

**THE RELATIONSHIP BETWEEN CONSUMER ACCEPTABILITY  
AND DESCRIPTIVE SENSORY ATTRIBUTES OF CHEDDAR  
CHEESE, WITH SPECIAL REFERENCE TO FREE CHOICE  
PROFILING**

by

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**(Language and style used in this dissertation are in accordance with the requirements of *Food Quality and Preference*)**

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## GLOSSARY OF ABBREVIATIONS

B.C.	- Before Christ
SED IFT	- Committee of the IFT Sensory Evaluation Division
SSHA	- Evaluation Sensorielle: Manuel Méthodologique
USA	- United State of America
BMI FOODPACK	- Dairy report. Food and Catering
QDA	- Quantitative Descriptive Analysis
h	- Hours
LAB	- Lactic acid bacteria
NaCl	- Sodium Chloride (salt)
kg	- Kilogram
cm	- Centimeter
°C	- degrees Celsius
mł	- Milliliter
RPI	- Research and Planning Intelligence (PTY) LTD
ANOVA	- Analysis of Variance
LSD	- Least Significant Difference
DF	- Degree of Freedom
F – value	- Measurement of distance between individual distributions. As F goes up, P goes down (i.e., more confidence in there being a difference between two means). To calculate: (Mean Square of X / Mean Square of Error) ( <a href="http://www.isixsigma.com/dictionary">http://www.isixsigma.com/dictionary</a> , 2007)
<i>P</i> – value	- The <i>p</i> -value is defined as the probability, calculated under the null hypothesis, of obtaining a value of the statistic that is as extreme as the one observed from the data (in a given direction) ( <a href="http://www.xlstat.com">http://www.xlstat.com</a> , 2007)
SEM	- Standard Error
Jhb	- Johannesburg

CT	- Cape Town
ASTM	- American Society for Testing and Materials
%	- Percentage
FCP	- Free choice profiling
GPA	- Generalized Procrustes analysis
PCA	- Principal component analysis
LSM	- Living standard measurement
NS	- Not significant
HI	- Household income

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## CHAPTER 1

### INTRODUCTION

Sensory evaluation is a relatively young science and the current practice in sensory science has been formed over the past 50 years in a technological and natural scientific context, to enhance sensory quality in the food industry. The methods used have been adapted from the 150 years of development in experimental psychology, which again have roots back into the 2500 year long history of philosophy (Martens, 1999).

In this natural scientific and technological context, sensory science is often considered to be a “soft” discipline, while in a psychological or humanistic context, sensory science is “hard”. The technologists do not trust human measurements, while the humanists protest against viewing “man as an instrument”. Nevertheless, both camps agree that sensory methods are reliable, relevant, robust and rapid (Martens, 1999).

Producing food that no one wants to eat, although it may be safe and nutritious, is meaningless in most cases. Although basic research requires knowledge of food systems, most sensory research is carried out on real food products. Especially solving “real world” problems involving the whole chain from laboratory to consumers, bridges the gap between sensory evaluation and market research (Martens, 1999).

Sensory science has proven success in research and development, and quality assurance in the food and beverage industries (Meilgaard, Civille & Carr, 1991; Stone & Sidel, 1993). The potential of using sensory evaluation to link product development to marketing has also been recognized (Moskowitz, 1994). Sensory science thus links the chain through the chemical-sensory-descriptive interface and the sensory-descriptive-affective-behavior interface (O’Mahony, 1995).

Understanding the development and variations in taste that occur during the development of a product, is an important tool in defining consumers’ expectations of taste. Aroma and texture of a product such as Cheddar cheese change over ripening time and although taste changes more readily

than other sensory attributes, all may be useful in discriminating between products, as well as explaining consumer preferences.

Consumers have a wide variety of cheese products to choose from, and depending on population segments and regional locations, flavor preferences of consumers also vary. Cheddar cheese is the most popular cheese variety in South Africa and represents the largest part of everyday cheese (BMI FOODPACK, 2006). Market breakdown for 2005 indicated that the everyday cheese category constituted more than three quarters of the cheese market industry. Expected consumption increases of 6.0% in 2006 and 5.59% in 2007 were forecasted in this category (BMI FOODPACK, 2006).

Cheddar is a hard natural cheese with an orange to yellow colouring, and if properly cured, it has a crumbly texture; maturation time affects the taste, with increasing sharpness over time (BMI FOODPACK, 2006). However, it is not clear which attributes in Cheddar cheese are used by consumers to discriminate between cheeses (Jack, Piggott & Paterson, 1993b).

Many descriptive analysis methods have been used for the sensory evaluation of cheese and/or Cheddar cheese (Brandt, Skinner & Coleman, 1963; Stone, Sidel, Oliver, Woolsey & Singleton, 1974; Muir & Hunter, 1991/2; Piggott & Mowat, 1991; Heisserer & Chambers, 1993; Muir, Hunter, Banks & Horne, 1995; Murray & Delahunty, 2000a; Murray & Delahunty, 2000b; Drake, Mcingval, Cadwallader & Civile, 2001; Delahunty & Drake, 2004). Murray & Delahunty conducted a study in 2000(a) where 15 trained assessors successfully used descriptive analysis methods. They described the product and packaging attributes of eight Cheddar cheese products, in order to gain insight into which attributes differentiate Cheddar cheese products from one another in terms of consumer acceptance. Sensory analyses of cheese texture have been performed extensively using the texture profile method (Brandt *et al.*, 1963) and quantitative descriptive analysis (QDA) (Stone *et al.*, 1974). During 1991/2, Muir & Hunter evaluated cheese by QDA to determine the effects or order of tasting and carryover effects of Cheddar cheese.

These panels all comprised of individuals who had undergone extensive formalised training to recognize or to know the nuances of the specific product (Moskowitz, 1984). The training process resulted in subjects who had an analytical approach to product evaluation and they functioned as human

instruments in evaluating their objective impressions of an attribute (Stone & Sidel, 1993). Potential panellists were screened for selected personal traits, interest and ability to discriminate or identify differences and generate reproducible results. Further training familiarised panellists with test procedures and increased their ability to recognize, identify and recall sensory characteristics (SED IFT, 1981). From this it is clear that the two main disadvantages of the descriptive sensory techniques are the time and money expenditures to formally train and maintain the panels (Szczeniak, 1987; Jack *et al.*, 1993b; King, Arents & Moreau, 1995; Lachnit, Busch-Stockfisch, Kunert & Krahl, 2003).

Even when using already existing vocabularies, a lot of time is involved in fine tuning the panel (Muir, Banks & Hunter, 1997; Drake, Yates & Gerard, 2005). Drake and co-workers (2005) reported that a trained descriptive sensory panel, using a previously identified sensory lexicon for Cheddar cheese, received 75 hours (h) training to determine the impact of serving temperature on the perception of Cheddar cheese flavour attributes, using the Spectrum method. Previously, using the same method on Cheddar cheese, panels on three sites required 40 to 75 h of training, prior to cheese evaluation (Drake, Gerard, Wright, Cadwallader & Civille, 2002). Caspia and co-workers (Coggins, Schilling, Yoon & White) conducted a study in 2006 where panellists trained for 30 h, using previously identified languages for sensory evaluation of Cheddar cheese, and the majority of them had more than 100 h of training regarding the evaluation of dairy products. In 1997, Muir *et al.* needed 30 evaluation sessions with 13 highly experienced, selected and trained assessors, to describe Cheddar cheese by using an experimental vocabulary for flavour and texture of Cheddar cheese.

Affective or consumer sensory testing is regarded as a valuable and necessary component of every sensory analysis program (Stone & Sidel, 1993). Regular consumers of food products have the ability to indicate their level of acceptance and/or preference for the product. However, when asking consumers to explain their level of acceptance or liking for a specific product, it has mostly resulted in unreliable data, in terms of product attributes that is unique or gives the product the edge or wow factor.

Thus, a consumer may be able to say whether he/she likes a product, but is unable to say why, or to provide a sensory interpretation of his/her tastes (Le Calvé, 2000). Some authors (Stone & Sidel, 1993; Lawless, 1995; SSHA, 1998) express more or less negative opinions about adding other questions to the overall hedonic judgements, in particular descriptive ones, to consumers. According to Lawless (1995), consumers are rarely analytical, they perceive products in an integrated fashion, show halo effects and use language imprecisely.

Expert panels, consisting mainly of cheese makers/graders, have been used in cheese attribute research. These specialists can show discrimination between cheeses with a greater resolution than instrumental methods of analysis (Szczesniak, 1987; Bodyfelt, 1988), but the relevance of such data to the study of consumer choice is limited. There is thus a need for a better understanding of Cheddar cheese attributes.

A new generation of descriptive analysis methods may prove to be the answer. Free Choice Profiling (FCP) (Williams & Langron, 1984) was developed to circumvent some of the problems of the above-mentioned techniques, and has been used successfully by consumers/untrained panels (Guy, Piggott, & Marie, 1989; McEwan, Moore & Colwill, 1989; Jack, Paterson & Piggott, 1993a; Jack *et al.*, 1993b; Jack, 1994; O'Riordan, Delahunty, Sheehan & Morrissey, 1998; González Viñas, Moya & Cabezudo, 2003), semi-naive consumers (McEwan *et al.*, 1989; Tang & Heymann, 2002; Delarue & Sieffermann, 2004; Deliza, Macfie & Hedderley, 2005) and trained assessors (McEwan *et al.*, 1989; Costell, Trujillo, Damasio & Duran, 1995).

A Cheddar cheese study conducted by McEwan and co-workers in 1989, reported that the results obtained from FCP and QDA procedures were similar and easily interpretable. This suggested that the less time consuming FCP method was an appropriate technique when used with trained assessors. In Scotland, Jack *et al.* (1993b) conducted a study where FCP was found to be a valid technique for gaining information on texture and appearance in Cheddar cheese from a group of untrained consumers. The assessors used their own vocabularies of descriptors to score samples, and the consequent absence of training provided time and cost advantages. O'Riordan *et al.*, (1998) compared the volatile compounds released during consumption of Cheddar

cheese by different assessors, determining the expressions of perceived flavour by FCP.

The aim of this study was therefore to determine whether data, obtained from FCP and using semi-naïve panellists (experienced in descriptive techniques but no previous experience with cheese) could express the perceptions of South African consumers on Cheddar cheese attributes. Firstly a consumer hedonic rating test will be done on a wide range of Cheddar cheeses available in South Africa. The top 15 Cheddar cheeses, as indicated by the results from the consumer rating test, will then be evaluated by the semi-naïve panel. These results will be used to determine the relationship between consumer acceptability and the descriptive sensory characteristics of the Cheddar cheese samples.

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## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 SENSORY SCIENCE IS A RELATIONAL AND INTERDISCIPLINARY FIELD

Experimental psychology played a major role over the last 50 years in the development of modern sensory science. According to Schultz and Schultz (1992), the history of psychology originated in the middle of the 19<sup>th</sup> century by scientists, inspired both by philosophy and by scientific discoveries.

Psychophysics is a branch of experimental psychology, dealing with the relation between physical stimuli and the personal sensory and hedonic reactions that ensue from those stimuli. The story of psychophysics and its influence on sensory analysis started more than a century and a half ago, in 1834, when E. H. Weber, a physiologist, began his pioneering studies on discrimination. In those days the notion that an individual could act as a measuring instrument to reveal the perception of private sensory magnitudes, was unthinkable. Weber, however, realized that in making a judgment of “same versus different”, the physical magnitude could be used as a dependent variable (Moskowitz, 2002).

In 1860 the German polymath, G. T. Fechner, came up with the inspiration to erect a scale of subjective magnitude by cumulating the just noticeable differences (jnd's). Keeping in mind that in 1860 there still was no concept of the human judge as a measuring instrument, Fechner reasoned that the just noticeable difference could act as a unit of subjective measurement, thus creating a scale of magnitude. The next impetus came from the pioneering work of L. L. Thurstone in psychometrics. In 1927 he compiled a valid sensory scale by measuring the variability or error of a response (Moskowitz, 2002).

Probably the single most important development was the gradually increasing, popular acceptance of the human as a valid measuring instrument by psychophysicists and others. As far back as the late 1800s there was a suggestion by Corin (as cited by Moskowitz, 2002) that one might use scales or descriptive terms to rate sensory magnitude. However, the real momentum

in psychophysics came from those involved in direct scaling (Stevens, 1975). It was Stevens' abiding view that the human subject could assign numbers validly to reflect the perceived intensity of stimuli, and that the numbers themselves had ratio-scale properties. He also recognized, accepted, and promoted the ability of untrained individuals to act as true measuring instruments.

Sensory analysis was not a particularly well recognized field in the 1940-1960s, except for a few pioneering books (e.g. Amerine, Pangborn & Roessler, 1965). In the food industry, sensory analysis was relegated to a service function, practitioners working on either descriptive analysis of flavours/textures or running fairly simplistic "taste tests" for product acceptance (Moskowitz, 2002).

In America a group of psychophysicists, interested in the chemical senses, were assembled in the 1970s. This group, the Behavioral Sciences Division, was to influence the sensory analysis and psychophysics world for the next several decades. On a parallel front, Rose Marie Pangborn was active at the University of California. With no formal training in psychophysics, and concentrating on psychophysical-type research in the food world, she quickly became a key person who encouraged and educated a generation of applied sensory analysts. Neither a theoretician, nor a modeller, but rather a solid empiricist, Pangborn shaped the field of sensory analysis, guiding it towards rigorous thinking in methodology and test execution (Moskowitz, 2002).

During the 1970s and 1980s other researchers like O'Mahony began serious research on the psychophysical foundations of discrimination. One of the continuing and most important jobs of a sensory analyst is to run discrimination panels in order to determine whether two samples subjectively differ. The discrimination tests lead to product reformulation, with potentially major cost-savings. Thus, any improvement in the technology and science of discrimination testing could prove important for the food industry. However, these methods did not lead to radically new prospects, beyond improvements in the implementation and analysis of discrimination tests (Moskowitz, 2002).

## 2.2 SENSORY SCIENCE IN THE FOOD INDUSTRY

In the food industry sensory analysis is used to establish differences and to characterize and measure sensory attributes of products. It also establishes whether product differences are noticeable to consumers and whether these differences are acceptable or unacceptable to the target consumer group (Lyon, Francombe, Hasdell & Lawson, 1992).

The various applications of sensory analysis, as noted by the SED IFT [Committee of the IFT Sensory Evaluation Division] (1981), Charley (1988) and Stone & Sidel (2004), include:

- \* new product development, reformulation and/or cost reduction
- \* monitoring competition
- \* product matching
- \* product optimization
- \* process change
- \* cost reduction and/or selection of a new source of supply
- \* quality control
- \* quality assurance
- \* determining storage stability
- \* product grading or rating
- \* product sensory specification
- \* raw materials specifications
- \* advertising claims
- \* correlation of sensory with chemical and physical measurements
- \* process/ingredient/analytical/sensory relationships and
- \* consumer acceptance and/or consumer preference.

The measure of acceptability, based on sensory properties of a product, is logical and necessary before a product is marketed and substantial capital has been invested (Lawless, 1991). Taste-paneling should run concurrently with formula development. As changes are made during the development stage, the product must be checked with experienced tasters. Ideally, a food company developing new products should have two taste panels. One is a semi-trained or experienced panel for checking the product in various stages

of development. The second panel is a small group of consumers who can help developers produce products that will be popular with the consuming public (Baker, 1988).

Affective or consumer sensory testing is regarded as a valuable and necessary component of every sensory analysis program. Regular consumers of food products have the ability to indicate their level of acceptance and/or preference for the product (Stone & Sidel, 1993). However, when asking consumers to explain their level of acceptance or liking for a specific product, it has mostly resulted in unreliable data, in terms of product attributes that is unique or gives the product the edge or wow factor.

Thus, a consumer may be able to say whether he/she likes a product, but is unable to say why, or to provide a sensory interpretation of his/her tastes (Le Calvé, 2000). Some authors (Stone & Sidel, 1993; Lawless, 1995; SSHA, 1998) express more or less negative opinions about adding other questions to the overall hedonic judgments, in particular descriptive ones, to consumers. According to Lawless (1995), consumers are rarely analytical, they perceive products in an integrated fashion, show halo effects and use language imprecisely.

An increasingly important aspect of sensory analysis is the evaluation of the relationship between preference/acceptability and the sensory characteristics of the samples. This allows the product developer to concentrate on the attributes and combination of attributes which are likely to result in the so-called ideal product for a particular segment of the consuming population. During the development of a new food product, experienced taste panels will likely find many faults which the developer must solve (Baker, 1988).

### **2.3 CHEDDAR CHEESE**

Since the 16th century, the hard cheese made from cow's milk in the Mendip Hills near the Cheddar Gorge, has been known as Cheddar. The cheese undoubtedly goes back to earlier centuries, perhaps even to the Romans, who first introduced the people of England to hard cheeses (Courtine, 1994; Harbutt, 2001).

Over the centuries, the recipe for this West Country cheese has been taken by emigrants to Canada, the USA, Australia, South Africa and New Zealand. More than any other British cheese, it has been copied and emulated, but it is not really Cheddar cheese unless it comes from the verdant hills of Somerset, Devon and Dorset (Courtine, 1994; Harbutt, 2001).

To taste a hand-made, unpasteurized, clothbound Cheddar, made from the milk of cows whose daily diet is fresh green grass, buttercups and daisies, is to taste a piece of magic. The bite is like chocolate, firm and yielding; the aroma is fresh, nutty and slightly savoury. The flavour differs from farm to farm, but there is always the rich sweetness of the milk, a classic acid tang and a long-lingering kaleidoscope of flavours (Harbutt, 2001). Cheddar is generally matured for between nine and 24 months, and has a fat content of  $\pm 34\%$  (45-50% in the dry matter) (Courtine, 1994; Harbutt, 2001).

Unlike the great cheeses of Europe, Cheddar's name is not protected, so it has been used and abused. Hundreds of tasteless tones are churned out in giant factories around the world. Even in Britain, both the consumers and the market have conspired against the farmhouse Cheddar cheese makers. Today there are only six cheese makers in Britain who still make traditional, clothbound Cheddars (Harbutt, 2001). Enquires has led to the conclusion that traditionally manufactured clothbound Cheddars are not produced in South Africa. Most cheeses sold in South Africa today are factory-made copies of Gouda and Cheddar, which is not surprising, given that the majority of European immigrants who first settled in this country came from Holland and Great Britain (Harbutt, 2001).

Cheddar cheese is the most popular cheese variety in South Africa and represents the largest part of everyday cheese (39.3%), with Gouda (23.7%) in second place (BMI FOODPACK, 2006). Market breakdown for 2005 indicates that the everyday cheese category constitutes 81.3% of the cheese market industry, followed by processed cheese (15.0%) and specialty cheese (3.7%). The everyday cheese consumption in 2005 was 67 130 tons, with an expected increase of 6.0% in 2006 and 5.59% in 2007 (BMI FOODPACK, 2006).

South African Cheddar cheese has an orange to yellow colouring and a crumbly texture; maturation time affects the flavour with increasing sharpness

over time (BMI FOODPACK, 2006). A leading South African dairy company supplies Cheddar cheese to the market at an age of 60 to 100 days (Laubscher, 2007). The typical composition consists of: 34.5 – 38.5% moisture; 30.5 – 34.5% fat;  $\pm$ 25% protein; 4.0 – 6.0% salt in moisture; and a pH between 5.05 – 5.30 (Laubscher, 2007).

Most consumers of Cheddar cheese consider texture and flavour to be its most important attributes (McEwan, Moore & Colwill; Jack, Paterson & Piggott, according to Lawrence, Gilles, Creamer, Crow, Heap, Honoré, Johnston & Samal, 2004). The final desirable flavour profiles and textures of ripened Cheddar cheese varieties are variable, as defined by different end-customer requirements and traditional cultural flavour expectations (Lawrence *et al.*, 2004). A vocabulary of sensory attributes has been developed to describe Cheddar (Muir & Hunter, 1992a), and has been modified to include five odour, ten flavour and five textural attributes (Muir, Hunter, Banks & Horne, 1995b) (Table 2.1). It should, however be noted, that Cheddar cheese flavour requirements are specific to country, ethnicity and end-application (Lawrence *et al.*, 2004).

Table 2.1 Sensory vocabulary for Cheddar cheese (Muir *et al.*, 1995b)

Odour attributes	Flavour attributes	Textural attributes
1. Odour intensity	1. Flavour intensity'	1. Firmness
2. Creamy / milky odour	2. Creamy / milky flavour	2. Rubbery character
3. Sulphur / eggy odour	3. Acid / sour flavour	3. Pasty character
4. Fruity / sweet odour	4. Sulphur / eggy flavour	4. Grainy character
5. Rancid odour	5. Fruity flavour	5. Mouth-coating character
	6. Rancid flavour	
	7. Bitter flavour	
	8. Animal / cowy / unclean flavour	
	9. Salty flavour	
	10. Sweet flavour	

#### 2.4 DESCRIPTIVE SENSORY STUDIES ON CHEDDAR CHEESE

Many descriptive analysis methods have been used for the sensory evaluation of cheese and/or Cheddar cheese (Brandt, Skinner & Coleman, 1963; Stone,

Sidel, Olivier, Woolsey & Singeleton, 1974; Muir & Hunter, 1991/2b; Piggott & Mowat, 1991; Heisserer & Chambers, 1993; Muir *et al.*, 1995b; Murray & Delahunty, 2000a; Murray & Delahunty, 2000b; Murray & Delahunty, 2000c; Drake, Mcingval, Cadwallader & Cville, 2001; Delahunty & Drake, 2004; Young, Drake, Lopetchara & McDaniel, 2004, Caspia, Coggins, Schilling, Yoon & White, 2006). Sensory analysis of cheese texture has been performed extensively, using the texture profile method (Brandt *et al.*, 1963) and QDA (Stone *et al.*, 1974).

Piggott and Mowat (1991) conducted a study to determine the sensory aspects of maturation of Cheddar cheese by descriptive analysis. A total of 30 cheeses (13 commercially available Cheddar or similar cheeses and 17 experimental cheeses) were evaluated by 13 assessors with previous experience of sensory analysis. After training, 24 terms were used for the descriptive analysis of the Cheddar cheese.

During 1991/2b, Muir & Hunter evaluated cheese by QDA to determine the effects or order of tasting and carryover effects of Cheddar cheese. Twelve brands of Cheddar cheese were evaluated by 24 assessors, using a sensory vocabulary that had been developed over several years at the Hannah Research Institute in the United Kingdom. This vocabulary comprised of seven odour, 11 flavour and five textural attributes.

A highly trained, descriptive sensory panel identified, defined, and referenced 30 flavour attributes of 42 naturally aged cheeses during a study in 1993, conducted by Heisserer and Chambers.

In 2000(a), Murray and Delahunty measured the packaging attributes and sensory attributes of aroma, flavour, texture and appearance of eight Cheddar cheeses by using 15 trained assessors. Descriptive analysis was conducted, using a vocabulary of 20 attributes for describing packaging and 32 attributes for describing the aroma, flavour, texture and appearance of the Cheddar cheese products. In another study in 2000(c), they used 15 trained assessors successfully in descriptive analysis methods. They described the product and packaging attributes of eight Cheddar cheese products, in order to gain insight into which attributes differentiate Cheddar cheese products from one another in terms of consumer acceptance.

Young and co-researchers performed a preference mapping study in 2004 on seven Cheddar cheeses with varying maturity levels. Descriptive sensory profiles were determined, using a trained panel of 14 assessors, who used an established cheese flavour sensory language. As mentioned earlier, the cheeses were evaluated for consumer acceptability in two demographic locations (100 consumers at each location), overall liking and other consumer attributes. The authors concluded that descriptive analysis and consumer evaluation showed distinctive flavour profiles for all seven Cheddar cheeses, as well as for their relationship to acceptability.

A trained sensory panel used the Spectrum method to determine the impact of serving temperature on the perception of Cheddar cheese flavour attributes (Drake, Yates & Gerard, 2005). Fourteen panellists used 15 terms, previously identified as a basic descriptive language for Cheddar cheese flavour (Drake *et al.*, according to Drake *et al.*, 2005), during the evaluation of seven cheeses.

All of the above-mentioned panels comprised of individuals who had undergone extensive formalised training to recognize or to know the nuances of the specific product (Moskowitz, 1984). Some panellists had completed as much as 120 h of training in flavour and texture analysis, and a minimum of 1000 h of general sensory testing (Heisserer & Chambers, 1993). The training process resulted in subjects who had an analytical approach to product evaluation and they functioned as human instruments in evaluating their objective impressions of an attribute (Stone & Sidel, 1993). Potential panellists were screened for selected personal traits, interest and ability to discriminate or identify differences and generate reproducible results. Further training familiarized panellists with test procedures and increased their ability to recognize, identify and recall sensory characteristics (SED IFT, 1981).

From this it is clear that the two main disadvantages of the descriptive sensory techniques are the time and money expenditures to formally train and maintain the panels (Szczesniak, 1987; Jack, Piggott & Paterson, 1993b; King Arents & Moreau, 1995; Lachnit, Busch-Stockfish, Kunert & Krahl, 2003). Even when using already existing vocabularies, a lot of time is involved in fine tuning the panel (Muir, Banks & Hunter, 1997a; Drake *et al.*, 2005; Caspia *et al.*, 2006). In 1997a, Muir *et al.* needed 30 evaluation sessions with 13 highly

experienced, selected and trained assessors, to describe Cheddar cheese by using an experimental vocabulary for flavour and texture of Cheddar cheese. Drake and co-workers (2005) reported that a trained descriptive sensory panel, using a previously identified sensory lexicon for Cheddar cheese, received 75 h training to determine the impact of serving temperature on the perception of Cheddar cheese flavour attributes, using the Spectrum method. Previously, using the same method on Cheddar cheese, panels on three sites required 40 h (location 2 and 3) and 75 h (location 1) of training, respectively, prior to cheese evaluation (Drake, Gerard, Wright, Cadwallader & Civille, 2002). Caspia and co-workers conducted a study in 2006 where panellists trained for 30 h, using previously identified languages for sensory evaluation of Cheddar cheese, and the majority of them had more than 100 h of training regarding the evaluation of dairy products.

Table 2.2 lists examples of descriptive vocabularies that have been used in various studies by various researchers. Similar terms were used in many cases, even though each descriptive language referenced was developed independently by different research groups. In addition, in many cases similar terms have been used to describe dominant characteristics of different cheese types. This comparison suggests that even though a remarkable variety of cheese types are produced, exhibiting a wide variety of sensory characteristics, it should be possible to develop and standardize a terminology that can be used universally. This vocabulary can then be used for all cheese types, eventually leading to a much-improved understanding about the eating quality of cheese (Delahunty & Drake, 2004).

Table 2.2 Examples of cheese sensory characteristics that have been used in descriptive sensory analysis (Delahunty & Drake, 2004)

References and cheeses studied	Descriptive vocabularies
Drake <i>et al.</i> , 2001, 2002, 2003 Gwartney <i>et al.</i> , 2002 Truong <i>et al.</i> , 2002 Cheddar, processed	Flavour: Cooked, whey, diacetyl, milkfat / lactone, fruity, sulphur / eggy, sulphur / match, free fatty acid, brothy, nutty, catty, cowy / phenolic, age, yeasty, mouldy / musty, methyl ketone / blue, oxidized, waxy / crayon, faecal, bell pepper, rosy / floral, scorched, bitter, salty, sweet, sour, umami, prickle / bite

cheese	Texture: Elasticity (evaluated by hand), hardness, cohesiveness, elasticity, adhesiveness between teeth, adhesiveness to teeth, cohesiveness of the mass (mass evaluated after 3-5 chews), adhesiveness of the mass, smoothness of the mass, smoothness of film (evaluated after swallow)
Hort & Le Grys, 2001 Cheddar	Texture: Creaminess, crumbliness, firmness, hardness, springiness, graininess
McEwan <i>et al.</i> , 1989 Cheddar	Odour: Strength, creamy / milky, sour, rindy, manure Flavour: Creamy/milky, strength, sour, manure, salty, acid, smoky, rindy Texture / mouthfeel: Tongue tingling, soft-firm, rubbery, mouth-coating, graininess
Muir & Hunter, 1992 abc Banks <i>et al.</i> , 1993 Muir & Banks, 1993 Muir <i>et al.</i> , 1995 abcd Muir <i>et al.</i> , 1996 Muir <i>et al.</i> , 1997 ab Cheddar, Farmhouse Cheddar	Odour: Intensity, creamy, sulphur, fruity, nutty, rancid, other Flavour: Cheddar intensity / overall intensity, creamy / milky, sour / acid, sulphur / eggy, fruity / sweet, nutty, rancid, bitter, cowy, unclean / manorial, salty, other Texture: Firmness, rubbery, crumbly, smooth, moist, grainy, mouth-coating
Piggot & Mowat, 1991 Jack <i>et al.</i> , 1994 Delahunty <i>et al.</i> , 1996 ab Cheddar	Appearance: White to orange Flavour: Milky, buttery, cheesy, mouldy, rancid, pungent, sour (aroma), sweet (aroma), salty (taste), sour (taste), bitter (taste), processed, strength, maturity, aftertaste Texture: Dry, hard / soft to firm, coarse, creamy, moist, smooth, sticky, grainy, crumbly, rubbery, chewy, pasty, mouth-coating
Roberts & Vickers, 1994 Cheddar	Aroma: Buttery, fatty, fruity, fermented, mouldy, nutty, sweaty / sour, pungent, rancid, smoky, spoiled dairy, vinegary, Flavour: Acid, acid bite, astringent, barny, bitter, buttery, cardboard, chemical, fatty, fruity, metallic, milky, mouldy, peppery, sweaty / sour, rancid, salty, sharp, smoky, soapy, diacetyl (yoghurt), sweet Aftertaste: Acid, bitter, milky, smoky, fishy, mouldy, peppery, soapy, sweaty / sour Texture: Chalk, chewy, creamy, crumbly, firm, grainy, moist, greasy, pasty, squeaky, waxy

## 2.5 CONSUMER STUDIES ON CHEDDAR CHEESE

Various consumer studies have been conducted on cheese products (McEwan, Moore & Colwill, 1989, Pagliarini, Monteleone & Wakeling, 1997;

Murray & Delahunty, 2000a; Mendía, Larráyo, Ordóñez, Ibáñez & Torre, 2003; Hersleth, Ueland, Allain & Naes, 2005, Caspia *et al.*, 2006).

McEwan and co-workers (1989) determined the sensory characteristics of Cheddar cheese and their relationship to acceptability, by evaluating seven varieties of Cheddar cheese with FCP and QDA. Preference judgments were obtained from 50 consumers, using a nine-point hedonic scale, while preference mapping determined the relationship between preference/acceptability and the sensory characteristics of the Cheddar cheese samples. The results suggested that the less time consuming FCP is an appropriate technique when used with trained assessors. Strength of odour and flavour, and rubbery and grainy texture were some of the important attributes separating the cheeses in a two dimensional perceptual space.

During a study by Murray & Delahunty in 2000(a), 200 consumers rated the cheeses' packaging for preference, while 207 different consumers rated the cheeses for sensory preference. A trained panel measured the packaging attributes and the sensory characteristics of Cheddar cheese by descriptive analysis. Preference mapping of the cheeses' sensory and packaging attributes allowed the preferred cheeses of the consumer segments, and their associated attributes, to be identified.

Young *et al.* (2004) determined consumer acceptability, overall liking and other consumer attributes for seven Cheddar cheeses. Results from the consumer acceptability tests were combined with descriptive sensory profile data, using preference mapping. Descriptive analysis and consumer evaluation showed distinctive flavour profiles for all seven Cheddar cheeses, as well as their relationship with acceptability. The concept of "Cheddar cheese" flavour varied widely among consumers, but consumers distinguished aged cheeses from young cheeses. These significant relationships illustrated that Cheddar cheese acceptance was related to maturity level and flavour characteristics, and varied widely among consumers, with specific segments preferring specific Cheddar flavour profiles.

In 2006 Caspia and colleagues conducted a study to determine the relationship between consumer acceptability and descriptive sensory attributes of three Cheddar cheese samples, using preference mapping. Firstly, a trained panel consisting of nine panellists differentiated between 7-,

9- and 12- month old Cheddar cheeses on the basis of taste, aroma and textural attributes. Consumer acceptability was then determined by 140 consumers in a three month trial, using a nine-point hedonic scale for overall acceptability, overall flavour, aroma, texture and appearance.

## **2.6 FREE CHOICE PROFILING**

Free Choice Profiling (Williams & Langron, 1984) (FCP) is a relatively new descriptive technique that may prove to be the answer to the time and money expenditures to formally train and maintain traditional descriptive panels. It was first developed by Williams & co-workers (Baines, Langron & Collins) in 1981, first applied by Williams & Langron in 1984 for the evaluation of commercial port wines, and further described by Arnold and Williams in 1986.

Free choice profiling has been used successfully by consumers/untrained panels (Guy, Piggot & Marie, 1989; McEwan *et al.*, 1989; Jack, Paterson & Piggott, 1993a; Jack *et al.*, 1993b; Jack, 1994; O’Riordan, Delahunty, Sheehan & Morrissey, 1998; González Viñas, Moya & Cabezudo, 2003), semi-naive consumers (McEwan *et al.*, 1989; Tang & Heymann, 2002; Delarue & Sieffermann, 2004; Deliza, Macfie & Hedderley, 2005) and trained assessors (McEwan *et al.*, 1989; Costell, Trujillo, Damasio & Duran, 1995).

The technique differs from conventional descriptive profiling in that products are evaluated by members of a panel, who describe perceived qualities of that product, using their own individual list of terms, rather than a common scorecard (Oreskovich, Klein & Sutherland, 1991). The panellist is allowed to invent and use as many terms as he or she needs to describe the sensory characteristics of a set of samples (Meilgaard, Civille & Carr, 1999).

Any sensory characteristics can be examined using FCP. The range of characteristics can be restricted by the researcher, but the number of descriptors produced is only limited by the perceptual and descriptive skills of the assessor (Oreskovich *et al.*, 1991). Table 2.3 summarises FCP studies on various products, including Cheddar cheese, and shows the variations in the number of products tested and categories described.

Table 2.3 Examples of Free-choice profiling studies

Authors	Categories being focused on during study	Numbers of assessors used in study	Numbers of descriptors identified	List of products
Jack <i>et al.</i> , 1993b	Texture Appearance	28 untrained	7-21 (av* = 11)	20 Cheddars
McEwan <i>et al.</i> , 1989	Odour Flavour Texture	8 trained	13-27 (av* = 18)	7 Cheddars
O'Riordan <i>et al.</i> , 1998	Odour Flavour	8 untrained	17-30 (av* = 25)	6 Cheddars
Jack <i>et al.</i> , 1993a	Texture	28 untrained	Unknown	19 Cheddars
Bárceñas <i>et al.</i> , 2003	Odour Flavour Texture	20 untrained	10-23	8 Ewe's milk Cheeses
González Viñas <i>et al.</i> , 2003	Appearance Texture Flavour Mouthfeel	12 assessors with no previous experience	17-36 (av* = 24)	10 commercial honeys
Deliza <i>et al.</i> , 2005	Appearance Odour Flavour Mouthfeel	10 consumers	8-17 (av* = 12)	4 passion fruit juice samples

Av\* = average number of descriptors identified

Thus, FCP can be used to describe a product in terms of a number of characteristics, such as appearance, flavour, aroma, texture, or any combination of these, similar to the Spectrum or QDA methods (Oreskovich *et al.*, 1991).

Wilton & Greenhoff (1988) suggested that consumer vocabularies can be readily interpreted by both scientific and other personnel, facilitating communication between functions. However, consumer descriptors can also be too personal and be interpreted by no-one, except the subject (Piggott, Sheen, Apostolidou, 1990). Wittgenstein's (1958) famous words that "meaning is use" point at problems with having a private language. People may have private words for their sense perceptions which may make it hard to communicate with one another. However, even with classical profiling methods (like Flavor Profile and Texture Profile), where it is considered that each panellist uses the consensus sensory lexicon/vocabulary in the same way, individual variations cannot be avoided completely (Williams & Arnold, according to Oreskovich *et al.*, 1991).

Another problem that may arise is when assessors, especially those with a lack of sensory experience, find it difficult to generate an adequate vocabulary to fully describe samples (Piggott *et al.*, 1990). It has been shown that a low level of training increases reproducibility of results and specificity of descriptors generated (Gains & Thomson, 1990). Any number of descriptors may be enough to describe any particular product, as long as the specific aim of the description is met. A description that includes all attribute categories (that is appearance, texture, mouthfeel, taste, aftertaste and afterfeel), can be as many as 107 attributes for Cheddar cheese (Venter, 2007).

The number of assessors may also influence the outcome of a test (Guy *et al.*, 1989). According to Oreskovich *et al.* (1991), FCP routinely uses eight to 20 panellists when evaluating products, which are comparable to conventional descriptive analysis techniques. Table 3 shows that as few as eight panellists, to as many as 28, can be used, with a mean of 16 assessors. There appear to be a correlation between the number of assessors and the number of products. With an increase in the number of products, the number of assessors is also increased (McEwan *et al.* 1989, Jack *et al.*, 1993b, 1989, O’Riordan *et al.*, 1998; Bárcenas, Pérez Elortondo & Albisu, 2003; González Viñas *et al.*, 2003; Deliza *et al.*, 2005). Guy *et al.* (1989), on the other hand, recruited 100 subjects to study the usefulness of FCP by consumers. It is possible to use a larger panel than in other descriptive methods, since no extensive training is required. It has not yet been established whether larger numbers are necessary or desirable, taking into account the difficulty of interpreting the data (Oreskovich *et al.*, 1991).

One of the unique features of FCP is the statistical treatment of the scores from the panellists. The data are mathematically manipulated through the use of a procedure known as the generalized Procrustes analysis (GPA) (Gower, 1975; Schlich, 1989; Oreskovich *et al.*, according to Lawless & Heymann, 1998). The GPA usually provides a consensus picture of the data from each individual panellist in two-or-three dimensional space.

The iterative technique is called Procrustes analysis in reference to Hellenic mythology. Procrustes, a nickname for Damastes or Polypemon, meaning “the stretcher”, was a robber who invited travelers to stay at his house (Kravitz, 1975). If the visitor did not fit his bed, he would either stretch

them or cut off their legs to make them fit the bed. His guests being thus incapacitated, Procrustes was able to help himself to his guests' possessions at his leisure (Lawless & Heymann, 1998).

Therefore, the technique allows one to scale, reflect and rotate multiple data matrices (one for each panellist for each replication) to obtain a consensus space (Gower, 1975). In a sense, the GPA force fits the data matrices from the individual panellists into a single consensus space. The most important aspect of the GPA is that it allows the analysts to determine the terms used by individual panellists that appear to be measuring the same sensory attributes as the other judges. With this technique each judge's data are transformed into individual spatial configurations. These configurations are then matched by GPA to a consensus configuration. The consensus configuration may be interpreted in terms of each individual assessor's vocabulary, as well as how the different terms, used by different assessors, may be interrelated (Lawless & Heymann, 1998). Product samples can also be scored during assessment for preference, which can then be mapped onto the perceptual product space (McEwan & Thomson, 1988).

Free choice profiling is particularly useful in determining which attributes are beneficial both in product development and marketing terms, when attempting to create the consumer's "ideal" product (Jack, 1994). According to Lawless & Heymann (1998), it seems that the best use for the FCP technique is in the area of perceptual mapping of product space. Perceptual maps are frequently created in marketing research. It has been shown that FCP allows the creation of perceptual maps that are very similar to those created by traditional mapping techniques, such as multidimensional scaling or sorting techniques, principal component analysis (PCA) of descriptive data, and PCA of consumer attribute analysis (Steenkamp, Van Trijp & Ten Berge, 1994; Wright, 1994; Howe & Heymann, 1996).

## **2.7 FREE CHOICE PROFILING ON VARIOUS PRODUCTS**

Free choice profiling was first applied by Williams & Langron in 1984 for the evaluation of commercial port wines. Eight commercial ports, seven tawnies and one ruby (all readily available on the French market), were evaluated by ten assessors, both expert and non-expert, to illustrate a “new approach to profile analysis”.

Free choice profiling of the eight commercial ports, coupled with GPA, enabled sample plots to be obtained for the ports in respect to their appearance, aroma and flavour. Individual sample plots were matched into a consensus plot and appeared sensible in terms of previous knowledge of the ports. They concluded that the experiment proved a success and clearly showed that there was no need to develop precisely defined vocabularies for describing products, in order to reveal relationships and differences between samples.

Free choice profiling has since been successfully applied to a broad range of food products, including: meat patties (Beilken, Eadie, Griffiths, Jones & Harris, 1991); sweet orange gels (Costell *et al.*, 1995); cooked hams (Delahunty, Mccord, O'Neill & Morrissey, 1997); grape jellies (Tang & Heymann, 2002); flavour and odour of orange-based lemonades (Lachnit *et al.*, 2003); Spanish unifloral honeys (González Viñas *et al.*, 2003); commercial black filter coffees (Narian, Paterson & Reid, 2003); strawberry yoghurt (Gámbaro, Giménez, Varela & Wittig De Penna, 2004); passion-fruit juice (Deliza *et al.*, 2005); and different cheese products like Parmigiano Regiano (Parolari, Virgili, Panari & Zannoni, 1994); Chilean goat cheese (González Viñas, Garrico & Wittig De Penna, 2001); and ewe's milk cheeses (Bárcenas *et al.*, 2003).

## **2.8 FREE CHOICE PROFILING ON CHEDDAR CHEESE**

McEwan and co-workers (1989) conducted a study to investigate the sensory characteristics of a selection of Cheddar cheeses, and to relate these to hedonic data obtained from consumers (untrained assessors). The first part of the investigation examined two approaches of sensory profile analysis to elicit the sensory attributes of the Cheddar cheese. Seven varieties of Cheddar cheese were evaluated using 8 semi-naïve assessors, performing

FCP (Williams & Langron, 1984) and conventional (QDA) profiling (Stone & Sidel, 1985). In the second part of the investigation, preference judgments were obtained from 50 consumers, using a nine-point hedonic scale. Preference mapping (PM) was used to determine the relationship between preference/acceptability and the sensory characteristics of the Cheddar cheese samples. The results from the FCP and QDA profiling procedures were similar and easily interpretable. This suggested that the less time consuming FCP was an appropriate technique when used with trained assessors.

A study by Jack *et al.* (1993a) investigated the relationship between rheology and the composition of Cheddar cheeses and texture, as perceived by consumers. Rheological measures, namely force deformation curves, were obtained by using an Instron Universal Testing Machine. Some compositional measurements, like protein, fat, moisture, sodium chloride, total ash content, calcium and magnesium, ash and pH, were also determined. Generalized Procrustes analysis of compositional and instrumental data, on the group of 19 Cheddars, displayed a range of textural characteristics and showed certain Instron and compositional variables that discriminated between the samples in terms of textural characteristics. Sensory analysis was performed using FCP with an untrained panel of 28 assessors and the data was analyzed with GPA. Results showed that there could be discriminated between the samples in terms of mouth feel or tertiary textural properties. Mouth feel correlated with moisture content, but could not be easily quantifiable using force-deformation analysis. The composition parameters did not change significantly with maturity or texture, but measures of elasticity and cohesiveness did correlate significantly.

Next, Jack and colleagues (1993b) asked the question whether texture and appearance were important factors in consumer choice of Cheddar cheese. They carried out a study with 20 Cheddar style cheeses, performing FCP with 28 untrained consumers to explore consumer discrimination. Results from this study indicated that Cheddar Cheeses were perceived as being very varied in both appearance and texture, and the consumer panel discriminated readily between products, using a range of descriptors.

During 1998, O’Riordan *et al.* conducted a study where the volatile compounds released during consumption of Cheddar were compared with the expressions of perceived flavour, as determined by FCP. Eight untrained assessors were chosen and each tasted six Cheddar cheeses during Buccal Headspace Analysis of the released volatile compounds. In parallel, each assessor’s mastication behaviour was measured using Electromyography, stimulated saliva production was determined during consumption and sensory perceptions of the cheeses’ flavour were recorded by using FCP. It was found that although there were differences between assessors’ mastication behaviour and saliva production rates, the assessors’ individual volatile profiles, obtained by Buccal Headspace Analysis, were similar for each cheese examined. Partial Least Squares were also successful in predicting the most important flavour differences between cheeses from the volatile compounds released during their consumption by different assessors. Results from the FCP found that there was considerable agreement between the different assessors, with respect to the flavour attributes of each of the Cheddar cheeses.

In summary it can be said that limited research has been done to understand consumer perception and acceptability of the flavour profiles of Cheddar cheese, using preference mapping techniques (Young, *et al.*, 2004). As noted before, Cheddar cheese flavour is characterized by complex flavour developments, associated with age and processing procedures; cheeses with varying maturity levels have distinctive flavour profiles (Drake *et al.* according to Young *et al.*, 2004). Moreover, external factors, like diverse demographics, may also contribute to different attitudes relating to consumer acceptability of Cheddar cheese. Following enquiries, it was concluded that no specific reports exist of FCP being done on Cheddar cheese attributes in South Africa.

Therefore, the aim of this study was to determine whether data, obtained from FCP and using semi-naïve panellists, could express the perceptions of consumers on Cheddar cheese attributes. Firstly, the acceptance of 15 Cheddar cheeses was determined by Cheddar cheese consumers (users and eaters), in terms of overall liking. Free choice profiling was then used as descriptive analysis method and a panel of ten semi-naïve assessors was responsible for the descriptive sensory profile of the 15 Cheddar cheese

samples. Internal preference mapping was done to ascertain a better understanding of the descriptive sensory attributes that influence consumer preferences and thus, examine the relationship between descriptive sensory data and consumer responses.

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## CHAPTER 3

### CONSUMER ACCEPTANCE STUDY ON 15 CHEDDAR CHEESES IN SOUTH AFRICA

#### 3.1 ABSTRACT

A panel of 220 consumers was asked to indicate their level of acceptance on a nine-point hedonic scale for overall acceptance of 15 Cheddar cheese products, in two locations in South Africa. Significant differences ( $P < 0.05$ ) occurred amongst consumer demographics for consumer acceptability. Female participants rated the cheese samples higher than their male counterparts, while older panel members gave higher scores than the younger members. The Johannesburg panels gave higher ratings than the panels in Cape Town. Coloured and white participants used higher values to score the cheeses than the black participants. The number of cheeses showing a significant difference for the different main effects was: gender (2); income (1); population group (3); age (8); and location (5). The 15 Cheddar cheese samples included five retail Cheddar cheeses from four dairy companies, four cheese samples from two culture houses and six experimental cheeses. The ageing period of the 15 cheeses ranged from 60 to 180 days, all being mild Cheddars, except one mature Cheddar cheese. Three of the cheeses were white in colour. For the overall liking attribute, there was a significant difference in acceptance ( $P < 0.05$ ) between the 15 Cheeses. Fisher's Least Significant Difference test at a 5% significance level was performed to determine which cheeses differed significantly from one another for overall liking/acceptance. The most liked cheese sample had the highest mean value of 7.16, was aged for 60 days and yellow in colour. The least acceptable cheese had a mean value of 4.75, was aged for 180 days and was white. The female and black members scored the white cheeses significantly lower than the rest of the panel. The liking for older cheeses did not show a definite pattern. The cheese that was 150 days old was significantly more liked by the female tasters, whereas the 180 day old cheese was significantly more liked by the male tasters. The older panel members liked the cheeses significantly more than the younger group and weren't significantly influenced by the white

colour of some cheeses. The Johannesburg panels liked the cheeses significantly more than the Cape Town panels, as indicated by their higher scores.

### 3.2 INTRODUCTION

All over the world a great diversity of cheeses are produced from the same raw materials: bovine, ovine, caprine or buffalo milks, lactic acid bacteria (LAB), coagulant and NaCl. It has indeed been said that there is a cheese for every taste preference and a taste preference for every cheese (Olsen according to McSweeney, Ottagalli & Fox, 2004).

No definite list of cheese types exists (McSweeney *et al.*, 2004). In 1970, Sandine & Elliker suggested that there are more than 1000 varieties, but Jim Path compiled a list in 2004 at the University of Wisconsin, containing 1400 varieties (McSweeney *et al.*, 2004) (available on Internet at <http://www.cdr.wisc.edu>). Attempts to classify these varieties exploited a number of cheese characteristics:

- \* texture, dependent mainly on moisture content;
- \* method of coagulation; and
- \* ripening indices (McSweeney *et al.*, 2004).

Cheddar cheese originated in England (named in the middle of the 19<sup>th</sup> century after the village in Somerset) and is one of the most important cheese varieties worldwide (McSweeney *et al.*, 2004; Lawrence, Gilles, Creamer, Crow, Heap, Honoré, Johnston, & Samal, 2004). The first Cheddar cheese factory, as opposed to farmhouse cheesemaking, was operational in the United States (New York State) in 1861, followed by Canada (Ontario) in 1864, and New Zealand and England in 1871. The word cheddaring refers to a procedure in the making of cheddar, where the curd is repeatedly cut and piled to allow maximum whey drainage, hence producing a firmer dense cheese.

The traditional manufacturing of Cheddar cheese consists of: (a) coagulation of the milk, which contains a starter culture, with rennet; (b) cutting the resulting coagulum into small cubes; (c) heating and stirring the cubes with the concomitant production of a required amount of acid; (d)

removal of the whey; (e) fusion of the cubes of curd into slabs by cheddaring; (f) cutting (milling) the cheddared curd; (g) salting; (h) pressing, and (i) packaging and ripening. There are many Cheddar cheese varieties available, as Cheddar cheese flavour requirements are specific to country, ethnicity and end application. Lawrence *et al.* (2004), describes the four main varieties as being low-fat Cheddar cheese, stirred curd or granular cheese, washed curd varieties, and Colby and Monterey cheese.

Cheddar cheese is the most popular cheese variety in South Africa, with Gouda in second place (BMI FOODPACK, 2006). Eighty-four percent of South African cheese consumers eat Cheddar and Gouda. Until eight years ago, the consumption ration for Cheddar and Gouda was 52:48, but the versatility of Cheddar has resulted in a ratio of 61:38. One reason for this change is newly found applications in the food manufacturing and catering sectors, which created new usage opportunities for Cheddar (South African Cheese, 2007). Gouda, on the other hand, is a semi-hard cheese, with a smooth texture and a more pliable body than Cheddar. It is creamy yellow in colour, with a typical nutty flavour.

Market breakdown for 2005 indicated that the everyday cheese category constitutes around 80% of the cheese market industry, followed by processed and specialty cheeses. Everyday cheeses include Cheddar, cottage cheese, cream cheese, Feta, Gouda, Mozzarella and other plain, natural cheeses like Emmental, Edam and any uncoloured cheese. Processed slices, processed cheese blocks and cheese spreads represent the processed cheese category, which is made from a base of plain natural cheese, heated to pasteurization temperatures. Speciality cheeses include mould cheeses (both white and blue mould cheeses), Parmesan-type cheeses (Parmesan and Provolone), speciality Italian cheeses (all Italian cheeses that are not classified elsewhere, like Mascarpone, Pecorino and Ricotta) and other speciality cheeses (such as goat's milk cheese, Leyden, Gruyere, Haloumi, Havarti, Colby and Amsterdammer) (BMI FOODPACK, 2006).

The everyday cheese consumption in South Africa was 67 130 tons in 2005, with an expected increase to 71 158 tons in 2006 and 75 136 tons in 2007 (BMI FOODPACK, 2006). According to South African Cheese (2007), South Africa produces about 82 000 metric tons of cheese per year. About

51% of this quantity is in the form of Cheddar (31%) and Gouda (20%), and the rest consists of other types, mainly Mozzarella, Feta and cream cheese.

South African Cheese (2007) lists 78 cheese factories, including big, modern, automated factories and small cheeseries. Twelve big automated and modern factories are responsible for about 65% of all cheeses made in South Africa, while the largest one can manufacture up to 45 metric ton of cheese per day, all of uniform quality. The rest is produced in medium to small cheeseries, some producing only 25 kilograms per day. The Western Cape is the undisputed cheese province of South Africa and it is estimated that more than 50% of all cheese is produced here (South African Cheese, 2007).

The per capita consumption of cheese in South Africa has risen from 1 to 1.9kg per year since 1995. This is great news for local manufacturers, but is still much lower than many other cheese producing countries. The French top the list with 25kg per year, followed by Greece and Germany with 20kg, and the Netherlands with 18kg. The English, Australians and New Zealanders are on 9kg, and the Japanese, just a little in front of South Africa, on 2kg (South African Cheese, 2007). According to The Wisconsin Milk Marketing Board (2007), the Greeks head the list of international cheese consumption for 2005 with 26.7kg per year, followed by France (24.2kg), Netherland (21.5kg), Italy (21.1kg), Germany (20.5kg) and countries like Sweden (17.3kg) and the United State of America (14.3kg).

In food products there are two main approaches to consumer sensory testing: the measurement of preference and the measurement of acceptance (Jellinek according to Lawless & Heymann, 1998). Affective or consumer sensory testing is regarded as a valuable and necessary component of every sensory analysis program (Stone & Sidel, 1993), and are conducted among large numbers of untrained, inexperienced people, who are representative of the target population of users of the product under study (Moskowitz, 1991). One of the applications of consumer testing is to obtain market and product information by determining the personal reaction by current or potential consumers of a product, a product idea or specific product characteristics (Meilgaard, Civille & Carr, 1987; McDermott, 1990).

Sensory characteristics are perceived by consumers when they observe, manipulate, smell and take cheese into the mouth for consumption, and are subsequently expressed as a behavioral response using actions or descriptive terms. According to the sensory scientists' point of view, consumers differ from one another. Sensory perception, and particularly its communication, thus differs between individuals as a result of physiological, psychological, social and cultural differences (Delahunty & Drake, 2004). The eating quality of cheese, or a consumer's liking for cheese, is an integrated response. The stimuli are the sensory characteristics, perceived before and during consumption. However, the response is influenced by other individual consumer-related factors that include sensory abilities, past experiences with cheese, what is expected from a cheese and when and where it will be consumed (Delahunty & Drake, 2004).

The aim of this study was to determine the acceptance of 15 Cheddar cheeses by a consumer panel, in terms of overall liking.

### **3.3 MATERIALS & METHODS**

#### **3.3.1 Evaluation of Cheddar cheese samples**

The 220 selected, regular Cheddar cheese consumers were asked to assemble at specified central venues to taste/evaluate and give their acceptability opinion on the 15 Cheddar cheeses. The term “regular” implicated that they must have eaten [on its own] and used Cheddar cheese [in baking, cooking etc.], within the last two to three weeks.

The products were evaluated during April 2006 in two major locations in South Africa: Johannesburg, Gauteng Province (three locations); and Cape Town, Western Cape Province. In Johannesburg, 110 Cheddar participants indicated their level/degree of acceptance for the 15 Cheddar cheeses in three areas: South Rand (recreational centre), East Rand (in-venue house) and West Rand (in-venue house). One hundred and ten Cheddar consumers from Cape Town also indicated their acceptance for the same 15 Cheddar cheeses at a community hall.

Groups of the same respondents convened every hour to taste five of the samples, until each participant had tasted all 15 cheeses. Each respondent tasted five samples of Cheddar cheese and completed the questionnaire on those samples. They were then asked to “rest” for at least 30 minutes after clearing their palette with a sip of water and half a rice cake. After this mandatory “rest” period they tasted another five (5) samples, completed the questionnaire and “rested” again for at least 30 minutes. The routine was repeated until all 15 cheeses were evaluated. Respondents received cash incentives after completion of the final evaluation form.

The questionnaire consisted of a nine-point hedonic scale (Figure 3.1). Respondents were asked to respond to the question “how much do you like or dislike the sample?” All 15 Cheddar cheese samples were coded with randomized, 3-digit codes and rotated to prevent bias. Each respondent received one cube of 1.5 x 1.5 x 4cm Cheddar cheese sample per product.

**Nine-point hedonic scale**

Instruction:  
Please indicate with a X how much you like or dislike the product OVERALL.

Sample code: \_\_\_\_\_

**OVERALL LIKING**

1	2	3	4	5	6	7	8	9
Dislike extremely	Dislike very much	Dislike moderately	Dislike slightly	Neither like nor dislike	Like slightly	Like moderately	Like very much	Like extremely

Figure 3.1 Nine-point hedonic scale (Lawless & Heymann, 1998; Stone & Sidel, 2004)

### 3.3.2 Sample preparation

Fifteen Cheddar cheese sample blocks were transported in cool boxes, with ice bricks, from the Sensory Laboratory fridge to the evaluation locations in the Johannesburg venues, prior to the day of evaluation. Cheeses for the evaluation in Cape Town were couriered in cool boxes in the evening to ensure that the samples were kept cold until arrival and appropriate cooling conditions could be supplied. The Sensory Laboratory fridge's temperature was kept between 2 to 6°C (degrees Celsius) to prevent any of the Cheddar cheeses to mature/age, since the starter cultures activity are lowered at these temperatures.

Preparation of the Cheddar cheese samples were conducted under the supervision and assistance of professional sensory analysts. Each of the 15 Cheddar cheese sample blocks were cut into smaller cubes of 1.5 x 1.5 x 4cm to serve to the respondents. The size of the cubes ensured easier handling by the respondents. Each sample was served in a 75ml clear cup, fitted with a white lid (Plastform Consol Ltd., Flamingo Crescent, Lansdowne, 7780, Johannesburg). Each of the respondents received one cube of each of the 15 Cheddar cheeses at ambient temperature (approximately 22°C).

### **3.3.3 Recruitment and screening of the consumer panels**

Research & Planning Intelligence (PTY) LTD (RPI) is a local market research company who conducted the recruitment and screening of the consumer panels. The questionnaire in Annexure 1 was given to potential participants of the Cheddar cheese study to recruit and pre-screen the appropriate consumers.

The market research company was instructed to follow demographic requirements as stipulated in Table 3.1. A total number of 220 regular Cheddar cheese consumers, half (n=110) male and half (n=110) female, representing a LSM (Living Standards Measurement) between 8 to 10 (i.e. earning between R7000 to more than R16000) participated in the consumer acceptance evaluation. One hundred and ten of the respondents had to be in the age group between 25 – 34 years and 110 in the age group between ages 35 – 49, to determine whether age plays a role in the choice of different types of Cheddar cheese. Population split had to represent 50% white participants and 50% black and coloured participants. The aim here was to detect whether race can be linked to consumer preference for Cheddar cheese types. Fulfilling all the above requirements, half of the trial had to represent acceptance opinions from Johannesburg (three locations) and half from Cape Town, since retail numbers for cheese were the highest in these two cities (Markinor according to Venter, 2007).

Respondents revealed personal information like name and surname only for administration purposes. These details were not used in any way after data capturing and/or further investigations.

Table 3.1 Demographic requirements for this study

		Request to RPI	Actual numbers
Location *	Johannesburg	1/3 South Rand	n = 110
		1/3 East Rand	
		1/3 West Rand	
	Cape Town	All areas	n = 110
Sex	Male	50%	n = 109
	Female	50%	n = 111
Age category	Between age 25 - 34	50%	n = 108
	Between age 35 - 49	50%	n = 112
Population split	White	50%	n = 110
	Black and Coloured	50%	n = 60 black + n = 50 coloured
LSM level **	8 – 10	100%	n = 220

\* Regular Cheddar cheese users and eaters. Earlier market research indicated that these regions represented the majority of the Cheddar cheese market.

\*\* LSM = Living standard measurement

### 3.3.4 Statistical analysis

All the data was collected in spread sheets using Microsoft Excell 2007 and all the statistical analyses were done using XLSTAT 2007. The significance of the overall acceptance measured for each Cheddar cheese sample was tested by means of analysis of variance (ANOVA). The different samples were used as the main effects at a significance level of 95 % ( $P \leq 0.05$ ). If the main effect was significant, Fisher's LSD-test was applied to determine the direction of the differences between mean values.

### 3.4 RESULTS AND DISCUSSION

#### 3.4.1 Analysis of the hedonic ratings of Cheddar cheese samples

Table 3.2 Product list with information on Cheddar cheese sample

Sample	Code	Ageing period in days	Colour	Type
Retail 1	449A	60-90	Yellow	Mild*
Experimental 1	364B	90	Yellow	Mild*
Experimental 1	671C	150	Yellow	Mild*
Experimental 2	863D	60	Yellow	Mild*
Experimental 2	946E	120	Yellow	Mild*
Retail 2	215F	90	Yellow	Mild*
Retail 3.1**	197G	60-90	Yellow	Mild*
Retail 3.2**	762H	60-90	Yellow	Mild*
Retail 4	591I	60	Yellow	Mild*
Culture house 1	703J	120	White	Mild*
Culture house 1	149K	90	White	Mild*
Culture house 1	438L	60	Yellow	Mild*
Culture house 2	135M	180	White	Mature
Experimental 1	547N	60	Yellow	Mild*
Experimental 1	241O	105	Yellow	Mild*

\* In South Africa, Cheddar is regarded as mild between 8 – 24 weeks, i.e. 56 - 168 days (Mulder, 2007).

\*\* Two types of packaging, namely resealable pack (retail 3.1) and shrink-wrap pack (retail 3.2).

Five retail Cheddar cheeses from four cheese manufacturers were bought from commercial stores. Two culture houses provided four cheese samples, three from one culture house and one from the other, respectively. Six experimental cheeses, incorporating two different cultures, completed the product list. The ageing period of the 15 cheeses ranged from 60 to 180 days, thus including two types of Cheddar cheese, namely mild and mature. Only three of the 15 cheeses were white in colour.

For the overall liking attribute, there was a significant difference in acceptance between the 15 Cheddar cheeses tested (Table 3.3).

Table 3.3 ANOVA (Analysis of Variance)

	<i>D.F.</i>	<i>Sum of Squares</i>	<i>Mean of Squares</i>	<i>F Value</i>	<i>P-value</i>
<b>Samples</b>	14	1576.933	112.638	29.79	< 0.001
<b>Judges</b>	219	4145.661	18.930	5.01	<0.001
<b>Error</b>	3066	11591.467	3.781		
<b>Total</b>	3299	17314.061	5.248		
<b>Standard Error (SEM) =</b>	0.131				

A Fisher's Least Significant Difference test at a 5% significance level was performed to determine which cheeses differed significantly from one another for overall liking (Table 3.4).

Table 3.4 Least square mean values for the preference of 15 cheese samples (n = 220)

<b>CHEESE SAMPLES</b>	<b>Liking (mean value out of nine)</b>	<b>P-value</b>
547N	7.16 <sup>a</sup>	<0.05
438L	7.00 <sup>ab</sup>	
946E	7.00 <sup>ab</sup>	
364B	6.76 <sup>abc</sup>	
863D	6.66 <sup>bcd</sup>	
762H	6.54 <sup>cde</sup>	
241O	6.43 <sup>cde</sup>	
197G	6.30 <sup>de</sup>	
671C	6.24 <sup>e</sup>	
149K	6.22 <sup>e</sup>	
703J	6.15 <sup>e</sup>	
591I	5.68 <sup>f</sup>	
215F	5.40 <sup>fg</sup>	
449A	5.08 <sup>gh</sup>	
135M	4.75 <sup>h</sup>	

Samples that share the same letter (a, b, c) are not significantly preferred to one another (equally liked), although there is a small difference in means.

From Table 3.4 it is evident that the liking for the different cheese samples differed significantly ( $P \leq 0.05$ ). The most liked cheese sample was sample 547N, with the highest mean value of 7.16, which corresponds to between “like moderately” and “like very much” on the hedonic scale. This cheese was aged for 60 days and yellow in colour. Cheese 135M was the least acceptable to the Cheddar cheese consumers with a mean value of 4.75, which is categorized as between “dislike slightly” and “neither like nor dislike” on the nine-point hedonic scale. This white cheese was aged for 180 days, the only mature cheese in the trial.

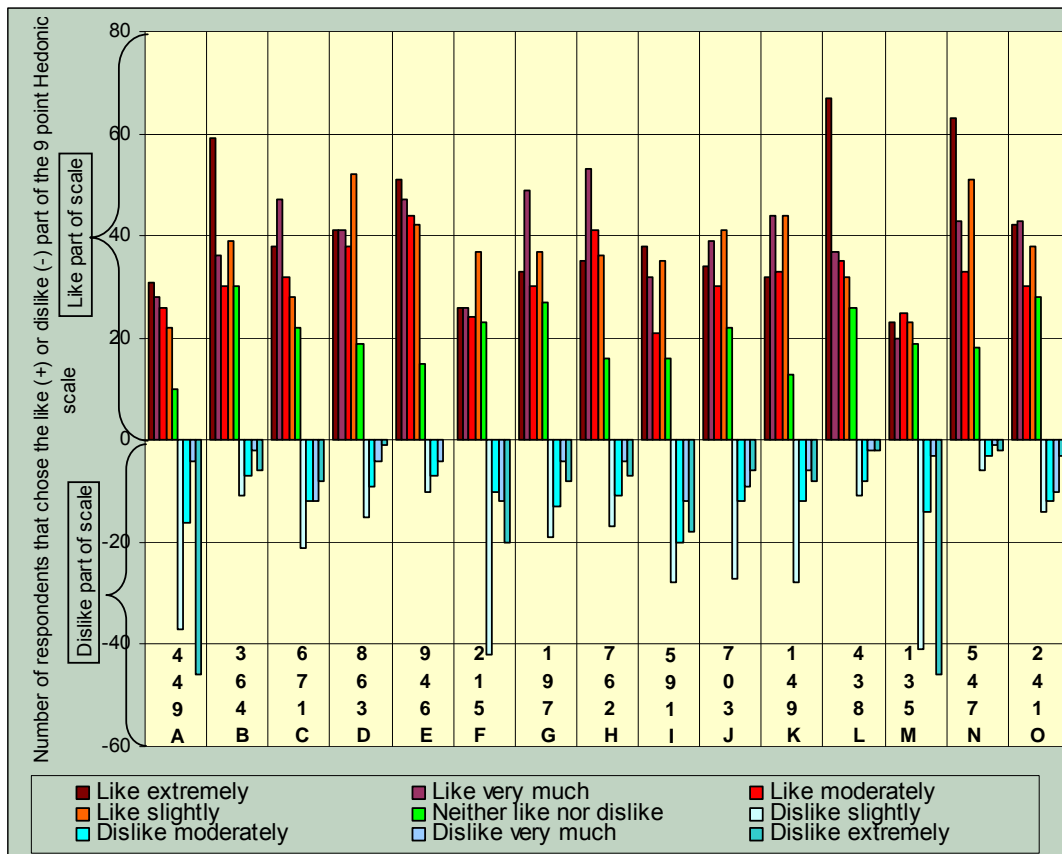


Figure 3.2 The frequency of the hedonic scale ratings per product

Figure 3.2 can be divided into two parts: i) bars pointing upwards, indicating the positive or “like” side of the hedonic scale, ranging from “like extremely” to “neither like nor dislike”; and ii) bars pointing downwards, indicating the negative or “dislike” side of the hedonic scale, categorized as between “dislike

slightly” to “dislike extremely”. It is clear that the positive indicators were in general used more frequently than the negative ones.

The following conclusions can also be drawn from Table 3.4:

- \* the liking for cheese samples 547N, 438L, 946E and 364B were similar and did not differ significantly from each other. These cheeses were all yellow in colour, with the ageing period ranging from 60 -120 days.
- \* the liking for cheese samples 438L, 946E, 364B and 863D were similar and did not differ significantly from each other. These samples were also yellow and ranged from 60 – 120 days in age.
- \* the liking for cheese samples 364B, 863D, 762H and 241O were similar and did not differ significantly from each other. These yellow cheese samples were ripened for 60 – 105 days.
- \* the liking for cheese 863D, 762H, 241O, and 197G were similar and did not differ significantly from each other. All these cheeses were yellow and ranged in age from 60 -105 days.
- \* The liking for cheese samples 762H, 241O, 197G, 671C, 149K and 703J did not differ significantly from each other. All these cheeses were yellow, except for samples 149 and 703, which were white. The ripening period ranged from 60 to 150 days.
- \* The liking for cheese sample 591I and 215F did not differ significantly from each other. These two cheese samples were yellow and the ripening period ranged from 60 to 90 days.
- \* The liking for cheese samples 215F and 449A did not differ significantly from each other. Both cheeses were yellow and 449A was ripened for 60 to 90 days and 215F was ripened for 90 days.
- \* The liking for cheeses samples 449A and 135M did not differ significantly from each other. Sample 449A was a yellow 60 day old cheese and sample 135M white, and ripened for 180 days. The least liked sample was 135M (4.75<sup>h</sup>), which did not differ significantly from the liking for sample 449A (5.08<sup>gh</sup>).

### 3.4.2 The effect of consumer profiles on the hedonic ratings of the Cheddar cheese samples

Significant differences occurred amongst consumer demographics for consumer acceptability (Table 3.5). It was found that female participants rated the cheese samples higher than their male counterparts, while older panel members gave higher scores than the younger members. The panels in Johannesburg gave higher ratings to the cheese samples than the panels in Cape Town. LSM had no significant influence on the rating of the Cheddar cheeses. Coloured and white participants used higher values to score the cheeses than the black participants.

Table 3.5 Effect of consumer profiling measurements on hedonic rating of 15 Cheddar cheese samples as obtained by ANOVA

				<i>P</i> -value
<b>Gender</b>	<b>Male</b>	<b>Female</b>		
	6.121	6.33		<i>P</i> = 0.007
<b>Age</b>	<b>25-34 Years</b>	<b>35-49 Years</b>		
	5.95	6.49		<i>P</i> < 0.0001
<b>Province</b>	<b>Cape Town</b>	<b>Johannesburg</b>		
	5.98	6.47		<i>P</i> < 0.0001
<b>LSM/ HH Income</b>	<b>LSM 8: R7000-8999</b>	<b>LSM 9: R9000-15999</b>	<b>LSM 10: R16000+</b>	
	6.21	6.17	6.38	NS
<b>Population Group</b>	<b>Black</b>	<b>Coloured</b>	<b>White</b>	
	5.76 <sup>b</sup>	6.38 <sup>a</sup>	6.40 <sup>a</sup>	<i>P</i> < 0.0001

Means with different superscripts in the same row differed significantly.

NS = Not significant

LSM = Living Standard Measurement

HI = Household Income

Fisher's LSD-test was then applied to all the main effects that were significant, to determine the direction of the differences between mean values (Table 3.6).

Table 3.6 Fischer's LSD for main effects of consumers' demographics on hedonic rating of 15 Cheddar cheeses

Cheese number	Gender		Sign. level	Population group			Sign. Level	Age		Sign. level	Location		Sign. level
	Male	Female		Black	Coloured	White		25-34	35-49		Cape	JHB	
449A	4.98 (2.76)	5.17 (2.89)	NS	4.60 (2.46)	5.14 (2.81)	5.31 (3.00)	NS	4.58 (2.84)	5.55 (2.74)	p<0.05	4.29 (2.80)	5.86 (2.63)	p<0.0001
364B	6.63 (2.02)	6.89 (2.02)	NS	6.58 (2.06)	6.56 (2.21)	6.95 (1.91)	NS	6.54 (1.94)	6.98 (2.08)	NS	6.35 (2.22)	7.18 (1.72)	p<0.01
671C	5.91 (2.47)	6.57 (2.06)	P<0.05	5.93 (2.20)	6.52 (2.09)	6.28 (2.42)	NS	5.88 (2.36)	6.59 (2.18)	p<0.05	6.00 (2.29)	6.48 (2.27)	NS
863D	6.54 (1.88)	6.78 (1.75)	NS	6.28 (1.86)	6.86 1.83	6.78 (1.77)	NS	6.58 (1.83)	6.74 (1.81)	NS	6.40 (1.95)	6.93 (1.64)	p<0.05
946E	6.99 (1.77)	7.00 (1.69)	NS	6.40 <sup>b</sup> (1.98)	7.34 <sup>a</sup> (1.21)	7.16 <sup>a</sup> (1.72)	p<0.01	6.81 (1.68)	7.18 (1.76)	NS	6.90 (1.70)	7.09 (1.76)	NS
215F	5.16 (2.50)	5.65 (2.27)	NS	5.17 (2.34)	5.30 (2.27)	5.58 (2.49)	NS	4.96 (2.35)	5.83 (2.37)	p<0.01	5.31 (2.38)	5.50 (2.42)	NS
197G	6.05 (2.18)	6.56 (2.04)	NS	6.10 (2.38)	6.34 (2.09)	6.40 (2.00)	NS	6.14 (2.21)	6.46 (2.04)	NS	6.32 (2.00)	6.29 (2.25)	NS
762H	6.27 (2.29)	6.80 (1.77)	NS	6.32 (2.13)	6.32 (2.12)	6.75 (1.98)	NS	6.23 (2.05)	6.83 (2.03)	p<0.05	6.31 (2.11)	6.76 (1.99)	NS
591I	5.68 (2.55)	5.68 (2.56)	NS	5.07 (2.48)	5.94 (2.56)	5.89 (2.54)	NS	5.14 (2.50)	6.20 (2.49)	p<0.01	5.48 (2.70)	5.87 (2.37)	NS
703J	6.16 (2.11)	6.14 (2.21)	NS	4.78 <sup>b</sup> (2.08)	6.66 <sup>a</sup> (2.05)	6.65 <sup>a</sup> (1.93)	p<0.0001	5.80 (2.24)	6.48 (2.03)	p<0.05	6.20 (2.00)	6.09 (2.31)	NS
149K	6.13 (2.18)	6.31 (2.14)	NS	5.00 <sup>b</sup> (2.16)	6.62 <sup>a</sup> (1.88)	6.70 <sup>a</sup> (2.02)	p<0.0001	5.79 (2.24)	6.63 (1.99)	p<0.01	5.94 (2.18)	6.50 (2.10)	NS
438L	6.88 (1.92)	7.12 (1.88)	NS	6.87 (1.83)	7.24 (2.02)	6.96 (1.89)	NS	7.00 (2.04)	7.00 (1.77)	NS	6.66 (2.01)	7.34 (1.73)	p<0.01
135M	5.11 (2.63)	4.40 (2.69)	P<0.05	4.18 (2.57)	5.02 (2.49)	4.94 (2.79)	NS	4.39 (2.78)	5.10 (2.54)	p<0.05	4.44 (2.53)	5.06 (2.80)	NS
547N	7.12 (1.60)	7.20 (1.74)	NS	7.07 (1.67)	7.40 (1.86)	7.10 (1.59)	NS	7.14 (1.67)	7.18 (1.68)	NS	6.85 (1.65)	7.46 (1.64)	p<0.01
241O	6.16 (2.20)	6.70 (1.97)	NS	6.12 (2.07)	6.44 (2.26)	6.60 (2.04)	NS	6.31 (2.12)	6.55 (2.08)	NS	6.20 (2.13)	6.66 (2.05)	NS

Means with different superscripts in the same row and treatment group differed significantly. NS = Not significant  
Values in brackets refer to standard deviations.

For the main effect gender, two cheeses showed significant differences. Cheese 135M (mature, white, 180 days, culture house), which had the lowest hedonic rating of all the cheeses, was rated much lower by the female section of the panel than by the male contingent. For cheese 671C (mild, yellow, 150 days, experimental) the opposite was true in that the scoring of the females was much higher than that of the males. Population group, as main effect, showed three significant differences. All three cheeses in this case, numbers 946E (mild, yellow, 120 days, experimental), 703J (mild, white, 120 days, culture house) and 149K (mild, white, 90 days, culture house), were rated higher by the coloured and the white panel members, than by the black panel members. No information was found in the literature to explain this and it may be related to cultural differences and previous experience. The main effect age showed the most significant differences, eight in total. The older age group scored all eight cheeses, numbers 703J (mild, white, 120 days, culture house), 215F (mild, yellow, 90 days, retail), 762H (mild, yellow, 60-90 days, retail), 591I (mild, yellow, 60 days, retail), 149K (mild, white, 90 days, culture house), 135M (mature, white, 180 days, culture house), 449A (mild, yellow, 60-90 days, retail) and 671C (mild, white, 120 days, culture house), higher than the younger age group. For the main effect location, five cheeses showed significant differences. The Johannesburg panels rated all five cheeses, numbers 863D (mild, yellow, 60 days, experimental), 438L (mild, yellow, 60 days, culture house), 547N (mild, yellow, 60 days, experimental), 449A (mild, yellow, 60-90 days, retail) and 364B (mild, yellow, 90 days, experimental), higher than their Cape Town counterparts.

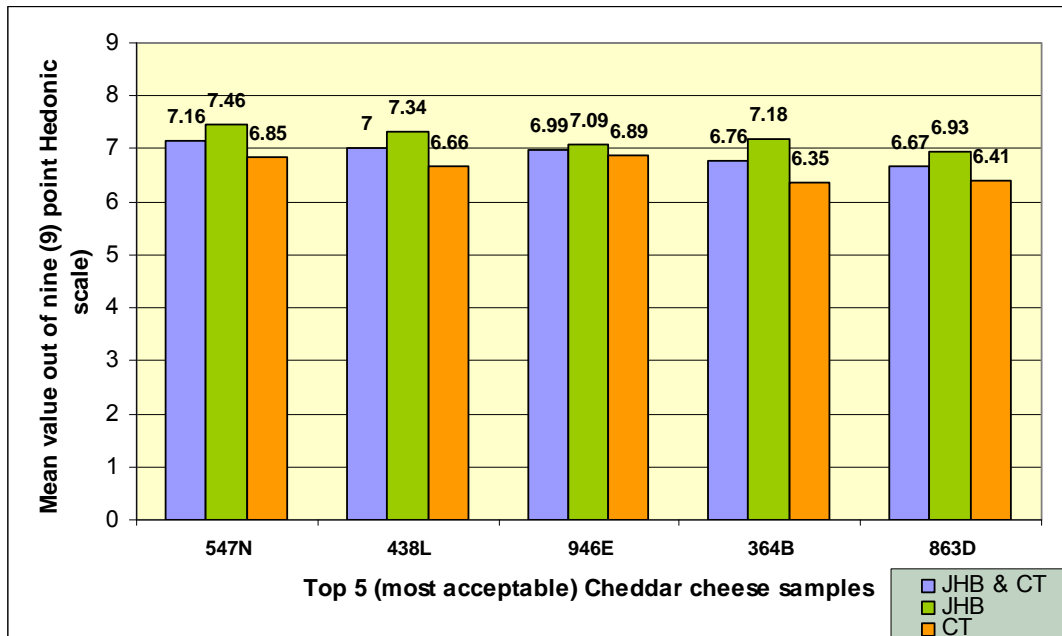


Figure 3.3 Five most acceptable Cheddar cheeses in major and individual locations in South Africa.

JHB = Johannesburg; CT = Cape Town

Figure 3.3 shows the five most acceptable Cheddar cheeses in the Johannesburg and Cape Town. Four of the cheeses that showed a significant difference for location, are present in this graph, indicating that although Cape Tonians rated them lower than their Johannesburg counterparts, these cheeses were firm favourites in both locations.

The acceptance of the 15 chosen Cheddar cheeses, in terms of overall liking, was determined by the consumer panel. The white cheeses did not perform well in this test, as two sections of the panel, the female and black members, scored them much lower than the rest of the panel. The female contingent was unsure as to whether they liked the older cheeses or not. They scored the oldest cheese (180 days) much lower than the males, but the 150-day-old sample much higher than the males. The older panel members, in general, liked the cheeses better than the younger group and weren't negatively influenced by the white colour of some cheeses. The Johannesburg panels liked the cheeses better than their Cape Town counterparts, as indicated by their higher scores.

### 3.5 CONCLUSION

The above-mentioned results are in agreement with Stone & Sidel's (1993) conclusion that regular consumers of food products do have the ability to indicate their level of acceptance and/or preference for a product. However, when the same consumers are asked to explain their level of acceptance or liking for that specific product, it will most likely result in unreliable data (Stone & Sidel, 1993). Nowadays it is increasingly important to link preference/acceptability with the sensory characteristics of the product. Results from the consumer acceptance study showed that South African Cheddar cheese consumers prefer younger Cheddar cheeses. According to a study conducted by Caspia and co-workers (Coggins, Schilling, Yoon & White) (2006), a descriptive panel could characterize 7- and 9-month-old cheeses as having young/undeveloped flavour such as 'cooked', 'buttery' and 'creamy' flavours. At 6-8 months of age, Cheddar cheese develops most of its flavour, and a full Cheddar cheese flavour is generally developed after 1 year of ripening (Caspia *et al.*, 2006). Young *et al.*, according to Caspia *et al.*, (2006), characterized the flavour attribute terms of 1-, 2- and 4-month-ripened Cheddar cheeses as cooked/milky, whey, diacetyl and milkfat/lactone. The 12-month-old cheese, in the study conducted by Caspia *et al.*, (2006), was characterized by aged/developed flavours such as 'sulfur', 'free fatty acid', and 'earthy', 'pungent', 'prickle bite', 'bitter' and 'sour'. Cheeses with more than 1 year of ripening were characterized by 'sulfur', 'brothy', 'nutty', 'free fatty acid' and 'catty' attribute terms (Young *et al.*, according to Caspia *et al.*, 2006).

In the end, knowing what characteristics the product has, will allow the product developer to deliver the ideal product for a particular segment of the consuming population (Baker, 1988). In 1984, Williams & Langron advocated that the relatively new descriptive technique, Free Choice profiling, may prove to be the answer to the time and money expenditures to formally train and maintain traditional descriptive panels. The subsequent aim was then to describe the 15 Cheddar cheeses by using FCP and a semi naïve panel.

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## CHAPTER 4

### DESCRIPTIVE SENSORY ANALYSIS OF CHEDDAR CHEESES IN SOUTH AFRICA, USING FREE CHOICE PROFILING

#### 4.1 ABSTRACT

Free choice profiling (FCP) was carried out in order to investigate how semi-naïve consumers (who had experience in descriptive work before, but not on Cheddar cheese and received minimal training on Cheddar cheese) described and perceived different Cheddar cheese samples. This method allowed participants to use their own attributes to describe and quantify the food product. The study used 15 different Cheddar cheeses available in South Africa, analyzed by ten consumers in three replications. The data was analyzed by using Generalized Procrustes Analysis. The FCP procedure generated between 21 and 42 attributes, with an average of 35, including 16 descriptors on the attribute aroma, 14 descriptors on the attribute texture/appearance, 15 descriptors on the attribute mouthfeel, 20 descriptors on the attribute taste, 18 descriptors on the attribute aftertaste and nine descriptors on the attribute afterfeel. Rubbery texture and sweet, buttery, Gouda taste and aftertaste attributes were some of the important attributes that separated the cheeses in the study. The results from the descriptive profiling method suggested that the FCP method, which is less expensive and time consuming, is an appropriate technique when used with semi-naïve assessors.

#### 4.2 INTRODUCTION

Sensory characteristics of a cheese at the time of its consumption, reflect the milk from which it was produced (e.g., a goats' milk cheese is distinct from a cows' milk cheese), the processes used in its production, and the physical and the chemical changes that occurred during maturation. For example, during cheese maturation, proteolysis breaks down proteins to amino acids, which may subsequently act as substrates for the formation of volatile compounds (Lawrence, Gilles, Creamer, Crow, Heap, Honoré, Johnston, & Samal, 2004).

Understanding the development and variations in flavour that occur during the development of cheese, is an important tool in defining consumers' expectations of taste. It is especially the aroma and texture of Cheddar cheese that change over ripening time, and although taste changes more readily than other sensory attributes, all may be useful in discriminating between products, as well as explaining consumer preferences (Lawrence *et al.*, 2004). Cheddar cheese develops most of its flavour at six to eight months of age, while a full Cheddar cheese flavour generally develops after one year of maturation. Research and marketing purposes demand the use of a sensory language for Cheddar cheese and many validated flavour lexicons for Cheddar cheese do exist (Muir & Hunter, 1992; Muir, Hunter, Banks & Horne, 1995; Muir, Banks & Hunter, 1997; Drake, Mcingval, Cadwallader & Cville, 2001; Drake, Gerard, Wright, Cadwallader & Cville, 2002; Drake, Gerard, Kleinhenz & Harper, 2003).

Factors like milk quality, starter cultures, manufacturing methods, consumer preferences and cultural influences all play a role in defining the borders of cheese classification. In South Africa, a Cheddar cheese is considered "green" when it is less than eight weeks old, "mild" between eight to 24 weeks and "mature" above 24 weeks. This is, however, not a regulatory guide and all Cheddars will not fit the profile, since sensory evaluation and the taster's opinion of the concept "mature" will also play a role. In the United Kingdom, Cheddar cheese is considered "green" up to 12 weeks, "mild" between 12–32 weeks and "mature" above 32 weeks (Mulder, 2007).

Cheddar cheese can be defined as having a close texture with a smooth, pliable and solid body, which does not crumble when squeezed between the fingers. The flavour is clean with acid and milk fat tones when "mild"; brothy with roasted-nut sweetness when older and a piquant sharpness when fully "matured" (Mulder, 2007). Mulder (2007) also emphasizes that one specific description/definition for Cheddar is very unlikely, because of the variety of characteristics and qualities that exists due to production methods and cheese age. Young Cheddar (two to three months), older Cheddar (eight to 12 months), commercially produced Cheddar and farm-house produced Cheddar would all differ in their descriptive definition. Mulder (2007) further

states that there are between five to eight different types of Cheddar cheese consumers and they all have a different “definition” for Cheddar.

Many descriptive analysis techniques, such as quantitative descriptive analysis (QDA), flavour profiling and the Spectrum method, have been used for the sensory evaluation of cheese and/or Cheddar cheese (Brandt, Skinner & Coleman, 1963; Stone, Sidel, Olivier, Woolsey & Singeleton, 1974; Piggott & Mowat, 1991; Muir & Hunter, 1992; Heisserer & Chambers, 1993; Muir *et al.*, 1995; Murray & Delahunty, 2000a; Murray & Delahunty, 2000b; Murray & Delahunty, 2000c; Drake *et al.*, 2001; Delahunty & Drake, 2004; Young, Drake, Lopetchara & McDaniel, 2004, Caspia, Coggins, Schilling, Yoon & White, 2006). Most of these techniques, however, imply the use of trained and experienced assessors, whose training involves a lot of time and expenditures. The generated terminology also tends to be complex and scientifically oriented (Deliza, Macfie & Hedderley, 2005). Consumer vocabularies, on the contrary, can be readily interpreted by both scientific and other personnel (Wilton & Greenhoff, 1988). However, consumer descriptors can also be too personal and be interpreted by no-one, except the subject (Piggott, Sheen, Apostolidou, 1990).

Free choice profiling (FCP) (Langron, 1983; Arnold & Williams, 1986) is a sensory technique developed to reduce the need for extensive panel training. It also eliminates the pre-established measure of agreement among the panellists on their interpretation and meaning of the terms they will employ (Deliza *et al.*, 2005). The technique has shown results compatible to those obtained by more conventional procedures, and has many practical advantages (Williams & Arnold according to Arnold & Williams, 1986). Free choice profiling assumes that assessors do not differ in how they perceive sensory characteristics, just in the way they describe them. Assessors develop idiosyncratic vocabularies (Williams & Arnold, 1985), which will inevitably vary from assessor to assessor, as they are grounded in individual experience and familiarity with the product. These procedures require little training; assessors must be objective, capable of using line scales, and use their vocabularies consistently (Williams and Langron, 1984). Any sensory characteristics can be examined using FCP. The range of characteristics can be restricted by the researcher, but the number of descriptors produced is

only limited by the perceptual and descriptive skills of the assessor (Oreskovich, Klein & Sutherland, 1991). Problems, however, arise in FCP when assessors, especially those with a lack of sensory experience, find it difficult to generate an adequate vocabulary to fully describe the samples (Piggott *et al.*, 1990). It is evident that a low level of training increases specificity of descriptors generated and reproducibility of results (Gains & Thomson, 1990). The gathering of information about cognitive perception directly from the consumers, (Moskowitz, 1996; Russel & Cox, 2003) has been shown as an invaluable tool in determining which attributes are beneficial both in product development and marketing terms when attempting to create the consumers' "ideal" product (Jack, 1994).

The aim of the study was to describe the sensory attributes of 15 Cheddar cheeses, found in South Africa, by using FCP.

### **4.3 MATERIALS AND METHODS**

#### **4.3.1 Cheddar cheese samples**

The 15 Cheddar cheese samples included: five retail Cheddar cheeses from four cheese manufacturers; four Cheddar cheeses from two culture houses, three from one culture house and one from the other, respectively; and six experimental cheeses, incorporating two different cultures. The ripening period for the 15 cheeses ranged from 60 to 180 days, thus including two types of Cheddar cheese, namely mild and mature. All the cheeses were yellow, except for three, which were white in colour (See table 3.2).

#### **4.3.2 Free Choice Profiling**

A group of ten trained panellists (contract workers of the company) were selected to participate in the FCP study, based on their taste and smell acuity, interest, ability to discriminate between the four basic tastes and availability for the entire study. The ten panellists have extended experience in descriptive sensory evaluation work, but not with Cheddar cheese.

Vocabulary development was carried out in a formal conference room with the assessors being asked to taste eight of the samples and generate as many terms as possible to describe appearance, texture, aroma, mouthfeel, taste, aftertaste and afterfeel. The remaining of the samples (i.e. 7 samples)

was assessed in a second session, allowing the addition of terms thought to have previously been omitted. Thus, the panellists received a representative sample of each of the 15 Cheddar cheese samples and were then trained to increase their sensitivity and ability to discriminate between the samples and identify sensory attributes. Each panellist had to give a clear definition of each attribute they developed to describe the specific attribute to be evaluated. An unstructured line scale, with appropriate anchors, ranging from zero (0) denoting not (e.g. not salty) to ten (10) denoting extreme (e.g. extremely salty) was constructed and used to evaluate the different samples. In order to ensure that panellists were not influenced in any way, no information with regard to the nature of the samples was provided. Panellists were once again informed not to use cosmetics (like lipstick) and to avoid exposure to foods and fragrances at least one hour before the evaluation sessions.

#### **4.3.3 Sample preparation, serving and evaluation procedures**

All samples were served and evaluated according to the sensory principles and methods described in the ASTM Manual on Descriptive Analysis Testing for Sensory Evaluation (ASTM Manual Series: MNL 13, 1992).

Panellists received two cubes of 1.5 x 1.5 x 4cm Cheddar cheese samples per product. This size, considerably larger than average bite size, was employed to ensure enough sample was available to evaluate all the necessary categories. The outer 3cm were removed from the cheese prior to cubing, to minimise the effects of surface drying. Samples were cut on the day of analysis, stored at a temperature between 2-6°C, and allowed 30 minutes to come up to room temperature, approximately 21°C, before assessment. The samples were served: one at a time; in a 75ml clear plastic cup with white lid (Plastform Consol Ltd., Flamingo Crescent, Lansdowne, 7780, Johannesburg); on a white polystyrene tray; at 15-18 °C; under white fluorescent light; and in individual sensory booths. All samples were served blinded, coded (three digit codes) and the serving order randomised to exclude any bias due to the position effect. Filtered water, at room temperature, and unsalted rice cakes (Vital Health Foods (Pty) LTD, Kuils Rivier, South Africa) were provided as palate cleansers before the start of

evaluation and between samples. Three evaluation sessions were scheduled with a 20 minute rest period between each session, amounting to a total of three evaluation sessions per product. During one session five samples were evaluated in triplicate. Three replications were considered the absolute minimum to ensure reliability and validity of results. Panellists were rewarded at the end of the day's evaluation sessions with refreshments and were paid for their participation.

#### **4.3.4 Test methodology**

With reference to the objective of the study, FCP was used in order to describe the differences existing between the 15 Cheddar cheese samples and to determine the direction of the differences. A general training programme, consisting of two, two hour sessions to develop an idiosyncratic list of appropriate descriptive terminology for the Cheddar cheese samples, was followed. Attributes were grouped together according to sensory characteristics such as appearance, texture/structure, aroma, mouthfeel, taste, aftertaste and afterfeel. No formal definition was developed for each attribute by each panellist; however, each one had to be able to explain all their attributes. A lexicon was compiled for each panellist, based on all the terms and definitions necessary for that panellist to describe the 15 Cheddar cheese samples (Annexure 2). Samples were thus scored on unstructured line scales, using the assessors' own vocabularies, anchored at the ends by the terms "not present/none" and "extremely/very high". Data were recorded on paper ballots and entered into worksheets for analysis.

#### **4.3.5 Statistical analysis**

Recorded data was entered into a Microsoft Excel 2007 worksheet and analyzed by generalized Procrustes analysis (GPA), using XLStat (Version 7.5.2). Generalized Procrustes analysis (Gower, 1975) was used to provide information on the inter-relationships between samples and assessors (Arnold & Williams, 1986; Oreskovich *et al.*, 1991). The main objects were to obtain an insight into the basic cognitive factors that the consumers used to distinguish between products, as well as the relationships between products in these factors (Hauser & Koppleman, 1979). The GPA consisted of three

logically distinct steps: the centroids of each assessor's data matrix were matched to eliminate the effect of use of different parts of the scales; isotropic scale changes removed differences in the scoring range used by different assessors; and configurations were matched as closely as possible by rotation and reflection of the axes (Arnold & Williams, 1986). A perceptual space was produced for each assessor which was matched as closely as possible with other assessors. A consensus configuration was then calculated as the average of individual configurations and simplified to a reduced dimensional plot by PCA.

The interpretation of descriptive sensory evaluation was simplified with the assistance of the multivariate statistical procedure, principal component analysis (PCA). With PCA, the smallest number of latent variables, called principle components, was identified. These principle components explained the greatest amount of observed variability. Residual errors, or the distances between the assessors' individual configurations and the consensus, were then used to calculate co-ordinates for plotting the assessors, to identify outliers or groups (Jack, 1994).

#### 4.4 RESULTS AND DISCUSSION

The FCP technique generated between 21 and 42 attributes, with an average of 35, amongst the ten panellists. Table 4.1 shows a clear relationship between attributes in all categories. In spite of this apparent agreement, there was no guarantee that all assessors used the attributes (Table 4.1) in the same way, or indeed attached the same importance to them in discriminating amongst the samples.

The attribute of aroma included 16 descriptors, including three of the four basic tastes, excluding bitter. Other descriptors included lunchbox/warm melted, nutty, barny and citrus. Descriptors, such as “buttery” (diacetyl) and “creamy” (milk fat), that have been classified by Drake *et al.*, 2001 to describe young/undeveloped flavours, were detected by die panel members and named to describe aroma, taste and aftertaste. This was in accordance with the age of all the cheese samples which were all mild cheddars, ranging between 60 to 150 days, except for one mature cheese (180 days old). For the attribute appearance/texture, 14 descriptors were used, including the visual characteristic colour. The attribute of mouthfeel contributed 15 descriptors, while the attribute taste had the most descriptors, 20 in total, including the four basic tastes. Bitterness is usually regarded as a defect in Cheddar cheese (Suriyaphan, Drake, Chen & Cadwallader, 2001) and was also detected as an aftertaste. Also included were flavours like mustard, pepper, parmesan/pecorino and blue cheese. The attribute aftertaste also used the four basic tastes amongst its 18 descriptors, as well as terms like oily, metal, ammonia and chemical. The attribute afterfeel had the least descriptors, only nine, including tacky, piquant/prick/burning, and sticky. Attributes such as “pungent”, “prick”, “bitter” and “sour”, are classified as aged/developed flavours (Caspia *et al.*, 2006) and may represent the older cheeses in the study.

Table 4.1 List of idiosyncratic sensory attributes developed by ten semi-naïve panellists to describe the 15 Cheddar cheese samples

<b>Aroma</b>	<b>Appearance / Texture</b>	<b>Mouthfeel</b>	<b>Taste</b>	<b>Aftertaste</b>	<b>Afterfeel</b>
1. Lunchbox cheese / warm-melted	1. Fine cracks	1. Hardness	1. Sweet	1. Oily	1. Astringent
1. Gouda / sweet milk / dairy	2. Holes	2. Tacky	2. Creamy	2. Sweet	2. Piquant / prick / burning
2. Sweet	3. Flaky	3. Pasty	3. Sour	3. Nutty	3. Dry
3. Salty	4. Shiny	4. Astringent	4. Bitter	4. Ammonia	4. Floury pieces / crumbs / pieces
4. Nutty	5. Hardness	5. Burning / tingling	5. Pungent / mature	5. Chemical	5. Tacky
5. Milky	6. Rubbery	6. Rubbery	6. Gouda	6. Bitter	6. Sticky
6. Musty	7. Compact	7. Creamy	7. Chemical	7. Mature	7. Oily / fatty
7. Sour	8. Fatty appearance	8. Floury / mealy	8. Mustard	8. Creamy	8. Mature
8. Yeasty	9. Crumbly	9. Crumbly	9. Ammonia	9. Buttery	9. Fatty coating
9. Buttery	10. Smooth surface	10. Sticky	10. Nutty	10. Sour	
10. Mature	11. Smeary / sticky	11. Dry	11. Buttery	11. Salty	
11. Barny	12. Smooth / creamy texture	12. Softness	12. Mature	12. Melted cheese	
12. Sour vinegar	13. Colour difference	13. Fatty	13. Salty	13. Metal	
13. Buttermilk	14. Dry	14. Tangy	14. Tangy	14. Tangy	
14. Dairy		15. Compact	15. Pepper	15. Sweet / Gouda / sweet milk	
15. Cheese spread			16. Fatty	16. Fatty	
16. Citrus			17. Yeasty	17. Yeasty	
			18. Sour vinegar	18. Blue cheese	
			19. Parmesan / pecorino		
			20. Blue cheese		

#### 4.4.1 AROMA CATEGORY

The principal component biplot for the aroma attribute (Figure 4.1) revealed that cheese sample 547N, that was liked the most by the consumer panel, had a cheese spread aroma, while sample 135M, which had the lowest score, had a musty and barny aroma. According to the eigenvalues (percentage by which variation is explained in the biplot), 68.09% of the variation is explained by dimension 1, and 15.21% of the variation is explained by dimension 2. This means that aroma attributes that are closer to dimension 1 (horizontal) are major determinants of variation in the 15 Cheddar cheese samples. A “dairy, buttery” aroma was characteristic of cheese samples 364B and 863D, while samples 671C, 946E, 241O, 438L and 197G had a Gouda/sweet milk aroma. Like the white cheese 135N, the other white Cheddar 149K also had a musty, barny aroma. The third white sample, 703J, tended to be more tangy, yeasty and sour, like samples 215F and 449A.

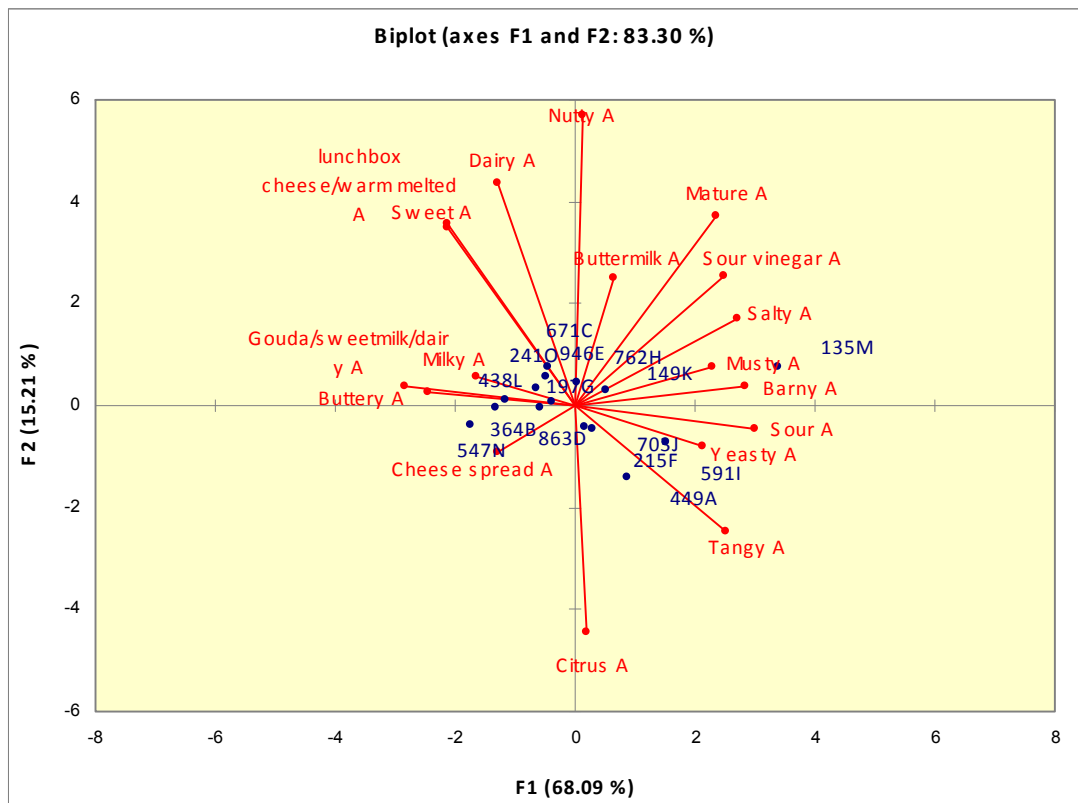


Figure 4.1 Generalized Procrustes analysis biplot of Free choice profiling for aroma attributes of 15 Cheddar cheese samples

#### 4.4.2 TEXTURE/APPEARANCE CATEGORY

On the attribute texture/appearance (Figure 4.2), the first dimension (F1) explained 51.62% of the variance in the data and the second dimension (F2) explained a further 32.94% of the variance in the data. The most liked cheese sample 547N's appearance/texture was fatty and in contrast with that, least liked sample 135M had a crumbly, flaky appearance/texture, with fine cracks. Texture/appearance descriptors which were mostly used to describe the Cheddar cheese samples were smooth/creamy, hardness, compact, smooth surface, rubbery, fatty appearance, smeary, sticky and shiny (Dimension 1).

In a study by Jack in 1994, it was determined that the more mature cheeses could be associated with terms such as crumbly, dry and hard textures. The generally less mature samples were associated with terms such as rubbery and soft textures. It was shown that immature samples were perceived as possessing rubbery characteristics, which developed into sticky, wetter textures as the cheese matured. These results, according to Jack (1994), agreed with the findings of Lawrence *et al.*, that, as a cheese matures, cohesiveness decreases. Jack (1994) concluded that a consumer panel could distinguish between samples in terms of textural maturity. In contrast, Caspia and co-workers (2006) noted that differences for cheeses with ripening periods from seven to 11 months were not highly perceivable by panellists. This is in agreement with the present study where the GPA for FCP on the texture/appearance category showed that the consumers could not distinguish between more or less mature cheeses in terms of texture. For example: cheeses 863D (60 days), 946E (120 days) and 364B (90 days) were all characterized as being rubbery in texture. Caspia *et al.* (2006) stated that the texture of Cheddar cheese may change as a result of ripening. Creamer & Olson and Charalambides *et al.*, (according to Caspia *et al.*, 2006) found that significant differences in firmness and crumbliness appeared in cheeses from one to 12 months of age, by using the texture profile analysis methodology.

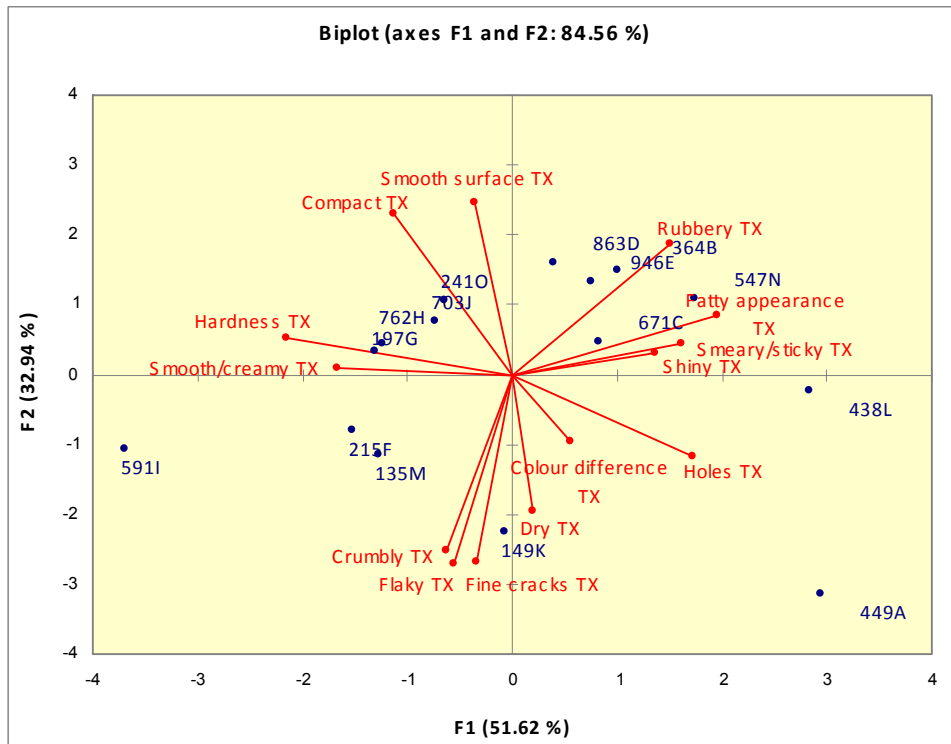


Figure 4.2 Generalized Procrustes analysis biplot of Free choice profiling for texture/appearance attributes of 15 Cheddar cheese samples

#### 4.4.3 MOUTHFEEL CATEGORY

Fifty-nine point zero three percent of the variation is explained by dimension 1, and 25.24% of the variation is explained by dimension 2 (Figure 4.3). Dimension 1 contained descriptors such as floury/mealy, crumbly, tangy, dry, astringent, burning/tingling, pasty, sticky and creamy. Sample 547N, the most liked cheese by the consumers, had a fatty, creamy mouthfeel, while the least liked sample 135M was described as burning and tingling.

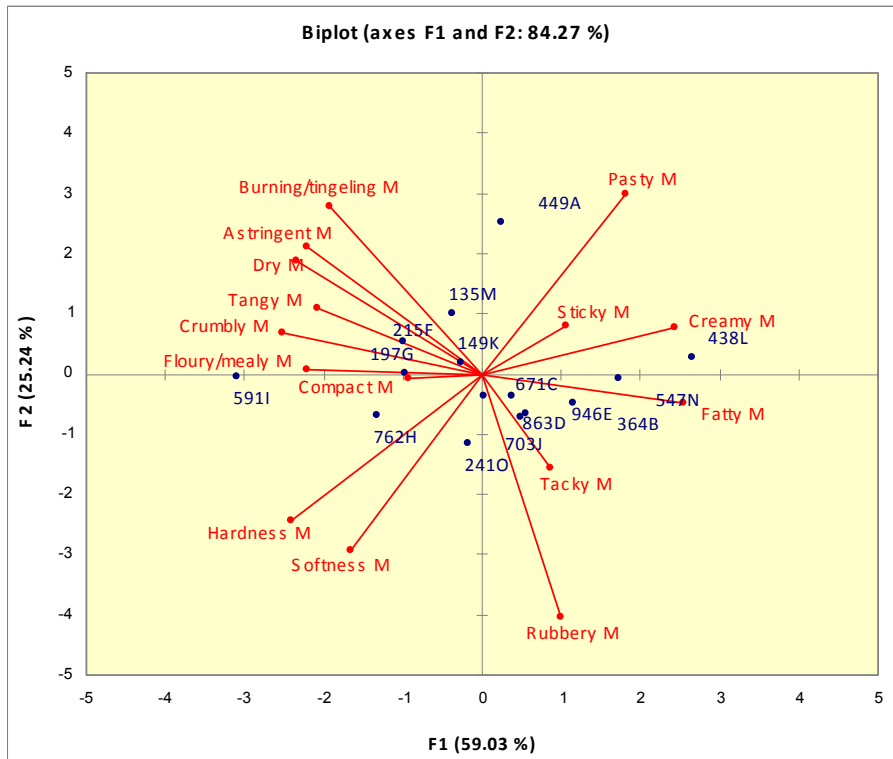


Figure 4.3 Generalized Procrustes analysis biplot of Free choice profiling for mouthfeel attributes of 15 Cheddar cheese samples

#### 4.4.4 TASTE CATEGORY

Of the variation, 79.34% is explained by dimension 1, and 8.61% of the variation is explained by dimension 2. Fifteen of the 20 descriptors for taste were found in dimension 1: sweet; buttery; Gouda; creamy; nutty; fatty; salty; blue cheese; yeasty; ammonia; Parmesan/pecorino, bitter, pepper, and sour vinegar (Figure 4.4). The most liked cheese sample 547N had a sweet taste and 135M, the least favourite cheese, tasted between sour vinegar and pungent/mature. According to a study conducted by Caspia and co-workers (2006), a descriptive panel could characterize seven and nine month old cheeses as having young/undeveloped flavour such as ‘cooked’, ‘buttery’ and ‘creamy’ flavours. Young *et al.*, according to Caspia *et al.*, (2006), characterized the flavour attribute terms of one, two and four month-ripened Cheddar cheeses as cooked/milky, whey, diacetyl and milkfat/lactone. The 12-month-old cheese, in the study conducted by Caspia *et al.*, (2006), was characterized by aged/developed flavours such as ‘sulfur’, ‘free fatty acid’,

and ‘earthy’, ‘pungent’, ‘prickle bite’, ‘bitter’ and ‘sour’. Cheeses with more than one year of ripening were characterized by ‘sulfur’, ‘brothy’, ‘nutty’, ‘free fatty acid’ and ‘catty’ attribute terms (Young *et al.*, according to Caspia *et al.*, 2006). In the present study, the GPA for FCP indicated that cheeses between the ages of 60 to 90 days (with typical more aged attributes), were characterized by a mustard taste (762H, 197G and 215F). Cheeses 449A (60-90 days) and 149K (90 days) were noted to be more pungent/mature, tangy and chemical. Cheeses with more sweet, buttery and Gouda-like attributes (i.e. 364B, 438L, 863D and 547N) were grouped together and had a ripening period of 60 days, except for 364B, that was 90 days of age. Older cheeses, between the ages of 105 to 150 days were grouped together. These cheeses (i.e. 703J, 946E, 241O, 671C) were characterized by less prominent sweet, buttery and Gouda taste attributes.

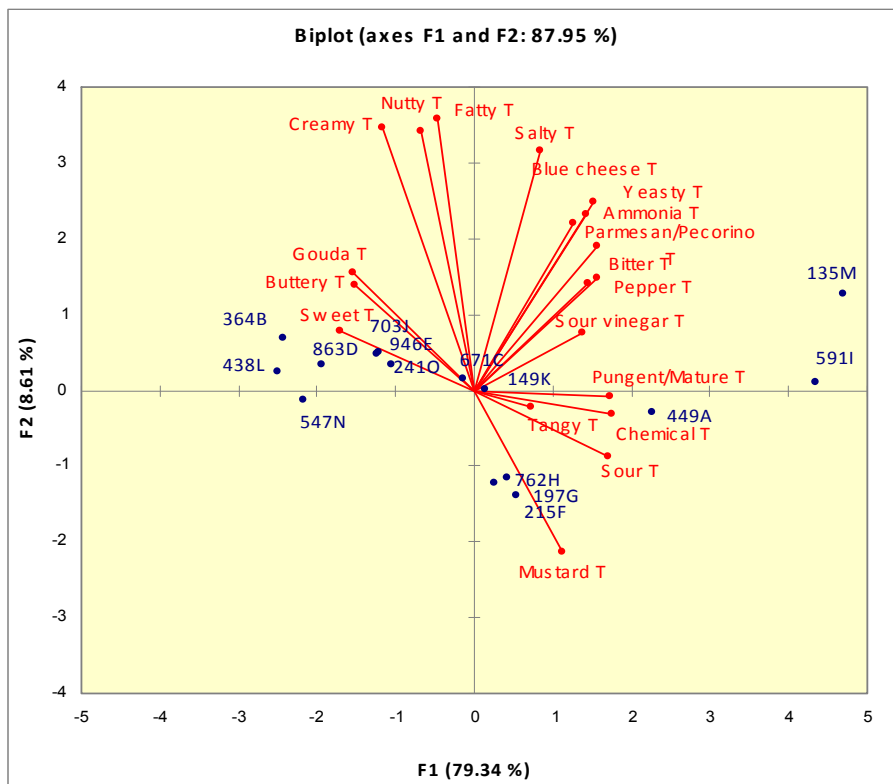


Figure 4.4 Generalized Procrustes analysis biplot of Free choice profiling for taste attributes of 15 Cheddar cheese samples

#### 4.4.5 AFTERTASTE CATEGORY

Dimension 1 explains 81.22% of the variation and 7.91% of the variation is explained by dimension 2 (Figure 4.5). Cheese sample 547N had a sweet/Gouda/sweetmilk and melted cheese aftertaste. The aftertaste for sample 135M was described as yeasty, metal, blue cheese and bitter. Dimension 1 contained 14 of the 18 descriptors for aftertaste: sour; metal; yeasty; bitter; blue cheese; salty; ammonia; fatty; nutty; creamy; buttery; melted cheese; sweet; and sweetmilk. Cheeses 449A (60-90 days), 591I (60 days) and 135M (180 days) were noted to be more mature, tangy, sour, metal, yeasty and bitter for the attribute aftertaste. These three samples were also perceived to be more pungent and mature in the taste category. The aftertaste attributes for cheeses 364B, 438L, 863D and 547N confirmed the conclusions that were made in the taste category. These cheeses were grouped together and had sweet/Gouda/sweetmilk, buttery and melted cheese attributes. Older cheeses (i.e. 703J, 946E, 241O, 671C), between the ages of 105 to 150 days, were again characterized by less prominent young attributes such as buttery, sweet and Gouda aftertaste attributes. This tendency was also noted in the taste category. Cheeses 215F (90 days), 197G (60-90 days) and 149K (90 days) were all very closely situated at the centre point of the GPA biplot and therefore revealed very low intensity aftertaste attributes.

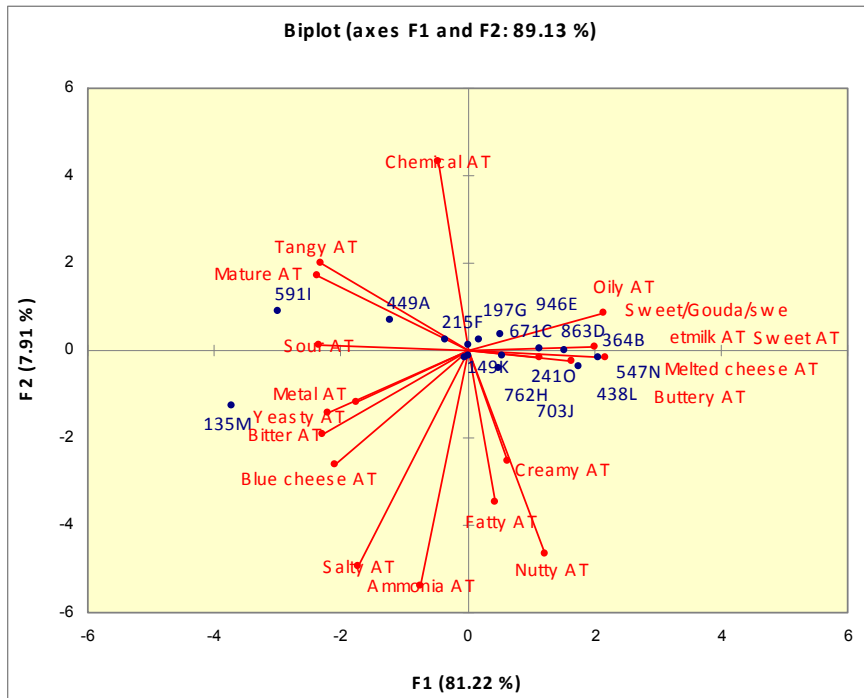


Figure 4.5 Generalized Procrustes analysis biplot of Free choice profiling for aftertaste attributes of 15 Cheddar cheese samples

#### 4.4.6 AFTERFEEL CATEGORY

An overwhelming 93.37% of the variation is explained by dimension 1, and 2.64% of the variation is explained by dimension 2 (Figure 4.6). Seven of the nine afterfeel descriptors were situated in dimension 1: fatty coating; oily/fatty; sticky; piquant/prick/burning; mature; tacky; and astringent. Sample 547N had a “fatty coating” afterfeel, along with eight other samples, while sample 135M had a tacky afterfeel. The GPA biplot indicated that products 135M, 449A and 591I can be characterized by more mature and piquant/prick/burning afterfeel attributes. It showed a positive correlation with the tendencies that were noted for the texture, taste and aftertaste categories. Last mentioned categories indicated that these cheeses were more crumbly, flaky and dry in texture and more mature and tangy on taste and aftertaste. The afterfeel biplot also confirmed that cheeses 149K, 215F and 197G were closely situated at the centre of the plot and therefore indicated that these cheeses had very low intensity and bland afterfeel attributes. All the rest of the cheeses (i.e. 547N, 438L, 703J, 863D, 671C, 364B, 946E, 241O) were grouped together in the same area on the afterfeel plot. These cheeses have

been characterized as having sweeter, more buttery and Gouda taste and aftertaste attributes, and more rubbery and compact texture attributes.

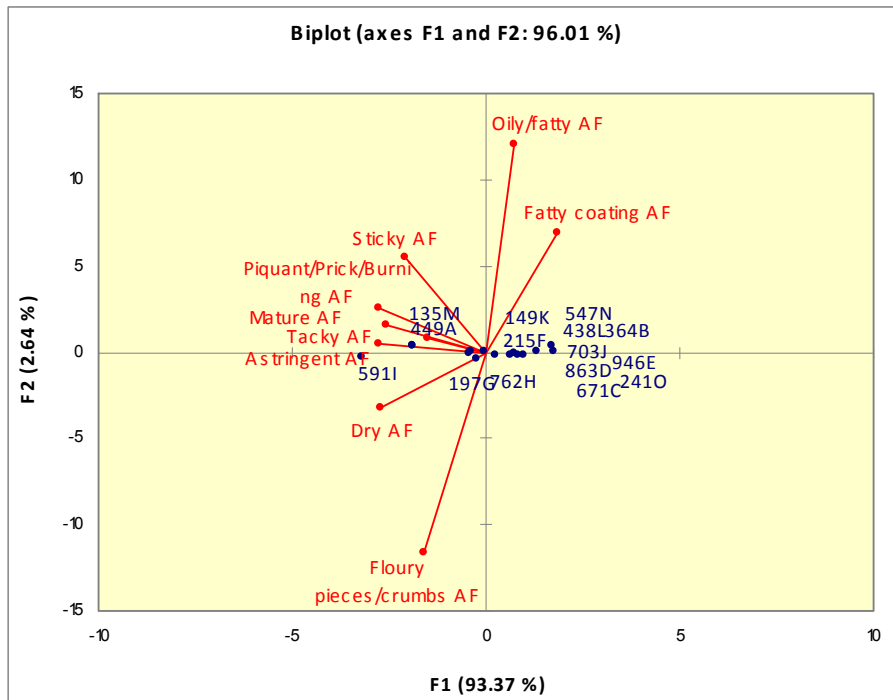


Figure 4.6 Generalized Procrustes analysis biplot of Free choice profiling for afterfeel attributes of 15 Cheddar cheese samples

#### 4.5 CONCLUSION

The FCP descriptive method was successful in describing the 15 Cheddar cheeses in the study. Ten semi-naïve assessors described the cheeses in six major categories. According to the results from Chapter 3, cheeses 547N, 438L, 946E, 364B and 863D were the most liked cheeses and can now be described by means of FCP, as having the following attributes:

- \* a Gouda, sweetmilk, buttery, milky, cheesespread aroma;
- \* a shiny and fatty appearance and rubbery, sticky and smeary texture;
- \* a fatty and creamy mouthfeel;
- \* a Gouda, sweet, buttery and creamy/oily taste and aftertaste; and
- \* a fatty coating and oily/fatty afterfeel.

Cheeses 449A and 591I were perceived as having more mature and pungent tastes and aftertaste, and tangy, sour and yeasty aromas. Cheese 591I had a

more floury/mealy mouthfeel and astringent afterfeel, and 449A was more pasty on mouthfeel and tacky on afterfeel. (Sticky, smeary, tacky and pasty are all attributes that refers to adhesiveness).

The attributes that were described by FCP can now be related to consumer acceptance data via preference mapping, in Chapter 5.

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## CHAPTER 5

### THE RELATIONSHIP BETWEEN CONSUMER ACCEPTABILITY AND DESCRIPTIVE SENSORY ATTRIBUTES OF CHEDDAR CHEESE, BY USING PREFERENCE MAPPING

#### 5.1 ABSTRACT

The results from the preference mapping indicated that two major (but very similar) consumer clusters showed higher acceptance for cheeses with more 'young/undeveloped' attributes. The 'ideal' Cheddar cheese, for the South African consumer, can therefore be described as having the following attributes: an aroma characterized by 'sweetmilk', 'Gouda-like' and 'buttery' attributes; a 'shiny' appearance and 'rubbery' texture; a mouthfeel characterized by 'rubbery', 'fatty', 'tacky' and 'soft- and/or hardness' attributes; a 'Gouda', 'buttery', 'sweet' taste; a 'Gouda', 'buttery', 'sweet' aftertaste; and an afterfeel that can be described as 'fatty coating' and 'oily/fatty'. Results from this study seem to support and confirm speculations from some cheese specialists in the dairy industry, who have perceived that Cheddar cheese, manufactured and available in the last few years, have showed/exerted more Gouda-like sensory attributes than typical known Cheddar-like attributes.

#### 5.2 INTRODUCTION

Sensory analysis is frequently carried out by companies in the initial steps of product development, or as a quality control tool, and provides valuable information in these instances. Consumer information, on the other hand, is routinely used by companies when researching new and existing market products. It forms the basis of many important company decisions regarding the launch of new products or the reformulation of existing lines (McEwan, 1996).

It has been observed that, although consumers are clear which products they like and dislike, they are not always able to describe specifically why they like or dislike a product. Any description given by consumers also tends to be of a hedonic nature and not descriptive. Provision of attribute rating scales for

consumers also holds various risks: different consumers will interpret attributes in different ways; consumers are open to biases in the use of response scales; and consumers will utilise these attributes as criteria in the provision of an overall preference/acceptance rating. It is therefore necessary to be able to relate external information about the products to consumer preference ratings, in order to understand what attributes of a product is driving preference. This information is essential not only to understand the market, but also to generate a successful new product (McEwan, Earthy & Ducher, 1998).

Using sensory analysis and consumer information independently does not always enable the company to derive most benefit from available resources. Sensory assessors are sometimes required to give preference or acceptability information, but this is a dangerous practise. Sensory assessors are unlikely to be representative of the target population, and, because of their training, are more perceptive than the average consumer. Likewise, consumers are frequently asked to give reasons for their judgements or descriptors, but whilst these can provide some useful information, they need to be interpreted with care. Consumer descriptors are rarely detailed enough or reproducible, and can therefore lead to misleading results due to the difficulties encountered in the interpretation process. By using sensory and consumer techniques in conjunction, a more complete picture can be obtained (McEwan, 1996).

Both logistic regression and preference mapping (PM) may be useful in explaining the relationship between consumer acceptability, trained descriptive analysis and flavour chemistry. Logistic regression may assist in determining the consumer acceptability of Cheddar cheese. Furthermore, its usefulness in explaining consumer acceptability should be compared to preference mapping, because it is the method most frequently used to relate consumer acceptability data to descriptive sensory attributes (Caspia Coggins, Schilling, Yoon, & White, 2006). It is only the consumer who can realistically provide hedonic data, while a trained sensory panel is able to provide reliable descriptive information. By relating these two data sets, one compliments the other, thus maximising the available information (McEwan, 1996). Since many product characteristics are interrelated, this approach will

enable the product developer to identify the various needs which should be adjusted, as well as indicate the effect other characteristics may have on liking. This approach also provides information on consumer segmentation, allowing the product developer to 'target' his product appropriately. While at first the approach may appear to require excessive resources, it may in fact reduce the overall input by scientifically designing the ideal product (McEwan, 1996).

A product resulting from using techniques such as PM will be 'designed'. The structured approach and combination of sensory analysis and consumer research cannot replace the creativity of the product developer. However, they can assist in identifying and summarizing market place options, thus helping the product developer to pin point the 'ideal' product. Therefore this product, given appropriate marketing, should achieve the competitive edge in the market place (McEwan, 1996).

Preference mapping also assists scientists in understanding the descriptive sensory attributes that influence consumer preferences (Schlich & McEwan; Murray & Delahunty according to Young, Drake, Lopetcharat, & McDaniel, 2004). According to Young & co-workers (2004), limited research has been performed, using PM techniques, to understand consumer perception and acceptability of the flavour profiles of Cheddar cheese.

Preference mapping (McEwan; McEwan, Earthy & Ducher; Schlich according to Murray & Delahunty, 2000) is a technique which refers to a range of multivariate statistical methods (McEwan *et al.*, 1998), and has been widely used to help scientists understand the sensory attributes which drive consumer preference (Beilken, Eadie, Griffiths, Jones & Harris; Dalliant-Spinnler, MacFie, Beyts & Hedderley; Helgensen, Ragnhild & Naes; Hough, Bratchell & Wakeling; Muñoz & Chambers according to Murray & Delahunty, 2000). The procedure requires an objective characterization of products' sensory attributes, achieved by descriptive analysis, which is then related to preference ratings for the product, obtained from a representative sample of consumers (Murray & Delahunty, 2000).

Preference mapping can broadly be divided into internal and external preference mapping. Internal preference mapping provides a map of the products and the consumer together, based purely on the preference ratings.

Internal preference mapping is useful to provide a sample map, based only on preference data. Therefore, it cannot be used to understand reasons for preference on its own. Internal preference mapping offers some advantages:

- \* it is easier to use and understand than external preference mapping, because it is similar to PCA;
- \* it allows actual preference dimensions to be determined, because only acceptability data is used;
- \* and it can be used as a screening procedure, without sensory profiling, to develop samples worthy of further sensory and consumer work.

The technique, however, also has disadvantages such as the fact that the program tends to break down after two dimensions in terms of interpretation. Percentage variance explained by the dimensions is often very low; the technique requires a fairly large number of samples (e.g., 12-20) to ensure that the PM can be undertaken successfully (McEwan, 1996).

Furthermore, all samples put forward to the consumer trial, must be evaluated by every consumer, which can be costly. A ready written PM program is also necessary so set up the technique, which may be expensive in some cases. Preference data is not always directly related to the sensory profile map, as the way trained panels perceive products is different from consumers. The procedure is mainly used for understanding and direction, rather than for prediction (McEwan, 1996).

The aim of this study was to determine how descriptive attributes in 15 commonly consumed Cheddar cheeses related to consumer acceptability, by using PM.

## 5.3 MATERIALS AND METHODS

### 5.3.1 Cheddar cheese samples

Five retail Cheddar cheeses from four cheese manufacturers were bought from commercial stores. Two culture houses provided four cheese samples, three from one culture house and one from the other, respectively. Six experimental cheeses, incorporating two different cultures, completed the product list. The ageing period of the 15 cheeses ranged from 60 to 180 days, thus including two types of Cheddar cheese, namely mild and mature. Only three of the 15 cheeses were white in colour.

Table 5.1 Product list with information on Cheddar cheese samples

Sample	Code	Ageing period in days	Colour	Type
Retail 1	449A	60-90	Yellow	Mild*
Experimental 1	364B	90	Yellow	Mild*
Experimental 1	671C	150	Yellow	Mild*
Experimental 2	863D	60	Yellow	Mild*
Experimental 2	946E	120	Yellow	Mild*
Retail 2	215F	90	Yellow	Mild*
Retail 3.1**	197G	60-90	Yellow	Mild*
Retail 3.2**	762H	60-90	Yellow	Mild*
Retail 4	591I	60	Yellow	Mild*
Culture house 1	703J	120	White	Mild*
Culture house 1	149K	90	White	Mild*
Culture house 1	438L	60	Yellow	Mild*
Culture house 2	135M	180	White	Mature
Experimental 1	547N	60	Yellow	Mild*
Experimental 1	241O	105	Yellow	Mild*

\* In South Africa, Cheddar is regarded as mild between 8 – 24 weeks, i.e. 56 - 168 days (Mulder, 2007).

\*\* Two types of packaging, namely resealable pack (retail 3.1) and shrink-wrap pack (retail 3.2).

### **5.3.2 Consumer panel**

A consumer panel of 220 participants tasted the 15 cheeses in two locations (see sections 3.3.1 - 3.3.4 in Chapter 3).

### **5.3.3 Free Choice Profiling**

Descriptive analysis was carried out by a semi naïve panel of 10 members, using FCP (see sections 4.3.1 – 4.3.5 in Chapter 4).

### **5.3.4 Statistical analyses**

Univariate and multivariate statistical methods were used in analyzing the results. Consumer and descriptive data were analyzed individually and then together. The data from the consumer panels were analyzed using XLSTAT 2007. The significance of the overall acceptance measured for each Cheddar cheese sample was tested by means of analysis of variance (ANOVA). The different samples were used as the main effects at a significance level of 95 % ( $p \leq 0.05$ ). If the main effect was significant, Fisher's LSD-test was applied to determine the direction of the differences between mean values. The descriptive data was analyzed by GPA, using XLStat (Version 7.5.2). Agglomerate hierarchical clustering was performed to cluster consumers together based on their liking of Cheddar cheese. Internal preference mapping was conducted on the acceptability scores of the consumer panel to determine the relationship between sensory attributes and consumer preference.

## **5.4 RESULTS AND DISCUSSION**

Internal preference mapping was performed to relate descriptive analysis data with consumer acceptability (XLSTAT 7.5, Microsoft Excel). Two clusters of consumers with different cheese preferences were obtained by agglomerate hierarchical clustering (Figure 5.1). It can be seen that the dendrogram was truncated at the 350 level, which is the cut off point allocated by the statistical program.

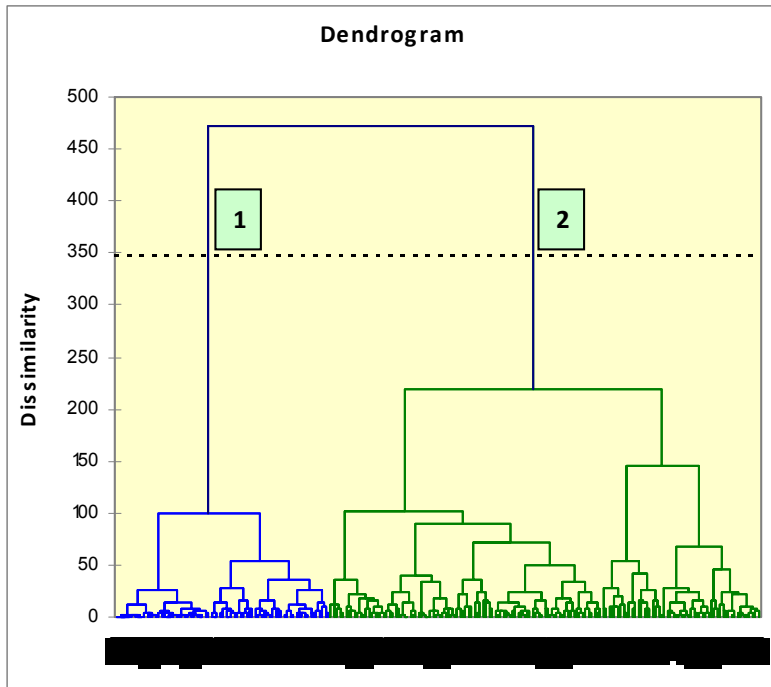


Figure 5.1 Dendrogram of the two major consumer clusters identified for all categories.

The two clusters are not a representation of certain attributes that would divide the consumers into two groups; rather it is an indication of the order in which the 15 Cheddars were preferred by the consumers.

In order to explain the consumer clustering and the attributes of the Cheddar cheese samples, it is necessary to again include the biplots from Chapter 4.

#### **5.4.1 Aroma category**

From the PM (Figure 5.2) and GPA biplots (Figure 5.3), it can be deduced that consumers in cluster 1 preferred Cheddar cheese that was more ‘milky’, ‘buttery’ and ‘cheese spread’ in aroma. Cheeses that could be characterized by these attributes were 241O, 438L, 364B, 197G and 863D. Consumers in cluster 2 preferred Cheddar to be more ‘sweetmilk’, ‘sweet’, ‘warm melted’ and ‘Gouda-like’ and cheeses that represented this category were 671C and 946E. It can be concluded that all the above mentioned attributes that distinguish cluster 1 and 2 from each other, are strongly related to an ‘ideal’ product with a more ‘sweetmilk’, ‘buttery’, ‘Gouda-like’ aroma.

#### **5.4.2 Texture/Appearance category**

When looking at the PM (Figure 5.4) and GPA biplot (Figure 5.5), it can be seen that consumers in cluster 1 preferred Cheddar cheese that had a ‘smooth surface appearance’ and ‘compact’ texture. Cluster 2 consumers showed a higher acceptability for cheeses characterized by having a ‘fatty appearance’ and ‘rubbery texture’. Cluster 1 and 2 consumers did not show a high level of acceptability in terms of ideal texture/appearance for cheeses 591I, 215F, 135M and 149K. These cheeses could be characterized by ‘crumbly’, ‘flaky’, ‘dry’ textures and the presence of ‘fine cracks’.

#### **5.4.3 Mouthfeel category**

The PM (Figure 5.6) and GPA biplot (Figure 5.7) indicated that clusters 1 and 2 were almost identical. Cheeses that were more acceptable to consumers, representing these clusters, could be characterized by ‘fatty’, ‘rubbery’ and ‘tacky’ attributes. These cheeses were 241O, 703J, 863D and 364B. Consumers’ acceptance indicated that the specific ‘hard- and/or softness’ of the Cheddar cheese, are attributes that are important for the mouthfeel category.

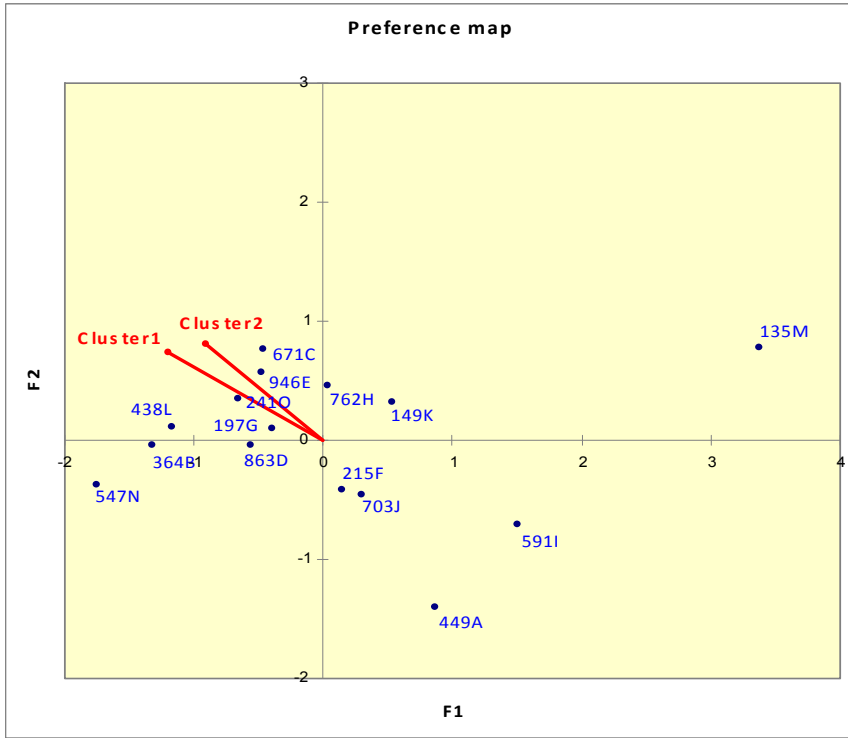


Figure 5.2 Internal preference map of identified consumer clusters and 15 Cheddar cheese samples for the aroma category

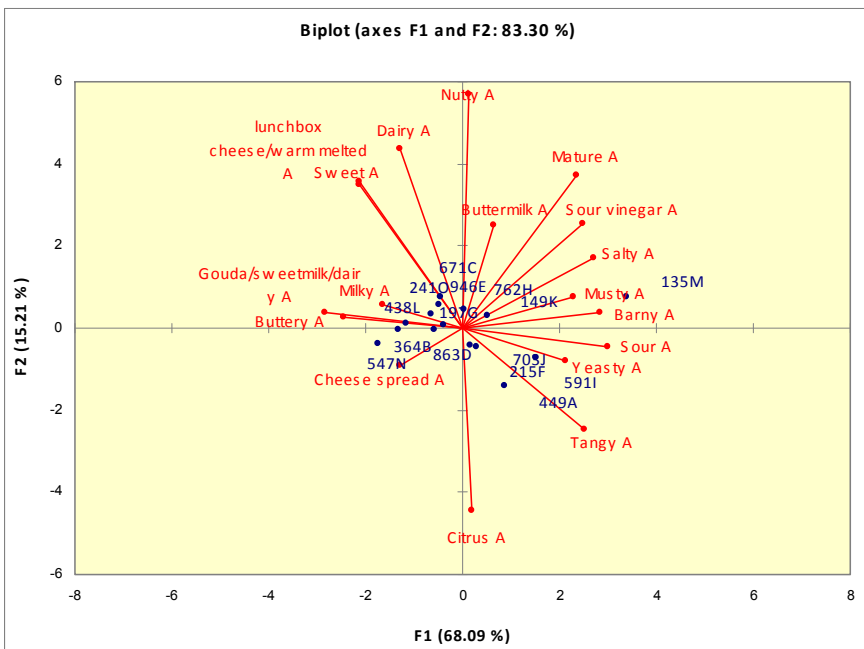


Figure 5.3 Generalized Procrustes analysis biplot for aroma attributes of 15 Cheddar cheese samples

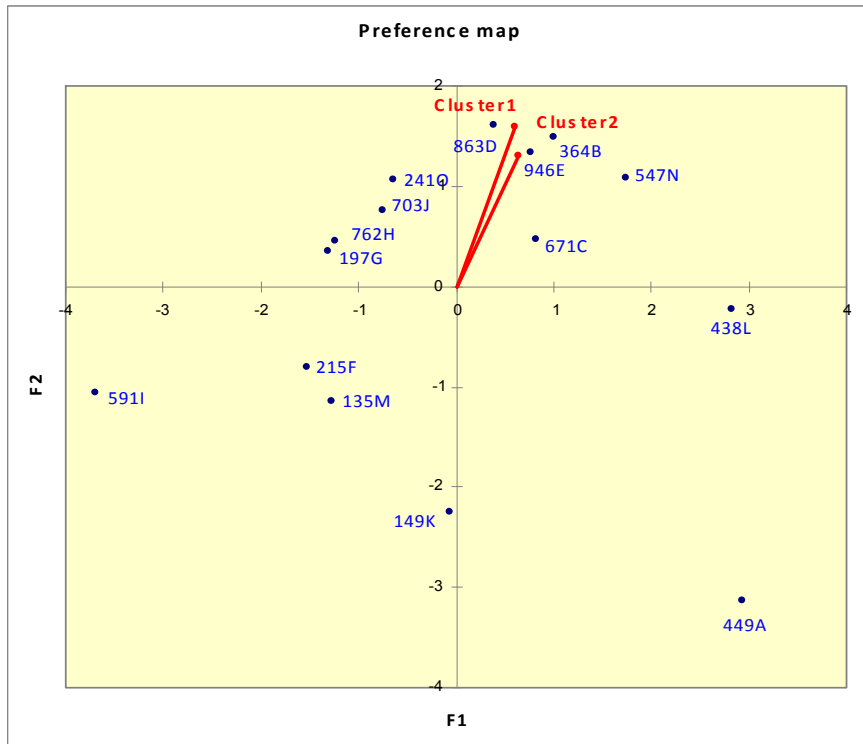


Figure 5.4 Internal preference map of identified consumer clusters and 15 Cheddar cheese samples for the texture/appearance category

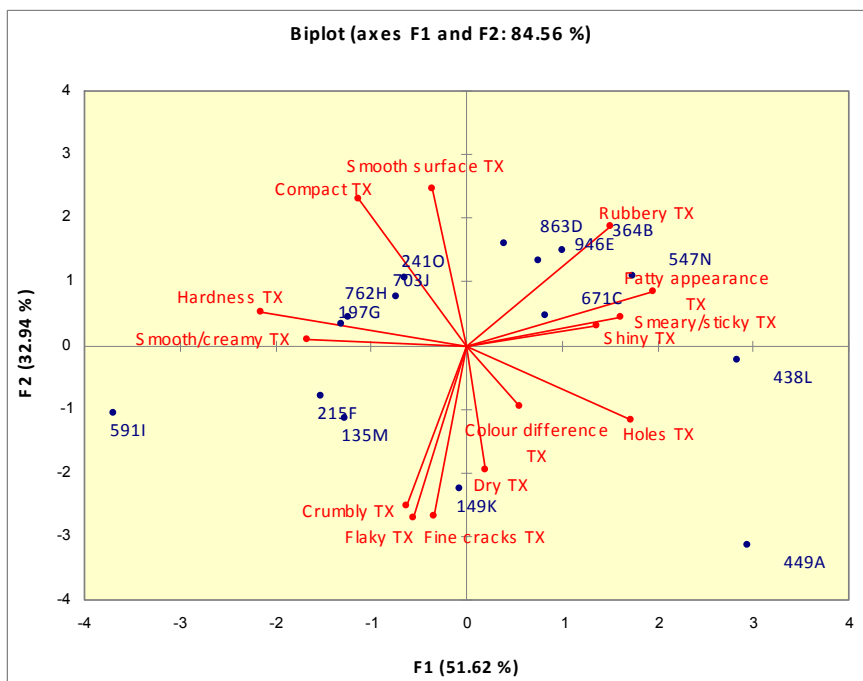


Figure 5.5 Generalized Procrustes analysis biplot for texture/appearance attributes of 15 Cheddar cheese samples

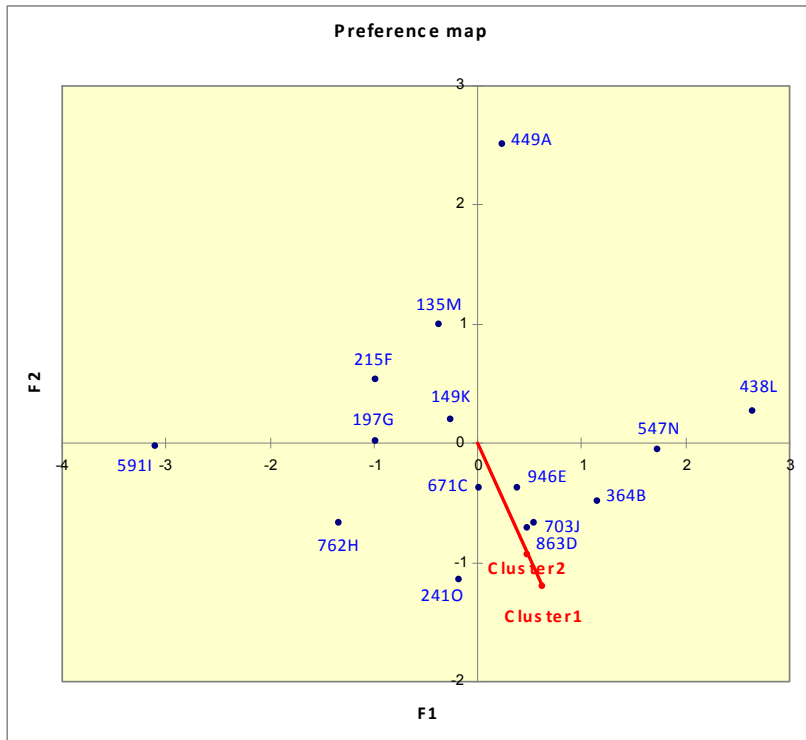


Figure 5.6 Internal preference map of identified consumer clusters and 15 Cheddar cheese samples for the mouthfeel category

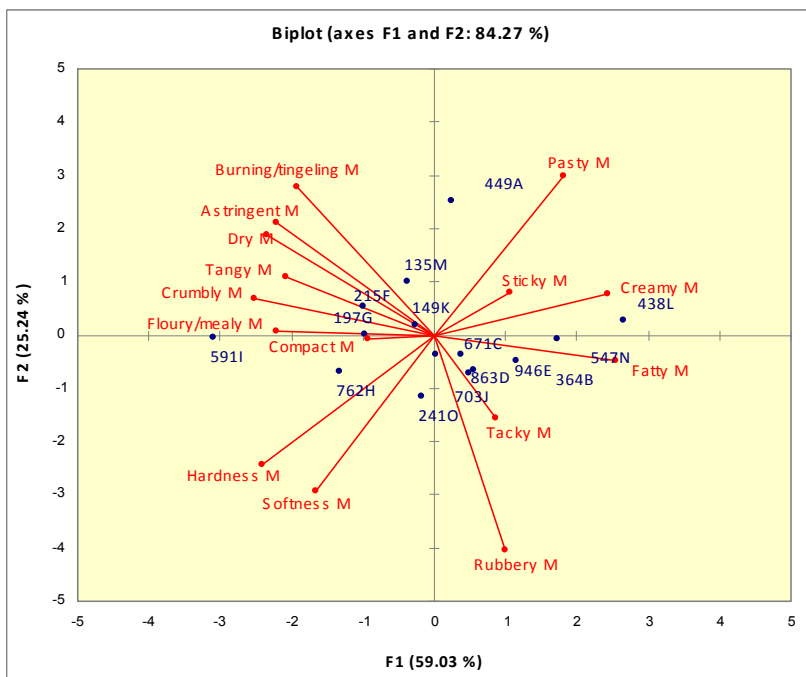


Figure 5.7 Generalized Procrustes analysis biplot for mouthfeel attributes of 15 Cheddar cheese samples

#### **5.4.4 Taste category**

Cluster 2 consumers indicated a liking for cheese with ‘Gouda’, ‘buttery’ and ‘sweet’ taste attributes (Figures 5.8 and 5.9). Cheeses that could be characterized by the above-mentioned attributes were: 703J; 946E; 241O; 364B; and 671C. Cluster 1 indicated a higher acceptability for cheeses 547N and 438L. The PM biplot indicated that cheese 863D was acceptable for consumers in both cluster 1 and 2. Consumers in clusters 1 and 2 found the cheeses with the more young/undeveloped taste attributes to be the most acceptable. Taste attributes like ‘creamy’, ‘nutty’ and ‘fatty’ fall in the same sub-category as ‘Gouda’, ‘buttery’ and ‘sweet’ taste attributes. Cheeses 449A, 762H, 197G and 215F were characterized by more aged/developed attributes like ‘pungent/mature’, ‘tangy’, ‘chemical’, ‘sour’ and ‘mustard’ tastes.

#### **5.4.5 Aftertaste category**

Cluster 1 consumers indicated a higher level of acceptance for cheeses 863D, 364B, 547N, 438L and 241O (Figures 5.10 and 5.11). These cheeses could be characterized by young/undeveloped flavours such as ‘sweet/Gouda/sweetmilk’, ‘sweet’, ‘melted cheese’ and ‘buttery’ aftertaste attributes. Cluster 2 consumers indicated a higher acceptance for cheeses that could be characterized by a more ‘oily’ aftertaste such as 946E and 671C. Highly disliked cheese like 135M was characterized by attributes like ‘metal’, ‘yeasty’, ‘bitter’, ‘blue cheese’ and ‘sour’ aftertaste.

#### **5.4.6 Afterfeel category**

Consumers in clusters 1 and 2 did not perceive the studied cheeses to be very prominent in terms of afterfeel attributes (Figures 5.12 and 5.13). It is clear that the ‘ideal’ Cheddar can be characterized by ‘fatty coating’ and ‘oily/fatty’ afterfeel, but should not reveal attributes such as ‘sticky’, ‘piquant/prick/burning’, ‘mature’, ‘tacky’ and ‘astringent’ afterfeel. The last mentioned attributes are all related to each other and are typical of more aged/developed cheeses. The PM biplot indicated that 135M, 449A and 591I could be characterized by the aged/developed attributes.

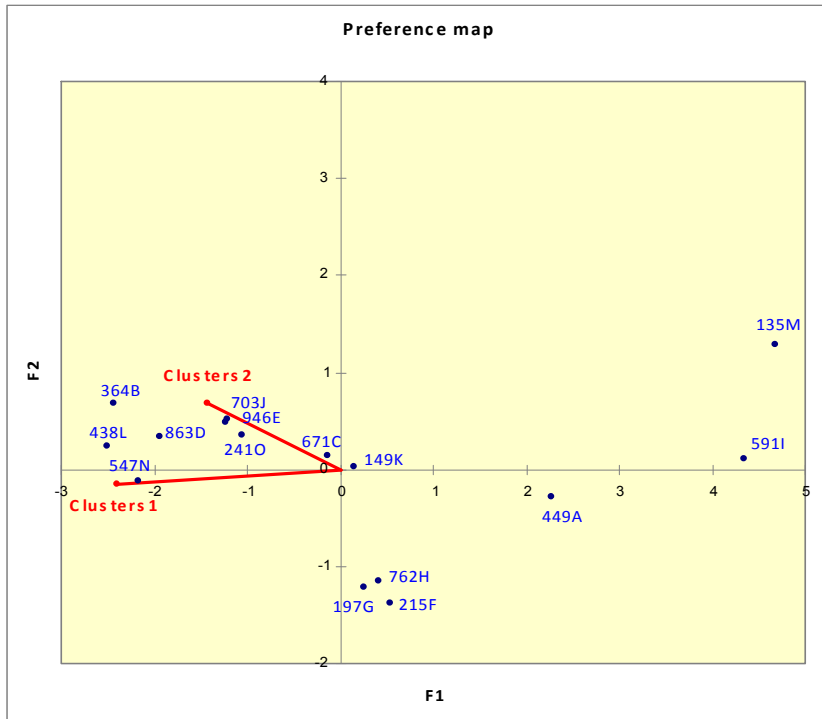


Figure 5.8 Internal preference map of identified consumer clusters and 15 Cheddar cheese samples for the taste category

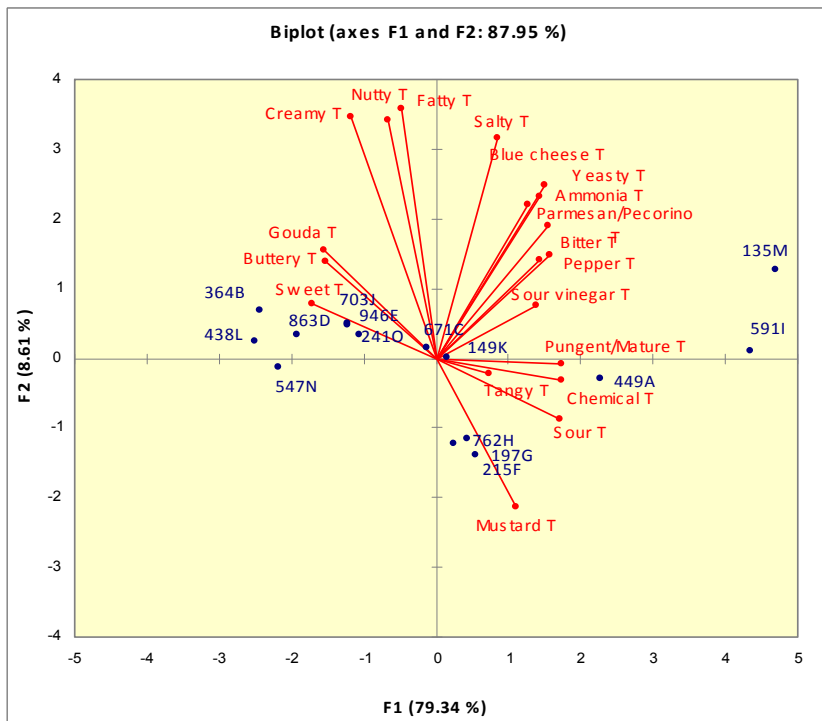


Figure 5.9 Generalized Procrustes analysis biplot for taste attributes of 15 Cheddar cheese samples

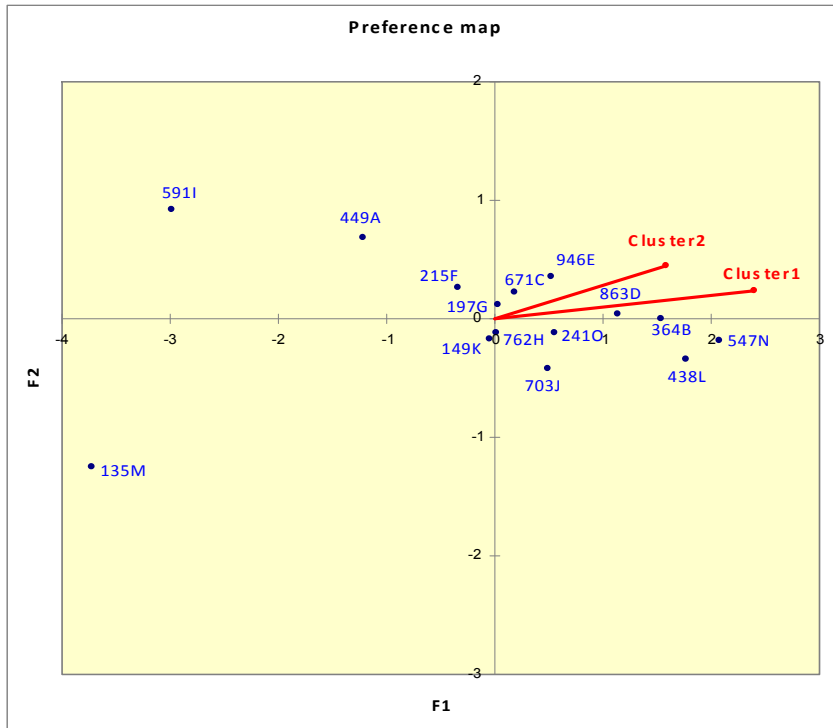


Figure 5.10 Internal preference map of identified consumer clusters and 15 Cheddar cheese samples for the aftertaste category

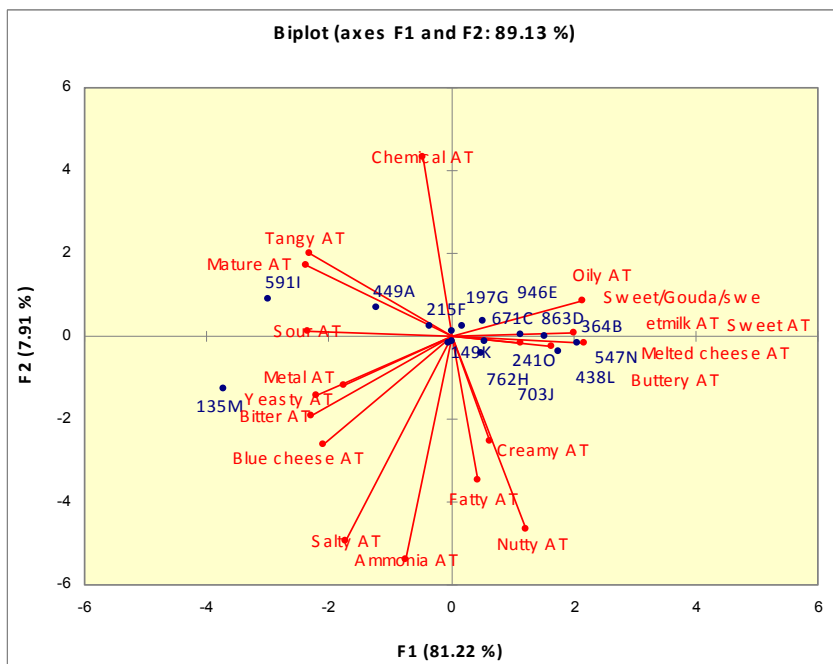


Figure 5.11 Generalized Procrustes analysis biplot for aftertaste attributes of 15 Cheddar cheese samples

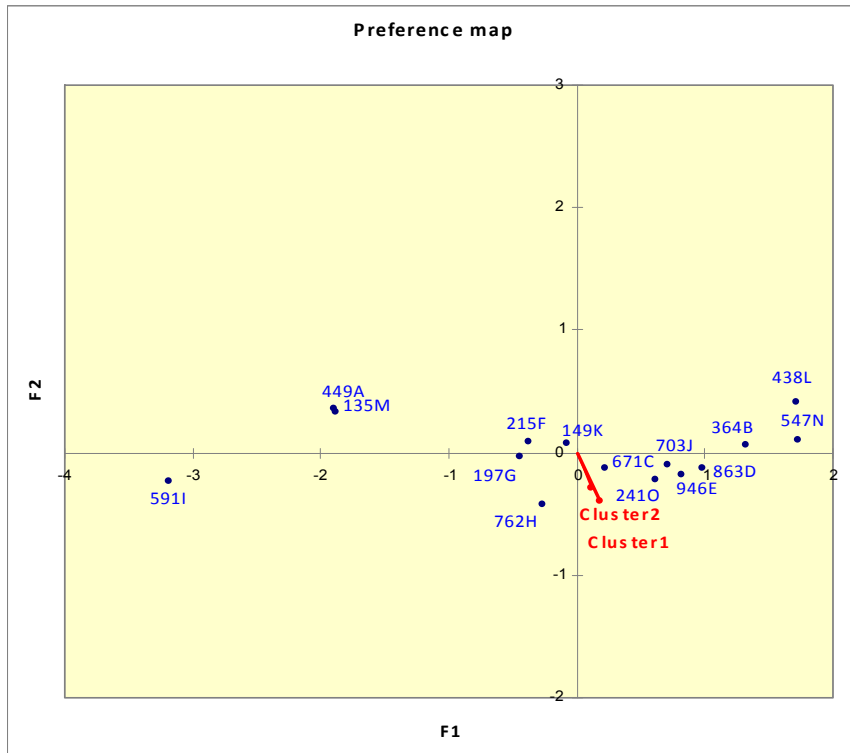


Figure 5.12 Internal preference map of identified consumer clusters and 15 Cheddar cheese samples for the afterfeel category

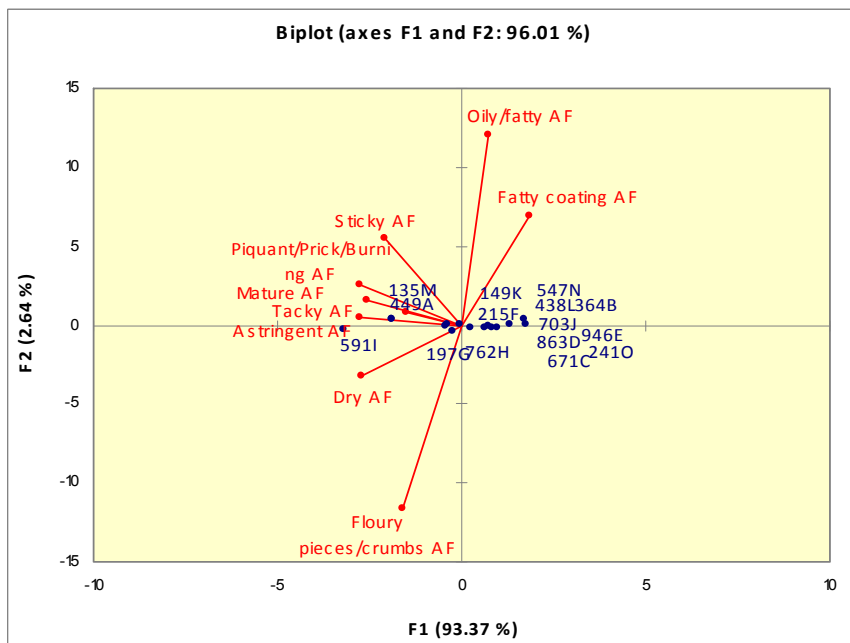


Figure 5.13 Generalized Procrustes analysis biplot for afterfeel attributes of 15 Cheddar cheese samples

When looking at the clusters that have been identified for all categories (i.e. aroma, texture/appearance, mouthfeel, taste, aftertaste and afterfeel), it was clear that two very similar groups of consumers were identified. One can explain the close relation between the clusters as due to the fact that screening of successful candidates for the study was very specific. Possible candidates had to eat (consume on its own) and use Cheddar cheese (use in cooking, baking, salads etc.) in the past two to three weeks. During the study there was exclusively focused on Cheddar cheese. Cheddar cheese is, according to [www.cheese.com](http://www.cheese.com) (Anon., 2007), the most widely purchased and eaten cheese in the world. Researchers in this study did not expect the PM to indicate any gaps in the market for new products. It was only expected to identify the attributes of an ideal Cheddar cheese. The category for mouthfeel and afterfeel indicated that cluster 1 and 2 were basically identical to one another. The mouthfeel and afterfeel categories were not very helpful in revealing the different attributes perceived to be important by cluster 1 and 2 consumers. It was therefore clear that consumers did not experience mouthfeel attributes and afterfeel attributes to be extremely important when judging the difference in acceptance between the 15 Cheddar cheeses, included in the study.

## **5.5 CONCLUSION**

The 'ideal' Cheddar cheese, for the South African consumer, can therefore be described as having:

- \* an aroma characterized by 'sweetmilk', 'Gouda-like' and 'buttery' attributes;
- \* a 'shiny' appearance and 'rubbery' texture;
- \* a mouthfeel characterized by 'rubbery', 'fatty', 'tacky' and 'soft- and/or hardness' attributes;
- \* a 'Gouda', 'buttery', 'sweet' taste;
- \* a 'Gouda', 'buttery', 'sweet' aftertaste; and
- \* an afterfeel that can be described as 'fatty coating' and 'oily/fatty'.

Some cheese specialists in the dairy industry have perceived that Cheddar cheese, manufactured and available in the last few years, have shown/exerted more Gouda-like sensory attributes than typical known Cheddar-like attributes (Laubscher, 2007). Results from this study seem to support and confirm these speculations.

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## CHAPTER 6

### GENERAL DISCUSSION AND CONCLUSIONS

The current practice in sensory science had been formed over the past 50 years in a technological and natural scientific context, to enhance sensory quality in the food industry (Martens, 1999). It has proven to be successful in research and development, as well as quality assurance in the food and beverage industries (Meilgaard, Civille & Carr, 1991; Stone & Sidel, 1993). The potential of using sensory evaluation to link product development to marketing has also been recognized (Moskowitz, 1994).

Although consumers are clear in indicating the products they prefer, any description given by consumers tends to be of a hedonic nature and not descriptive. It is therefore necessary to be able to relate external information about the products to consumer preference ratings, not only to understand the market, but also to generate a successful new product (McEwan, Earthy & Ducher, 1998).

Many descriptive analysis methods have been used for the sensory evaluation of cheese and/or Cheddar cheese (Brandt, Skinner & Coleman, 1963; Stone, Sidel, Oliver, Woolsey & Singleton, 1974; Muir & Hunter, 1992; Piggott & Mowat, 1991; Heisserer & Chambers, 1993; Muir, Hunter, Banks & Horne, 1995; Murray & Delahunty, 2000a; Murray & Delahunty, 2000b; Drake, Mcingval, Cadwallader & Civille, 2001; Delahunty & Drake, 2004). Two main disadvantages of these techniques are the time and money expenditures to formally train and maintain the panels (Szczesniak, 1987; Jack, Piggott & Paterson, 1993; King, Arents & Moreau, 1995; Lachnit, Busch-Stockfisch, Kunert & Krahl, 2003). Free choice profiling (Williams & Langron, 1984) was developed to circumvent these problems.

Consumers have a wide variety of cheese products to choose from, and in South Africa, Cheddar cheese is the most popular everyday cheese (BMI FOODPACK, 2006). Cheddar cheese requirements are specific to country, ethnicity and end application, resulting in many varieties (Mulder, 2007). Understanding the development and variations in flavour that occur during the development of cheese, is an important tool in defining consumers'

expectations of taste (Lawrence, Gilles, Creamer, Crow, Heap, Honoré, Johnston, & Samal, 2004). Cheddar cheese develops most of its flavour at six to eight months of age, while a full Cheddar cheese flavour generally develops after one year of maturation. Many validated flavour lexicons for Cheddar cheese do exist (Muir & Hunter, 1992; Muir *et al.*, 1995; Muir, Banks & Hunter, 1997; Drake *et al.*, 2001; Drake, Gerard, Wright, Cadwallader & Cville, 2002; Drake, Gerard, Kleinhenz & Harper, 2003). One specific description/definition for Cheddar is very unlikely, because of the diverse variety of characteristics and qualities that exists due to production methods and cheese age. According to Mulder (2007), there are between five to eight different types of Cheddar cheese consumers, all having a different “definition” for Cheddar.

The aim of this study was therefore to determine whether data, obtained from FCP and using semi-naïve panellists (experienced in descriptive techniques but no previous experience with cheese) could express the perceptions of South African consumers on Cheddar cheese attributes. Firstly, a consumer hedonic rating test was done on 15 Cheddar cheeses available in South Africa. This was followed by a FCP evaluation of the same 15 Cheddar cheeses by a semi-naïve panel. The results were used to determine the relationship between consumer acceptability and the descriptive sensory characteristics of the Cheddar cheese samples.

A combined panel of 220 consumers, in Cape Town and Johannesburg, was asked to indicate their level of acceptance on a nine-point hedonic scale for overall acceptance of 15 Cheddar cheese products. The Cheddar cheese samples included five retail Cheddar cheeses from four dairy companies, four cheese samples from two culture houses and six experimental cheeses. The ageing period of the cheeses ranged from 60 to 180 days, all being mild Cheddars, except one mature Cheddar cheese. Three of the cheeses were white in colour. Significant differences ( $p < 0.05$ ) occurred amongst consumer demographics for consumer acceptability. Female participants rated the cheese samples higher than their male counterparts, while older panel members gave higher scores than the younger members. The Johannesburg panels gave higher ratings than the panels in Cape Town. Coloured and white participants used higher values to score the cheeses than the black

participants. The number of cheeses showing a significant difference for the different main effects was: gender (two); income (one); population group (three); age (eight); and location (five). For the overall liking attribute, there was a significant difference in acceptance ( $p < 0.05$ ) between the 15 Cheeses. Fisher's Least Significant Difference test at a 5% significance level was performed to determine which cheeses differed significantly from one another for overall liking/acceptance. The most liked cheese sample had the highest mean value of 7.16, was aged for 60 days and yellow in colour. The least acceptable cheese had a mean value of 4.75, was aged for 180 days and was white. The female and black members scored the white cheeses significantly lower than the rest of the panel. The difference in acceptance for older cheeses did not show a definite pattern. The cheese that was 150 days old was significantly more accepted by the female tasters, whereas the 180 day old cheese was significantly more accepted by the male tasters. The older panel members indicated that the cheeses were significantly more acceptable than the younger group, and weren't significantly influenced by the white colour of some cheeses. The Johannesburg panels accepted the cheeses significantly more than the Cape Town panels, as indicated by their higher scores.

Free choice profiling (FCP) was carried out in order to investigate how semi-naïve consumers (who had experience in descriptive work before, but not on Cheddar cheese and received minimal training) described and perceived the above mentioned 15 Cheddar cheese samples. This method allowed participants to use their own attributes to describe and quantify the food product. The cheese samples were analyzed by ten semi-naïve consumers in three replications. The data were analyzed by using GPA. The FCP procedure generated between 21 and 42 attributes, with an average of 35, including 16 descriptors on the attribute aroma, 14 descriptors on the attribute texture/appearance, 15 descriptors on the attribute mouthfeel, 20 descriptors on the attribute taste, 18 descriptors on the attribute aftertaste and nine descriptors on the attribute afterfeel. Rubbery texture and sweet, buttery and Gouda taste and aftertaste attributes were some of the important attributes that separated the cheeses in the study. The results from the

descriptive profiling method suggested that the FCP method, which is less expensive and time consuming, is an appropriate technique when used with semi-naïve assessors.

The relationship between the consumer acceptability of Cheddar cheese and its descriptive sensory attributes was determined by using PM and logistic regression for the 15 Cheddar cheeses. The results from the PM indicated that two major (but very similar) consumer clusters, showed higher acceptance for cheeses with more 'young/undeveloped' attributes. The most acceptable cheeses could be characterized by sweet, buttery and Gouda taste and aftertaste attributes.

In conclusion it can be said that FCP again has proven to be a trustworthy tool in the international field of sensory evaluation. Not only has it limited expenses concerning money and time, it has also shown that semi-naïve assessors could successfully be used to gain information on 15 Cheddar cheeses in the South African market. Results from this study indicated that FCP produced easily interpretable data and could successfully be applied by the PM technique to indicate the relationship between consumer acceptability and descriptive sensory attributes of the 15 Cheddar cheeses. The FCP descriptive method was successful in compiling a sensory profile for the ideal Cheddar cheese for the South African consumer. Results from this study supported and confirmed speculations that in the last few years there had been a tendency towards manufacturing Cheddar cheeses that have showed more Gouda-like sensory attributes than typical known Cheddar-like attributes. It can therefore be concluded that this technique can be used to replace the traditional descriptive sensory techniques to obtain descriptive information on food products.

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## CHAPTER 7

### SUMMARY

The main aim of this study was to determine whether data, obtained from FCP and using semi-naïve panellists (experienced in descriptive techniques, but no previous experience with cheese), could express the perceptions of South African consumers on Cheddar cheese attributes. Firstly a panel of 220 consumers was asked to indicate their level of acceptance on a nine-point hedonic scale for overall acceptance of 15 Cheddar cheese products, in two locations in South Africa. The 15 Cheddar cheese samples included five retail Cheddar cheeses from four dairy companies, four cheese samples from two culture houses and six experimental cheeses. The ageing period of the 15 cheeses ranged from 60 to 180 days, all being mild Cheddars, except one mature Cheddar cheese. Significant differences ( $p < 0.05$ ) occurred amongst consumer demographics for consumer acceptability. The number of cheeses showing a significant difference for the different main effects was: gender (two); income (one); population group (three); age (eight); and location (five). For the overall liking attribute, there was a significant difference in acceptance ( $p < 0.05$ ) between the 15 Cheeses. Fisher's Least Significant Difference test at a 5% significance level was performed to determine which cheeses differed significantly from one another for overall liking/acceptance. The most liked cheese sample had the highest mean value of 7.16, was aged for 60 days and yellow in colour. The least acceptable cheese had a mean value of 4.75, was aged for 180 days and was white.

Free choice profiling (FCP) was carried out in order to investigate how semi-naïve consumers (who had experience in descriptive work and received minimal training on Cheddar cheese) described and perceived different Cheddar cheese samples. This method allowed participants to use their own attributes to describe and quantify the food product. The study used 15 different Cheddar cheeses available in South Africa, analyzed by ten consumers in three replications. The data were analyzed by using generalized Procrustes analysis. The FCP procedure generated between 21

and 42 attributes, with an average of 35, including 16 descriptors on the attribute aroma, 14 descriptors on the attribute texture/appearance, 15 descriptors on the attribute mouthfeel, 20 descriptors on the attribute taste, 18 descriptors on the attribute aftertaste and nine descriptors on the attribute afterfeel. Rubbery texture and sweet, buttery and Gouda taste and aftertaste attributes were some of the important attributes that separated the cheeses in the study. The results from the descriptive profiling method suggested that the FCP method, which is less expensive and time consuming, is an appropriate technique when used with semi-naïve assessors.

The relationship between consumer acceptability and descriptive sensory attributes of cheddar cheese were determined by using preference mapping (PM). The results from the PM indicated that two major (but very similar) consumer clusters, showed higher acceptance for cheeses with more 'young/undeveloped' attributes. The 'ideal' Cheddar cheese, for the South African consumer, can therefore be described as having the following attributes: an aroma characterized by 'sweetmilk', 'Gouda-like' and 'buttery' attributes; a 'shiny' appearance and 'rubbery' texture; a mouthfeel characterized by 'rubbery', 'fatty', 'tacky' and 'soft- and/or hardness' attributes; a 'Gouda', 'buttery', 'sweet' taste; a 'Gouda', 'buttery', 'sweet' aftertaste; and an afterfeel that can be described as 'fatty coating' and 'oily/fatty'.

Results from this study seem to support and confirm speculations of some cheese specialists in the dairy industry who have perceived that Cheddar cheese, manufactured and available in the last few years, have showed/exerted more Gouda-like sensory attributes than typical known Cheddar-like attributes. Therefore, the results from the study indicated that data, obtained from FCP and using semi-naïve panellists, successfully expressed the perceptions of South African consumers on Cheddar cheese attributes.

## OPSOMMING

Die doel van die studie was om te bepaal of data, verkry deur middel van *Free choice profiling (FCP)*, en met die hulp van semi-naïewe paneellede (persone met ondervinding in beskrywende tegnieke, maar geen vorige ondervinding met kaas nie), gebruik kan word om die Suid-Afrikaanse verbruiker se persepsie van Cheddarkaas-eienskappe te verklaar. Eerstens is 'n paneel van 220 verbruikers gevra om hul aanvaarbaarheid vir 15 Cheddarkaasprodukte op 'n negepunt hedoniese skaal aan te dui, in twee stede in Suid-Afrika. Die 15 kaasprodukte was afkomstig vanaf verskeie verskaffers, naamlik vyf kommersiële Cheddarkase vanaf vier suiwelmaatskappye, vier kaasprodukte vanaf twee kultuurhuise en ses eksperimentele kase. Die 15 Cheddarkase was verouder vir 60 tot 180 dae. Al die Cheddars was dus matig, behalwe vir een beleë Cheddarproduk.

Beduidende verskille ( $p < 0.05$ ) het voorgekom onder die verbruikers se demografiese inligting vir verbruikersaanvaarbaarheid. Die aantal kase wat 'n beduidende verskil vir die verskillende hoofeffekte getoon het was: geslag (twee); inkomste (een); populasie groep (drie); ouderdom (agt); en gebied (vyf). Die algehele "hou van"-eienskap het 'n beduidende verskil in aanvaarbaarheid ( $p < 0.05$ ) getoon tussen die 15 Cheddarkase. 'n *Fisher's Least Significant Difference* toets is gedoen by 'n 5%-beduidendheids vlak om te bepaal watter kase beduidend van mekaar verskil vir algehele aanvaarbaarheid. Die mees aanvaarbare produk het die hoogste gemiddelde waarde van 7.16 gehad en was geel van kleur en 60 dae verouderd. Die mins aanvaarbare kaasproduk het 'n gemiddelde waarde van 4.75 gehad en was wit van kleur en verouderd vir 180 dae.

*Free choice profiling (FCP)* is uitgevoer om te ondersoek hoe semi-naïewe verbruikers verskillende Cheddarkase ervaar en beskryf. Hierdie metode het deelnemers toegelaat om hul eie eienskappe te beskryf en die voedselproduk te kwantifiseer. Tydens die studie is dieselfde 15 Cheddarkase deur tien semi-naïwe paneellede in drie herhalings geproe. Die data is ge-analiseer deur gebruik te maak van *generalized Procrustes analysis*. Die *FCP*-prosedure het tussen 21 en 42 eienskappe genereer met 'n gemiddeld van 35 eienskappe. Die aroma kategorie het 16 terme ingesluit;

14 vir tekstuur/voorkoms, 15 vir mondgevoel; 20 vir smaak; 18 vir nasmaak en nege eienskappe vir nagevoel. Rubberige tekstuur en soet, botterige en Gouda-smaak en nasmaak was sommige van die belangrike eienskappe wat die kase van mekaar geskei het in hierdie studie. Hierdie resultate het getoon dat die *FCP*-metode, wat minder duur en tydsaam is, 'n geskikte tegniek is wanneer semi-naïewe deelnemers gebruik word.

Die verwantskap tussen verbruikersaanvaarbaarheid en beskrywende sensoriese eienskappe van Cheddarkaas is bepaal deur gebruik te maak van *preference mapping (PM)*. Die resultate vanaf die *PM* het aangedui dat twee hoof (maar baie eenderse) verbruikersgroepe die kase met 'jong/onderontwikkelde' eienskappe meer aanvaarbaar gevind het. Die 'ideale' Cheddarkaas, vir die Suid-Afrikaanse verbruiker, kan dus beskryf word aan die hand van die volgende eienskappe: 'n aroma kenmerkend met 'soetmelk', 'Gouda-agtige' en 'botterige' eienskappe, 'n blink voorkoms en rubberige tekstuur, 'n rubberige, vetterige, klewerige en sag of harde eienskap in terme van mondgevoel, 'n 'Gouda-', 'botterige' en 'soet' smaak, 'n 'Gouda-', 'botterige' en 'soet' nasmaak en 'n nagevoel wat beskryf kan word as 'vetterige smeer in die mond' en 'olierig /vetterig'.

Die resultate van hierdie studie ondersteun en bevestig spekulasies van sommige kaasspesialiste in die suiwelindustrie wat ervaar het dat Cheddarkaas wat die afgelope paar jaar vervaardig en beskikbaar was, meer Gouda-agtige tipe eienskappe getoon het as tipies kenmerkende Cheddar-agtige eienskappe. Die studie het ook getoon dat die data verkry via *FCP* en met die gebruik van semi-naïewe paneellede, die persepsie van Suid Afrikaanse verbruikers van Cheddarkaas-eienskappe suksesvol kon weergee.

## ANNEXURE 1

### RPI: RECRUITMENT QUESTIONNAIRE

Good morning/afternoon/evening. My name is ..... and I work for a company called Research and Planning Intelligence. We are currently recruiting people to participate in some taste tests for us. If you are willing to participate, I would just like to ask you a few questions about yourself. Thank you.

Q.1 Have you participated in any market research within the last 6 months?

YES	1	Close
NO	2	Continue

Q.2 Do you or any members of your family or friends work for:

A market research company	Yes	No
An advertising agency/ promotions company	Yes	No
A newspaper, Radio station, Television company	Yes	No
A Manufacturer, Retailer or Distributor of dairy products	Yes	No

IF YES TO ANY OF THE ABOVE – CLOSE

#### RECRUITING QUESTIONS

1. Are you wholly or partially responsible for household grocery purchases?

Yes	1	<i>CONTINUE</i>
No	2	<i>CLOSE</i>

2. Which of the following products have you bought in the last 3 months?

	Bought	
Bread	1	
Fresh Milk	2	
Cheese	3	<i>IF CHEESE CONTINUE</i>
Yoghurt	4	
Fruit Juice	5	

3a. Which types of cheese do you eat regularly? By eat I mean consume cheese on its own...

3b. Which types of cheese do you use regularly? By use I mean use cheese in cooking, baking, salads etc....

	3a. Eat Regularly	3b. Use Regularly	
Cheddar Cheese	1	1	<i>IF CHEDDAR CHEESE USED AND EATEN, CONTINUE</i>
Speciality Cheese, such as Brie, Mozzarella, Provolone etc.	2	2	

Cottage Cheese	3	3
Cream Cheese	4	4
Processed Cheese	5	5
Feta Cheese	6	6
Other type	7	7

4a. How often do you eat cheddar cheese?

4b. How often do you use cheddar cheese?

	4a. Eat	4b. Use
Everyday	1	1
Not everyday, but 2 – 6 times a week	2	2
Once a week	3	3
Once every two weeks	4	4
Once every three weeks	5	5
Once a month	6	6
Less often	7	7

*RESPONDENTS MUST BE REGULAR USERS OF CHEDDAR CHEESE i.e. they must have used and eaten cheddar cheese within the last 2-3- weeks*

5a. Which brand/s of cheddar cheese do you know or have you heard of even if you have never tried it yourself?

5b. Which brand/s of cheddar cheese do you eat regularly?

	(a) Spontaneous awareness	(b) Eat Regularly
Clover	01	01
SACCA	02	02
Country Style	03	03
Dairybelle	04	04
Parmalat	05	05
Lancewood	06	06
Simonsberg	07	07
Woolworths	08	08
Pick 'n Pay	09	09
Fox n Crow	10	10
Spar	11	11
Other (please specify)	12	12

#### DEMOGRAPHICS

RECRUIT TO QUOTA:

6. GENDER:

Male		<u>RECRUIT TO QUOTA</u>
Female		

7. LSM (Living Standards Measurement) / HOUSEHOLD INCOME:

LSM 8 R7000-8999		<u>RECRUIT TO QUOTA</u>
LSM 9 R9000-15 999		
LSM 10 R 16000+		

8. AGE GROUP:

25-34 years		<u>RECRUIT TO QUOTA</u>
35-49 years		

9. POPULATION GROUP:

Black		<u>RECRUIT TO QUOTA</u>
Coloured		
White		

Recruiting Criteria: (not to be disclosed to respondents!)

- LSM 8-10
- Males and Females
- Age: 25-49 yrs
- Black/Coloured and White
- Johannesburg and Cape Town

RECRUIT ACCORDING TO QUOTA. IF RESPONDENT QUALIFIES, RECRUIT TO A TASTE TEST TO TEST OF SOME SAMPLES. EXPLAIN THAT THEY WILL TASTE FIVE SAMPLES AND RATE THEM AND THEN THEY WILL BE ASKED TO WAIT FOR ABOUT 30-60 MINUTES BEFORE TASTING ANOTHER 5 SAMPLES, RATING THEM WAITING ANOTHER 30-60 MINUTES BEFORE TASTING THE FINAL 5 SAMPLES AND RATING THEM. THE TASTE TEST WILL LAST FOR ABOUT 2 HOURS. IF RESPONDENT IS WILLING TO MEET THESE CONDITIONS, MAKE AN APPOINTMENT FOR THE TASTE TEST SESSION.

Date/ Time: \_\_\_\_\_

Venue: \_\_\_\_\_

Respondents Name: \_\_\_\_\_ Recruiter: \_\_\_\_\_

Respondents Company Name: \_\_\_\_\_ Date: \_\_\_\_\_

Tel No. (W) \_\_\_\_\_ Time: \_\_\_\_\_

Cell No. \_\_\_\_\_

RECRUITER DECLARATION

I certify that this interview has been personally carried out by me with the person who's details are reflected on this document.

I further declare that all the information is truthful and as told to me by the respondent. I understand that any

Discrepancies discovered during back-checking of this questionnaire will result in legal action.

\_\_\_\_\_  
Recruiter Signature

OFFICE USE ONLY:

CHECKED / CONFIRMED:

By: \_\_\_\_\_ Date: \_\_\_\_\_

## ANNEXURE 2

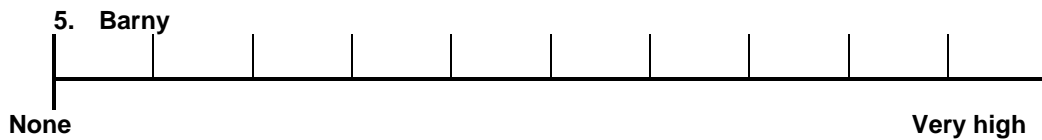
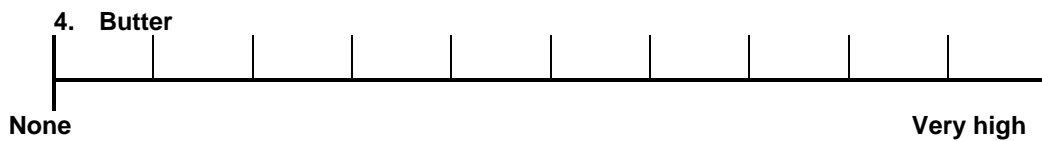
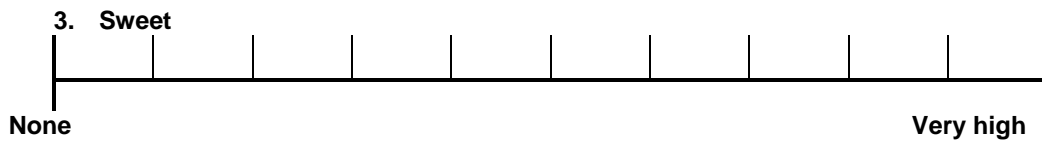
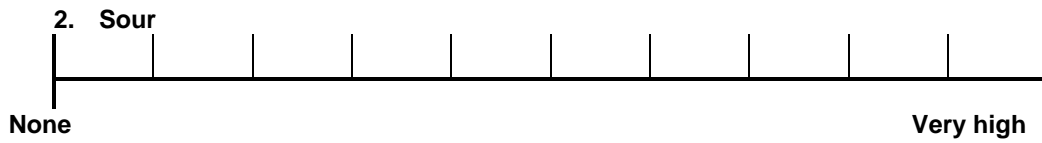
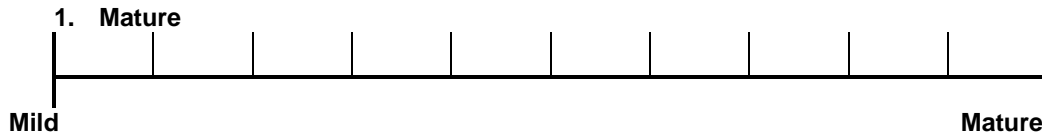
### Evaluation ballots for all ten assessors:

**Semi-naive assessor 1**

**Code:** \_\_\_\_\_

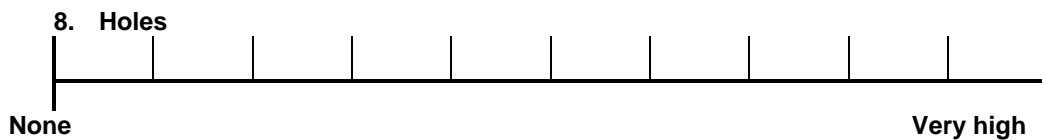
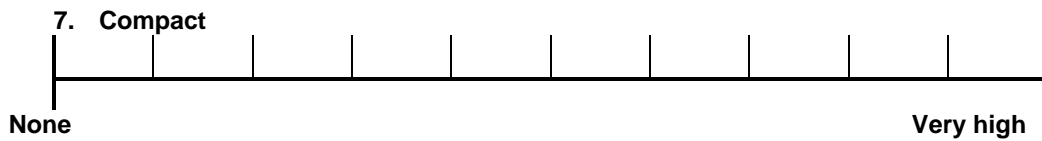
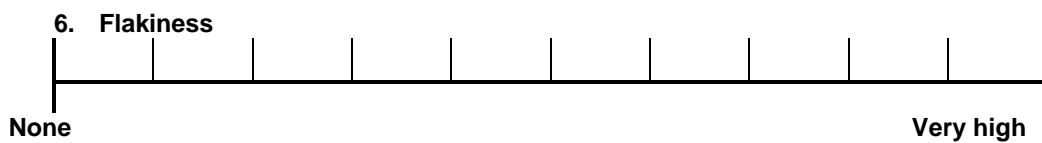
#### AROMA:

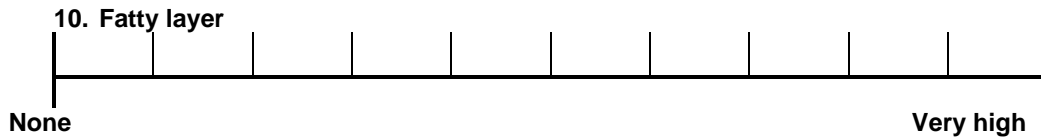
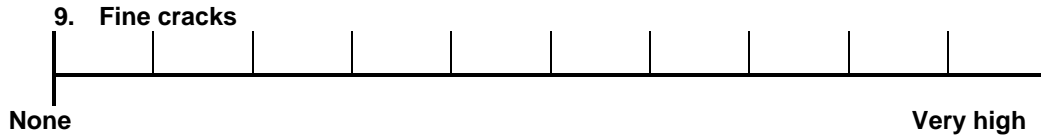
Open container and smell immediately.



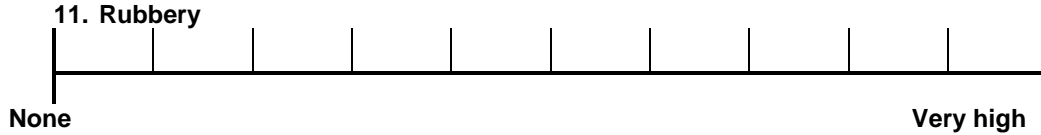
#### APPEARANCE/TEXTURE:

Look at sample from the top.

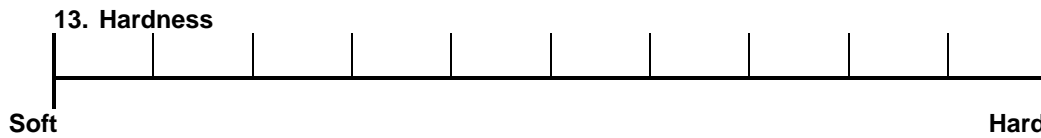
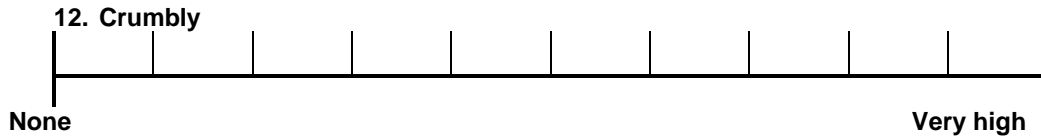




Press between thumb and forefinger 3 times.

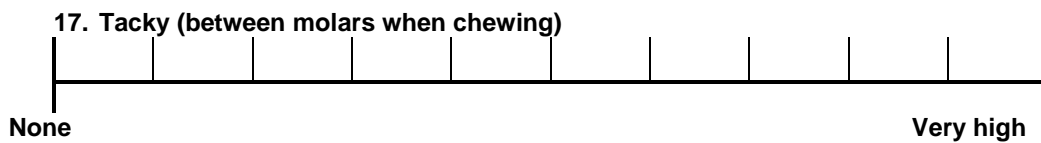
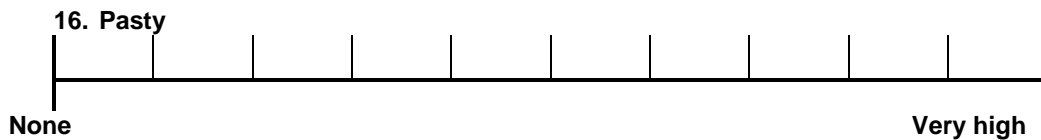
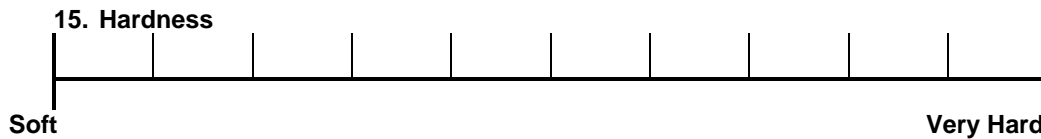
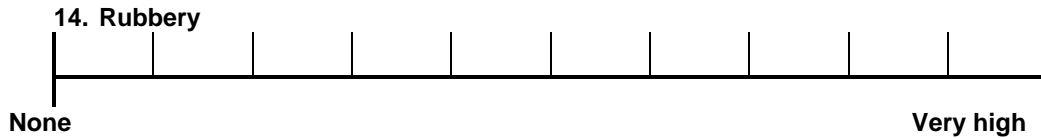


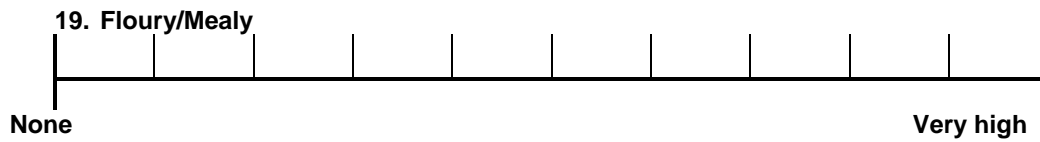
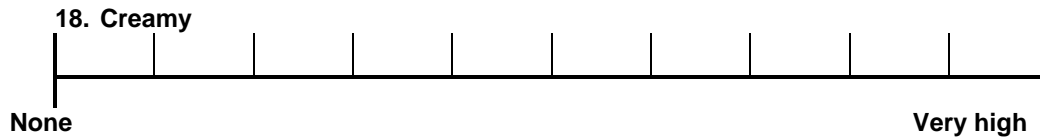
Cut in half.



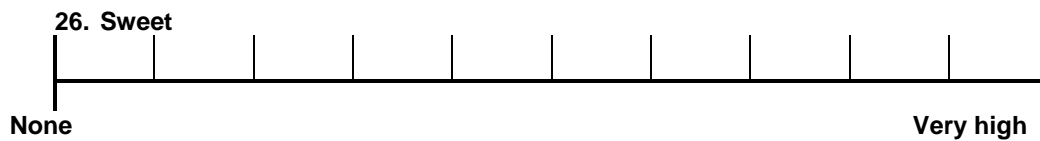
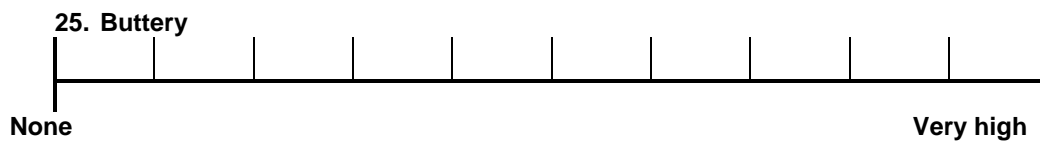
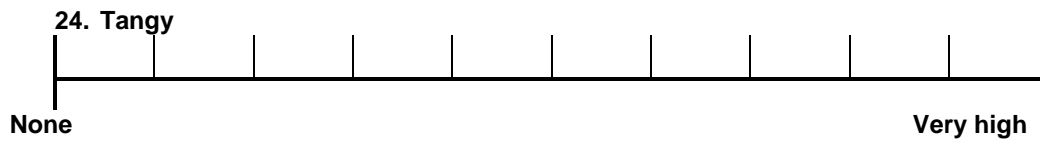
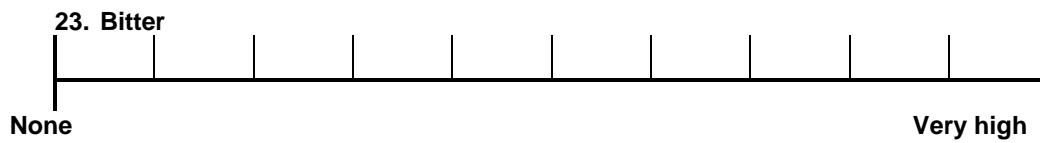
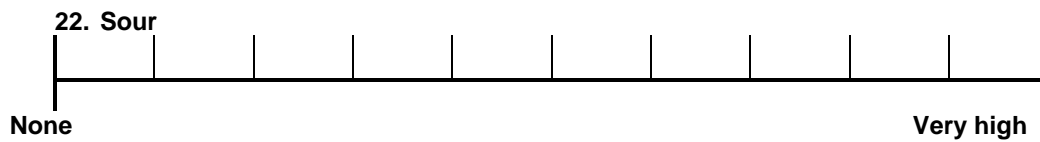
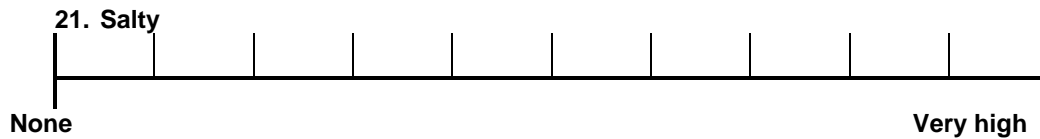
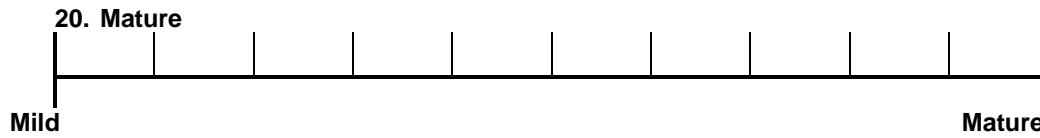
**MOUTHFEEL:**

Roll between palate and tongue – then chew – then swallow.

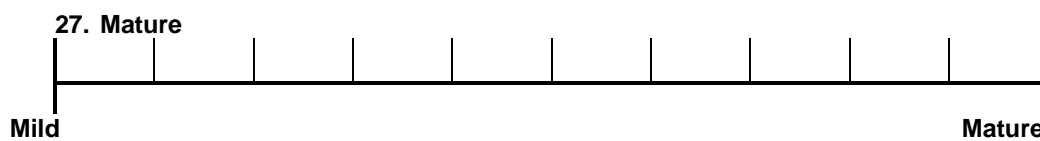


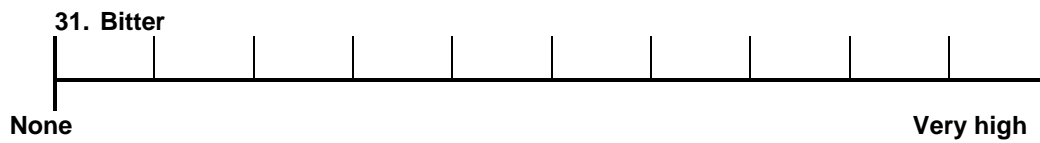
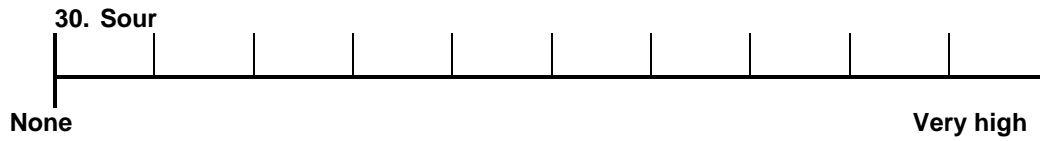
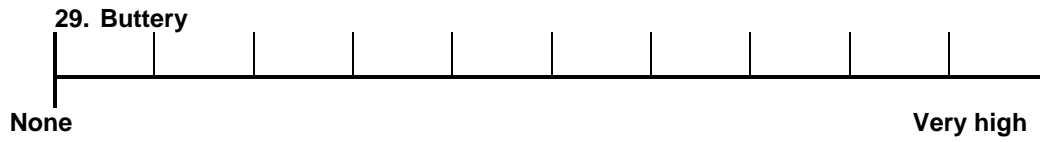
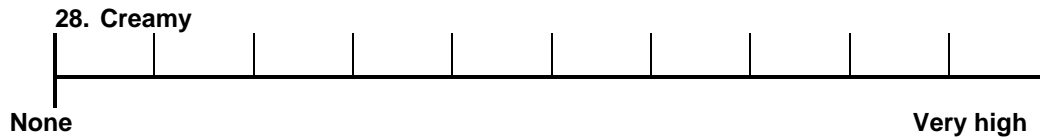


**TASTE:**

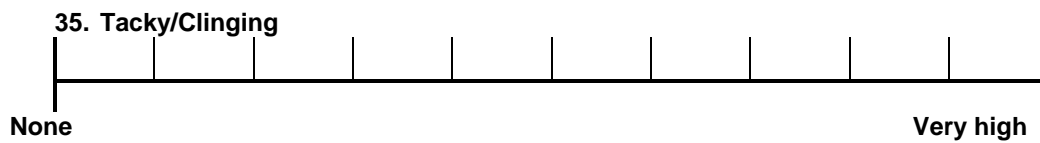
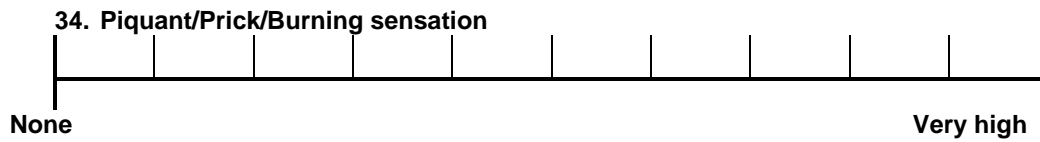
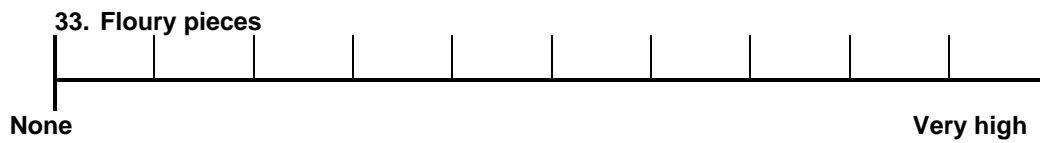
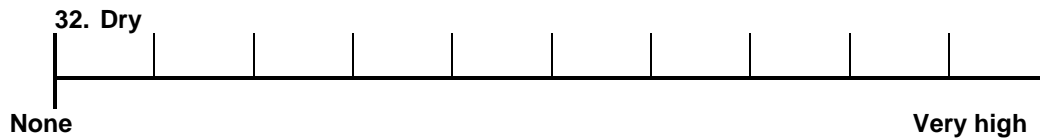


**AFTERTASTE:**





**AFTERFEEL:**



**Semi-naive assessor 2**

**Code:** \_\_\_\_\_

**AROMA:**

Open cup and take 2 good sniffs.

1. **Sour/vinegar**

None Very high

2. **Musty**

None Very high

3. **Sweet**

None Very high

4. **Dairy**

None Very high

5. **Salty**

Mild Mature

**APPEARANCE/TEXTURE:**

View from top. Cut in half and press between thumb and forefinger 3 times.

6. **Soft - Firm**

Soft Firm

7. **Smooth/Creamy**

None Very high

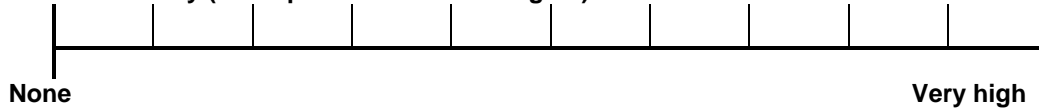
8. **Rubbery/Clay**

None Very high

9. **Holes (round or vein-like)**

Few Many

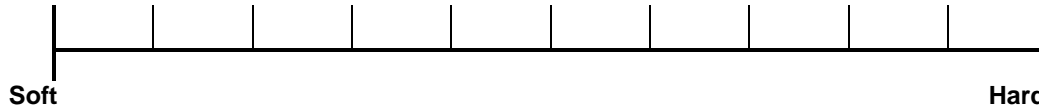
**10. Crumbly (when pressed between fingers)**



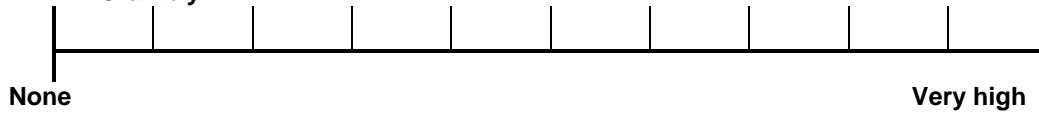
**MOUTHFEEL:**

Bite in half and push against palate squeeze with tongue and then chew with molars.

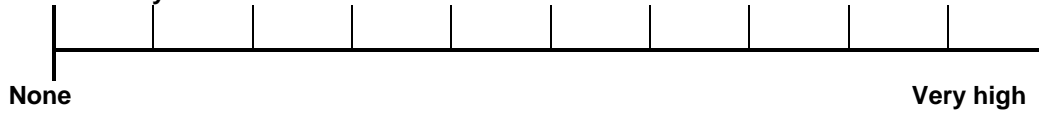
**11. Firm**



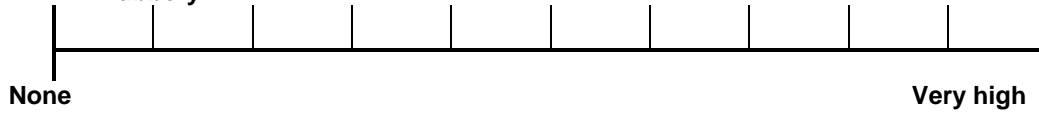
**12. Crumbly**



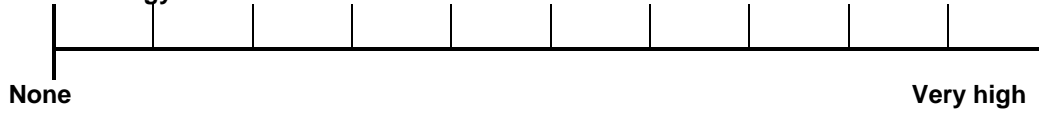
**13. Pasty**



**14. Rubbery**

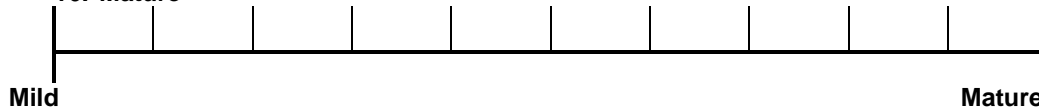


**15. Tangy**

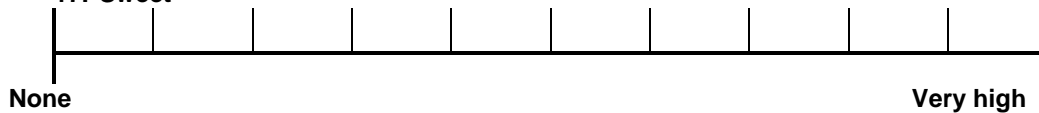


**TASTE:**

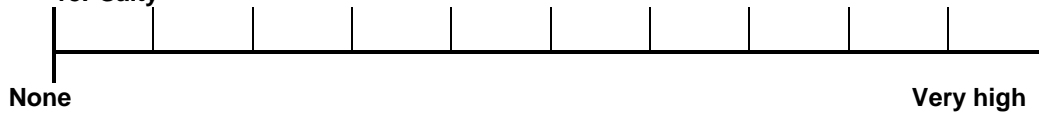
**16. Mature**

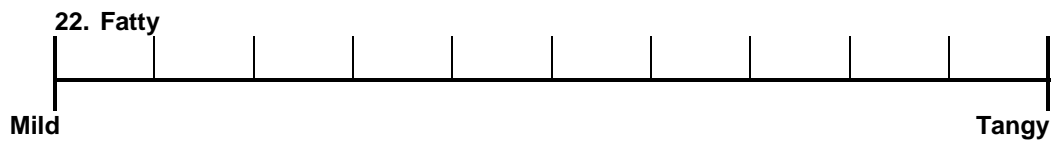
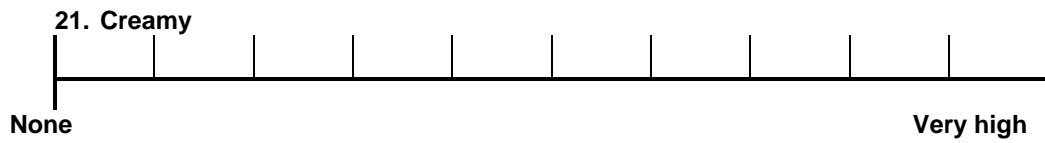
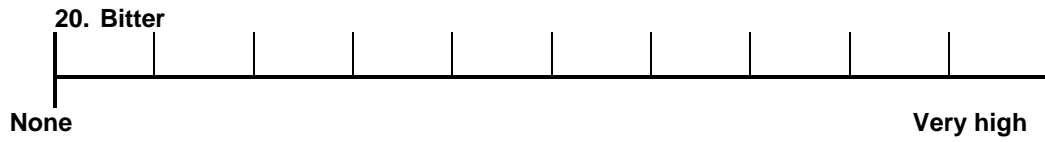
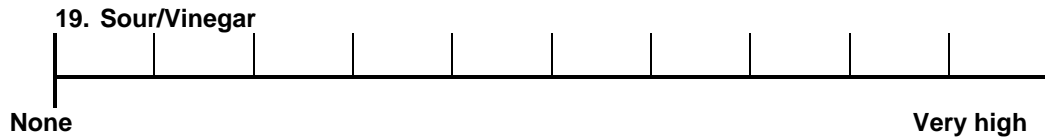


**17. Sweet**

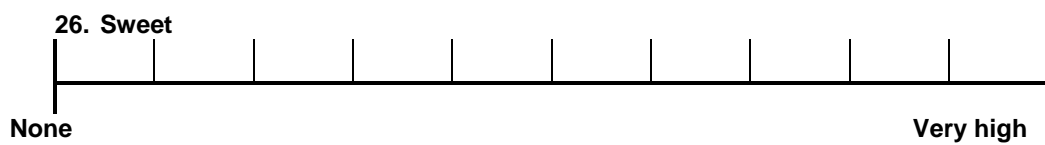
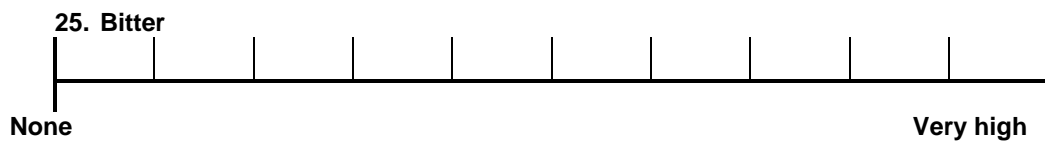
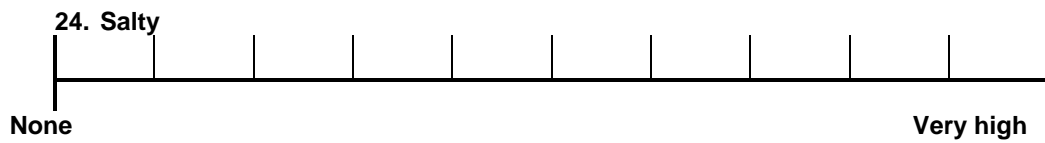
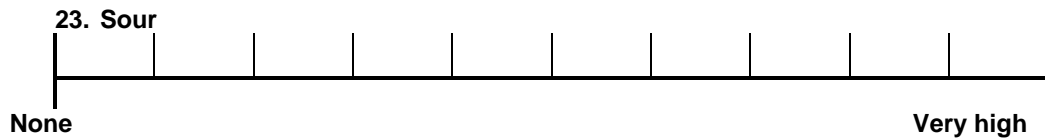


**18. Salty**

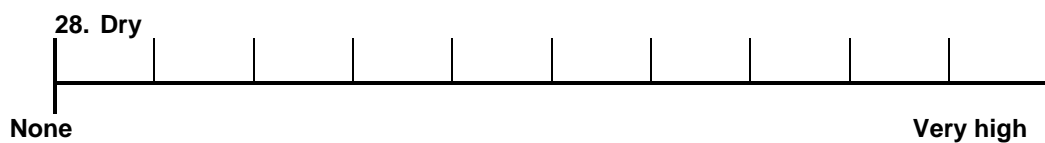
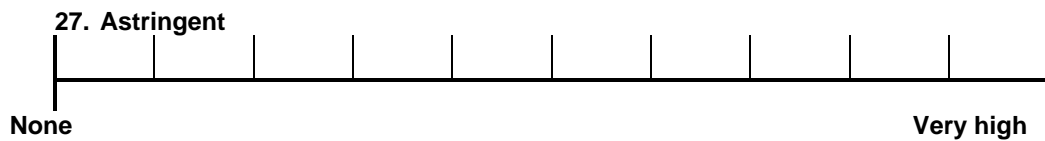


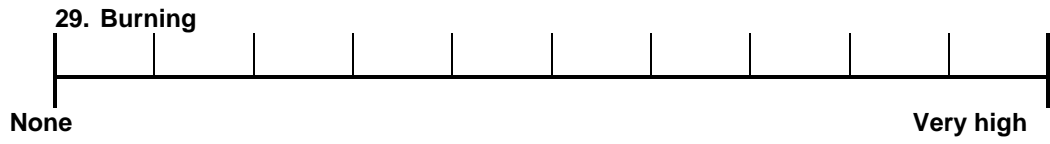


**AFTERTASTE:**



**AFTERFEEL:**





**APPEARANCE/STRUCTURE/TEXTURE:**

View from top and turn in all directions.

**1. Compact (appearance)**

None Very high

**2. Holes**

None Very high

**3. Cracks**

None Very high

**4. Smooth**

None Very high

**5. Soft/hard (texture)**

None Very high

**6. Rubbery**

None Very high

**7. Pliable**

None Very high

**8. Crumbly**

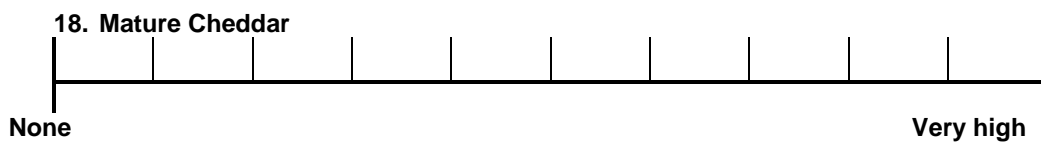
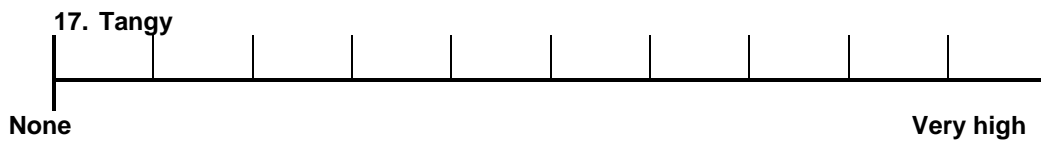
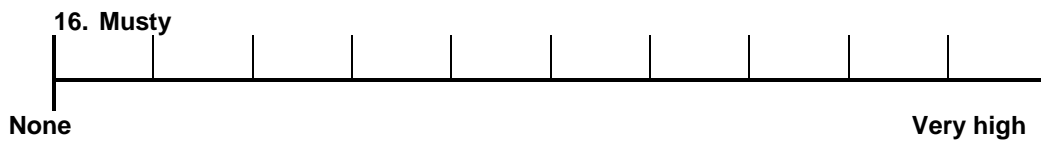
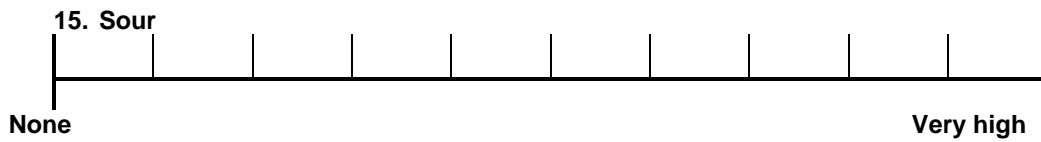
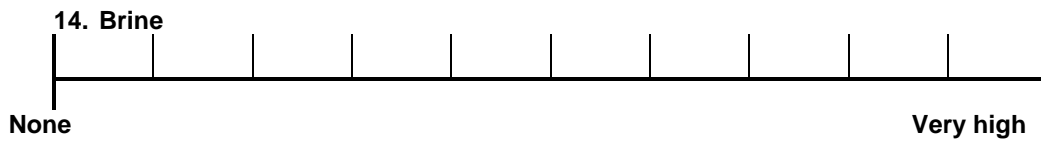
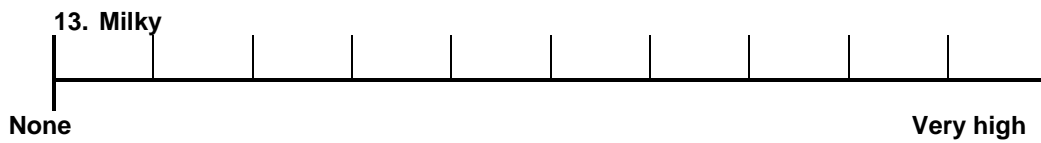
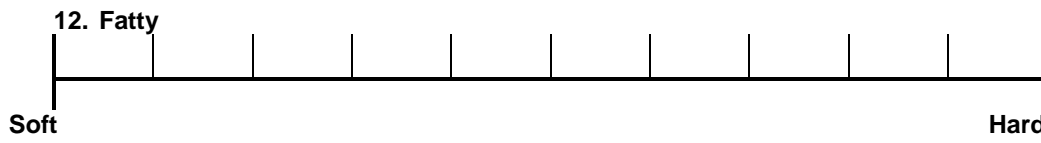
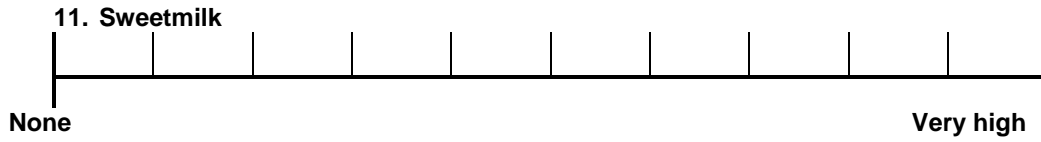
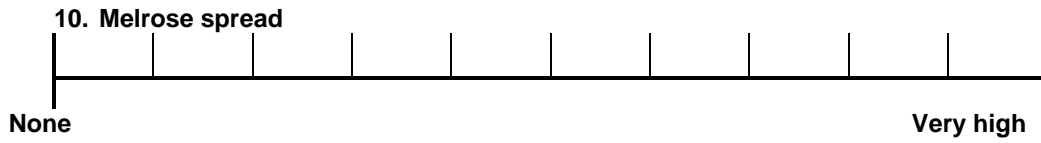
None Very high

**9. Fatty**

Dull Oily

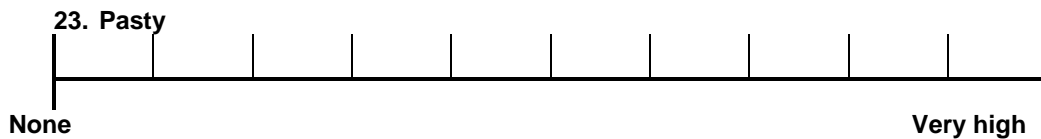
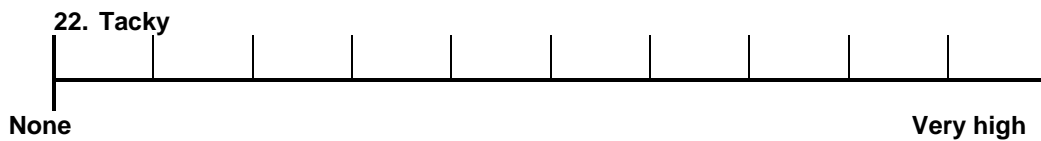
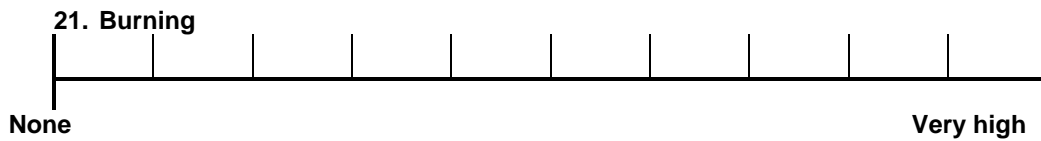
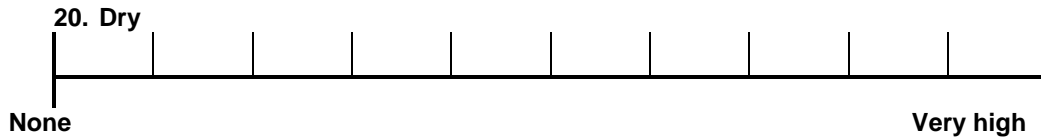
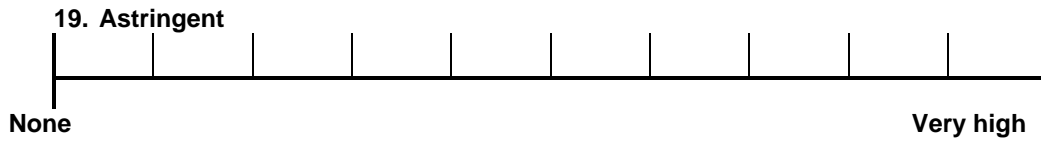
**AROMA:**

Take 6 good sniffs, while cheese stays in cup.



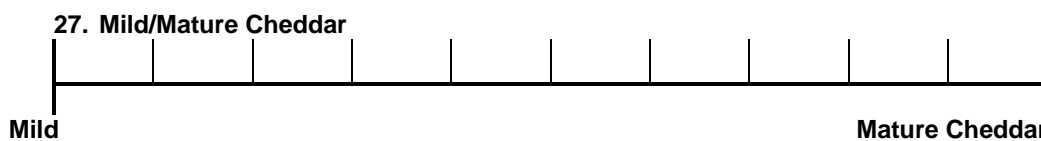
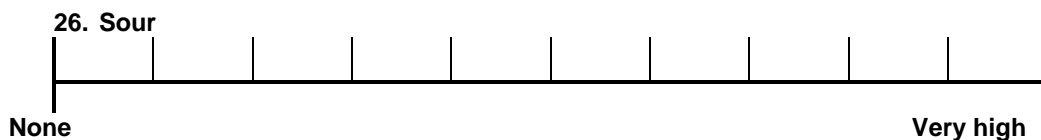
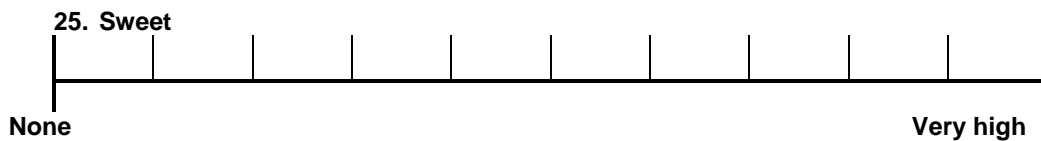
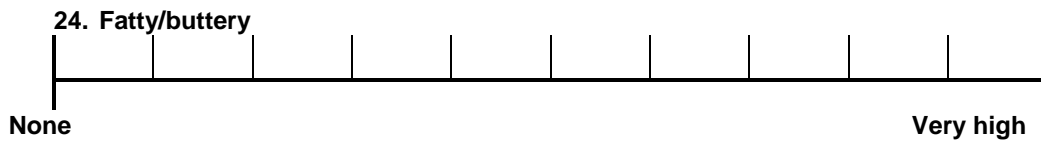
**MOUTHFEEL:**

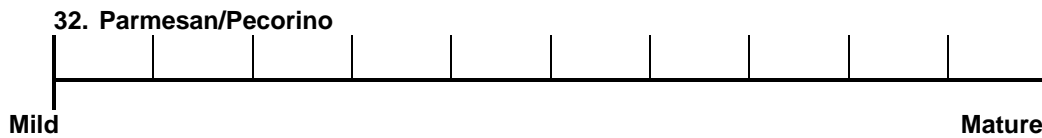
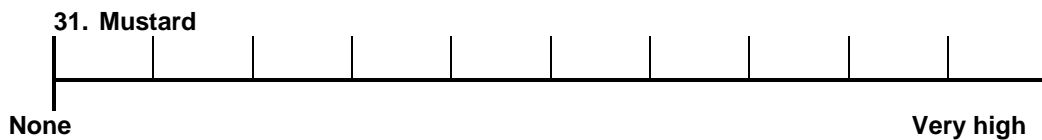
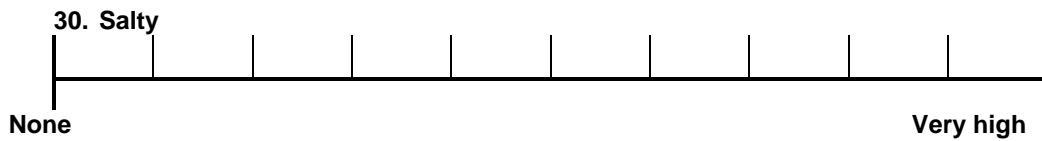
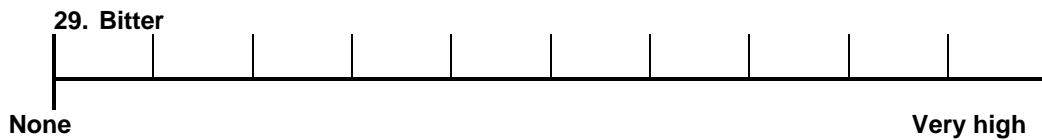
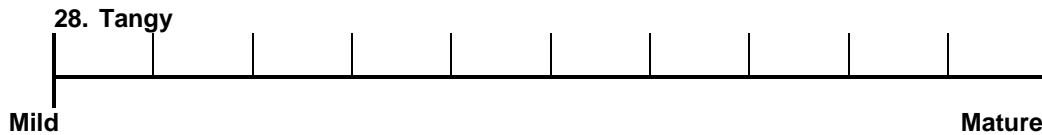
Taste 1/2 piece of cheese, chew 10 times and hold against palate.



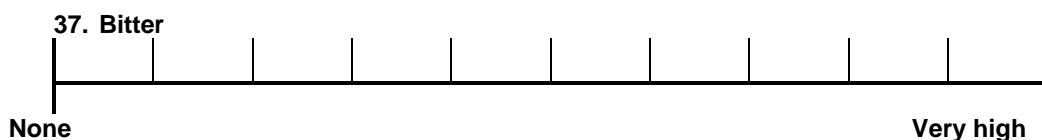
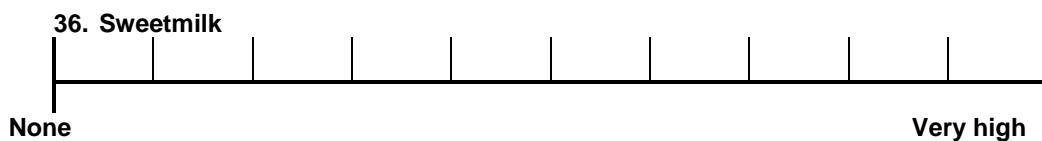
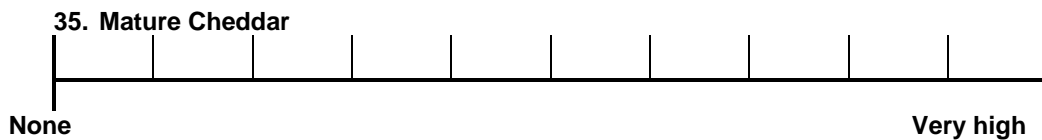
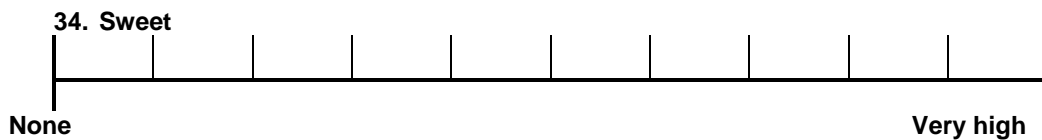
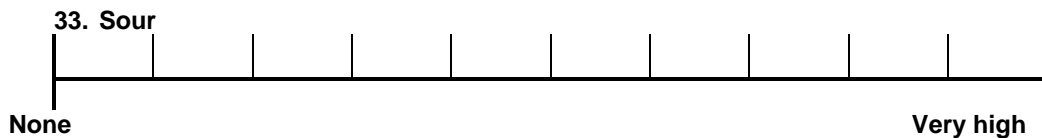
**TASTE:**

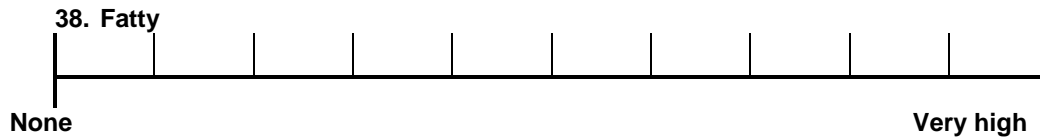
Taste other half of cheese.





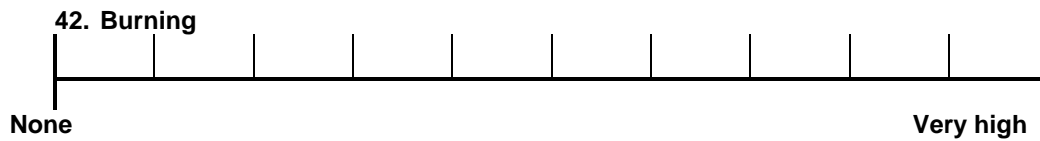
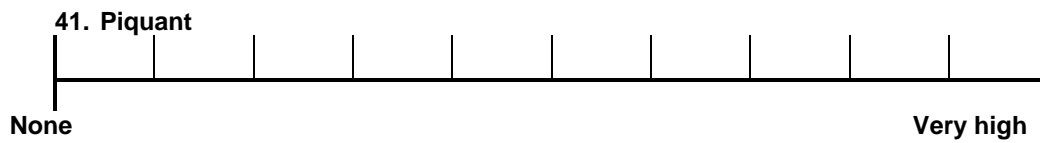
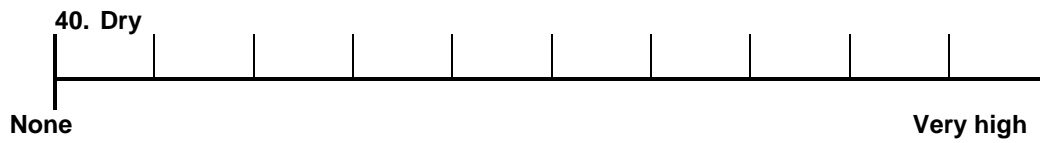
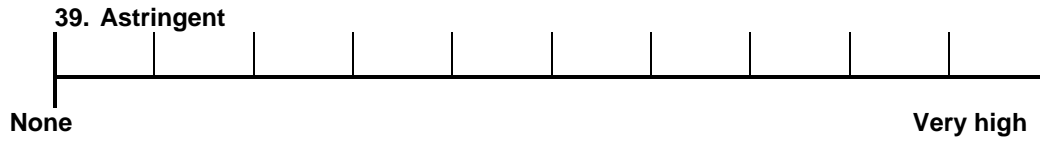
**AFTERTASTE:**  
Taste one piece and roll in mouth.





**AFTERFEEL:**

Taste one piece and roll in mouth.



**Semi-naive assessor 4**

**Code:** \_\_\_\_\_

**AROMA:**

Open cup and smell product.

1. **Sour**

None Very high

2. **Musty**

None Very high

3. **Sour (Vinegar)**

None Very high

4. **Sweetmilk**

None Very high

5. **Mature**

Mild Mature

6. **Salty**

None Very high

7. **Warm/melted**

None Very high

**APPEARANCE/TEXTURE:**

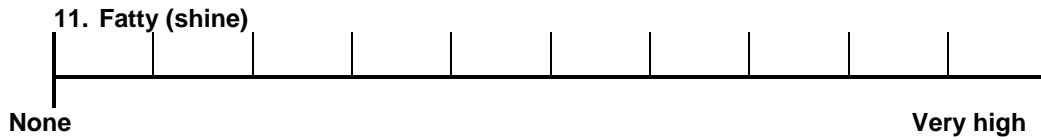
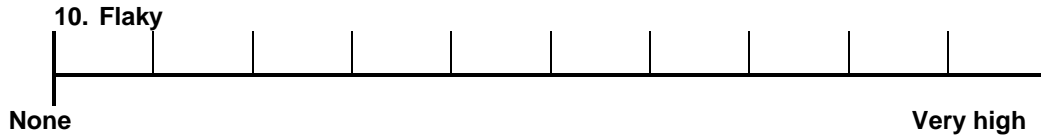
Evaluate appearance looking at the whole product in cup.

8. **Light flecks**

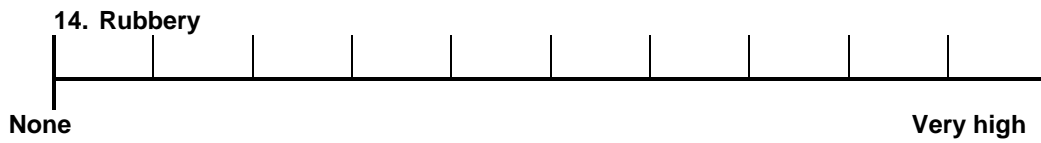
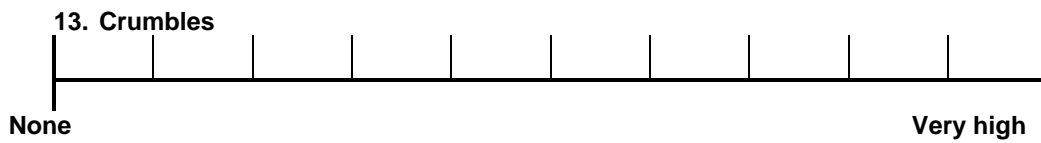
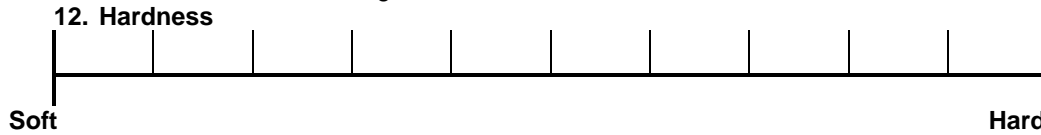
None Very high

9. **Elongated holes**

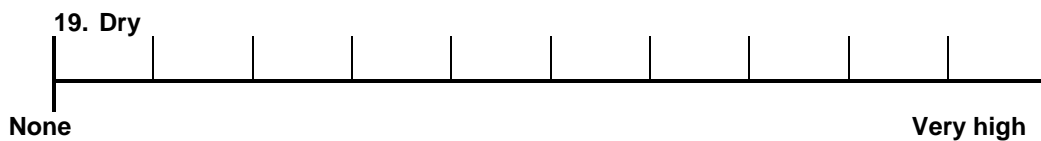
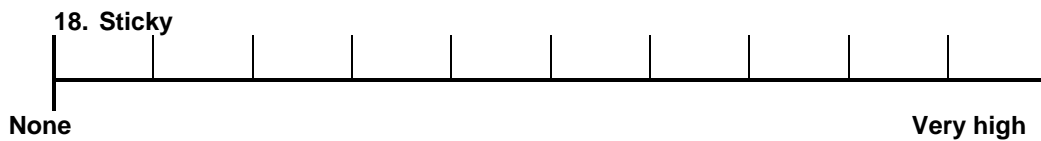
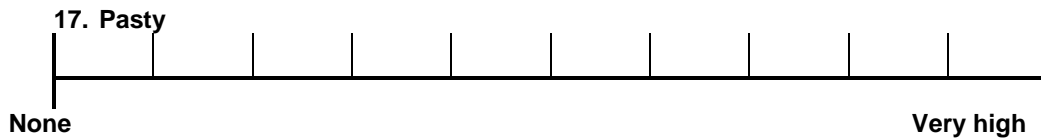
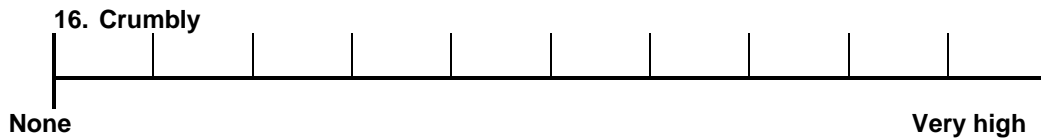
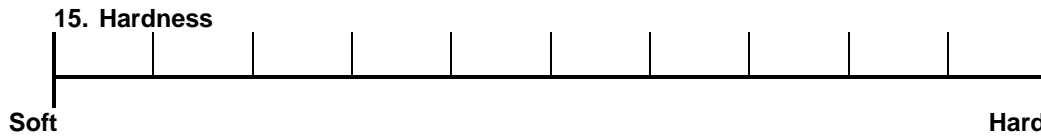
Few Many

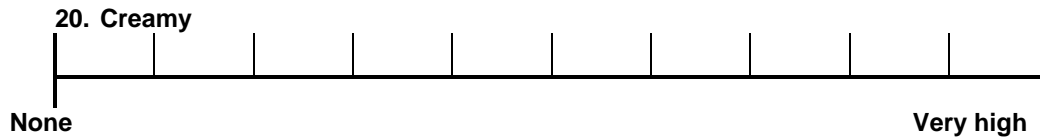


Press between thumb and forefinger 3 times.

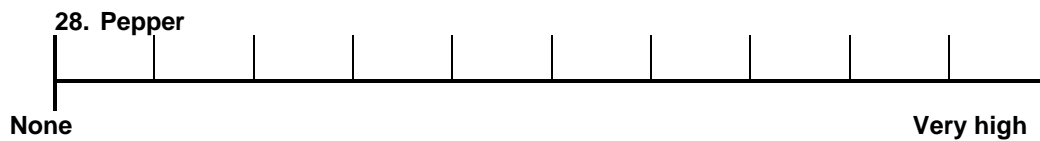
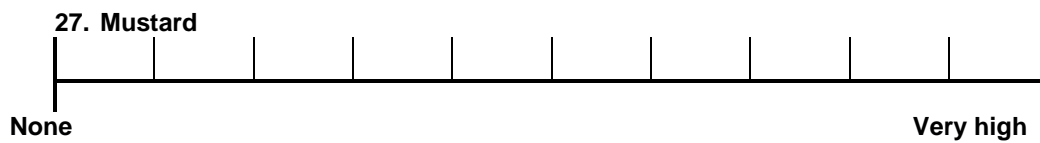
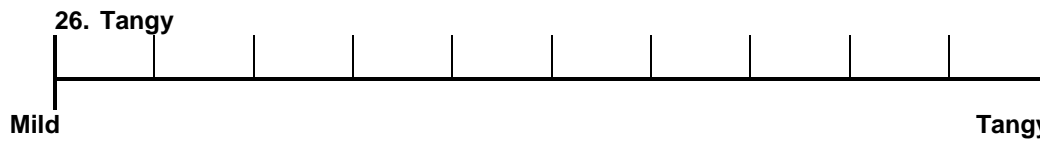
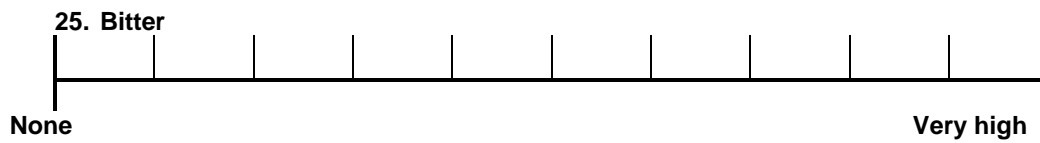
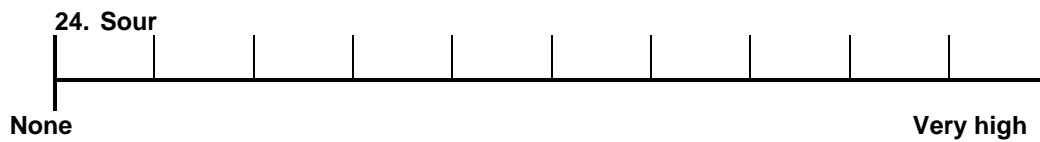
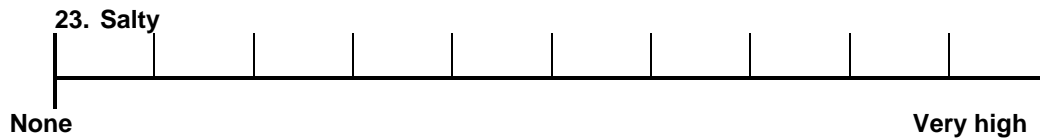
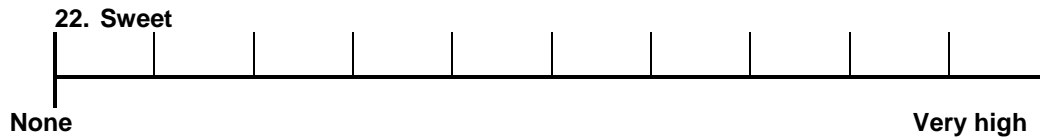
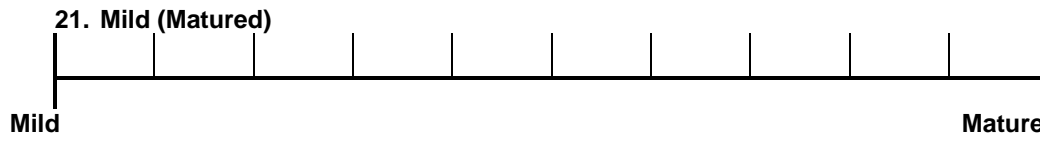


**MOUTHFEEL:**

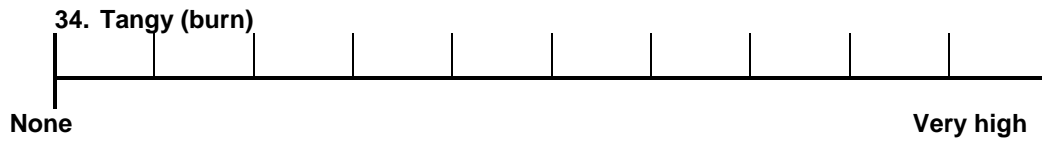
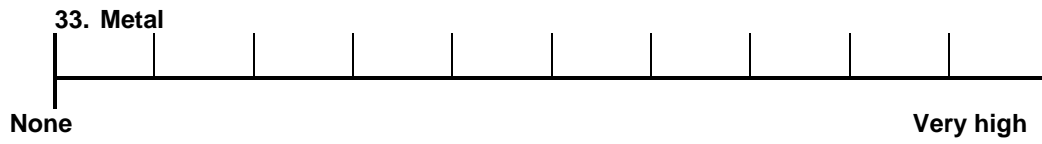
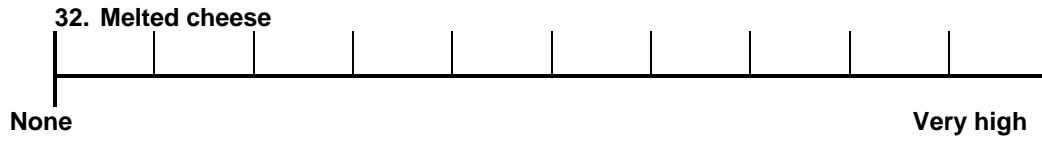
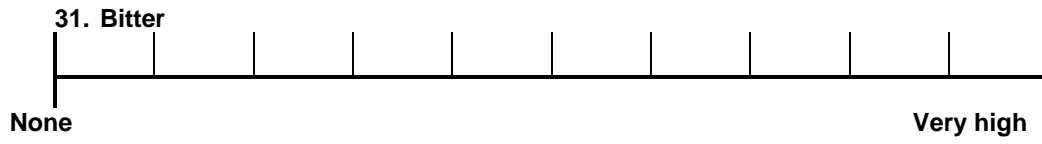
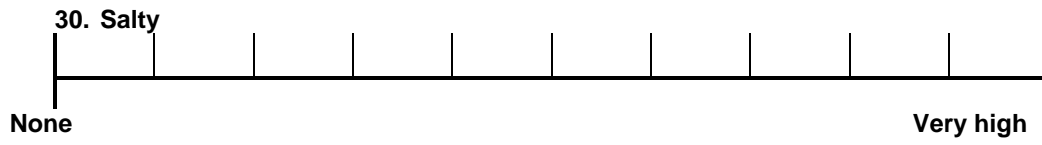
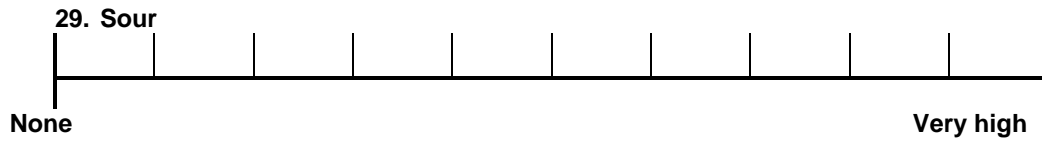




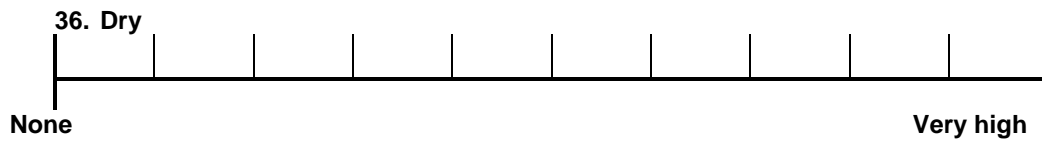
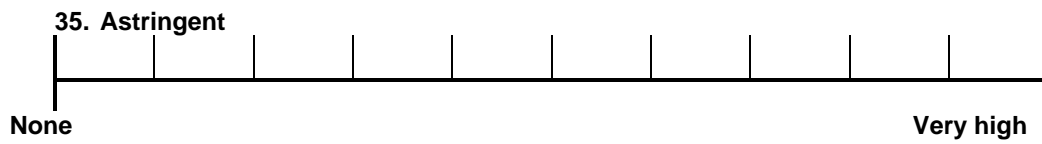
**TASTE:**



**AFTERTASTE:**



**AFTERFEEL:**



**Semi-naive assessor 5**

**Code:** \_\_\_\_\_

**AROMA:**

Smell twice.

1. Sweet

None Very high

2. Sour

None Very high

**APPEARANCE/TEXTURE:**

Cut and press between thumb and forefinger.

3. Holes

None Very high

4. Shiny

Dull Shiny

5. Soft/hard

Soft Hard

6. Firm

None Very high

7. Fatty

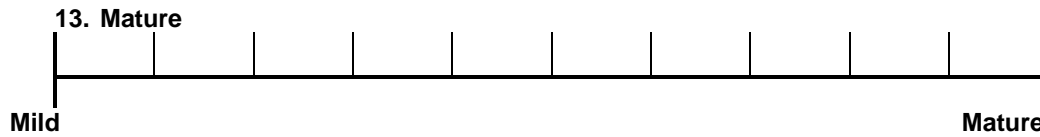
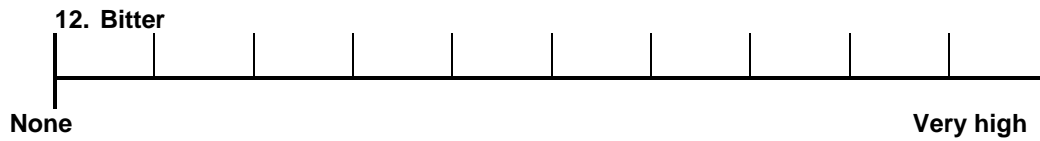
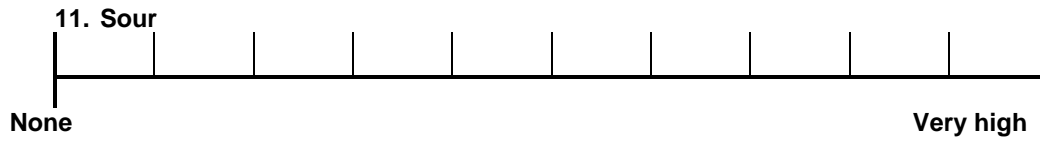
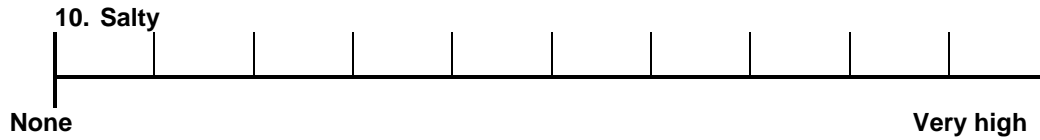
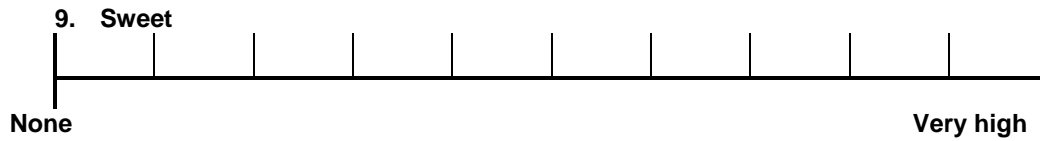
None Very high

8. Rubbery

None Very high

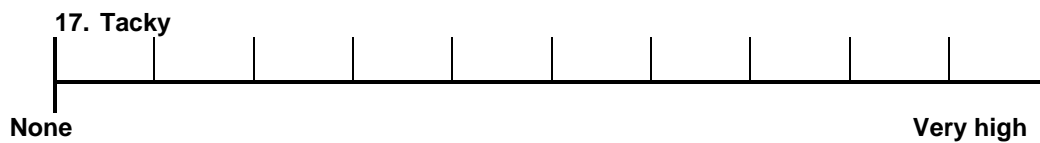
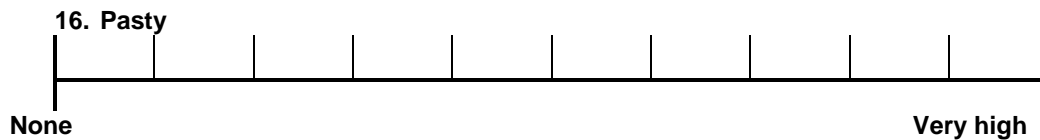
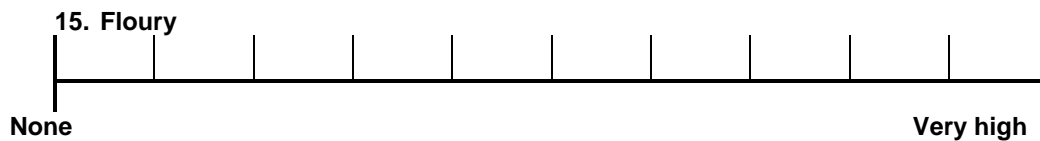
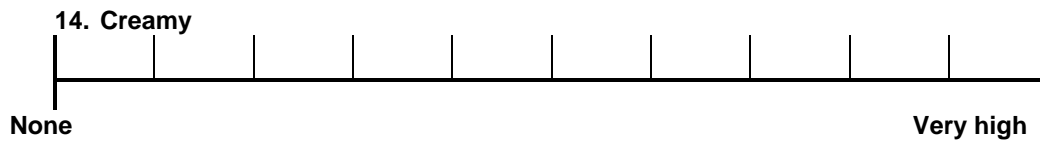
**TASTE:**

Taste approximately 2 small pieces.



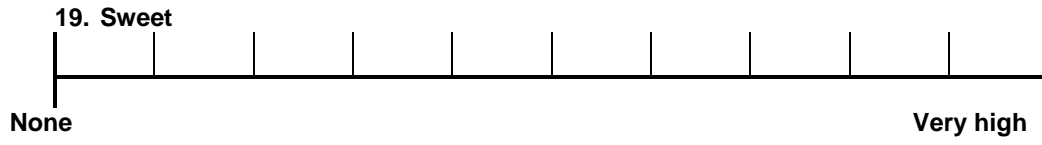
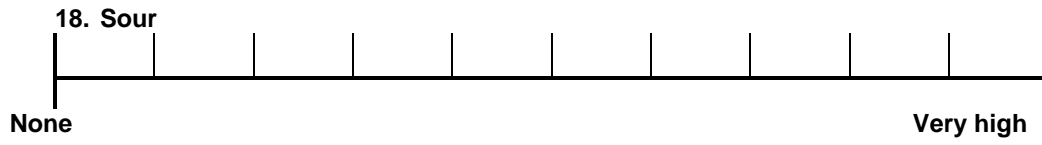
**MOUTHFEEL:**

Taste one piece and roll in mouth.



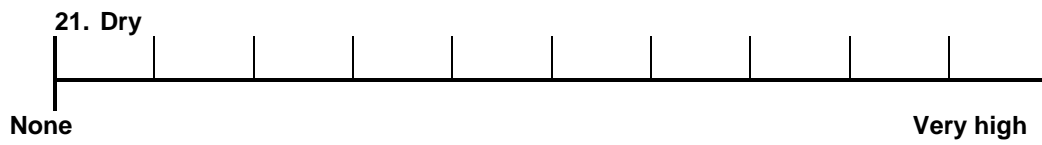
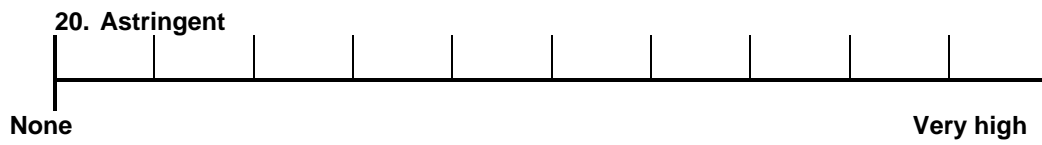
**AFTERTASTE:**

Taste one piece and roll in mouth.



**AFTERFEEL:**

Taste one piece and roll in mouth.

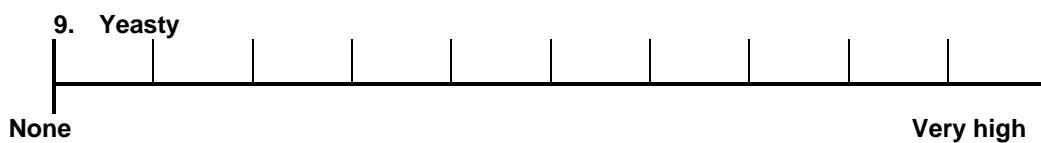
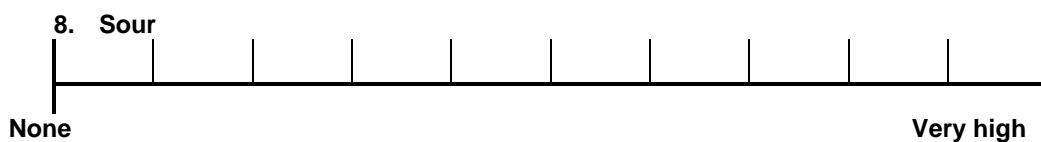
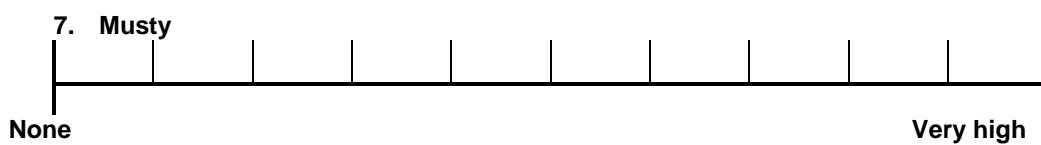
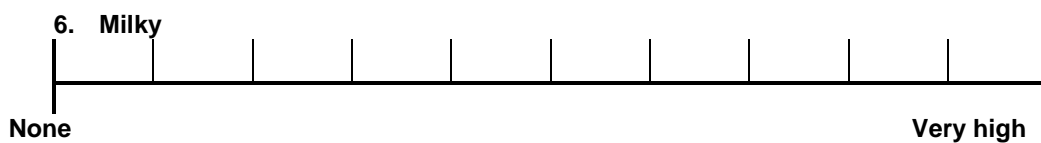
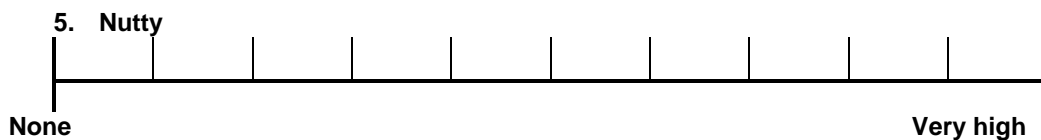
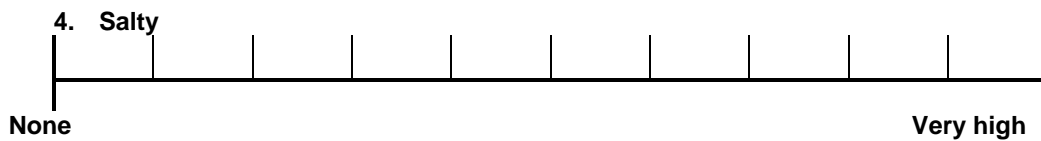
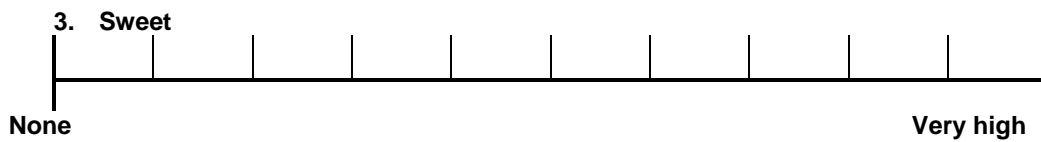
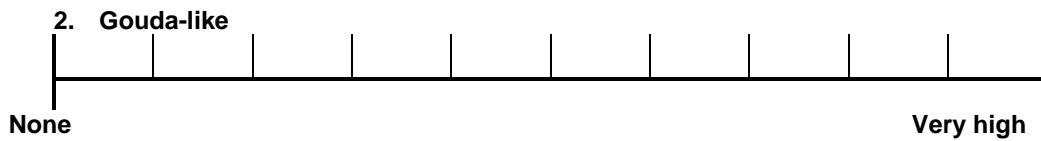
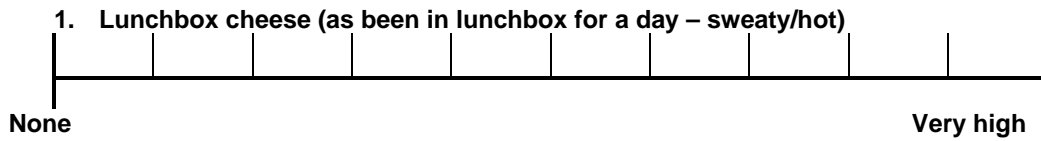


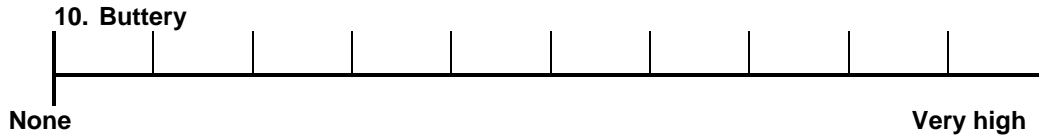
**Semi-naive assessor 6**

**Code:** \_\_\_\_\_

**AROMA:**

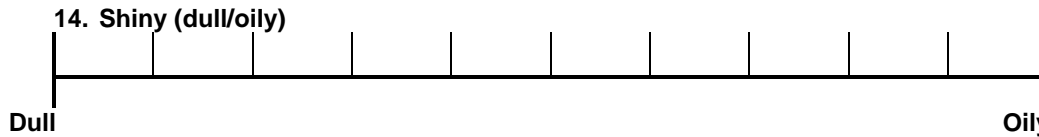
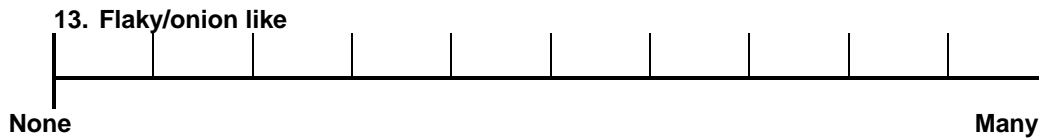
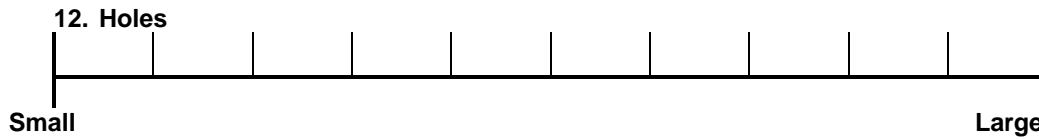
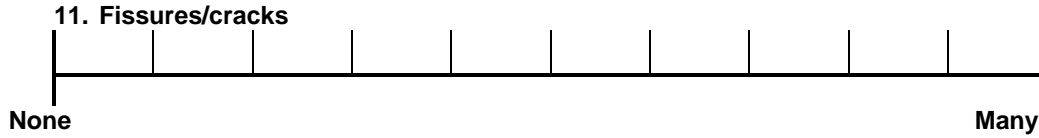
Smell 2-3 times (without touching in the box).



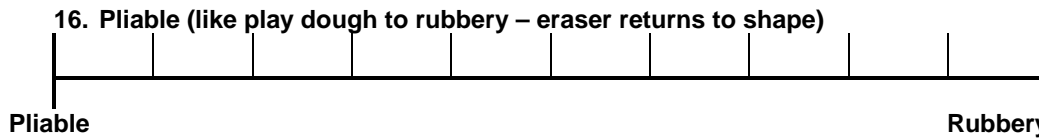
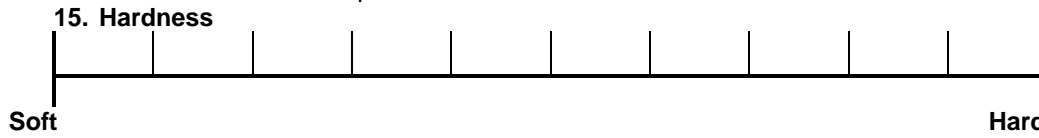


**APPEARANCE/TEXTURE:**

Evaluate appearance looking at the whole product, before cutting.

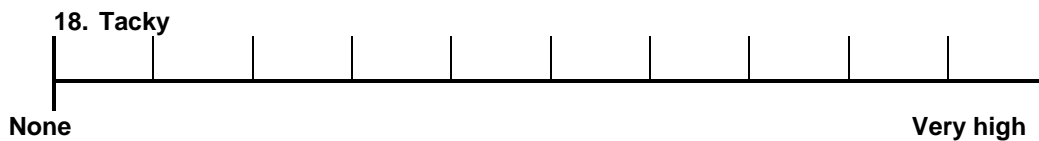
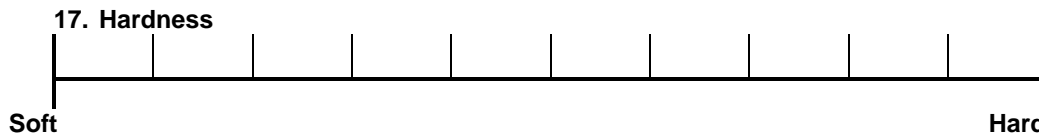


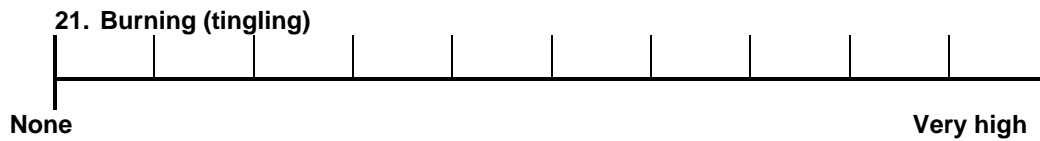
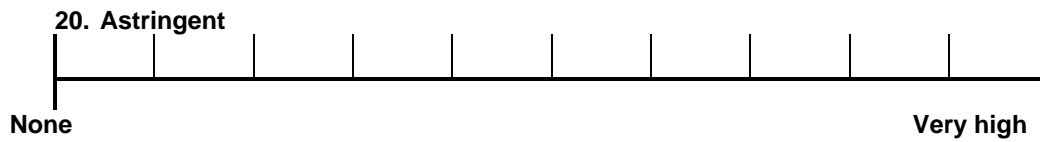
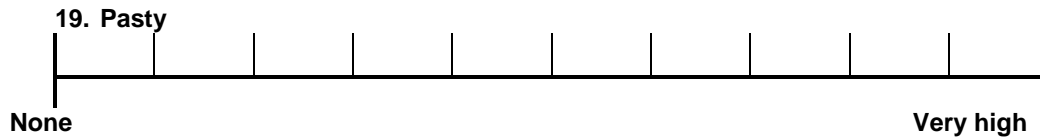
To measure the texture cut the product in half.



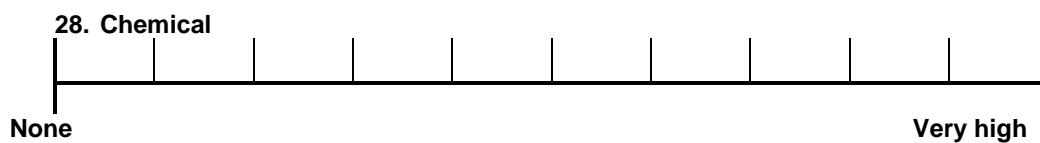
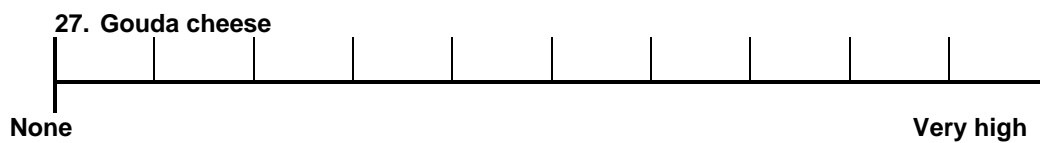
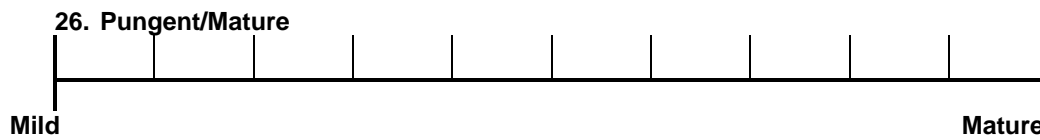
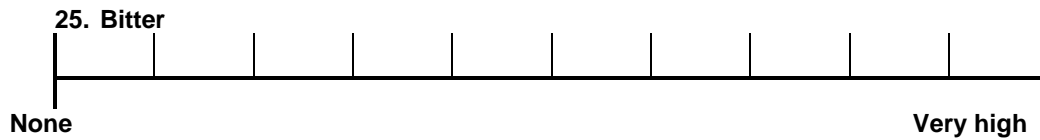
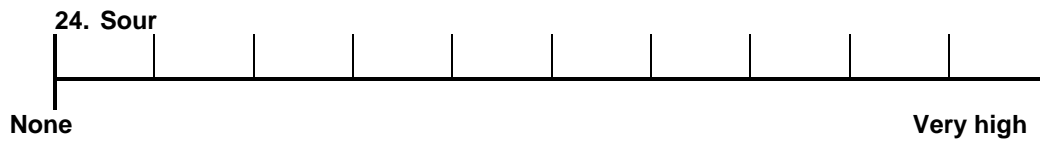
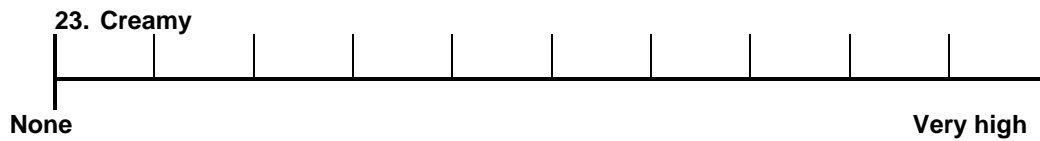
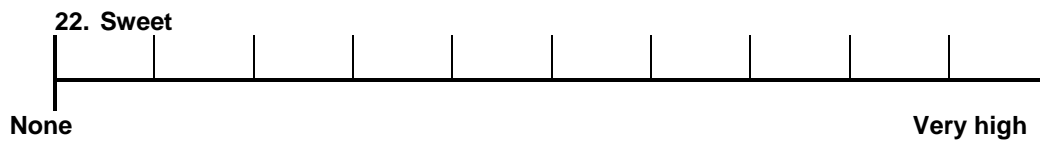
**MOUTHFEEL:**

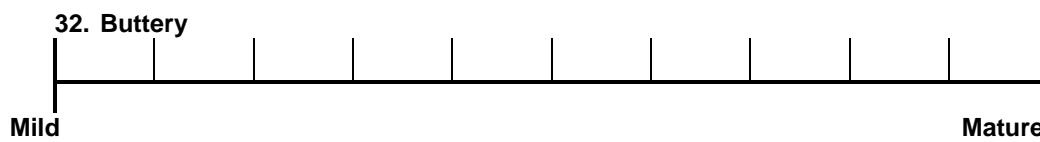
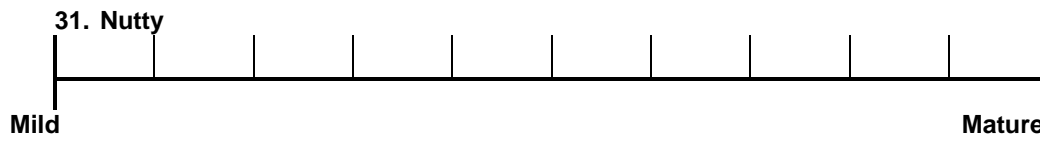
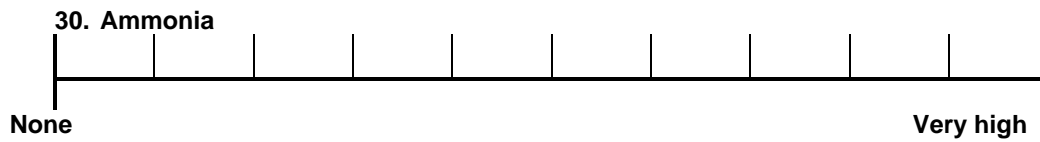
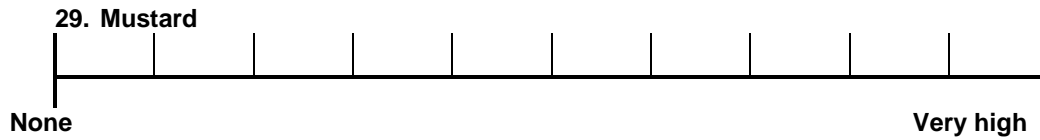
Taste ¼ cube in mouth press against palate.



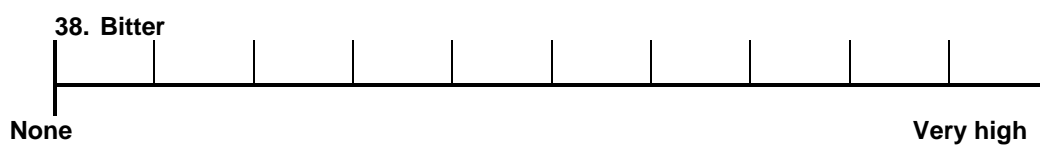
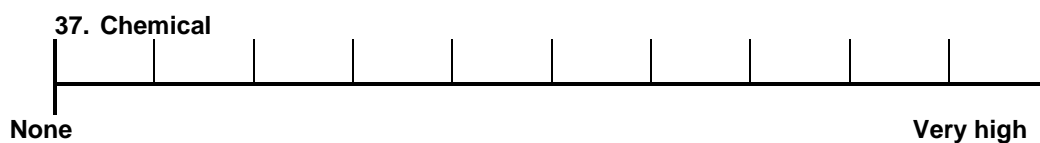
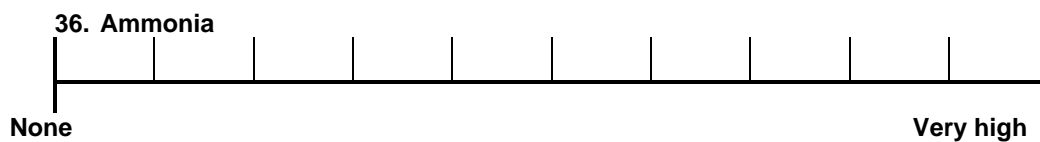
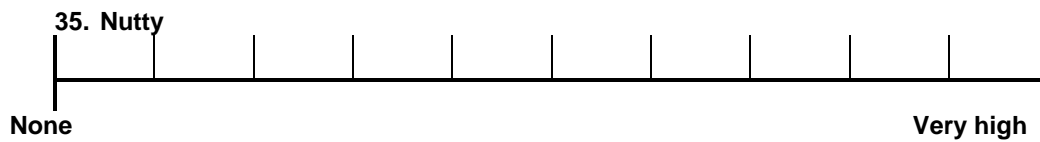
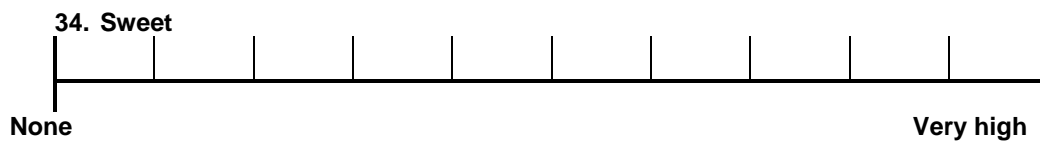
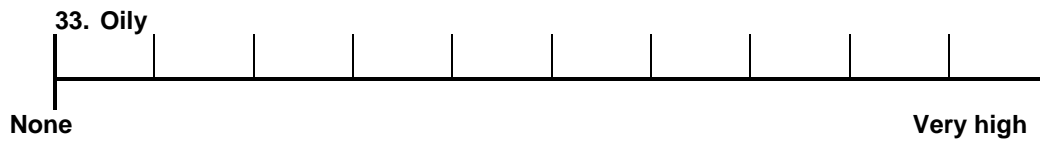


**TASTE:**  
Taste approximately 2 small pieces.



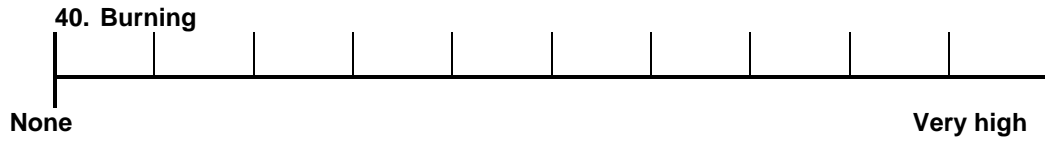
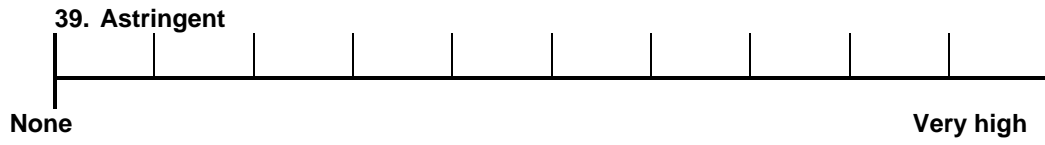


**AFTERTASTE:**  
Taste one piece and roll in mouth.



**AFTERFEEL:**

Taste one piece and roll in mouth.

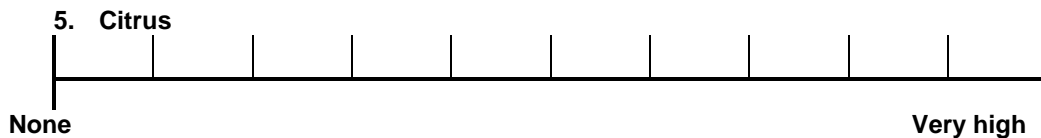
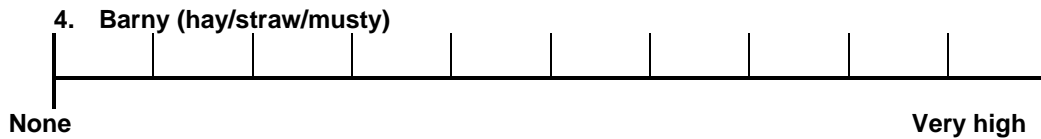
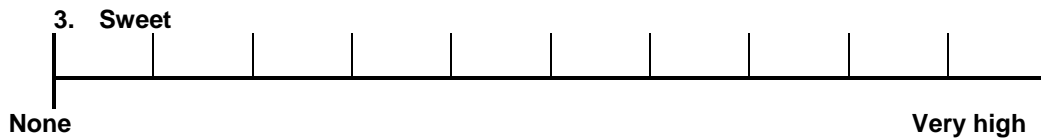
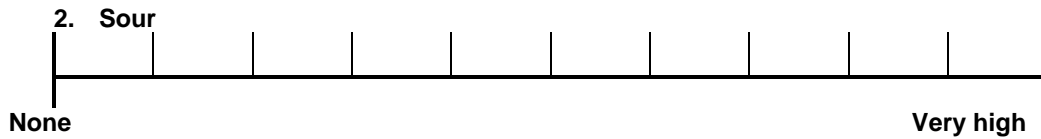
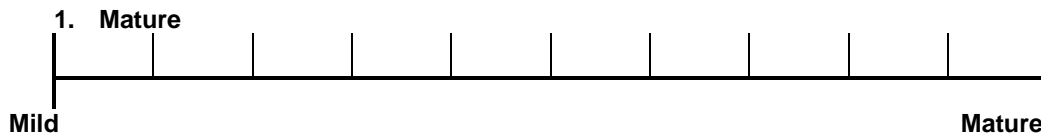


**Semi-naive assessor 7**

**Code:** \_\_\_\_\_

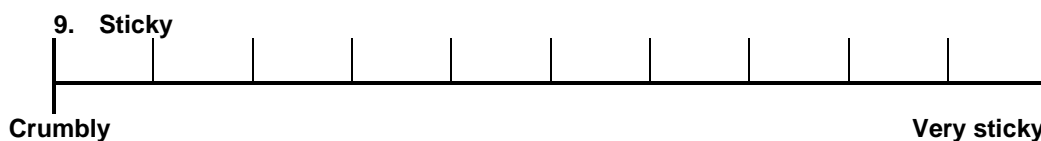
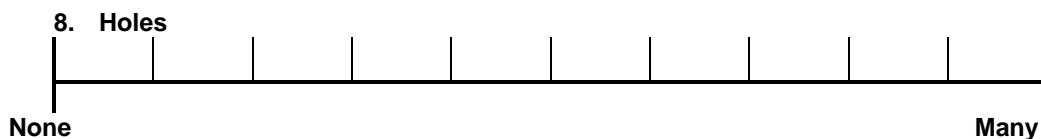
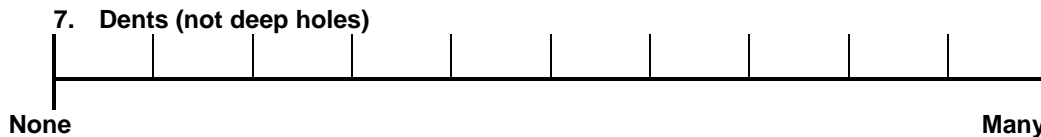
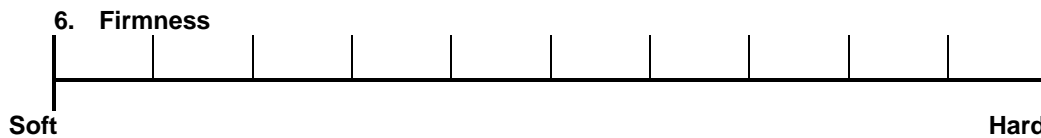
**AROMA:**

Lift container up to nose and put nose into container taking 2-3 good sniffs.



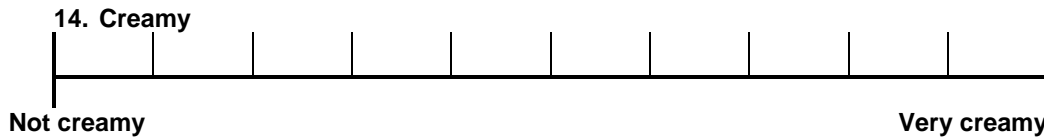
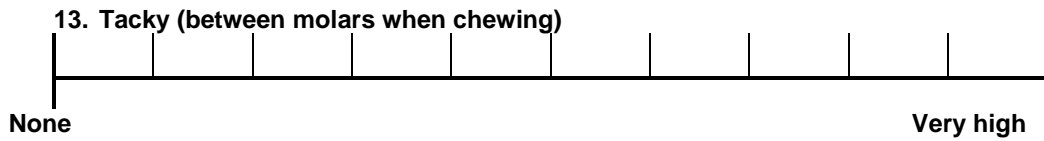
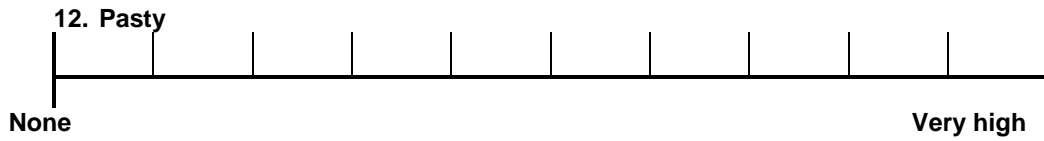
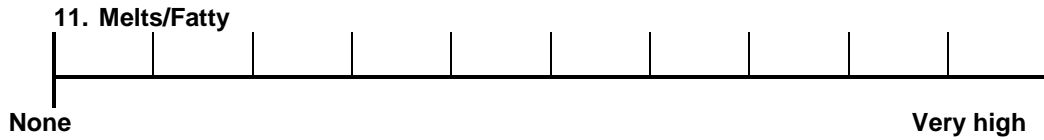
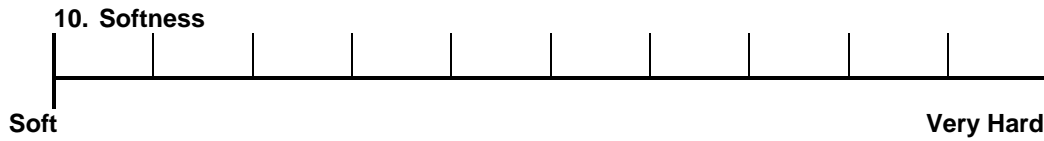
**APPEARANCE/TEXTURE:**

Cut sample in half to measure hardness. Then squeeze between thumb and middle finger 5 times.

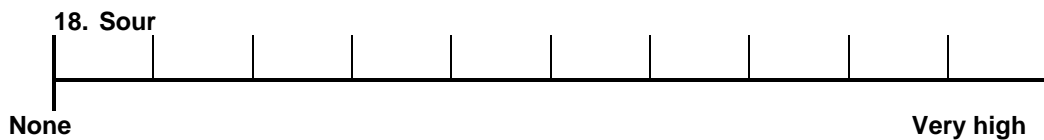
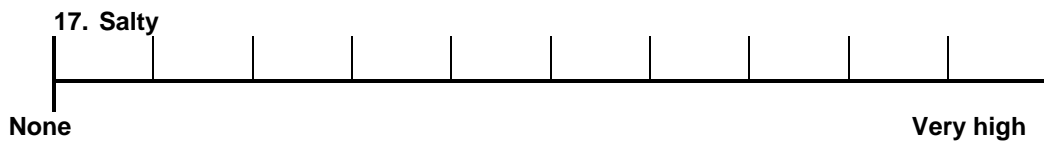
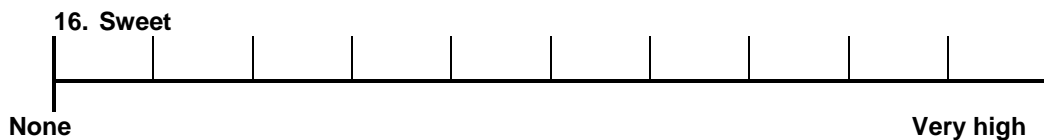
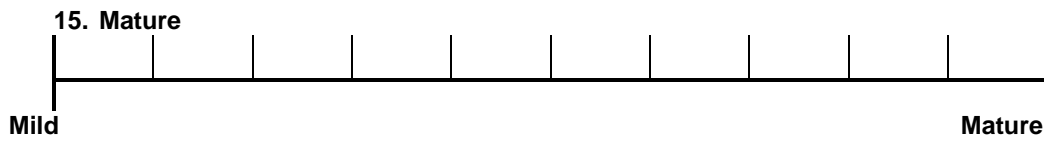


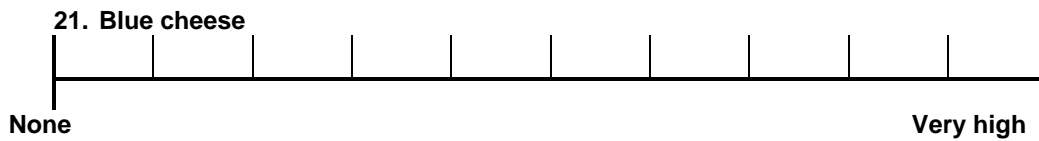
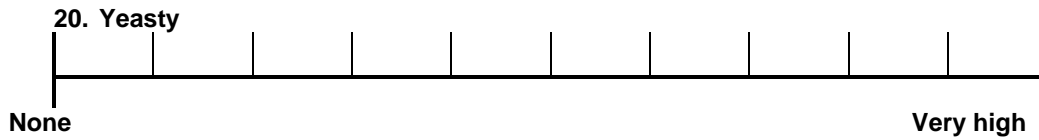
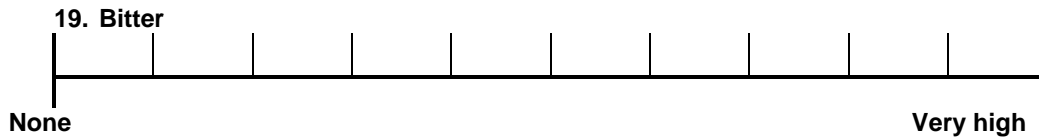
**MOUTHFEEL:**

Roll between palate and tongue – then chew – then swallow.

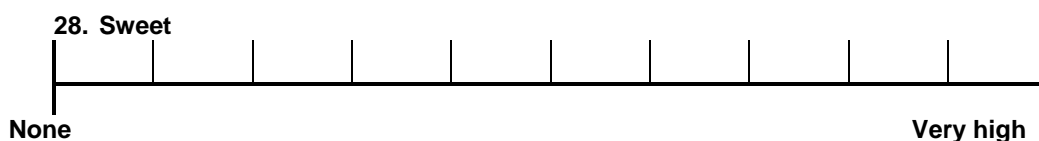
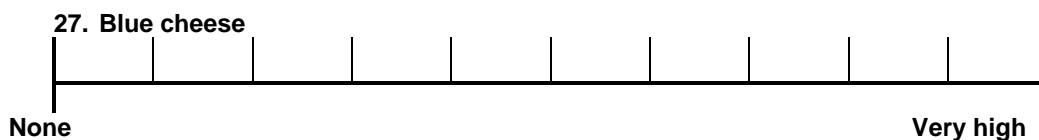
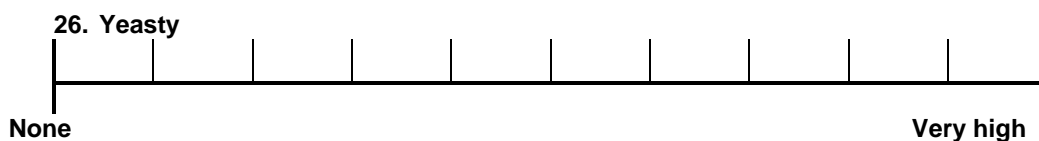
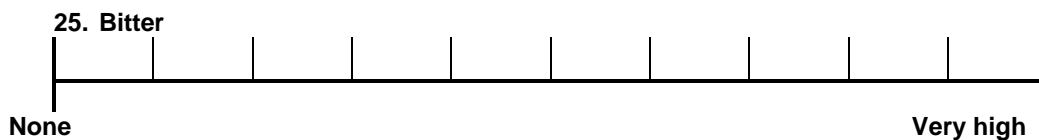
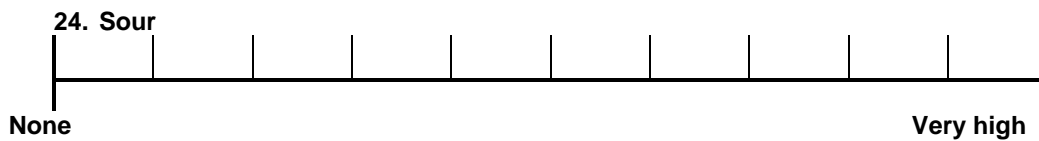
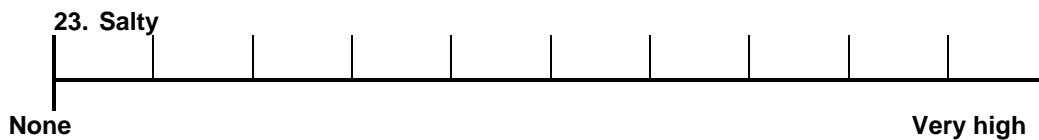
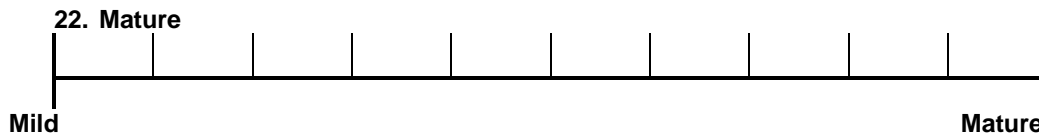


**TASTE:**

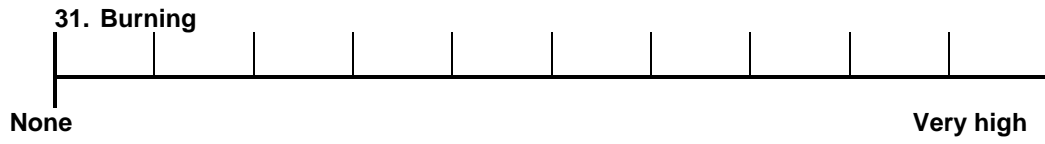
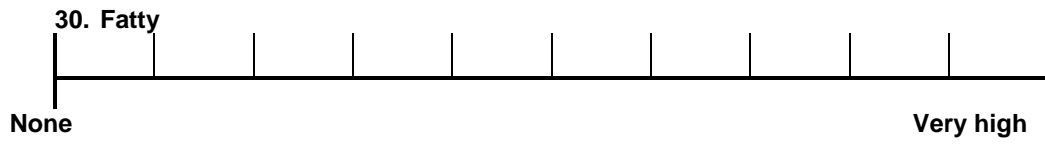
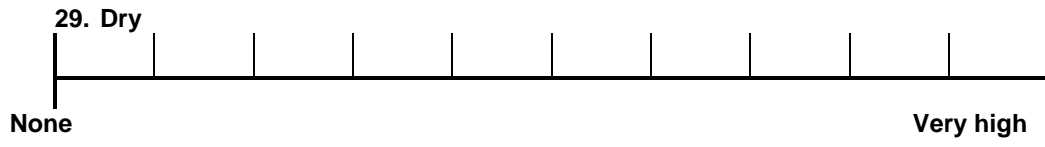




**AFTERTASTE:**



**AFTERFEEL:**



**Semi-naive assessor 8**

**Code:** \_\_\_\_\_

**AROMA:**

Open cup and smell 2-4 times.

1. **Sour**

None Very high

2. **Musty**

None Very high

3. **Sweet**

None Very high

4. **Buttermilk**

None Very high

**APPEARANCE/TEXTURE:**

Evaluate appearance looking at the whole product in cup. Texture – cut in half and press between first and third finger.

5. **Oily/fatty (appearance)**

None Very high

6. **Holes**

Small Large

7. **Cracks/veins**

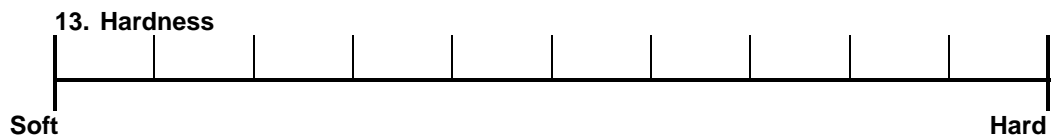
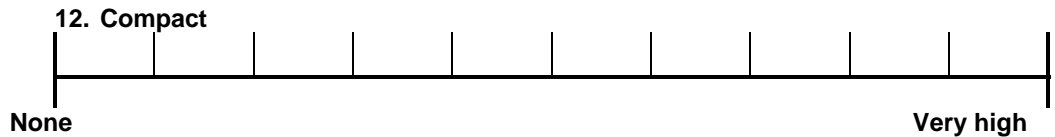
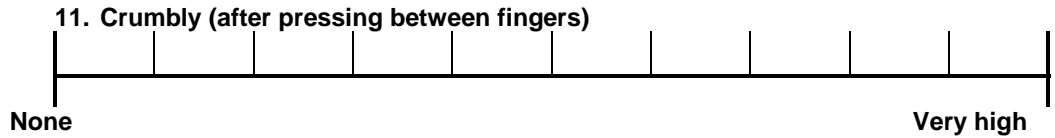
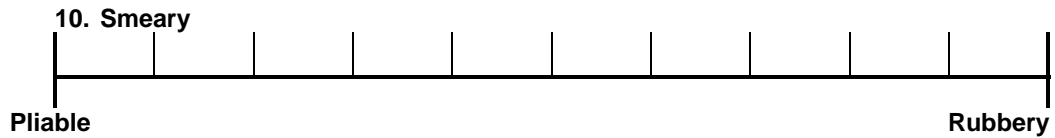
None Very high

8. **Smooth surface**

Not smooth Very smooth

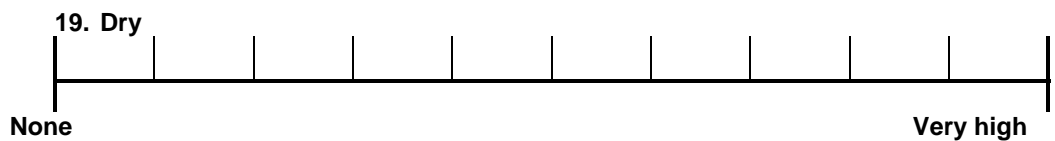
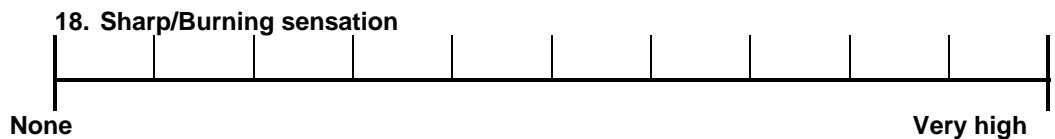
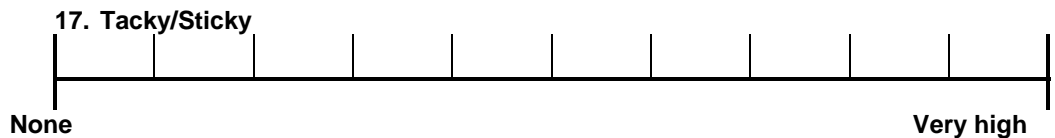
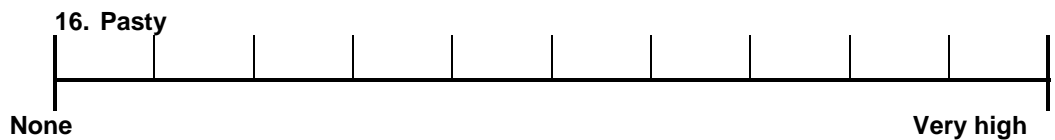
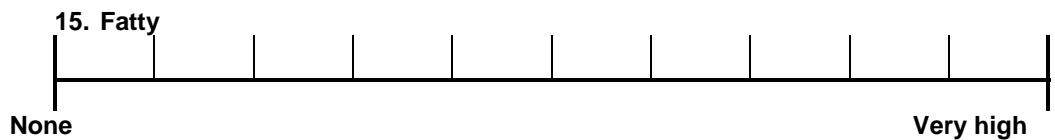
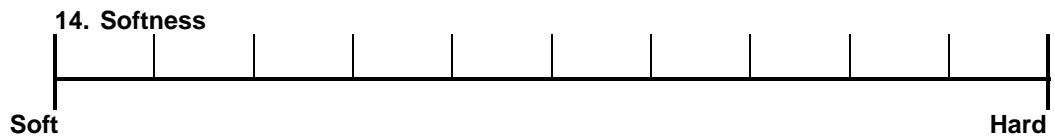
9. **Shiny**

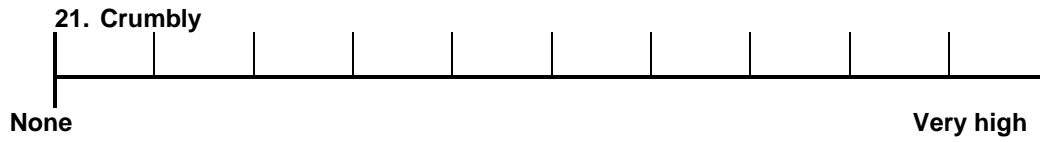
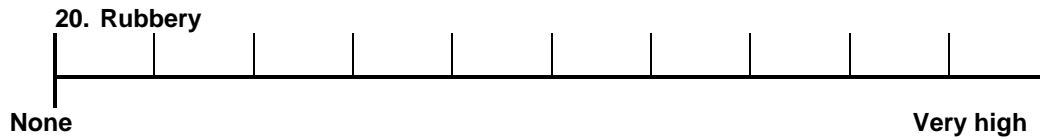
Dull/Matt Shiny



**MOUTHFEEL:**

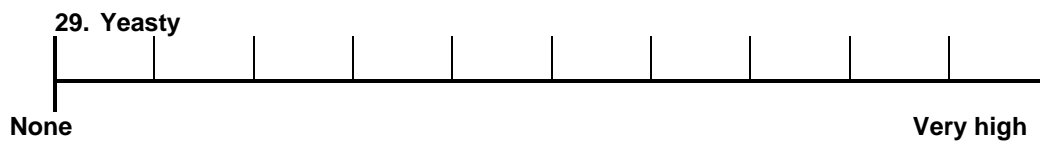
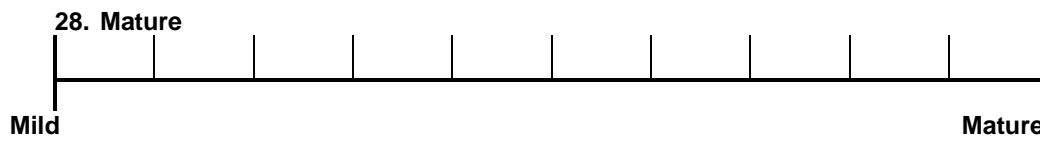
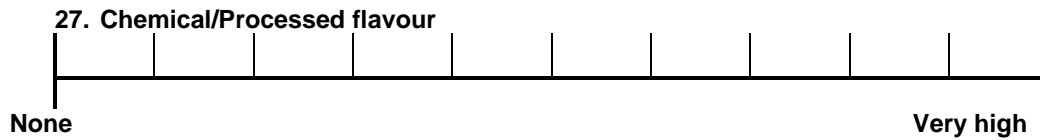
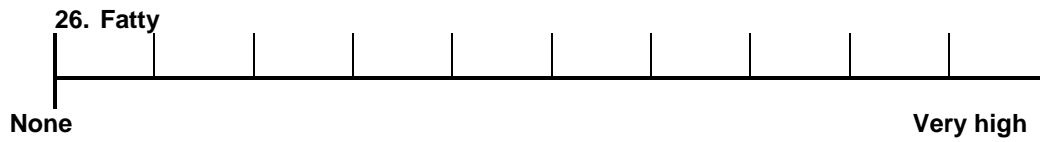
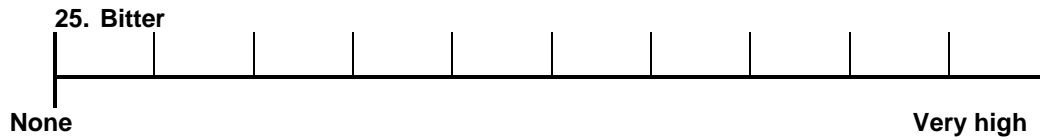
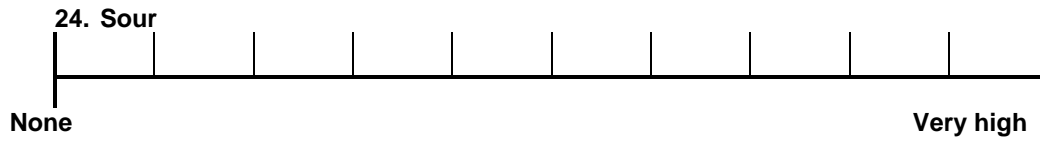
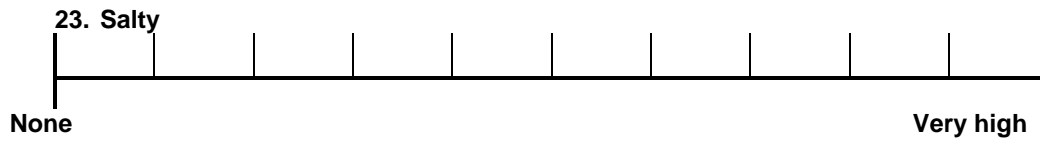
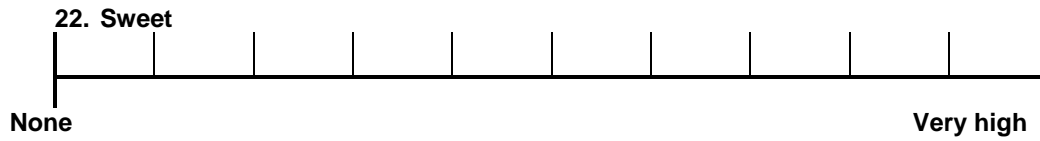
Take ½ cube in mouth press with tongue for 1 – 2 seconds against palate and chew further.



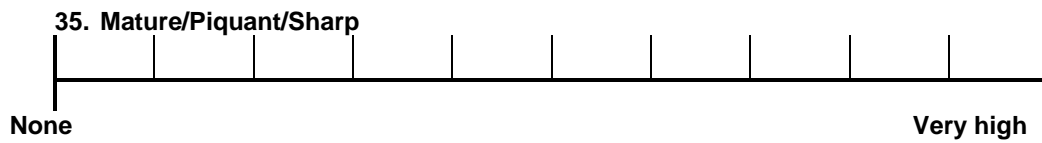
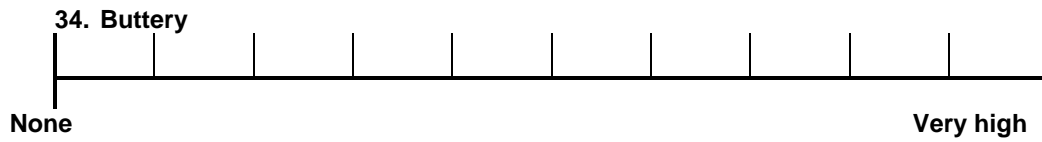
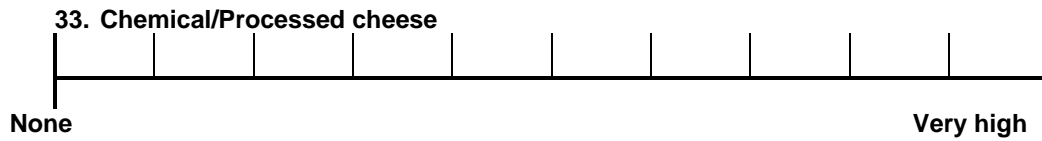
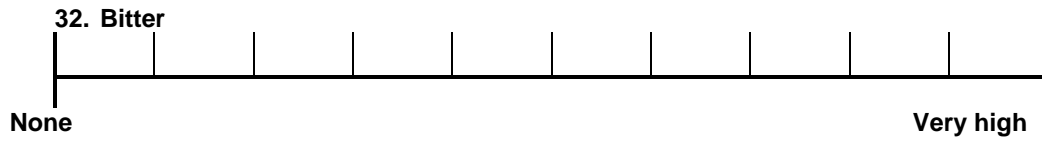
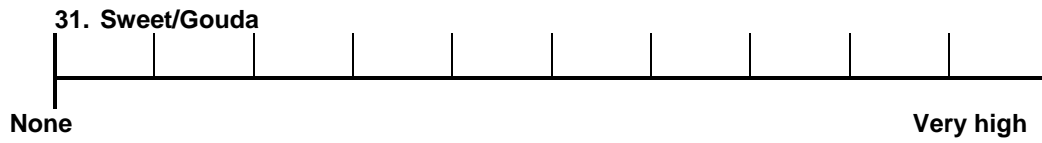
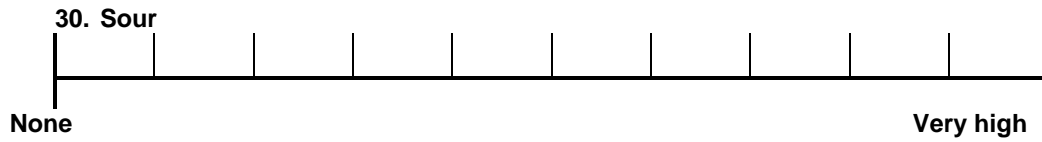


**TASTE:**

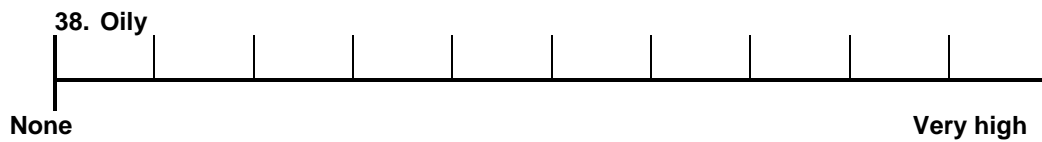
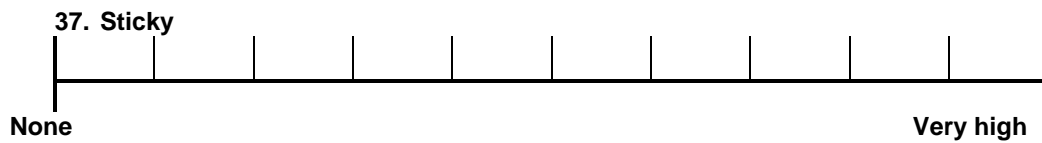
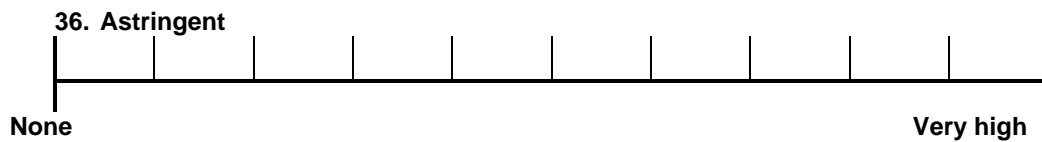
Taste other half of cheese.

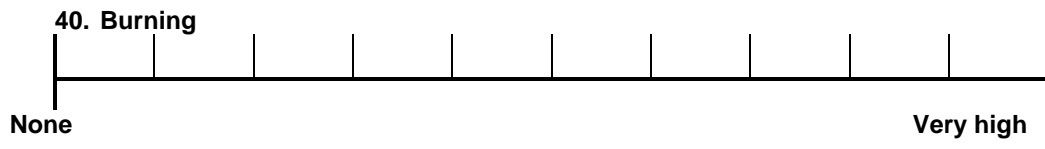
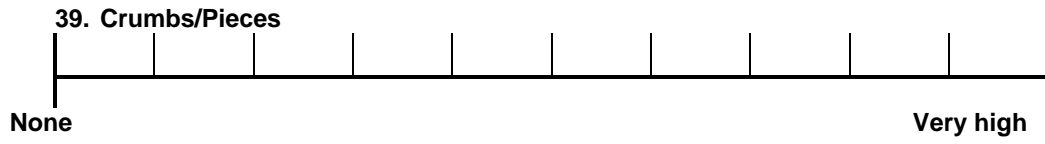


**AFTERTASTE:**



**AFTERFEEL:**





**Semi-naive assessor 9**

**Code:** \_\_\_\_\_

**AROMA:**

Take 3 good sniffs, while cheese stays in cup.

1. Sweet (Gouda)

None Very high

2. Buttery

None Very high

3. Nutty

None Very high

4. Salty (Brine)

None Very high

5. Yeasty

None Very high

6. Mature

Mild Mature

7. Sour

None Very high

**APPEARANCE:**

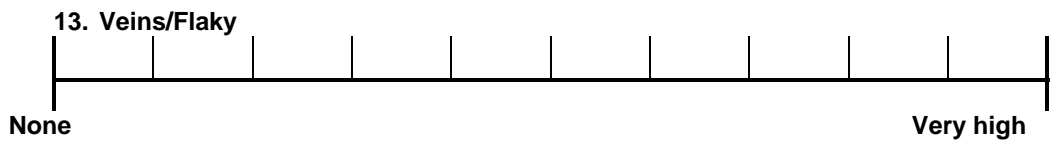
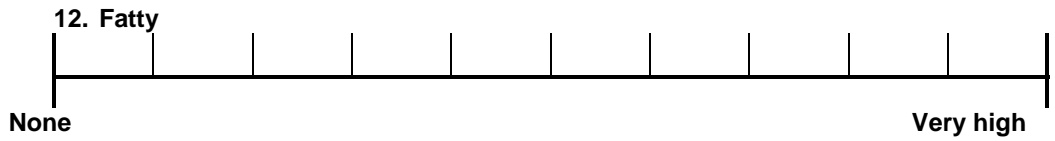
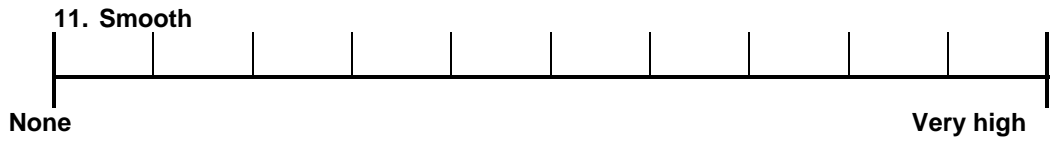
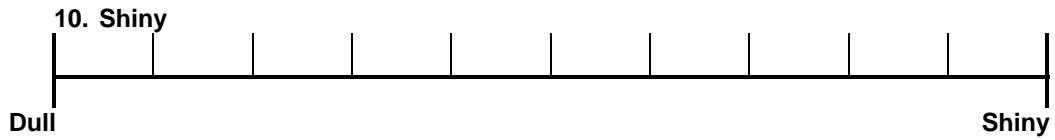
View from top.

8. Compact (appearance)

None Very high

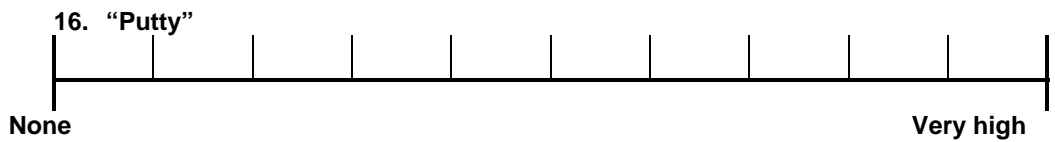
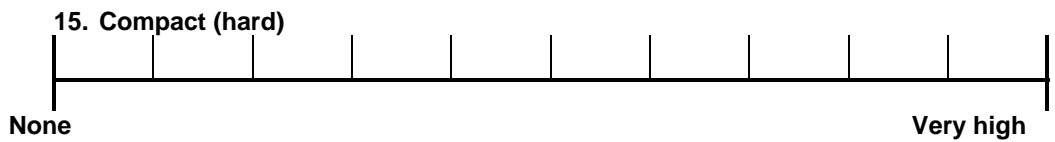
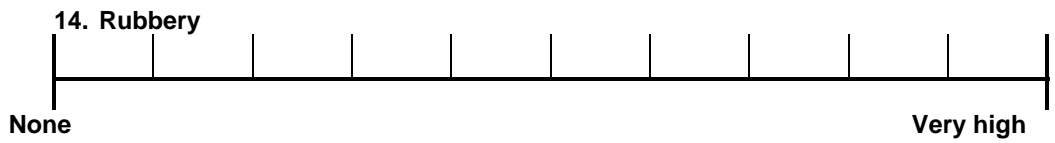
9. Holes

None Many (10)



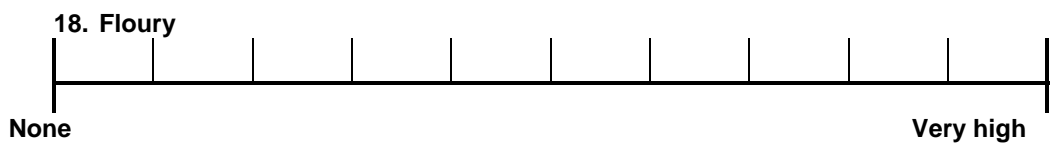
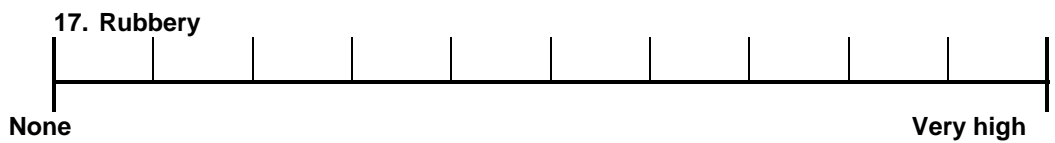
**TEXTURE:**

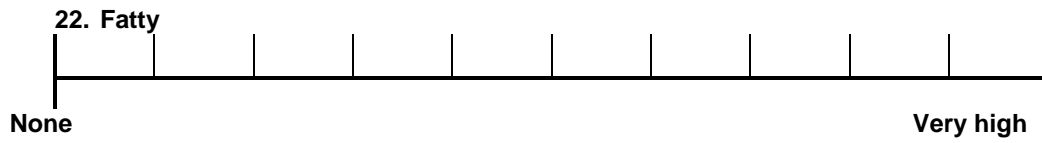
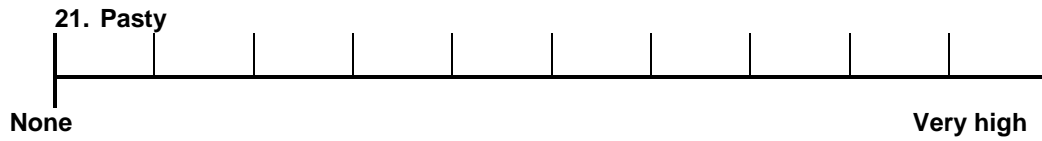
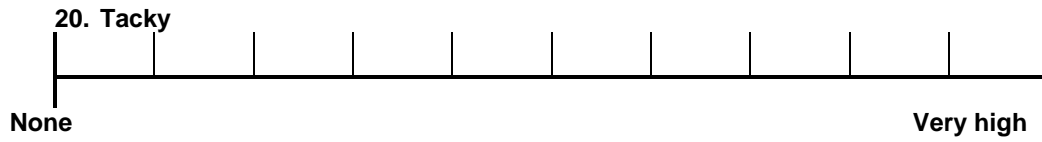
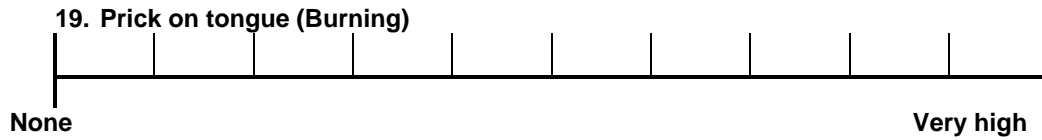
Cut in half and evaluate after pressed on sides 3 times.



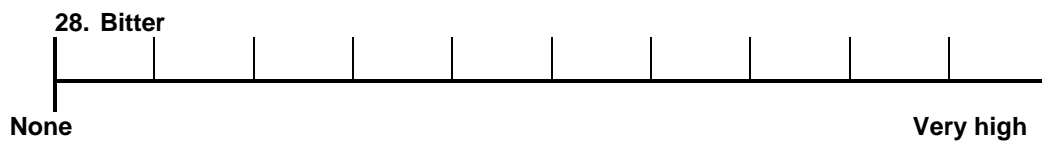
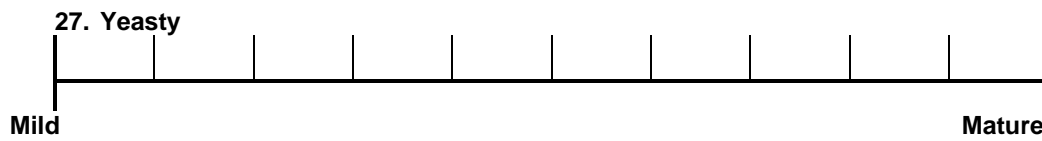
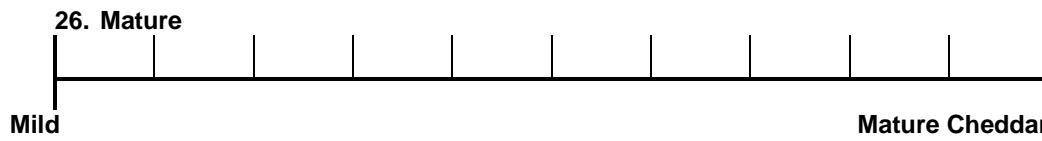
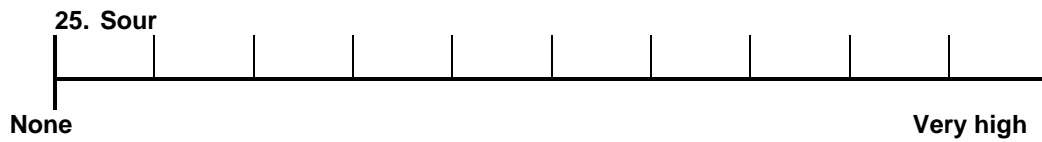
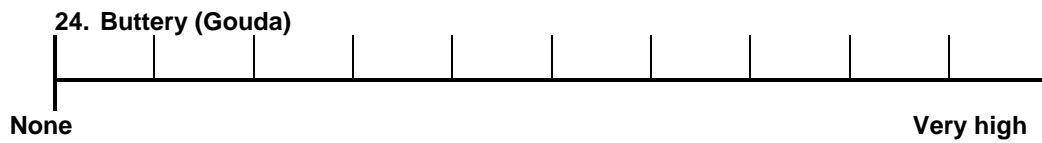
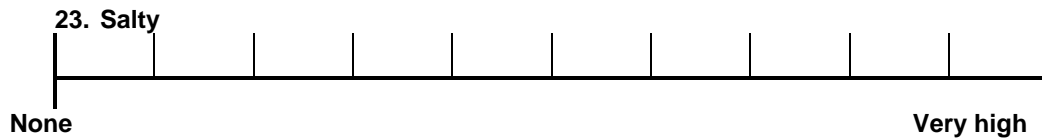
**MOUTHFEEL:**

Press the sample with the tongue against the palate and chew 10 times.



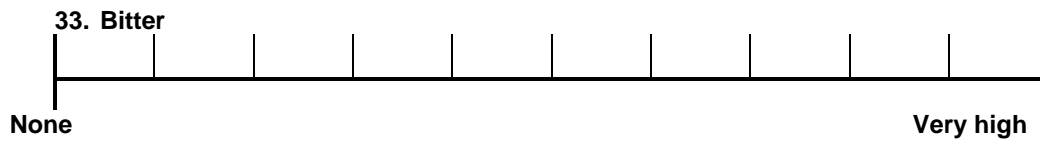
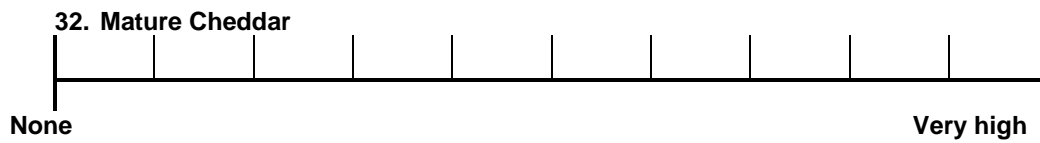
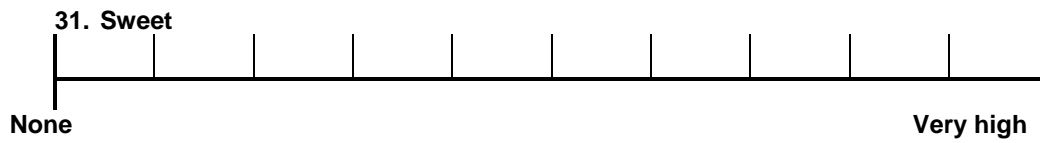
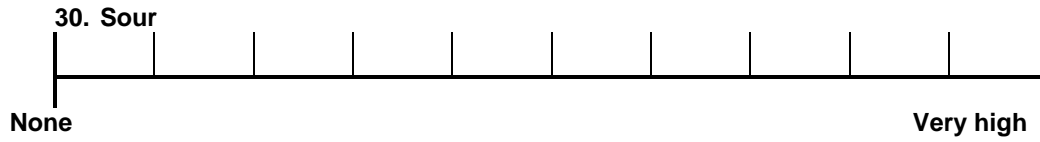
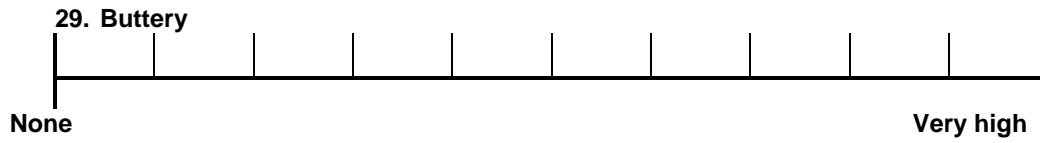


**TASTE:**



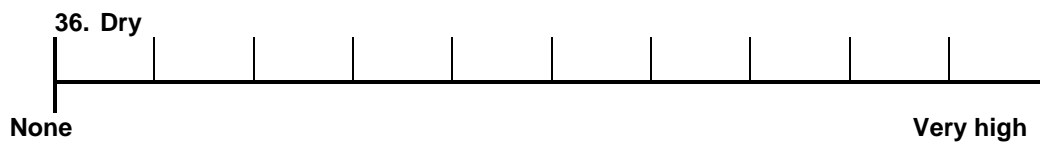
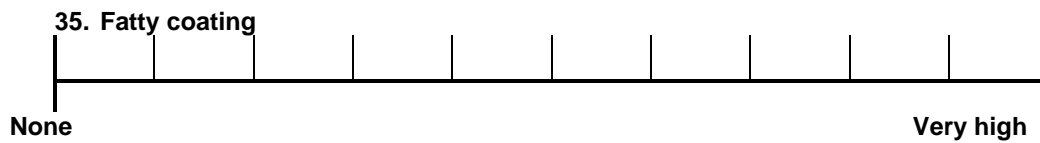
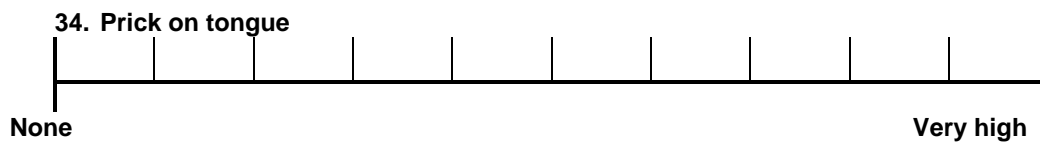
**AFTERTASTE:**

Taste one piece and roll in mouth.



**AFTERFEEL:**

Taste one piece and roll in mouth.

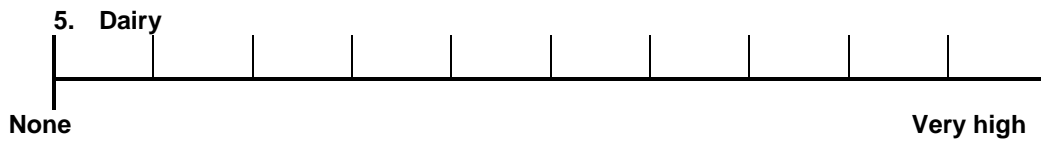
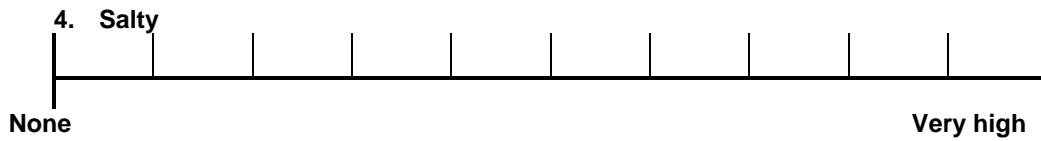
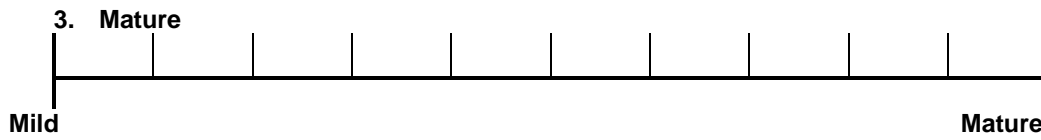
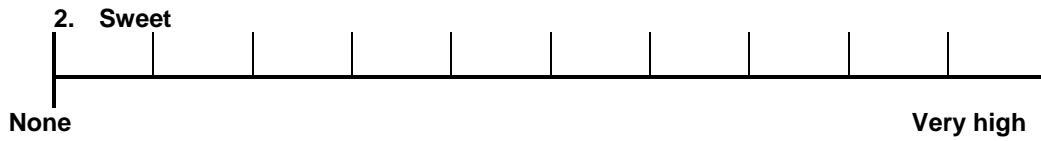
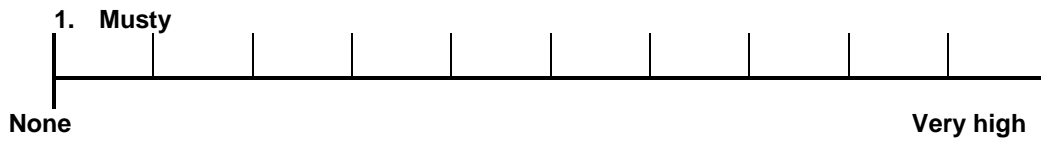


**Semi-naive assessor 10**

**Code:** \_\_\_\_\_

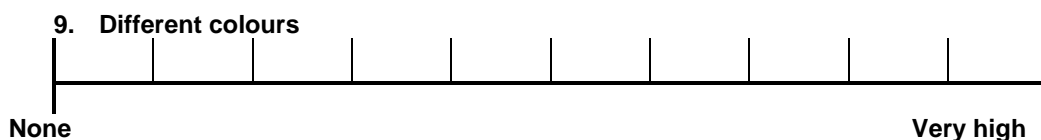
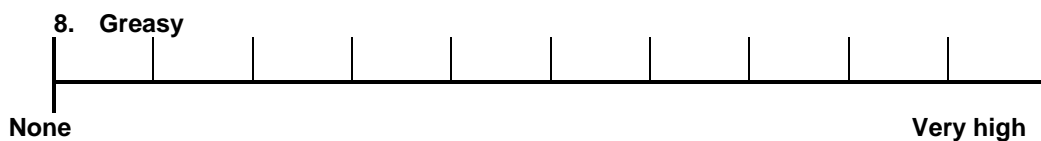
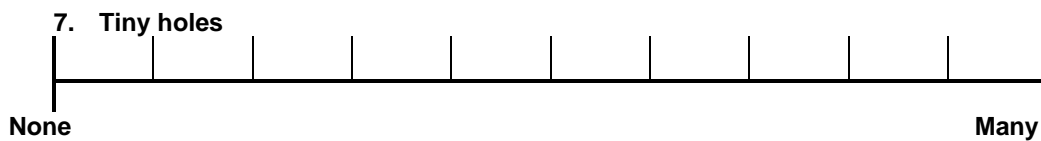
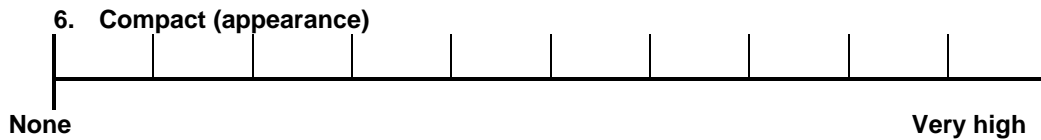
**AROMA:**

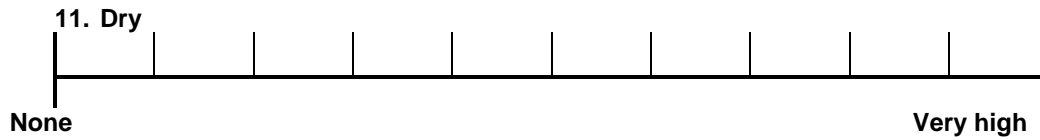
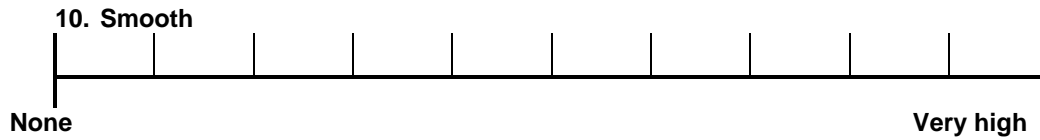
Open container and take 2 good sniffs.



**APPEARANCE:**

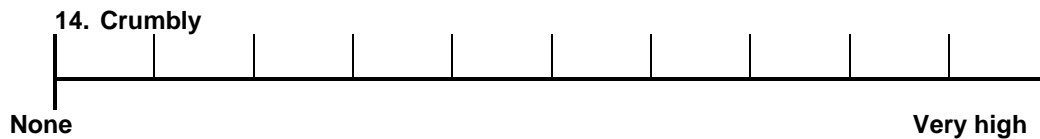
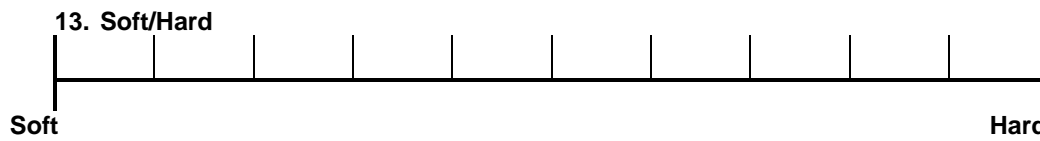
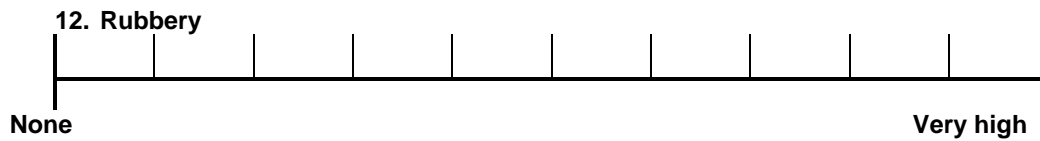
View from top while product is on tray and then cut in half.





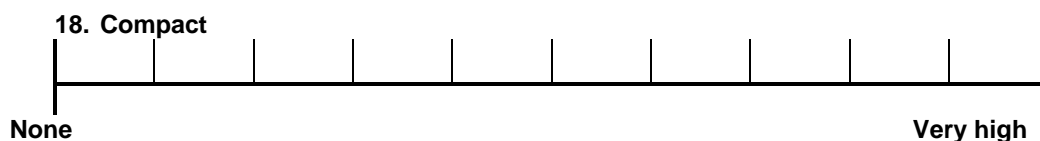
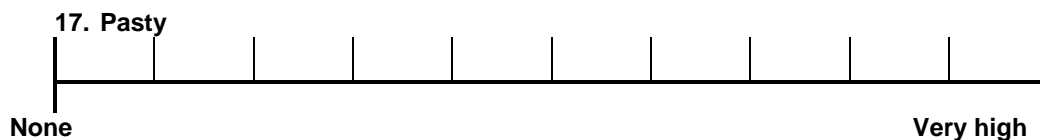
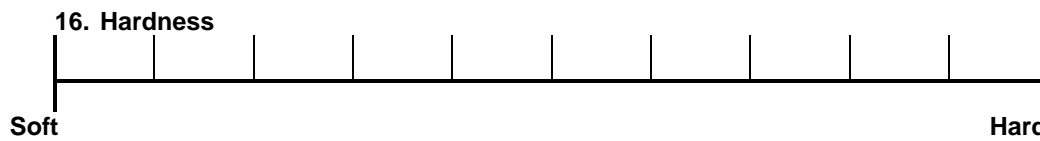
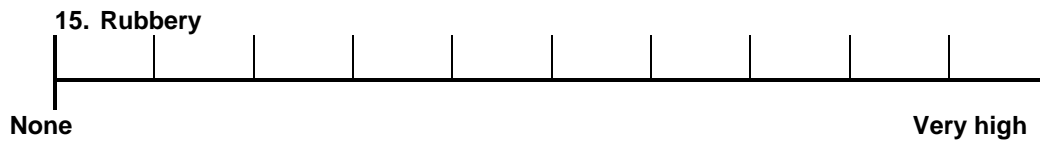
**TEXTURE:**

Cut in half and evaluate after pressed between fingers on sides 3 times.



**MOUTHFEEL:**

Roll in mouth against palate, chew and swallow.



19. Dry

None Very high

**TASTE:**

20. Tangy

None Very high

21. Creamy

None Very high

22. Salty

None Very high

23. Sour

None Very high

24. Sweet

None Very high

25. Bitter

None Very high

**AFTERTASTE:**

26. Salty

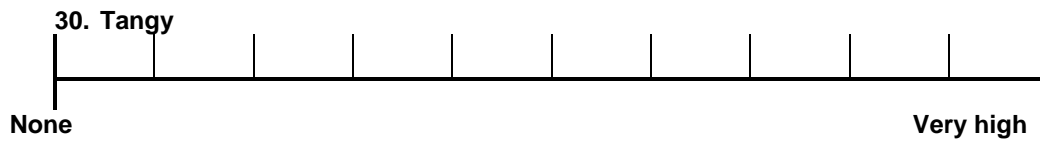
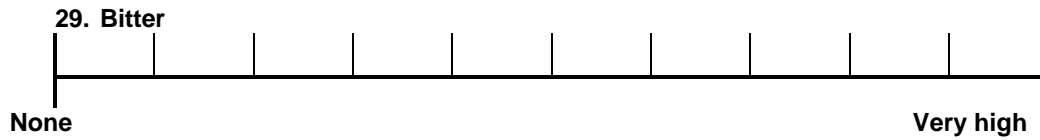
None Very high

27. Sour

None Very high

28. Sweet

None Very high



**AFTERFEEL:**

Taste one piece and roll in mouth.

