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Sensory characteristics of flavored milk candies

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SENSORY CHARACTERISTICS OF FLAVORED MILK CANDIES

A Thesis
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The Department of Food Science

by
Noemi Raquel Pavon
Lic. en Bromatologia, 2001
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ABSTRACT

A natural milk candy, composed mainly of milk powder, has not been commercially sold in the U. S. market. The milk candy we developed contains calcium and other essential nutrients, which make it a potential food supplement for adults and children. This thesis research was designed to characterize sensory properties of flavored milk candies and to determine the consumer sensory profile driving product acceptance and purchase intent. A descriptive trained panel (n=12) developed a lexicon and evaluated 3 milk candies (plain, chocolate, and coffee) in triplicate using a 15-cm line scale. 335 adult consumers evaluated acceptability of appearance, size/shape, texture, aroma, specific flavor, sweetness, and overall liking of three flavored milk candies. 92 children evaluated acceptability of overall liking of chocolate and plain flavored milk candies. Data were statistically analyzed. A lexicon included aroma notes: buttery, caramel, cheesy, and cooked; flavor notes: buttery, caramel, cooked, and sweet. Evaluations of the flavored milk candies revealed that they were different, based on descriptive sensory attributes. Cheesy aroma, buttery aroma and caramel aroma were discriminating attributes, while sweet and cooked flavors were least discriminating. Chocolate and coffee flavors may be used to mask strong undesirable cheesy and cooked flavor and aroma notes. Taste, specific flavor, overall liking and aroma were critical to acceptance of the products. Different flavors added to the milk candy caused a significant difference in the consumer responses toward sensory attributes evaluated. Acceptance of the three milk candies could be predicted by taste, specific flavor, sweetness, and overall liking. The purchase intent of flavored milk candies was positively influenced by flavor, overall liking, specific flavor and acceptance. Children liked the chocolate flavored milk candy better than the plain one. There were no significant differences in the way children and adults accepted chocolate and plain milk candies. Our survey indicated that
consumers would be more willing to buy flavored milk candies enriched with calcium and minerals that promote health benefit. Further consumer sensory studies together with marketing research are needed to confirm the outcome from this study and to warrant the potential of this new product in the US market.
CHAPTER 1. INTRODUCTION

Dairy products are the major source of calcium as well as other important nutrients, in human diet. Even though calcium is so important for human health, it is one of the nutrients most likely to be consumed in low amounts by children and adults. Data obtained from the 1994-96 Continuing Survey of Food Intakes by Individuals revealed that 71% of 6 to 11 years old girls and 62% of similar aged boys did not meet 100% of the recommended daily intake of calcium. Eighty eight percent females and 68% males between the ages of 12 to 19 years did not meet 100% of the calcium recommendation of 1,300mg/day. In addition, adult females failed to meet the recommended dietary allowance of calcium. The consumption of fluid milk among young children has decreased by 16% since the late 70’s (USDA, 1997). One of the reasons for this decrease in calcium intake may be due to the competition from other beverages, particularly soft drinks, fruit drinks and flavored teas (Crane and others, 2000). Children and adolescents have increased their intake of soft drinks, fruit drinks and fruit-flavored drinks at the expense of milk.

New value-added milk products are entering the market. Some examples are milks fortified with calcium, cultured milk fortified with multivitamins and minerals, flavored milks with banana, chocolate and strawberry flavors, new ready-to-drink blends of evaporated milk and black, green and chamomile teas with spices of cinnamon, ginger and clove. Milk powder has been used mainly as a food ingredient, but there is still a gap in the food market, which leads to the opportunity to arrive with a new food product of which milk powder could constitute the major proportion.

A natural milk candy, composed mainly of milk powder, and rich calcium and other nutrients, has not been commercially sold in the U. S. market. The milk candy represents a great in-between meal dietary snack. The flavored milk candy contains calcium, phosphorus, iron and
other essential nutrients, which makes it a potential food supplement for adults and children. It can be flavored with chocolate, coffee and other natural flavors.

Sensory tests, such as descriptive analysis and consumer affective tests, are regularly used to study food ingredient effects, processing variables and storage changes on the perceived sensory properties of food products. Sensory analysis provides marketers with an understanding of food product quality, directions for product quality, profiles of competing products, and evaluations of product reformulations from a consumer perspective.

This research was designed to characterize sensory properties of flavored milk candies and to determine the consumer sensory profile driving product acceptance and purchase intent.

This thesis is divided into 5 chapters. Chapter one provides a brief introduction and discusses the research justification. Chapter two presents a literature review of key concepts, which are related to this research. Chapter 3 explains the descriptive sensory analysis of the flavored milk candies where a sensory profile was developed for the products. Chapter 4 details consumer studies with adults and children giving information about responses of consumers regarding the flavored milk candies. Chapter five is an overall summary and conclusions of the research. Following chapter five is a list of references cited for this thesis. The final section is the appendices containing questionnaires for panelist screening for the descriptive analysis, consent forms, questionnaire for consumer studies with children and adults, and SAS codes. The last section concludes with a VITA of the author of this work.
CHAPTER 2. REVIEW OF LITERATURE

2.1 Dairy Products

Milk and other dairy foods are the major source of calcium in human diet. A glass of milk contains approximately 240 mg of calcium. Milk also provides other essential nutrients such as riboflavin, phosphorus, protein, potassium, vitamin A, vitamin B12 and niacin. The calcium from dairy products is readily bio-available. An individual’s body absorbs about 35% of the calcium contained in a dairy product (Heaney and others, 1988). Calcium digestion is facilitated by lactose ingestion (Schaafsma, 1980). On the other hand the calcium from non-dairy products may be absorbed at only 75% the efficiency of calcium from dairy foods (Heaney and others, 2000). Even though calcium is so important for human health, it is one of the nutrients most likely to be consumed in low amounts by children, adolescents, and adult. Data obtained from the 1994-96 Continuing Survey of Food Intakes by Individuals revealed that 71% of girls between the age of 6 to 11 years and 62% of similar aged boys did not meet 100% of the recommended daily intake of calcium. Among females and males with the age of 12 to 19 years, 88% and 68%, respectively, did not meet 100% of the calcium daily intake recommendation of 1,300mg/day. Adult females failed to meet the recommended dietary allowance of calcium.

Among the young children, consumption of fluid milk decreased by 16% since the late 70’s (USDA, 1997). One of the reasons for this decrease in calcium intake may be due to the competition of beverages, particularly soft drinks, fruit drinks and flavored teas (Crane and others, 2000). Children and adolescents have increased their intake of soft drinks, fruit drinks and fruit-flavored drinks at the expense of milk. Lactose intolerance is another important reason of why US consumers decline to drink milk.
Nevertheless, new value-added milk products are entering the market, and perhaps replacing the diminished market position of traditional fluid milk. Many of them stand out as being indicators of where the value-added milk products category is headed these years. According to the reports in the Dairy Foods Magazine, in late 1999, Suiza Foods (Dallas, TX) developed value-added milks geared to very specific needs, such as its “Milk Made Better” line is fortified with calcium. The 3 varieties include Kidsmilk (with 50% more vitamins), Fit milk (which is fat free but has the taste of low fat milk), and Life milk (for the 40+ age group). Dannon (Tarrytown, NY) brought its “Actimel” dairy-based dietary supplement from Europe to the U.S. It contains "a combination of beneficial cultures" and should be taken every morning to "keep the body at its best." Lancashire Dairies introduced in April, 2002 flavored milks with banana, chocolate and strawberry flavors.

The Havana Cappuccino Co has just launched to the market the new ready-to-drink Royal Mandalay Chai™, which is made with evaporated milk and a blend of black, green and chamomile teas with spices of cinnamon, ginger and clove. Cholesterol-reducing margarine spreads also made a big splash in the dairy category. Unilever Foods (Greenwich, CT) and McNeil Specialty Products (Fort Washington, PA) introduced margarines made with plant stanol esters, which help reduce blood serum cholesterol. Unilever’s Take Control and McNeil’s Benecol started with just margarine spreads (at three times the price of regular margarine) and branched out to salad dressings and snack bars.

Perhaps the most innovative among new products in the dairy industry today is the New Bottle Can (a re-closable aluminum beverage container that ranges in size from 300-500 ml). It is manufactured by Japan-based Daiwa Can Co., and Mitsui & Co., Ltd., and will initially be
imported to the United States. Ball Corp. (Broomfield, Colorado) has the exclusive rights to sell and distribute the container in the US (Berry, 2003)

Cheese introductions include the usual lineup of healthy, imported, pre-cut, shredded, and flavored varieties. Two companies offered cheese in unusual forms. Crystal Farms (Minneapolis) offered cheese in an aerosol can under the Cheezoids label, and Ariza Cheese, (Paramount, California) introduced Cheese U Squeeze, which comes in a toothpaste-like tube (Dairy Foods, 2002, 2003)

The 2002 consumption of whole milk powder in the US was 26 million tons compared with that in 1998 (52 million tons). On the other hand, non-fat milk powder had an increase in its consumption during 2002 of about 20%, compared with that of 1998 (USDA, 2002).

Milk powder is produced by removing water from pasteurized, homogenized liquid milk (whole fat, partially skimmed, or fat free), either by roller drying, freeze-drying, or spray-drying processes (Early, 1998). It possesses all the appealing qualities of milk and, in its dry form, is an important ingredient for manufacturing a wide range of food products. Whole milk powder has a shelf life of about 6 months (Early, 1998). Milk powder is a milk ingredient considered to be natural, nutritious, cost-effective and beneficial in its functionality. It has a particularly wide range of applications in the confectionery industry, namely for chocolate, toffee and caramel confections, ice cream, milk beverages, toppings and icings, recipe dishes, infant formula, breakfast cereals, soups and sauces, bakery products and coffee whiteners (Early, 1998).

Milk powder has been used mainly as a food ingredient, but there is still a gap, which leads to the opportunity to arrive with a new food product of which milk powder could constitute the major proportion.
2.2. Milk Candy

Traditionally, it has been believed that milk is a nutritional food itself. It does not need to be fortified or further processed to be positioned in the functional food market. This belief is not totally wrong, as milk is inherently a nutritional food. But, we live in a society of quick decisions and promises. New names and functional claims are the stamp of today’s food marketing space. Consumers want more from their foods. Therefore, the key word for the growth is innovation. Innovative products within the dairy segment may include milk-based products or milk as a carrier for good-for-you ingredients, and as an ingredient viewed as the good-for-you ingredient.

The Dairy Council of California conducted a survey in September 2002 where 40% of the respondents indicated that they purchased foods to improve their family’s health or prevent disease. Approximately 65% thought that dairy products could help decrease the risk of disease and/or optimize the health and wellness of one or more members of their families. Most of participating women believed that neither calcium fortified foods nor calcium supplements are good alternatives to dairy products (Berry, 2003). An increasing awareness of the role of diet and appropriate nutrition to maintain and improve health, as well as to prevent diseases has been emerging in the US.

An alternative for consumers to meet the recommended daily allowance of calcium are taking food supplements, such as multivitamin supplements containing calcium or chewable candies enriched with elevated percentages of calcium.

New products in the form of snacks have arisen in the food market as options for consumers to get their nutrients. Viactiv™ chews, from McNeil Nutritionals, PA, and CalBurst™ chews, from Nature Made®, CA, are some examples of chewable candies enriched with 500 mg of calcium and vitamin D. Flinstones® Bone Building Calcium Chews, from Bayer,
USA, is one of the first chewable enriched with 500 mg of calcium targeted for children from 4 to 18 years old. One disadvantage of these types of products, especially when targeted to children, is that if consumed in overindulgence, there is a risk of excess calcium intake, which can cause calcification of bones and soft tissues, and kidney stones. Another drawback is that these products may contain artificial colorants, flavors, and preservatives (i.e. Butylated Hydroxytoluene (BHT), Silicon Dioxide, Sodium Benzoate, Sodium Prussiate Yellow, Vanilla Flavor) making them less natural.

A natural milk candy, composed mainly of milk powder, which contains calcium and other essential nutrients, has not been commercially sold in the U. S. market. The milk candy represents a great in-between meal dietary snack. Each serving of 10 - 30 milk candies (10 to 30g) makes a healthy sustaining snack and provides a good source of additional energy. Compared to conventional snacks and sweet confectionery, the milk candy is a much less processed product. The flavored milk candy we developed contains calcium, phosphorus, iron and many other essential nutrients, which make them a potential food product for adults and children.

Calcium is a nutrient that can be obtained from several sources, such as dairy products, almonds, spinach, and meat. Dairy products are the most recommended source of calcium with relatively high bioavailability. Calcium plays a positive role in the prevention of osteoporosis, hypertension heart disease and other chronic diseases (Barasi, 1997; McCarron and Hatton, 1996; Welten and others, 1995). Calcium represents the most abundant mineral in the body, 99% is found in bones and teeth, while 1% is found in cells, blood, and other tissues (Di Rienzo, 2001). Recent studies recommended that the consumption of calcium could contribute to the
weight loss. Zemel and others (2000) have suggested that high calcium diets apparently inhibit lipogenesis.

Phosphorus is considered to be closely associated with calcium, as both are present in bones. This mineral is involved in all the functioning of the metabolic machinery. The United States recommended daily allowance of phosphorus is at 700 mg for adults and 500 mg for children (Institute of Medicine, 1997).

The recommended daily intake of Iron is 15 mg for adult females and 10 mg for adult males and 10 mg for children. Iron is essential to the formation of hemoglobin and myoglobin, which carry oxygen in the blood and muscles. It also makes up part of many proteins and enzymes in the body. Almost two-thirds of the iron in human body is found in hemoglobin (blood) (Barasi, 1997). There are two forms of dietary iron: heme and nonheme. Iron in meat, fish, and poultry is found in a chemical structure known as heme. The human body efficiently absorbs heme iron. Iron in plants such as lentils and beans, is arranged in a different chemical structure called nonheme iron. Flours, cereals, and grain products that are enriched or fortified with iron are good dietary sources of nonheme iron. Nonheme iron is not as well absorbed by human as heme iron. (Barasi, 1997). Iron deficiency is the most common nutritional deficiency worldwide. Although full-blown anemia is rarely evident, partial deficiency is widespread (Bread, 2001; Hershko, 2003). The addition of iron to infant formulas, cereals, and grain products has been credited with improving the iron status of millions of infants, children, and women (Clydesdale and others, 1985).

The milk candy is a versatile product. It can be produced to have a broad spectrum of target consumers. The milk candy can be fat-reduced or calorie-reduced, by lowering the content of fat or processed as sugar-free. This product can be targeted to either adults or to children. The
shape, size, flavor and color can be varied easily. Moreover, the milk candy can be enriched with
different additional essential nutrients, making it an advantageous and competitive functional
food product.

2.3. Sensory Evaluation and Statistical Analysis of Data

Food companies regularly use sensory tests, such as descriptive analysis and consumer
affective tests, to study ingredient effects, processing variables and storage changes on the
perceived sensory properties of their products. Sensory analysis provides marketers with an
understanding of product quality, directions for product quality, profiles of competing products,
and evaluations of product reformulations from a consumer perspective (Stone and Sidel, 1993).

Sensory evaluation techniques include: 1) Descriptive Sensory Analysis, 2) Discriminative Sensory Analysis, and 3) Consumer affective tests.

Descriptive Sensory Analysis has been widely used to characterize in detail aroma,
flavor, and oral texture attributes of food products. All descriptive analysis methods involve the
objective detection, description and quantification of sensory attributes of a product by trained
panelists (Meilgaard and others, 1999). Descriptive sensory techniques include Quantitative
Descriptive Analysis (QDA®), Flavor Profile Analysis (FPA), Texture Profile Analysis (TPA),
Free Choice Profiling, and Spectrum™ Descriptive Analysis.

Among the discriminating sensory tests, paired-comparison, duo-trio test, and triangle
test are the most commonly used. Basically they are utilized to detect differences between two or
more food products (Stone and Sidel, 1993).

Consumer affective tests can help the sensory scientist to understand the behaviour of
different consumers groups (Piggot, 1988), and therefore to understand potential buyers of the
product and in which way such a product can be inserted into the food market. Data obtained
from consumer affective tests represent key information in studies of product development, quality control, food product acceptance, and food service evaluation (Piggot, 1988). There are two types of affective tests, quantitative and qualitative. Qualitative tests (i.e., focus group interviews, focus panel, one-on-one interviews) measure subjective responses of a small group of representative consumers to the sensory properties of products by having them talk about their feelings in an interview or group setting (Meilgaard and others, 1999). Quantitative tests determine the responses of a large group of consumers to a set of questions regarding preference, liking, sensory attributes, etc. (Meilgaard and others, 1999).

Many food industries would like to get opinions from young consumers. The fact is that in the modern world, members of families have altered their tasks, increasing the number of working parents. These parents, who once controlled the food that was bought in the house, are allowing their children to make more decisions about the food that is consumed at home. Today’s kids have more choices and more control in their decisions (Popper and Kroll, 2003; Rodriguez, 2001). The number of adolescents in the US will reach 5.6 million in 2010. The purchasing power of children is increasing. Children are more informed than in the past and styles of consumerism are evolving (Sune and others, 2002). It can be thought children spend most their money on chocolates, sweets, and different types of confections. Manufacturers may think that changing and reducing size, intensifying colors and flavors, and giving more attractive shapes to food products, can master this market. But this does not always give helpful results. Therefore, it is constructive to study the taste perception and product acceptance by young consumers.

The American Society for Testing Materials’ (ASTM) Committee 18 is developing guidelines for sensory testing with children. As part of this program, the relationship between
children’s cognitive skills and their age has been studied. For example, the ability to understand scales does not exist until age three. At three to five years, children start to understand simple scales, but the use of sorting or identification tasks is more effective for obtaining feedback (Guinard, 2001). Children of five- to eight-year-olds increasingly understand scales; however, the scale and wording used should be simple. Pre-teens are “capable of understanding scaling concepts with adequate instruction,” and teenagers can understand scales similarly as adults do. Children between 7 and 11 years old are considered well developed, as they can discriminate between products through a set of sensory properties that they can define. They can also reason about what they taste and recognize sweet and sour. (Guinard, 2002; Rodriguez, 2001).

Some experiments were conducted with children. Kimmel and others (1994) found that children over two reliably performed a paired-preference test, and children as young as four could use a seven-point hedonic scale. Children three to six years old could express their degree of food liking using a three-, five-, and seven-point hedonic scale (Chen and others, 1996). The acceptability of lower-fat desserts by pre adolescent children was studied using the conventional 9-point hedonic scale (Bordi and others, 2001). Swaney-Stueve (2002) investigated the performance of young trained panels versus that of adult experts, concluding that children can describe foods similarly as adults.

In order to obtain objective and accurate interpretation, sensory evaluation data have to be statistically examined. The best display for understanding how to interpret sensory data involves two levels of analysis: univariate, and multivariate statistical methods. The two approaches have their advantages and limitations, and their uses will depend on the objective of the study, and also on the resulting data.
One of the most common univariate statistical analyses used is the Analysis of Variance (ANOVA). This technique compares the means of two or more samples and tests whether they belong to the same population (i.e., they are all the same); or whether they come from different populations (i.e., one or more are different) (O’Mahony, 1986). Following ANOVA, a post-hoc comparison test can be performed in order to obtain a more detailed understanding of the differences. Bonferroni’s test, LSD, Tukey’s adjustment, Duncan’s test, and Scheffé’s test represent different alternatives. ANOVA has been widely used in sensory evaluation. It is regularly the first step for the differentiation of perceived sensory attributes among food samples. Some applications of ANOVA in sensory works include the descriptive analysis in the characterization of espresso coffees (Maeztu and others, 2001), the development of a sensory profile of cheeses (Murray and Delahunty, 2000), the sensory description of fluid milk (Claassen and Lawless, 1992; Lawless and Claassen, 1993), the differentiation among milk formulated with different percentages of fat (Phillips and others, 1995). Patel and Gupta (1978) applied ANOVA to study differences among sensory defects perceived in different samples of milk powder. Kamath and others (1998) developed descriptive flavor profile for quality of commercial whole, partially skimmed, and skimmed milk powder samples. They executed analysis of variance in order to differentiate intensities of developed attributes in such samples. Differentiation of commercial soymilks was analyzed with ANOVA (Torres-Penaranda and Reitmeier, 2001).

ANOVA has been extensively performed to evaluate the differentiation in the acceptability of sensory attributes when conducting consumer affective tests (Hough and others, 1992; Murray and Delahunty, 2000; Yeh and others, 2002). ANOVA has also been applied for
the evaluation of the performance of trained panelists in descriptive sensory evaluation (Bantivoglio and Tepper, 1998; Hough and others, 1998; Noronha and others, 1995).

A range of multivariate statistical analyses can be helpful in the investigation of sensory data (Dijksterhuis, 1995). The majority of them include Multivariate Analysis of Variance (MANOVA), Descriptive Discriminant Analysis, Predictive Discriminant Analysis, Principal Component Analysis, General Procrustes Analysis, Cluster Analysis and Partial Least Square Regression (Dijksterhuis, 1995; Ennis, 1988; Muñoz, 1997; Powers, 1984, 1988; Resurreccion, 1988). Multivariate techniques can be useful for the determination of differences between individual trained panelists, differences among food samples, relationships between sensory and instrumental analyses, the relationship between descriptive sensory data and consumer data, and the understanding of consumer acceptance (Dijksterhuis, 1995).

Multivariate Analysis of Variance (MANOVA) can be viewed as an extension of ANOVA, in where more than one dependent variable is studied. It is used to assess group differences across multiple metric dependent variables simultaneously (Hair and others, 1998). However, MANOVA constitutes a technique that is insufficient by itself, and it is usually accompanied with other multivariate methods, such as Descriptive Discriminant Analysis. Researchers in sensory evaluation have utilized it for the determination of differences among food samples employing a group of sensory attributes concurrently (Hough and others, 1992; McNeil and others, 2002; Ahlgren and others, 2002), for the evaluation of trained panelists’ performance (Bantivoglio and Tepper, 1998; Martin and others, 2000; McEwan and others, 2002), and for the differentiation of food products based on hedonic evaluations (Hough and others, 1992; Martinez-Marroquin and others, 2002; Pacheco and others, 2000; Pavon and others, 2002; Walker and others, 2002).
Principal Component Analysis (PCA) is a technique based on the transformation of an original data matrix into a smaller set of unrelated or non-orthogonal composites that together account for most of the original matrix’s total variance. The objective is to explicate as much of the total variation of the data with as few principal components (PC) as possible (Allen and Rao, 2000). Each of the components is a linear combination of some of the original variables (Muñoz, 1997). Partial Least Square Regression (PLS) is a recent technique that generalizes and combines aspects from principal component analysis and multiple regression. It is principally useful for the prediction of a set of dependent variables from a set of independent variables (i.e., predictors) (Abdi, 2003). PLS is particularly useful when the number of factors is larger than the number of observations (over fitting) (Tobias, 1997). In these cases, even though the number of factors is large, there may be only a few underlying factors (variables) that account for most of the variation in the response. PLS tries to extract these factors, accounting for as much of the manifest factor variation as possible (Tobias, 1997).

PCA has been used and reviewed by researchers for various food products applications in the sensory evaluation area. PCA may be applied for the investigation of hedonic data thus can produce a product - consumer space based on the acceptance data (Hough and others, 1992; Greenhoof and McFie, 1994). It is also a tool to delineate differences in the relations among descriptive sensory attributes of food products (Powers, 1984). The relationship between consumer and descriptive data, as well as sensory and instrumental data can be clearly visualized by PCA. PCA was used to create an external preference map of powdered chocolate milk (Hough and Sanchez, 1998). The trained panelist performance can be monitored by PCA (McEwan and others, 2002; Powers, 1984). Ward and coworkers (1999) applied it to study acceptance of strawberry yogurt by children in European markets. Aguilar (1994) applied PCA
to analyze developed sensory characteristics of milk chocolate with lactose from spray-dried milk powder. Sensory characterization of ultra pasteurized milk was done with the aid of PCA (Chapman and others, 2001). Drake and others (2002) described sensory properties of milk powders. Prediction of consumer acceptance by descriptive data of domestic/ imported jasmine rice for US-Asian consumers was performed using PCA (Suwansri and others, 2002). PCA was used for mapping consumer perceptions of creaminess and liking of liquid dairy products (Richardson-Harman and others, 2000). Descriptive profile of commercial peanut butter products was analyzed with PCA (McNeil and others, 2002).

Weller and Stanton (2002) came up with a quality control measurement by combining instrumental data, consumer data, and descriptive data of cereal products. They applied PLS to visualize relationships. Hough and others (1992) applied PLS for the exploration of the sensory profile of “dulce de leche” (a dairy based confectionary). Sune and others (2002) compared sensory attributes used by children and experts to evaluate chocolate samples by PLS.

Generalized Procrustes Analysis is mostly used when free choice-profiling method is performed; by applying this technique two or more samples are matched in a multidimensional space by translation, scale change, rotation, and reflection. In other words, it first derives a principal component analysis-like space for each individual data and then matches these spaces through an iterative process. Some applications of this method to sensory analysis are described by Andani (2001), Saba and Rosati (2002), and McEwan (1989, 2002).

Cluster analysis (CA) is a technique that involves the use of mathematical and graphical tools to situate and define grouping of data (Muñoz, 1997). It is a procedure that groups variables or cases according to some measure of similarity (Resurreccion, 1988). Variables within a cluster (group) are highly associated with each other, while those in diverse clusters are relatively
different from each other (Hair, 1998). CA can be used for determining agreement between trained panelists (Powers, 1984; Yeh and others, 2002; Richardson-Harman, and others, 2000), and to differentiate products (McNeil and others, 2002; Noronha and others, 1995). Additionally, for hedonic evaluation, clustering is advantageous since consumers vary greatly in their likes or dislikes, according to cultural, age, and sex differences (Murray and Delahunty, 2000; Powers, 1984; Santa Cruz and others, 2002).

Descriptive Discriminant Analysis (DDA; Huberty, 1994) is a statistical technique that permits the examination of the correlation between metric independent variables and multiple dependent measures (Hair, 1998). It facilitates the study of interrelationships among sets of multiple dependent variables and multiple independent variables (Resurreccion, 1988). The canonical coefficient is an indicator of how discriminative a variable can be. A variable with canonical coefficient near 1.0 represents a good discriminant variable. On the other hand, a low value of canonical coefficient (far from 1.0) does not indicate discriminant properties. DDA is useful for obtaining discriminative variables in the differentiation of food samples, when descriptive sensory analysis was performed and also for the differentiation in acceptability of food products when consumers evaluated acceptance. Some applications of DDA are discrimination of odor and flavor attributes in commercial milk powders (Kamath and others, 1999), evaluation of acceptance of a new bite-size hamburger nugget (Nadarajah and others, 2002), discrimination in the performance of two independent trained panels (Martin and others, 2000), and determination of sensory attributes driving consumer acceptance and purchase intent of seafood sausages (Pacheco and others, 2000). Noronha and others (1995) applied it to evaluate panelists’ performance and differentiate milk gels using a group of texture descriptive attributes. Determination of discriminative texture attributes in ovine milk cheeses were studied employing
DDA (Irigoyen and others, 2002). Silversten and others (1999) applied DDA to evaluate similarities and differences between wines from the same region and from the different regions of origin.

Logistic Regression and Predictive Discriminant Analysis represent statistical methods that are useful when the objective is to predict a categorical variable (nominal or non-metric) (Hair and others, 1998). Logistic regression models are useful to describe the effect of predictors (independent variables) on a binary dichotomous response variable (dependent variable), which follows an S-shaped curve (Agresti, 1996). Results from Logistic regression can be interpreted either using estimated probability or estimated odds ratio. Logistic Regression can predict the estimated probability that one event will (success) or will not occur (failure) based on a number of predictors (independent variables) (Hair and others, 1998). If the predicted probability is greater than 0.5, the prediction is yes (success), otherwise no (Agresti, 1996). An odds ratio of 1 indicates total independence, translating to a null association between the probability of success of the predicted variable with the predictors variables. If independence exists, then the probability of success of the dependent variable cannot be predicted by the independent variable. In other words, the probability of success or failure of the dependent variable is not influenced by the independent variable. Negative odds ratio values indicate a decrease in the probability of success, and positive odds ratio values show increased probability of success (Hair, 1998). Logistic Regression has been applied in a few cases within the sensory evaluation area. Malundo and others (2001) studied the relationship between consumer and descriptive sensory data used for the identification of critical flavor properties of mango. They applied logistic regression on consumer responses and the outcome was expressed as probability of purchase related to descriptive attributes. Walker (200) explored the relationship between purchase intent/product
acceptance (dependent variables) and acceptability scores of sensory attributes (independent variables) evaluated by consumers in low fat sugar-free orange sherbet containing soy protein. Probability of purchase and product acceptance of bite-sized hamburger nuggets were predicted using acceptability scores of sensory attributes evaluated by consumers as predictors in a logistic regression model (Nadarajah and others, 2002).

Predictive Discriminate Analysis (PDA, Huberty, 1994) is a method that can be used for classification of unknown observations into known populations. This technique indicates how apparently unrelated variables work together to describe and differentiate among products (Muñoz, 1997). Percent hit rate is a common measurement used in PDA to classify observations. Hit rate (%) indicates how well independent variables can be used to predict the response (or group). Therefore, when hit rate (%) of a certain variable gets closer to 100%, better prediction is getting from the particular variable. Overall acceptability (yes/no) and purchase intent (buy/not-buy) for a low-fat sugar-free sherbet containing soy protein were determined using PDA (Walker and others, 2002). PDA was used to determine what attributes drive consumer sensory acceptance and purchase intent of a novel seafood sausage (Pacheco and others, 2000), and often formulations of chicken nuggets (Ahmenda and others, 1998).

A search of literature revealed no papers on the descriptive analysis and on the affective consumer study of flavored milk candies. The objectives of this research were to (1) develop a descriptive lexicon for flavor and aroma of flavored milk candies in order to understand differences among chocolate, coffee and plain milk candies (2) to identify consumer sensory attributes that drive consumer acceptance and purchase intent, and (3) to compare acceptance of flavored milk candies of adults versus children’s.
CHAPTER 3: DESCRIPTIVE SENSORY ANALYSIS OF FLAVORED MILK CANDIES

3.1. Introduction

Within the descriptive sensory analysis category, different techniques have been developed and applied. Flavor Profile Analysis (FPA) presents a written record of a list of product’s sensory aroma and flavor attributes, chemical feeling factors, and aftertaste. In FPA panelists first work individually to characterize different product attributes and assign intensity ratings on a continuous scale. A leader then conducts an open discussion and the group merges their individual results into the final profile (Meilgaard and others, 1999). The Texture Profile analysis is based on the principles of the Flavor Profile analysis. It is used to get textural dimensions of a food in terms of mechanical, geometrical, fat, and moisture characteristics of foods. The degree to which each is present; and the order in which they appear are taken into account. Quantitative Descriptive Analysis (QDA)® (Lawless and Heymann, 1998) utilizes an unstructured category scale not less than six trained panelists. It provides a means whereby assessors’ judgments are independent and the data is easily analyzed. Trained objective panels evaluate intrinsic product attributes such as appearance, odor, flavor, and texture (Moscowitz, 1994). Free choice profiling is based in the free descriptive evaluation of a food. This technique allows panelists to describe products using individual developed terms and score sheets. The data obtained are analyzed using Generalized Procrustes Analysis.

The Spectrum™ Descriptive Analysis is a detailed and accurate method used to obtain the description of a product’s sensory attributes. It provides information on the perceived sensory attributes, the intensities of each, and statistical evaluation of the descriptive data (Muñoz and Civille, 1992). The Spectrum™ technique may be applied a numerous applications such as food products, beverages, personal care and products, home care, paper, and other products.
The Spectrum™ method tends to be universal, which means that results obtained from the performance of a particular Spectrum analysis may be reproducible and get similar results, provided that the experiment is correctly done, with identical conditions.

In this study the Spectrum Descriptive Analysis was performed to evaluate the flavored milk candies.

Our preliminary study indicated that some U.S. consumers did not prefer the plain milk candy due to its strong oxidized, cheesy and cooked aroma. Therefore, another objective of this study was to determine if added chocolate and coffee flavor can be used to mask the less-desirable flavor.

The research involved (a) initial panelists screening, (b) panel orientation and training, (c) product evaluation, and (d) statistical data analysis and interpretation.

3.2. Materials and Methods

3.2.1. Sample Description

The milk candy is a proprietary food product imported from Thailand. It is composed of 79% milk powder and 21% sugar. The plain (without added flavor), chocolate (chocolate flavor added), and coffee (coffee flavor added) milk candies were evaluated. Each candy tablet weighs 1 gram and the product is packaged in an aluminum pouch for protection from light, humidity and foreign odors. Each package contains 100 pieces of candy. Twenty grams of product contain 94.2 mg of calcium, 90.8 mg of phosphorus, 5.6 mg of iron, and 2.64 g of protein, providing 95.4 kcal energy.

3.2.2. Panel Selection and Training

Fourteen panelists were recruited from Louisiana State University. They were pre-selected on the basis of good health conditions, time availability, no allergy to dairy, chocolate
and coffee products, any aversion to dairy products and willingness to participate. Panelists were then subjected to preliminary acuity tests to investigate their ability to recognize basic taste in solution, basic aromas, and to describe basic attributes related to dairy products. After the screening process twelve panelists were selected. Five panelists were female and seven were male in the range of 18-35 years old of age.

Training consisted of: (1) Initial orientation session where panelists received detailed explanation about the descriptive sensory methodology and general description of the milk candy product, (2) group meetings for lexicon development and selection of reference standards, which required ten 1-hour sessions and (3) individual training on the developed lexicon, which required ten 30-minutes sessions.

During opening sessions panelists took part in a lexicon-generation exercise. They were provided with the three samples (plain, chocolate and coffee flavors), which were diluted in 2%-fat milk. They were asked to smell and taste them and list as many aromas and flavor terms as possible for each sample and discuss individual results to come up with a consensus. Figure 3.1 illustrates the panel during a group training session.

Throughout subsequent sessions panelists were exposed to different reference samples and they practiced the lexicon development process. During the last two sessions panelists checked the developed lexicon and reduced the number of terms by eliminating redundant ones or those for which panelists could not reach consensus, agreed on precise definitions of the terms, and selected standards needed to describe them. After the final session, panelists had agreed on a list of eight clearly defined terms, the appropriate reference standards and their intensities on the 15-cm intensity line scale (Table 3.1 and Table 3.2).
Panelists attained individual training on the different intensities of the developed lexicon (Tables 3.1 and 3.2) using a 15-cm line scale. They worked in partitioned booths, with positive airflow, free from distracting noises and odors. They were provided with room-temperature drinking water, unsalted crackers and an expectoration cup to cleanse their palate.

3.2.3. Product Evaluation

The twelve panelists evaluated plain, chocolate and coffee flavored milk candies (Figure 3.2) using the developed lexicon, which included four aroma and four flavor attributes (Table 3.1 and Table 3.2). Figure 3.1 illustrates panelists during one of the group training sessions. They were seated in a conference-type table to facilitate communication. Samples were placed in 2oz. plastic cups; three tablets were served for each sample. The panelists evaluated three samples once during a 60-minutes session and the evaluation was repeated two more times. Figure 3.3 shows one of the trained panelists performing the evaluation. The three evaluation sessions were
separated by at least one hour to eliminate flavor carryover and fatigue effects. Panelists worked in partitioned booths, with positive air flow, free from noise and odors, and under red light in order to mask different colors of the three samples, and therefore to prevent bias. The panelists were instructed not to swallow the samples, and were asked to rinse their palate well with water between samples. For this purpose, panelists used room-temperature drinking water and unsalted crackers. Subjects recorded the intensities of the attributes on the 15-cm scale, where zero indicates the absence of intensity, and fifteen corresponds to an extreme intensity.

3.3. Data Analysis

The data were analyzed using univariate and multivariate statistical analysis. Analysis of Variance (ANOVA, proc mixed, SAS version 8.2, 2001) was performed to determine significant effects of the attribute intensities in each of the three flavored milk candies.

A significant F-ratio ($\alpha < 0.05$) from the ANOVA indicated that an attribute was used to find differences among the three flavored milk candies. The Tukey’s adjustment post-hoc test was performed to study individual significant differences among the three milk candies.

Multivariate Analysis of Variance (MANOVA) was used to determine differences among the three milk candies, expressed in terms of mean vectors of the eight sensory attributes (buttery aroma, cheesy aroma, caramel aroma, cooked aroma, cooked flavor, sweet flavor, buttery flavor, and caramel flavor). Descriptive Discriminant Analysis (DDA, proc candisc SAS version 8.2, 2001) was applied to identify sensory attributes that essentially emphasized differences among the three flavored milk candies. When applying this technique, canonical coefficients are calculated. The highest value for canonical coefficient is 1.0, which indicates perfect discrimination. When the canonical coefficient of a variable gets closer to 1, such variable is a discriminating variable.
**Figure 3.2:** Three flavored milk candies

**Figure 3.3:** A trained panelist performing sensory evaluation of flavored milk candy in partitioned booth under red light
Table 3.1: Flavor attribute: definitions and corresponding reference standards used in the trained panel evaluation

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Reference/Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWEET</td>
<td>Taste on the tongue stimulated by sugars and high potency sweeteners.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-16% sucrose solution</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>-10% sucrose solution</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>- 8% sucrose solution</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>- 5% sucrose solution</td>
<td>5.0</td>
</tr>
<tr>
<td>CARAMEL</td>
<td>Sweet aromatic associated with characteristic of browned sugars and caramelized sweetened milk.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Caramelized condensed milk Carnation Nestle (cooked in water bath at 100°C for 2.30 hrs)</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>-20% caramelized condensed milk Carnation Nestle (cooked in water bath at 100°C for 2.30 hrs) in 1% fat milk solution</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>- Caramel candy Kraft</td>
<td>11.0</td>
</tr>
<tr>
<td></td>
<td>- 10% caramelized condensed milk Carnation Nestle (cooked in water bath at 100°C for 2.30 hrs) in 1% fat milk solution</td>
<td>5.0</td>
</tr>
<tr>
<td>COOKED</td>
<td>Aromatic associated with heated milk, UHT milk, burnt milk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-UHT 2% fat milk Parmalat microwaved 30 sec</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>- UHT 2% fat milk Parmalat</td>
<td>6.0</td>
</tr>
<tr>
<td>BUTTERY</td>
<td>Aromatic associated with fresh butterfat, sweet cream</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-0.4% butter flavor GIVAUDAN #528090 in 1%fat milk solution</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>-0.3% butter flavor GIVAUDAN #528090 in 1%fat milk solution</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>-0.1% butter flavor GIVAUDAN #528090 in 1%fat milk solution</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Table 3.2: Aroma attribute: definitions and corresponding reference standards used in the trained panel evaluation

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>Reference/Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEESY</td>
<td>Aromatic associated with skim milk, dairy products or cheese.</td>
<td>-American Cheese Kraft 15.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Velveeta Cheese Kraft 13.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Cheese/handy-snack Kraft 8.0</td>
</tr>
</tbody>
</table>
| CARAMEL | Sweet aromatic associated with characteristic of brown sugars and caramelized sweetened milk.                                             | - Caramelized condensed milk
          |                                                                                                                                           | Carnation Nestle (cooked in water bath at 100ºC for 2.30hrs) micro waved 30’ 13.0 |
|         |                                                                                                                                           | -20% caramelized condensed milk
          |                                                                                                                                           | Carnation Nestle (cooked in water bath at 100ºC for 2.30hrs) microwaved 30’ in 1%fat milk sol 8.0 |
|         |                                                                                                                                           | -10% caramelized condensed milk
          |                                                                                                                                           | Carnation Nestle (cooked in water bath at 100ºC for 2.30hrs) microwaved 30’in 1%fat milk sol 4.0 |
| COOKED  | Aromatic associated with heated milk, UHT milk.                                                                                             | -UHT 2% fat milk Parmalat microwaved 30sec 10.0                                        |
|         |                                                                                                                                           | -UHT 2%fat milk Parmalat 4.0                                                          |
| BUTTERY | Aromatic associated with fresh butterfat, sweet cream.                                                                                      | -0.4% butter flavor GIVAUDAN #528090 in 1%fat milk solution 15.0                       |
|         |                                                                                                                                           | -0.3% butter flavor GIVAUDAN #528090 in 1%fat milk solution 10.0                       |
|         |                                                                                                                                           | -0.1% butter flavor GIVAUDAN #528090 in 1%fat milk solution 6.0                        |
Principal Component Analysis (PCA Unscrambler® v8.0, CAMO 2003) was executed to evaluate attributes and attribute-sample relationship. This technique is based on the transformation of an original data matrix into a smaller set of non orthogonal composites that together account for most of the original matrix’s total variance. The objective is to explicate as much of the total variation of the data as possible with fewer principal components (Allen and Rao, 2000).

3.4. Results and Discussion

3.4.1. Analysis of Variance (ANOVA)

The model used for the analysis of the descriptive sensory evaluation was a randomized block design, in which panelists were considered as blocks. ANOVA was executed using the SAS mixed procedure (SAS version 8.2, 2001). Table 3.3 shows the means, standard deviations and Pr > F values for the intensities of each of the attributes evaluated in each of the three flavored milk candies.

The cheesy aroma (P < 0.0001), buttery aroma (P = 0.0006), caramel aroma (P = 0.0002), cooked flavor (P = 0.005), caramel flavor (P = 0.007), and buttery flavor (P = 0.03) showed significant differences in their intensities among the three milk candies. Cooked aroma (P=0.2) and sweet flavor (P = 0.8) were not significant different among the three samples.

The Tukey’s adjustment post-hoc test indicated that cheesy aroma and buttery aroma had different intensities in the plain milk candy compared with the chocolate and the coffee flavored milk candies. Cooked aroma and sweet flavor were not different among the three milk candies. Caramel aroma intensities were different among the plain, chocolate and coffee candies. Buttery flavor and caramel flavor had different intensities when comparing plain milk candy with chocolate and coffee samples (Table 3.3).
### Table 3.3: Means, standard deviations and analysis of variance for aroma and flavor attributes of the three flavored milk candies

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Flavored milk candies</th>
<th>Pr &gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plain</td>
<td>Chocolate</td>
</tr>
<tr>
<td>Buttery Aroma</td>
<td>6.6 ± (2.9)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.9 ± (3.2)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cheesy Aroma</td>
<td>5.4 ± (1.9)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.0 ± (1.8)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cooked Aroma</td>
<td>5.9 ± (3.2)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.9 ± (2.7)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Caramel Aroma</td>
<td>3.6 ± (3.0)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.3 ± (2.7)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cooked Flavor</td>
<td>8.7 ± (2.1)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.3 ± (2.3)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Buttery Flavor</td>
<td>5.2 ± (2.4)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.8 ± (2.2)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sweet Flavor</td>
<td>7.7 ± (1.8)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.8 ± (1.7)&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Caramel Flavor</td>
<td>7.1 ± (3.2)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.8 ± (2.0)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Means in each row having different superscripts are significantly different (P ≤ 0.05)

#### 3.4.2. Overall Product Differences- Pooled within Canonical Structure r’s

Multivariate Analysis of Variance (MANOVA) indicated that all three flavored milk candies were different overall (Wilks’ Lambda Pr >F < 0.0001, Table 3.4). Descriptive Discriminant Analysis (DDA, proc candisc SAS version 8.2, 2001) was performed in order to determine which attributes emphasized the differences among the three flavored milk candies. The first (90%) and second (10%) dimensions of pooled within canonical structure (Table 3.5) together explained 100% of the variability. They revealed that cheesy aroma (0.71), buttery
aroma (0.68), and caramel aroma (0.74) were discriminating attributes, while cooked aroma (0.13) and sweet flavor (0.01) were least discriminating attributes.

**Table 3.4: Multivariate analysis of variance statistics and F approximations**

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>F value</th>
<th>df</th>
<th>Pr &gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilks’ Lambda</td>
<td>0.41</td>
<td>6.79</td>
<td>16</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pillai’s Trace</td>
<td>0.65</td>
<td>5.92</td>
<td>16</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hotelling-Lawley Trace</td>
<td>1.28</td>
<td>7.71</td>
<td>16</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Roy's Greatest Root</td>
<td>1.15</td>
<td>14.10</td>
<td>8</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

**Table 3.5: Canonical structure r’s describing group differences among flavored candies a**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>CAN 1</th>
<th>CAN 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buttery Aroma</td>
<td>0.28</td>
<td>0.68</td>
</tr>
<tr>
<td>Cheesy Aroma</td>
<td>0.71</td>
<td>0.17</td>
</tr>
<tr>
<td>Caramel Aroma</td>
<td>0.30</td>
<td>0.74</td>
</tr>
<tr>
<td>Cooked Aroma</td>
<td>0.13</td>
<td>0.15</td>
</tr>
<tr>
<td>Cooked Flavor</td>
<td>0.25</td>
<td>0.38</td>
</tr>
<tr>
<td>Buttery Flavor</td>
<td>0.24</td>
<td>0.01</td>
</tr>
<tr>
<td>Sweet Flavor</td>
<td>0.01</td>
<td>0.13</td>
</tr>
<tr>
<td>Caramel Flavor</td>
<td>0.34</td>
<td>0.27</td>
</tr>
<tr>
<td>Variance explained</td>
<td>90%</td>
<td>10%</td>
</tr>
</tbody>
</table>

a CAN 1 AND CAN 2 are based on pool within group variances.
r’s is the correlation between a single attribute and the linear composite of all attributes.

### 3.4.3. Principal Component Analysis (PCA)

Principal Component Analysis (PCA, Unscrambler® version 8.0, CAMO 2003) was used to study attribute-sample relationships. With PCA, a sensory space was created where samples were positioned in the attribute-sample space according to their characteristic sensory attributes. The distance between a sample and an attribute indicated the extent to which the attribute can be
used to describe such sample. Individual observations for product attributes were used to perform PCA. If two variables had high loadings along the same PC, it meant that the two variables were highly correlated. If both loadings had the same sign, the correlation was positive (when one variable increased, so did the other). Otherwise, it was negative (when one variable increased, the other decreased).

The attribute-sample map (Figure 3.4) and the corresponding PCA factor loadings (Table 3.6) were used to make conclusions on attribute-sample relationships.

**Table 3.6:** Factor loading scores for sensory attributes of three flavor milk candies

<table>
<thead>
<tr>
<th>Attributes</th>
<th>PC 1</th>
<th>PC 2</th>
<th>PC 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buttery Aroma</td>
<td>0.50</td>
<td>-0.20</td>
<td>0.30</td>
</tr>
<tr>
<td>Cheesy Aroma</td>
<td>0.26</td>
<td>-0.50</td>
<td>4.8e-02</td>
</tr>
<tr>
<td>Cooked Aroma</td>
<td>0.54</td>
<td>-0.07</td>
<td>-0.36</td>
</tr>
<tr>
<td>Caramel Aroma</td>
<td>0.40</td>
<td>0.63</td>
<td>-0.33</td>
</tr>
<tr>
<td>Cooked Flavor</td>
<td>0.36</td>
<td>-0.14</td>
<td>-0.20</td>
</tr>
<tr>
<td>Buttery Flavor</td>
<td>0.26</td>
<td>-0.287</td>
<td>0.31</td>
</tr>
<tr>
<td>Sweet Flavor</td>
<td>0.20</td>
<td>0.04</td>
<td>8.7e-02</td>
</tr>
<tr>
<td>Caramel Flavor</td>
<td>0.2</td>
<td>0.56</td>
<td>0.73</td>
</tr>
</tbody>
</table>

PC = Principal Component

For the attribute-sample PCA (Figure 3.4), three PCs explained 72% of the data variability. The main sample differences and similarities, and attributes relationships were explained by the first and second PC, which explained 38% and 20% of the variability, respectively. Figure 3.4 illustrates aroma and flavor descriptive attribute-milk candies map of PC1 and PC2. Principal component (PC) 1 was characterized mainly by buttery aroma and cooked aroma notes. Principal component (PC) 2 was characterized mostly by caramel aroma,
cheesy aroma and caramel flavor notes. Principal component (PC) 3 (not shown) was characterized by caramel flavor notes.

Figure 3.4: PCA Bi-plot of descriptive sensory attributes of three flavored milk candies. Descriptive sensory attributes are plotted in red color, products in blue color.

Plain milk candy could be separated from chocolate and coffee milk candies by PC 1. Plain milk candy was best described by cheesy aroma, cooked flavor, butty aroma and butty flavor notes. Chocolate milk candy was described by caramel aroma and caramel flavor notes. Coffee milk candy could not be characterized by any of the sensory attributes because it presented low intensities of the studied attributes.

3.5. Conclusions

Descriptive Sensory evaluations of the three flavored milk candies revealed that they were different among one another. Cheesy aroma, butty aroma and caramel aroma were
discriminating attributes. Sweet flavor and cooked aroma were least discriminating. Plain milk candy was characterized by cheesy aroma, buttery aroma, cooked aroma, cooked flavor and buttery flavor notes. Caramel aroma and flavor aroma notes characterized chocolate milk candy. Coffee milk candy obtained low intensities scores for discriminating attributes.

Determination of the product sensory characteristics presented in each of the milk-flavored milk candies provide in depth understanding of the product quality. Chocolate and coffee flavors may be used to mask strong undesirable cheesy and cooked flavor and aroma notes, and consequently it may increase product acceptability.
CHAPTER 4: CONSUMER AFFECTIVE STUDY OF FLAVORED MILK CANDIES

4.1. Introduction

The use of sensory affective tests can help the product developers to understand the behaviour of different consumers groups (Piggot, 1988) and, therefore, to understand potential buyers of the product and in which way such product can be inserted into the food market. Data obtained form consumer affective tests represents key information in studies of product development, quality control, food product acceptance, and food service evaluation (Piggot, 1988). This type of testing is a very accurate tool in understanding consumer preferences.

There are two types of affective tests, quantitative and qualitative. Qualitative tests (i.e., focus group interviews, focus panel, one-on-one interviews) measure subjective responses of a sample of representatives consumers to the sensory properties of products by having them talk about their feelings in an interview or group setting (Meilgaard and others, 1999). Quantitative tests determine the responses of a large group of consumers to a set of questions regarding preference, liking, sensory attributes, etc. (Meilgaard and others, 1999). Quantitative tests tend to be more popular for a number of different reasons. They allow the researcher to gain much more data and information in a much shorter amount of time than qualitative tests do. Quantitative tests are less expensive compared to qualitative. This type of tests allow the researcher to ask the very specific questions, and in most cases only allow the consumer to choose their response from a given list of answers. This allows the researcher to pinpoint certain areas he or she would like to concentrate on. The hedonic scale is a common tool to quantify consumer acceptance. The number of scale categories that have been used are 5, 7 or 9 point-scale. The 9 point hedonic scale of food acceptance has been the one most used (Piggot, 1988). Once the quantitative testing is complete, the data can be summarized and/or statistically
analyzed. Within quantitative category, affective tests can be divided into preference and acceptance tests. The later are practical to determine the “affective status” of a product (Meilgaard and others, 1999). Consumer acceptance of a food product can be defined as the experience characterized by a positive attitude toward the product; and/or actual utilization of food by consumers (Resurreccion, 1998). Food sensory acceptance tests give information about the acceptance of a product without the package, label, price, etc. The difference between marketing research and food sensory evaluation is that sensory tests are based on the evaluation of sensory attributes of the product, while marketing techniques also involve external factors, such as brands or prices (Resurreccion, 1998). Sensory affective methods study the acceptance of appearance, flavor, texture and overall liking as perceived by consumers.

Overall appearance includes all visible sensory attributes such as color, size and shape as well as surface texture (Cardello, 1994). Appearance is commonly used by consumers to infer food product quality; frequently this is the only cue available, especially at the moment of purchase (Schröder, 2003). Flavor involves sensory attributes like taste, specific flavor, aroma and sweetness. It can be defined as “the complex combination of the olfactory, gustatory, and trigeminal sensations perceived during tasting” (Shröder, 2003). Aroma is the odor of a food, resulting from the process that involves the course of volatiles through the nasal passages located in the nose, when a person inhales them (voluntarily or otherwise) (Meilgaard and others, 1999). Texture is referred as the tactile feel properties, measured as geometrical, mechanical and moisture properties by the tactile nerves in the surface of the skin of the hand, lips, or tongue (Piggott, 1988). Overall liking can be defined as a complex expression of liking of the product as a whole.
Many food industries would like to get opinions from young consumers. The fact is that in the modern world, members of families have alternated roles, increasing the number of working parents. These parents, who once controlled the food that was bought in the house, are allowing their children to make more decisions when food is concerned (Rodriguez, 2001). The number of adolescents in the US will reach 5.6 million in 2010. The purchasing power of children is increasing. Children are more informed than in the past and styles of consumerism are evolving (Sune and others, 2002).

It is constructive to study the taste perception and product acceptance by young consumers. The American Society for Testing Materials’ (ASTM) Committee 18 is developing guidelines for sensory testing with children. As part of this program, they have studied the relationship between children’s cognitive skills and their age. For example, the ability to understand scales does not exist until age three. At three to five years, children start to understand simple scales, but the use of sorting or identification tasks is more effective for obtaining feedback (Guinard, 2001). The children with five- to eight-year-olds increasingly understand scales; however, the scales should be simple. Pre-teens are capable of understanding scaling concepts with adequate instruction, and teenagers can understand scales similarly as adults do. Children between 7 and 11 years old are considered well developed, as they can discriminate between products through a set of sensory properties that they can define. They can also reason about what they taste and recognize sweet and sour (Guinard, 2002; Rodriguez, 2001).

This study was conducted to determine consumer responses to flavored milk candies. Quantification of overall appearance, size, texture, aroma, taste, specific flavor, sweetness, and
overall liking differences of the three flavored milk candies, as well as understanding their effects on consumer acceptability were the objectives of this study. Research was conducted in two phases: 1) consumer affective test with adults, (2) consumer affective test with children.

4.2. Materials and Methods

4.2.1. Sample Description

The milk candy is a proprietary food product imported from Thailand. It is composed of 79% milk powder and 21% sugar. The plain (without added flavor), chocolate (chocolate flavor added), and coffee (coffee flavor added) milk candies were evaluated. Each candy tablet weighs 1 gram and the product is packaged in an aluminum pouch for protection from light, humidity and foreign odors. Each package contains 100 pieces of candy. Twenty grams of product contain 94.2 mg of calcium, 90.8 mg of phosphorus, 5.6 mg of iron, and 2.64 g of protein, providing 95.4 kcal energy.

4.2.2. Consumer Affective Test with Adults

Consumers (n = 335) were randomly recruited from Louisiana State University and from a local church in Baton Rouge. Subjects were recruited by flyers, faxes, phone calls, emails and posting advertisements on LSU campus.

The criteria for recruitment were: (1) at least 18 years old, (2) not allergic to milk, chocolate and/or coffee products, (3) available to participate in a particular testing date and time, and (4) positive attitude. A total of seven consumer sessions were carried out from 10:00-11:30 am and 2:30-4:30 pm during 3 days.

Consumers were instructed on the procedure to be followed. They were informed that each sample was randomly coded with a 3-digit number. These numbers corresponded to those
appearing on each of the three pages of the questionnaire. Prior to the product evaluation, participants were asked to complete a demographic and socioeconomic survey, which included questions regarding age, gender, race, ethnicity, education level, employment status, and household income. Subjects were asked if they were aware of the existence of a flavored milk candy in the form of a tablet in the US market, about their knowledge of the health benefits of calcium and their interest in buying a flavored milk candy enriched with calcium, vitamins and minerals, which promote health benefits.

**Figure 4.1:** Sample presentation for consumer affective test

Three milk candy tablets of the plain, chocolate and coffee flavored milk candies were tasted at room temperature in a random 3-digit number coded 2 oz-plastic cups in a sequential, monadic presentation. Room-temperature drinking water, unsalted crackers and expectoration cups were provided to consumers to cleanse their palate in between samples evaluation, in order to minimize sensory carryover and/or fatigue effects (Figure 4.1).
Consumers were seated in a testing room with controlled lighting and positive airflow, free of distracting odors. Figure 4.2 illustrates some consumers performing the actual test. Participants were told to chew at least half of the tablet and to evaluate the three samples for acceptability of overall appearance, size and shape, texture, taste, aroma, specific flavor, sweetness and overall liking using a 9-point hedonic scale (1=dislike extremely, 5= neither like, nor dislike, and 9=like extremely) (Peryam and Pilgrim, 1957). Consumers were also asked to rate the specific flavor of each milk candy (milk for the plain one, “chocolate” for the chocolate flavored one, and “coffee” for the coffee flavored one) on a 3-point “just about right” (JAR) scale with “just about right”= 2, “too weak”=1, and “too strong”=3. Participants evaluated acceptance of the product using a yes/no scale (Moscowitz, 1994). Finally, consumers evaluated purchase intent (yes/no) and purchase intent after additional information about health benefits of the flavored milk candies had been provided.

Figure 4.2: Consumers evaluating three flavored milk candies
4.2.3. Consumer Affective Test with Children

Pre-teenagers (n = 92) were recruited from the LSU lab school. The screening criteria were: (1) consent from parents or legal guardian, (2) in the range of 10-12 years old, (3) not allergic to milk, chocolate and/or coffee products, (4) available with positive interest in participating in the particular testing date and time.

Children were instructed about the taste test procedure to follow. Prior to the product evaluation, children were asked to complete a demographic questionnaire, which included questions regarding age, gender and grade they were currently in.

Three tablets of each of the plain and chocolate flavored milk candies were served at room temperature in 2 oz- plastic cups in a sequential, monadic presentation. Room-tempered drinking water and expectoration cups were provided to participants to cleanse their palate in between samples evaluation, in order to minimize sensory carryover and/or fatigue effects.

Consumers were seated in their classrooms with controlled lighting. They were instructed to chew at least half of a tablet and to evaluate the two samples for acceptability of overall liking, using a combination of Kroll & Pilgrim scale and facial scale (1=super bad, 5= not good no bad and 9 = super good) with a facial scale (see Appendix I) (Kroll, 1990). Figure 4.6 and 4.7 exemplify the actual day of the test.

4.3. Data Analysis

4.3.1 Consumer Affective Test with Adults

Data were analyzed using univariate and multivariate statistical analyses. A Randomized Block Design was followed and Analysis of Variance (ANOVA, proc mixed, SAS version 8.2, 2001) was performed to determine differences in acceptability for each of the sensory attributes
Figure 4.3: Children participating in the consumer affective test

Figure 4.4: A young consumer evaluating acceptability of overall liking of two flavored milk candies
among the three samples. The Tukey’s adjustment post-hoc test was applied to accomplish all paired-wise comparisons of acceptability of each of the three flavored milk candies.

Multivariate analysis of variance (MANOVA) was used to determine overall differences (including all sensory attributes simultaneously) in the acceptability among the three samples. When MANOVA results suggest that there are group differences, then Descriptive Discriminant Analysis (DDA) represents a post-hoc method to indicate the predictor variables that best explain this group separation. Descriptive Discriminant Analysis (DDA, proc candisc, SAS version 8.2, 2001 Huberty, 1994) was performed to identify discriminating sensory acceptability attributes that contributed to differences among the three flavored milk candies.

Predictive Discriminative Analysis (PDA, proc discrimin, SAS version 8.2, 2001, Huberty, 1994) and logistic regression were performed to identify sensory attributes critical to overall acceptability and purchase intent. For PDA, hit rate (%) of acceptability was calculated for each of the sensory attributes, for female and male consumers, as well as for combined gender. Logistic regression (proc genmod, SAS version 8.2, 2001) models were generated to predict purchase intent. Predictive Discriminative Analysis and Logistic regression are statistical methods that can give similar conclusions but they work in a different mode. Logistic regression models are useful to describe the effect of predictors (independent variables) on a binary dichotomous response variable (dependent variable), which follows an S- shaped curve (Agresti, 1996). Equation 4.2 represents the logistic regression model for purchase intent predicted by variables X, Z and Y, where \( \pi_{\text{yes}} \) represents the probability of buying the product (success), and \( 1-\pi_{\text{yes}} \) indicates the probability of not buying the product (failure). The formula implies that the probability of success \( \pi_{\text{yes}} \) increases or decreases depending on the predictors. The rate
of increase (decrease) is determined by $\beta$. Therefore, $\beta x$ indicates the rate of change in probability of success or failure depending on variable $x$, $\beta y$ depending on variable $y$, and $\beta z$ depending on variable $z$. Results from logistic regression can be interpreted either using an estimated probability or an estimated odds ratio. Equation 4.3 indicates the estimated probability of buying the product, $\pi_{yes}$ (success), predicted by variables $X$, $Y$ and $Z$. Equation 4.4 represents the odds ratio of purchase intent $\theta_{pl,x}$ when variable $X$ increases one unit on the 9-point hedonic scale.

Interpreting the odds ratio is a practical way to understand relationships between dependent and independent variables. Odds ratio between a dependent variable and an independent variable describes an association between them. Mathematically it is the ratio of the odds of such responses, and it can be calculated by exponentiating $\beta$. Equation 4.4 describes the odds ratio of purchase intent depending on variable $X$. Equation 4.1 illustrates an odd of a response, which is the probability of a “success” ($\pi_{yes}$) divided the probability of a “failure” ($1-\pi_{yes}$).

\begin{align*}
4.1 \quad & \frac{\pi_{yes}}{1-\pi_{yes}} \\
4.2 \quad & \ln\left(\frac{\pi_{yes(x,z,y)}}{1-\pi_{yes(x,z,y)}}\right) = \alpha + \beta x + \beta z + \beta y \\
4.3 \quad & \pi_{yes(x,z,y)} = \frac{\exp(\alpha + \beta x + \beta z + \beta y)}{1 + \exp(\alpha + \beta x + \beta z + \beta y)} \\
4.4 \quad & \theta_{pl,x} = \exp \beta x \quad (\text{i.e., } \ln^{-1} \beta) 
\end{align*}
When an estimated odds ratio equals 1.0 it means that there is no significant association between the two variables (Agresti, 1996). That is, the probability of success remains constant through the change of the independent variables. In other words, when an odds ratio is equal to 1.0 it means that the independent variable is not influencing the dependent variable (Agresti, 1996).

On the other hand, Predictive Discriminative Analysis works with classification of products based on several variables simultaneously. It is analog of a regression analysis. A fitted set of data to a mathematical function will give an observation its highest probability of being assigned to the known correct population whereas minimizing the probability that the same observation will be misclassified (Resurreccion, 1998). The developed discriminative variables can be then used to predict acceptability of the products. PDA uses a “% hit rate” to predict directly, while logistic regression uses the estimated odds ratio, which does not represent a direct prediction. In some situations, logistic regression can represent advantageous choice over Predictive Discriminant Analysis. The Discriminant Analysis relies on strictly meeting the assumptions of normality and homogeneity of variance, while Logistic Regression does not face these strict assumptions and is much more robust when these assumptions are not met, making it a statistical technique of more applicability in certain cases (Hair and others, 1998).

McNemar test was performed to analyze the change in probability of purchase intent before and after consumers had been informed about the health benefits of the product. The McNemar’s test represents a comparison of dependent proportions for binary response variables. It is a two-related sample difference test, that follows a Chi-square distribution with 1 df (Agresti, 1996). Consumers are categorized in two categories, in a “before” condition and then the same consumers are re-categorized in an “after” condition (O’Mahony, 1986). The null hypothesis
(H₀, \pi_{+1} - \pi_{1+} = 0 \text{ or } \pi_{+1} - \pi_{1+} = 0) stated that there was no significant difference in the probability of buying the product before and after consumers had been informed about its health benefits. In other words, the question was whether the differences between the probability of those who answered yes after (π_{+1}) and the probability of those who answered yes before (π_{1+}) is significant, or whether it was merely chance. The aim is to know if participants were influenced or not by the fact that they were informed about health benefits of the product, and therefore their opinions changed from a “before” status to an “after” status. To complement this test and obtain more detailed understanding, a 95% confidence interval for the difference of proportions was calculated. The difference of two sample marginal proportions (p_{+1} - p_{1+}) estimates the true difference (π_{+1} - π_{1+} or π_{+1} - π_{1+}). Equation 4.5 indicates the formula used to calculate sample proportions, where n_{ij} is the number of subjects making response i at the first question (before), and response j at the second question (after knowing that the product contained health promoting ingredients) and N is the total number of responses. Equation 4.6 is used to calculate confidence interval of difference of proportions. The term (p_{+1} - p_{1+}) indicates the difference between the proportion of participants that answered 1 (yes) after knowing that the product contained health promoting calcium and minerals (p_{+1}), and the proportion of participants that answered 1 (yes) before knowing that the product contained health promoting ingredients (p_{1+}). Equation 4.6 is useful to calculate 95% confidence interval of such difference. The term \frac{2}{\alpha} z denotes the standard normal percentile having a right-tail probability equal to \alpha/2 (in this case a 95% interval, \alpha=0.05, \frac{2}{\alpha} z_{\alpha/2} = 1.96). ASE is the estimated standard error for the proportion difference and was calculated using equation 4.7; where p_{11}= proportion of subjects that answered 1 (yes) before knowing and 1(yes) after knowing, p_{22}= proportion of subjects that
answered 2(no) before knowing and 2(no) after knowing that the product contained health promoting minerals and vitamins. A 95% confidence interval denotes that the calculated difference of proportions is 95% of the time correct, with an alpha level set at 0.05, which correspond to the 5% error allowed. When 0 is included in the confidence interval, then there is no significant difference.

\[ p_{ij} = \frac{n_{ij}}{N} \]

\[ (p_{+1} - p_{1+}) \pm z_{\alpha/2}(ASE) \]

\[ ASE = \sqrt{\frac{p_{+1}x(1-p_{1+}) + p_{-1}x(1-p_{-1}) - 2x(p_{11}p_{22} - p_{12}p_{21})}{N}} \]

The internal mapping is an alternative method, unlike conventional analysis, used to study individual subject differences that are built into a model and play an integral role (Greenhoff and McFie, 1994). For this intention, PCA (Principal Component Analysis) was used to reproduce a product space according to consumers’ acceptance evaluation. PCA is a multivariate statistical technique that reduces raw data into a smaller set of non-orthogonal composites that account for large amount of the variance of the original data (Allen and Rao, 2000). Internal map permit the visualization of consumers’ behavior individually, and compared to the average response.

4.3.2. Consumer Affective Test with Children

Analysis of Variance (ANOVA, proc mixed, SAS version 8.2, 2001) was performed in order to detect differences in the acceptability of overall liking among the plain and chocolate milk candies. The analysis was completed for gender, girls and boys, separately, as well as combined.
Analysis of Variance (ANOVA) was also performed to determine differences in the acceptability of overall liking among the plain and chocolate milk candies comparing adult with children evaluation.

Principal Component Analysis (PCA, Unscrambler® version 8.0, 2003) was performed in order to obtain a graphical overview of the effects identified by ANOVA and to examine correlation between consumers (adults and children) hedonic scores and the overall liking of chocolate and plain flavored milk candies. The individual consumer ratings of overall liking for the two samples were used.

An internal map (overall liking - samples) in Figure 4.8 and the corresponding PCA factor loadings (Table 4.19) were used to reach conclusions on differences in the acceptability of overall liking of the products.

4.4. Results and Discussion

4.4.1. Consumer Affective Test with Adults

4.4.1.1. Consumer Demographics and Product Information

Demographic information is detailed in Table 4.1. The majority of the participating consumers was in the age range of 18-34 years old (71%); followed by consumers in the range of 35-44 years old (17.5%). The lowest percentage of participants (12.5%) was 54 years old or older. Of the total, 56% of subjects were female and 44% were male. A greater proportion of them were white (64%), followed by African American (13.5%), Asian (11%), Hispanic-Spanish (6.0%), and Others (4.0%). Their education level was divided into college (50%), graduate level (27.5%), completed college (13.2%), high school (8.7%), and less than high school (0.3%). About 65% of the consumers had household annual incomes of less than $50,000, and 35% had annual household income of $50,000 or higher.
Table 4.2 gives detailed product information about flavored milk candies (tablets) collected from consumers. A large percentage of consumers (82.5%) answered that they have not seen a flavored milk candy in the form of tablet in the US market. Ninety two percent of them said they knew about the health benefits of calcium. A higher percentage of women (93.5%) answered that they were aware of health benefits of calcium, compared to men (90.3%), About 84% of the consumers declared that they were willing to purchase a flavored milk candy enriched with vitamins and minerals. Again, female consumers responded in a higher percentage (88%) when compared to males (79%). These results may be influenced by the fact that females are more aware of the important role of calcium intake in reducing the risk of osteoporosis during post menopause.

4.4.1.2. Consumer Acceptability

4.4.1.2.1. Analysis of Variance (ANOVA)

Table 4.3 reports the mean scores and ANOVA results for the acceptability of overall appearance, size and shape, texture, taste, aroma, specific flavor, sweetness and overall liking of plain, chocolate and coffee milk candies. The analysis of variance and a post-hoc test indicated an existence of differences in acceptability of appearance, size and shape, aroma, taste, specific flavor, sweetness, and overall liking of the three flavored milk candies. Acceptability of overall appearance for plain milk candy is highest with a score of 5.9, while the lowest score was observed for coffee milk candy (5.5). Plain milk candy got 6.2 score in size and shape which was higher than that of the coffee flavored candy. Plain and chocolate milk candies were not different in acceptability of their texture (6.0 and 5.9), while coffee (with a mean score of 5.5) was different when compared to the two. Chocolate milk candy was most accepted when consumers evaluated taste and aroma attributes with hedonic scores of 6.2 and 5.7, respectively. Coffee
flavored milk candy was least accepted with the scores for taste, aroma, specific flavor, and sweetness attributes of 4.5, 4.5, 4.6 and 5.2, respectively. The chocolate flavored milk candy was the most accepted when participants estimated overall liking, with a score of 6.1, followed by the plain milk candy with a score of 5.8. The coffee milk candy had again the lowest score, with 4.5 (5= neither like nor dislike), indicating significant lower in acceptability when compared with the other two samples (chocolate and plain).

4.4.1.2.2. Overall Product Differences- Pooled within Canonical Structure r’s

Multivariate Analysis of Variance (MANOVA) indicated that the three flavored milk candies were significantly different when the effects of all sensory acceptability scores were considered simultaneously. Probability values of MANOVA’s statistics were less than 0.0001 (Wilks’ Lambda, Pillai’s Trace, Hotelling-Lawley Trace, and Roy’s Greatest Root). These outcomes substantiated the results obtained from ANOVA.

To get a better understanding of such a difference, Descriptive Discriminant Analysis was performed. The first and second dimensions of pooled within canonical structure were used to identify discriminating attributes. The two dimensions explained 100% of the variability. They established that taste, specific flavor, overall liking and aroma were discriminating attributes with canonical coefficients of 0.95, 0.87, 0.84 and 0.62, respectively (Table 4.4). These results will support a later application of PCA for flavor-aroma attributes.

4.4.1.3. Product Acceptance and Purchase Intent

Seventy four of the participants indicated that the plain milk candy was acceptable, 79% said that chocolate was acceptable, and 51% said that the coffee milk candy was acceptable. When consumers were asked if they were willing to buy the product, 44% said they would buy the plain candy, 43% would buy the chocolate candy, and only 22% would buy the coffee
sample. Participants were also asked if they would buy the product knowing that it contained calcium and other minerals and vitamins. After participants had been informed about the health benefits of the product, 67% said they would buy the plain candy, 68% would buy the chocolate candy and 39% responded that they would buy the coffee milk candy.

4.4.1.3.1. Product Acceptance - Predictive Discriminant Analysis (PDA)

PDA was performed using proc discrim in SAS version 8.2, 2001. Results indicated that acceptability of the product could be generally predicted by taste (82.5%), aroma (74.0%), specific flavor (82.0%), and overall liking (84.0%) (Table 4.5). Taste, specific flavor, sweetness, overall liking and texture could predict the acceptance of plain milk candy.

The acceptance of chocolate milk candy was predicted mostly by taste, specific flavor, sweetness and overall liking. Specific flavor, overall liking and taste were the attributes used to predict the acceptance of the coffee milk candy.

4.4.1.3.2. Purchase Intent- Logistic Regression and Predictive Discriminant Analysis (PDA)

Purchase intent for each of the three flavored milk candies was predicted using the logistic regression. The resulting models are described in Table 4.6, where $Y$ corresponds to the

$$\log\left(\frac{\pi_{yes}}{1-\pi_{yes}}\right),$$

and $(\pi_{yes})$ represents the probability of buying the product, while $(1-\pi_{yes})$ indicates the probability of not buying the product. $X^{\text{gender}}$ represents the predictor gender, $X_1=$overall appearance, $X_2=$size/shape, $X_3=$texture, $X_4=$taste, $X_5=$aroma, $X_6=$specific flavor, $X_7=$sweetness, $X_8=$overall liking, $X_{\text{jar}1}=$JAR “too strong”, $X_{\text{jar}2}=$JAR “just about right” (The JAR “just about right = too strong” category was excluded, it was used for comparison), and $X^{\text{accept}}=$acceptance.
Table 4.1: Demographic and socioeconomic information

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24 years</td>
<td>20.0%</td>
<td>33.0%</td>
<td>53.0%</td>
</tr>
<tr>
<td>25-34 years</td>
<td>9.0%</td>
<td>9.0%</td>
<td>18.0%</td>
</tr>
<tr>
<td>35-44 years</td>
<td>5.0%</td>
<td>4.5%</td>
<td>9.5%</td>
</tr>
<tr>
<td>45-44 years</td>
<td>3.5%</td>
<td>4.5%</td>
<td>8.0%</td>
</tr>
<tr>
<td>over 54 years</td>
<td>6.0%</td>
<td>5.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44.0%</td>
<td>56.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>6.0%</td>
<td>7.5%</td>
<td>13.5%</td>
</tr>
<tr>
<td>Hispanic/Spanish</td>
<td>3.0%</td>
<td>3.0%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Asian-American</td>
<td>1.2%</td>
<td>0.3%</td>
<td>1.5%</td>
</tr>
<tr>
<td>White</td>
<td>27.5%</td>
<td>36.5%</td>
<td>64.0%</td>
</tr>
<tr>
<td>Asian</td>
<td>5.2%</td>
<td>5.8%</td>
<td>11.0%</td>
</tr>
<tr>
<td>Other</td>
<td>1.0%</td>
<td>3.0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>0.0%</td>
<td>0.3%</td>
<td>0.3%</td>
</tr>
<tr>
<td>High school</td>
<td>4.3%</td>
<td>4.4%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Some college</td>
<td>19.1%</td>
<td>31.2%</td>
<td>50.3%</td>
</tr>
<tr>
<td>Completed college</td>
<td>6.0%</td>
<td>7.2%</td>
<td>13.2%</td>
</tr>
<tr>
<td>Graduate (M.S., M.A., Ph.D., Ed.)</td>
<td>14.5 %</td>
<td>13%</td>
<td>27.5%</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;9,999</td>
<td>10.0%</td>
<td>14.0%</td>
<td>24.0%</td>
</tr>
<tr>
<td>10,000-19,999</td>
<td>9.0%</td>
<td>10.5%</td>
<td>19.5%</td>
</tr>
<tr>
<td>20,000-29,999</td>
<td>4.2%</td>
<td>5.2%</td>
<td>9.4%</td>
</tr>
<tr>
<td>30,000-39,999</td>
<td>2.3%</td>
<td>3.9%</td>
<td>6.2%</td>
</tr>
<tr>
<td>40,000-49,999</td>
<td>1.6%</td>
<td>4.2%</td>
<td>5.8%</td>
</tr>
<tr>
<td>50,000-59,999</td>
<td>3.6%</td>
<td>1.2%</td>
<td>4.8%</td>
</tr>
<tr>
<td>60,000-69,999</td>
<td>2.3%</td>
<td>4.2%</td>
<td>6.5%</td>
</tr>
<tr>
<td>70,000-79,000</td>
<td>1.3%</td>
<td>2.5%</td>
<td>3.8%</td>
</tr>
<tr>
<td>80,000-89,999</td>
<td>1.7%</td>
<td>1.3%</td>
<td>3.0%</td>
</tr>
<tr>
<td>90,000-99,999</td>
<td>1.3%</td>
<td>1.3%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Over 100,000</td>
<td>6.2%</td>
<td>8.1%</td>
<td>14.3%</td>
</tr>
</tbody>
</table>
Table 4.2: Consumer product information about flavored milk candies

<table>
<thead>
<tr>
<th>Question</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you ever seen a flavored milk candy in the form of tablet in the US market?</td>
<td>Male</td>
</tr>
<tr>
<td>YES</td>
<td>17.2%</td>
</tr>
<tr>
<td>NO</td>
<td>82.8%</td>
</tr>
</tbody>
</table>

| Are you aware of the health benefits of calcium?                         | Male | Female | Combined |
| YES                                                                      | 90.3% | 93.5%  | 92.1%    |
| NO                                                                       | 9.7%  | 6.5%   | 7.9%     |

| Would you buy a milk flavored milk candy enriched with calcium and vitamins/minerals? | Male | Female | Combined |
| YES                                                                      | 79.2% | 88.1%  | 84.2%    |
| NO                                                                       | 20.8% | 11.9%  | 15.8%    |

Table 4.3: Means, standard deviations and analysis of variance for acceptability attributes of the three flavored milk candies 

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Milk candies</th>
<th></th>
<th></th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plain</td>
<td>Chocolate</td>
<td>Coffee</td>
<td></td>
</tr>
<tr>
<td>O. Appearance</td>
<td>5.9± (1.8)(^{a})</td>
<td>5.7± (1.7)(^{ab})</td>
<td>5.5± (1.6)(^{bc})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Size/Shape</td>
<td>6.2± (1.6)(^{a})</td>
<td>6.1± (1.6)(^{ab})</td>
<td>5.9± (1.6)(^{bc})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Texture</td>
<td>6.0± (1.9)(^{a})</td>
<td>5.9± (1.7)(^{a})</td>
<td>5.5± (1.8)(^{b})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Taste</td>
<td>5.8± (2.2)(^{a})</td>
<td>6.2± (1.8)(^{b})</td>
<td>4.5± (2.1)(^{c})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Aroma</td>
<td>5.0± (1.9)(^{a})</td>
<td>5.7± (1.7)(^{b})</td>
<td>4.5± (1.8)(^{c})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Specific Flavor</td>
<td>6.1± (2.1)(^{a})</td>
<td>6.2± (1.7)(^{a})</td>
<td>4.6± (2.2)(^{b})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sweetness</td>
<td>6.1± (1.9)(^{a})</td>
<td>6.0± (1.6)(^{a})</td>
<td>5.2± (1.9)(^{b})</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Overall Liking</td>
<td>5.8± (2.0)(^{a})</td>
<td>6.1± (1.7)(^{a})</td>
<td>4.5± (2.1)(^{b})</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

51
Means in each row having different superscripts are significantly different (Pr ≤ 0.05).

**Table 4.4:** Canonical structure r’s describing group differences among flavored candies

<table>
<thead>
<tr>
<th>Attributes</th>
<th>CAN 1</th>
<th>CAN 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Appearance</td>
<td>0.13</td>
<td>0.24</td>
</tr>
<tr>
<td>Size and Shape</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Texture</td>
<td>0.28</td>
<td>0.17</td>
</tr>
<tr>
<td>Taste</td>
<td>0.85</td>
<td>0.13</td>
</tr>
<tr>
<td>Aroma</td>
<td>0.62</td>
<td>0.48</td>
</tr>
<tr>
<td>Specific Flavor</td>
<td>0.87</td>
<td>0.32</td>
</tr>
<tr>
<td>Sweetness</td>
<td>0.54</td>
<td>0.26</td>
</tr>
<tr>
<td>Overall Liking</td>
<td>0.84</td>
<td>0.19</td>
</tr>
<tr>
<td>Variance explained</td>
<td>73%</td>
<td>27%</td>
</tr>
</tbody>
</table>

CAN 1 and CAN 2 are based on pool within group variances.

r’s is the correlation between a single attribute and the linear composite of all attributes.

It can be seen that, jar₁ (P=0.04), jar₂ (P=0.0003), overall liking (P=0.002), and acceptance (P=0.04) were critical for the purchase intent of the plain milk candy (Table 4.7).

Estimated odds (exp β) were calculated (i.e., ln⁻¹ β). For instance, the estimated odds of buying the plain milk candy when consumer evaluated “jar” are exp 1.94, equals 6.98 (Table 4.7). Then, the estimated odds of buying the plain milk candy are 6.98 times higher when
consumers evaluated that the flavor was just about right than when they evaluated it was too strong. In other words, the probability of buying the plain candy increased when consumers said that the specific flavor of the product was “just about right”. The estimated odds of buying this product were 2.58 times higher when overall liking increased one point on the 9-point hedonic sale. This is, the higher the scores for overall liking, the higher the probability of buying such product.

**Table 4.5**: Classification results form Predictive Discriminate Analysis (PDA) - % Hit Rate for acceptability of three flavored milk candies evaluated by adults

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Milk Candies</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plain</td>
<td>Chocolate</td>
</tr>
<tr>
<td>Overall Appearance</td>
<td>64.3%</td>
<td>63.5%</td>
</tr>
<tr>
<td>Size</td>
<td>69.6%</td>
<td>58.0%</td>
</tr>
<tr>
<td>Texture</td>
<td>75.5%</td>
<td>73.5%</td>
</tr>
<tr>
<td>Taste</td>
<td>84.0%</td>
<td>82.2%</td>
</tr>
<tr>
<td>Aroma</td>
<td>71.6%</td>
<td>64.9%</td>
</tr>
<tr>
<td>Specific Flavor</td>
<td>83.4%</td>
<td>84.5%</td>
</tr>
<tr>
<td>JAR (just about right for specific flavor)</td>
<td>77.0%</td>
<td>67.4%</td>
</tr>
<tr>
<td>Sweetness</td>
<td>80.6%</td>
<td>79.8%</td>
</tr>
<tr>
<td>Overall Liking</td>
<td>87.6%</td>
<td>82.5%</td>
</tr>
</tbody>
</table>
Table 4.6: Full Logistic regression models for predicting consumer purchase intent of three flavored milk candies

<table>
<thead>
<tr>
<th>Milk candy</th>
<th>Predictive Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain</td>
<td>$Y = -11.92 - 0.008 X_{gender} + 0.18 X_1 + 0.16 X_2 + 0.12 X_3 - 0.16 X_4 + 0.08 X_5 + 0.20 X_6 + 1.89 X_{jar1} + 1.94 X_{jar2} - 0.24 X_7 + 0.95 X_8 + 2.16 X_{accept}$</td>
</tr>
<tr>
<td>Chocolate</td>
<td>$Y = -11.03 - 0.09 X_{gender} - 0.07 X_1 - 0.03 X_2 + 0.08 X_3 + 0.19 X_4 + 0.14 X_5 + 0.55 X_6 + 0.12 X_{jar1} - 0.18 X_{jar2} - 0.06 X_7 + 0.33 X_8 + 2.90 X_{accept}$</td>
</tr>
<tr>
<td>Coffee</td>
<td>$Y = -11.82 + 0.58 X_{gender} + 0.18 X_1 + 0.28 X_2 + 0.11 X_3 - 0.32 X_4 - 0.12 X_5 - 0.47 X_6 - 0.56 X_{jar1} + 0.5 X_{jar2} + 0.03 X_7 + 0.50 X_8 + 3.00 X_{accept}$</td>
</tr>
</tbody>
</table>

Table 4.7: Estimated odds ratio and $Pr > X^2$ for logistic regression models used to predict consumer’s purchase intent of plain milk candy

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$Pr &gt; X^2$</th>
<th>Estimated Parameters ($\beta$)</th>
<th>Estimated odds ratio = $(\exp \beta)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender ($X_{gender}$)</td>
<td>0.98</td>
<td>0.008</td>
<td>0.99</td>
</tr>
<tr>
<td>Overall appearance ($X_1$)</td>
<td>0.18</td>
<td>0.18</td>
<td>1.20</td>
</tr>
<tr>
<td>Size/shape ($X_2$)</td>
<td>0.26</td>
<td>0.16</td>
<td>1.18</td>
</tr>
<tr>
<td>Texture ($X_3$)</td>
<td>0.37</td>
<td>0.12</td>
<td>1.12</td>
</tr>
<tr>
<td>Taste ($X_4$)</td>
<td>0.47</td>
<td>-0.16</td>
<td>0.85</td>
</tr>
<tr>
<td>Aroma ($X_5$)</td>
<td>0.47</td>
<td>0.08</td>
<td>1.09</td>
</tr>
<tr>
<td>Specific Flavor ($X_6$)</td>
<td>0.33</td>
<td>0.20</td>
<td>1.22</td>
</tr>
<tr>
<td>jar ($X_{jar1}$,&quot;too weak&quot;)</td>
<td>0.04*</td>
<td>1.89</td>
<td>6.61</td>
</tr>
<tr>
<td>jar ($X_{jar2}$,&quot;just about right&quot;)</td>
<td>0.0003*</td>
<td>1.94</td>
<td>6.98</td>
</tr>
<tr>
<td>Sweetness ($X_7$)</td>
<td>0.15</td>
<td>-0.24</td>
<td>0.78</td>
</tr>
<tr>
<td>Overall Liking ($X_8$)</td>
<td>0.002*</td>
<td>0.95</td>
<td>2.58</td>
</tr>
<tr>
<td>Acceptance ($X_{accept}$)</td>
<td>0.04*</td>
<td>2.16</td>
<td>8.71</td>
</tr>
</tbody>
</table>

*Significantly different at alpha ≤ 0.05.
Finally, acceptability was very important to determine if consumers would purchase the plain candy, with estimated odds of 8.71 times higher for those who accepted the product compared to those who did not accepted. The probability of buying the product increased when the product, of course was considered as acceptable.

Purchase intent of chocolate milk candy was critically influenced by specific flavor (P=0.0006) and acceptance (P= 0.008) (Table 4.8).

**Table 4.8:** Estimated odds ratio and Pr > $X^2$ for logistic regression models used to predict consumer purchase intent of chocolate milk candy

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Pr &gt; $X^2$</th>
<th>Estimated Parameters ($\beta$)</th>
<th>Estimated odds ratio = $(\exp \beta)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (X_{gender})</td>
<td>0.74</td>
<td>0.09</td>
<td>0.90</td>
</tr>
<tr>
<td>Overall appearance (X_1)</td>
<td>0.55</td>
<td>-0.07</td>
<td>0.93</td>
</tr>
<tr>
<td>Size/shape (X_2)</td>
<td>0.85</td>
<td>-0.03</td>
<td>0.97</td>
</tr>
<tr>
<td>Texture (X_3)</td>
<td>0.52</td>
<td>0.08</td>
<td>1.08</td>
</tr>
<tr>
<td>Taste (X_4)</td>
<td>0.31</td>
<td>0.19</td>
<td>1.20</td>
</tr>
<tr>
<td>Aroma (X_5)</td>
<td>0.25</td>
<td>0.14</td>
<td>1.15</td>
</tr>
<tr>
<td>Specific Flavor (X_6)</td>
<td>0.006$^*$</td>
<td>0.55</td>
<td>1.73</td>
</tr>
<tr>
<td>jar (X_{jar 1}, &quot;too weak&quot;)</td>
<td>0.86</td>
<td>0.12</td>
<td>1.13</td>
</tr>
<tr>
<td>jar (X_{jar 2}, &quot;just about right&quot;)</td>
<td>0.80</td>
<td>-0.18</td>
<td>0.83</td>
</tr>
<tr>
<td>Sweetness (X_7)</td>
<td>0.73</td>
<td>-0.06</td>
<td>0.94</td>
</tr>
<tr>
<td>Overall Liking (X_8)</td>
<td>0.20</td>
<td>0.33</td>
<td>1.40</td>
</tr>
<tr>
<td>Acceptance (X_{accept})</td>
<td>0.008$^*$</td>
<td>2.89</td>
<td>18.0</td>
</tr>
</tbody>
</table>

*Significantly different at alpha ≤ 0.05.

The estimated odds of buying the chocolate candy were 1.73 times higher when specific flavor increased one unit on the 9-point hedonic scale. In other words, purchase intent is positively influenced by an increase in the acceptability of specific flavor. Buying intention of
coffee flavored milk candy was influenced only by acceptance of the product \((P=0.004)\) (Table 4.9). This result suggested that in general positive purchase intent of coffee product was minimal, unless it was accepted. The calculated odds ratio for acceptability was 21.47 (Table 4.9). The estimated odds of buying the coffee milk candy when consumer said that the product was acceptable were 21.47 times higher than when consumers said that it was unacceptable, meaning that consumers who did accept the coffee milk candy were more likely to buy the product than those who did not accept it.

**Table 4.9**: Estimated odds ratio and \(Pr > X^2\) for logistic regression models used to predict consumer purchase intent of coffee milk candy

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Pr &gt; (X^2)</th>
<th>Estimated Parameters ((\beta))</th>
<th>Estimated odds ratio = ((exp \ \beta))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender ((X_{gender}))</td>
<td>0.17</td>
<td>0.58</td>
<td>1.80</td>
</tr>
<tr>
<td>Overall appearance ((X_1))</td>
<td>0.33</td>
<td>0.18</td>
<td>0.83</td>
</tr>
<tr>
<td>Size/shape ((X_2))</td>
<td>0.13</td>
<td>0.28</td>
<td>1.32</td>
</tr>
<tr>
<td>Texture ((X_3))</td>
<td>0.53</td>
<td>0.11</td>
<td>1.11</td>
</tr>
<tr>
<td>Taste ((X_4))</td>
<td>0.20</td>
<td>-0.32</td>
<td>1.38</td>
</tr>
<tr>
<td>Aroma ((X_5))</td>
<td>0.45</td>
<td>-0.12</td>
<td>0.88</td>
</tr>
<tr>
<td>Specific Flavor ((X_6))</td>
<td>0.06</td>
<td>-0.47</td>
<td>1.61</td>
</tr>
<tr>
<td>jar ((X_{jar1}, \text{&quot;too weak&quot;}))</td>
<td>0.41</td>
<td>-0.56</td>
<td>0.57</td>
</tr>
<tr>
<td>jar ((X_{jar2}, \text{&quot;just about right&quot;}))</td>
<td>0.47</td>
<td>0.50</td>
<td>0.61</td>
</tr>
<tr>
<td>Sweetness ((X_7))</td>
<td>0.89</td>
<td>0.03</td>
<td>1.03</td>
</tr>
<tr>
<td>Overall Liking ((X_8))</td>
<td>0.07</td>
<td>0.50</td>
<td>1.65</td>
</tr>
<tr>
<td>Acceptance ((X_{accept}))</td>
<td><strong>0.004</strong></td>
<td>3.00</td>
<td><strong>21.47</strong></td>
</tr>
</tbody>
</table>

*Significantly different at alpha \(\leq 0.05\).

Predictive Discriminate Analysis was used to analyze attributes that were significant for logistic regression (Table 4.10). The obtained results support the conclusions made from logistic regression.
Table 4.10: % Hit Rates for purchase intent for acceptability attributes for three flavored milk candies

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Milk candies</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plain</td>
<td>Chocolate</td>
<td>Coffee</td>
<td>Combined</td>
</tr>
<tr>
<td>Specific Flavor</td>
<td>78.2%</td>
<td>73.5%</td>
<td>78.6%</td>
<td>72.2%</td>
</tr>
<tr>
<td>Overall Liking</td>
<td>75.5%</td>
<td>75.0%</td>
<td>81.8%</td>
<td>75.5%</td>
</tr>
<tr>
<td>Acceptance</td>
<td>70.0%</td>
<td>70.3%</td>
<td>63.5%</td>
<td>67.7%</td>
</tr>
<tr>
<td>Jar for specific flavor</td>
<td>70.0%</td>
<td>57.0%</td>
<td>56.0%</td>
<td>50.4%</td>
</tr>
</tbody>
</table>

4.4.1.3.3. Purchase Intent– McNemar test

The McNemar test was performed using proc freq/agree (SAS version 8.2, 2001). It was used to establish any potential association between purchase intent of the milk candy before and after the consumers being informed that the product may offer health benefits. Table 4.11, Table 4.12 and Table 4.13 describe counts and frequencies of purchase intent responses before and after knowing that the product contained health promoting ingredients.

Table 4.11: Purchase intent responses for plain milk candy before and after knowing that the product was enriched with health-promoting calcium and minerals

<table>
<thead>
<tr>
<th>Purchase intent (Question 1)</th>
<th>Purchase Intent after knowing health benefits (Question 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>YES</td>
<td>145 (43.7%)</td>
</tr>
<tr>
<td>NO</td>
<td>78 (23.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>223 (67.2%)</td>
</tr>
</tbody>
</table>
Table 4.12: Purchase intent responses for chocolate milk candy before and after consumers were informed that the product was enriched with health-promoting calcium and minerals

<table>
<thead>
<tr>
<th>Purchase intent (Question 1)</th>
<th>Purchase Intent after knowing health benefits (Question 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>YES</td>
<td>143 (43.1%)</td>
</tr>
<tr>
<td>NO</td>
<td>82 (24.7%)</td>
</tr>
<tr>
<td>Total</td>
<td>225 (67.7%)</td>
</tr>
</tbody>
</table>

Table 4.13: Purchase intent responses for coffee milk candy before and after knowing that the product was enriched with health-promoting calcium and minerals.

<table>
<thead>
<tr>
<th>Purchase intent (Question 1)</th>
<th>Purchase Intent after knowing health benefits (Question 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>YES</td>
<td>70 (21.1%)</td>
</tr>
<tr>
<td>NO</td>
<td>60 (18.1%)</td>
</tr>
<tr>
<td>Total</td>
<td>130 (39.2%)</td>
</tr>
</tbody>
</table>

Table 4.14 gives details about McNemar test results. It can be seen that a significant difference existed between the two responses, with a chi square ($\chi^2$) values of 75 (for the evaluation of plain milk candy), 79 (for the evaluation of the chocolate milk candy), and 49 (for the evaluation of the coffee milk candy), which are greater than the critical $\chi^2_{df,1}$ of 3.84, with $\Pr > \chi^2 < 0.0001$ for the three cases (with an alpha = 0.05). The decision of buying the milk candy was influenced by the fact that consumers had been informed about the health benefits of the product. The difference of proportions ($p_{+1} - p_{1+}$) between purchase intent after ($p_{+1}$) and before ($p_{1+}$) knowing that the product was enriched with calcium and minerals was calculated for each
of the evaluation of the three flavored milk candies. For example, the proportion of consumers that answered yes to purchase intent of plain milk candy before knowing the health benefits of the product is 0.44 (i.e., applying equation 4.5, \( p_{1+} = 146/332 \)). The proportion of consumers that answered yes to purchase intent of plain milk candy after they had been informed about the health benefits of the product is 0.67 (i.e., applying equation 4.5, \( p_{+1} = 223/332 \)). Then the difference of proportions \( (p_{+1} - p_{1+}) \) between consumers that said yes to purchase intent of plain milk candy after had been informed that the product was enriched with health promoting calcium and minerals \( (p_{+1}) \), and consumers who said yes to purchase intent of plain milk candy before knowing the health benefits of the product \( (p_{1+}) \) is 0.23 (i.e., \( 0.67 - 0.44 \)).

The 95% confidence intervals for the difference of proportions were calculated in order to obtain a better understanding of the association between the two questions’ responses (i.e., applying equation 4.6). The 95% confidence interval for the difference of proportion of purchase intent of plain milk candy was 0.19, 0.27 (i.e., \( 0.23 \pm 0.04 \)). The confidence interval explained that, for the plain milk candy, the probability that consumers would buy it after they had been informed about the health benefits of the product was 0.19 to 0.27 times higher than the probability that consumers would buy it before they had been informed about the health benefits.

The 95% confidence interval for the difference of proportion of purchase intent of chocolate milk candy was 0.20, 0.28 (i.e., \( 0.24 \pm 0.04 \)). The probability of buying the chocolate milk candy after participants had been informed that the product was enriched with health promoting ingredients was from 0.22 to 0.26 higher than the probability of buying the product before consumer had known that it contained health promoting minerals and vitamins.

The 95% confidence interval for the difference of proportion of purchase intent of coffee milk candy was 0.12, 0.22 (i.e., \( 0.17 \pm 0.05 \)). The probability of buying the coffee milk candy
after participants had been informed that the candy was enriched with health promoting ingredients was 0.12 to 0.22 higher than the probability of buying the product before consumers had been informed about the health benefits of the product. There was a positive increase in the probability of buying the flavored milk candies after consumers had been informed that the product was enriched with health promoting ingredients. Therefore, there was a positive increase in the purchase intent after consumers had been informed the flavored milk candies were enriched with health-promoting calcium and other minerals. Walker (2002) studied the difference in the purchase intent of low-fat sugar-free orange sherbets before and after consumers had been informed that the product contained health promoting soy protein. Koh and others (2003) studied the difference in the buying intention of flavored milk candies before and after consumers had been informed about the health benefits of the products. In both studies, the fact that the product could promote health benefits positively increased the purchase intent of them.

Table 4.14: McNemar Test

<table>
<thead>
<tr>
<th>Milk candy</th>
<th>95% C I for difference of proportions</th>
<th>Statistic $X^2$</th>
<th>Pr &gt;$X^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain</td>
<td>(0.19, 0.27)</td>
<td>75</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Chocolate</td>
<td>(0.20,0.28)</td>
<td>79</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Coffee</td>
<td>(0.12,0.22)</td>
<td>49</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

4.4.1.4. Internal Mapping – Principal Component Analysis

Principal Component Analysis was performed using Unscrambler ® v 8.0, 2003. Individual scores for acceptability of overall liking for the three flavored milk candies were utilized. Factor Loadings shown in Table 4.15 and PCA bi-plot illustrated in Figure 4.3 were
used to arrive at conclusions about consumers’ overall liking of the three flavored milk candies. For the overall liking PCA two components explained 86% of the data variability. The main sample differences and similarities were explained by the first and second component, which explained 61% and 24% of the variability, respectively. Figure 4.3 illustrates overall liking attribute- consumers’ map of PC1 and PC2. Symbols with different colors correspond to different observations’ scores for overall liking. For instance, based on the scale on top of the figure, plain and chocolate flavored milk candies were more liked with scores in the range of 5.6 to 7.4 (orange symbols). Overall liking of coffee milk candy had lower scores, locating the product near the limit of 4.5 -5.8 range (green colored symbols).

In general, the three samples were positively correlated with PC 1. Coffee flavored milk candy obtained a high positive loading score for PC 2. Then PC 2 could separate coffee milk candy from plain and chocolate milk candies.

Based on the results obtained from Descriptive Discriminant Analysis (DDA), Principal Component Analysis was performed using Unscrambler ® version 8.0, 2003 to visualize the acceptability of flavor attributes. Individual scores for acceptability of taste, aroma, and specific flavor for the three flavored milk candies were used.

**Table 4.15:** Factor loading scores obtained from PCA of overall liking

<table>
<thead>
<tr>
<th>Flavored milk candies</th>
<th>PC 1</th>
<th>PC2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain</td>
<td>0.64</td>
<td>-0.56</td>
</tr>
<tr>
<td>Chocolate</td>
<td>0.46</td>
<td>-0.27</td>
</tr>
<tr>
<td>Coffee</td>
<td>0.62</td>
<td>0.78</td>
</tr>
</tbody>
</table>

PC =Principal Component
Factor loading scores from Table 4.16 and PCA bi-plot illustrated in Figure 4.6 and 4.7 were used to arrive at conclusions about consumers’ acceptability of flavor attributes of the three flavored milk candies. For the flavor PCA two PC components explained 68% of the data variability. The main sample differences and similarities were explained by the first and second component, which explained 48% and 20% of the variability, respectively. Figures 4.6 and 4.7 describe flavor attributes- consumers’ map of PC1 and PC2. Figure 4.4 illustrates how hedonic scores of taste, specific flavor and aroma attributes can differentiate the three flavored milk candies. Figure 4.7 gives detail of how consumers rated acceptability of such attributes. Different colors indicated different points on the scale. For example, specific flavor, taste and aroma of plain sample and taste, specific flavor, and aroma of chocolate sample were very well accepted,
with scores ranging from 7.4 to 9 (where 9 = extremely like). On the other hand, coffee aroma was less accepted (situated in the range of 5.8 to 7.4).

**Table 4.16:** Factor loadings for acceptability scores of flavor and aroma attributes when adults evaluated of three flavored milk candies

<table>
<thead>
<tr>
<th>Attributes</th>
<th>PC 1</th>
<th>PC 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taste Plain</td>
<td>0.41</td>
<td>-0.38</td>
</tr>
<tr>
<td>Taste Chocolate</td>
<td>0.26</td>
<td>-0.21</td>
</tr>
<tr>
<td>Taste Coffee</td>
<td>0.40</td>
<td>-0.50</td>
</tr>
<tr>
<td>Aroma Plain</td>
<td>0.30</td>
<td>-0.23</td>
</tr>
<tr>
<td>Aroma Chocolate</td>
<td>0.25</td>
<td>-0.16</td>
</tr>
<tr>
<td>Aroma Coffee</td>
<td>0.33</td>
<td>0.27</td>
</tr>
<tr>
<td>Specific Flavor Plain</td>
<td>0.40</td>
<td>0.51</td>
</tr>
<tr>
<td>Specific Flavor Chocolate</td>
<td>0.37</td>
<td>-0.36</td>
</tr>
<tr>
<td>Specific Flavor Coffee</td>
<td>0.22</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

PC =Principal Component

In general, acceptability scores of flavor attributes for the three samples were positively correlated with PC 1. Figures 4.5, 4.6 and 4.7 show that consumers did not behaved the same manner, and their evaluation showed a diverse attitude toward the acceptability of the three flavored milk candies.
**Figure 4.6**: Internal map PCA Bi-plot for acceptability of flavor attributes of three flavored milk candies (I)

**Figure 4.7**: Internal map PCA Bi-plot for acceptability scores of flavor attributes of three flavored milk candies (II)
4.4.2. Consumer Affective Test with Children

4.4.2.1. Analysis of Variance (ANOVA)

Table 4.17 gives mean scores, standard deviations and ANOVA results for overall liking of chocolate and plain flavored milk candies. Chocolate milk candy was better liked with a mean score of 6.0 for girls (6 = just a little good), 5.4 for boys, and 5.7 for combined gender. Plain milk candy was less preferred, with a mean score of 4.0 (4 = just a little bad) for girls, 3.5 for boys, and 3.6 for both combined gender. ANOVA indicated that these differences were significant, suggesting that when all children evaluated the two products they detected significant difference (P > F < 0.0001), as well as when girls (P > F < 0.0001) and boys (P > F = 0.0002) evaluated the two samples separately. Children are more likely to prefer flavored milk products rather than plain ones. Lavin and Lawless (1998) studied the influence of added color and flavor to milks on the acceptability of sweetness evaluated by children and adults. They suggested that because of the addition of vanilla flavor, the sweetness of milk was more accepted by children. Ward and others (1999) evaluated yogurts’ acceptance drivers for children. They concluded that children liked flavored yogurt with sweet, strawberry, vanilla and creamy flavor more than those with cooked, sourness and raisin flavor. Some aspects of food preference are innate; young children tend to like sweet, and have aversion to bitter (Popper and others 2003).

Analysis of variance (ANOVA) was performed in order to obtain information about potential difference in the liking of the chocolate and plain flavored milk candies when evaluated by adult and children. Table 4.18 shows mean scores, standard deviations and probabilities for ANOVA test of overall liking of the two products. Adults (6.0) and children (5.7) preferred the chocolate milk candy similarly (P > F = 0.17). Swaney-Stueve (2002) investigated the performance of young trained panels (8-10, 13-14 and 16-18 years) compared to the adult
experts, and concluded that children can describe foods as similarly as adults. Guinard (2001) suggested that children between 7 and 11 years old are considered well developed, and they can understand the 9-point hedonic scale as well as adults.

Adult consumers liked the plain milk candy more than children consumers, with a mean score of 5.8 compared with 3.6, and ANOVA suggested that this differences was significant with a $P > F < 0.0001$. Children are usually prone to be influenced by a single stimulus dimension, such as appearance or color (Lavin and Lawless, 1999; Sune and others, 2002). On the other hands, adults have the ability to handle more abstract reasoning. In addition, preferences and acceptance for foods are largely learned (Popper and Kroll, 2003). Culture, exposure, and time are key factors in the choice that consumers make when they accept food products. Therefore, adults could be influenced by the mentioned factors, when they liked the plain milk candy more than children did.

**Table 4.17:** Means, standard deviations and ANOVA results for overall liking of two flavored milk candies, evaluated by children 10-12 years old

<table>
<thead>
<tr>
<th>Milk candy</th>
<th>Girls</th>
<th>Boys</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate</td>
<td>6.0 ± (2.2)</td>
<td>5.4 ± (2.3)</td>
<td>5.7 ± (2.3)</td>
</tr>
<tr>
<td>Plain</td>
<td>4.0 ± (0.0)</td>
<td>3.5 ± (2.1)</td>
<td>3.6 ± (2.1)</td>
</tr>
<tr>
<td>Pr &gt; F</td>
<td>&lt; 0.0001</td>
<td>0.0002</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

**Table 4.18:** Means, standard deviations and ANOVA results for overall liking of two flavored milk candies, evaluated by children and adult consumers

<table>
<thead>
<tr>
<th>Milk candy</th>
<th>Adults</th>
<th>Children</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate</td>
<td>6.0 ± (1.7)</td>
<td>5.7 ± (2.3)</td>
<td>0.17</td>
</tr>
<tr>
<td>Plain</td>
<td>5.8 ± (2.0)</td>
<td>3.6 ± (2.1)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>
4.4.2.2. Internal Mapping - Principal Component Analysis.

Individual scores from adults and children evaluation of acceptability of overall liking for plain and chocolate flavored milk candies were used to perform Principal Component Analysis (Unscrambler ® version 8.0, 2003). Factor Loadings shown in Table 4.19 and PCA bi-plot illustrated in Figure 4.8 were used to arrive at conclusions about consumers’ overall liking of the two flavored milk candies. Two components explained 100% of the data variability for the PCA.

**Figure 4.8**: Internal Map. PCA bi-plot for acceptability of overall liking of two flavored milk candies evaluated by adults and children

**Table 4.19**: Factor loading scores for PCA of acceptability of two flavored milk candies

<table>
<thead>
<tr>
<th>Flavored milk candy</th>
<th>PC 1</th>
<th>PC 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chocolate</td>
<td>0.72</td>
<td>-0.70</td>
</tr>
<tr>
<td>Plain</td>
<td>-0.70</td>
<td>0.72</td>
</tr>
</tbody>
</table>

PC= Principal Component
The main sample differences and similarities were explained by the first and second component, which explained 70% and 30% of the variability, respectively. Figure 4.8 displays overall liking—consumers’ map of PC1 and PC2. Symbols with different colors correspond to different individual observations’ scores for overall liking. For instance, based on the colored scale on top of the figure, plain flavored milk candies was less liked, it was located near scores in the range of 5.5 to 7.4 (green and orange symbols). Chocolate milk candy was the most liked, since the product was located near scores ranging around 7.4 (orange symbols). Symbols denoted as A corresponded to individual scores obtained from adults’ evaluation, and C corresponded to individual scores obtained from children’s evaluation. In this case, as in PCA represented in Figures 3.2 and 3.3, individual observations are spread, indicating the difference in the consumers’ behavior. Nevertheless, it can be seen that in general, they are mixed, showing that both groups (adults and children) accepted the products in similar mode.

4.4. Conclusions

The objective of the consumer affective test with adults and children was to recognize detailed sensory attributes driving acceptance and purchase intent of a new flavored milk candy. Different flavors added to the milk candy caused a significant difference in the consumer responses toward evaluated sensory attributes. Three hundred and thirty five adult consumers and 92 pre-teenagers participated in this study. Chocolate and plain flavored milk candies were similarly the most accepted, and coffee flavored milk candy was least accepted. Taste, specific flavor, overall liking and aroma were discriminating attributes for acceptability of the products.

Acceptance of plain, chocolate and coffee milk candies could be predicted by taste, specific flavor, sweetness, overall liking and aroma. Purchase intent of plain milk candy was positively influenced by flavor, overall liking and acceptability. Purchase intent of chocolate
milk candy was positively influenced by specific flavor, and acceptance. Finally the purchase intent of coffee milk candy was influenced only by acceptance.

Children aged 10 to 12 years old liked the chocolate flavored milk candy the most, while plain was the least accepted. There were no significant differences in the way children and adults accepted chocolate and plain flavored milk candies. Consumers would be more willing to purchase flavored milk candies when enriched with calcium and other minerals that promote health benefits.
CHAPTER 5: SUMMARY AND CONCLUSIONS

Traditionally it has been believed that milk is a nutritional food itself. It does not need to be fortified or further processed to be positioned in the functional food market. This is not totally wrong, as milk is inherently a nutritional food. But, we live in a society of quick decisions and promises. New names and functional claims are the stamp of today’s food marketing space. Consumers want more from their foods. Therefore, the key word for the company growth is innovation. Innovative products within the dairy segment include milk-based products or, milk as a carrier or being viewed as the good-for-you ingredient.

New value-added milk products are entering the market, standing out as being indicators of where the value-added milk products category is headed during these years. Milks fortified with calcium and vitamins, cultured milks enriched with multivitamin complex, flavored milks, blends of black, green ad chamomile teas with milk, cholesterol-reducing margarine spreads, flavored cheeses, and squeezable cheeses are examples of some value-added product categories.

A natural milk candy, composed mainly of milk powder, which contains calcium and other nutrients, has not been sold in the U.S. market. The milk candy represents a great in-between meal dietary snacks. Each serving of 10-30 milk candies (10 to 30g) makes a healthy sustaining snack and provides a good source of additional energy. Compared to conventional snacks and sweet confectionery, the milk candy is a much less processed product. The flavored milk candy contains calcium, phosphorus, iron and many other essential nutrients, which make them a potential food product for adults and children.

Sensory evaluation (descriptive analysis and consumer affective studies) is key to the successful introduction of new food products and the reliable monitoring of existing food products in the marketplace.
The objective description of a food product in terms of perceived sensory attributes enables the differentiation among product’s formulations, specification of the sensory properties the products, and characterization to allow recognition in the food market. The acceptance of a new food product by consumers is largely determined by its sensory characteristics.

Consumer affective analysis can help the scientists to understand the behaviour of different consumers groups and, therefore to understand potential buyers of the product, what sensory attributes drive to product acceptability, and therefore in which way such product can be inserted into the food market.

Many food industries would like to obtain opinions from young consumers. The fact is that in the modern world, demographics of families have alternated their tasks, increasing the number of working parents. These parents, who once controlled the food that was bought in the house, are allowing their children to make more decisions when food is concerned. The purchasing power of children is increasing. Therefore, it is constructive to study the taste perception and product acceptance by young consumers.

Sensory affective tests indicate acceptability of food products without labels, price, or packages. Sensory consumer tests are usually done in highly controlled laboratory settings, appropriate for uncovering the physiological effects of exposure to some food stimulus on humans. Consumer affective studies are accomplished to improve appearance, flavor, and texture as perceived by consumers in order to influence their food choices (or purchase intent) in the sale level. However, results from sensory consumer studies should not be expected to give complete results compared as those obtained from marketing research.
The objectives of this research were to characterize flavored milk candies through the development of sensory descriptive lexicon and to determine consumer sensory profile driving product acceptance and purchase intent.

Evaluations of the three flavored milk candies revealed that they were different from one another, based on descriptive sensory attributes. A lexicon developed to describe the milk candies included aroma notes: buttery, caramel, cheesy, and cooked; flavor notes: buttery, caramel, cooked, and sweet. Cheesy aroma, buttery aroma and caramel aroma were discriminating attributes. Sweet flavor and cooked flavor were least discriminating. Plain milk candy was characterized by cheesy aroma, buttery aroma, cooked aroma, cooked flavor and buttery flavor notes. Caramel aroma and flavor aroma notes characterized chocolate milk candy. Coffee milk candy obtained low intensity scores for discriminating attributes.

Determination of the product sensory characteristics presented in each of the milk flavored milk candies increased an understanding of the product quality. Chocolate and coffee flavors may be used to mask strong undesirable cheesy and cooked flavor and aroma notes.

Different flavors added to the milk candy caused a significant difference in the consumer responses toward evaluated sensory attributes. Chocolate and plain flavored milk candies were well accepted, and coffee flavored milk candy was least accepted. Taste, specific flavor, overall liking and aroma were discriminating attributes for the acceptability of the products.

Acceptance of plain, chocolate and coffee milk candies could be predicted by taste, specific flavor, sweetness, overall liking and aroma. The purchase intent of plain, chocolate, and coffee milk candies was positively influenced by flavor, overall liking, specific flavor and acceptance.
Children aged 10 to 12 years old liked the chocolate flavored milk candy more than the one. There were no significant differences in the way children and adults accepted chocolate and plain flavored milk candies.

Consumer purchase decision was influenced by the fact that the product was enriched with calcium and other vitamins and minerals. Consumers would be more willing to buy flavored milk candies enriched with calcium and other minerals that promote health benefits.

More research needs to be done before launching the product to the U.S. market. Some modifications may be needed; this includes the addition of alternative flavors, such as strawberry or vanilla. In addition, the shape and size may be re-modeled; perhaps animals, cartoons, or funny shapes may be used for a new milk candy targeted to children. Nevertheless, new consumer sensory studies together with marketing research should be done to warrant the success of the new products.

This study represents the first step for the development of a process to insert or position the new milk candy in the U.S. market.
REFERENCES


Unscrambler version 8.0. 2003. CAMO Technologies Inc. 501 Silverside Road Wilmington DE


APPENDICES
APPENDIX A. CONSENT FORM FOR DESCRIPTIVE ANALYSIS

I, __________________________, agree to participate in the research entitled “Sensory Evaluation of Flavored Milk Candies”, which is being conducted by Witoon Prinyawiwatkul, Associate Professor of the Department of Food Science, phone number (225)-578-5188.

I understand that participation is entirely voluntary and whether or not I participate will not affect how I am treated on my job. I can withdraw my consent at any time without penalty or loss of benefits to which I am otherwise entitled and have the results of the participation returned to me, removed from the experimental records, or destroyed. 105 consumers will participate in this research. For this particular research, about 20-30 min. participation will be required for each consumer.

The following points have been explained to me:

1. In any case, it is my responsibility to report prior to participation to the investigators any allergies I may have.
2. The reason for the research is to gather information on consumer attitude and their acceptance of flavored milk candies. The benefit that I may expect from it is a satisfaction that I have contributed to solution and evaluation of problems relating to such examinations.
3. The procedures are as follow: Coded samples will be placed in front of me and I will evaluate them by normal standard methods and indicate my evaluation on score sheets. All procedures are standard methods as published by the American Society for Testing and Materials and the Sensory Evaluation Division of the Institute of Food Technologists.
4. Participation entails minimal risks: The only risk that can be envisioned is an allergic reaction to milk, sucrose, coffee, and chocolate products. However, because it is known to me beforehand what type of food to be tested, the situation can normally be avoided.
5. The results of this participation will be confidential and will not be released in any individual identifiable form without my prior consent unless required by law.
6. The investigator will answer any further questions about the research, either now or during the course of the project.

The study has been discussed with me and all my questions have been answered. I understand that additional questions regarding the study should be directed to investigators listed above. In addition, I understand that research at Louisiana State University, which involves human participation, is carried out under the oversight of the Institutional Review Board for Human Research Subject Protection. Questions or problems regarding these activities should be addressed to Dr. David Morrison (225)578-8236. I agree with the terms above and acknowledge I have been given a copy of the consent form.

______________________________  __________________________________
Signature of Investigator     Signature of Participant
Witness:___________________________               Date: _________________________
APPENDIX B. QUESTIONNAIRE FOR PANELIST SCREENING FOR DESCRIPTIVE ANALYSIS

Name:___________________________     Date:___________________
Phone Nº: ________________________               email: __________________

Screening Part I:

Match each solution to one of the perceived tastes (sweet, sour, salty, or bitter)

<table>
<thead>
<tr>
<th>Taste</th>
<th>Write down the solution number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet</td>
<td></td>
</tr>
<tr>
<td>Sour</td>
<td></td>
</tr>
<tr>
<td>Salty</td>
<td></td>
</tr>
<tr>
<td>Bitter</td>
<td></td>
</tr>
</tbody>
</table>

Screening Part II:

1. Rank the sweetness intensity of the solutions from the least sweet to the sweetest. Write down the solution number on the space below.

   _______  _______  _______  _______
   Least sweet        Sweetest

2. Rank the saltiness intensity of the solutions from the least salty to the saltiest. Write down the solution numbers on the space below.

   _______  _______  _______  _______
   Least salty        Saltiest

3. Rank the sourness intensity of the solutions from the least sour to the sourest. Write down the solution numbers on the space below.

   _______  _______  _______  _______
   Least sour        Sourest

4. Rank the bitterness intensity of the solutions from the least bitter to the most bitter. Write down the solution numbers on the space below.

   _______  _______  _______  _______
   Least sour        Sourest
Screening Part III:

Please taste and sniff the first set of samples and rest between samples. Taste and sniff the second set of samples. Match the samples from the second set with the first set. Write down the sample numbers of the second set next to the first. Then determine which term(s) from the list below would best describe each sample.

<table>
<thead>
<tr>
<th>First set</th>
<th>Second Set</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>079</td>
<td></td>
<td></td>
</tr>
<tr>
<td>318</td>
<td></td>
<td></td>
</tr>
<tr>
<td>992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>467</td>
<td></td>
<td></td>
</tr>
<tr>
<td>134</td>
<td></td>
<td></td>
</tr>
<tr>
<td>723</td>
<td></td>
<td></td>
</tr>
<tr>
<td>844</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sweet/Salty  Vanilla  Caramel  Cheese  Butter
Cream/milky  Cooked milk
APPENDIX D. SAS CODE FOR DESCRIPTIVE ANALYSIS

a. Analysis of Variance (ANOVA)

options nodate nonumber;
data all;
input Panelist Sample$ pdt$ Abuttery Acheesy Acooked Acaramel Fcooked Fbuttery Fsweet Fcaramel;
cards;
Inserted data; run;
proc sort data=all; by sample; proc means data=all; by sample; var Abuttery Acheesy Acooked Acaramel Fcooked Fbuttery Fsweet Fcaramel; run; Proc mixed Data=all;
Class sample; Model Abuttery=sample/htype=3;run;
proc mixed data=all;Class sample;
model Acheesy=sample/htype=3;run;random panelist;
proc mixed data=all;Class sample;model Acooked=sample/htype=3;random panelist;run;
proc mixed data=all;Class sample;
model Acaramel=sample/htype=3;random panelist;run;
proc mixed data=all;Class sample;model Fcooked=sample/htype=3;random panelist;run; proc mixed data=all;Class sample;
model Fbuttery=sample/htype=3;random panelist;run;
proc mixed data=all;Class sample;model Fsweet=sample/htype=3;random panelist;run;
model Fcaramel=sample/htype=3;random panelist;run;
quit;

b. Multivariate Analysis of Variance (MANOVA) and Descriptive Discriminate Analysis (DDA)

dm "clear log; clear output";
options nodate nonumber;
data one;
input panel  sample $ pdt $ abutter acheese acooked acaramel fcooked fbutter fsweet fcaramel;
datalines;
Inserted data
;
proc candisc out=outcan mah;
class sample;
var abutter acheese acooked acaramel fcooked fbutter fsweet fcaramel ;
run;
quit;
I, _________________________, agree to participate in the research entitled “Consumer Sensory Evaluation of Flavored Milk Candies”, which is being conducted by Witoon Prinyawiwatkul, Associate Professor of the Department of Food Science, phone number (225)-578-5188.

I understand that participation is entirely voluntary and whether or not I participate will not affect how I am treated on my job. I can withdraw my consent at any time without penalty or loss of benefits to which I am otherwise entitled and have the results of the participation returned to me, removed from the experimental records, or destroyed. 105 consumers will participate in this research. For this particular research, about 20-30 min participation will be required for each consumer.

The following points have been explained to me:

7. In any case, it is my responsibility to report prior to participation to the investigators any allergies I may have.
8. The reason for the research is to gather information on consumer attitude and their acceptance of flavored milk candies. The benefit that I may expect from it is a satisfaction that I have contributed to solution and evaluation of problems relating to such examinations.
9. The procedures are as follow: Coded samples will be placed in front of me and I will evaluate them by normal standard methods and indicate my evaluation on score sheets. All procedures are standard methods as published by the American Society for Testing and Materials and the Sensory Evaluation Division of the Institute of Food Technologists.
10. Participation entails minimal risks: The only risk that can be envisioned is an allergic reaction to milk, sucrose, coffee, and chocolate products. However, because it is known to me beforehand what type of food to be tested, the situation can normally be avoided.
11. The results of this participation will be confidential and will not be released in any individual identifiable form without my prior consent unless required by law.
12. The investigator will answer any further questions about the research, either now or during the course of the project.

The study has been discussed with me and all my questions have been answered. I understand that additional questions regarding the study should be directed to investigators listed above. In addition, I understand that research at Louisiana State University, which involves human participation, is carried out under the oversight of the Institutional Review Board for Human Research Subject Protection. Questions or problems regarding these activities should be addressed to Dr. David Morrison (225)578-8236. I agree with the terms above and acknowledge I have been given a copy of the consent form.

Signature of Investigator _______________________________ Signature of Participant _______________________________
Witness: _______________________________ Date: _______________________________
APPENDIX F. QUESTIONNAIRE FOR CONSUMER STUDY WITH ADULTS

Questionnaire

DEMOGRAPHIC SURVEY: All information collected will not be identified with your name.

1. What is your age group? (Please check one)
   18-24 years_____________  25-34 years_____________  35-44 years_____________
   45-54 years_____________  55-64 years_____________  Over 64 years_____________

2. What is your gender? Male_____________ Female_____________

3. Which do you consider yourself to be? (Please check one)
   African-American_____________  Hispanic/Spanish_____________
   Asian-American_____________  White (Caucasian)_____________
   Other (Please specify)_____________

4. Level of education? (Please check one)
   Less than high school_________  Some college_________  Graduate (M.S., M.A., Ph.D., Ed.)
   High school_________  Completed college_________

5. Which of these categories best describes your gross 2002 household income? (Please check one)
   Under $9,999_________  $10,000 - 19,999_________  $20,000 - 29,999_________  $30,000 - 39,999_________
   $40,000 - 49,999_________  $50,000 - 59,999_________  $60,000 - 69,999_________  $70,000 - 79,999_________
   $80,000 - 89,999_________  $90,000 - 99,999_________  Over $100,000_________

MILK CANDY PRODUCT INFORMATION

1. Have you heard of or seen milk candies in a tablet form in the US market?
   Yes [ ]  No [ ]

2. Are you aware of the health benefits of calcium?
   Yes [ ]  No [ ]

3. Would you consider buying flavored milk candies enriched with calcium or other vitamins/minerals?
   Yes [ ]  No [ ]
SAMPLE No:________

1. How would you rate the OVERALL APPEARANCE/COLOR of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

2. How would you rate the SIZE and SHAPE of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

3. How would you rate the TEXTURE and/or MOUTHFEEL of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

4. How would you rate the TASTE of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

5. How would you rate the ODOR/AROMA of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

6. How would you rate the COFFEE FLAVOR of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

7. Please rate the COFFEE FLAVOR of this product based on your preference.

- Too weak [ ]
- Just about right [ ]
- Too strong [ ]

8. How would you rate the SWEETNESS of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

9. Please rate your OVERALL LIKING of this product?

<table>
<thead>
<tr>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Dislike</th>
<th>Neither Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
<th>Like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely</td>
<td>Very much</td>
<td>Moderately</td>
<td>Slightly</td>
<td>nor Dislike</td>
<td>Slightly</td>
<td>Moderately</td>
<td>Very much</td>
<td>Extremely</td>
</tr>
</tbody>
</table>

10. Is this product ACCEPTABLE?  YES [ ]  NO [ ]

11. Would you BUY this product if it were commercially available?  YES [ ]  NO [ ]

12. Would you BUY this product after knowing it contains health promoting calcium and other vitamins/minerals?  YES [ ]  NO [ ]
APPENDIX G. SAS CODE FOR CONSUMER STUDY WITH ADULTS

a. Analysis of Variance (ANOVA)

options nodate nonumber;
data consumer;
input Sample$ Panelist age gender eth education income Q1candy i Q2candy i Q3candy i ovappea size texture taste aroma specflavor jar sweetness oliking accept buy buyknow;
cards;
inserted data
run;
proc sort data=consumer; by sample;
proc means data=consumer; var ovappea size texture taste aroma specflavor sweetness oliking;
by sample; run;
proc mixed data=consumer;class sample;
model ovappea=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample; model size=sample/htype=3;
random panelist;lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample;
model texture=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample;
model taste=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample;
model aroma=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample;
model specflavor=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample;
model sweetness=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
proc mixed data=consumer;class sample;
model oliking=sample/htype=3;random panelist;
lsmeans sample/adjust=tukey;run;
quit;

b. Multivariate Analysis of Variance (MANOVA) and Descriptive Discriminant Analysis (DDA)

dm "clear log; clear output";
options nodate nonumber;
data all;
input Sample$ Panelist age gender eth education income Q1candyi Q2candyi Q3candyi ovappea size texture taste aroma specflavor jar sweetness oliking accept buy buyknow; datalines;
inserted data
proc candisc out=outcan mah;
class sample;
var ovappea size texture taste aroma specflavor jar sweetness oliking;
run;
c. Predictive Discriminant Analysis (PDA) for acceptability.

dm "clear log; clear output";
options nodate nonumber;
data all;
input Sample$ Panelist age gender eth education income Q1candyi Q2candyi Q3candyi ovappea size texture taste aroma specflavor jar sweetness oliking accept buy buyknow; datalines;
inserted data; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var ovappea size texture taste aroma specflavor jar sweetness oliking;
proc discrim crossvalidate pool=yes posterr;
class accept;
var ovappea;by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var size;by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var texture; by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var specflavor; by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var taste; by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var aroma; by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var sweetness; by sample; run;
proc discrim crossvalidate pool=yes posterr;
class accept;
var oliking; by sample; run;
run;
d. Logistic Regression

options nodate nonumber;
data consumer;
input Sample Panelist age gender eth education income Q1candyi Q2candyi Q3candyi ovappea size texture taste aroma specflavor jar sweetness oliking accept buy buyknow;
if buy=1 then buy=1; if buy=2 then buy=0; n=1;
cards;
Inserted data;
run;
proc sort data=consumer;by sample;run;title" purchase intent";
proc genmod data=consumer; class gender accept jar; model buy/n=   gender ovappea size texture taste arom specflavor jar sweetness oliking accept /dist=bin link=logit;by sample; run; quit;

e. Predictive Discriminant Analysis (PDA) for Purchase Intent.

dm "clear log; clear output";
options nodate nonumber;
data all;
input Sample$ Panelist age gender eth education income Q1candyi Q2candyi Q3candyi ovappea size texture taste aroma specflavor jar sweetness oliking accept buy buyknow;
datalines;
Inserted data; run;
proc discrim crossvalidate pool=yes posterr;
class buy;
var specflavor ;by sample; run;
proc discrim crossvalidate pool=yes posterr;
class buy;
var oliking;by sample; run;
run;
proc discrim crossvalidate pool=yes posterr;
class buy;
var jar ;by sample;run;
run;

f. Mc Nemar Test

options nodate nonumber;
Data one;
Input sample BUY BUYKNOW count;
datalines;
*Inserted data*
run;
proc freq; weight count;
tables buy*buyknow/agree;by sample;
run;
quit;
Dear Parents:

We are requesting your consent for your child to participate in a taste test to evaluate flavored milk candies. The reason for this research is to gather information on consumer attitude and their acceptance of flavored milk candies. We hope to expand our understanding of these products within the U.S. children population. The product is a milk candy and is composed of 79% milk powder and 21% sugar. It is a very nutritious and healthy product. Each 20g of this product provides 95.4 kcal, 2.64 g protein, 94.2 mg calcium, 90.8 mg phosphorus and 5.6 mg Iron. The milk candy is regularly consumed and commercialized in Thailand and the Thai Food and Drug Administration approved it as safe for consumption.

Since it is a new product for the U.S. young consumers, one of our objectives is to study its acceptability as well as to develop a descriptive profile of the milk candy.

According to the American Academy of Pediatrics, calcium intake in childhood may be a critical factor in preventing osteoporosis later in life. Moreover, calcium is a major component of mineralized tissues and is required for normal growth and skeletal development. Optimal calcium intake, along with a healthy diet and regular exercise, is important to maximize peak adult bone mass, its maintenance, and to minimize bone loss among the elderly. Calcium requirements may vary among the different stages of an individual’s life. The greatest needs are during the periods of rapid growth in childhood, pregnancy and lactation, and in later life. The calcium consumption of 1,000 mg per day should be able to maintain bone mass during skeletal maturity. One of the greatest advantages of the milk candy product is that it represents an alternative source of nutrients for those who need a relatively large quantity of calcium in their diet for a normal growth, such as children and adolescents.

This research will be conducted by Mrs. Noemi Pavon, a graduate student in the Food Science Department at the Louisiana State University, under the guidance of Dr. Witoon Prinyawiwatkul, Ph.D. Before deciding whether you will allow your child to participate, please read the description of the project below.

This project will consist of a single session of approximately 20 minutes. We will make sure that this will not interrupt the classroom activities. The procedures are as follow: Coded samples will be placed in front of the child and he/she will evaluate them by the normal standard methods and indicate his/her evaluation on score sheets. All procedures are the standard methods as published by the American Society for Testing and Materials and the Sensory Evaluation Division of the Institute of Food Technologists.

At any time your child can discontinue the research session. The procedure is safe, enjoyable and game-like. The principal benefits are of a scientific and educational nature. The results will lead to a better understanding of young children’s perception of food. There are no risks to your child, unless they are allergic to milk, sugar and/or chocolate.
Pictures may be taken during the session and will be used only for research purposes. We will not identify your child’s name in any reports of our research.

Your child’s participation in this study is voluntary. You, as a parent, are free to deny our request for your child’s participation in this research project. Whether or not your child participates in this study will have no bearing on you or your child’s status with the school program or the Louisiana State University. Should you have any questions about the research, please contact us at (225) 578-5197. We appreciate your cooperation and hope that you will allow your child to participate. If you consent, please complete the attached form, sign the form and return it to the teacher.

Thank you very much and enthusiastically look forward to your positive response.

Sincerely,

______________________                      __________________________
Dr. Witoon Prinyawiwatkul                                   Noemi Pavon
Associate Professor                                               Graduate Student
Department of Food Science                                 Department of Food Science
Louisiana State University                                      Louisiana State University

Dear Parent/Guardian

During the consumer test to be carried out in school, your child will taste milk products. Participation entails minimal risks: The only risk that can be envisioned is an allergic reaction to milk, sucrose, and chocolate products. However, because you know beforehand what your child will be testing, the situation can normally be avoided. I would be grateful if you could complete the form below and return it to your child’s class teacher for our records. Thanks for your kind cooperation in this.

Noemi Pavon

Name of participating child: ………………………………………………………
Parent’s name:………………………………………………………………………, (Please type / print legibly)

Signature: ……………………………………………………………………(parents/guardian)
Date………………………………………………………………………………

By signing my name, I allow my child to participate in the research on flavored milk candies
APPENDIX I. QUESTIONNAIRE FOR CONSUMER STUDY WITH CHILDREN

Grade: _______  Age: _______

___  ___

Super Good......................... ___
Really Good.......................... ___
Good................................. ___
Just a little good.................... ___
Maybe good or maybe bad .......... ___
Just a little bad..................... ___
Bad.................................... ___
Really Bad........................... ___
Super Bad............................ ___
APPENDIX J. SAS CODE FOR CONSUMER STUDY WITH CHILDREN

a. Analysis of Variance (ANOVA)

options nodate nonumber;
data young;
input Consumer Sample$ Grade Age Gender Liking;
cards;
Inserted data; run;
proc sort data=young; by sample; run;
proc means data=young; var liking; by sample; run;
proc mixed data=young; class sample; model liking=sample/htype=3; random consumer; run;
proc sort data=young; by gender; run;
proc mixed data=young; class sample; model liking=sample/htype=3; random consumer; by gender; run;
quit;


options nodate nonumber;
data chladult;
input age$ Ch Plain;
cards;
Inserted data;
run;
proc means data=chladult; var ch plain ; by age; run;
proc mixed data=chladult; class age; model ch=age/htype=3; run;
proc mixed data=chladult; class age; model plain=age/htype=3; run;
quit;
VITA

Noemi Raquel Pavon graduated from Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo in 2001 with Licenciatura en Bromatologia degree. In August 2001, she enrolled at Louisiana State University to pursue a Master of Science degree in food science. She will receive the degree of Master of Science in August, 2003.