*. Participants expressed other causes of recession, as follows: *"the financial management and the monetary systems has not been received a good control"; "the policy system for investments is not thorough";* and *"our banking was not prepared to face recession*.

Effect and reaction to recession: The four respondents working in bureaucratic government (education and manufacture) and information technique indicated that they were not affected by economic recession. However, they did not disclaim that it is hard to reach new targets like the years before. According to most of the participants, with the rising of fuel and material prices, they spent substantially more on manufacturing goods, and shipping merchandise. Companies would prefer not to push those cost increases down the chain to customers. They accept to reduce their incomes, cut down spending, or even add supported service; but, they do not want to discount the product prices. The underlying reasons of this behaviour were explored further in the focus groups. Respondents talked about: *"Streamlining operations",*

"Cutting back on inventories", *"Reducing part-time staff hours"*, *"Conserving energy"*, *"Buying more local goods to save on transportation"*, *"Offering incentives to keep customers engaged"*, *"Paying more attention in local market", "Recruiting/selecting superior sellers", "Adding supported services"*, and *"losing customers if price hikes"*. The two participants who are retailers (in different focus groups), indicated another difficulty in rotating capital for company. They mentioned that *"most suppliers request cash in business"*, and *"have not enough cash for commercial transaction"*. Furthermore, in Vietnam, *"Cash is King"*. So, companies/retailers prefer to keep their capital invested in bank rather than making risky investments.

When asked about their daily lives, many participants recognised having changed their behaviour during recession. They have to "*work harder*, *study further* and/or *improve their skill to keep jobs*" Besides, they mentioned cutting down spending on: "*doing shopping*, *using food away from home, using out of home entertainment, upgrading technology (home equipments, cell phone, computers, motors), smoking* and *using luxury products.*"

Forecasting the ending time of recession: The period at the end of 2009 was predicted to be the most difficult period for the economy. That is a corollary of all the decisions from sweeping job and changing spending habits that people made from the end of 2008 and first quarter of 2009. However, participants' belief in the Government's economic stimulating package was strong enough to lift up the economy. Three out of nine participants in group G2 showed a positive point of view in recession period: "*This time is a good opportunity for companies that have good strategy in management and business*, *This is a chance to reject the business live from hand to mouth, this is also a good chance for small-scale companies compete with large-scale ones about price and marketing strategies.*"

Most participants are optimistic as to their market ability to ride out the current economic recession. It is interesting that they appear more confident in their future. They mentioned that the "*Recession, will] just survive for a short time", "we will overcome this time soon", "our government has stimulated the economy, we do not worry so far", and "our economy will recover in the next year*". So, Vietnam stays at the 14th position in the Nielson Global Consumer Confidence Index (Nielson, 2008).

3.1 Marker survey

The survey data were analysed using a Wilcoxon *t*-test to determine whether there is a significant change in expenditure between two periods. Besides, the percentage of spending for each subcategory was calculated to forecast trends of spending habits.

The changes of expenditures in crisis time: The maximum and median values expenditure costs before and during recession are presented Table 3.along with Wilcoxon t-test. Statistically significant differences ($p<0.05$) were found for 11 subcategories. The expenses of three out of eleven sub-categories have been increasing in recession period, including: food at

home, party for communicative relationship, and payment for rent. In contrast, eight expenditures have been declining, including: alcoholic beverages, clothes, jewellery, travelling, private transportation, telephone, home equipments with/and without motors.

Table 3. Main expenditure categories and subcategories of consumers' spending in recession period comparing with the time before. The (-) sign indicate decreasing spending during recession period compared with the time before and the (+) sign increasing spending

Items of Consume		***Max***		***Median***		***t-value of wilcox.test***	***Result Change/Not***
		Before	After	Before	After		
1. Food	Food for home consumption	8000	7000	1000	1000	0.006	C (+)
	Service: fast food, take-out, delivery, buffet and cafeteria (away from home)	4000	3600	500	400	0.5741	N
2. Beverages and Tobacco	Alcoholic beverages	2000	2000	50	50	0.0004	C (-)
	Non-Alcoholic beverages	2200	2300	200	200	0.2696	N
	Tobacco & smoking products	600	700	0	0	0.9546	N
3. Clothing products	Casual, sportswear, formal, undergarments and sleep clothes	2000	2000	167	150	0.0071	C (-)
	Hat, comforter, glasses	500	700	20	20	0.5256	N
	Shoes, sandal, slipper	800	1500	50	50	0.5725	N
4. Tools & health-care services	Private tools (tower, paper handkerchief, shaver, tampon...)	800	900	70	80	0.4239	N
	Cleaning & beauty products (shampoo, soap, detergent, shower-cream, perfume, lipstick…)	800	800	50	50	0.1230	N
	Jewellery	1500	1500	0	0	0.0495	C (-)
	Beauty service (spa, beauty salon…)	1000	1000	0	0	0.5020	N
5. Cultural activities, sport, recreational facilities	Publication	800	600	90	90	0.1998	N
	Travelling	2000	2000	0	0	0.0039	C (-)
	Sport activities (tennis, swimming, badminton…)	700	800	0	0	0.3263	N
	Recreational activities (cinema, theatre, game, bar, karaoke, go fishing…)	1200	1200	70	50	0.0624	N
6. Transportation, post	Public transportation	500	500	0	0	0.1142	N
	Private transportation	1000	1000	300	250	0.0328	C (-)
	Letters, package	400	700	0	0	0.4017	N

	Telephone: home phone, mobile, fax	1100	1100	200	200	0.0282	C (-)
7. Medical-care	Medical, hospital and related services	1500	1500	0	0	0.2551	N
8. Education	Foreign Language	2000	3000	0	0	0.3559	N
	Intensive-course to enrich your career	5000	4000	0	0	0.1018	N
9. Communicative relationship	Gift	700	900	0	0	0.2905	N
	Party (marriage, death anniversary…)	1500	1500	300	300	0.0003	C (+)
10. Home equipments	With motors (washing, machine, fan, television, freeze)	2500	2700	50	50	2.3e-05	C (-)
	Without motors (furniture, porcelain...)	5000	1500	30	10	0.0002	C (-)
11. Housing, building materials	Payment for rent	4500	5000	0	0	0.0001	C (+)
	Repair, construct (building arterials, paint, lime)	3500	3000	0	0	0.1563	N
	Immovable (house, apartment, land…)	6000	6000	0	0	1	N
12. Saving	Saving money (in bank, at home)	10000	10000	1000	1000	0.5725	N
	Take out insurance	5000	5000	0	0	0.7865	N
	Stock investment	4200	4200	0	0	0.4227	N

The spending distribution of each sub-category is shown in Figure 1. Three items account for approximately 40% of participants' incomes: food at home (18-21%), saving (15-16%) and food away from home (7-8%). Besides, consumers spent about 2-5% of their incomes for the following sub-categories: alcoholic beverages, clothes, jewellery, travelling, private transportation, telephone (home phone, mobile and fax), home equipments (with and without motors), payment for rent and party (communicative relationship).

The way consumers spend for their needs: The spending sub-categories were grouped to form the five following groups of needs (Figure 2):

- *Basic needs* including expenditures of food, beverages & tobacco, and clothing products;
- *Luxury needs* including tools & health-care services, and cultural activities;
- *Future needs* including medical care, education, and communicative relationship;
- *Transportation needs*, including transportation and post;
- *Real properties need* including housing and savings.

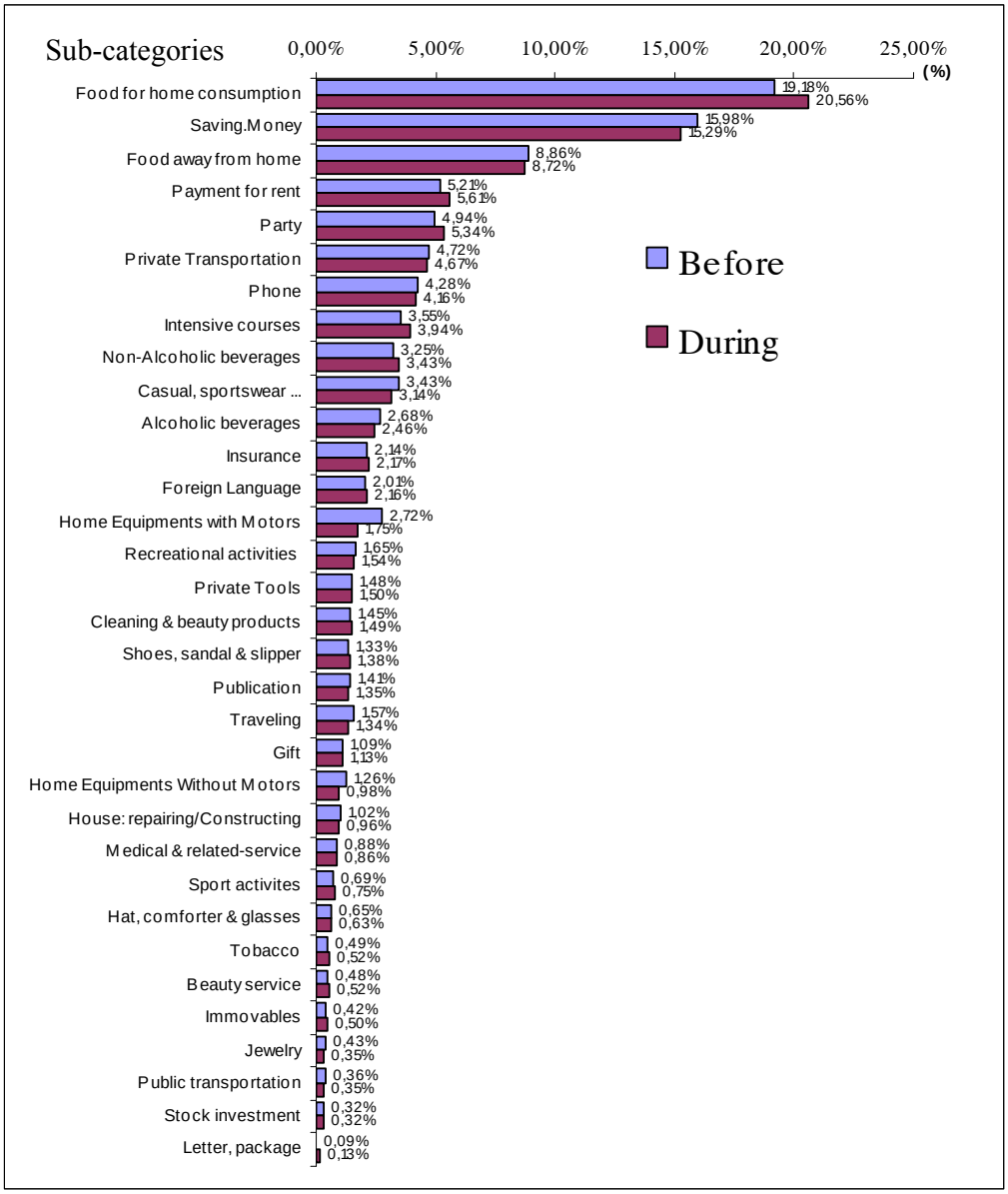

Figure 1. Distribution of consumers' spending

On the whole, Vietnamese consumers spend the same amount of their income in basic needs before and during the recession (39.87% before and 40.83% during the recession period). Yet results from the focus group suggested a decrease in basic needs during the recession. Participants declared cutting down on: food away from home, new clothes, alcoholic beverages, out of home entertainment. So, the question is: why do consumers think they spend less on basic need during recession when in fact they declare spending the same amount in a questionnaire?

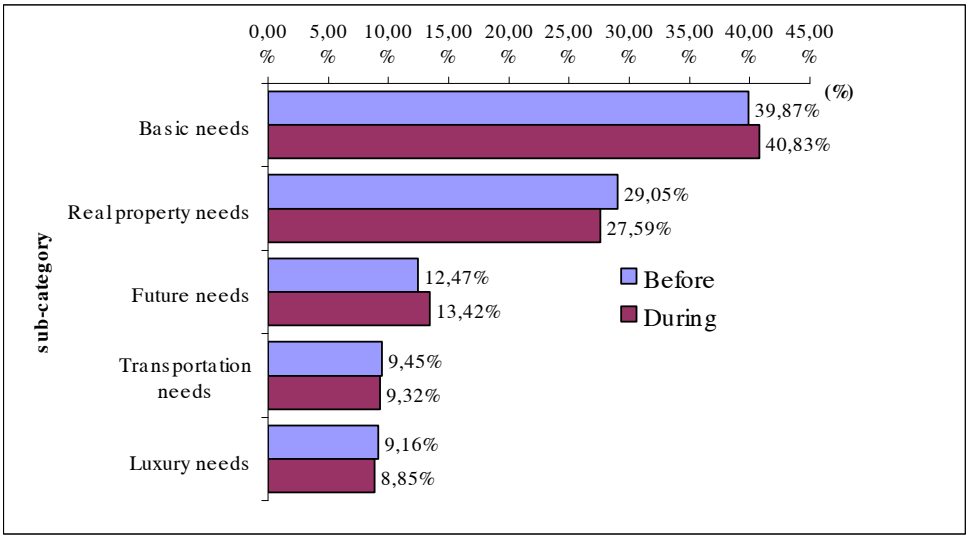

Figure 2. Spending distribution based on needs of Vietnam consumers in recession period compared with the time before recession.

Global spending on *"Luxury need"* and *"Transportation need"* were also very stable (9.16% and 9.45% respectively), and *"Real property needs"* declined slightly from 29.05% to 27.59%. This result was expressed in the focus group sessions by: items such as cutting down on travelling, private transportation, jewellery, investing in real property. This suggests that consumers will try to cut down spending as much as they can. Interestingly, despite saving behaviour; *"Future needs"* does not decline; or even, it increases very slightly from 12.47% to 13.42%. It showed that Vietnamese consumers are optimistic enough to invest in health and education (*i.e*. invest for future).

4. CONCLUSIONS

Like consumers all over the world, Vietnamese consumers feel their lifestyle has been impacted by global economic recession. They fear job loss and price increases. So, they have to change their behaviour by cutting down spending on some sub-categories (alcoholic beverages, new clothes, food away from home, entertainment, telephone expense, jewellery, private transportation, travelling, telephone, home equipments). However, Vietnamese consumers are optimistic. They invest in future (health and education). And they expect that Vietnamese economy will recover at the end of 2010 with Government's stimulating package.

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EFFECTS OF AGE AND GEOGRAPHICAL ORIGIN IN PREFERENCE OF CONSUMERS FOR YAM TUBERS AND MIX WHEAT YAM FLOURS COOKIES

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Abstract

Yams (Dioscorea spp.) are important root crops cultivated in Madagascar and constitute an important source of calories. Yet, despite a 45% rate of malnutrition prevalence, yam is part of dietary customs only in the oriental and southern regions of Madagascar. The main objective of this study is to evaluate whether the consumption of yam and yam derived products could be extended to other areas of Madagascar in particular to urban areas. In a first experiment we showed that among the four varieties of yam the most cultivated in Madagascar *(D. esculenta*, and three cultivars of *D. alata spp*.) *D. esculenta* and to a lesser extend *D. alata. ovilalaina* had the best nutritional and sensory potentialities. In the main experiment, we used *D .esculenta and D. alata. ovilalaina* to make cookies with different wheat/yam proportion of dry flour going from 100% wheat 0% yam (reference) to 50% wheat 50 % yam. Preference tests were realised in an urban community and a rural community. For each region, 60 adults and 60 children of school age evaluated 11 cookies on a 9-point hedonic scale. A three-way ANOVA showed a significant cookies × origin interaction: Participants from rural community liked best cookies with up to 20% yam flours whereas participants in urban community appreciated more cookies with 0% yam flavour and an interaction between age and origin: In rural community adults appreciated more cookies than children and inversely in urban community.

Key words: Madagascar; Yam; Nutrition; Sensory evaluation; cookies.

1. INTRODUCTION

Yams (*Dioscorea spp*.) are an important source of carbohydrate for many people of the sub-Sahara region. Globally, roots and tubers are the second staple food after cereals, with a total annual production of about 626 million tones, including 153 million in Africa (Oluwatoyin *et al.*, 2007). In Madagascar, the flora of yams, Dioscorea (or "oviala" in Malagasy) is particularly rich with probably more than 40 species, about one-tenth of the Flora of Dioscoreaceae in the world. Several studies were conducted on domesticated varieties to improve the availability and potential use in food yam tubers. In Madagascar, these studies focused on the ecological diversity, the traditional use and the development of sustainable management systems. They showed a large diversity of cultivars in the Eastern, humid and Western dry regions of Madagascar. Yet, despite a 45% rate of malnutrition prevalence, yam is part of dietary customs only in the Oriental and Southern regions.

The main objective of this study is to evaluate whether the consumption of yam and yam derived products could be extended to other areas of Madagascar in particular to urban areas. More precisely we evaluated the effects of age and geographical origin on consumers' preference for yam tubers and mix wheat yam flour cookies. Our approach was twofold. First, we determined the nutritional and hedonic potentialities of the four varieties of yam, the most cultivated in Madagascar: *D. esculenta*, and three cultivars of *D.alata spp*. Then, we selected the two varieties with the highest nutritional and hedonic potential and used them to make cookies with different wheat/yam proportion of dry flour going from 100% wheat 0% yam (reference) to 50% wheat 50 % yam.

Proteins, carbohydrates and starches contents in floor largely influence the structural and textural properties of derived products (Nindjin *et al*., 2006). The mix optimal threshold of yam flours would thus be function of mainly proteins contents and other components which contribute to form dough elasticity and firmness properties as well as overall taste. A partial substitute of the wheat flour by starchy products (tubers and cereal) constitutes an interesting alternative in terms of cost profit, reason for which FAO proposed flours program (FAO, 1999). To evaluate the effect of age and geographical origin on the optimal threshold of yam flours that can be incorporated without decreasing hedonic responses, we carried out a series of preference tests in an urban community and a rural community. For each community, 60 adults and 60 children of school age evaluated 11 cookies (the reference, 10 cookies incorporating respectively 10%, 20%, 30%, 40%, and 50% of D.*esculenta or D.alata. ovilalaina dry flour)* on a 9-point hedonic scale.

2. EXPERIMENT 1: NUTRITIONAL AND SENSORY POTENTIALITIES OF FOUR VARIETIES OF YAM TUBERS

2.1 Material and method

Plants materials and samples harvest site: Brickaville, a rural region in the Middle Eastern of Madagascar (18°48'S et 49°04'E), was the harvest site of *D.alata spp, D.esculenta*. Several batches of each variety were harvested in five villages of producer region: Razanaka, Fanasana, Andevoranto, Anivorano, Lohariandava (Figure 1).

Nutritional characteristics of yam tubers: Samples were peeled, washed, sliced into cubes which were freeze-dried using an Edwards bench freeze-drier (Edwards Instruments Ltd., Hornchurch, Essex, UK) and ground in a Hammer mill (Christy and Norris Ltd., UK) into flour to pass through a 250µm sieve. The samples were analysed in triplicate for moisture, ash, crude fat, crude protein contents and minerals using Association of Official Analytical Chemist Approved methods (AOAC, 2000). Carbohydrate content was estimated by difference.

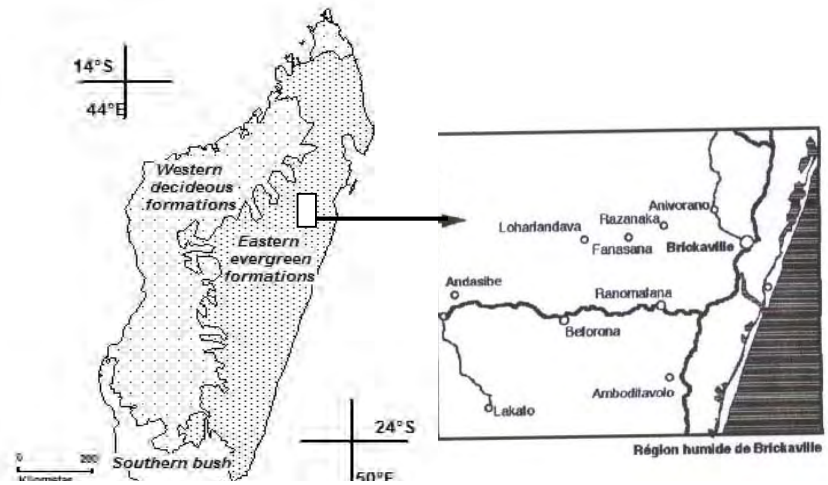

Figure 1: Harvest site

Hedonic ratings of yam tubers: For each variety, tubers were peeled and cut into pieces of approximately 0.05 Kg and cooked in water (P/V: 1/1), T°= 45°C during 20 to 25 min. Hedonic tests were realised using a 9-point hedonic scale labelled in Malagasy and illustrated with smiley (Figure 2) as well as four 7-point intensity scales (Tableau 1) Participants were recruited in three regions: a producer region 18°48'S et 49°04'E, an urban community 18°52'S et 47°31'E and a rural community18°46' S et 47°34' E. For each region, 60 adults and 60 children of school age participated in the tests. In each region, each age group was balanced for gender.

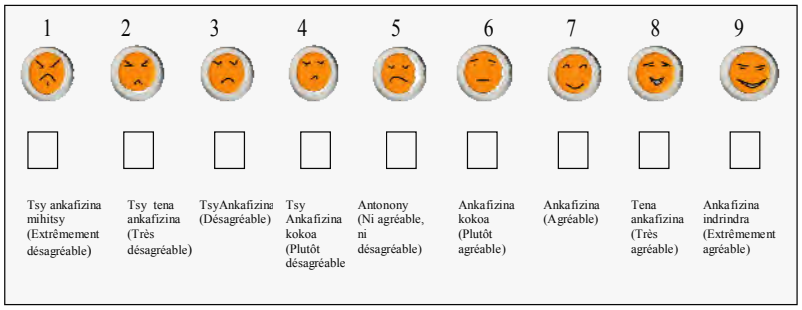

Figure 2: Liking scale

Table 1: four intensity scales used in the yam consumer test.

Attributes	***left anchor***	***right anchor***
Faharenesana tsiro mamy *Sweetness*	Tsy mamy mihitsy *not sweet*	Mamy be *very sweet*
Toetoetra *Firmness*	Tena mafy *very firm*	Tena malemy *not firm*
Loko *Colour*	Tena matroka *very dark*	Tena mazava *very light*
Fanatelomana *Ease to swallow*	Tena sarotra atelina *difficult to swallow*	Tena mora atelina *easy to swallow*

2.2. Results

Results were analysed using a Multiple Factor Analysis (MFA, Escofier & Pagès, 1998) with yam varieties as observations and nutritional and consumer data as variables. MFA is a generalisation of principal component analysis (PCA) that allows for the simultaneous analysis of multiple data sets. Its main goal is to compare the different data sets and to combine them into a common structure called a compromise. The subspace defined by the first two principal components explains around 90% of the variance (52% and 38 %, for PC 1 and 2, respectively) and therefore we limited our interpretation to these dimensions (Figure 3). The first PC is strongly correlated with liking and opposes the two varieties *D. Ovilalaina* and *D. esculenta* which were preferred by all consumers for their sweetness and firmness as well as characterised by high calcium, proteins, carbohydrates, starch and calories contents to the *D. Ovy fotsy* and *D. Ovibe* varieties. These last two varieties were richer in fibres and in humidity with a lighter colour but were not as appreciated as the other ones.

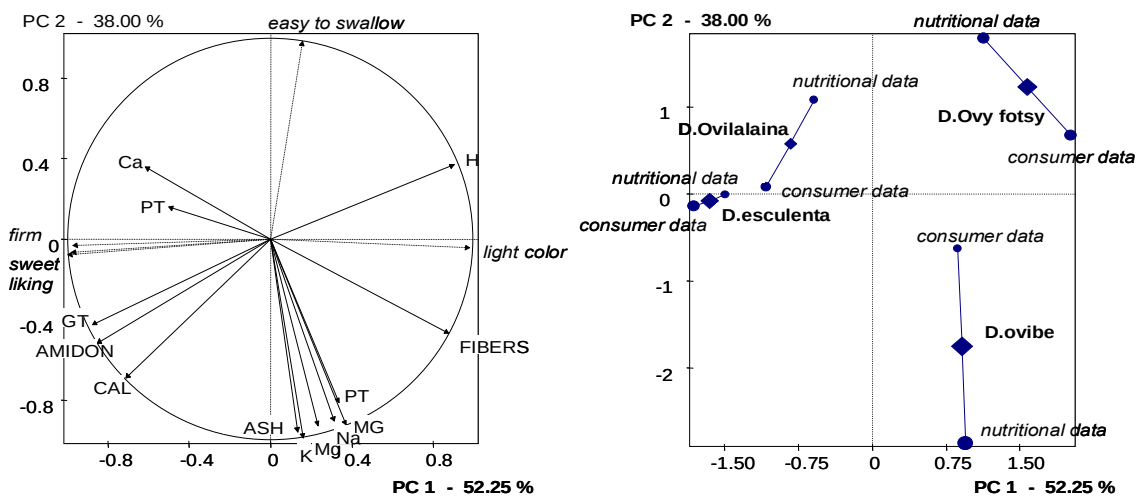

Figure 3: Projection of the nutritional and consumers data sets (left panel) and yam varieties (right panel) onto the MFA first two principal components.

A finer analysis of the raw data indicates that *D. esculenta* is characterised by higher contents in proteins (6, 7 $g100g^{-1}db$), in carbohydrates (90.6 $g100g^{-1}db$) and is less fibrous (7.4 $g100g^{-1}db$) than all other varieties. For all consumers, *D. esculenta* and in a lesser extend *D.alata ovilalaina* obtained the best liking scores. Additionally a three-way analysis of variance (ANOVA) with origin and age as within-subject variables and yam variety as between-subject variable revealed a significant effect of origin and age on the global appreciation of yams. Adults coming from a region where yams are cultivated (Brickaville) liked more the four varieties used in this test than other consumers.

3. EXPERIMENT 2: EFFECT OF AGE AND ORIGIN ON PREFERENCE FOR WHEAT AND YAM COOKIES

3.1 Material and method

Formulation and preparation of cookies: D. esculenta and *D. alata. ovilalaina* were used to make cookies with different wheat/yam proportion of dry flour going from 100% wheat 0% yam (reference) to 50% wheat 50 % yam (Table 1). Ingredients used were dry yam wheat composite flours (45 %), caster sugar (27%), shortening (20%), powdered milk (2.25%), $NAHCO_3$ (0.50%), NaCl (0.42%) and 8.5ml of water. Cookies were baked at 200°C for 10 to 15 min.

Table1: Wheat/yam flour formulation

cultivar	*Botanical name*	*Code*	*Formulation*
	Triticum aestivum	B	Wheat flour (100%)
	D.esculenta	E10	Wheat flour (90%) / yam flour (10%)
	D.esculenta	E20	Wheat flour (80%) / yam flour (20%)
Mavondro	*D.esculenta*	E30	Wheat flour (70%) / yam flour (30%)
	D.esculenta	E40	Wheat flour (60%) / yam flour (40%)
	D.esculenta	E50	Wheat flour (50%) / yam flour (50%)
	D.alata	A10	Wheat flour (90%) / yam flour (10%)
	D.alata	A20	Wheat flour (80%) / yam flour (20%)
Ovilalaina	*D.alata*	A30	Wheat flour (70%) / yam flour (30%)
	D.alata	A40	Wheat flour (60%) / yam flour (40%)
	D.alata	A50	Wheat flour (50%) / yam flour (50%)

Preference tests: Two tests were realised, one in an urban community and one in a rural community. For each region, 60 adults and 60 children of school age evaluated 11 cookies, (the reference and 10 cookies incorporating respectively 10%, 20%, 30%, 40%, and 50% of *D. esculenta or D. alata. ovilalaina* dry flour on the same 9-point hedonic scale as in experiment 1.

3.2 Results and discussion

A three-way ANOVA with origin and age as between-subject variables and type of cookies as within-subject variable was carried out. Results showed a significant effect of age and origin:

- children (M = 6.34) appreciated more cookies than adults (M = 6.23), F (1, 236) = 31.74, p<.001.
- rural consumers (M = 6.86) appreciated more cookies than urban consumers (M = 5.71), F (1, 236) = 3368.24, p < .001.

However, the main effect of age should be interpreted with some caution since this variable interact significantly with consumers' origin, F (1, 236) = 229.87, p < .001. In rural community, adult consumers (M = 6.96) appreciated more cookies than children (M = 6.77) whereas in urban community, children (M = 5.91) appreciated more cookies than adult consumers (M = 5.49). Moreover, these two variables interact significantly with the type of cookies, F (10, 236) = 15.18, p < .001. To analyse further this three ways interaction we carried out LSD mean comparison tests on each consumer group separately (see, Figure 4).

The main point that can be noted on Figure 4 is that the optimal threshold of yam flours that can be incorporated without decreasing hedonic responses depends on the origin of the consumers and to a lesser degree on their age. All urban consumers significantly preferred the 100% wheat cookie (reference) whereas rural consumers significantly preferred the cookies with 20% of yam flour. Although small significant differences appear between the two varieties of yam at all incorporation levels, for adult consumers this effect of yam variety remains smaller than that observed between successive incorporation levels. In contrast, children, and in particular urban children seem to be more sensitive to the difference between the two varieties of yam than between two successive levels of incorporation. The higher preference for cookies made from the *D. esculenta* variety might be due to the smaller contain in fibres and the higher content in sugar of this variety compared to the *Ovilalaina* variety. However further analyses are needed to support this interpretation.

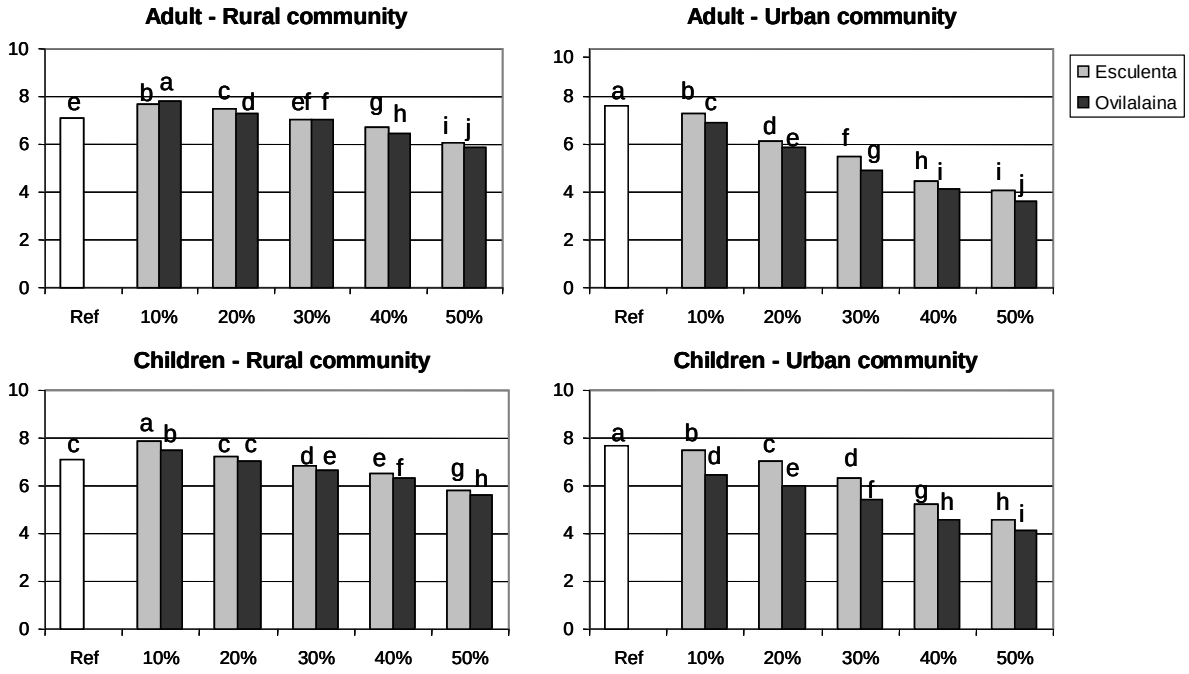

Figure 4: average liking scores for the cookies as a function of the proportion of yam flour incorporated in wheat flour. The letters represent the results of the LSD test at $\alpha = .05$.

The fact that consumers from rural communities used to consume yam tubers have a higher optimal threshold of yam flours that can be incorporated in cookies than consumer from urban communities rarely exposed to yam tubers can be put in perspective with cross cultural studies on food preference. For example, Prescott (1998) in a program comparing Japanese and Australian consumers highlighted that familiarity with a product influenced the assessment of individual characteristics of the product such as sweetness and saltiness. Japanese and Australian consumers differed in their liking of salty and sweet products: They tended to find too salty or too sweet products from the other country when these products

were considered about right by consumers from the country. A more recent study, conducted in France and in Pakistan, showed that biscuits coming from a country are better scored by the panellists coming from this country than biscuits coming from the other country (Pagès, Bertrand, Ali, Husson, & Lê, 2007).

IV. CONCLUSION

This study has allowed evaluating the effects of age and geographical origin in preference of consumers for mix wheat yam flour cookies. *D. esculenta* is characterised by higher contents in proteins, in carbohydrates and is less fibrous than other varieties. Preference tests realised in a producer region, an urban community and a rural community with 60 adults and 60 children of school age in each region showed that although consumers in producer region and in rural community appreciated more yam tubers than urban consumers. All consumers liked best *D. esculenta and to a lesser extend D. alata. ovilalaina.* Participants from rural community liked best cookies with up to 20% yam flours whereas participants in urban community appreciated more cookies with 0% yam flavour and in rural community adults appreciated more cookies than children and inversely, children appreciated more cookies than adults in urban community. In conclusion, age and origin effects were observed in global preference of consumers: Rural consumers appreciated more yam tubers and cookies with mix wheat yam flours than urban consumers. The present study inscribes itself in the frame of preliminary studies that aim to develop a better knowledge of quality components for yam flours derived products and of consumer expectations. The tool presented here using consumer tests could eventually facilitate the design and evaluation of improved and market oriented production for yam tubers and dry yam flour derived products.

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Part 3: Application in the food industry / Product development

GAINING INSIGHT INTO MARKETING STRATEGIES AND RETAILER PERCEPTIONS OF US BEEF IN VIETNAM: A FOCUS GROUP APPROACH

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Abstract

Vietnam is considered an emerging market for the United States (US) beef industry. However, little is known about the perceptions of Vietnamese retailers and consumers regarding US beef. As a result, the US Department of Agriculture Emerging Markets Program funded a *US Beef Export School* with the dual purpose of (a) enhancing awareness of US beef agribusiness "from-farm-to-table" in the Vietnam retail sector as well as (b) assessing marketing strategies and ascertaining retailer perceptions regarding US beef using a focus group approach. A multi-disciplinary team from Texas Tech University, Oklahoma State University and Ho Chi Minh City University of Technology with support from the US Meat Export Federation and the National Cattlemen's Beef Association collaborated in forming strategic alliances between the US and Vietnam with the purpose of enhancing export of US beef to Vietnam.

Data were obtained from a convenience sample of *US Beef School* participants. Two focus group interviews (N = 11) were conducted with executives representing the food retail sector in the northern and southern regions of Vietnam. A discussion guide was produced in English, translated into Vietnamese, and back-translated into English. A bilingual member of the research team led the participants through each 90-minute discussion session. The professional audio recording of each session was transcribed into English, and a note-CD-transcript-based content analysis was prepared. The focal point of this presentation is the summary of the major themes resulting from the content analysis: (a) factors affecting beef import decisions, (b) perceptions of US beef, (c) purchase of US beef by Vietnam retailers for importation, and (d) implications for the US beef industry.

Keywords: US beef, export, focus group, Vietnam, retailer perception.

1. INTRODUCTION

Penetration of United States (US) agricultural exports typically depends on high-income markets such as Japan and the European Union (USDA/ERS, 2007). Recently, significant and steady economic growth in developing countries such as Vietnam has created a number of emerging markets that offer opportunities for growth of US agricultural exports, especially high quality meat products. Identified as one of the world's rapidly developing markets, Vietnam has an increasing demand for high quality beef. Drivers of this demand include:

increasing population, rising income and spending on food, limited resources for live cattle production, and consumer concerns regarding safety and quality of domestically produced beef. From 2005 to 2007 export statistics indicate more than a 100% increase in importation of US beef to Vietnam (USDA/ERS, 2008).

In 2008, about 8,000 Vietnamese retailers, restaurant operators, chefs, and distributors sampled US beef at a food show in Ho Chi Minh City and most participants expressed an interest in purchasing beef imported from the US (USMEF, 2008). A review of the scholarly and industry literature revealed a void in the knowledge of Vietnamese retailer and consumer perceptions regarding US beef. Further, research has shown social and cultural differences can create varied perceptions of and demand for foods including factors such as source, price, quantity, and quality of meat (Resurreccion, 2004; Kizilaslan *et al*., 2008; Glitsch, 2000; Ackerman & Tellis, 2001; Grunert, 2006).

It has been well documented that product quality is determined not only on intrinsic and extrinsic cues at the point of purchase, but also on opinions formed during product preparation and/or consumption when quality expectations are confirmed or rejected (Bredahl, 2004; Banovic *et al*., 2009). As in all cultures, Vietnamese have distinct methods of meat preparation and cooking. Many traditional dishes utilise tougher cuts of beef such as flank steaks, shanks, or tendons and wet cooking methods are more common in Vietnam than the dry cooking techniques (Nguyen, 2006). In this context, targeted product selection, and fabrication and packaging strategies for US beef are essential in the development of marketing plans that enhance the export of value-added components of US beef. Additionally, it is customary for Vietnamese consumers to purchase meat on the day of preparation at local fresh markets or retail food outlets, resulting in a "just in time" marketing strategy for US beef in the wholesale and retail market sectors in Vietnam.

2. OBJECTIVES

In an effort to narrow the gap of understanding in the US beef industry regarding the Vietnam retail meat market, the US Department of Agriculture Emerging Markets Program (USDA/EMP) funded a *US Beef Export School* to enhance awareness of US beef agribusiness "from-farm-to-table" in Vietnam retail sectors as well as to assess marketing strategies and to ascertain retailer perceptions regarding US beef using a focus group approach. As part of the *US Beef Export School*, this preliminary research was conducted to determine: (a) the perceptions of Vietnam retailers regarding US beef, and (b) factors important in the development of viable marketing strategies for imported US beef.

3. METHODOLOGY

Focus group interviews were selected as an appropriate method for generating a breath of insight regarding US beef and import potential in a short time frame. Qualitative research methods for focus group sessions followed guidelines described by Krueger and Casey

(2009). The study was approved by Texas Tech University (TTU) Institutional Review Board for Protection of Human Subjects. All instruments and forms (*i.e.*, moderator guide, consent form, orientation guide) were developed in English, translated to Vietnamese, and back-translated to English.

3.2 Participants and group formation

Two focus group interviews were conducted in May 2009. The participants were executives representing four companies in the food retail sector in the northern and southern regions of Vietnam attending the US *Beef Export School*. Six participants comprised the first focus group and five other participated in the second focus group session. Participants were assigned to one of the focus group sessions based on company affiliation and position within their company to avoid the possibility of undue influence or dominance of higher ranking co-workers.

3.3 Procedures and questions

The focus group interviews were conducted in a conference room on the TTU campus and lasted 90 minutes with an intermission halfway through. The sessions were audio recorded by a professional audio technician using state-of-the-art, industry quality digital technology to ensure accurate transcription of individual comments and accurate recognition of voice inflection. The same bilingual moderator, the first author, conducted the two focus group interviews. Prior to conducting the two focus groups, the moderator received training by observing and assisting in two focus group interviews conducted by a professionally trained and experienced focus group moderator. The second, third, and fourth authors assisted in the focus groups and observed to ensure that similar procedures were followed across the two interviews.

A two–part structured moderator guide was developed by the research team based on the research objectives. A questioning route approach was used in the development of the questions to be asked by the moderator in the focus group sessions to ensure a practical structure for organising the discussion sequence and to facilitate the analysis of results (Kruger & Casey, 2009). The questioning route in each section included uncued and cued questions in open-ended and sentence format as suggested in Krueger and Casey (2009).

In the first 40 minutes, each group was led through a series of opening, introductory, and transition questions. Opening questions were formulated to engage individuals in a conversational dialogue and gain insight into the participants' industry experience, company ownership, and potential customers for imported beef. Introductory questions were designed to obtain participants' thoughts and opinions about product attributes as well as trading policies and procedures considered important in beef import decisions. Transition questions were developed to discover the participants' perceptions and beliefs regarding major

implications for their company associated with offering US beef to Vietnam consumers, and specific characteristics ascribed to US beef.

Following a 15-minute intermission, the moderator addressed key and ending questions with the participants in the final 50 minutes of each session. Key questions were constructed to generate specific information regarding the form in which they anticipate purchasing product (*i.e.*, whole carcass, primals, subprimals, portion cuts), fabrication and packaging; and to explore company and consumer procedures on distribution, wholesale and consumer storage, and retail display of US beef. Ending questions were designed to gain closure to the discussion, ensure no critical aspects related to export of US beef to Vietnam had been overlooked in the discussion, and to brainstorm about future in-country activities the research team should consider implementing to enhance export of US beef to Vietnam.

The focus group questions and procedures were reviewed by a panel of three members of the research team experienced in teaching, research, and outreach in meat science as well as three members of the research team experienced in planning, conducting, and publishing focus group research. Based on comments and recommendations from the expert panel, questions were clarified and procedures adjusted prior to conducting the two focus group interviews.

Prior to the beginning of each focus group sessions, participants were asked to sign a consent form agreeing to be audio recorded, verifying they understood participation was voluntary and that no penalties would be imposed if they choose not to participate. At the beginning of each session, a member of the research team provided an overview of the discussion sequence and topic focus. At the intermission the moderator consulted with the research team to confirm the coverage of topics. At the conclusion of each session, the research team thanked the participants for their time and input.

At the completion of the two focus groups, saturation of responses had been achieved: no new perceptions or insights associated with the importation of beef from the US were mentioned by the participants. Throughout the interviews, special care was taken to ensure that responses were offered from all participants and that no single individual dominated the discussion. Opinions were specifically solicited from any participant who appeared reticent to offer suggestions.

3.4 Data analysis

Bilingual members of the research team prepared a verbatim transcript of each focus group using detailed notes taken at the interview sessions and by listening to the audio CDs. The content analysis followed a systematic process described by Krueger and Casey (2009). When conducting the note-CD-transcript-based qualitative content analysis, certain words, consistency, similarities, intensity and frequency of comments, and stand-alone responses were taken into consideration. Instead of using numbers, explicit qualifiers were used for interpreting agreement, disagreement, or level of consensus: “A Couple” = one or two

participants; "Several" = at least 3, but less than 1/3 of participants; "Some" = at least ¼, but not much more than 1/3 of participants; "A Fair Number" = at least 1/3, but less than 1/2 of participants; "Evenly Divided " = 1/2 of participants; "Many" = more than 1/2, but less than 2/3 of participants; "Most" = at least 3/4, but less than 90% of participants; "Almost All" = at least 90%, but less than 100% of participants; and "Participants" = 100% of participants (Harp *et al*., 1998; Assante *et al*., 2007; Templeton, 1996). When analysing the interviews, the researchers looked to identify broad concepts or themes from the responses to questions.

4. RESULTS AND DISCUSSION

Two focus groups were conducted with 11 participants consisting of 7 males and 4 females. The participants were Vietnamese executives in the food retail sector and meat industry with position titles ranging from general director and CEO to production and quality manager. Job responsibilities included general supervision, management, production supervision, and quality implementation and assurance. All participants significantly contribute to organisational policy-making and import decisions.

Participants represented five state-owned and one privately-owned company. Nine participants were employed by the state-owned companies and two participants were employed by the privately-held company. These companies represent a significant market share of meat products in both the southern and northern regions of Vietnam. Four state-owned companies and the privately owned company have marketed imported non-US beef for domestic retailing or value-added processing. Participants from five companies (four state-owned, one privately-owned) expressed a desire to import US beef in the near future. The one remaining state-owned company wanted to obtain additional information on consumer demand before committing to importing US beef. Most companies intend to market imported US beef to high-income consumers or up-scale restaurants. One state-owned company has the capacity and desire to sell US beef to wholesalers or other food retailers.

The content analysis which was based on the opinions, ideas, perceptions, and purchase motives disclosed by the participants, evolved to include four major themes: (a) factors affecting beef import decisions; (b) perceptions of US beef; (c) purchase of US beef by Vietnam retailers for importation; and (d) implications for the US beef industry. These themes are expanded upon in the discussion that follows.

4.1 Factors affecting beef import decision

Most participants thought that price and quality of beef were important criteria in their decision to import beef. Across cultures, consumers expect an affordable price in relation to quality. As retailers, in order to make profit selling meats, their opinions should reflect those of their consumers. This finding is consistent with prior studies using consumer surveys and focus group discussions, in which consumer perceptions of meat and other food products were found to be dependent on intrinsic food properties, as well as the interaction between intrinsic

properties and immediate extrinsic factors such as price and information (Dransfield *et al*., 1998; Acebron & Dopico, 2000). Price is perceived as relevant cue to quality when consumers do not have adequate information about intrinsic food properties. Although the results may vary across studies, most indicated that price and quality are positively related (Acebron & Dopico, 2000). Moreover, the term of "quality" expressed by the participants in the present study often included safety. Scientifically, safety is a separate issue from quality. However, safety is a critical attribute of food products across cultures. Consumers invariably expect foods to be safe, and without safety, consumers will not purchase foods (Verbeke *et al.*, 2006).

Most participants indicated that in order to forge a desirable relationship between importer and exporter, the exporter should provide marketing assistance, service, and technical support to the importer. Many of the participants desired information about prospective exporters, beef cuts, assurances of product availability, and information on consumer demand. It is understandable that retailers and importers are cautious and need to be well-informed regarding the purchase of beef because beef has a relatively higher price, requiring a larger investment than other meats (Resurreccion, 2004).

Participants revealed that country-of-origin is an important factor in the import decision. The term "*county-of-origin*" and "*brand*" were used interchangeable by almost all of the focus group participants. Further in the discussion, the participants indicated that to Vietnamese consumers US products are generally a symbol of reliability, quality, and safety. As such, Vietnam consumers would be willing to purchase US beef at a higher price than domestic beef or beef imported from countries other than the US. These observations were also noted by Sepulveda *et al*. (2008), who found that region or origin of production was perceived as a quality attribute. Banovic *et al*. (2009) also reported that quality cues related to beef brands were highly and positively correlated with product origin; and brand of beef was found to be the major extrinsic quality cue. Consumers used brand and origin as a determinant for both perception of intrinsic quality attributes and quality expectations (Grunert, 2006). However, a couple of participants noted that the country-of-origin influences purchasing, provided the consumer has an awareness of the beef's origin and related quality. Also relevant to the importer are logistical and cost concerns associated with the geographic proximity of the exporter to Vietnam.

Aging of meat, a common practice in the US beef industry, was not initially perceived as a factor influencing importation decisions simply because all of the participants lacked an understanding of the aging process and the impact on meat quality. Participants indicated they need more information on meat aging before they could evaluate the importance of aging in the decision making process. Additionally, participants felt that they would need to educate the consumer about the benefits derived from the aging process. After the moderator explained the aging process and its advantages, a fair number of participants were concerned

that aging might affect safety, shelf life, fresh appearance, and cost. However, several did not think aging would be relevant to the import decision, and indicated that they would decide whether or not to import beef based on quality traits rather than on utilisation of a specific technology or process.

When asked about grass-versus grain-fed beef, many participants thought it was an important factor that could influence beef flavour. Again, a fair number of participants thought feed was not important as long as the beef quality meets or exceeds consumer expectations. Additionally, in the context of grass- vs. grain-feeding, a couple of participants said they preferred the flavour of domestic beef, while a couple of others thought that US grain-fed beef was very flavourful and that beef flavour would be attractive to Vietnam consumers. It is also important to recognise that Vietnamese typically consume highly seasoned grass-fed beef containing little marbling prepared by wet cooking methods. During the *US Beef School* and prior to the focus group sessions, the participants consumed meals featuring highly-marbled, dry-cooked (grilling) beef entrées. Grilling or dry cooking causes thermal oxidation of lipids resulting in an intensified cooked beef flavour (Wood *et al.*, 2004). Therefore, sensory attributes of beef consumed at the *US Beef School* may have impacted their perception of the flavour of US beef.

At this point, it was apparent that the greater the knowledge the participants had on a particular factor that influences a quality attribute, the more important the factor became in the decision-making process. Consequently, an increase in knowledge leads to more informed decision-making. Quality perceptions of meat have been traditionally based on intrinsic attributes such as colour and visible fat. Over time, fuelled with debate and information regarding issues such as health and safety, consumers have relied increasingly on extrinsic attributes to evaluate the perceived meat quality. Consumers in focus group discussions were usually confident that they could judge the sensory quality of the meat without additional information (Grunert, 2006). However, if provided with additional information, and the more they understood the information, the more important the information became in their quality perception (Grunert & Grunert, 1995). Once an extrinsic cue is established in the customer's mind, the effects on quality perception can be exceptional, as in the case of country-of-origin as previously discussed. However, it is interesting to note that information is perceived as least credible coming directly from producers (Poppe & Kjaernes, 2003).

All participants agreed that Vietnamese consumers evaluate the quality of beef on the appearance (bright red colour) and texture (softness); therefore, prefer to purchase fresh rather than frozen beef. Hence, beef imported in the frozen state must be thawed for retail display. Meat colour has been well-documented as a predominant intrinsic factor indicating freshness (Glitsch, 2000; Grunert, 2006; Grunert, 1997; Lynch *et al*., 1986). Lynch *et al*. (1986) concluded that while the bright red colour of ground beef was important, informed consumers were more likely to have positive purchase intent toward vacuum-packaged ground beef even

though it was purple in colour and were as willing to buy the purple vacuum-packaged ground beef as the bright red product. These findings support the belief of some participants that the utilisation of educational materials at point-of-purchase could modify beef purchasing patterns of consumers in Vietnam.

4.2 Perceptions of US beef

Participants immediately ascribed high quality to US beef. Most participants characterised US beef as reputable and reliable in terms of quality and safety. Many thought US beef was expensive although some participants considered US beef to be reasonably priced or affordable (some cuts) in relation to value and some did not think about price. A fair number of participants considered US beef to be tender, frozen, dry-cooked, and produced in abundance. Almost all participants encountered US beef for the first time while attending the *US Beef Export School*. Therefore, it is reasonable to conclude that their first impression of US beef came primarily from eating high quality beef prepared at up-scale restaurants and by caterers specialising in beef preparation, through experiential learning including field trips to one of the largest meat packing plants and cattle feed yards in the US, and classroom activities conducted by nationally-recognised industry representatives and academic beef specialists. Participants agreed that offering US beef would have a significant positive impact on their companies and retail stores. Because the US is recognised as a good trademark, the presence of US beef might positively impact company image and increase the value of other goods offered in their retail stores.

4.3 Purchase of US beef by Vietnam retailers for importation

Participants indicated they would purchase primals or subprimals depending on price. However, some participants would also import quarters and special orders such as shanks for traditional Vietnamese dishes. The special demand for low-value, underutilised cuts such as shanks provides an opportunity for the creation of value-added products destined for meat markets in Vietnam. All the participants would further fabricate and package imported beef cuts. Participants immediately agreed that fresh beef would be their first choice because of customer preference as previously discussed. The primary target markets in Vietnam for US beef would be high-income consumers and up-scale restaurants. Participants recognised the importance of having sufficient freezer and cooler systems for meat storage. Most participating companies have central warehouses with freezer and cooler systems for storage, and refrigerated trucks for meat distribution. Some companies depend on suppliers to deliver meat to their retail stores. Most wholesale customers have their own freezer and cooler systems while the ultimate consumer utilises refrigerator/freezer units for in-home meat storage. The USMEF has expressed concern about the cold chain in Vietnam meat retail markets. However, as reported by the participants, imported US beef would be sold in supermarkets under conditions that would ensure proper preservation of quality. Further,

some participants reported that their company provides in-store consumer information regarding proper refrigeration of meat products.

Vietnamese customers shop for meat several time a week, purchasing single-meal portions. They are not in the habit of buying meat in bulk or storing meat for long periods of time. Instead, they prefer to buy meat when it is still "*fresh at store*." Therefore, successful retailers in Vietnam plan inventory assortments according to these shopping orientations. As a result, Vietnamese retailers are more likely to buy portioned primals and subprimals than retailers in the US. By customising the type and size of cuts retailers are in a better position to achieve higher sell-through margins. In an interview on Meatingplace.com (Gabbett, 2009), John Niemann, vice president for beef pricing, sales and business management at Cargill, one of the largest meat packers in the US, revealed the company boosted beef sales by marketing half-cuts and third- cuts to help retailers offer steaks at consumer-desirable price points. Additionally, price is usually the extrinsic factor that is processed fastest when consumers make a decision of whether or not to buy a package of meat (Grunert, 2004; Grunert, 2006).

4.4 Implications for the US beef industry

Most participants agreed that the US beef industry should provide technical support to Vietnamese importers by providing adequate information on product quality, export companies, and assist in organising experiential marketing, promotional events, and point-of-purchase informative materials. In this context, participants repeatedly suggested that the US beef industry could learn from the successes of US apple exporters in Vietnam. Most of participants agreed that the initial introduction of US beef at the retail level should saturate the market with a large-scale, national campaign. Additionally, some participants suggested that the US beef industry should advise Vietnam importers regarding regulations and procedures. Finally, some of the participants concluded that the US beef industry could best enhance export opportunities by assisting Vietnamese retailers in conducting marketing and consumer research focused on the purchase and consumption of beef in Vietnam.

5. IMPLICATIONS AND RECOMMENDATIONS

This research was an initial effort to explore retailer perceptions of US beef and the potential for import penetration. Preliminary results suggest a positive business environment for marketing US beef export to Vietnam. Further, the research team believes that the focus group participants' suggestions are industry-relevant and should be implemented. To validate these findings, more focus groups with a sensory component in retail and foodservice sectors should be conducted. Future quantitative research is needed to examine the qualitative findings with a larger sample of retailers and consumers.

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FORMULATION OF FLOUR BASED PEANUT SNACK USING MIXTURE DESIGN

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Abstract

Flour based peanut snack is a well-known local fried product widely consumed in Thailand. Its textural characteristic is one of the key determining factors influencing consumer acceptance. The aim of this study was to formulate three flours combinations using mixture design facilitated by Design Expert 6.0.5. Rice flour, wheat flour, and tapioca flour were chosen for the study. A quadratic model was assumed for the variable design, resulting in 14 flour combinations so that the total flour was controlled at 25% w/w. Hedonic scoring and Just-About-Right scale were employed for sensory evaluation of the product. The results indicates that a flour combination consisting of 13% rice flour and 12% tapioca flour achieved the highest liking score, satisfactory attributes and minimum cost.

Keywords: Flour based peanut snack, mixture design, hedonic scoring, just-about-right-scale

1. INTRODUCTION

Peanut (*Arachis hypogaea* L.), despite its name, is not a nut but belongs to the *Leguminosae* family. It is planted and consumed worldwide. The main nutrients in peanut seeds include protein (30%), fat (47%), and carbohydrate (12%) (http://th.wikipedia.org, 2008). In Thailand, it is cultivated nationwide and used as ingredient for various snacks or main dishes. Flour based peanut snack is of these locally consumed products. This product is flat-round in shape with around 6-7 cm in diameter. The number of peanut seeds in each piece varies (*e.g.*, from 8-20 seeds). It is mostly produced and sold daily by small business sellers. Nevertheless, its recipe and process have not yet been widely studied and adapted for industrial production.

The main ingredients of flour based peanut snacks include flour, sugar, salt, egg, water, and coconut milk. The brief processing steps include flour and sugar mixing, addition of salt, egg, water, and coconut milk, filtration, addition of peanut followed by deep oil frying, cooling and packing, respectively. Similar to any other crispy snacks, the textural characteristic of the flour based peanut snack is one of the key attributes influencing consumer acceptance. Numerous studies have been reported on flour blend effect, mostly focusing on soy flour and corn flour incorporation in fried wheat flour based snack (Senthil, Ravi, Bhat, & Seethalakshmi, 2002; Ward, Resurreccion, & McWatters, 1998; Ahamed, Singhal, Kulkarni, & Pal, 1997). In this context, the amylose-amylopectin ratio of flour or flour blend plays a major role because it determines the volume expansion and the texture of the finished snack. Amylose content has also been reported to be associated with the extent of oil uptake in deep fat-fried snack (Ahamed, Singhal, Kulkarni, & Pal, 1997). These quality attributes influence

consumer perception and acceptance of the final product. In flour based peanut snack, however, rice flour (83% amylopectin), wheat flour (72% amylopectin), and tapioca flour (83% amylopectin) (Hizukuri, 1988) are normally used as mixed ingredients. Therefore, the purpose of this study was to find the combination of these three flours which will result in a satisfactory flour based peanut snack product. Hedonic and Just-About-Right (JAR) scales were employed for sensory evaluation of the product.

2. MATERIALS AND METHODS

2.1 Product ingredients

The product contained dried raw peanut seeds, sesame, rice flour, wheat flour, tapioca flour, water, coconut milk, egg, fine salt, sugar. Palm oil was used for frying.

2.2 Flour based peanut snack preparation

Flour base was prepared from a mixture of flours and sugar to which was incorporated salt, egg, water and coconut milk. The combination was well mixed until the sugar was completely dissolved before sieving through a strainer to remove large particles. Peanut seeds and sesame were then added, and the mixture was transferred into the round-flat metal mould (diameter of 5.3 cm) to control the product shape and size. The product was subsequently deep fried in palm oil at 180 °C for around 40 seconds, then at 140 °C for around 15 seconds. The fried product was then let cool down to ambient temperature before being packed in laminated aluminium foil bag.

2.3 Experimental design

Except for flours of which total amount was controlled at 25% w/w, all other ingredients were fixed in product formulation. According to a preliminary experiment, the proportion range was 3 to 13% for tapioca flour, 13 to 23% for rice flour and 5 to 13% for all purpose wheat flour. Design Expert 6.0.5 (Stat-Ease, Inc.) was employed for mixture design with assumed quadratic model, resulting in 14 flour combinations (Table 1).

Table 1. Flour combinations from mixture design.

Flour Combination	*Rice flour (%)*	*Wheat flour (%)*	*Tapioca four (%)*
1	15.50	3.35	6.15
2	18.00	-	7.00
3	23.00	2.00	-
4	13.00	-	12.00
5	18.00	7.00	-
6	13.00	7.00	5.00
7	19.25	3.85	1.90
8	15.50	7.00	2.50
9	13.00	3.50	8.50
10	23.00	-	2.00
11	13.00	-	12.00
12	18.00	-	7.00
13	13.00	7.00	5.00
14	18.00	7.00	-

2.4 Product evaluation

All product samples were evaluated in order to obtain liking scores (7-point hedonic scale) and JAR scores (1 = Much too weak, 2 = Too weak, 3 = Just about right, 4 = Too strong, 5 = Too much strong). Each of 40 panellists was served with one piece of product. Product hedonic attributes included appearance, colour, flavour, sweetness, saltiness, and crispness. Selected samples were evaluated for attribute intensity employing JAR. Colour, sweetness, saltiness, and hardness were also evaluated.

3. RESULTS AND DISCUSSIONS

Regarding the hedonic sensory evaluation, the results indicate that combinations 1, 2, 4, 5, 6, 8, 9, 11, 12, and 13 did not differ significantly (see Table 2). We also found that crispness contributed significantly to the overall hedonic score (see Table 3). As indicated in Table 2, the flour combination 11 (rice flour 13%, tapioca flour 12%). received the highest score which was not significantly different from the score of combination 13 (rice flour 13%, wheat flour 7%, tapioca flour 5%). The results also suggest that rice flour at 13% constitute the right proportion. The largest proportion of rice flour at 23% (combinations 3 and 10) tended to lower the crispness hedonic score. This result could be explained by the influence of amylose-amylopectin ratio of flour or flour blend as reported in the literature (Senthil, Ravi, Bhat, & Seethalakshmi, 2002; Ward, Resurreccion, & McWatters, 1998; Ahamed, *et al.,* 1997). However, further investigation was made on flour combinations 11 and 13 employing JAR to profile the product so that a specific improvement could be suggested.

Table 2. Hedonic scores (*1 = Extremely dislike, 5 = Neither like nor dislike, 9 = Extremely like)* of flour based peanut snacks from 14 flour combinations. *Letters indicate significant difference amongst values in the same column (p < .05).*

Flour combination	Mean liking score						
	Overall	Appearance	Colour	Flavour	Sweetness	Saltiness	Crispness
1	6.4^{ab}	6.4^{bc}	6.4^{a}	6.2^{a}	6.1^{ab}	5.9^{a}	6.0^{bc}
2	6.4^{ab}	6.4^{bc}	6.4^{a}	6.2^{a}	6.1^{ab}	5.9^{a}	6.0^{bc}
3	6.1^{bc}	6.3^{c}	5.9^{ab}	5.8^{ab}	5.6^{b}	5.6^{a}	5.8^{bcd}
4	6.4^{ab}	6.4^{bc}	6.4^{a}	6.2^{a}	6.1^{ab}	5.9^{a}	6.0^{bc}
5	6.4^{ab}	6.4^{bc}	6.4^{a}	6.2^{a}	6.1^{ab}	5.9^{a}	6.0^{bc}
6	6.4^{ab}	6.4^{bc}	6.4^{a}	6.2^{a}	6.1^{ab}	5.9^{a}	6.0^{bc}
7	5.9^{bc}	6.1^{c}	6.1^{ab}	5.5^{ab}	5.7^{ab}	5.8^{a}	5.8^{bcd}
8	6.2^{abc}	6.2^{c}	6.7^{a}	6.0^{ab}	6.1^{ab}	5.9^{a}	5.3^{cd}
9	6.4^{ab}	6.9^{ab}	6.1^{ab}	6.1^{ab}	6.4^{a}	6.1^{a}	6.0^{bc}
10	6.1^{bc}	6.5^{abc}	6.5^{a}	5.4^{b}	5.7^{ab}	5.7^{a}	5.6^{bcd}
11	6.4^{ab}	5.9^{c}	5.5^{b}	6.1^{ab}	6.38^{ab}	6.2^{a}	7.4^{a}
12	6.4^{abc}	6.4^{bc}	6.4^{ab}	6.4^{a}	6.34^{ab}	6.1^{a}	5.7^{bcd}
13	6.6^{ab}	7.2^{a}	6.9^{a}	6.1^{ab}	6.38^{ab}	6.1^{a}	6.7^{ab}
14	5.5^{bc}	6.6^{abc}	6.3^{ab}	5.7^{ab}	5.54^{b}	5.5^{a}	4.8^{d}

Table 3 Linear model describing relationship between overall liking score and product attribute liking scores (*Overall liking score* = $Y = 2.18247901352456-9.22815493277694E-02*X_1+.228769258786121*X_2+6.34402086385718E-02*X_3+.994663018412948*X_4-.769223467650164*X_5+.234665755839502*X_6$)

Source	Value	Standard error	t	Pr > |t|
Intercept	2.182	1.623	1.345	0.221
Appearance (X_1)	-0.092	0.106	-0.867	0.415
Colour (X_2)	0.229	0.121	1.893	0.100
Flavour (X_3)	0.063	0.208	0.306	0.769
Sweetness (X_4)	0.995	0.513	1.941	0.093
Saltiness (X_5)	-0.769	0.482	-1.595	0.155
Crispness (X_6)	0.235	0.079	2.966	0.021*

According to the JAR test (Figure 1), over 50% of the panellists were satisfied with the product attributes of colour, sweetness, saltiness and hardness. However, the product obtained from flour combination 11 seemed to be too strong in colour and hardness for some tasters (about 40%). This result suggested that two formulas of the product could be developed as hard texture and soft texture to satisfy two different consumer groups of preference. However, when cost is considered, flour combination 11 should be selected.

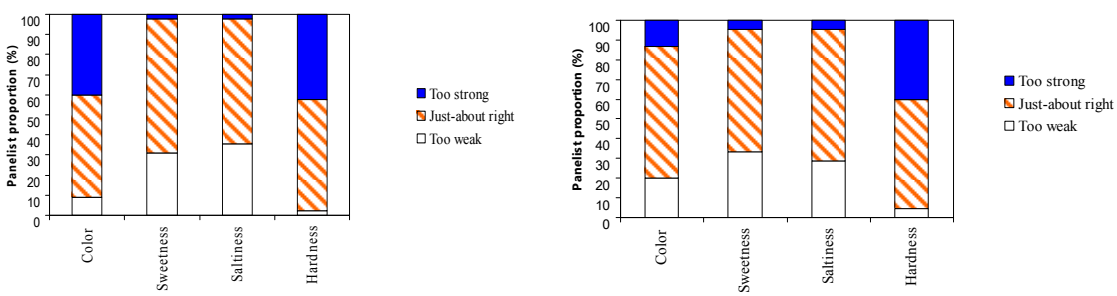

Figure 1 Product attribute intensity justified by panellists using JAR scale a) Flour combination 11 (left panel) and b) Flour combination 13

4. CONCLUSIONS

According to this study, the most suitable flour combination for flour based peanut snack production consists of 13% rice flour and 12% tapioca flour because this combination obtained the highest hedonic score and had minimum cost.

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APPLICATION OF GREEN TEA EXTRACT TO BISCUIT CREAM

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Abstract

Tea, is well-known for its health benefits, and also plays an important role in domestic and foreign trade of Vietnam. In Vietnam, tea is used mainly as a beverage in various forms, while its utilisation in other fields is limited. In addition, only young tea leaves and buds are used for these purposes, leaving large amount of tea leaves unused. The aim of our current work was to examine the possibility to use freeze dried extract from "unused" tea leaves as ingredient for biscuit cream to improve oxidation stability of this product.

In the present work, the radical scavenging activity of the extract from older leaves of local tea was evaluated using DPPH assay. We measured the perception thresholds of some sensory attributes associated with green tea extract in samples of biscuit cream. We found that changes in brightness, astringency, sweetness, and bitterness were detected at level of 0.5%, 0.75%, 1% and 1% respectively. Finally, green tea extract was used as an ingredient for biscuit cream at three levels: 500ppm, 1000ppm and 1%. Samples were stored at 40°C and the oxidation stability of products with addition of BHT, green tea extracts, and without any antioxidant were evaluated by measuring the peroxide and TBA values. We found that green tea extracts showed good inhibition effect on lipid oxidation of the cream. The inhibition effect of green tea extract at level of 500ppm was equivalent to the effect of BHT at 200ppm. The higher the concentration of tea extract applied, the greater the effect.

Keywords: green tea, biscuit, antioxidant, sensory analysis, lipid oxidation.

1. INTRODUCTION

Green tea is a popular drink in Vietnam as well as in many parts of the world. Its consumption has increased in many countries since the discovery of its health benefits. It has been well documented that green tea possesses antioxidant, antimicrobial, anticarcinogen effect and others. These effects are supposed to be linked to bioactive substances present in tea such as catechins, methylxanthine. Among these substances, epigalocatechin galate (EGCG) is very important because of its high concentration and high activity (Gramza & Korczak, 2005; Shahidi & Nuczk, 2003; Wang *et al*., 2000; Hara, 2001). The chemical characterisation and bioactivity of green tea depends on many factors, such as geographical location, cultivar species, season, age of the leaves, climate and horticultural practices (Fernandez, Pablos, Martín, & González, 2002; Lin, Tsai, Tsai, & Lin, 2003). In most studies, green tea was from Chinese, Japanese or Indian origin, and tea of Vietnamese origin was rarely studied, this is particularly the case for tea from central Vietnam.

Vietnam is one of the biggest tea producers of the world. Tea here is made mainly from the buds and young leaves. Local people use older leaves to make drink as well, but using older leaves for other purpose is unpopular in the country, including for extending food shelf-life. Biscuit is a favourite food which is usually stored for extended time before consumption. During the storage, we observe oxidation of the lipid component of the biscuit, particularly from the cream which has a large proportion of shortening. This slow oxidation process deteriorates the nutritional and sensory value of the product, making it unacceptable for consumers. In order to delay this process, synthetic antioxidants such as BHA, BHT have been used, but the safety of these compounds is questionable and there is a trend to restrict their use.

This paper presents a study on the possibility to use the extract from older tea leaves for preventing oxidation of biscuit cream.

2. MATERIALS AND METHODS

2.1 Chemicals:

DPPH (2.2-diphenyl 1-picryl hydrazyl) from Sigma, Singapore; TBA (Thiobarbituric acid) from Merck, Germany; Methanol in DPPH assay from Merck, Germany; other chemicals of Chinese origin.

2.2 Preparation of green tea extract

Fresh green tea was collected from the tea field in the countryside near Danang City, Vietnam. Young tea leaves and the buds were left, and only the older leaves were used for experimental purposes. Tea enzymes were inactivated by exposing the tea leaves to steam for 45 seconds. The moisture of the tea measured after steaming was 63.97% (analysed by Ohaus MB35 Moisture Analyser).

The green tea was extracted with water as follows: steamed tea leaves were cut into to 2-3 mm width bands and soaked in water (20 ml/1 g dry mass). All the materials were contained in a 2-necked round bottom flask, connected with a condenser and a thermometer. The extraction took place in water bath at 90 ^{o}C for 30 minutes. The extract was then filtered and concentrated in vacuum oven at 60°C, 200 mbar. The concentrated extract was stored at -20 ^{o}C before freeze-drying for 12 h, yielding brown yellow powder.

2.3 Evaluation of free radical scavenging capacity of tea extract with DPPH assay

The free radical scavenging capacity of the tea extracts was determined and compared with that of BHT using the DPPH discoloration method (Lu & Chen, 2008). Four concentrations of the tea extract in methanol 100ppm, 300ppm, 500ppm, 700ppm, were prepared. Dilutions of the tea extracts or BHT in methanol (1 ml) were added to 1 ml of DPPH (0.1 mM in MeOH) and mixed thoroughly and allowed to stand for 40 min before absorbance was measured at 517 nm using a Biorad spectrophotometer. The mixture of DPPH solution (1 ml) and methanol (1

ml) were used as a negative control. Results were expressed as Inhibition Capacity (IC) which is calculated as follows:

$$IC = \frac{A_{DPPH} - A_{sample}}{A_{DPPH}} x100(\%)$$

where A_{DPPH} represents the absorbance of the negative control sample and A_{sample} the absorbance of analysed sample.

2.4 Preparation of biscuit cream:

The formula of basic biscuit cream was as follows: shortening, 41.03 g; lecithin, 0.54 g; icing sugar, 50.74 g; milk powder, 7.13 g (Manley, 2000). These materials were provided by Quang Ngai Confectionary, Vietnam. The shortening was agitated intensively by hand-mixer, so that it became soft. Then the melted shortening was added with other ingredients and mixed thoroughly again. The product was smooth without any grittiness.

2.5 Measurement of peroxide value

According to AOAC 965.33

2.6 Measurement of thiobarbituric value (Alexander, 1996)

Ten gram of cream was added with 2.5 ml HCl 4N and 97.5 ml distilled water in 500 ml round bottom flask which was connected to a simple distillation unit. The first 50 ml of distillate were collected, from which 5 ml were transferred to a glass tube. After addition of 5 ml TBA solution (2mg/ml butanol) the content of the tube was boiled in a water bath for 2 h, quickly cooled in tab water to reach ambient temperature and the absorbance of orange colour of the solution was measured at 532 nm against the control sample which was prepared in the same way with exception that 10 ml of distilled water was used instead of the 10 g of cream for distillation.

2.7 Sensory analysis:

We assessed, using rated difference scales (Lawless & Heymann, 1998), the perception thresholds of three attributes: bitterness, astringency and sweetness. Six different samples were prepared; among them there were two control samples without tea addition (one coded and one used as reference) and four cream samples to which were added tea extract at levels: 0.25%, 0.50%, 0.75% and 1% with regard to cream weight. All samples were coded with randomised 3-digit numbers except the control used as reference. For each attribute, the difference between the coded sample and the reference was rated. The rating scale ranged from 0 (no difference) to 9 (extreme difference). The brightness liking of control and four samples with tea addition were also determined using a 10-point scale (0: dislike a lot and 9: like a lot). The attributes were evaluated in the following order: astringency, bitterness, sweetness and brightness.

The evaluation took place in separate booths equipped with red and white lamps, except for the analysis of brightness which was carried out under white light. The evaluation of other attributes took place under red bulbs to mask the brightness difference.

The panel consisted of 30 students from Department of Food Technology, Danang University of Technology, who knew well sensory evaluation techniques. In order to reach an accurate result, panellists were provided with bread and distilled water to clean their palates after every tasting.

2.8 Statistical analysis

Statistical assessment was carried out with the software system of Statgraphics Plus for Windows 4.0. The rated difference of each attribute at all levels were compared using LSD test with significant level of $\alpha = .05$.

3. RESULTS AND DISCUSSION

3.1 Radical scavenging activity of the tea extract

The antioxidant effect of green tea is well known. However, in most studies only commercial tea products or young tea leaves have been used, and therefore very few studies have focused on the antioxidant property of older leaves. In order to examine the anti-radical effect of older leaves of the local tea, we employed the DPPH assay mentioned above and determined the Inhibition Capacity (IC) of the tea extract at various concentrations and of the BHT at 200ppm. Results are shown in Table 1.

Table 1: Inhibition Capacity (IC) of the tea extracts and BHT.

Samples	BHT(200ppm)	Tea extract			
		700ppm	500ppm	300ppm	100ppm
IC (%)	95.3	96.4	95.4	94.3	93.2

The result showed that the tea powder possessed very good anti-radical activity at all concentrations applied. Higher concentration scavenged the free radical DPPH better. Tea powder at concentration 500ppm had nearly the same radical scavenging activity of the synthetic antioxidant BHT at 200ppm.

Tea catechins are believed to be the main compounds responsible for the antioxidant activity of tea. It is also known that the content of tea catechins in older leaves is lower than in young leaves (Hara, 2001). However, the results of our measurements indicate that the extract from old leaves of the local tea could be a good source of antioxidants and could replace BHT to inhibit the oxidation of food lipid and because tea extract is natural, it could overcome the problem rising from concerns about synthetic antioxidants.

3.2 Evaluation of recognition threshold of astringency, bitterness, sweetness and brightness change in biscuit cream.

The tea extract had brown yellow colour along with a bitter and astringent taste and this could affect the sensory properties of biscuit cream. Therefore, it is necessary to measure the

recognition threshold of astringency, bitterness, sweetness, and brightness change of biscuit cream because these properties could guide how much tea extract can be applied without changing much the sensory properties of the product.

Five samples of cream were prepared and analysed according to sensory analysis method mentioned earlier. Mean values and standard evaluation were calculated for each attribute. LSD test at significance level 5% was employed using software Statgraphics Plus 4.0. Results were shown in table 2 and table 3.

Table 2: Score of rated difference between coded and reference samples.

Attribute	***Samples***				
	Control	**0.5%**	**0.75%**	**1.00%**	**1.25%**
Astringency	0,03±0.18[a]	0,93±1.57[ab]	1,33±2.15[b]	1.40±2.11[b]	2.70±2.71[c]
Bitterness	0,03±0.18[d]	0,83±1.58[de]	0,90±1.99[de]	1,17±2.09[e]	2,87±2.89[f]
Sweetness	0,01±0,31[g]	0,73±1,05[gh]	1,17±1,32[gh]	1,53±1,50[h]	1,83±1,42[i]

Table 3: Brightness liking score of cream samples.

Samples				
Control	**0.5%**	**0.75%**	**1.00%**	**1.25%**
8.53±0.63[k]	6.83±0.83[l]	6.03±1.25[m]	5.60±1.50[m]	4.57±1.38[n]

Scores were expressed as mean ± standard deviation. Index above the score showed significant difference at level 5% by LSD test. Scores with the same letter were not significantly different each other.

The results showed that addition of tea powder affected the sensory properties of the samples of biscuit cream. The brightness of product was less favoured even at the lowest level of tea extract application (0.5%) in comparison with the control. The LSD test showed significant difference in brightness liking at this level. When tea was added at a concentration of 1.25%, the average hedonic score was less then five, meaning that people do not like this colour of cream, this suggest that colorant may be added, in this case, in order to improve the colour appearance of the cream. The brightness change was due to the brown yellow colour of tea extract, this change was more evident at high concentration of the extract. Because of this change in appearance, the evaluation of other sensory attributes was carried out under colour mask (*i.e.*, under red light).

Tea possesses a characteristic astringency and bitterness therefore we can expect that, the addition of the extract to the cream will create a change in the perception of astringency and bitterness of the cream. However, when the tea extract was added at a level of 0.5%, only few panellists could recognise astringency and bitterness, as indicated by the LSD test which showed no difference between tested and reference samples. At a level of 0.75%, astringent taste in the cream samples was detected by more panellists but still few panellists detected the bitterness of the products. The difference in astringency between samples with a 0.75% extract addition and the reference sample was statistically significant, while the difference in

bitterness was not significant. It could be conjectured that the sweetness of the product masked the bitterness better than the astringency. The bitterness of the samples was more evident at level of 1.00% when LSD test showed that the samples with a 1.00% tea addition were significantly different from the reference samples.

Sweetness is also a characteristic property of the biscuit cream because it contains a large amount of sugar. Results from Table 2 also showed that the addition of tea powder could change this characteristic. The LSD test showed that this change was significant only at the tea concentration above 1.00%.

Therefore, it is possible to conclude that the recognition threshold of astringency, bitterness, and sweetness of the tea extract in biscuit cream is 0.75%, 1% and 1% respectively, while brightness liking of the cream decreases at a level of 0.5%.

3.3 Effect of green tea extract on the oxidation stability of biscuit cream

Biscuit cream contains large amount of lipid that could readily oxidize during storage. To examine if the extract from old leaves of local tea could replace BHT to protect biscuit cream from oxidation an experiment was carried out as follows.

We prepared six lots of biscuit cream with the formulation mentioned earlier: one was a control sample without any addition; one was treated with 200ppm BHT; tea extract was added to the other samples, with tea extracts having the following concentrations: 500ppm, 1000ppm and 1%. Thirty grams of cream from each lot was weighted into 100 ml beaker. Samples were prepared for six measurements in duplicates (12 beakers). The beakers were stored in the oven at 40°C during 16 days. Every three days, the samples were taken for analysis of peroxide value and TBA value; mean values were calculated. Results are shown in Figures 1 and 2 which display the relationship between measured values and storage time.

Peroxides are primary by-products of oxidation process of lipids and their concentration in lipids is characterised by their peroxide value. It could be noted from Figure 1 that this parameter increased continuously during the storage of all samples at elevated temperature (40°C). Addition of the synthetic antioxidant BHT or tea extract lowered the peroxide value. The analysis of BHT samples and samples with 500ppm tea extract indicated that the BHT at 200ppm and the tea extract at 500ppm had the same inhibiting effect on the formation of peroxides. The results also showed that higher concentration of tea extract decreased PV levels more. We also found that application of the tea extract at a concentration level of 1% was the most effective. This suggested that tea extracts did not show prooxidant effect at high level, in contrast with what is observed for vitamin E which has prooxidant effect at high concentration (Pokorny, 2001).

Similarly, the increase of TBA Value (TBAV) during storage was observed from Figure 2. TBAV reflected the concentration of malonaldehyde in samples. It is a typical secondary product of lipid oxidation. The courses of TBAV changes during the storage showed that all extract

treatments could delay the formation of malonaldehyde and that this effect could be rank \-ordered as: 1% > 1000ppm > 500ppm ≈ BHT.

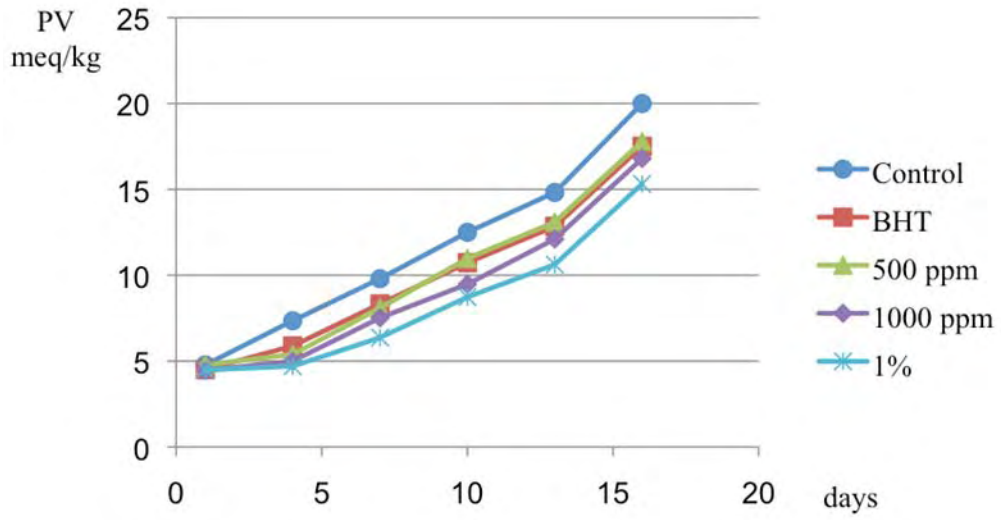

Figure 1: Changes of peroxide value during storage.

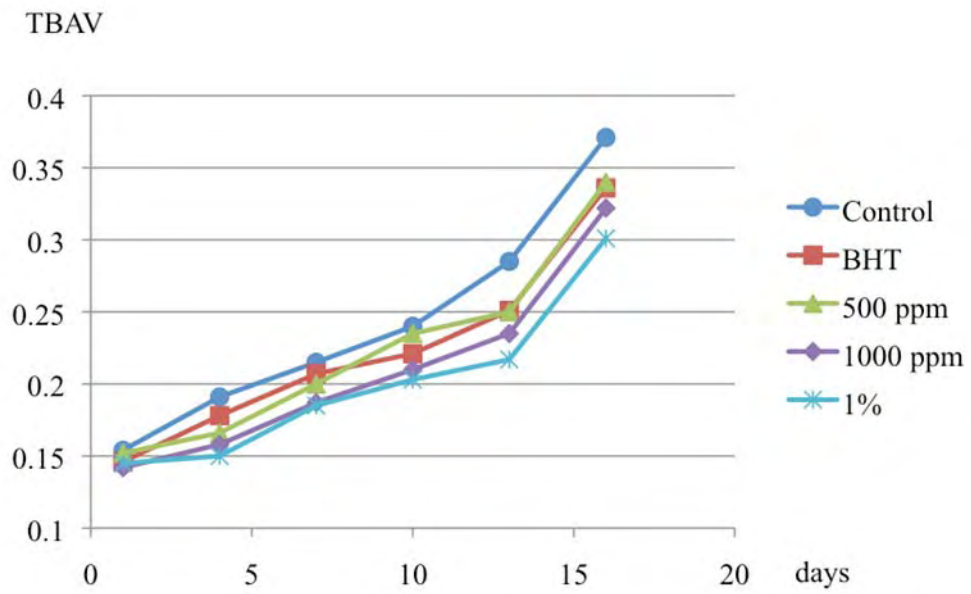

Figure 2: Changes of thiobarbituric acid value during storage.

Results from the analysis of PV and TBAV in cream samples during the storage showed that the extract from old leaves of local tea could delay the oxidation of biscuit cream. Green tea extracts at concentration 500ppm were as effective as BHT at 200ppm. This concurs with the conclusions from the DPPH assay. The antioxidant effect of the tea extract could be explained by the radical scavenging activity, but, the chelating ability of catechins could also contribute to this effect (Pokorny, 2001; Hara, 2001).

In a similar study on antioxidant property of tea extract, Wanasundara and Shahidi (1998) reported that an aqueous ethanol extract of green tea showed prooxidant effect in edible oil possibly due to catalytic effect of chlorophyll. In our work, we used water as solvent, so the content of chlorophyll is negligible and the extract exhibits strong antioxidant property.

Our study suggests that application of green tea to biscuit cream does not have a prooxidant effect and this could be an advantage if the extract is needed to be applied at high concentration (*e.g.* in production of functional food). As an aside, some authors also suggested to use some spices in prevention of lipid oxidation in biscuits (Reddy, Vrooj, & Kumar, 2005).

In summary, the extract from old leaves of the local tea near Danang, Vietnam has been proven to be a potential natural antioxidant that could replace BHT in application to biscuit cream. Its recognition threshold for astringency, bitterness, sweetness change and brightness change in biscuit cream is 0.75%, 1%, 1% and 0.5% (with regard to cream weight) respectively.

4. CONCLUSIONS

Using natural antioxidants to replace synthetic ones is a current trend in food industry. However, only few natural antioxidants and few applications have been successful. This work evaluated the possibility to use older leaves of local tea in central Vietnam to inhibit oxidation of lipids in biscuit cream. In order to do so, antiradical activity of the extract was evaluated and the effect of the tea extract on sensory properties of the cream was also studied.

The results from the sensory and chemical analysis provided useful information on the threshold value of green tea extract in biscuit cream and on the oxidation stability of the cream fortified with tea extract. Below the threshold value, the sensory quality of green tea extract fortified cream is not significantly compromised. Also the cream is proven to be more stable against oxidation.

So it seems that green tea extract fortified biscuit could be a functional food product with additional health benefits. This provides a good guide for those biscuit manufacturers who want to pursue the production of functional biscuits with green tea extract fortification.

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Part 4: Sensory-instrumental relationship

EXPLORING THE OPTIMISATION MODEL OF VIETNAMESE CONSUMERS FOR STERILISED MILKS

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Abstract

The objective of this study was to describe the sensory and physico-chemical properties of seven commercial strawberry sterilised milk products bought in local supermarkets and to evaluate consumer preferences for these products. We performed three types of analyses: (1) descriptive analysis, (2) physico-chemical analysis, and (3) consumer analysis. For the descriptive analysis, six trained panellists identified and evaluated 13 sensory attributes (involving taste, aroma, texture) using 7-point structured line scales. In the second analysis, the gross physico-chemical compositions of the milk products were determined for *total protein, fat content viscosity,* and *colour* using the *CIE L*a*b* tristimulus method. In the third analysis, we performed a consumer analysis, in which 140 consumers from a panel were asked to evaluate the overall-liking of the samples using a 7-point hedonic scale.

The results differentiated the milk samples based on sensory attributes (e.g., *pink colour, greasiness, creaminess*) and physico-chemical properties (*fat content and viscosity*), respectively. We found that *health* and *sensory appeal* were the most important factors when choosing products and that *sweetness* and *greasiness* were the key sensory attributes driving consumer preference. Multiple factor analysis (MFA) showed that consumer preference was more correlated to sensory attributes than to physico-chemical properties. Preference mapping revealed four clusters of consumers.

Key words: dairy products, Vietnamese consumer, preferences, food choice

1. INTRODUCTION

Until recently cow milk was not easily available in the Vietnamese market and so dairy products were not part of Vietnamese food habits. It is only for the last twenty years that Vietnamese companies have been producing fresh milk. Today Vietnam has a total of 22 milk factories. Vinamilk with nine plants has a productivity equal to 1.2 billion litres per year (Dinh, 2009). Recent surveys indicate that the consumption of fresh milk and dairy products is increasing (USDA, 2007). Consumers consider dairy products as high value processed food products which also have nutritional and health benefits. Among the dairy products currently available in the market, strawberry sterilised milks are the most popular. Yet, consumer motivations for choosing this type of products are still not well understood. So the purpose of

this research was to analyse (1) the sensory attributes of strawberry sterilised milk, (2) its physico-chemical parameters, and (3) consumer preference.

2. MATERIALS AND METHODS

2.1 Stimuli

We used seven strawberry sterilised milks produced by Tetrapak technology: DutchLady, Vinamilk, Nutifoods, Daisy, Izzi, Milky, and Ancomilk. The strawberry sterilised milk samples were stored in refrigerated conditions (4 to 5°C); they were taken out of the refrigerator one hour before the experiment and maintained at room temperature (25°C). Samples were served in 30 ml white plastic cups coded with three-digit numbers.

2.2 Methods

Descriptive test. Six panelists (4 females and 2 males) were screened and trained under ISO 13300–1:2006 and ISO 5492, 2008 standard. During training, panelists tasted products and agreed on a list of attributes, definitions, references, and scale measurements. The training lasted for one week with one session of two hours per day. At the end of training, panellists evaluated the seven strawberry milk samples on 7-point structured line scales with one repetition. Thirteen scales were used to perform the evaluation. These scales were 1) astringent, 2) butter, 3) brown, 4) cream, 5) film, 6) greasiness, 7) oral viscosity, 8) sourness, 9) sour flavour, 10) sweetness, 11) strawberry aroma, 12) strickiness, and 13) pink. Samples were presented in a randomised balanced block design within each session.

Consumer test. One hundred and forty consumers from Hochiminh City (Vietnam) agreed to participate in this study. All consumers were adults and most were between the age of 18 and 65 year old and their distribution roughly matched the Vietnamese population age distribution. The numbers of men and women were roughly equal. Participants had to evaluate their overall liking of strawberry sterilised milk products on 7-point scales. Samples were served in random orders. Participants were also asked to fill in a small questionnaire on their food habits and preferences for dairy products.

Gross composition parameters. The Color of products was determined with a Konica Minolta CR-410 colormeter using color scale CIE *L*a*b* (Gámbaro, Ares, Giménez, & Pahor, 2007). The apparent viscosity of products was measured with a Brookfield VI rotary viscometer (Brookfield Engineering Laboratories Inc., Stoughton, MA); using spindle no. 1 at 60 r.p.m. Measurements were made at ambient temperature. To avoid thixotropic effects, the samples were thoroughly stirred just before measurements. The Kiendahj method was used to measure total protein content of strawberries sterilised milks (TCVN 5537:1991) and the gravimetric method to was used to determine fat content in milk products. (TCVN 6508:1999)

Data analysis: The packages SensomineR and FactomineR (with R version 2.8.0, Lê & Husson, 2006) were used to analyse sensory and consumer preferences data. Descriptive test data were analysed with analysis of variance (ANOVA). Preference mapping (PREFMAP) was

used to combine sensory properties and consumer data to explore consumer-preferences. ANOVA was also used to analyse the difference between the physico-chemical properties of the milk products. Consumer data, physio-chemical properties, and sensory properties were combined using multiple factor analysis (MFA, see Morand & Pagès, 2006) to describe the relationship between sensory, physio-chemical properties, and consumer preferences.

3. RESULTS AND DISCUSSION

3.1. Physico-chemical properties

Fat content, total protein, viscosity, and color of milk products are shown in Table 1. The results indicate that *Ancomilk* and *Izzi* have high fat content, as opposed to *Milky, Nutifood, Daisy*, and *Dutchlady* which all have a low fat content. We found no significant differences about total protein amount (p >.05). *Nutifood* has the highest viscosity.

3.2. Sensory properties

The thirteen scales rated by the six trained panellists were analysed using principal component analysis (PCA). The first two principal components (PCs) of the analysis explained 62.4% of the variance.

Table 1. Physio-chemical analysis and colorimetry of products:*L*. a*. b*: colour parameters* (Gámbaro *et al*., 2007)

Products	Fat [g/100ml]	Total Protein [g/100ml]	L*a*b colormetric			Viscosity [Cp]
			L*	a*	b*	
Milky US	0.804±0.03	1.364±0.03	107.300±2.82	37.97±2.50	06.54±0.78	11.30±2.50
Nutifood	1.110±.003	1.348±0.04	104.157±2.63	05.54±2.90	23.48±1.50	25.10±1.87
Daisy	0.911±0.03	1.218±0.03	108.963±2.54	37.43±2.80	05.80±0.95	08.69±1.10
Vinamilk	1.726±0.05	1.422±0.05	109.937±2.80	34.62±2.75	04.49±0.75	10.16±1.55
DutchLady	1.084±0.06	1.466±0.04	110.943±2.74	24.59±2.76	12.52±1.09	10.87±1.78
Ancomilk	1.726±0.04	1.494±0.06	101.450±2.53	35.39±2.54	09.79±0.75	14.13±1.96
Izzi	2.004±0.04	1.417±0.04	110.455±2.64	41.06±2.55	-1.25±0.05	09.12±1.09

Figure 1b shows the plot of the correlations between the sensory scales and the first two PCs along with the "correlation circle." As can be seen from this graph, the sensory scales form two distinct clusters. The first cluster includes texture properties such as: *oral viscosty, greasiness, stickiness;* and the second cluster includes aroma properties such as: *sweetness, strawberry aroma, sour flavour*. The *brown* color was negatively correlated with *pink* color ($r = -.85$; $p < .05$) and *strawberry* aroma ($r = -.80$, $p < .05$).

Figure 1a displays the projections of the products on the first two PCs. Ancomilk and Nutifood are clearly differenciated from the other products. Ancomilk was associated to *stickiness, greasiness, stickiness,* and *strawberry*; Nutifood was associated to the *brown* color and at the opposite side of PC-1, Izzi was characterised by *sweetness, pink color,* and *strawberry aroma.*

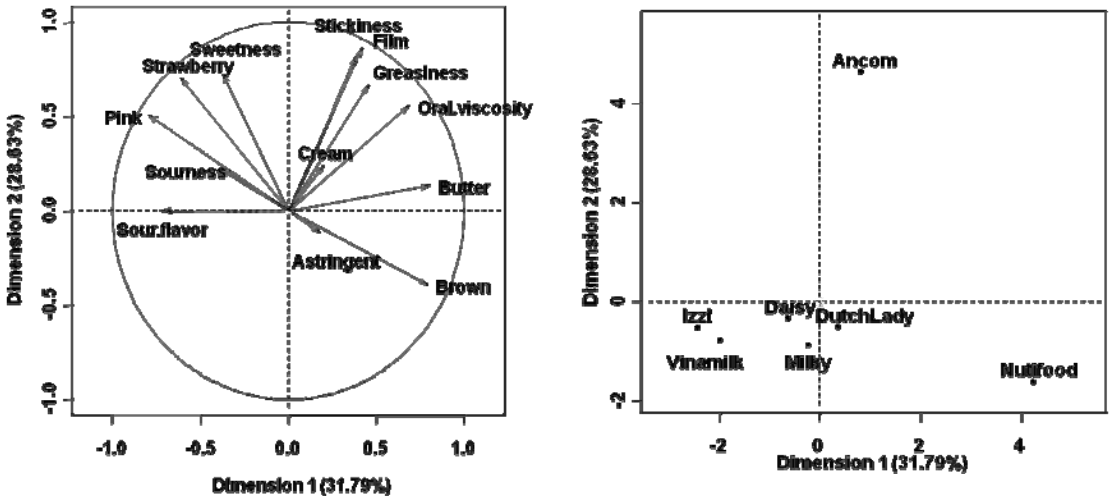

Figure 1. Correlation cirle (a) and product projection (b) of the seven sterilised milks studied.

3.3. Consumer preferences

For all products studied, the average of overall liking score was around 4 exept for Daisy. We analysed the data using a repeated measurement design ANOVA with product being the within subject factor. We observed a significant difference between product preferences ($p < .05$). The most liked product was Vinamilk and the least liked product was Daisy (Figure 2).

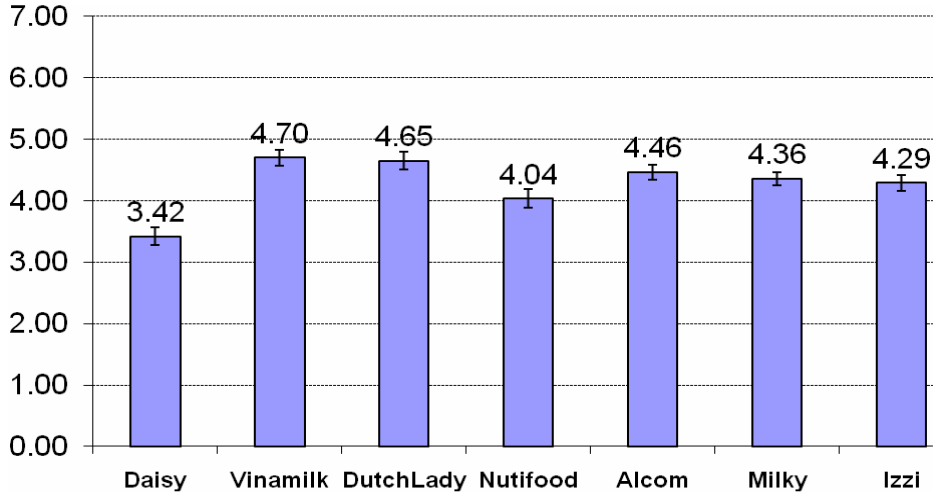

Figure 2. The overall liking score of 140 consumers

The results of survey on milk consumer habit showed that more than 87% of the consumers reported that they often drink milk, at least "1 to 3 times per week." Among the products studied, Vinamilk and Dutch Lady are the most familiar products as more than 90% participants reported usually drinking them. When chosing milk, consumers were interested in *health* (71%), *sensory appeal* (64%), *origin* (41%), *trademark* (40%), and *price* (26%). Only 5% of consumers reported being concerned by *package* (see Figure 3).

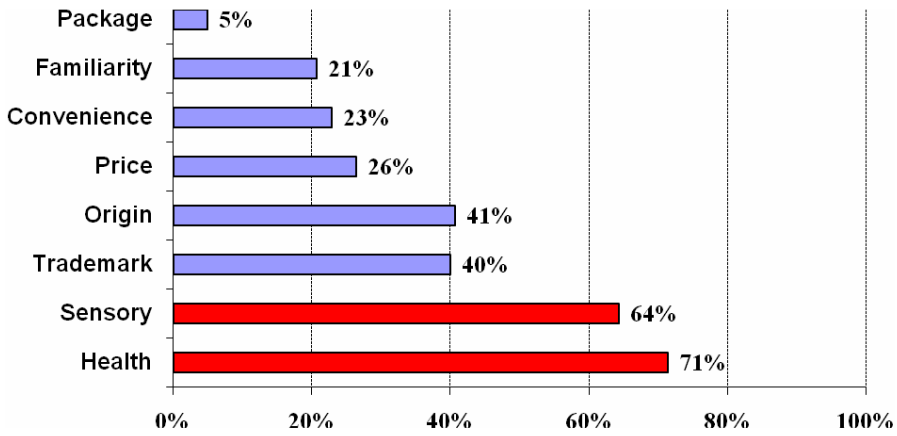

Figure 3. The principal factors influencing milk choice of consumer

A preference mapping analysis confirmed the results of the hedonic test. About 70% of consumers liked Vinamilk and Izzi products and about 60% liked Dutch Lady, Daisy, Nutifood, and Ancomilk. From the preference mapping analysis, we can derive a description for an optimum product which would be close to Vinamilk and Izzi and which would be characterised by *pink color, strawberry aroma*, and *sweetness* (Figure 4).

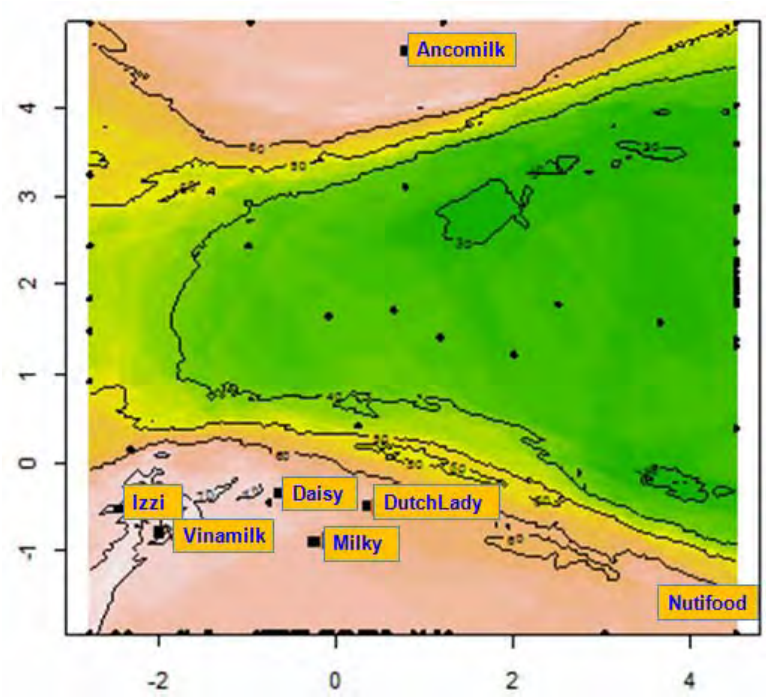

Figure 4. Preference mapping of strawberry sterilised milks

The analysis also indicate that there were four clusters of consumers which were cluster 1 (46 consumers), cluster 2 (37 consumers), cluster 3 (28 consumers), and cluster 4 (29 consumers) as shown Figure 5.

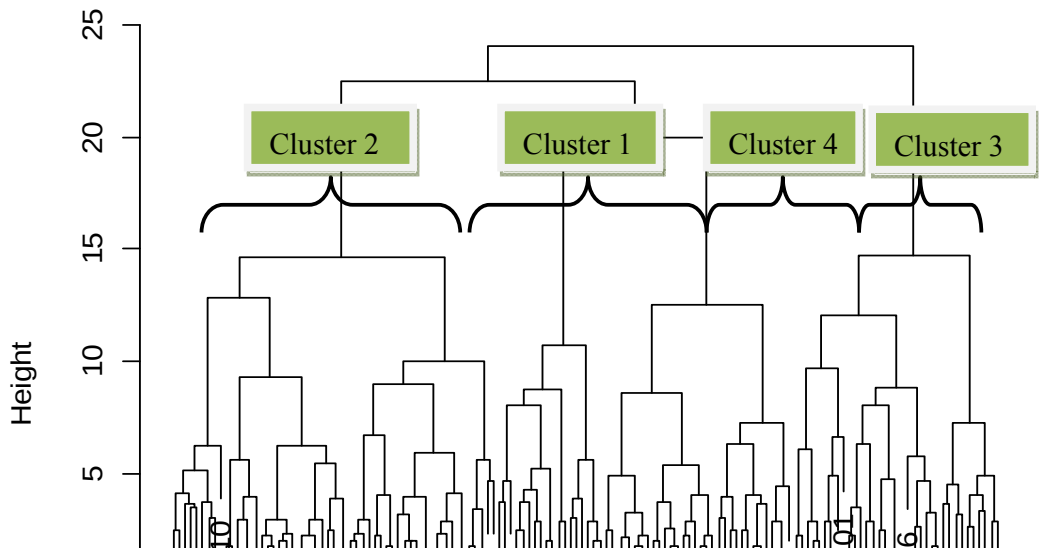

Figure 5. Cluster consumers from preference mapping

3.4. Relationship between sensory, physico-chemical, and consumer data

Multiple factor analysis (MFA) was used to analyse a data matrix obtained by the concatenation of three data sets: sensory profile, physico-chemical parameters, and average score of each of the four clusters of consumers obtained from the preference mapping analysis. The first three PCs of the MFA explained 75.59% of the variance. Figure 6 shows the plot of the correlation of these PCs with variables used in the analysis." Consumer clusters 1 and 2 are associated with *sweetness, protein, and greasiness*; consumers cluster 3 is associated with *strawberry aroma, sour flavor and pink colour*, and consumer cluster 4 was associated with *film, strawberry sourness* and *oral viscosity*.

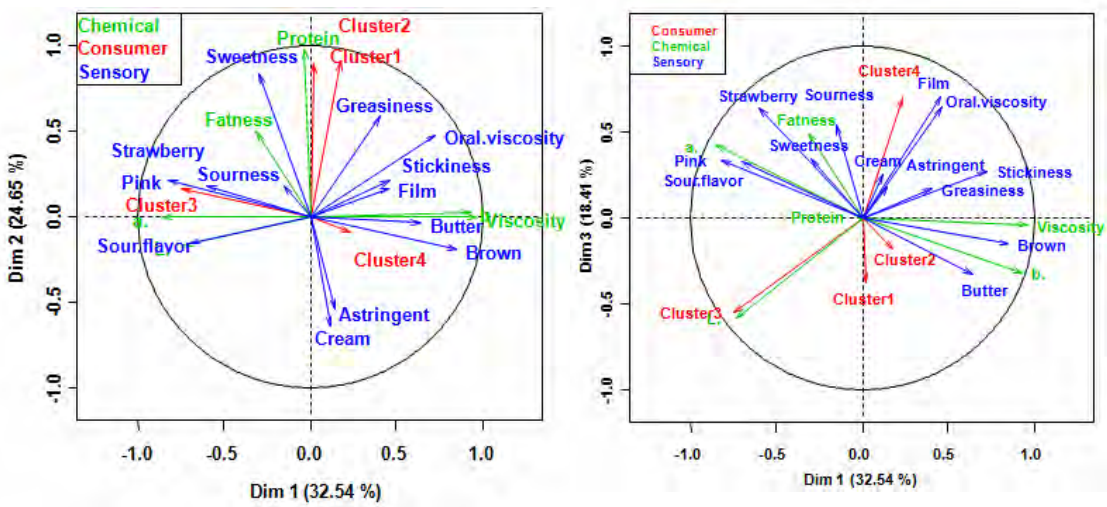

Figure 6. MFA: Correlation of chemical, sensory, and consumer variables with PCs1 and 2 (left) and PCs 1 and 3 (right).

4. CONCLUSION

This study examined thirteen sensory properties of strawberry sterilised milk products and their relationships with the physico-chemical properties of these milks. Among the products studied, the preferred product was Vinamilk, which was characterised by *strawberry aroma, sweetness,* and *pink color*. Finally, *sensory appeal* and *health* are very important when choosing milk products.

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Vietnamese standard, TCVN 6508:1999. *Gravimetric method determined fat content in milk products.*

THREE COMPOUNDS WITH POTENT α-GLUCOSIDASE INHIBITORY ACTIVITY PURIFIED FROM SEA CUCUMBER *STICHOPUS JAPONICUS*

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Abstract

Diabetes mellitus is a worldwide health problem which is increasing every year. One therapeutic approach to decrease postprandial hyperglycemia is to slow down the absorption of glucose through inhibition of α-glucosidase. Here we explore the potential α-glucosidase inhibitory activity of compounds extracted from sea cucumber, *Stichopus japonicus.* We found that the aqueous methanol extract of sea cucumber, *Stichopus japonicus* inhibited yeast α-glucosidase activity by 68% at 0.5 mg/ml. The following hexane fraction was the most potent (≈98% inhibition at 10 μg/ml). Three compounds with potent α-glucosidase inhibitory activities were purified from *S. japonicus*. IC_{50} values of compound 1, 2 and 3 were 1.22, 0.17 and 0.36 μg/ml against *Saccharomyces cerevisiae* α-glucosidase, and 2.49, 0.24 and 0.21 μg/ml against *Bacillus stearothermophilus* α-glucosidase, respectively. Both compound **1** and 2 inhibited yeast α-glucosidase activity non-competitively (K_i value of 0.98 and 0.06 μg/ml), while compound 3 showed a mixed type inhibition (K_i value of 0.61 μg/ml). In addition, compound 1, 2 and 3 were very stable under thermal and acidic conditions up to 30 and 60 min. We conclude that compounds of *S. japonicus* have potential as natural nutraceuticals and that these compounds could be use to prevent diabetes mellitus because of their high α-glucosidase inhibitory activity.

Keywords: α-Glucosidase, α-Glucosidase inhibitors, *Stichopus japonicus*, Diabetes mellitus.

1. INTRODUCTION

Diabetes has become an alarming global problem in recent years. According to the International Diabetes Foundation (IDF), the number of people diagnosed with diabetes in the last twenty years has risen from 30 million to over 246 million. It is also a lifestyle-related disease known to trigger many complications, nephropathy, retinopathy, neuropathy, cardiovascular diseases, and so on (Saijyo *et al*., 2008). Type-2 diabetes is the most common form of diabetes, accounting for 90% of cases, and it is usually characterised by an abnormal rise in blood sugar right after a meal, called postprandial hyperglycemia (Apostolidis, Kwon, & Shetty, 2006). Mammalian α-glucosidase (α-D-glucoside glucohydrolase, EC 3.2.1.20) located in the brush-border surface membrane of intestinal cells, is the key of enzyme which catalyses the final step in the digestive process of carbohydrates. Hence, α-glucosidase inhibitors can retard the liberation of D-glucose of oligosaccharides and disaccharides from dietary complex carbohydrates, delay glucose absorption, and, therefore suppress postprandial

hyperglycaemia (Lebovitz, 1997). Such inhibitors, including acarbose and voglibose, are currently used clinically in combination with either diet or other anti-diabetic agents to control blood glucose levels of patients (Van de Laar *et al*., 2005). A main drawback of the current α-glucosidase inhibitors (such as acarbose) is the presence of side effects such as abdominal bacterial fermentation of undigested carbohydrates in the colon (Bischoff *et al*., 1985). To either avoid or decrease the adverse effects of current agents and also to provide more candidates of drug choices, it is still necessary to search for new α-glucosidase inhibitors for further drug development (Lam *et al*., 2008).

The sea cucumber (a cylindrical marine invertebrate) has long been used as a tonic food in the Ido-pacific region as well as a traditional medicine in East Asia due to its high nutraceutical value (Zhong, Khan, & Shahidi, 2007). Several papers published in the last two decades support these medical claims and document multiple biological activities of sea cucumber extracts such as wound healing promoter and exhibiting antimicrobial, anticancer and immunomodulatory properties (Mamelona *et al*., 2007).

The sea cucumber, *Stichopus japonicus*—a widespread species in East Asia, including Korea, China, Japan and Far Eastern Russia (Kanno, Li, & Kijima, 2005)—contains antifungal triterpene glycosides, holotoxins A, B, and C (Kitagawa, Sugawara, & Yosioka, 1976). However, its α-glucosidase inhibitory activities have not been reported. The objective of this study was to investigate the inhibitory effects of sea cucumber on α-glucosidase activity.

2.. MATERIALS AND METHODS

2.1 Materials

Live specimens of sea cucumbers *Stichopus japonicus* were purchased from a fishery market in Kangnung, South Korea. *B. stearothermophilus* and *S. cerevisiae* α-glucosidase, rat intestinal acetone powder, p-Nitrophenyl-α-D-glucopyranodase (pNPG), and glucose assay kit (GAGO-20) were purchased from Sigma Chemical Co. (St. Louis, MO, USA). Sephadex LH-20 and Sephacryl HR-100 columns were purchased from Pharmacia Biotech Ltd. (Uppsala, Sweden). The other chemicals used in this study were of analytical grade.

2.2 Sample preparation

Fresh sea cucumber specimens were washed with tap water. The body wall was cut into small species. All samples were frozen at -80 ^{0}C for 24 h, and vacuum dried at 30 ^{0}C for 72 h. The dried samples were ground to fine powder and sieved with a ≤ 600 μm sieve and kept frozen at -20 ^{0}C until used.

2.3 Extraction and purification of α-glucosidase inhibitors

The powder of sea cucumber (200 g) was extracted with refluxing 80% methanol (2 × 5 l, each for 2 h). After the solvent was removed under reduced pressure at <40^{0}C, the residue (70.5 g) was suspended in water and then successively partitioned with n-hexane, $CHCl_3$, EtOAc, and n-BuOH. The n-hexane fraction (17.6 g) was chromatographed over silica gel (2.0

× 15.0 cm) eluting with n-hexane, hexane–$CHCl_3$, and $CHCl_3$–MeOH (in order of increasing polarity) to give nine main fractions (F1-F9). Fraction F1 and F4 were further purified by Sephadex LH-20 (3.0 × 30.0 cm) to obtain three fractions (compound 1, 102 mg; compound 2, 67 mg; compound 3, 82 mg).

2.4 Assay for α-glucosidase inhibitory activity

α-Glucosidase inhibitory activity was performed following the modified method of Kim, Nam, Kurihara, and Kim (2008). A reaction mixture containing 2.2 ml of 0.01 M phosphate buffer (pH 7), 0.1 ml of 0.25 U/ml α-glucosidase in 0.01 M phosphate buffer (pH 7), and 0.1 ml of sample was pre-incubated for 5 min at 37 ^{0}C, and then 0.1 ml of 3 mM pNPG as a substrate in the same buffer was added to the mixture. After further incubation at 37 ^{0}C for 30 min, the reaction was stopped by adding 1.5 ml of 0.1 M Na_2CO_3. Enzymatic activity was quantified by measuring the absorbance at 405 nm. The percentage of α-glucosidase enzyme inhibition by the sample was calculated by the following formula: % inhibition = [AC – AS]/AC×100, where AC is the absorbance of the control and AS is the absorbance of the tested sample. The concentration of an inhibitor in the reaction mixture required to inhibit 50% of enzyme activity under the foregoing assay conditions is defined as the IC_{50} value.

2.5 Purification of rat intestinal α-glucosidase

Rat intestinal α-glucosidase was purified according to the method of Kim, Nam, Kurihara, and Kim (2008). Commercial rat intestine acetone powder (10 g) was dissolved in buffer A (100 ml) (0.1 M potassium phosphate buffer containing 5 mM EDTA, pH 7.0), sonicated at 4 °C for 15 s, and then centrifuged at 27,000*g* at 4 °C for 60 min to obtain supernatant A. The precipitate was dissolved in buffer A (100 ml), sonicated, and then centrifuged (32,000*g*, 60 min, 4 °C) to obtain supernatant B. The combined supernatant was dialysed against buffer B (0.05 M potassium phosphate buffer containing 0.4 mM EDTA, pH 7.0) for 48 h. This was concentrated to 20 ml by ultrafiltration (cut off membrane 10 kDa) and then loaded onto a Sephacryl HR-100 column (2.6 × 60.0 cm) equilibrated with buffer B in advance. Rat intestinal α-glucosidase was eluted with buffer B at a flow rate of 0.2 ml/min.

2.6 Inhibitory assay for rat intestinal α-glucosidase (sucrase and maltase) activity

Rat intestinal α-glucosidase inhibitory activity was determined according to the modified method of Kurihara, Mitani, Tawabata, and Takahashi (1999). Sucrase activity was determined in a mixture of 500 mM sucrose (0.1 ml), the isolated compound in MeOH (0.05 ml), and 0.1 M maleate buffer (pH 6.0, 0.75 ml). The mixture was preincubated at 37 C for 5 min, and reaction was initiated by adding rat intestinal α-glucosidase (0.1 ml) to the reaction mixture. The mixture was incubated at 37 C for 60 min. The reaction was terminated by adding 2.0 M maleate–Tris–NaOH buffer (pH 7.4, 1.0 ml). To measure maltase activity, maltose (500 mM) was used instead of sucrose. The glucose release in the solution was determined using a glucose assay kit based on the glucose oxidase/peroxidase method. One

unit of α-glucosidase activity was defined as the amount of enzyme that liberated 1.0 μM of substrate per min. One unit of α-glucosidase inhibitory activity was defined as a 1 unit decrease in α-glucosidase activity.

2.7 Stability under thermal and acidic conditions

The stability of purified compounds under thermal and acidic conditions assays were performed following the method of Kim *et al*. (2005). Compounds 1, 2 and 3 were treated at 100 ^{0}C for 30 min or 37 ^{0}C for 40 min and 60 min at pH 2. Each compound was then used for inhibition assay against *B. stearothermophilus* and *S. cerevisiae* α-glucosidases. The relative inhibitory activity of bromophenol at pH 2 was calculated based on the inhibitory activity of the control.

2.8. Kinetics of α-glucosidase inhibitor

For kinetic analyses of *S.cerevisiae* α-glucosidase by compounds 1, 2 and 3, the enzyme and test compounds were incubated with increasing concentration of pNPG. Inhibitory kinetics of compounds 1, 2 and 3 for yeast α-glucosidase was determined by Lineweaaver-Burk plot analysis of the data (Lineweaver & Burk, 1934), which were calculated from the result according to Michaelis-Menten kinetics.

2.9 Statistical analysis

SPSS for windows (version 10.0, SPSS Inc., Chicago, IL) was used for statistical analysis. Each value is expressed as the mean ± standard deviation (SD). Differences among groups at various times of the experiment were subjected to a one-way analysis of variance (ANOVA) followed by Duncan's multiple-range *t*-test. A value of $p < .05$ is considered to indicate a statistically significant effect.

3. RESULTS AND DISCUSSION

3.1 Extraction and isolation of α-glucosidase inhibitors

The powder of *S. japonicus* (200 g) was reflux extracted using 80% MeOH. The aqueous MeOH extract inhibited yeast α-glucosidase by 68% at 0.5 mg/ml. In order to isolate α-glucosidase inhibitors from sea cucumber, the 80% MeOH extract was fractionated by monitoring *S.cerevisiae* α-glucosidase inhibitory activity. Firstly, the concentrated extract was suspended in water and successively partitioned with n-hexane, $CHCl_3$, EtOAc, and n-BuOH. The n-hexane fraction showed the most potent inhibitory activity effects on yeast α-glucosidase (approximately inhibition 98% at 10 μg/ml), followed by EtOAc (20.7%), even though the H_2O fraction resulted in the highest solute yield (68.1%), followed by the n-hexane (23.2%), BuOH (4.0%), , $CHCl_3$ (3.3%), and EtOAc (1.4%) fractions (Table 1). A large amount of the solute in the aqueous MeOH (80%) extract was shifted over to H_2O fraction, but this fraction showed no α-glucosidase inhibitory activity at 0.5 mg/ml. Lipids, chlorophyll, refined oil, and sterols were dissolved and fractioned in n-hexane; , $CHCl_3$ is a excellent solvent for extracting resin. In addition, polyphenols such as flavonoids and tannins are typically extracted in EtOAc and

water-soluble components are shifted over to BuOH fraction (Suffness, Newman, & Snader, 1989). In a previous study, we found that the highest α-glucosidase inhibitory activity was observed in the EtOAc fraction of the red alga, *Grateloupia elliptica*, followed by BuOH, and H_2O fractions, while n-hexane and , $CHCl_3$ fractions did not show any α-glucosidase inhibitory activity at 0.1 mg/ml (Kim, Nam, Kurihara, & Kim, 2008). Because the n-hexane fraction appeared to be the most potent α-glucosidase inhibitory activity, the main α-glucosidase inhibitor of *S. japonicus* was provisionally considered to be a fatty acid compound.

The hexane fraction in *S. japonicus* was further purified to isolate the compounds with α-glucosidase inhibitory activity using silica gel, Sephadex LH-20 chromatographic separations, respectively. Two fractions among nine fractions eluted from silica gel column showed α-glucosidase inhibitory activity. Finally, three fractions from Sephadex LH-20 chromatographic separation were pooled, and then confirmed and classified as compound 1 (102 mg), 2 (67 mg) and 3 (82 mg). We are currently analysing the structure of these compounds.

Table 1. α-Glucosidase inhibitory activities of the solvent-partitioned fraction of sea cucumber, *S. japonicus* at different concentrations.

Fractions	Yield (%)	α-Glucosidase inhibitory activity (%)		
		0.01 mg/ml	0.1 mg/ml	0.5 mg/ml
n-Hexane	23.2	98.2 ± 0.2[a]	98.3 ± 0.1[a]	98.8 ± 0.8[a]
$CHCl_3$	3.3	NI[3)]	NI	8.0 ± 2.3[c]
EtOAc	1.4	20.7 ± 4.5[b]	92.5 ± 4.7[b]	98.5 ± 0.1[a]
n-BuOH	4.0	17.9 ± 5.3[b]	18.5 ± 3.6[c]	42.9 ± 1.4[b]
Water	68.1	NI	NI	NI

[1] Values are expressed as mean ± SD. Mean in the same column with different superscripts are significantly different ($p < 0.05$). [2] The final concentration in the reaction mixture. [3] No inhibition.

3.2 Assay for α-glucosidase inhibitory activity

Isolated compounds inhibited *Saccharomyces cerevisiae* and *Bacillus stearothermophilus* α-glucosidase activity in a dose-dependent manner (Figure 1). The IC_{50} values for compounds 1, 2 and 3 were determined to be 1.22, 0.17 and 0.36 μg/ml against *S. cerevisiae* α-glucosidase, and 2.49, 0.24 and 0.21 μg/ml against *B. stearothermophilus* α-glucosidase, respectively (Table 2). Compound 2 had strongest yeast α-glucosidase inhibitory activity among these compounds, and IC_{50} value (0.17 μg/ml) of 2 was about seven and two-fold lower than those of compounds 1 and 3, respectively. Compounds 2 and 3 showed more potent inhibitory activity against both yeast and bacterial α-glucosidases than compound 1. Nacao *et al*., (2004) reported that two sulphated fatty acids from a marine sponge *Penares sp*., sulphates A1 and B1, inhibited yeast α-glucosidase inhibitory activity (IC_{50} values of 1.2 and 1.5 μg/ml, respectively). It can be seen that the IC_{50} of compounds 2 and 3 were lower than those of

sulphates fatty acids, A1 and B1. In contrast, the commercial inhibitor, acarbose exhibited no α-glucosidase inhibitory activities against *S. cerevisiae* and *B. stearothermophilus* α-glucosidases (Table 2). This is in agreement with other reports that either described a very weak inhibitory activity of acarbose (Oki, Matsui, & Osajima, 1999) or no inhibition against *S. cerevisiae* α-glucosidase (Kim *et al*., 2004; Kim, Nam, Kurihara, & Kim, 2008). A similar result was observed for voglibose and glucono-1,5-lactone, which strongly inhibited mammalian α-glucosidases, whereas no inhibition was observed in yeast and bacterial α-glucosidases (Oki, Matsui, & Osajima, 1999; Kim, Nam, Kurihara, & Kim, 2008). In contrast, Oki, Matsui, & Osajima (1999) showed that (+)-catechin, an inhibitor of *S. cerevisiae* α-glucosidase, had no inhibitory effect on enzymes from mammalian species.

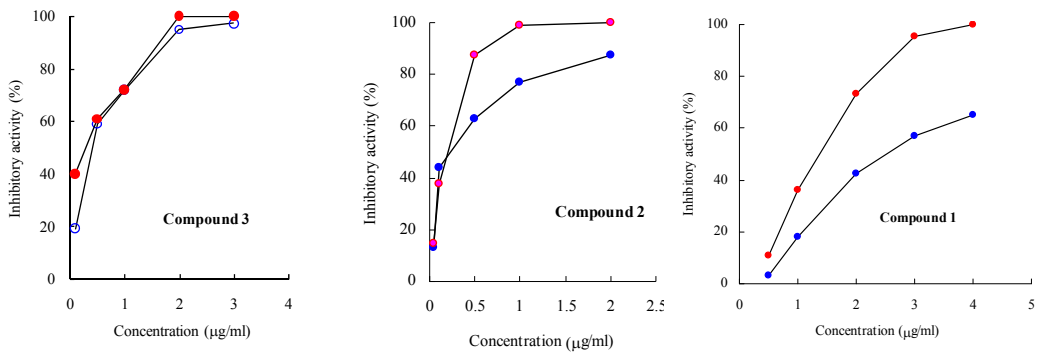

Figure 1. Dose-dependent inhibition of *S.cerevisiae* (●) and *B. Stearothermophilus* (●) α-glucosidases by sea cucumber compounds.

Table 2. IC_{50} values of isolated compounds from *S. japonicus* against α-glucosidases

Inhibitors	*IC_{50}*[1,2]			
	S. cerevisiae α-glucosidase	*B. Stearothermophilus* α-glucosidase	Sucrase (mg/ml)	Maltase (mg/ml)
Compound 1	1.22 ± 0.02^a	2.49 ± 0.07^a	3.52 ± 0.15^a	4.21 ± 0.31^a
Compound 2	0.17 ± 0.01^c	0.24 ± 0.02^b	2.30 ± 0.11^b	3.47 ± 0.07^b
Compound 3	0.36 ± 0.01^b	0.21 ± 0.01^c	0.08 ± 0.02^c	0.10 ± 0.03^c
Acarbose	NI[3]	NI	0.02 ± 0.01^d	0.05 ± 0.01^d

[1] Values are expressed as mean ± SD. Means in the same column with different superscripts are significantly different ($p < .05$). [2] The IC_{50} value is defined as the inhibitor concentration to inhibit 50% of its activity under assayed conditions. [3] NI: no inhibition.

3.3 Inhibitory activity against rat-intestinal sucrase and maltase

The inhibitory activities of *S. japonicus* compounds against rat-intestinal sucrase and maltase were also compared with those of acarbose (Table 2). The IC_{50} values of compounds 1, 2 and 3 were 3.52, 2.30 and 0.08 mg/ml against rat-intestinal sucrase, and 4.21, 3.47 and 0.10

against maltase, respectively. The IC_{50} value of acarbose was 0.02 mg/ml against sucrase and 0.05 mg/ml against maltase, respectively. Hence, acarbose was a better inhibitor against mammalian α-glucosidase than the *S. japonicus* compounds. In previous studies, most mammalian α-glucosidase inhibitors did not effectively inhibit microbial α-glucosidases, whereas catechin, an inhibitor of *S. cerevisiae* α-glucosidase, did not inhibit mammalian α-glucosidases (Oki, Matsui, & Osajima, 1999). Therefore, the higher mammalian α-glucosidase inhibitory activity of acarbose compared to sea cucumber compounds is likely due to the substrate specificities that depend on the source of α-glucosidases. This suggests that the binding of compounds is less specific to the enzyme because these compounds can bind to various proteins included in the crude enzyme solution. Bacterial, yeast, and insect enzymes, called α-glucosidase I, show higher activity toward heterogeneous substrates such as sucrose and *p*NPG, and either less or no activity toward homogeneous substrates such as maltooligosaccharides; this implies that α-glucosidase I recognises the "glucosyl structure" in the substrate (Kimura, 2000). The mould, plant, and mammalian enzymes, called α-glucosidase II, hydrolyze homogeneous substrates more rapidly than heterogeneous substrates, indicating that this class of α-glucosidases recognises the "maltostructure" (Kimura *et al*., 2004). The hydrolysis of *p*-nitrophenol 2-deoxy-α-D-arabino-hexopyranoside was catalysed by α-glucosidase II (Nishio *et al*., 2002), but no such reaction was observed with α-glucosidase I, suggesting that the 2-OH groups in the glucose moiety are essential for α-glucosidase I (Kimura *et al*., 2004). The α-glucosidase II catalysed the hydration of D-glucal to produce 2-deoxy-α-D-arabino-hexose, but α-glucosidase I yielded no detectable hydration product (Chiba *et al.,* 1988). The strong enzymatic inhibitory activity against microbial α-glucosidases shown by sea cucumber compounds is clearly better than the activity of commercial inhibitors such as acarbose and voglibose at low concentration. It is likely that sea cucumber compounds can decrease blood glucose level but with fewer, if any, adverse gastrointestinal effects, and abdominal discomfort than acarbose and voglibose (Tewari *et al*., 2003; Iwai, 2008).

3.4 Kinetics of enzyme inhibition

The inhibition mode of isolated compounds against S. *cerevisiae* α-glucosidase was analysed from the data derived from enzyme assays containing difference concentrations of pNPG, ranging from 2 to 10 mM at each different of the compounds. The data indicate that both compounds 1 and 2 showed non-competitive inhibition against S. *cerevisiae* α-glucosidase, while compound 3 displayed a mixed type inhibition mode (Figure 2). The different inhibition kinetics of these compounds seemed to be due to structural differences formed by the origins of the enzymes (Kim *et al*., 2005). The K_i (inhibition constant) values of compounds 1, 2, and 3 were 0.98, 0.06, and 0.61 μg/ml, respectively (Table 3), which shows that compound 2 was a more effective inhibitor than compounds 1 and 3.

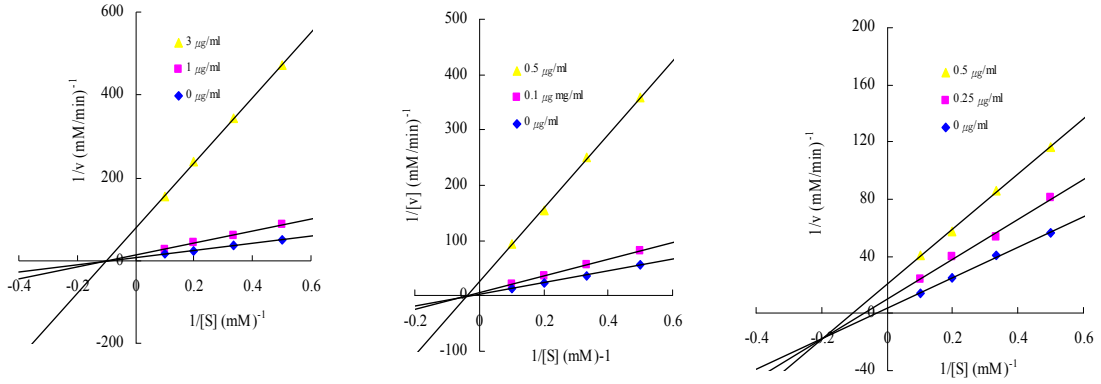

Figure 2. Lineweaver-Burk plot of *S. cerevisiae* α-glucosidase inhibition of isolated compounds from *S. japonicus* at different concentrations of pNPG.

Table 3. K_i values and inhibition mode of isolated compounds against yeast α-glucosidase.([1] K_i value was determined by Dixon plot analysis.[2] Inhibition mode was determined by Lineweaver–Burk plot).

Compounds	*K_i (μg/ml)*[1]	*Inhibition mode*[2]
1	0.98	Non-competitive
2	0.10	Non-competitive
3	0.61	Mixed

3.5 Stability of purified compounds under thermal and acidic conditions

To determine the potential for industrial usage and stability in digestive organs of the sea cucumber compounds, we investigated the stability of extracts at high temperature and low pH by measuring inhibitory activity on bacteria *B. stearothermophilus* and yeast *S. cerevisiae* α-glucosidases of sea cucumber compounds. Table 4 shows that the inhibition activity of all compounds retain more than 99% of its value against both bacteria and yeast α-glucosidases after standing for up to 30 min at 37 ^{0}C. The acidic condition (pH 2) was used to mimic the pH encountered by the compound in the stomach. The inhibitory activity of sea cucumber compounds against *S. cerevisiae* α-glucosidase was very stable at pH 2 for 40 min and remained from 80% (compound 1) to 88% (compound 3) for 60 min, respectively, while these compounds remained moderately against *B. stearothermophilus* α-glucosidase, the inhibitory activities were remained from 75 to 83% and 67 to 69% for 40 and 60 min, respectively. This finding was similar to the result of pine bark extract, where its inhibitory activity against yeast *S.cerevisiae* α-glucosidase was very stable under thermal condition and mildly stable under acidic condition (Kim *et al*., 2005). This result suggests that the purified compounds from *S. japonicus* are stable under thermal and acidic conditions and can be a candidate for development of a α-glucosidase inhibitor. Moreover, *S. japonicus* may be useful for potential usage of industrial use or as food additive.

Table 4. Effects of thermal and acidic conditions on inhibitory activities of *B. sterothermophilus* and *S. cerevisiae* α-glucosidase.Results are expressed as means ± SD, *n* = 5

Conditions	Compounds	Relative inhibition[a] (%)	
		B. sterothermophilus α-glucosidase	*S. cerevisiae* α-glucosidase
100 ^{0}C for 30 min	1	99.6 ± 0.4	99.4 ± 0.2
	2	99.8 ± 0.1	99.8 ± 0.2
	3	99.7 ± 0.4	99.8 ± 0.2
pH 2 for 40 min	1	78.4 ± 2.4	92.8 ± 1.2
	2	75.3 ± 2.5	90.5 ± 2.1
	3	82.7 ± 3.3	99.3 ± 0.1
pH 2 for 60 min	1	69.5 ± 2.5	85.2 ± 3.2
	2	67.5 ± 1.7	80.6 ± 1.4
	3	67.0 ± 5.7	87.8 ± 0.2

4. Conclusion

One of the therapeutic approaches for preventing diabetes mellitus is to retard absorption of glucose via inhibition of α-glucosidase. Hence, the search for α-glucosidase inhibitors in marine organisms is important because these inhibitors could control the postprandial hyperglycemia of diabetic patients. In this study, three compounds with strong α-glucosidase inhibitory activity were purified from sea cucumber *S. japonicus* collected from the eastern coastal area of the Korean peninsula. Therefore, compounds of *S. japonicus* can potentially be developed as a novel natural nutraceutical to prevent diabetes mellitus because of their strong α-glucosidase inhibitory activity.

The search for α-glucosidase inhibitors in marine organisms is important because these inhibitors can help control the postprandial hyperglycemia of diabetic patients. Although it is still not clear whether sea cucumber α-glucosidase inhibitors can suppress hyperglycemia, we found that sea cucumber compounds greatly inhibited yeast and bacterial α-glucosidase

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Zhong, Y., Khan, M.A., & Shahidi, F. (2007). Compositional Characteristics and Antioxidant Properties of Fresh and Processed Sea Cucumber (*Cucumaria frondosa*). *Journal of Agricultural and Food Chemistry*, 55(4), 1188-1192.

VOLATILE COMPONENTS AND SENSORY CHARACTERISTICS AND CONSUMER LIKING OF COMMERCIAL BRAND OYSTER SAUCES

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Abstract: The objectives of this study are 1) to compare the volatile compounds, the taste compounds and the sensory attributes of four commercial oyster sauces, and 2) to determine the relationship between these compounds and sensory attributes. In addition, a consumer test was applied to evaluate the overall liking of these four sauces. A total of 74 volatile compounds were identified, most of these being alcohols, furans, aldehydes and pyrazines . Most of the samples showed a clear sensory organisation. Glutamic was the dominant free amino acid in all samples. Canonical correlation analysis showed that sweet amino acids including threonine, serine, glycine, and alanine were strongly associated with sweet taste. Three sensory attributes (oyster, fishy and fired pork dour) were highly correlated to alcohols (1-Penten-3-ol), aldehydes (propanal, butanal) and pyrazines, respectively. Cluster analysis of hedonic scores showed that there were four clusters of consumers with similar preference. According to preference mapping, consumers mostly like sample VN which has oyster odour and sweet taste; By contrast, sample TL was unacceptable because of its soy sauce odour.

Key words: oyster sauce, SPME, sensory attributes, volatile compounds, preference mapping

1. INTRODUCTION

Flavour is one of the important factors in assessing the quality of oyster sauce as a savoury product. Oyster sauce is a viscous dark brown sauce commonly used in Chinese, Philippines, and Thai cuisine. In the past, to produce oyster sauce, fresh oysters were boiled, seasoned with soy sauce, salt, and other spices and then preserved. Together, all these ingredients created this ancient flavour. Although the cooking process did get rid of the fishy flavour, some kinds of oyster sauce are on the salty side while others have much less salt than soy sauce. In some countries, including the UK, the oyster content in some sauces is lower than its Asian counterparts of the same brand due to laws regulating the import of seafood.

In order for a product to succeed, its flavour needs to be acceptable by the consumer. The flavour of any food consists of both the aroma and the taste of the food. The taste components of foods are generally non-volatile while their aroma constituents are volatile (Shahidi, 1998). However, describing flavour of the product is not an easy task in sensory evaluation. It is nearly impossible for everyone to interpret and define flavour terms, mainly because each person has a unique experience of the sense of taste, smell, and ability to articulate this experience (Park, 2005). However, even though the overlap of sensory attributes can be challenging, it can, nevertheless, be readily grasped by trained assessors if the reference chemical compounds are provided during training (Garcia-Gonzalez *et al*., 2008). In addition,

since the 1960s, the ability of scientists to identify flavour components has expanded with the use of gas chromatography, mass spectroscopy, and other methods that allow the isolation, separation, and identification of the minor components found in foods, herbs, and spices sometimes at concentrations as low as parts per billion and below. Moreover, variety of traditional products such as blue type chesses, Reggianito chesses, red wine, and biscuits have been analysed by solid phase microextraction (SPME) coupled with gas chromatography-mass spectrometry (GC-MS) to study the aroma profile (Jurado *et al*, 2008, Panseri *et al*, 2008). Nevertheless, a frequently asked question about flavour analysis in food industry is "Can an instrument provide enough information?" In general, instrumental data are relevant issue for quality control measurements because of instrumental data have advantages such as being faster and simpler to obtain than sensory evaluation with humans.

The consumer, who is the ultimate user and the target of the food industry, speaks a louder voice than any instrumental data. This is why consumer liking tests are conducted throughout stages of product cycle such as: decision making of a new product development, product maintenance, product improvement, product optimisation, and assessment of market potential. Preference mapping, which combines description data and consumer acceptance, can be used to uncover market segmentation and identifies drivers of liking for each segment.

Little research has been published using both preference mapping and instrumental techniques to understand the relationship among volatile compounds, sensory characteristic, and consumer acceptability. A product such as oyster sauce can be ideal for performing this type of integrative research because oyster sauce flavour is characterised by complex components which associated with specific manufacture methods. Moreover, different demographic groups may have different attitudes relating to consumer acceptability of the oyster sources. Consequently, the objectives of the present study are to compare the volatile compounds, the taste compounds, and the sensory attributes. Specifically, we want to analyse the relationships between these compounds and attributes as well as consumers hedonic scores in four commercial brands of oyster sauce.

2. MATERIALS AND METHODS

2.1. Materials

Samples of oyster sauces belonging to four certified brands were obtained from Vietnam, Thailand, and China (Table 1). Two of the samples were collected from the same company in China (which is considered the birth place of the oyster sauce). In order to obtain homogenous samples, all the sauces were obtained from the same batch and the same launch day.

Table 1: Manufacture and ingredients of four kinds of oyster sauce.

Code	*Country manufacture*	*Ingredients*
VN	Vietnam	Oyster extract, starch, salt, caramel, sugar
TL	Thailand	Oyster extract (30%), soy sauce, sugar, salt, starch.
CN1	China	Oyster mixture (oyster extract, water, salt), sugar, water, MSG, starch, flour, caramel
CN2	China	Oyster mixture (oyster extract, water, salt), sugar, water, MSG, starch, flour, caramel

2.2 HS-SPME

A manual fibre-holder for SPME and one type of fibre coating Carboxen / Polydimethylsiloxane CAR/PDMS 75µm was applied. The volatiles were desorbed in the GC injection port for 7 min at 270^0C. The optimised condition of extraction process was the reference used in previous studies using SPME. Three grams of sauce were placed into 20ml glassy vial and tightly capped with PTTE septum. The septum covering each vial was then pierced with SMPMEneedle and the fibre coating was exposed into headspace for 35 min at 60^0C. A magnetic stirrer and temperature-control water bath was using during the extraction process.

2.3 GC-MS

Chromatography was performed using an Agilent technology 6890N gas chromatograph interfaced to an Agilent 5975B inner MSD mass spectrometer. A HP-5MS 5% Phenyl Methyl Siloxane capillary non-polar column (30m × 0.25mm i.d. × 0.25µm film thickness) was applied. The injection was made in splitless mode at a temperature of 270^0C. The following oven temperature program was used: initial temperature 30^0C hold for 1 min, then an increase of 2^0C /min to 130^0C; then followed by an increase of 15^0C/min to 270^0C and hold at that temperature for 5 min. Helium was used as carrier gas with flow of 1.0 ml/min. The mass spectra were obtained in electron-impact mode (EI) at 70eV using full scan with a scan range of 30-300m/z at a rate of 2.5s. $scan^{-s}$. Data acquisition and integration were loaded out with the ChemStation chromatography software. The compounds present in the volatile profile of the oyster sauce samples were identified by matching of their mass spectra against the NIST05 library and RI values. In addition, identifying the unknown peak we used previous literature reviews and extra-references such as retention indices Adams.

2.4 Taste compounds

Free amino acids (FAAs). FAAs were determined according to the recommended procedure from the manufacture AAA (L-8500, Hitachi, Tokyo, Japan)

Determination Na, K, and phosphorus. Sodium and potassium were evaluated by atom absorption spectroscopy (ISO 8070-1987). Phosphorus were converted into molybdenum blue and then determined by spectrometer (ISO 3946-1982)

2.5 Sensory evaluation

Many traits related to sensory characteristics of products were evaluated by Quantitative Descriptive Analysis (QDA®) (Stone & Sidel, 2007). Eleven assessors were selected from 25 students of Food Science and Technology College, Shanghai Ocean University. They had acceptable ability to detect basic taste and common odours (Piper & Scharf, 2006).

About one gram of the oyster sauces was served on a small plate to each of the panellists. Not all the samples were analysed simultaneously due to the short time rest between two samples. For each sensory trial, the samples and replicates were served, in a random order, on coded plates. The temperature of the experimental room was set up at 20^0C ± 2^0C and the room was lighted with fluoresces lights. The panellists evaluated the samples using the QDA® procedure on 9-point rating scales. Water and a light biscuits were consumed before the first sample to minimise the effect of first sample as well as between samples as a refresher.

2.6 Consumer test

A total of 125 regular consumers (aged 21 to 53) living in Shanghai China, were recruited according to their responses to a brief screening questionnaire about sex, age, and product usage. The term "regular" indicated that the consumer uses oyster sauces (origin, cook, etc) at least three times a week. In the first part of the questionnaire, consumers indicated their level of acceptance on a nine-point hedonic scale ("dislike extremely" being 1 and "like extremely" being 9) of four oyster sauces about colour, odour, taste, after-taste, mouth-feel, and overall liking. They were asked to "rest" for at least 30 seconds between evaluating samples by taking a sip of water. Then, the consumers answered the questions related to their product routine such as frequency, time, place serving, etc. All these questions were translated into Chinese and explained well to each participant. Oyster samples were coded randomly.

2.7. Statistical analysis

SAS software (version Release 9.1, SAS institute, Cary, NC, USA) was used to analyse statistically data. Mixed univariate analysis of variance (ANOVA) with panellist and panellist × sample treated as random factors were applied to the sensory attributes data of four samples. In addition, the influence and the range differences between assessors, samples, and assessor × sample on the scores were also used in the model. Principal component analysis (PCA) was used to study the sensory profiling of four samples with 18 sensory attributes. Analyses were performed using R software version 2.7. To understand consumers' responses further, the hedonic ratings were also analysed using agglomerative hierarchical clustering (AHC). External preference mapping was performed by combining PCA and the consumer dataset.

Table 3 Codes and mean peak area of volatile compounds identified in four kinds of oyster sauce and *p* value of each volatile compound. *Note: all volatile compounds were significantly different (p < .01) between four samples (using ANOVA combined Kruskal Wallis test).*

Code	Name of compounds	Relative peak area (%□Mean±SD)			
		CN1	CN2	TL	VN
Alcohols					
A1	Ethyl alcohol	0.25 ±0.05	0.15 ± 0.01	1.75 ± 0.02	10.83 ± 3.20
A2	1-Butanol	2.98 ± 0.13	1.16 ± 00	N.D.	N.D.
A3	1-Pentanol	0.36 ± 0.03	0.64 ± 0.08	N.D.	N.D.
A4	1-Penten-3-ol	N.D.	N.D.	N.D.	0.1 ± 0.02
A5	1-Butanol, 2-methyl	N.D.	N.D.	0.83 ± 0.08	N.D.
A6	2,3-Butanediol	N.D.	N.D.	0.12 ± 0.18	N.D.
Aldehydes					
A7	Acetaldehyde	N.D.	N.D.	0.16 ± 0.02	N.D.
A8	Hexanal	N.D.	N.D.		0.08 ± 0.00
A9	2-Butenal	N.D.	N.D.	0.64 ± 0.09	N.D.
A10	Butanal, 3-methyl	N.D.	N.D.	23.37 ± 1.63	0.3 ± 0.12
A11	Butanal, 2-methyl	0.94 ± 0.06	0.57 ± 0.03	14.91 ± 1.18	0.07 ± 0.02
A12	Propanal, 2-methyl	1.48 ± 0.08	0.52 ± 0.02	4.59 ± 0.20	N.D.
A13	Propanal, 3-(methylthio)	N.D.	N.D.	0.55 ± 0.10	N.D.
Furans					
A14	Furan	2.37 ± 0.39	0.84 ± 0.00	1.16 ± 0.03	0.47 ± 0.13
A15	Furan, 2-methyl	0.52 ± 0.02	0.72 ± 0.04	1.63 ± 0.13	N.D.
A16	Furan, 2-pentyl	N.D.	0.09 ± 0.04	N.D.	N.D.
A17	Furan, 2-ethyl	N.D.	0.07 ± 0.00	N.D.	N.D.
A18	Furfural	N.D.	N.D.	2.37 ± 0.09	0.58 ± 0.24
A19	3-Furanmethanol	16.65 ± 1.62	16.92 ± 061	N.D.	N.D.
A20	Furan, 2,5-dimethyl	N.D.	N.D.	0.17 ± 0.02	N.D.
A21	3(2H)-Furanone, dihydro-2-methyl	1.2 ± 0.00	N.D.	0.28 ± 0.03	0.08 ± 0.01
A22	2-Furancarboxaldehyde, 5-methyl	N.D.	N.D.	0.2 ± 0.04	0.05 ± 0.03
Pyrazines and pyridines					
A23	Pyrazine, 2,5-dimethyl	6.01 ± 0.62	15.28 ± 0.77	0.13 ± 0.02	0.1 ± 0.04
A24	Pyrimidine, 4,6-dimethyl	3.19 ± 0.37	3.93 ± 0.38	0.97 ± 0.19	N.D.
A25	Pyrazine, 2,3-dimethyl	0.86 ± 0.09	1.11 ± 0.16	0.15 ± 0.05	N.D.
A26	Pyrazine, methyl	11.91 ± 0.85	11.67 ± 0.68	3.92 ± 0.66	0.06 ± 0.00
A27	Pyrazine	6.15 ± 0.06	5.63 ± 0.04	N.D.	N.D.
A28	Pyridine	0.39 ± 0.01	0.67 ± 0.20	N.D.	N.D.
A29	Pyridine, 2-methyl	N.D.	0.07 ± 0.04	N.D.	N.D.

A30	Pyrazine, 2-ethyl-6-methyl	0.7 ± 0.16	0.7 ± 0.15	N.D.	N.D.
A31	Pyrazine, 2-ethyl-5-methyl	0.55 ± 0.29	2.18 ± 0.26	N.D.	N.D.
A32	Pyrazine, 2-ethyl-3-methyl	0.47 ± 0.23	0.39 ± 0.07	N.D.	N.D.
A33	Pyrazine, trimethyl	0.63 ± 0.12	2.08 ± 0.25	0.05 ± 0.01	0
A34	Pyrazine, 3-ethyl-2,5-dimethyl	0.38 ± 0.4	2.21 ± 2.5	N.D.	N.D.
A35	Ethanone, 1-(1H-pyrrol-2-yl)	N.D.	0.15 ± 0.06	N.D.	N.D.
A36	Pyrazine, 2-ethyl-3,5-dimethyl	N.D.	1.08 ± 1.91	N.D.	N.D.
A37	Pyrazine, 2,6-diethyl	N.D.	0.14 ± 0.02	N.D.	N.D.
A38	Pyrazine, 2,3-diethyl-5-methyl	N.D.	0.12 ± 0.03	N.D.	N.D.
A39	Pyrazine, 3,5-diethyl-2-methyl	N.D.	0.2 ± 0.05	N.D.	N.D.
A40	Pyrazine, 3,5-dimethyl-2-propyl	N.D.	0.08 ± 0.02	N.D.	N.D.
A41	2,3,5-Trimethyl-6-ethylpyrazine	N.D.	0.12 ± 0.03	N.D.	N.D.
A42	Pyrazine, 2,5-dimethyl-3-(2-methylpropyl)	N.D.	0.05 ± 0.02	N.D.	N.D.
Esters					
A43	Ethyl Acetate	N.D.	N.D.	2.09 ± 0.13	23.23 ± 2.52
A44	1,2-Propanediol, 2-acetate	N.D.	N.D.	N.D.	0.6 ± 0.06
A45	1,2-Propanediol, diacetate	N.D.	N.D.	N.D.	0.23 ± 0.12
Ketones					
A46	Acetone	16.45 ± 0.92	8.69 ± 2.11	N.D.	N.D.
A47	2-Butanone	8.51 ± 0.4	8.6 ± 0.93	0.92 ± 0.11	N.D.
A48	2-Propanone, 1-hydroxy	2.75 ± 0.17	3.44 ± 0.52	0.62 ± 0.10	N.D.
A49	2-Propanone, 1-methoxy-	N.D.	1.39 ± 0.408	N.D.	N.D.
A50	2-Butanone, 3-hydroxy	0.41 ± 0.00	0.6 ± 0.02	N.D.	N.D.
A51	2,3-Butanedione	N.D.	N.D.	5.81 ± 0.21	N.D.
A52	Ethanone, 1-(2-furanyl)	0.77 ± 0.05	N.D.	0.72 ± 0.16	0.15 ± 0.10
A53	3-Pentanone	N.D.	N.D.	0.18 ± 0.03	N.D.
Sulfur compounds					
A54	Dimethyl sulfide	N.D.	N.D.	10.34 ± 0.12	4.41 ± 1.61
A55	Disulfide, dimethyl	N.D.	N.D.	0.63 ± 0.080	0.05 ± 0.01
A56	Methanethiol	N.D.	N.D.	0.17 ± 0.04	N.D.
Amines					
A57	Trimethylamine	N.D.	0.54 ± 0.19	N.D.	N.D.
Chlorinated compounds					
A58	Trichloromethane	1.78 ± 0.31	N.D.	0.94 ± 0.06	N.D.
Aromatics					
A59	Benzaldehyde	0.34 ± 0.37	0.04 ± 0.00	0.21 ± 0.05	N.D.

A60	Thiophene	0.08 ± 0.01	0.12 ± 0.00	N.D.	N.D.
A61	Limonene	N.D.	0.17 ± 0.13	N.D.	0.18 ± 0.20
Acids					
A62	Acetic acid	5.07 ± 0.53	4.71 ± 0.2	8.27 ± 0.25	N.D.
A63	Propanoic acid	0.4 ± 0.36	0.27 ± 0.17	N.D.	N.D.
A64	Butanoic acid	N.D.	0.09 ± 0.01	N.D.	N.D.
A65	Benzenecarboxylic acid	N.D.	N.D.	1.17 ± 0.06	0.41 ± 0.90
A66	Sorbic Acid	N.D.	N.D.	0.21 ± 0.31	N.D.
Unknown					
A67	Triacetin	N.D.	N.D.	N.D.	48.89 ± 8.41
A68	Oxazole, 4,5-dimethyl-	N.D.	1.845 ± 0.57	N.D.	N.D.
A69	1,3-Dioxane, 2-methyl	N.D.	N.D.	0.34 ± 0.01	N.D.
A70	1,3-Dioxolane, 2-heptyl-4-methyl	N.D.	N.D.	0.25 ± 0.13	N.D.
A71	4-Methylthiazole	N.D.	0.37 ± 0.1	N.D.	N.D.
A72	Thiazole, 2-methyl	N.D.	0.15 ± 0.01	N.D.	N.D.
A73	Methacrolein	N.D.	N.D.	0.07 ± 0.01	N.D.
A74	Propylene Glycol	N.D.	N.D.	4.73 ± 2.07	5.08 ± 0.90
A75	Ethyl ether	N.D.	N.D.	0.11 ± 0.005	N.D.

N.D. means non-detected, and the same as below.

3. RESULTS AND DISCUSSIONS

3.1 Analysing the volatile and semi-volatile compounds dataset

Table 3 shows the chemical volatiles well identified (% Mean ± SD) in oyster sauces manufactured from different processing method and countries. A total of 75 compounds were figured out, including esters, alcohols, aldehydes, sulphur compounds, pyrazines, furans, ketones, aromatics, acids, and chlorinated compounds. Amongst of volatiles, the table indicates that pyrazines, aldehydes, and ketones were dominant. The same results were reported in agreement with previous studies (Shahadi, 1998).

To figure out the overall profile of volatiles in four samples, we applied PCA (see Figure 2). The first principal component (PC-1) explained 55.82% of the variance across four samples while PC-2 explained 25.74% of the variance. We decided to keep only two factors for further analysis and to analyse the circle of correlation showing the correlations (*i.e.*, loadings) between the PCs and the variables used in the analysis (see Figure 2). We divided the plane made by the first two components into four quadrants (called Q1 to Q4). In the first quadrant Q1, the CN2 could be represented by most compounds of pryrazines such as pyrazine 3-ethyl-2,5-dimethyl, pryazine 2,6-diethyl, pyrazine 2,3-diethyl-5-methyl, ketons such as acetone, 2-butanone, and furans such as furan, furan 2-pentyl, 3-furanmethanol. The opposite side Q3 contains few volatiles but most of the compounds are the alcohols such as 1-pental-1-ol, propandiol and triacetin. These compounds were the dominant volatiles of sample VN. Two

samples CN1 and TL located in Q2 and Q4, respectively. The volatile contributions of the quadrant Q4 are aldehydes such as acetaldehyde, butanal 3-methyl, butanal 2-methyl, propananl 2-methyl, and propanal 3-methylthio-, with the exception hexanal. Aromatic and chlorinated compounds constitute the volatile representative of Quadrant Q2. The location of volatile compounds in the PCA plot and the quantitative values of each sample are explored further in the next part of this study.

3.2 Analysing the taste compounds dataset

The taste-active constituents are water-soluble low-molecular weight components. The most important compounds are free amino acids (FAA) and inorganic salts. Table 5 illustrates the content of the FAAs and minerals in four commercial brand oyster sauces.

Table 5. Free amino acids (FAAs) composition of four kinds of oyster sauce ($p < 0.01$) [a]

Schlichtherle-Cerny Grosch (1998),.

No.	*Amino acids (%)*	*VN*	*TL*	*CN1*	*CN2*	*Taste*[a]
1	Aspartic acid	0.06	2.82	0.01	0.31	Umami
2	Threonine	N.D.	1.44	N.D.	0.05	Sweet
3	Serine	N.D.	1.92	N.D.	0.05	Sweet
4	Glutamic acid	96.49	65.73	10.51	90.61	Umami
5	Glycine	N.D.	6.35	0.03	1.9	Sweet
6	Alanine	0.03	0.5	0.04	2.1	Sweet
7	Cystine	1.44	0.99	0.06	0.51	N.D.
8	Valine	N.D.	2.25	N.D.	0.12	Bitter
9	Methionine	N.D.	0.72	N.D.	N.D.	N.D.
10	Isoleucine	N.D.	1.76	N.D.	0.05	Bitter
11	Leucine	0.09	3.17	0.01	0.15	Bitter
12	Phenylalamine	0.95	1.54	N.D.	0.36	Bitter
13	Lysine	N.D.	2.38	89.23	0.56	Bitter
14	Histidine	0.92	7.19	0.11	3.21	Bitter
15	Arginine	N.D.	0.99	N.D.	N.D.	Bitter
Total (%)						
	Umami FAAs	96.55	68.55	10.52	90.92	
	Sweet FAAs	0.03	10.21	0.07	4.1	
	Bitter FAAs	1.96	20	89.35	4.45	
	Unkown FAAs	1.47	1.25	0.06	0.53	
Minerals (mg/100g)						
	Phosphate	2437.58 ± 111.98	1551.222 ± 196.35	3495.264 ± 0.00	5286.685 ± 112.07	Sour- Salt
	Sodium	3616.24 ± 0.00	2697.26 ± 0.00	4170.614 ± 0.00	4039.677 ± 0.00	Sour- Salt
	Potassium	18.40017 ± 0.00	104.6486 ± 0.00	44.53474 ± 0.00	137.8532 ± 0.00	Sour- Salt

All these FAAs were observed in previous reports related to oyster sauce and oyster raw materials (Shadihi, 1998). Glutamate (Glu) was the highest among all kinds of FAAs. Its amount in relative proportions was remarkable; the percentage of these FAAs in each product was 96.5, 65.7, 10.5, and 90.6%, respectively. The result was similar to fermented oyster sauce (Young & Park, 2005) with the highest percentage of Glu in free amino acid composition. Proportions of the content between FAAs and the tasty one could contribute to oyster sauce taste. Free amino acids, such as Glu, Glycine (Gly), Lysine (Lys) and Phenylalamine (Ala) were abundant and are recognised as being important in the tastes of fish and shellfish sauces (Young & Park, 2005).

The most interesting finding in mineral composition is that the concentrations of mineral are much higher that threshold, excepting for potassium in CN1 and VN sample. (Schlichtherle-Cerny, 1998). The highest concentration of sodium is found in CN1, followed by CN2. We found the same pattern of results for phosphate content with the CN1 and CN2 samples. The taste of oyster sauce was described as savoury and desirable, which corresponds to descriptors of saltiness, umami, sweetness, and other tastes. The relationships between the taste sensory attributes and non-volatile compounds will be determined in the next part of this study.

3.3 Analysing the sensory dataset

Table 6 shows the definitions of the sensory attributes assessed by the panellists and Figure 7 their mean intensities when evaluating the four kinds of oyster sauces. From the ANOVA results conducted on the descriptive data of the four oyster sauce samples, we find that most of the attributes were significantly different across samples ($p < .001$ for oyster odour, fishy odour, salty, and fried pork) and some colour and appearance attributes ($p < .01$) distinguished the oyster sauce. A significant assessor × sample interactions were found for attributes. The replications and replication × assessor were not a significant source of variation for the sensory attributes.

Mean intensity and SD of the four samples are given in Table 8. Samples CN1 and CN2, which were manufactured under the same method, received similar rating for almost all sensory attributes such as appearance (colour, texture), fishy odour, fried pork odour and some kinds of taste. The higher intensities in typical odour attributes of sample such as oyster, soy sauce for samples VN and TL may have been due to different ingredients and processing. In contrast, samples CN1 and CN2 showed different sensory profiles than the two other samples, with higher intensities in brow, stickiness, and fried pork odour, and with lower intensity in oyster and soy sauce odours. In addition, sample CN2 was rated as very intensive in saltiness and umani taste. This can be explained by the traditional Chinese oyster sauce manufacture process which uses fresh oyster broth and salt.

Table 6: List of sensory attributes of oyster sauce with descriptions.

Sensory attributes	Definition
Appearance	
Brown	The colour of chocolate
Stickiness	The quality of being sticky. Sticky is covered with a substance that stays fixed to any surface it touches
Smoothness	The quality of being smooth. Smooth is having a surface or substance that is perfectly regular and has no holes, lumps or areas that rise or fall suddenly. Your hand move cross it and feel it flat.
Thickness	The quality of being thick. Thick is the solution with high concentration of substance
Melting-mouth feel	The quality of easiness of being melted. To turn something becomes soft.
Odour	
Oyster	The odour associated with oyster hydrolysed solution[1]
Fishy	The odour associated with fish sauce
Soya sauce	The odour associated with soy sauce
Fried pork	The odour associated with Chinese "rou song" fried pork
Caramel	The odour associated with caramel
Taste	
Sweet	The taste on the tongue associated with sucrose solution
Sour	The taste on the tongue associated with citric acid
Bitter	The taste on the tongue associated with caramel solution
Salty	The taste on the tongue associated with salt solution
Umami	The taste on the tongue associated with Monosodium Glutamate
Aftertaste	
Sweet	The taste left the tongue after swallowing and associated with sucrose solution
Umami	The taste left the tongue after swallowing and associated with monosodium glutamate
Bitter	The taste left the tongue after swallowing and associated with caramel solution

[1] Oyster hydrolysed solution made from oyster and papaya enzyme

Table 7. Significant levels for the sensory attributes of four kinds of oyster sauce (***, **, * indicate significant differences using *F* test *at* $p < .001$, $p < .01$, $p < 0.5$, respectively, using a mixed ANOVA model with sample as random effect. NS: non significant.)

Sensory attributes	Assessor	Sample	Assessor* Sample	Replication
Brown	***[a]	***	***	NS
Stickiness	***	**	***	NS
Smoothness	NS	***	***	NS
Thickness	***	***	***	NS
Melting-mouth feel	***	***	***	NS
Oyster	***	***	***	NS
Fishy	***	***	***	NS
Soya sauce	***	***	***	NS
Fried pork	NS	***	***	NS

Carmel odour	*	*	***	NS
Sweet	***	NS	***	NS
Sour	***	NS	***	NS
Caramel Bitter	***	NS	***	NS
Salty	***	*	***	NS
Umami	***	NS	***	NS
After-sweet	***	NS	***	NS
After-umami	***	NS	***	NS
After-bitter	***	NS	***	NS

Table 8. Mean value for sensory attributes of four oyster sauces

No.	Distributes	Sample				
		VN	TL	CN1	CN2	P
1	Brown	3.45 ± 0.82	4.18 ± 1.05	6.77 ± 1.14	7.6 ± 0.83	*<0.0001*
2	Stickiness	3.9±0.80	4.04 ± 1.44	3.13 ±1.36	3.13 ± 1.39	*0.017*
3	Smoothness	2.13 ± 0.23	2.18 ± 0.33	3.27 ± 1.05	3.45 ± 1.40	*0.0001*
4	Thickness	5.86 ± 1.70	5.2 ± 1.73	6.59 ± 1.20	6.7 ±1. 06	*0.0001*
5	Melting-mouth feel	2.5 ± 1.20	1.9 ± 0.43	3.09 ± 1.28	3.77 ± 1.77	*0.0012*
6	Oyster	5.5 ± 0.74	1.86 ± 0.63	1.82 ± 0.9	2.0 ± 0.86	*<0.0001*
7	Fishy	3.27±2.30	2.45 ± 1.44	3.27 ± 1.99	3.54 ± 2.27	*<0.0001*
8	Soy sauce	2.90 ± 1.67	6.68 ± 1.47	3.13 ± 1.84	3.72 ± 1.97	<0.0001
9	Fried pork	2.09 ± 1.42	2.27 ± 1.47	5.0 ± 1.78	5.86 ± 1.87	<0.0001
10	Caramel	3.49 ± 2.39	3.77 ± 2.00	2.95 ± 1.61	3.3 ± 1.12	0.68
11	Sweet	4.95 ± 1.60	4.04 ± 1.70	4.13 ± 1.68	4.27 ± 1.70	0.33
12	Sour	3.8 ± 2.19	3.4 ± 2.02	4.0 ± 1.68	3.45 ± 2.20	0.58
13	Bitter	3.13 ± 1.79	3.36 ± 2.23	3.86 ± 1.98	3.72 ± 1.76	0.53
14	Salty	5.73 ± 1.72	6.18 ± 1.43	6.41 ± 0.86	7.0 ± 1.12	*0.02*
15	Umami	5.54 ± 1.94	5.22 ± 1.91	5.72 ± 1.87	6.0 ± 1.70	0.32
16	After-sweet	3.81 ± 2.08	3.81 ± 1.79	3.41 ± 1.26	3.4 ± 1.49	0.77
17	After-umami	4.72 ± 2.02	4.77 ± 2.28	5.31 ± 2.45	5/63 ± 2.46	0.13
18	After-bitter	2.4 ± 2.13	2.45 ± 1.43	3.18 ± 2.04	3.27 ± 2.10	0.26

In order to determine the overall sensory evaluation, PCA was used on all sensory attributes. The results of the PCA are shown in Figure 2 where we plotted the "circle of correlation" along with the correlations (*i.e.*, loadings) of the sensory attributes with the PCs. For ease of interpretation, we have number the four quadrants from 1 to 4. In the first quadrant, saltiness, fried pork odour, and aftertaste perception characterise sample CN2. The second quadrant shows soy sauce odour and stickiness which characterise the TL sample. In the fourth quadrant melting and fishy odour characterise sample CN1. The third quadrant corresponds to the oyster odour and sweet taste. The first two PCS explained 91.15% of the total variance and therefore we can trust the positions of the variables displayed in Figure 2.

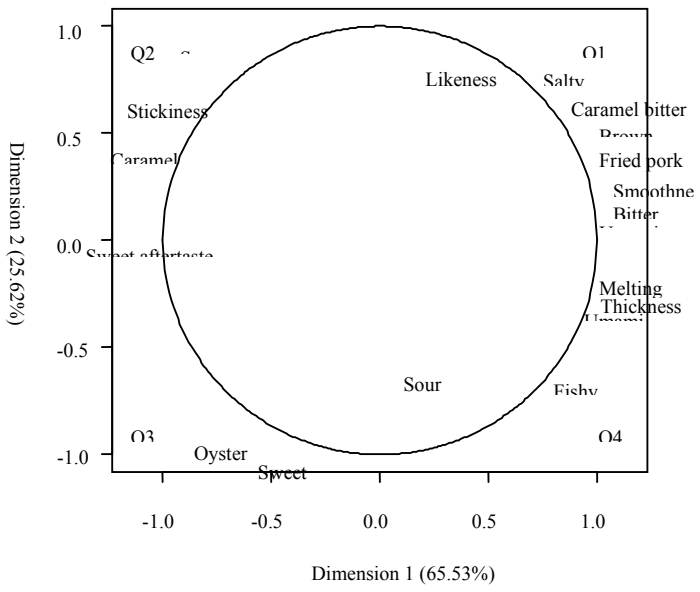

Figure 2. Plot of principal component analysis of the sensory attributes of four samples.

3.4 The relationship between sensory attributes, taste compounds and volatile compounds

To determine the relationships between taste compounds and sensory data in the four oyster sauce samples, we used canonical correlation. The correlation coefficients with each taste sensory attributes are presented in Table 9 where we can see that the sweet FAAs show a high correlation (r = .99) with sweet taste (including sweet aftertaste). Sample CN1, which had the highest amount of bitter FAAs (89.36%), also showed the highest intensity in bitter taste. However, this relation between the concentration of bitter FAA and intensity of perceived taste does not hold for the other samples maybe because the bitter taste is also connected to the hydrophobic peptides (Schlichtherle-Cerny, 1998). Components related to umami such as FAAs, inosine monophosphate (IMP) are considered important contributors to the sensory quality (Dang *et al*., 2008). However there was no significant difference of umami intensity between our four samples (*e.g.,* the sample VN had the highest concentration of umami FAAs but yet received nearly the lowest rating in sensory profile). Therefore, it seems that the correlation between FAAs and taste intensity is likely to depend on many other factors such as the presence of peptides and some other flavour compounds, as well as their synergistic effects (Schlichtherle-Cerny, 1998).

There has been little work on the flavour of minerals in food. Fuke and Konosu (1991) believed that inorganic salts such ad Na+, K+, Cl- and PO43- contributed to fish flavour (Shahidi, 1998). Case in point, CN1 and CN2 had the highest amount of minerals, and CN1 received the highest for fishy odour. This result is corroborated by canonical correlation, with phosphate (r = .84) and sodium (r = .92). In addition, salty is highly correlated to phosphate

and potassium with values of *r* equal to (respectively) .77 and .76. However salt was poorly correlated to free amino acids.

PCA was applied to analyse the relationships between volatile compounds and sensory attributes. The peak area values of volatile compounds were projected onto the plot built with the sensory information evaluated by trained panellists. The information content is indicated by the position of the compounds and sensory characteristic as well as the distance between them. As a rule of thumb, the vicinity of a volatile to an attribute illustrates a good relationship between them, but this interpretation may depend on other surrounding sensory attributes. In addition, the distance of a volatile to the centre of the circle reflects how much this volatile contributes to the aroma (Garcia-Gonzalez *et al*., 2008). This means that the volatiles close to the centre of the circle will take up less contribution than the volatiles close to the perimeter of the circle. From Figure 3 we can see that the most important volatile compounds contributing to oyster sauce odour include furan 2-methyl, aldehydes, pyrazine methyl, ethanone 1,2-furanyl, acid acetic. In Figure 3, we also see that most of the volatiles are located in Quadrants Q1 and Q4. As mentioned above, Q1 was characterised by the presence of most of the pyrazines, pyridines (excepting pyridine 3-methyl), furan 2-pentyl, 3-furanmethol, furfural, ketons (excepting 2,3 butanedione, 3-pentanone). In addition, we found in Q1 the sample CN2 and the variables from the sensory dataset, fried pork, salty taste, and caramel bitter taste. We cannot, however, explain the presence of these pyrazines and ketons, particularly the pyrazines near the fried pork flavour. The soy sauce flavour location is close to all kinds of aldehydes excepting hexanal, alcohols such as 2,3-butanediol, methaneniol, and 1-3 dioxane 2-methyl, 1,3-dioxane 2-heptyl-4-methyl. As the result, Q2 could be defined by the aldehydes, 2,3-butanediol group and the soy sauce odour as well. This location seemed to agree with previous studies about soy sauce odour (Yan et al., 2008). One surprise is, in fact, to find the sulphur compounds near the caramel odour and opposite to fishy odour which is believed to be associated to these compounds. This surprising position could be explained by the low concentration of the sulphur compounds in the samples which may be too low to affect flavour.

In the third quadrant, we found compounds including 1-penten-3-ol, hexanal, 1,2-propanediol-2-acetate, 1,2-propandiol diacetate and oyster odour. Therefore, the relationship between oyster and those compounds has been observed. In previous studies, 1-penten-3-ol and hexanal have been believed to contribute the odour of oyster (Shahidi, 1998).

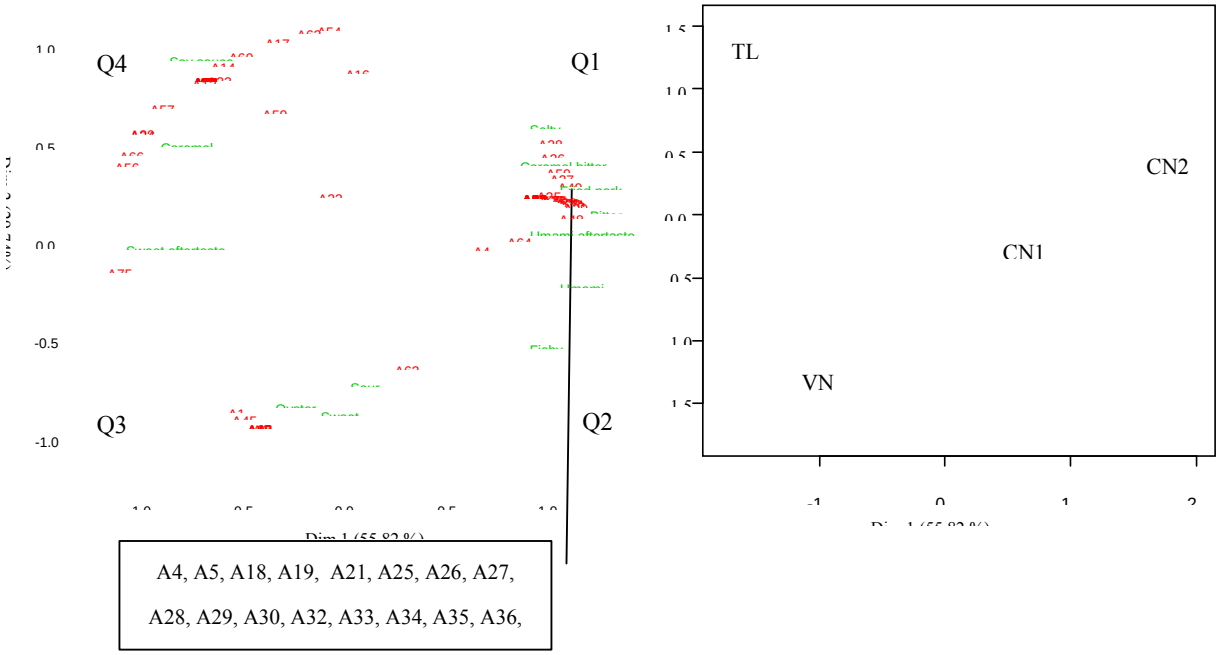

Figure 3. Plot of principal component analysis of the sensory attributes and volatile compounds and individual factors. The codes are listed in Table 3

The next step was to determine the variance of each of the sensory traits that could be correlated to individual compounds of the volatiles dataset. Table 9 shows the correlation detected between the sensory attributes and the volatiles identified and quantified in the four experimental samples. Only the larger *r*-coefficients were illustrated in the table and, as expected, the highest *r* (> .97) was found with sweet taste and odour. This strong correlation maybe due to volatile compounds being mostly linked to odour perception (see, *e.g.*, Park, 2005)

Table 9. The statistical correlation value between sensory attributes and volatile compounds identified in oyster sauces

Sensory attribute	Volatile compounds	R-coefficient
Oyster	A1, A4, A5, A6	> 0.97
Fishy	A2, A13, A15	> 0.96
	A61, A62	> 0.99
Soya sauce	A8, A9, A10, A11	> 0.96
	A51	> 0.99
Fried pork	A17, A21, A42, A45, A50, A51, A52, A53, A54, A55, A58, A64, A65, A68, A69, A72, A73, A74	> 0.98
Caramel	A14, A26	> 0.95
Sour	A31, A32, A33, A35	> 0.90

3.5. Consumer test

Significant differences ($p < .05$) occurred among demographics for consumer's overall liking. Sample VN was rated higher than any of its counterparts, while sample CN2 gave lowest

scores. Sample TL took the second position of grades, ahead of sample CN1. However, consumers' rates on distributions (colour, odour, taste, after taste, mouth feel) did not show any clear and significant clustering.

Analysis of the overall acceptance data by Agglomerative Hierarchical Clustering (AHC) identified four consumer clusters including cluster 1 (26.4%, $N = 33$), cluster 2 (24%, $N = 30$), cluster 3 (32%, $N = 40$) and cluster 4 (17.6%, $N = 22$). Cluster analysis of consumers' overall liking data showed that four clusters of consumers with similar preference patterns could be formed.

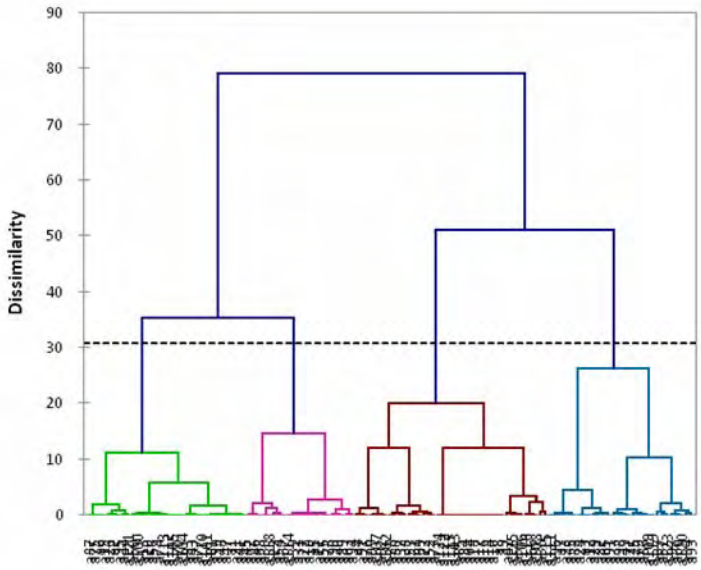

Figure 3: Dendrogram of the four major consumer clusters idendified for all categories

Finally, the relationships between sensory attributes and consumer liking were analysed with preference mapping (PREFMAP). PREFMAP was performed on the coordinates of the oyster source in the two-dimensional factor space and on the ratings given by the consumers, summarised by the standardised ratings for the four clusters. Results indicate that consumers of Cluster 1 preferred VN and TL because of their light brown colour, and sweet aftertaste, but that VN was preferred because of its sweet taste and oyster odour. In Cluster 2, the participants liked TL's strong soy sauce odour, sour taste and caramel bitter taste, stickiness in texture but did not like VN's oyster and fishy flavour and sour taste. By contrast, participants of Cluster 3 liked CN1and CN2's dark brown colour, smooth, thick, melt texture, fried pork flavour, umami after-taste, flavour of oyster aroma, fish flavour, and sweet-sour taste. The participants of Cluster 4 preferred VN because of its sweet taste and oyster odour, (like the participants of Cluster 1) also because of its moderate brown colour, rough thin, melt texture and sweet after-taste.

PREFMAP shows that the sample TL which is characterised by a strong caramel flavour, soy sauce flavour, and salty taste, is not liked by all clusters. By contrast, sample VN is the most preferred one for most clusters, especially Clusters 1 and 4.

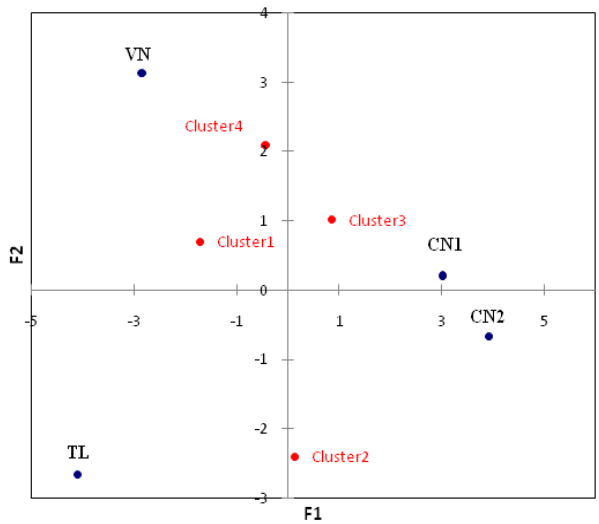

Figure 4. Preference map of combined consumer data with descriptive analysis results.

4 CONCLUSIONS

This study shows the differences in volatile compounds, taste compounds and sensory attributes of four commercial brands of oyster sauces. Each sample had the typical odour of the oyster sauce, but there were significant differences in taste perception between these four samples. These differences in taste can be explained by differences in ingredients and processing of oyster extracting (fermentation or boiling). Overall, the CN1 and CN2 were very similar in volatile composition and sensory characteristic. This similarity could be explained by the similarity of processing and ingredients of two these samples. We found also a strong relationship between the volatile, taste compounds and sensory attributes. In particular, sweet taste highly correlated with the concentration of sweet free amino acids. The flavour of oyster, soy sauce, and fried pork odour were correlated with the concentration of 1-penten-3-ol, aldehydes and pyrazines.

Consumer liking of the four samples was evaluated at the same time. Preference mapping revealed the relationships between consumer clusters and sensory descriptions. We can draw the conclusion that sample VN was accepted by most of consumer clusters because of its sweet taste and oyster odour, but also because the presence of 1-penten-3-ol and sweet free amino acids. Although the complexity of the problems means that we could not explain every sensory characteristic from their bio-chemical composition, we feel that the correlation between the concentration of aldehydes and the perception of soy sauce odour is large enough to recommend that producers avoid incorporating these aldehydes in their formulation. Finally, we need to keep in mind that consumers like a specific product not only because of its sensory attributes, but also because of its price, nutritional value, etc (Park, 2005). Further studies should explore more deeply complex relationships between different characteristics of

products. This will help food companies to find the "multi-aspects" important for their marketing and product development.

Acknowledgement

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RELATIONSHIP BETWEEN SENSORY DESCRIPTIVE AND CHEMICAL PROPERTY OF JIAOGULAN (*Gynostemma pentaphyllum.*) TEA WITH LIME JUICE

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Abstract

The objective of this research was to study the relationship between sensory and chemical properties of Jiaogulan tea with lime juice (JTLJ) fortified with Jiaogula extract. We used mixture design methodology to create eight formulas of JTLJ. The chemical and physical factors were moisture content, total soluble solid, total acidity, total saponin, gypenoside, ginsenoside Rb1 and colour (L*, a*, b*, △E). The hybrid sensory descriptive analysis was conducted by ten panellists. They generated 13 attributes to rate the beverage. The results showed that a principal component analysis could explain 88.71% of the total variance with two components. The first principal component explained 50.44% of the variance and showed that, on one hand, total soluble solid was associated to sweet and sweet aftertaste and that, on the other hand, the moisture, total saponin, ginsenoside Rb1, gypenoside were associated with bitter and astringent aftertastes. The second principal component explained 38.28% of the variance and showed that the yellow colour, clearness, lime aroma, Jiaogulan aroma, lime flavour, Jiaogulan flavour and total acidity were negatively correlated with pH and b*.

Key Words: Jiaogulan, descriptive analysis, PCA, Gypenoside, Saponin

1. INTRODUCTION

Gynostemma pentaphyllum Makino (Cucurbitaceae), known as Jiaogulan in Chinese herbal medicine, is a perennial vine endemic in southern China, Japan, India, and Korea (Blumert & Liu, 1999). In oriental countries, *G. pentaphyllum* is a well known edible and medicinal plant (Hu, Chen & Xie 1996). Recently, *G. pentaphyllum* has attracted great attention owing to its anti-tumour activities (Zhou, Liang, & Hu, 2001), anti-gastric ulcer effect (Rujjanawate, Kanjanapothi, & Amornlerdpison, 2004), immunomodulatory effect (Qian, Wang, & Tang 1998) and potential for treating hyperlipidaemia (Cour, Molgaard & Yi, 1995). Because of this recent interest, the cultures of *G. pentaphyllum* and their extraction process in health care have been put into large scale production. Phytochemical studies of this plant had identified about 90 dammarane-type glycosides, mainly named gypenosides (Gy), and closely related to the ginseng saponins. Indeed, gypenosides III, IV, VIII, XII and malonyl gypenosides III and VIII are identical to ginsenosides Rb1, Rb3, Rd, F2, and malonyl ginsenosides Rb1 and Rd (Takemoto *et al*., 1983; Kuwahara *et al*., 1989; Piacente & Pizza, 1995).

Even though *G. pentaphyllum* is said to be one of the most commonly used medicinal plants in many countries in Asia, especially China, there is no report of the sensory properties of this plant. Therefore, the objective of this research was to investigate the sensory descriptive analysis and to study the relationship between sensory and physical-chemical properties of Jiaogulan tea product.

2. MATERIALS AND METHODS

2.1 Preparation of Jiaogulan powder and Jiaogulan extract

Jiaogulan leaves were purchased from the Royal Project, Chiang Mai, Thailand**.** The fresh leaves were washed and dried by vacuum microwave drier until the moisture content was below 7%, as specified by the Thai Industrial Standard Institute of green tea TIS 460-2526 (TISI, 1983). After that, it was milled and packed in tight closed container. About 5 g of Jiaogulan powder was extracted with distilled water by the microwave extraction at full power (800 watt) for 1.47 minutes (Sittikaipong, Apichartsrangkoon, & Utama-ang, 2008). The extract was filtered and evaporated at 60°C by vacuum rotary evaporator. The concentrated solution was freeze- dried and kept at –20°C until used.

The Jiaogulan powders consisted of saponin 95.03 mg/g, gypenoside 29.70 mg/g and ginsenoside Rb1 0.18 ppm. The Jiaogulan extract consisted of saponin 180.94 mg/g, gypenoside 122.47 mg/g and ginsenoside Rb1 0.48 ppm.

2.2 Formulation of Jiaogulan tea with lime juice (JTLJ)

The Jiaogulan beverage consisted of 1% Jiaogulan tea, lime juice, sugar, 0.035% ascorbic acid and 0.01% jiaogulan extract. The experiment used three variables; 1% Jiaogulan tea (50 to 80%), sugar (5 to 30%) and lime juice (5 to 20%). Eight treatments—shown in Table 1—were generated using D-optimal mixture design (Gacula, 1993),.

Table 1: Eight formulas of JTL created by mixture design.

Formulation	1% Jiaogulan tea (%)	Sugar (%)	Lime juice (%)
1	85	5	9.95
2	68.32	18.32	13.32
3	85	9.95	5
4	64.95	30	5
5	50	29.95	20
6	74.95	5	20
7	59.16	24.14	16.66
8	64.95	30	5

2.3 Physical and chemical properties

The physical measurement of JTLJ were assessed as follows: colour L^*, a^*, b^* and ΔE (Minolta, Chroma meter CR-310, Japan) using D65 illuminant, 10° observer. The Chemical measurement included: total soluble solids (refractometer, PAL-1 Atago, Japan), pH (Hanna HORIBA: F-22, Japan), total acidity (AOAC 2000), total saponin (Kwon *et al*., 2003), total gypenoside (Department of Medical Sciences, 2005) and total gynsenoside Rb1 (Wu, Lin, & Chau, 2001).

2.4 Sensory descriptive analysis

We evaluated JTLJ using a hybrid descriptive analysis method (Einstein, 1991; Grosso & Resurreccion, 2002) that was modified from both the Quantitative Descriptive Analysis (QDA, Tragon Corp., Redwood City, CA, U.S.A.) and the Spectrum^{TM} Analysis methods (Sensory Spectrum, Inc., Chatham, NJ, U.S.A.). The sensory evaluation was conducted in the sensory evaluation research unit, Department of product development technology, faculty of agro-industry, ChiangMai University, and using Su sense program from Silpakorn University, Thailand. Ten panellists were selected from the students who passed the sensory evaluation course. The training program was completed over a period of four weeks. Six 2-hour training sessions were conducted over that period of time. The training program included terminology development, reference, line scale training (unstructured 15 cm.), using warm-up samples (Plemmons & Resurreccion, 1998). The trained panellists generated 13 attributes along with the consensusal references corresponding to each attribute (Table 2). Before evaluating products in individual booth, the panellists were calibrated using four basic taste reference standards (Meilgaard *et al*., 2007) and a warm-up sample for reliability of rating. Each panellist received 30 ml of sample in 1 oz plastic cup with a cover slip. The samples were served at room temperature.

Table 2. Attributes of Jiaogulan tea with lime juice created by trained panellists using descriptive analysis

Attributes	Definitions	References
Appearance		
Yellow colour	Light yellow to intense yellow	Tratarzine 0.01%
Clearness	The degree of clarity of sample	Distilled water, corn starch 0.4%
Aroma		
Lime aroma	Aromatic associated with artificial lime aroma	Artificial lime aroma (Winner, Thailand)
Jiaogulan aroma	Aromatic associated with Jiaogulan aroma	Jiaogulan tea
Flavour		
Sourness	The taste on the tongue associated with aqueous solution of citric acid	Citric acid solutions (0.05, 0.08, 0.15%)
Sweetness	The taste on the tongue associated with aqueous solution of sugar	Sucrose solutions (2.0, 5.0, 10.0, 16.0%)
Bitterness	The taste on the tongue associated with aqueous solution of caffeine	Caffeine solutions (0.05, 0.08, 0.15, 0.20%)
Lime flavour	Aromatic in mouth associated with artificial lime flavour	Concentrate lime juice (5%)
Jiaogulan flavour	Aromatic in mouth associated with Jiaogulan flavour	Jiaogulan tea (1%)
Aftertaste		
Sour aftertaste	The intensity of sourness after swallowing the sample	Citric acid solutions (0.05, 0.08, 0.15%)
Sweet aftertaste	The intensity of sweetness after swallowed the sample	Sucrose solutions (2.0, 5.0, 10.0, 16.0%)
Bitter aftertaste	The intensity of bitterness after swallowed the sample	Caffeine solutions (0.05, 0.08, 0.15, 0.20%)
Astringent aftertaste	The shrinking of feeling after swallowed the sample	Alum (0.07%)

2.5 Statistical analysis

The mixture design was created by Design-Expert program version 6.0.1.0 (Stat-Ease Inc., MN). The response data obtained from the physical and chemical measurements, sensory descriptive analysis and consumer acceptance test were analysed 1) by analysis of variance (ANOVA) with a second order model followed by mean difference which was determined by Tukey HDS, 2) multiple regression analysis, and 3) principal component analysis (PCA), Statistical analyses were performed with the SPSS® software package (SPSS Inc., Chicago, IL).

3. RESULTS AND DISCUSSION

3.1 Physical and chemical properties

The physical properties of eight JTLJ: colour L*, a*, b*, ΔE, are given in Table 3, along with their significant differences. Because jiaogulan tea and lime juice were mixed with different ratios all differences are significant. The chemical properties of the eight JTLJs are given in Table 4, along with their significant differences. Again all treatments were significantly different. The soluble solid, total acidity and pH were also significantly different in all formulations. The active compounds; saponin and gypenosid varied significantly in some formulations but gensenoside Rb1 showed no significant difference.

Table 3. Means and standard deviations of physical properties of JTLJ: Different letters in the same column indicate significant differences at $p < .05$

Formulations	L*	a*	b*	ΔE
1	53.72 ± 0.01^{g}	6.87 ± 0.01^{b}	71.50 ± 0.04^{c}	51.10 ± 0.00^{b}
2	60.68 ± 0.03^{f}	4.68 ± 0.01^{d}	68.52 ± 0.04^{e}	47.04 ± 0.01^{c}
3	62.12 ± 0.15^{e}	4.91 ± 0.01^{c}	73.57 ± 0.03^{a}	51.10 ± 0.01^{c}
4	69.81 ± 0.09^{a}	1.88 ± 0.01^{h}	72.54 ± 0.06^{b}	44.10 ± 0.02^{g}
5	64.63 ± 0.01^{c}	3.07 ± 0.01^{f}	63.05 ± 0.02^{h}	44.28 ± 0.00^{e}
6	49.01 ± 0.01^{h}	7.17 ± 0.01^{a}	67.73 ± 0.01^{f}	53.61 ± 0.01^{a}
7	63.03 ± 0.01^{d}	3.95 ± 0.01^{e}	66.91 ± 0.00^{g}	45.69 ± 0.01^{d}
8	68.46 ± 0.03^{b}	2.51 ± 0.03^{g}	70.97 ± 0.03^{d}	44.22 ± 0.03^{f}

Table 4. Chemical properties of JTLJ. Different letters in the same column indicate significant differences at $p < .05$

Formulations	Total saponin (% w/v)	Total gypenoside (% w/v)	Total gynsenoside Rb1 (% w/v)	pH	Total soluble solid (%)	Total acidity (%)
1	12.71 ± 0.11^{g}	2.81 ± 0.10^{f}	6.3 ± 0.85^{ns}	3.04 ± 0.01^{d}	7.17 ± 0.06^{g}	0.79 ± 0.04^{d}
2	37.87 ± 0.09^{e}	3.36 ± 0.14^{e}	6.57 ± 1.88^{ns}	2.82 ± 0.01^{f}	17.10 ± 0.10^{e}	1.07 ± 0.11^{c}
3	21.78 ± 0.14^{f}	3.78 ± 0.11^{d}	6.47 ± 0.90^{ns}	3.37 ± 0.01^{b}	11.07 ± 0.06^{f}	0.39 ± 0.04^{ef}
4	78.20 ± 0.15^{a}	8.03 ± 0.07^{a}	5.53 ± 1.10^{ns}	3.58 ± 0.01^{a}	28.93 ± 0.06^{c}	0.30 ± 0.04^{f}
5	68.85 ± 0.06^{c}	7.59 ± 0.12^{b}	8.43 ± 1.00^{ns}	2.75 ± 0.02^{g}	29.67 ± 0.58^{b}	1.52 ± 0.08^{a}
6	12.16 ± 0.13^{h}	2.47 ± 0.16^{g}	6.73 ± 0.81^{ns}	2.91 ± 0.02^{e}	7.00 ± 0.00^{g}	1.47 ± 0.07^{a}
7	48.30 ± 0.16^{d}	4.13 ± 0.12^{c}	6.60 ± 0.82^{ns}	2.90 ± 0.02^{e}	25.00 ± 0.00^{d}	1.28 ± 0.04^{b}
8	79.97 ± 0.11^{b}	7.37 ± 0.08^{b}	7.57 ± 1.26^{ns}	3.29 ± 0.02^{c}	30.67 ± 0.58^{a}	0.47 ± 0.04^{e}

3.2 Sensory descriptive analysis

Ten trained panellists evaluated eight formulations of JTLJ with the thirteen attributes: yellow colour, clearness, lime aroma, Jiaogulan aroma, sourness, sweetness, bitterness, lime flavour, Jiaogulan flavour, sour aftertaste, sweet aftertaste, bitter aftertaste and astringent aftertaste followed by perception. The results are shown in Figure 1. The ANOVA showed that treatments affected all sensory attributes (Table 5).

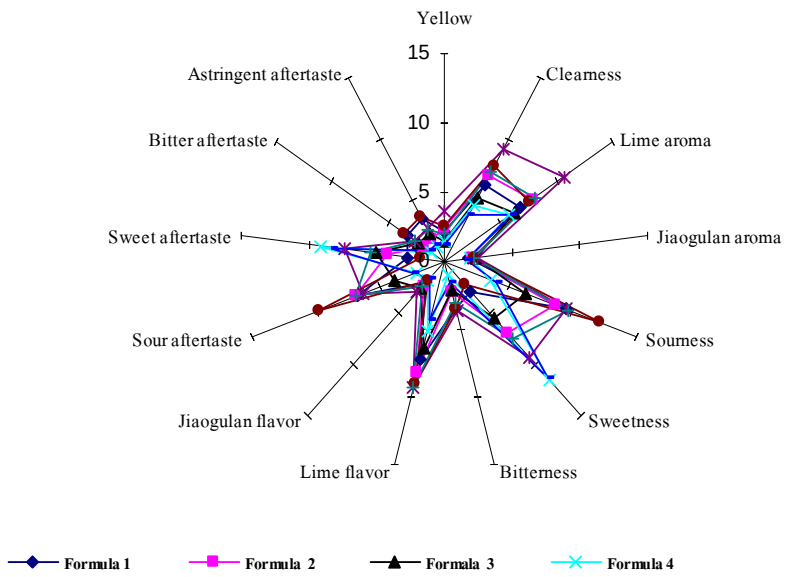

Figure 1. Spider web of descriptive sensory data of JTLJ

Table 5. Sensory descriptive mean rating of eight JTLJformulations. Different letters in the same column indicate significant differences at $p < .05$

Formulatio	Yellow	Clearness	Lime aroma	Jiaogulan aroma	Sourness	Sweetness	Bitterness
1	2.18 ± 0.29^{d}	6.16 ± 0.30^{e}	6.77 ± 0.44^{d}	1.71 ± 0.21^{e}	9.62 ± 0.39^{b}	2.79 ± 0.33^{f}	3.58 ± 0.42^{a}
2	2.40 ± 0.24^{c}	6.96 ± 0.27^{d}	7.83 ± 0.41^{bc}	2.09 ± 0.29^{c}	8.70 ± 0.45^{c}	6.88 ± 0.47^{d}	2.30 ± 0.38^{c}
3	1.45 ± 0.25^{e}	5.16 ± 0.41^{f}	6.21 ± 0.33^{e}	2.26 ± 0.33^{b}	6.40 ± 0.40^{d}	5.47 ± 0.38^{e}	1.96 ± 0.28^{d}
4	1.43 ± 0.24^{e}	4.65 ± 0.26^{g}	5.84 ± 0.37^{f}	1.89 ± 0.44^{d}	3.60 ± 0.37^{f}	11.43 ± 0.38^{a}	0.89 ± 0.22^{f}
5	3.60 ± 0.25^{a}	9.21 ± 0.52^{a}	10.65 ± 0.39^{a}	2.45 ± 0.39^{a}	9.58 ± 0.43^{b}	9.25 ± 0.51^{b}	3.62 ± 0.42^{a}
6	2.56 ± 0.29^{b}	7.79 ± 0.59^{b}	7.60 ± 0.53^{c}	2.15 ± 0.30^{bc}	12.21 ± 0.65^{a}	2.13 ± 0.27^{g}	3.57 ± 0.35^{a}
7	2.08 ± 0.28^{d}	7.31 ± 0.37^{c}	8.05 ± 0.58^{b}	2.13 ± 0.30^{bc}	9.70 ± 0.35^{b}	7.37 ± 0.57^{c}	3.09 ± 0.29^{b}
8	1.28 ± 0.25^{f}	3.84 ± 0.57^{h}	5.93 ± 0.38^{f}	1.65 ± 0.26^{e}	4.07 ± 0.39^{e}	11.28 ± 0.45^{a}	1.51 ± 0.32^{e}

Table 5 (continued)

Formulation	Lime flavour	Jiaogulan flavour	Aftertaste			
			Sourness	Sweetness	Bitterness	Astringent
1	7.33 ± 0.50[d]	1.99 ± 0.47[d]	6.74 ± 0.33[c]	2.64 ± 0.31[g]	3.26 ± 0.31[b]	3.53 ± 0.37[a]
2	8.24 ± 0.35[c]	2.33 ± 0.48 [c]	6.85 ± 0.35[bc]	4.25 ± 0.57[f]	1.83 ± 0.15[f]	1.83 ± 0.15[d]
3	6.30 ± 0.70[e]	2.58 ± 0.43[b]	3.95 ± 0.31[e]	4.95 ± 0.33[e]	2.33 ± 0.24[e]	2.33 ± 0.24[c]
4	5.10 ± 0.45[f]	1.93 ± 0.34[d]	2.22 ± 0.26 [g]	9.14 ± 0.50[a]	1.23 ± 0.27[g]	1.23 ± 0.27[e]
5	9.30 ± 0.67[a]	2.93 ± 0.50[a]	6.32 ± 0.33[d]	7.26 ± 0.30[c]	2.75 ± 0.27[c]	2.75 ± 0.27[bc]
6	9.00 ± 0.62[b]	1.76 ± 0.23[e]	9.80 ± 0.50[a]	1.79 ± 0.23[h]	3.65 ± 0.51[a]	3.65 ± 0.51[ab]
7	9.31 ± 0.66[a]	2.43 ± 0.50[c]	6.93 ± 0.42[b]	5.42 ± 0.46[d]	2.52 ± 0.22[d]	2.52 ± 0.22[c]
8	4.35 ± 0.74[g]	1.68 ± 0.22[e]	2.46 ± 0.29[f]	8.28 ± 0.30[b]	1.37 ± 0.18[fg]	1.37 ± 0.18[e]

3.3 The relationship between sensory descriptive and physical-chemical properties

PCA) was applied to investigate the relationship between sensory and physical-chemical data. PCA transforms the original variables into new orthogonal variables called principal components (PCs). Therefore, PCA expressed the total variation in the data set with only a few PCs. In PCA, the components are ranked according to their explained variance (Moigne *et al*., 2008).

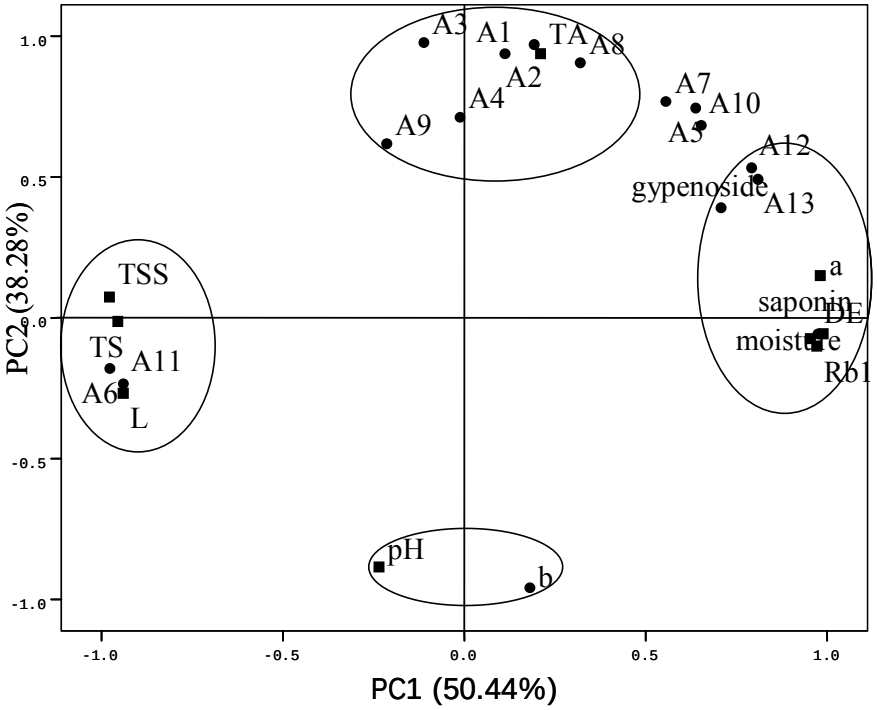

Figure 2: Principal component analysis generated by physical-chemical properties and sensory descriptive attributes A1: Colour A2: Clearness A3: Lime aroma A4: Jiaogulan aroma A5: Sourness A6: Sweetness A7: Bitterness A8: Lime flavour A9: Jiaogulan flavour A10: Sour aftertaste A11: Sweet aftertaste A12: Bitter aftertaste A13: Astringent aftertaste TS:Total solid L: Lightness +a: redness, -a: green +b: yellow, -b: blue DE : Colour difference TSS: Total soluble solid

The results showed that PCA could explain 88.71% of the variance with two components (Figure 2). PC1 explained 50.44% of the variance and showed that, on the one hand, total soluble solid was associated to sweet and sweet aftertaste and that, on the other hand, the moisture, total saponin, ginsenoside Rb1, gypenoside were associated with bitter and astringent aftertastes. The bitter taste of Jiaogulan comes from its saponin glycoside content (Cheeke, 2001) and the bitterness perdures as an aftertaste. Peleg *et al.* (1999) studied the flavonoid compound in tea by a time-intensity test and found that the maximum bitter intensity decreased whereas the astringency increased. But Utama-ang (2006) observed that, when the saponin in Jiaogulan tea increased, so did the bitterness and astringency. PC2 explained 38.28% of the variance and showed that the yellow colour, clearness, lime aroma, Jiaogulan aroma, lime flavour, Jiaogulan flavour and total acidity were negatively correlated with pH and b*.

4. CONCLUSION

In this research, our objectives were to investigate the relationship between physical-chemical properties and sensory descriptive property of JTLJ. The sensory descriptive analysis by trained panellists defined 13 attributes of JTLJ.; yellow, clearness, lime aroma, Jiaogulan tea aroma, sourness, sweetness, bitterness, lime flavour, Jiaogulan tea flavour, sourness aftertaste, sweetness aftertaste, bitterness aftertaste and astringent aftertaste. PCA showed a clear relationship between sensory attributes and physical-chemical properties with PC1 and PC2 explaining respectively 50.44% and 38.28% of the experimental variance. This shows that the sensory descriptive method by trained panellists could relate to instrument measurements for the evaluation of the properties of JTLJ

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