

2003 MAFMA Final Report

Project Title **Determining what characteristics consumers desire in Swiss cheese**
PI (s) **Jeannine F. Delwiche, Ph.D.**
Co-PI (s) **Rachel E. Liggett**
Academic
Institution **The Ohio State University**
Award Date **October 2003-May 2005**

1. Objective Summary

To determine the characteristics of Swiss cheese consumers desire by relating sensory consumer and descriptive data

To provide feedback to Swiss cheese manufacturers for the potential to produce more desirable cheeses and possibly increase their economic advantage

2. Objective Accomplishments

Through the use of partial least squares regression, attributes important to liking of Swiss cheese was determined. For the most important attributes and all attributes tested, it was determined whether each had a positive impact, negative impact or no impact on liking. Specific samples were profiled and mapped onto the space to understand consumer perception. A statistical model was built which can predict consumer liking of Swiss depending on the intensities of various sensory attributes of the product. Swiss and baby Swiss samples were compared to predict a perceptual ideal product which would be well-liked.

3. Unexpected findings, if any

None to report.

4. Practical impacts of research efforts.

Short Term Impacts:

Swiss cheese manufacturers are better able to understand why their existing cheeses are performing as they are based on consumer perception

Long Term Impacts:

Swiss cheese manufacturers may incorporate the findings into their current formulations to create products that better meet consumer demand and increase their economic advantage.

Report to Swiss Cheese Consortium and manufacturers (providers of funding)

Determining what characteristics consumers desire in Swiss cheese

Investigators

Rachel Liggett, MaryAnne Drake, and Jeannine Delwiche

Funding

SCC, OARDC, MAFMA

Objectives

1. Determine descriptive analysis profiles of various Swiss cheeses
2. Determine consumer liking and acceptance of same cheeses
3. Determine which cheese attributes are most desirable, and if multiple market segments exist.

Project Status

Data analysis complete; model testing and publication forthcoming (Autumn 2005)

Background

There are many high quality Swiss cheeses, but these same cheeses vary in their flavor characteristics. However, there is currently no known published research that examines consumer liking as a function of these differences. Therefore, further investigation into consumer perception of these differences in terms of preference and acceptability is needed. This research explored the following *hypothesis*: The characteristics of Swiss cheese that drive consumer liking can be determined by comparison of consumer acceptability ratings with descriptive analysis ratings.

Methods

Fifteen different cheeses were collected from member companies of the Swiss Cheese Consortium and assessed by a descriptive analysis panel and consumers during the same time period. These cheeses included four baby Swiss (B1, B2, B3, B4), one Emmenthal (E5) and 10 Swiss (S06, S07, S08, S09, S10, S11, S12, S13, S14, S15). Cheeses were cut into 2 cm cubes prior to serving (see Figure 1).



Figure 1. Consumer evaluation of Swiss cheese

Descriptive Analysis. A 12-member descriptive analysis panel, trained using the Spectrum method and having ≥ 100 hr of experience evaluating cheeses, assessed 21 attributes for all cheeses on a 15-pt category horizontal category scale (see Table 2 for lexicon). Panelists evaluated each sample in triplicate following a counterbalanced complete block design over a two week period.

Consumer Liking. One hundred one consumers rated *overall liking* for all cheeses on the 9-pt hedonic scale. Panelists evaluated each sample one time following a counterbalanced complete block design in one day (see Table 1 for demographic breakdown of consumers).

Consumer Dissimilarity. Twenty-five panelists rated *dissimilarity* of cheeses presented in pairs on a 15 cm continuous line scale. Sixty of the 196 possible pairs of cheeses were evaluated following a counterbalanced cyclic design over a four day period (see Table 1 for demographic breakdown of consumers).

Table 1. Demographic breakdown of consumer panelists.

		Liking (n=101)	Dissimilarity (n=25)			Liking (n=101)	Dissimilarity (n=25)	
Gender	Male	48	7	Age	18-25 years	51	13	
	Female	53	18		26-35 years	27	8	
Swiss Cheese Consumption	> Once/week	9	1		36-45 years	12	4	
	Once/week	26	5		46-55 years	8	0	
	Twice/month	28	11		56-65 years	3	0	
	Once/month	10	2		Ethnicity	White	70	17
	Once/3 mon	13	3			Asian	18	6
	Once/6 mon	4	0			Black	7	1
	Once/year	5	0			Hispanic	2	1
	< Once/year	6	3			No response	4	0

Table 2. Swiss cheese descriptive analysis lexicon¹

Descriptor	Definition	Reference
*Cooked/milky	Aromatics associated with cooked milk	skim milk heated to 85°C for 30 min
*Whey	Aromatics associated with Cheddar cheese whey	fresh Cheddar whey
*Diacetyl	Aromatic associated with diacetyl	diacetyl
*Milkfat	Aromatics associated with milkfat	fresh coconut meat, heavy cream, δ -dodecalactone
*Vinegar	Aromatics associated with vinegar	Distilled white vinegar, acetic acid
*Dried fruit	Aromatics associated with dried fruits, specifically peaches and apricots	Dried apricot half
*Fruity	Aromatics associated with different fruits	Fresh pineapple, ethyl hexanoate
*Sulfur/eggy	Aromatics associated with cooked eggs	Hardboiled egg, mashed
*Sulfur/cabbage	Aromatics associated with cooked cabbage	Boiled cabbage, dimethyl trisulfide
*Cheesy/butyric acid	Aromatics associated with butyric acid	Butyric acid
*Brothy	Aromatics associated with boiled meat or vegetable stock	Canned potatoes, Wylers low sodium beef broth cubes, methional
*Nutty	The nut-like aromatic associated with different nuts	lightly toasted unsalted nuts, unsalted cashew nuts, unsalted wheat thins
*Sweaty	Aromatic associated with human sweat	Hexanoic acid
Cow/phenolic	Aromas associated with barns and stock trailers, indicative of animal sweat and waste	Bandaids, p-cresol, phenol
Sour	Fundamental taste sensation elicited by acids	citric acid (0.08 % in water)
*Bitter	Fundamental taste sensation elicited by various compounds	caffeine (0.08% in water)
Salty	Fundamental taste sensation elicited by salts	sodium chloride (0.5 % in water)
*Sweet	Fundamental taste sensation elicited by sugars	sucrose (5 % in water)
Umami	Chemical feeling factor elicited by certain peptides and nucleotides	MSG (1 % in water)
*Prickle	Chemical feeling factor of which the sensation of carbonation on the tongue is typical	Soda water
*Metallic	Chemical feeling factor elicited by metallic objects in the mouth	Aluminum foil

¹adapted and modified from the Cheddar cheese lexicon (Drake et al., 2001)

Results

Descriptive Analysis. ANOVA shows the cheeses were differentiated by 17 of the 21 attributes, i.e., they were found to be significantly different (* in Table 2). These attributes were then used to determine what characteristics impact the liking of these cheeses for this group of consumers.

Cluster Analysis. Cluster analysis of liking ratings suggests the existence of two market segments (see Figure 2). Examination of the data shows that Segment 2 rated all samples nearly the same for liking while Segment 1 rated the samples differently enough to find significant differences in liking. However, since this segment only contains 39 subjects and the demographic breakdowns of the two segments are quite similar, further analysis of Segment 1 would not provide meaningful insight.

Partial Least Squares Regression (PLSR). PLSR attempts to model the variance in X (overall liking) that can be explained by the variance in Y (descriptive attributes). This data is adequately explained by 3 principal components, 2 of which are discussed here. A combination of “dairy” attributes, including *diacetyl*, *whey* and *milkfat*, underlie the first principal component, with all being positively correlated with liking. Samples having high intensities of these

attributes, including B1, B3, B4 and S06 are relatively well-liked by these

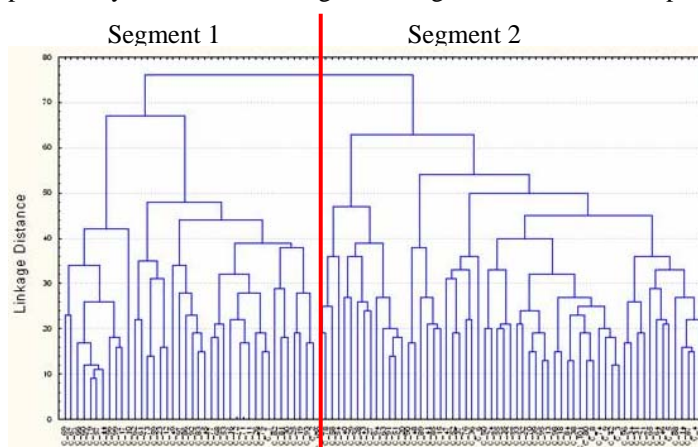


Figure 2. Cluster analysis of liking ratings.

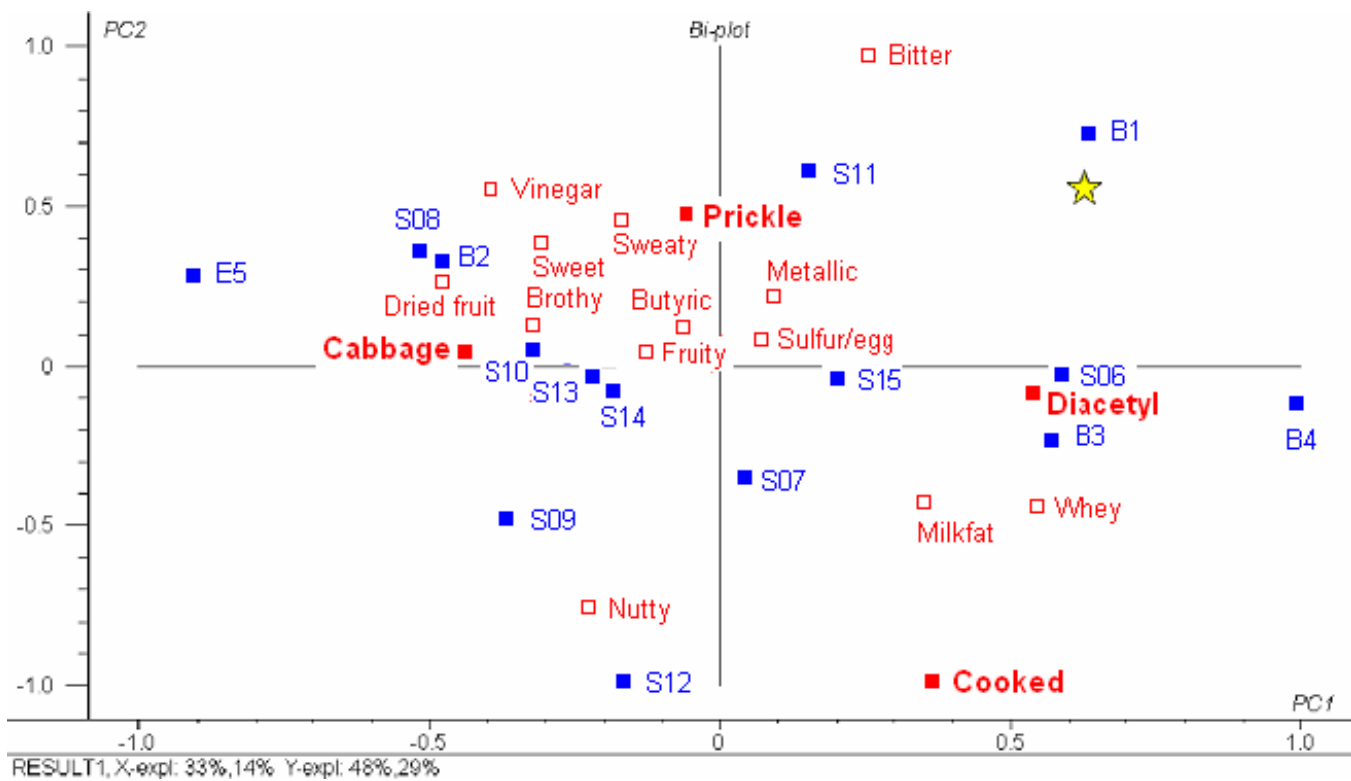


Figure 3. Bi-plot of samples and attributes for principal components 1 and 2

consumers. The second principal component is largely related to *cooked* flavor, which is negatively correlated with liking. Sample S12 (Swiss) has a high intensity of this attribute and as a result is less liked. The yellow star represents an “ideal” sample which would have the highest overall liking (see Figure 3). Further analysis of the data with Emmenthal and Swiss only (excluding baby Swiss) has minimal impact on the perceptual space and the same conclusions are drawn.

From the information obtained from this analysis, it is possible to build a regression equation which would model the overall liking of a given cheese based on the intensities of its descriptive attributes. Using the general regression equation, the following attributes are most important:

$$y = -0.765(\text{cabbage}) - 0.689(\text{cooked}) + 0.648(\text{diacetyl}) + 0.571(\text{prickle}) + \dots + a_n x_n$$

Cabbage flavor and cooked flavor are both negatively correlated with liking and diacetyl and prickle are both positively correlated with liking. These attributes are presented in **bold type** in Figure 3. Analyzing the Emmenthal and Swiss cheese alone maintains the same important attributes and correlations but in a slightly different order:

$$y = 0.741(\text{diacetyl}) + 0.598(\text{prickle}) - 0.496(\text{cooked}) - 0.419(\text{cabbage}) + \dots + a_n x_n$$

Maximum Likelihood Estimation of Ideals (MLEI). MLEI attempts to estimate “ideal” products based on consumer responses of dissimilarity between pairs of products. This analysis shows that one ideal product would meet the needs of this consumer population (see Figure 4). In Figure 4 (a), which shows the ideal relevant to all samples evaluated, the baby Swiss cheeses, colored in blue, have the most overlap with the ideal. Sample S06 and S11 have the most overlap of the Swiss cheeses and the Emmenthal and remaining cheese have no overlap with the ideal at all. Sample B3, having the most overlap with the ideal, is largely characterized by diacetyl and whey, as is Sample S06. Sample S11 is largely characterized by prickle, which was found to be positively correlated with liking. Further analysis of the data excluding the baby Swiss samples also shows the existence of one ideal sample having very little overlap with any of the cheeses tested. Samples S09 and S12 have the most overlap with the ideal and are characterized by nutty flavor.

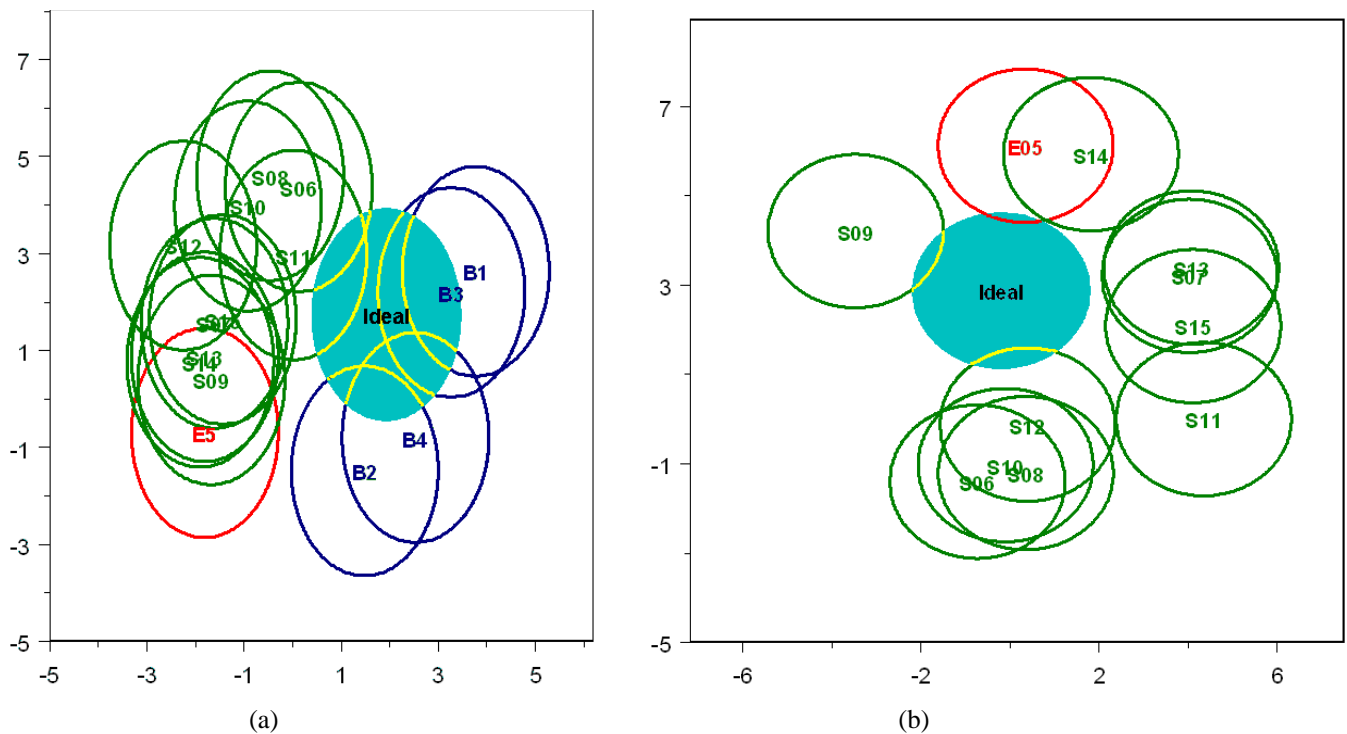


Figure 4. Maximum Likelihood Estimation of Ideals with all samples tested (a) and Emmenthal and Swiss only (b)

Significance

PLSR and MLEI both show that this consumer population likes baby Swiss more than Swiss and this is likely dependent on the increased “dairy” notes. It is possible that preferences may differ for other segments of the population, but further study is needed to examine this issue. Examination of the liking scores of different age groups indicated that the difference in means for those under 25 differed by less than a point from those over 25. An additional area requiring further investigation is the impact of texture on liking. The current descriptive analysis did not include texture terms and their impact upon liking was thus not assessed. Future comparison will be made between instrumental data and consumer assessments, including instrumental measures of texture. Nonetheless, it may be necessary to collect trained panel assessments of texture and consumer assessments on identical cheeses.