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I am submitting herewith a thesis written by April Rae Parker entitled "Effect of Labeling on Consumer Perception of Commercial and Laboratory-Produced Vanilla Ice Creams". I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Food Science and Technology.

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Effect of Labeling on Consumer Perception of Commercial and Laboratory-Produced Vanilla Ice Creams

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Abstract

Ice cream, produced in millions of gallons, has been a favorite comfort food to many people since its development centuries ago. Vanilla ice cream has long been a staple in the ice cream industry with its production and consumption being the highest when compared to other flavors. Since many consumers want more “natural” foods, the objective of this study was to study the effect of labeling the type of vanilla flavoring on consumer perception of commercial ice cream and laboratory-produced vanilla ice cream.

Four commercial vanilla ice creams, one containing natural vanilla, one with artificial, and two containing both, were evaluated by several sensory panels. Nine-point hedonic scales were used to evaluate overall liking, appearance, color, flavor, vanilla flavor, sweetness and 9-point intensity scales were used to evaluate the strength of vanilla flavor and the strength of sweetness of the commercial ice creams. When the samples were not labeled with the type of vanilla flavoring, ANOVA data showed that the naturally flavored ice cream was not liked as well as the ice cream with mixed flavorings overall and for vanilla flavor. When the samples were labeled with the type of vanilla flavoring, the artificially flavored ice cream was not liked as well as the mixed flavored ice creams. The naturally flavored ice cream was liked as well as one of the mixed flavored ice creams overall and for flavor and vanilla flavor. Another experiment was conducted with an incomplete block design (n=150) with the same four ice creams being labeled (correctly or incorrectly) for twelve combinations. No

overall, flavor, vanilla flavor, or sweetness differences in hedonic scores existed among the products, yet differences did exist between the ice creams with particular labels no matter which product was used. Products labeled “natural” were liked more ($p<0.05$) overall and for vanilla flavor than the products with other labels.

Further experimentation involved using a standard ice cream base mix to adjust for the effect of other ingredients on flavor. A ranking test was used to determine which amount of artificial or natural vanilla flavoring (6,8,10,or 12 mL) was liked best for strength of vanilla flavor. Further experiments using the base mix used ice cream made with 10 mL of 2-fold pure vanilla extract, 10 mL of artificial vanilla flavoring, or 5mL of natural and 5 mL of artificial flavoring. In general, the 10 mL of vanilla flavoring matched the “ideal” strength of vanilla flavoring.

Hedonic and intensity testing similar to that used for the commercial ice cream was used for the laboratory-produced ice cream. For an experiment where the ice cream was not labeled with the type of vanilla flavoring, ANOVA showed the naturally flavored ice cream was not liked as well as the other two samples overall, for color, flavor, vanilla flavor, or sweetness. When the samples were labeled with the type of vanilla flavoring used, the artificially flavored ice cream was not liked as well as the other two samples overall and for flavor and vanilla flavor. Another experiment was conduced using an incomplete block design with each ice cream being labeled (correctly or incorrectly) with the type of vanilla flavoring for a total of 9 combinations. The naturally flavored ice cream was not liked as well overall and for flavor and vanilla flavor as the other two samples. No differences were found among the samples when they were evaluated based on the label assigned to the ice cream.

For both the commercial and the laboratory-produced ice creams, labeling was shown to have an effect on consumer perception. Psychological effects on consumer perceptions need further consideration and research.

Table of Contents

Chapter Page

List of Tables

Table Page

Chapter I

Introduction

Many stories mixing fact and fiction describe the beginnings of ice cream and the first person to introduce the dessert to others. Everyone from the Roman Emperor Nero to Charles I of England to Marco Polo have stories attached to them as being the first to enjoy frozen desserts resembling modern day sherbets (Goff 2000). In the United States, Dolley Madison, wife of President James Madison, created a stir when she served ice cream at the White House at the inaugural ball in 1812 (Anon 2000). In the mid-1800s Nancy Johnson created the first hand-cranked freezer although reports vary about the patent information (Anon 2000; Goff 2000). Commercial production was started in North America by Jacob Fussell in Baltimore, MD in 1851 (Goff 2000). Development of the homogenizer, mechanical refrigeration, and the continuous freezing process also contributed to the evolution of today's product known as ice cream.

Today ice cream, produced in millions of gallons, is a favorite "comfort" food to many people. This flavorful and diverse dessert is so dearly loved in the United States that Ronald Reagan declared July to be National Ice Cream Month (Zaborsky 2001). Ice cream products, available in many unique flavors, were produced by 1,124 manufacturers in 2000 (Agriculture Statistics Board and others 2001). Products are made available in reduced-fat, low-fat, and no-sugar varieties to provide for people with different nutritional needs along with many inclusions to accommodate any individual's desire. Ice cream is an approximately

$3.5 billion retail industry with each American consuming an average of "23.2 quarts of ice cream, ice milk, sherbet, ices, and other commercially produced frozen dairy products" per year (Hollingsworth 1999; Anon 2001). In 1999, trends showed an increase in consumption of high-butterfat ice creams as consumers gave into their cravings and indulged in ice cream (Hollingsworth 1999). As some of the reduced-fat or reduced-calorie products did not live up to consumer expectations, some people decided to just go ahead and eat a portion of the calories and fat found in some of their favorite desserts (Anon 1999).

Liking of a product's taste may no longer be as desirable to many people as the word "natural". Trends in consumer demands are leaning towards organic foods and food made from natural ingredients without preservatives and other "chemicals" that people have decided they no longer want in their food. In the past several years, one brand of ice cream has commercials making the point that their ice cream is a wholesome natural product and that a young child can read all the ingredients listed in their ice cream (Breyers 2002). In the United States, the organic food industry "has grown 20% every year for the past ten years" and now is a $6 billion piece of the grocery industry as many companies are interested in organic foods (Ianzito 2001). Many consumers believe that organic or natural foods are safer, more healthful, and more wholesome than other products. Worries about chemical additives, genetically modified foods, and Mad Cow Disease have all increased organic sales (Pollan 2001). While using "organic" and "all natural" on products is a great marketing tool, it is interesting to study whether consumers actually like the naturally flavored product better or does the labeling of these products affect consumer perception.

Vanilla is a flavor that is incorporated into many products so it is of interest to look at this ingredient and consumer perception. Natural vanilla has become more expensive in the past several years but if consumers do not really like the taste of natural vanilla, why should the companies go to the extra expense of using it? Many companies follow current trends of having all natural products, which leads to sales to consumers who believe they want these products; the companies might benefit by consumer acceptance of products containing both artificial and natural flavorings, especially if consumers really do not like the taste of naturally flavored products. It is of interest to see which type of flavoring (natural, artificial, or a mixture) is liked best by consumers and if labeling can affect consumer perception. Therefore, the goals of this research were to 1) determine which of four commercial ice creams containing different types of vanilla flavoring is liked best by consumers, 2) ascertain if consumer perception of commercial ice cream can be affected by labeling (correctly or incorrectly) the type of vanilla used in the product, 3) investigate the type of vanilla flavoring liked best by consumers in laboratory-produced ice cream that adjusts for the effect of other ingredients on flavor, and 4) discover the effect of labeling (correctly or incorrectly) on vanilla ice cream made with the same base mix but with different vanilla flavorings.

Chapter II

Review of Literature

Ice Cream Ingredients

Ice cream is a “frozen mixture of a combination of components of milk, sweeteners, stabilizers, emulsifiers, and flavoring” with the possible addition of other ingredients like eggs, colorings, and starch hydrolysates (Marshall and Arbuckle 1996). The mixture of these ingredients is pasteurized and homogenized before freezing, which quickly removes heat and incorporates air into the product to create a smooth and creamy texture. Today ice cream comes in a variety of colors, flavors, qualities, and prices, yet all frozen desserts classified as ice cream have to meet the same minimum standards as set by the federal government in the Code of Federal Regulations (CFR) Title 21 Section 135.110. Ice cream must contain “not less than 1.6 pounds of total solids to the gallon, and weighs not less than 4.5 pounds to the gallon” (FDA 2001a). Ice cream must contain at least 10% milkfat and 10% nonfat milk solids and not more than 3% stabilizers, except if the product contains 1% increments above the 10% minimum for milkfat, the amount of nonfat milk solids may decrease in proportion to the increase of milkfat (FDA 2001a).

Milkfat is an essential ice cream ingredient that is used to create a proper balance of flavor and textural properties as well as satisfy legal standards. It is extremely important that the fat in the ice cream is of good quality since any off-flavors produced by rancidity or oxidation will be carried over into the final product (Andreasen and Nielsen 1998). Milkfat can affect ice cream flavor by "contributing its own natural richness and creaminess; by contributing flavors acquired through hydrolysis, oxidation, or processing; and by modifying the perception of flavorful substances in the product" (Ohmes and others 1998). The fat globules concentrate at the surface of air cells during the freezing process, which imparts the characteristic rich flavor (Marshall and Arbuckle 1996). Vanilla, a fat-soluble flavor, is carried by fat into the mouth where the flavors are volatilized prior to sensory reception in the olfactory system. If there is not enough fat to carry the flavor, it rapidly volatilizes and quickly disappears from the perceived flavor profile (Ohmes and others 1998).

Many studies have been conducted to determine the effect of fat and possible fat replacers on the flavor of the ice cream. Guinard and others (1997) found that increased fat caused "higher buttery, custard/eggy and sweet flavor" as well as "fatty, creamy, doughy, and mouthcoating texture" as perceived by a trained 13-judge panel. A 136-judge panel consumer liked ice creams containing 18% fat with either 13 or 18% sugar the most (Guinard and others 1997). Ohmes and others (1998) showed that fat is important as a flavor modifier and milkfat "significantly reduced the syrup, whey, and cooked milk flavors and increases the fresh milk and cream flavors of ice cream" when compared to fat substitutes. Li and others (1997) demonstrated that as fat content increases, the amount of free vanillin decreases as determined with HPLC. In addition, a 63-judge panel from the University of Missouri-Columbia indicated that as fat content increases, the overall liking increases.

Nonfat milk solids consist of proteins, lactose, and minerals. The proteins add nutritional value to the ice cream and affect the whipping characteristics (Andreasen and Nielsen 1998). In addition, protein from the nonfat milk solids helps to stabilize the foam during the incorporation of air when making ice cream and stabilizes the fat emulsion after homogenization (Andreasen and Nielsen 1998; Walstra and others 1999). Casein acts as an emulsifier at the interfacial area around the fat globule but whey proteins only interact with the fat to a limited extent (Andreasen and Nielsen 1998). Nonfat milk solids enhance palatability of ice cream but do not contribute much to the flavor (Marshall and Arbuckle 1996). Lactose can add a slightly sweet taste while the minerals in nonfat milk solids can add a slightly salty taste; yet, too much of either can result in undesirable flavors.

Sweeteners like sucrose or corn syrup make the ice cream sweet and increase consumer acceptance. Sugars, varying from 12-20% of the mixture, can also “enhance the pleasing creamy flavor and the delicate fruit flavors” (Marshall and Arbuckle 1996). Sugars depress the freezing point of the ice cream inversely proportional to their molecular weight (Andreasen and Nielsen 1998; Walstra and others 1999; Marshall and Arbuckle 1996). This allows the sweeteners to control the amount of water that freezes and therefore the softness and mouthfeel of the ice cream. Sweeteners also increase viscosity, which improves the body and texture of the ice cream. Too much sugar will make the ice cream too sweet, soggy, and sticky while too little sugar could cause too much ice to form and the flavor defect of sandiness to occur (Walstra and others 1999). Guinard and others (1996) found that out of ice creams containing various sugar and fat levels, the favorite ice cream among 146 university students was the one containing 13.54% sugar and 14.99% fat. Guinard and others (1997) showed that increasing sugar content “caused higher vanilla, almond, buttery, custard/eggy,” and sweetness flavors as well as “fatty, creamy, doughy, and mouthcoating characteristics” as determined by 13 judges. A consumer panel with 146 panelists liked the ice creams containing 13% sugar with either 14 or 18% fat more than the ice creams containing 8 or 18% sugar independent of fat concentration.

Stabilizers improve the mouthfeel of ice cream by increasing the viscosity and preventing the formation of ice crystals (Marshall and Arbuckle 1996). They generally do not affect flavor. Stabilizers can be divided into three main types: gelatin stabilizers from animal sources, vegetable stabilizers, and gums. Combinations of stabilizers in commercial ice cream are normally used to obtain desirable texture properties and prevent a soggy or heavy body in the ice cream (Marshall and Arbuckle 1996). Miller-Livney and Hartel (1997) showed that in most cases carrageenan and locust bean gum are most effective in retarding ice crystal growth which can lead to a coarse texture while xanthan gum and gelatin are only effective when combined with sucrose or high fructose corn sweeteners and stored at -15ºC but not –5.2 or –9.5ºC.

Emulsifiers, commonly mono- and diglycerides, are used to produce a smoother texture and reduce the whipping time of the ice cream (Marshall and Arbuckle 1996). Abd El-Rahman and others (1997) evaluated the effect of the presence of emulsifiers in vanilla ice cream made with cream, an anhydrous milkfat, a high-melting milkfat fraction, or a low-melting milkfat fraction on sensory scores for vanilla ice cream. They found no differences among samples for overall acceptability, flavor, or texture with or without an emulsifier present. Baer and others (1997) studied the effect of type of emulsifier (polysorbate 80 blend with monoglycerides and diglycerides, 40% α-monoglyceride, 70% α-monoglyceride, and lecithin) on 2% fat ice cream and found that all increased viscosity, reduced whipping time, provided heat shock stability, reduced ice crystal size, and improved the body and texture of the low-fat ice cream.

Egg yolk solids are one optional ingredient that adds a characteristic flavor to the overall blend of flavors in the ice cream. They also improve the body and texture of the ice cream and help with the whipping ability (Marshall and Arbuckle 1996). Other optional ingredients such as caseinate derivatives or mineral salts can be added to enhance flavor or to improve the body and texture of the ice cream. It is important that no matter which ingredients are used in ice cream that they be of good quality because the quality of the final product will be a direct reflection of the quality of the ingredients.

Vanilla

Vanilla is produced from beans from plants belonging to the orchid family. Due to the growth requirements of these plants, only the climates in regions around the equator allow for the growth and production of vanilla beans. Three commercial varieties are available: *Vanilla fragrans* (otherwise known as *V.*

planifolia), *V. tahitensis*, and *V. pompona* (Marshall and Arbuckle 1996). *V. planifolia* and *V. tahitensis* are used to produce vanilla extracts and flavorings while the *V. pompona,* grown in Martinique and Guadeloupe, is used for perfumes and fragrances. There are a variety of common names for the vanilla beans including: Mexican from Mexico; Bourbon from the islands off the east coast of Africa, such as Madagascar; South American from Guadeloupe, Dominica and Martinique; Indonesian from Indonesia; and Tahitian from Tahiti and Society Islands (Goff 2000). Between 25 and 30% of the world's supply of vanilla beans come from Indonesia while approximately 70% comes from Madagascar. Each type of vanilla possesses its own unique flavor due to growth region and the processing procedure. Bourbon vanilla from Madagascar is "characterized by a full-bodied taste accompanied by a sharp vanillin lift and underlying rummy notes" while Mexican beans are described as having a softer vanillin flavor and a "vinous (wine-like) nose with a fruity, prune like edge" (Webster 1995). Indonesian beans of high quality are similar to Bourbon beans but lack the complete fullness and have a good fruity flavor with a slight spiciness (Webster 1995). Lower quality Indonesian beans called Java beans have a harsher flavor with a "deep, woody, smoky, phenolic flavor" that is often accompanied by a "strong spicy note", probably due to the different processing method (Webster 1995). Tahitian vanilla is produced from a different species, *V. tahitensis*, than other vanillas and has a distinguishable flavor characterized by "a sweet cherry or almond-like character" (Webster 1995).

In order to obtain the flavoring, the vanilla pods must be cured, which initiates the necessary enzymatic reactions that develop the unique flavors and aromas associated with vanilla (Riley and Kleyn 1989). McCormick (1988) defined curing as “the process in which the pods absorb heat from the sun, they exude fats which blend with the natural resins present to provide the substrate for the enzymes in the bean.” The process of curing varies among the different growing regions with one being developed in Mexico called the sun process and another developed in Madagascar (Reineccius 1994).

The Mexican process requires that the vanilla pods be stored in sheds until they shrivel and then they are placed in large mahogany sweating boxes with mats placed around the boxes so that proper temperatures are maintained and enzymatic reactions take place (Reineccius 1994). The sweating process is repeated 6-8 times over 2-3 weeks until the beans turn dark brown. After the desired color is acquired, the beans receive fewer “sweatings” to help reduce moisture levels and then the beans are placed in aging boxes for 2-3 months. Following aging, the beans are bundled according to quality, packed in special tins lined with wax paper, and shipped to market. The entire curing process takes approximately 8 months. (Reineccius 1994).

The Madagascar process is shorter and starts with the green vanilla pods being wilted in hot water for 7-15 min at 79-85ºC in order to destroy the chlorophyll and increase enzymatic reactions (Riley and Kleyn 1989). After the hot water treatment, the pods are spread out on blankets and exposed to the sun until night when they are wrapped in the blankets (Reineccius 1994). This process is repeated daily for 2-8 weeks during which time enzymatic reactions take place and “key products such as tannins, fats and oils, vanillin, and nitrogenous components are formed” (Riley and Kleyn 1989). Next the beans are placed in trays and stored in warehouses for natural dehydration and curing. The final steps are sorting for quality, bundling, and shipping to market (Reineccius 1994).

Originally to extract the flavor, vanilla beans were ground with sugar (known today as vanilla sugar) but now liquid extraction is used (Webster 1995). One method involves a percolation process similar to the one used for coffee; however, it is limited to a fourfold concentration (Webster 1995). Typically an ethyl alcohol-water mixture is used as a solvent but in order to modify the characteristics of the extract, the ethanol-water ratio can be altered or alternatives such as supercritical carbon dioxide can be used (Webster 1995). By using CO_2, the extracts have higher vanillin content and more floral notes than conventionally extracted vanilla but it is expensive and only valid for some specialized applications (Webster 1995).

Vanilla contains vanillin and over 200 other compounds, many of which are volatile. These compounds include esters, oils, acids, aromatic aldehydes, and resins (Reineccius 1994). Yet, of all these components, only vanillin (3-methoxy-4-hydroxy-benzaldehyde) is synthesized (Reineccius 1994). Synthetic vanillin is “usually produced from lignin that is present in sulfite waste liquors from paper mills at a concentration of approximately 6%” (Riley and Kleyn 1989). Vanillin can also be synthesized from guaiacol (from wood creosote), eugenol (from clove oil), and lignin (Jagerdeo and others 1999). Imitation vanilla flavors are typically composed of a small number of synthetic compounds including “vanillin, ethyl vanillin, piperonal and low levels of a few esters” (Heath 1978). According to McCormick (1988), synthetic vanillin “exhibits a characteristic vanilla-like note, but lacks some of the aromatic factors present in the natural bean.” Pure vanilla has a “delicate, yet rich and mellow aroma” while imitation has a “heavy, grassy odor” and leaves an unpleasant aftertaste according to Reineccius (1994).

Ethyl vanillin (3-ethoxy-4-hydroxy-benzaldehyde) is closely related to vanillin but it is not found in nature; it is prepared synthetically from safrole and used in the preparation of imitation vanilla flavorings (Heath 1978). It has an intense flavor and is 3-4 times stronger than vanillin and can replace 10% of vanillin without being noticeable (Heath 1978).

Vanilla is the only flavor that has a standard of identity. Vanilla can be found in two different areas of Title 21 of the CFR- one under Food Dressings and Flavorings in chapter I part 169.175 that describes vanilla extract and vanilla flavoring and the other under Frozen Desserts chapter I part 135.110, which describes vanilla in ice cream. In chapter I part 135.110, there are three different labels possible for vanilla in ice cream. “Vanilla” is used if no artificial flavorings are used, “vanilla flavored” if the food contains both a natural flavor and an artificial flavor with the natural flavor being dominate, or “artificial vanilla” if the food contains both a natural and artificial flavor with the artificial flavor predominating or if the artificial flavor is used alone (FDA 2001a).

As described in chapter I part 169.175 of the CFR, vanilla extract is “the solution in aqueous ethyl alcohol of the sapid and odorous principles extractable from vanilla beans” with the ethyl alcohol being not less than 35% by volume and the vanilla constituent being “not less than one unit per gallon” (FDA 2001b). Vanilla flavoring must follow the same standards of identity as vanilla extract except it contains less than 35% ethyl alcohol by volume (FDA 2001b). Vanilla also can be found in several other forms such as vanilla powder, concentrated vanilla extract, vanilla-vanillin extract, or vanilla-vanillin flavoring.

Natural vanilla, containing unique flavor compounds, has always been unstable in price and when a hurricane destroyed the vanilla crop in the 1980’s the price rose dramatically (Webster 1995). A cyclone in early 2000 destroyed almost 1/3 of the total vanilla crop as it swept through Madagascar. Since it takes 3 years for new vanilla plants to be planted, flower, produce beans and almost another year to get the ripened beans to market, it will take a long time to recoup losses. Due to losses in 2000, the price has risen again with a gallon of vanilla extract costing over $100 in 2002 (Thompson 2002). Vanilla is not just a common flavor but allows a flavorist to create a myriad of tastes and profiles by custom blending vanilla beans from various sources (Webster 1995).

Consumer Acceptance

Vanilla ice cream has long been a staple in the ice cream industry; its production and consumption are the highest compared to other ice cream flavors. Part of the high consumption is the use of vanilla ice cream in other products such as banana splits, milkshakes, and sundaes. In 1999, vanilla ice cream accounted for 29.3% of the US supermarket sales (Agricultural Statistics Boards and others 2001). Reports over the last several years indicate that as low-fat ice cream sales declined, consumers indulged in full-fat ice cream as they decided that the taste of ice cream is worth the extra calories and fat. (Anon 1999). Alternatively Hollingsworth (2003a) indicates as worries about obesity sweep the country, more and more people are looking for foods that offer both good taste and healthy attributes. Despite the past decline in sales of reduced-fat ice creams, manufacturers are now expecting sales to increase because of consumer education and health concerns as well as reformulated, better tasting products (Hollingsworth 2003a). Not only are consumers looking for lower fat but they are also searching for foods that provide other nutritional benefits. For example, Breyers® ice cream is introducing ice creams that are lactose-free or calcium-rich in order to give health conscience consumers alternative treats.

Many food manufacturers have become well versed in promoting “all natural” or “vitamin added” products as a way to convince consumers to buy their products because they are purportedly better and healthier. So-called healthy foods include nutraceuticals, fortified foods, supplements, organic and natural foods with the total U.S. natural product sales being $26 billion in 1999 (Hollingsworth 2000). While consumers have rejected past healthy products due to their lack of appealing flavor, many manufacturers are coming up with better tasting, more appealing foods that are lower in fat, sugar, or calories and hope to persuade consumers to buy healthy foods. One of the reasons for the growth of the healthy food industry is the introduction of niche restaurants that have launched meals using exotic ingredients and healthy alternatives (Hollingsworth 2000).

Increased consumer knowledge, a variety of fad diets, the increased availability of organic foods, and marketing of these products to specific groups have all added fuel to the growing natural foods industry. The Organic Trade Association reports organic foods currently represent about 2% of the retail market with sales growing 20% a year despite the fact that some organic products may cost twice as much as their regular counterparts (Hollingsworth 2003b). Many advocates of organic foods proclaim them to be more environmentally friendly, healthier, and better tasting than other foods although no scientific studies have determined that they are healthier or more nutritious (Hollingsworth 2003b). IFT (1990) believes that “consumers desire more fresh or fresh-like products that are visually appealing, full-flavored, nutritious, convenient to prepare and serve, pesticide-free, and available year-round at a reasonable price” but all of these attributes are not currently available in products. Therefore as the battle continues to wage between those who desire organically grown foods and those who do not believe they hold an added benefit, it is accurate to state that neither group is willing to compromise when it comes to the taste of the product.

Increased press coverage and general concern about unhealthy Americans, genetically modified foods, the environment, and possible effects of chemical residues in food products have all motivated some consumers to look for natural/organic alternatives. Labeling of these products is a marketing tool that can affect consumer decisions to buy products whether it is a new product that the consumer wants to try or a natural product that the consumer believes to have added benefits. Companies with brands such as Radical Cuisines®, Certified Organic Soups®, YoSelf® , Nature Valley®, Morningstar®, and Nature's Own® have developed natural or organic products with labels that consumers are beginning to recognize (Sloan 2002).

Although consumers repurchase products based on taste, price, or other factors, labeling (package design or structure or claims) can also increase sales of products. Rice (1995) looked at several food products that have labels designed to increase sales. Molson Dry® (liquor company in Canada) and Coors® used holograms on their labels to attract attention and entice consumers to try their beer. Borden won the 1994 New Product of the Year by International Dairy Foods Association for their Crazy Milk line- flavored milks with colorful packages and fun names geared towards children. Specialty Brands released 10 entrees called Spice Islands Quick Meals that are made of rice/bean/vegetables or pasta/vegetables in colorful, attractive packages. Lisa Henderson, director of new products for Specialty Brands, suggested that the appearance of the packages had a strong impact on the market effectiveness of their products (Rice 1995).

Light and others (1992) conducted a study to determine if label information (nutritional labeling, ingredient information, and product claims) and perceived risks associated with the selected foods would affect the hedonic responses to high-fat and low-fat samples of processed American cheese and vanilla ice cream. Consumer panelists rated their liking for the dairy products without any information, then rated them with the labeling information, and finally completed a questionnaire about the risk perception. For the vanilla ice cream, the low-fat sample was not liked as much as the normal-fat sample no matter if labeling information was provided or not. There was no difference for liking between the low-fat ice cream with labeling information and the low-fat sample without labeling information. Also, there was no difference for liking between the normal-fat ice cream with or without the labeling information. Overall this study indicated that providing information does not change the response of most consumers; the differences in liking the product were based on the fat level found in the products. Light and others (1990) believe that information "may influence an initial purchase of a product, but in the final analysis, liking of a product is determined by its sensory analysis."

Bower and Turner (2001) conducted a study on the effects of liking, brand names, and prices on the purchase intent for crisp snack foods. Overall it was found that for university staff and students, liking the product had more effect on purchase intent than either the brand, price, or both sets of information when dealing with economy and brand name crisp snack foods. Alternatively, Jacoby and others (1971) found that extrinsic factors not intrinsic factors (taste, texture, aroma) affect consumer product choices.

Wansink and Park (2002) conducted a study to determine if ingredient labels "contains soy protein" versus "contains protein" and health claims "may reduce heart disease" versus "no claim" could influence consumer perception of two segments of consumers (taste-conscious and health-conscious) for a nutrition bar that did not contain soy. They concluded that labeling can influence consumer perception but labels do not influence all consumers equally.

While several studies have shown that liking of a particular product has more bearing on consumers and their intent to purchase items, these studies were conducted in a laboratory and thus cannot accurately judge what consumers are going to do when they enter a grocery store or other buying situation. Marketers therefore try to influence consumers by using packages that are colorful, eye appealing, memorable, or contain information such as health claims that promote the product as something consumers should eat and use. Since some consumers desire all natural/organic products in order to promote better health or because they believe the products to be better tasting or other reasons, manufacturers are producing "natural" products to give consumers what they want. Yet do consumers really prefer "natural" products or do they just believe they are better because the word is listed on the package and can labeling effect consumer perception?

Chapter III

Materials and Methods

Experiments with Commercial Ice Cream

Three experiments were conducted using 4 regional, commercial vanilla flavored ice creams to determine which one was liked best by consumers and to evaluate if labeling of vanilla type does effect consumer perception. As shown in Appendix A, one ice cream contained natural vanilla, one contained artificial vanilla, and the other 2 contained a mixture of natural and artificial flavorings. The ice cream was bought in a local grocery store and held in the freezer at -19°C until the day prior to panel when it was scooped into individual 59-mL clear plastic cups (Georgia-Pacific) using a #30 metal scoop. The small, lidded containers of ice cream were placed back into the freezer at -19°C until the morning of panel when they were placed into another freezer at -21°C in the laboratory. Hedonic testing (degree of liking) of the ice creams was conducted with 9-point hedonic scales, as shown in Appendix B, that ranged from dislike extremely to like extremely for the following attributes: overall, appearance, color, flavor, vanilla flavor, and sweetness. Two 9-point unstructured scales were used as intensity scales to determine the strength of vanilla flavor (extremely weak to extremely strong) and strength of sweetness (not at all sweet to extremely sweet). A scorecard was given to the panelists in the first two experiments to establish their “ideal” strength of vanilla flavor and strength of sweetness on an unstructured scale (Szczesniak and others 1975). A demographics page was also given to obtain information about the age and gender of the panelists as well as how often the panelists ate ice cream and vanilla ice cream, previous dairy products training, and brands of ice cream typically eaten by the panelists.

Students, staff, and faculty from The University of Tennessee in Knoxville, TN, were used as panelists for all experiments. No criteria were used for obtaining panelists other than their willingness to taste vanilla ice cream. In The University of Tennessee Sensory Laboratory, samples were individually presented under cool white fluorescent lighting. For Experiments A, B, and C each panelist was presented with a tray containing, a glass of water, a spoon, and the paper scorecards. For all the experiments, the samples were served individually to each panelist.

Experiment IA—No Labeling of Vanilla Type

Seventy-two panelists each received all 4 samples of commercial ice cream individually to create a complete balanced design. Panelists were given the scorecard shown in Appendix B. This experiment was replicated several months later. Data were combined from both panels for analysis.

Experiment IB—Labeling of Vanilla Type

Seventy-two panelists were used to create a balanced design. The same 4 commercial ice creams were used again with each sample being labeled with the type of vanilla––natural, artificial, or a mixture of natural and artificial. Each panelist received all 4 samples of ice cream. The scorecards were the same as shown in Appendix B except there was not a question asking the panelists to identify the type of vanilla used in the product. This experiment was replicated several weeks later and data were combined for analysis.

Experiment IC—Labeling (Correctly or Incorrectly) of Vanilla Type

For Experiment IC, an incomplete block design was used with 150 panelists over a 2-day period using the same 4 commercial ice creams. The ice cream was labeled (either correctly or incorrectly) with the type of vanilla- natural, artificial, or a mixture of artificial and natural- used for a total of 12 treatments. Each panelist received 4 samples of ice cream individually to evaluate. Assignment of samples to each panelist was determined by using PROC OPTEX (SAS Institute, Inc 2001). No ideal scorecard was given for this experiment. The scorecard for hedonic testing plus two intensity questions and the demographic pages were the same as shown in Appendix B.

Data Collection and Analysis

For each experiment the data were collected with paper ballots and hand coded and checked. The data were entered in SAS version 8.02 for statistical analysis (SAS Institute Inc. 2001). PROC GLM and frequencies were run on the data as shown in Appendix C. Analysis of variance (ANOVA) tables, as shown in Appendix D, were examined at to determine if there were significant differences ($p<0.05$) among the mean scores for each ice cream. Mean separation was accomplished by least significant differences (LSD). Experiments IA and IB both had panels conducted in separate months; therefore, the month was considered a fixed effect with month and product interactions being evaluated for significance using PROC GLM.

Experiments with Ice Cream made with the Same Base Ingredients

In order to investigate the type of vanilla flavoring liked best by consumers and to discover the effect of labeling (correctly or incorrectly) on vanilla ice cream, a base mix that adjusts for the effect of other ingredients on flavor was used for further experimentation. A standard 14% fat ice cream mix that did not contain any flavoring (Appendix A) was obtained from Purity Dairies (Dean Foods, Nashville, TN) and used to make ice cream. Specified amounts of artificial and pure vanilla extract (2-fold) obtained from Van Labs (New York) were added to the ice cream mix. Ice cream was made from the mix one day prior to the sensory panel using an ice cream maker (Cuisinart® model Ice 20, East Windsor, NJ). Freezer bowls used in the mixers were placed in the freezer at -19°C several days prior to making the ice cream. To make the ice cream, 750 mL of the base mix were put into the ice cream maker with a specified amount of vanilla (as discussed below for each experiment). The mixer was run 20 min (as indicated in the directions for the mixer). Following mixing, the ice cream was scraped off of the plastic dasher. The ice cream temperature ranged from -4.6 to -6.0ºC. A ruler was used to determine the height of the ice cream. The ice cream, scooped using a #40 plastic cookie dropper scoop, was put in 59-mL clear plastic cups (Georgia-Pacific) with lids that were labeled with random 3-digit numbers, placed into plastic boxes, and then hardened in a freezer at -19°C. After cleaning up the freezer bowls and allowing them to defrost, known volumes (mL) of distilled water was placed in the bowl to the same height as the ice cream that had been made in that bowl. Overrun, the amount of air incorporated in to the ice cream, was calculated for each mix using the following equation (Chandan 1997): 100*(volume of ice cream)-(volume of mix at 750 mL) /volume of mix at 750 mL. The average overrun across all the ice creams was 23%. Temperature of the room where the ice cream was made ranged from 19.9 to 23.1°C. There was not enough ice cream in a single mixer for an entire panel so a total of 4 mixers and 12 bowls were randomly selected and used. Each panelist was presented with a tray containing a glass of water and a spoon. Each sample was served individually to the panelists except for Experiment IIA, where four samples were presented together.

Experiment IIA—Ranking Analysis of Liking of Strength of Vanilla

Experiment IIA was a ranking test using 48 panelists to determine the amount of vanilla liked best for strength of vanilla flavoring. For the artificial vanilla, the manufacturer recommended between 0.3 to 0.6 % (volume basis) of the mix or 2.25-4.5 mL vanilla for 750 mL of mix. Informal sensory testing in the laboratory showed that approximately 10 mL was more appropriate. For natural vanilla, 45 oz per 100 gal of mix or 2.64 mL per 750 mL of mix was used initially (Thompson 2002). Preliminary testing showed that more vanilla might be needed. For testing 6, 8, 10, and 12 mL per 750 mL of mix were used for both artificial and natural flavorings. The ice cream was made as previously stated. For 48 panelists, 2 mixer bowls of ice cream for each level of vanilla flavoring were made with 24 samples of ice cream being taken from each bowl. All 4 mixers were used with 8 of the bowls for each panel. Each panelist received all 4 samples at the same time on a tray with a glass of water and spoon and was asked to rank them based on likeability of the strength of the vanilla flavoring. A panel was conducted with natural vanilla flavor and a repetition was performed a week later. Two panels were conducted with artificial vanilla flavor with the repetition being the following day. The data from the 2 panels for each type of flavoring were combined to determine rank sums.

Experiment IIB—No Labeling of Vanilla Type

As determined in Experiment IIA (ranking analysis), this experiment used the following amounts of vanilla to make the ice cream with 750 mL of mix: 10 mL of natural vanilla flavoring, 10 mL of artificial vanilla flavoring, or 5 mL of artificial plus 5 mL of natural for a mixed flavored ice cream. Each panelist received each of the 3 samples individually. The panel had a balanced design with 60 panelists getting each of the three samples individually. Scorecards, including the ideal, given to the panelists were similar to the one found in Appendix B except there was not a question asking the panelists to identify the type of flavoring used in the samples. A repetition of this experiment was performed and the data were combined for analysis. For 60 panelists, all 4 of the mixers were used with 9 of the bowls for a single panel with a third of the samples being taken from each bowl.

Experiment IIC—Labeling of Vanilla Type

Experiment IIC was a balanced design with 60 panelists where the panelists received each of the 3 samples of ice cream, described in Experiment IIB, but they were labeled with the type of vanilla used. This was used to see if labeling affects consumer likeability. The scorecard was the same as described above. The samples were served and evaluated individually. A repetition of this experiment was performed and the data was combined for analysis.

Experiment IID—Labeling (Correctly or Incorrectly) of Vanilla Type

Experiment IID was an incomplete block design with 150 panelists, who each received 3 samples, and the sensory panel was conducted over a two-day period. The ice creams were labeled (correctly or incorrectly) with the type of vanilla flavoring for a total of 9 treatments (3 flavors x 3 labels). The scorecard was the same as described in Experiment IIA and the samples were individually served.

Data Collection and Analysis

Data were collected using FIZZ, a computer sensory program developed by Biosystems (2002) in France. For Experiment IIA, ranking was used with the program allowing each of the 4 samples to be ordered from lowest to highest for likeability of strength of vanilla flavor. In Experiments IIB, IIC, and IID the program provided a nine-point scale for hedonic testing with the scale ranging from like extremely to dislike extremely for overall likeability, appearance, color, flavor, vanilla flavor, and sweetness. Also, Experiments IIB, IIC, and IID, used an unstructured scale for strength of vanilla and strength of sweetness with references points of extremely too sweet to not at all sweet for sweetness and extremely strong to extremely weak for vanilla flavor. An ideal page was used to determine the ideal strength of vanilla flavoring and strength of sweetness.

Data for the ranking test (Experiment IIA) were calculated in FIZZ using the Friedman's test to determine if differences existed among the rank sums. The rank sums also were analyzed according to Basker (1988). Data for Experiments IIB IIC and IID were exported from FIZZ to an EXCEL file and then transferred to SAS version 8.02 for analysis. PROC GLM was used to determine means values and frequencies of demographic questions were also determined. PROC GLM with the PDIFF option was used for mean separation. Differences were deemed significant at $p<0.05$. For Experiment IID, the type of label placed on the sample was used as an effect instead of day like the other experiments to see if there was an interaction between product and the label placed on the product.

Chapter IV

Results and Discussion

Experiments with Commercial Ice Cream

Experiment IA—No Labeling of Vanilla Type

This experiment was conducted to determine hedonic scores for 4 commercial ice creams that contained natural vanilla flavoring, artificial flavoring, or a combination of natural and artificial flavorings. Two panels were conducted in May and October 2001 with the same ice creams being used for each test. As shown in Table 1, the combination of panel data resulted in product by time interactions ($p<0.05$) for appearance, color, and flavor scores. For appearance, the mean value for the mixed flavored ice cream 2 was between *liked moderately* and *liked very much* in October but was less than *liked moderately* in May. For color, the mixed flavored ice cream 2 was liked more in October than in May. All other ice creams did not differ over time within the specific ice cream for appearance and color. For flavor, the naturally flavored ice cream differed over time with the ice cream being above *liked slightly* in May but being between *neither liked nor disliked* and *liked slightly* for October. The ingredient list and nutrition label information, as shown in Appendix A, did not differ between months for the 4 commercial ice creams; therefore, the differences in hedonic scores between the months could be explained by production differences, alterations in consumer perception of ice cream, or differences in the panels

Table 1—Least-squares mean hedonic values[ab] for several sensory characteristics of four commercial vanilla ice creams evaluated by consumer panels in May and October 2001 (n=72)

		Type of vanilla			
		Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Appearance	May	7.0 c	7.3 ab	7.4 a	6.9 c
	October	7.2 abc	7.0 bc	7.3 a	7.5 a
Color	May	7.3 ab	7.3 ab	7.5 a	7.1 b
	October	7.3 ab	7.1 b	7.4 a	7.5 a
Flavor	May	6.4 a	6.4 a	6.9 a	6.4 a
	October	6.4 a	5.5 b	6.6 a	6.7 a

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values within the same attribute with like letters are not significantly different at $p>0.05$.

and the people who participated.

As shown in Table 2 with no product x time interactions, the combination of data from May and October resulted in the mean value overall for both mixed flavored ice creams and the artificial ice cream being close to *liked moderately*. The artificially flavored and the naturally flavored ice creams were both liked the same overall, but the mixed flavored ice creams were liked more than the naturally flavored ice cream overall. For vanilla flavor, the naturally flavored ice cream was not liked as well as the other three samples with the naturally flavored ice cream being *liked slightly* and the mean value for the other three samples being between *liked slightly* and *liked moderately*. There were no differences for sweetness among the four samples.

As shown in Table 3, the ideal strength of vanilla flavor was not met by any of the commercial ice creams. Mixed ice cream 1 was not different from the natural flavored ice cream, but both of these were more intense than the mixed

Table 2—Least-squares mean hedonic values[ab] for several sensory characteristics of four commercial vanilla ice creams evaluated by consumer panels in May and October 2001 (n=144)

	Type of vanilla			
	Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Overall	6.6 ab	6.2 b	6.8 a	6.7 a
Vanilla flavor	6.4 a	5.9 b	6.6 a	6.5 a
Sweetness	6.4 a	6.3 a	6.6 a	6.6 a

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values in the same row with like letters are not significantly different at p>0.05.

Table 3—Least-squares mean intensity values[a] for two sensory attributes of an ideal and four commercial vanilla ice creams evaluated by consumer panels in May and October 2001 (n=144)

		Type of vanilla			
	Ideal	Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Strength of vanilla flavor[b]	6.5 a	5.0 c	5.8 b	5.5 b	4.8 c
Strength of sweetness[c]	5.9 a	5.7 a	5.1 b	5.9 a	5.1 b

[a] Values within the same attribute with like letters are not significantly different at p>0.05.
[b] Scale ranged from 1=extremely weak to 9=extremely strong.
[c] Scale ranged from 1=not at all sweet 9=extremely sweet.

ice cream 2 and the artificially flavored ice cream, which did not differ. For strength of sweetness, both the artificial and mixed ice cream 1 did not differ from the ideal with all three being sweeter than the other two products. The natural ice cream did not differ from the mixed ice cream 2 for strength of sweetness but neither of these were as sweet as the artificial, mixed ice cream 1, and the ideal. There was a time difference ($p<0.05$) for strength of vanilla flavor with October (5.7) having a higher overall mean across all products than May (5.3).

As shown in Figure 1, all of the ice creams were most frequently identified by consumers as containing artificial flavoring. Only 17% of the panelists correctly identified the naturally flavored ice cream while 56% of the panelists correctly identified the artificially flavored ice cream. Forty-seven percent of the panelists identified the naturally flavored ice cream as containing artificial flavoring and approximately 50% of the panelists called the mixed flavored ice creams artificial. Of all the panelists, only 2% labeled all 4 samples with the correct type of vanilla flavoring. Three of the samples were correctly labeled by 11% of the panelists, while 34% of the panelists correctly identified 2 of the samples. Thirty-eight percent of the panelists correctly identified 1 sample while 22% of the panelists could not correctly identify any of the samples. This indicates that the majority of panelists cannot correctly identify the type of vanilla flavoring used in these ice creams especially natural flavoring.

From these panels, the results indicate that the naturally flavored ice cream was liked less overall than the ice creams containing a mixture of

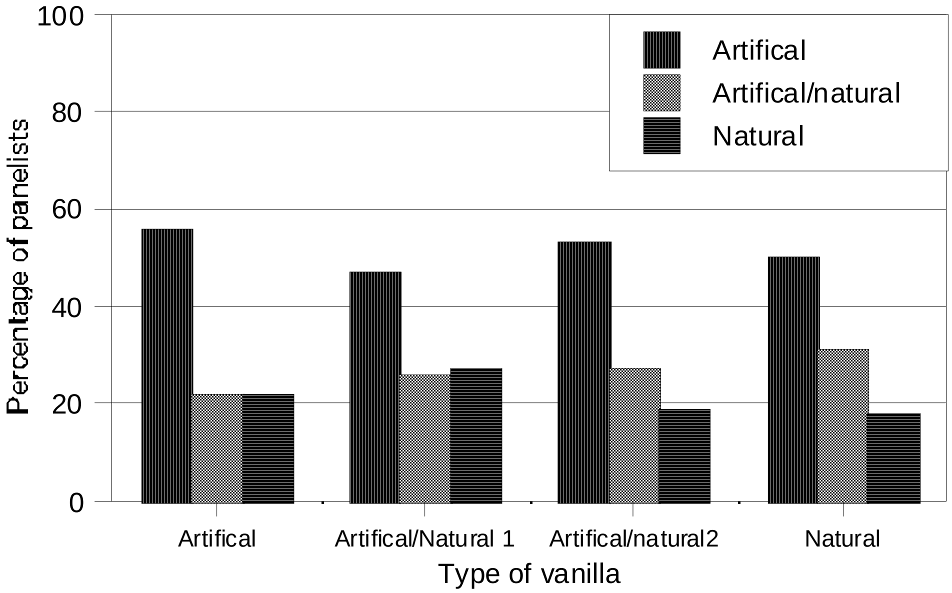

Figure 1—Percentage of panelists (n=144) who identified type of vanilla flavorings used in each ice cream.

flavorings. There were no differences in the overall likeability between the artificial and natural flavored ice creams. The naturally flavored ice cream was liked less for vanilla flavoring than the other three samples. Also, only 17% of the panelists could correctly identify the ice cream containing natural vanilla flavoring. The different ingredients used in the four ice cream samples can possibly explain part of the differences. The naturally flavored ice cream contained egg yolks, which add a characteristic flavor, plus some consumers do not like the alcoholic or medicinal taste associated with natural vanilla flavoring. The artificially flavored ice cream contained buttermilk, unlike the other ice creams, which could add a distinctive flavor. Buttermilk has a slightly acidic flavor due to the addition of ingredients such as sodium citrate to liquid milk or lactic acid to powdered buttermilk. Percentage of fat also varied among the ice creams. The naturally flavored ice cream and mixed flavored 1 ice cream both had approximately 11% fat while mixed flavored ice cream 2 had around 14% and the artificial flavored one had a slightly over 9%. The differing amounts of fat could alter perceptions because milkfat does contribute to flavor through its own properties and by being a carrier for fat-soluble flavorings. Also, the different amount of sweeteners contributes to flavor and can affect the body and texture of the ice cream.

Even with different ingredients, results suggest that panelists cannot identify natural vanilla flavoring in ice cream and do not really like naturally flavored ice cream when compared to other ice creams containing other types of flavoring. It is possible that people only like the idea of natural flavorings without particularly liking the flavoring. To determine if labeling of the type of vanilla in the ice cream did affect consumer perception of vanilla ice cream, another study was conducted.

Experiment IB—Labeling of Vanilla Type

Sensory panels were conducted in March and April 2002 with the same four commercial ice creams but the samples were identified as to the type of flavoring used in each vanilla ice cream sample. As shown in Table 4, the addition of the label altered the results when compared to the Experiment IA results. Overall, both mixed flavored ice creams were *liked moderately* and both were liked more than the artificially flavored ice cream, which had a mean value

Table 4—Least-squares mean hedonic values[ab] for several sensory characteristics of four commercial vanilla ice creams evaluated by consumer panels (n=144)

	Type of vanilla			
	Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Overall	6.5 c	6.8 bc	7.3 a	7.0 ab
Appearance	7.4 a	7.6 a	7.5 a	7.3 a
Color	7.3 a	7.4 a	7.5 a	7.4 a
Flavor	6.4 c	6.7 bc	7.2 a	6.9 ab
Vanilla flavor	6.1 c	6.5 bc	7.2 a	6.8 b
Sweetness	6.4 c	6.7 bc	7.1 a	6.9 ab

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values within the same attribute with like letters are not significantly different at p>0.05.

between *liked slightly* and *liked moderately*. The naturally flavored ice cream and mix 2 were liked the same overall and the naturally flavored ice cream was liked the same as the artificially flavored ice cream. There were no differences among the samples for appearance and color with all the sample means being between *liked moderately* and *liked very much*. For flavor and sweetness, both mixed flavored ice creams were *liked moderately* and liked more than the artificially flavored ice cream. The naturally flavored and mixed flavored 2 ice creams were both almost *liked moderately* for both flavor and sweetness. The naturally flavored ice cream and the artificially flavored ice cream did not differ for flavor and sweetness with both being between *liked slightly* and *liked moderately*. For vanilla flavor, mixed flavored ice cream 1 had a mean value above *liked slightly* and was liked more than all the other ice creams. The natural and mixed 2 ice creams were liked the same for vanilla flavor and the naturally flavored ice cream was liked the same as the artificially flavored one. No time x product interactions or time differences occurred (p>0.05).

The perceived ideal was stronger in vanilla flavor than any of the commercial ice creams (Table 5). The naturally flavored ice cream was more intense than all the other ice creams for strength of vanilla flavor; mix 1 was more intense in vanilla flavor than the mix 2 and the artificially flavored ice cream. Mix 2 and the artificially flavored ice cream did not differ for strength of vanilla flavor with both being weaker in strength of vanilla flavor than the ideal or the other two ice creams. The ideal was not different from mixed flavored ice cream 1 for strength of sweetness but differed from the other three ice creams. The ideal and mix 1 were sweeter than the other three ice creams. There were no differences between results from the two months.

In the Experiment IA data set, it was shown that the naturally flavored ice cream and the artificially flavored ice cream were liked the same overall, but the

Table 5—Least-squares mean intensity values[a] for two sensory attributes of an ideal and four commercial vanilla ice creams evaluated by consumer panels (n=144)

		Type of vanilla			
	Ideal	Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Strength of vanilla flavor[b]	6.8 a	4.9 d	6.4 b	5.9 c	5.2 d
Strength of sweetness[c]	6.2 a	5.5 b	5.2 b	5.9 a	5.4 b

[a] Values within the same attribute with like letters are not significantly different at p>0.05.
[b] Scale ranged from 1=extremely weak to 9=extremely strong.
[c] Scale ranged from 1=not at all sweet 9=extremely sweet.

naturally flavored ice cream was liked less for flavor and vanilla flavor than all the other ice creams. In the Experiment IB data set where the ice cream was correctly labeled with the type of flavoring used, the naturally flavored ice cream was liked the same as the artificially flavored ice cream and one of the ice creams containing artificial and natural flavoring overall and for flavor and vanilla flavor. The naturally flavored ice cream was liked the same as the mixed flavored ice cream 2 in Experiment IB unlike in Experiment IA where the naturally flavored ice cream was liked less than mix 2, which may be a result of the labeling. To see if labeling truly had an effect on the likeability of the ice cream, a further study was conducted.

Experiment IC—Labeling (Correctly or Incorrectly) of Vanilla Type

In late April 2002, an incomplete block design was used with each panelist receiving four samples of ice cream. Each ice cream (product) was labeled with all possible flavor types. No product x label interactions were found for any of the attributes. As shown in Table 6, no differences occurred among the products overall, or for flavor, vanilla flavor, and sweetness. For appearance, the naturally and artificially flavored ice creams both had mean values above *liked moderately* and did not differ. Mix 1 did not differ from the mixed flavored ice cream 2 for appearance with both having mean values at *liked moderately*. The naturally and artificially flavored ice creams were liked more than the other two for overall appearance. For color, the naturally and artificially flavored ice creams were not

Table 6— Least-squares mean hedonic values[abc] for several sensory characteristics of four commercial vanilla ice creams evaluated by consumer panels (n=150)

	Type of vanilla			
	Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Overall	6.8 a	6.7 a	6.8 a	6.8 a
Appearance	7.3 a	7.3 a	7.0 b	6.9 b
Color	7.4 a	7.3 a	6.8 b	6.6 c
Flavor	6.7 a	6.7 a	6.8 a	6.8 a
Vanilla flavor	6.4 a	6.4 a	6.6 a	6.7 a
Sweetness	6.6 a	6.7 a	6.7 a	6.7 a

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values within the same attribute with like letters are not significantly different at p>0.05.
[c] Values for ice cream samples across 3 labels- artificial, natural, and both artificial and natural flavorings.

different and liked more than the other two products. The other two ice creams differed in color with mix 2 having the color least liked.

As shown in Table 7, for strength of vanilla flavor there were no differences between mix 1 and the naturally flavored ice cream and there were no differences between the artificially flavored ice cream and mix 2. Mix 1 and the naturally flavored ice cream were stronger in vanilla flavor than the other two samples. For strength of sweetness, mix 1 did not differ from the naturally flavored ice cream. The naturally flavored ice cream and mix 2 were not different in strength of sweetness. Mixed flavored ice cream 2 did not differ in strength of sweetness from the artificially flavored ice cream. Mixed flavored ice cream 1 and the naturally flavored ice cream were sweeter than the artificially flavored ice cream.

When looking at the effect of labeling independent of product type, any ice

Table 7—Least-squares mean intensity values[ab] for two sensory attributes of four commercial vanilla ice creams evaluated by consumer panels (n=150)

	Type of vanilla			
	Artificial	Natural	Artificial/natural mix 1	Artificial/natural mix 2
Strength of vanilla flavor[c]	4.8 b	5.7 a	5.6 a	5.0 b
Strength of sweetness[d]	5.2 c	5.6 ab	5.8 a	5.4 bc

[a] Values for ice cream samples across 3 labels- artificial, natural, and both artificial and natural flavorings.
[b] Values within the same attribute with like letters are not significantly different at p>0.05.
[c] Scale ranged from 1=extremely weak to 9=extremely strong.
[d] Scale ranged from 1=not at all sweet 9=extremely sweet.

cream labeled “natural” was liked more overall and for vanilla flavor than the ice creams labeled “artificial” or “both artificial and natural” as shown in Table 8. Any ice creams labeled as containing ‘both artificial and natural’ flavorings did not differ overall or for vanilla flavor from the ice creams labeled “artificial”. For appearance, the ice creams labeled “natural” and “both artificial and natural” were liked the same and more than the ice creams labeled “artificial”. For color and flavor, the ice creams labeled “natural” were liked the same as the ice creams labeled as having “both artificial and natural” flavorings. The ice creams labeled “artificial” and “both artificial and natural” were liked the same for color and flavor. The ice creams labeled “natural” were liked more than the ice creams labeled “artificial” for both color and flavor. No matter which label was applied, all of the ice creams were liked the same for sweetness and strength of sweetness. For strength of vanilla flavor, there was no perceived difference for the ice creams labeled “natural” or “both artificial and natural” but the ice creams labeled

Table 8—Least-squares mean hedonic and intensity values[a] for several sensory characteristics of vanilla ice cream labeled with a type of flavoring as evaluated by consumer panels (n=200)[b]

	Label assigned to ice cream		
	Natural	Both artificial and natural	Artificial
Overall[c]	7.1 a	6.8 b	6.5 b
Appearance[c]	7.3 a	7.2 a	6.9 b
Color[c]	7.2 a	7.1 ab	6.9 b
Flavor[c]	7.0 a	6.7 ab	6.5 b
Vanilla flavor[c]	6.9 a	6.5 b	6.2 b
Sweetness[c]	6.8 a	6.6 a	6.5 a
Strength of vanilla flavor [d]	5.4 a	5.4 a	5.0 b
Strength of sweetness[e]	5.5 a	5.5 a	5.4 a

[a] Values within the same attribute with like letters are not significantly different at p>0.05.
[b] n=200 values across 4 commercial vanilla ice creams.
[c] Scale ranged from 1=extremely dislike to 9=extremely like.
[d] Scale ranged from 1=extremely weak to 9=extremely strong.
[e] Scale ranged from 1=not at all sweet 9=extremely sweet.

"artificial" were perceived to have a weaker vanilla flavor than the other two samples.

By looking at the data for the incomplete block design conducted in Experiment IC, it can be seen that no overall, flavor, vanilla flavor, or sweetness differences existed between the products no matter what they were labeled. By looking at the previous data sets, it has been shown that there are overall differences between these four commercial products. The correct or incorrect labeling of the type of flavoring used in the ice cream did have an effect on the perception of the ice cream. The ice creams labeled as "natural" were perceived as being liked more overall and in vanilla flavor than the other ice creams even though the Experiment IA data showed that the naturally flavored ice cream was liked less than the ice creams with a mixture of flavorings. The Experiment IB data set also shows that the naturally flavored ice cream is liked less than mix 1, which is flavored with both artificial and natural flavorings. The word “natural” is a powerful word that gives people the idea that the product is better and should be liked more than the other products.

Demographics

As shown in Appendix E, the demographics were very similar for the 3 panels who evaluated the commercial ice cream. Approximately 66% of the panelists were female for all the panels with the highest number of people being between 20 and 29 years old. The majority of the panelists eat ice cream at least once a month or more often with most of them eating vanilla ice cream once every 2-3 months or more often. Breyers’, Baskin Robbins, and Mayfield ice cream are the three brands most commonly eaten by the panelists.

Experiments with Ice Cream made with the Same Base Ingredients

Experiment IIA—Ranking Analysis of Liking of Strength of Vanilla

For further exploration of the effect of labeling it was necessary to make ice cream using vanilla flavorings but using the same base mix to account for the effect of different sweeteners, stabilizers, emulsifiers, and other ingredients on perceived tastes. The first step was to make ice cream with varying amounts of vanilla to determine if consumers liked one strength over another. Ranking tests were done over two days and judged by 48 panelists each day for both natural and artificial vanilla flavoring. As shown in Table 9, no differences were perceived among the 4 levels of pure vanilla flavoring used. The same base mix with 14% fat was used with artificial vanilla flavor. No differences were perceived in the likeability of the strength of vanilla flavor among the four levels of artificial vanilla flavoring.

From Table 9, it can be seen that no differences were perceived among the different levels of vanilla flavoring for either the artificial or the natural vanilla; therefore, it was decided to use 10 mL of either vanilla flavoring for further experiments based on the fact that 10 mL was most frequently (28% for both types of flavoring) ranked first or second for both types of vanilla. For the mixed vanilla flavoring, 5 mL of each type of flavoring was used.

Experiment IIB—No Labeling of Vanilla Type

This experiment was conducted using the same base mix in order to determine how well the ice cream using artificial, natural, or a mixture of

Table 9—Rank sums of 4 laboratory-produced ice creams judged for likeability of strength of vanilla flavor by 96 panelists over a 2-day period for each type of flavoring

	Amount flavoring added (mL)			
Flavoring	6	8	10	12
Vanilla extract (2-fold pure)	242 a	252 a	240 a	226 a
Artificial vanilla	221 a	259 a	231 a	249 a

[a] Rank sums with like letters are perceived to be liked the same for strength of vanilla flavor.
[b] Scale ranged from 1=like the best to 4=like the least.
[c] Determined by using charts from Basker, 1988; critical value=46.0.

flavorings was liked. There was a product x day interaction for appearance ($p<0.05$) with values (7.0-7.2) including the mean value for the naturally flavored ice cream on day 1. As shown in Table 10, the natural flavored ice cream was liked less than other 2 products for overall likeability, color, flavor, vanilla flavor, and sweetness. The other two products did not differ significantly for these attributes.

As shown in the naturally flavored ice cream on day 2 (6.4) differing from the other mean the Table 11, there were no differences among the samples and the ideal for strength of vanilla flavor or strength of sweetness. Unlike Experiment IA where none of the commercial samples met the ideal for strength of vanilla flavor and only one sample met the ideal for strength of sweetness, all three made samples did meet the ideal for strength of vanilla flavoring and strength of sweetness. Overall and for vanilla flavor, both Experiment IA using commercial ice creams and Experiment IIB using the same base mix showed that the naturally flavored ice creams was not liked as well as the mixed flavored ice

Table 10—Least-squares mean hedonic values[ab] for several sensory characteristics of three laboratory-produced vanilla ice creams as evaluated by consumer panels (n=116)

	Type of vanilla		
	Natural	Artificial	Artificial and natural mix
Overall	6.1 b	6.7 a	6.8 a
Color	6.7 b	7.3 a	7.2 a
Flavor	5.9 b	6.6 a	6.7 a
Vanilla flavor	5.8 b	6.5 a	6.5 a
Sweetness	6.0 b	6.6 a	6.5 a

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values within the same attribute with like letters are not significantly different at $p>0.05$.

Table 11—Least-squares mean intensity values[a] for two sensory attributes of an ideal and three laboratory-produced vanilla ice creams as evaluated by consumer panels (n=116)

		Type of vanilla		
	Ideal	Natural	Artificial	Artificial and natural mix
Strength of vanilla flavor[b]	6.3 a	6.2 a	6.0 a	6.2 a
Strength of Sweetness[c]	6.0 a	6.0 a	6.1 a	6.0 a

[a]Values within the same attribute with like letters are not significantly different at p>0.05.
[b] Scale ranged from 1=extremely weak to 9=extremely strong.
[c] Scale ranged from 1=not at all sweet 9=extremely sweet.

creams but the artificially flavored ice creams not significantly different from the mixed flavored ice creams.

Experiment IIC—Labeling of Vanilla Type

In Experiment IIC the same three laboratory-produced ice creams were used but the type of vanilla used was indicated on the sample containers to determine if labeling does affect consumer perception. As shown in Table 12, for appearance, color, and sweetness there were no differences among the three samples. Overall and for flavor and vanilla flavor, the naturally flavored ice cream was liked the same as the mixed flavored ice cream and both were liked more than the artificially flavored ice cream. The results overall and for flavor and vanilla flavor were opposite of the results obtained in Experiment IIB, using the same base mix, where the ice cream was not labeled. In Experiment IIB, the naturally flavored ice cream was the one sample not liked as well as the other two whereas in this experiment the artificially flavored ice cream was not liked as much as the other two samples. These experiments indicated that labeling can

Table 12—Least-squares mean hedonic values[ab] for several sensory characteristics of three laboratory-produced vanilla ice creams as evaluated by consumer panels (n=120)

	Type of vanilla		
	Natural	Artificial	Artificial and natural mix
Overall	7.1 a	6.3 b	7.0 a
Appearance	7.0 a	7.0 a	7.2 a
Color	7.0 a	7.1 a	7.1 a
Flavor	6.9 a	6.2 b	6.9 a
Vanilla flavor	6.7 a	6.1 b	6.8 a
Sweetness	6.7 a	6.4 a	6.7 a

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values within the same attribute with like letters are not significantly different at $p>0.05$.

affect consumer perception.

As shown in Table 13, the ideal did not differ from the naturally flavored ice cream or the mixed flavored ice cream for strength of vanilla flavor. The mixed flavored ice cream did not differ from the artificially flavored ice cream. The artificially flavored ice cream (5.9) was not as strong as the ideal (6.5) for strength of vanilla flavor. This differs from the previous experiment where all three samples met the ideal for strength of vanilla flavor. The effect of labeling could have altered the perception of the artificially flavored ice cream. The ideal did not differ from any of the products for strength of sweetness. There was a day difference for strength of sweetness with day 1 having a higher mean average (6.2) than day 2 (5.8).

In this experiment and Experiment IB using commercial ice creams, the artificially flavored ice creams were not liked as well as the mixed flavored ice creams overall and for flavor or vanilla flavor; the naturally flavored ice creams

Table 13—Least-squares mean intensity values[a] for two sensory attributes of an ideal and three laboratory-produced vanilla ice creams as evaluated by consumer panels (n=120)

		Type of vanilla		
	Ideal	Natural	Artificial	Artificial and natural mix
Strength of vanilla flavor[b]	6.5 a	6.6 a	5.9 b	6.3 ab
Strength of Sweetness[c]	5.9 a	6.0 a	6.0 a	6.1 a

[a] Values within the same attribute with like letters are not significantly different at p>0.05.
[b] Scale ranged from 1=extremely weak to 9=extremely strong.
[c] Scale ranged from 1=not at all sweet 9=extremely sweet.

did not differ significantly from the mixed flavored ice creams for overall likeability, flavor, and vanilla flavor. The effect of labeling can be seen because these results vary from Experiment IIB, using the same base mix, and Experiment IA, using commercial ice creams, where the ice cream was not labeled. These results suggest that labeling products changes consumer perception of natural and artificially flavored ice cream. By labeling naturally flavored ice cream, the liking of the product was increased while labeling had a detrimental effect on the liking of the artificially flavored ice cream.

Experiment IID—Labeling (Correctly or Incorrectly) of Vanilla Type

For Experiment IID, an incomplete block design was used to look at the same three laboratory-produced ice creams. Each ice cream was labeled with all possible flavor types. As shown in Table 14, the same trend was followed for overall likeability, flavor, and vanilla flavor with the artificial and mixed flavored ice creams being liked the same. The naturally flavored ice cream was not liked

Table 14—Least-squares mean hedonic values[abc] for several sensory characteristics of three laboratory-produced vanilla ice creams evaluated by consumer panels (n=150)

	Type of vanilla		
	Natural	Artificial	Artificial and natural mix
Overall	6.1 b	6.9 a	6.9 a
Appearance	6.9 b	7.1 ab	7.2 a
Color	6.9 b	7.2 a	7.0 ab
Flavor	5.8 b	6.7 a	6.8 a
Vanilla flavor	5.8 b	6.7 a	6.8 a
Sweetness	6.2 b	6.5 ab	6.7 a

[a] Scale ranged from 1=extremely dislike to 9=extremely like.
[b] Values within the same attribute with like letters are not significantly different at $p>0.05$.
[c] Values for ice cream samples across 3 labels-artificial, natural, and both artificial and natural flavorings.

as much as the other two samples overall, for flavor, or for vanilla flavor. For appearance and sweetness, the artificially flavored ice cream and the mixed flavored ice creams did not differ significantly. The naturally flavored ice cream was not liked as much as the mixed flavored ice cream but the naturally flavored ice cream did not differ from the artificially flavored ice cream. For color, the artificially flavored ice cream did not differ from the mixed flavored ice cream but did differ from the naturally flavored ice cream. The mixed flavored ice cream did not differ from the naturally flavored ice cream. The results overall and for flavor and vanilla flavor are the same as the results from Experiment IIB, using the same base, with the naturally flavored ice cream not being as liked as well as the other two samples. These results varied from Experiment IIC were the samples were correctly labeled.

As shown in Table 15, there were no differences among the three samples for strength of vanilla flavor or for strength of sweetness. These results are the

Table 15—Least-squares mean intensity values[ab] for two sensory attributes of three laboratory-produced vanilla ice creams evaluated by consumer panels (n=150)

	Type of vanilla		
	Natural	Artificial	Artificial and natural mix
Strength of vanilla flavor[c]	5.8 a	6.0 a	6.2 a
Strength of Sweetness[d]	6.0 a	6.0 a	6.2 a

[a] Values within the same attribute with like letters are not significantly different at p>0.05.
[b] Values for ice cream samples across 3 labels- artificial, natural, and both artificial and natural flavorings.
[c] Scale ranged from 1=extremely weak to 9=extremely strong.
[d] Scale ranged from 1=not at all sweet 9=extremely sweet.

same as the ones from Experiment IIB, where no label was applied to the samples made with the same base mix.

As shown in Table 16, there were no significant differences among the ice cream samples when separated into groups based on label not type of vanilla flavoring overall and for appearance, color, flavor, vanilla flavor, or sweetness. These results vary from the ones found in Experiment IIC with the commercial ice creams where any ice cream labeled “natural” was liked more than the ice creams labeled something else. Also for Experiment IID, there were no significant differences among the ice cream samples, separated by label and not type of vanilla flavoring, for strength of vanilla flavor or for strength of sweetness.

Demographics

As shown in Appendix E, Experiment IIA (ranking analysis) had 66% female panelists with most of the panelists being between 20-29 years of age for both the panels using natural vanilla flavoring and the panels using artificial

Table 16—Least-squares mean hedonic and intensity values[a] for several sensory characteristics of three laboratory-produced vanilla ice creams labeled with a type of flavoring as evaluated by consumer panels (n=150)[b]

	Label assigned to ice cream		
	Natural	Artificial	Artificial and natural mix
Overall [c]	6.7 a	6.5 a	6.7 a
Appearance [c]	7.1 a	7.0 a	7.1 a
Color [c]	7.0 a	7.1 a	7.0 a
Flavor [c]	6.6 a	6.3 a	6.5 a
Vanilla Flavor [c]	6.5 a	6.2 a	6.5 a
Sweetness [c]	6.6 a	6.4 a	6.5 a
Strength of vanilla flavor[d]	5.9 a	6.1 a	5.9 a
Strength of sweetness[e]	6.0 a	6.3 a	6.0 a

[a] Values within the same attribute with like letters are not significantly different at $p>0.05$.
[b] n=150 values across 3 laboratory-produced ice creams.
[c] Scale ranged from 1=extremely dislike to 9=extremely like.
[d] Scale ranged from 1=extremely weak to 9=extremely strong.
[e] Scale ranged from 1=not at all sweet 9=extremely sweet.

vanilla flavoring. The majority of the panelists eats ice cream every 2-3 weeks or more often and eats vanilla ice cream once every 2-3 months or more often. For Experiments IIB, IIC, and IID there was almost an even number of males and females with the females being slightly higher and the largest age group was 20-29 for all the panels. Most of the panelists eat ice cream once a month or more often and eat vanilla ice cream once every 2-3 months or more often. Breyers' and Mayfield ice cream were the most commonly eaten brands by the panelists in all three experiments.

Chapter V

Summary and Conclusions

Based on this study, labeling of the type of vanilla flavoring used in ice cream does have an effect on consumer perception of ice cream. Like trends were seen for commercial ice creams and the laboratory-produced ice creams where no label was applied to the samples and the experiments where an accurate label was applied. Without any label present on the commercial or laboratory-produced samples, the naturally flavored ice cream was not liked as much as the other ice creams; yet, when the ice cream was labeled, the naturally flavored ice cream was liked as well as or better overall than the other samples. The only difference among the laboratory-produced ice cream samples was the type of vanilla flavoring used in the samples so it is possible the vanilla flavoring was not as masked by other possible ingredients like the commercial ice creams that were made with a variety of ingredients. The laboratory-produced ice creams used more vanilla flavoring than was recommended by the manufacturer. The panelists could have been able to tell differences among the samples because the vanilla was very strong. It is possible this occurred because the laboratory-produced ice cream had a higher percentage of fat than the several of the commercial ice creams. Also, the commercial ice creams varied in the ingredients used while the laboratory-produced ice creams had the same base mix with the only alteration being the type of vanilla used in the samples. As King (1994) showed, the base is an important part of ice cream that affects the overall flavor of the product. These results have indicated that the vanilla also can play a role in the flavor of ice cream.

While accurate labeling can alter consumer perception of the ice cream, labeling (correctly and incorrectly) just created confusion for panelists and no differences were found among the commercial samples for hedonic scores of overall, flavor, vanilla flavor, and sweetness. For the laboratory-produced ice creams with correct and incorrect labels, it is possible that the consumers ignored the label or the label did not affect their liking decisions. For overall likeability, flavor, and vanilla flavor, the results of correct and incorrect labeling were the same as the ones found with no labeling on the samples—the naturally flavored ice cream was liked the least of the three samples.

While there were no differences in the commercial samples across correctly and incorrectly labeled samples, there were differences among the ice creams when separated by label instead of type of vanilla flavoring. Any sample labeled “natural” was liked more than the other samples overall and for vanilla flavor. The samples labeled “natural” also had a more intense perceived strength of vanilla flavor than the other samples. For the commercial ice creams, the word “natural” on the sample, despite the actual flavoring used, apparently biased consumer’s perception of the product. For the laboratory-produced ice creams, no differences were found among the ice cream samples for any attribute when they were divided into groups based on label instead of type of vanilla flavoring; however, differences were found among the laboratory-produced ice cream no matter what label was applied. The naturally flavored ice cream was not liked as well as the other two samples. One explanation could have been that the consumers did not believe the labels placed on the ice cream based on their previous knowledge and experience; therefore, the hedonic scores were based totally on the liking of the vanilla flavor and the label placed on the samples did not affect the decision. The varying ingredients found in the commercial ice cream sample can affect the overall taste of the sample plus the strength of the vanilla was not as strong as consumers wanted so the label on the commercial samples could have been more believable since it was hard to distinguish among the types of vanilla flavoring. This would have led to the differences found among the commercial ice creams when separated by label instead of type of vanilla flavoring.

In general, for both the commercial and laboratory-made ice creams when no label or only accurate labels were presented, the artificial and natural mixed flavored ice creams were liked the best or just as well as any other sample. Accordingly, it would seem that manufacturers of ice cream would prefer to use a mixture of vanilla flavors in order to achieve the highest likeability of flavor plus avoid certain pitfalls such as the extremely high cost of natural vanilla or the “fake” flavor of artificial vanillas. Yet, manufacturers using only natural vanilla in their product may promote it as just including natural flavorings, which is a popular marketing technique to convince consumers to buy the product since many people are looking for all-natural products. Alternatively, manufacturers using just artificially flavored products can produce and sell a cheaper product since the artificial vanilla does not cost as much as natural vanilla. Natural vanilla is dependent on the conditions where the plant is grown as well as the handling and processing of the beans to determine quality. Artificial vanilla can have more consistent quality control since it is chemically produced.

While the mixed flavored ice creams were liked the best in general, in this study it was found that labeling does affect consumer perception of natural and artificial flavorings both in commercial ice creams and laboratory-made ice creams. It is up to the manufacture to decide if the advantages of one type of flavoring outweigh the disadvantages. Should the price of natural vanilla continue to rise and/or manufacturers no longer find it cost effective, further research may be needed in the market place to determine if it is the label, the taste likeability, the price, or other factor that affects consumer purchasing of vanilla ice cream.

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Appendices

Appendix A

Ingredient Lists and Information from Nutrition Labels of Commercial Ice Creams and Prepackaged Base Mix

Ingredient lists and information from nutrition labels of commercial ice creams and prepackaged base mix

Artificial and natural mixed flavored ice cream 1: milk, cream, sugar syrup, corn syrup, whey, skim milk, natural and artificial flavor, guar gum, mono- and diglycerides, locust bean gum, polysorbate 80, carrageenan, annatto (for color)

Artificial and natural mixed flavored ice cream 2: milk, cream, corn syrup, whey, nonfat milk solids, stabilizer (cellulose gum, mono- and diglycerides, guar gum, carrageenan), natural and artificial vanilla flavor, annatto color

Artificial flavored ice cream: milk, cream, sugar, corn syrup, high fructose corn syrup, whey, buttermilk, guar gum, mono- and diglycerides, locust bean gum, polysorbate 80, carrageenan, artificial flavor, annatto (for color)

Natural flavored ice cream: milk, cream, nonfat milk, sugar, corn syrup, egg yolks, vanilla extract, lecithin, locust bean gum, guar gum, salt, annatto (color)

Prepackaged base mix: milk, cream, sugar, corn syrup, mono-and diglycerides, locust bean gum, guar gum and carrageenan

Information from the nutritional label of 4 commercial brands of ice cream.

Type of vanilla	Serving size (g)	Total fat (g)	Sugars (g)
Artificial	64	6	11
Natural	71	8	14
Artificial and natural mix 1	70	8	15
Artificial and natural mix 2	65	9	12

Appendix B
Sample Scorecards for Experiments IA, IB, and IC

Vanilla Ice Cream Judge _____ Order _ Sample **562**

This ice cream sample is made with Natural vanilla flavoring.

You will receive four samples today. Please eat enough of the sample to form an opinion and then answer the questions below. Please comment on the product and its characteristics.

		COMMENTS
OVERALL, how much did you like or dislike the sample.	_____ like extremely _____ like very much _____ like moderately _____ like slightly _____ neither like nor dislike _____ dislike slightly _____ dislike moderately _____ dislike very much _____ dislike extremely	
How much did you like or dislike the OVERALL APPEARANCE of this product?	_____ like extremely _____ like very much _____ like moderately _____ like slightly _____ neither like nor dislike _____ dislike slightly _____ dislike moderately _____ dislike very much _____ dislike extremely	
How much did you like or dislike the overall COLOR of this product?	_____ like extremely _____ like very much _____ like moderately _____ like slightly _____ neither like nor dislike _____ dislike slightly _____ dislike moderately _____ dislike very much _____ dislike extremely	
How much did you like or dislike the FLAVOR of the product?	_____ like extremely _____ like very much _____ like moderately _____ like slightly _____ neither like nor dislike _____ dislike slightly _____ dislike moderately _____ dislike very much _____ dislike extremely	

Please continue to the next page.

Vanilla Ice Cream **Judge _______ Order__Sample 562**

COMMENTS

How much did you like or dislike the VANILLA FLAVOR of the product?

_____ like extremely
_____ like very much
_____ like moderately
_____ like slightly
_____ neither like nor dislike
_____ dislike slightly
_____ dislike moderately
_____ dislike very much
_____ dislike extremely

How do you feel about the STRENGTH of the vanilla flavor?

Extremely Weak _____ : _____ : _____ : _____ : _____ : _____ : _____ : _____ : _____ Extremely Strong

How much did you like or dislike the SWEETNESS of the product?

_____ like extremely
_____ like very much
_____ like moderately
_____ like slightly
_____ neither like nor dislike
_____ dislike slightly
_____ dislike moderately
_____ dislike very much
_____ dislike extremely

How do you feel about the STRENGTH of the sweetness of the ice cream?

Not at all Sweet _____ : _____ : _____ : _____ : _____ : _____ : _____ : _____ : _____ Extremely Sweet

Please return the tray and scorecard through the hatch and wait for the next sample.

Judge________ PANEL INFORMATION

In order to evaluate the data, we would like to have some information about you. Please provide the information below. Your name will not be associated with the data in anyway.

Gender
_____ Male
_____ Female

Age
_____ younger than 20
_____ 20-29
_____ 30-39
_____ 40-49
_____ 50-59
_____ 60-69
_____ 70 and older

How often do you eat ice cream?
______ once a week or more often
______ every 2-3 weeks
______ once a month
______ once every 2-3 months
______ once every six months
______ once a year
______ less than once a year
______ never

How often do you eat Vanilla Ice cream?
______ once a week or more often
______ every 2-3 weeks
______ once a month
______ once every 2-3 months
______ once every six months
______ once a year
______ less than once a year
______ never

Have you ever participated in dairy products evaluation training?
______ Yes
______ No

Please mark all brands of ice cream that you eat.
______ Edy's
______ Blue Bell
______ Breyers
______ Country Club
______ Haagen-Dazs
______ Ben and Jerry's
______ Mayfield
______ Store brand
______ Purity
______ Texas Gold
______ Private Selection
______ Marble Slab
______ Baskin Robbins
______ Godiva
______ Other. Please List _________

Thank you for participating in our panel today! ***Treats are available in the hall.***

Appendix C
SAS Programs for Analysis of Data

Experiment IA

proc print; **run**;
proc freq; **run**;
proc sort; by product; **run**;
proc means;by product; var overall appear color flavor
vanilla strong sweet ssweet; **run**;
proc freq; table (overall appear color flavor
vanilla sweet)*product/ norow nopercent; **run**;
proc glm; classes product time judge; model overall appear color flavor strong ssweet vanilla
sweet = product time product*time judge; lsmeans product*time time product/pdiff;
run;

Experiment IA Ideal

proc glm; class product judge time; model strong ssweet=product time product*time judge;
lsmeans product time   product*time /pdiff stderr; **run**;
proc sort; by product time; **run**;
proc means; by product time; **run**;

Experiment IB

proc print; **run**;
proc freq; **run**;
proc sort; by product; **run**;
proc means;by product; var overall appear color flavor
vanilla strength sweet strsweet; **run**;
proc freq; table (overall appear color flavor
vanilla sweet)*product/ norow nopercent; **run**;
proc glm; classes product time judge; model overall appear color flavor strength strsweet
vanilla sweet = product time product*time judge; lsmeans product*time time product/pdiff;
run;

Experiment IB Ideal

proc glm; classes product judge time; model strength   strsweet=product time product*time
judge; lsmeans product time roduct*time /pdiff stderr; **run**;
proc sort; by product time; **run**;
proc means; by product time; **run**;

Experiment IC

/*proc print; run;
proc freq;
run;*/
proc sort; by product; **run**;
proc sort; by label;**run**;
proc freq; table label *(overall appear color flavor
vanilla strength sweet strsweet)*product/ norow nopercent; **run**;
proc glm; class product judge label; model overall appear color flavor
vanilla strength sweet strsweet = product label product*label
judge; lsmeans product label product*label/pdiff;
run;
/*proc sort;by product;run;
proc sort; by label;run;
proc sort;by type;run;

proc glm; class label type judge; model overall appear color flavor vanilla
strength sweet strsweet=label type label*type judge; lsmeans label type
label*type/pdiff;
run;*/
quit;

Experiment IIB

proc sort; by product; **run**;
proc means;by product; var overall appear color flavor
vanflav strvan sweet strsweet; **run**;
proc freq; table (overall appear color flavor
vanflav sweet)*product/ norow nopercent; **run**;
proc glm; classes product day judge; model overall appear color flavor strvan strsweet
vanflav sweet = product day product*day judge; lsmeans day product*day product/pdiff;
run;
quit;

Experiment IIB Ideal

proc sort; by product; **run**;
proc means; by product; **run**;
proc glm; class product day judge; model strvan
strsweet = product day product*day judge; lsmeans product/pdiff; **run**;
quit;

Experiment IIC

proc sort; by product; **run**;
proc means;by product; var overall appear color flavor
vanflav strvan sweet strsweet; **run**;
proc freq; table (overall appear color flavor
vanflav sweet)*product/ norow nopercent; **run**;
proc glm; classes product day judge; model overall appear color flavor strvan strsweet
vanflav sweet = product day product*day judge; lsmeans day product*day product/pdiff;
run;

Experiment IIC Ideal

proc sort; by product; **run**;
proc means; by product; **run**;
proc glm; class product day judge; model strvan
strsweet = product day product*day judge; lsmeans product day/pdiff; **run**;
quit;

Experiment IID

proc freq;**run**;
proc sort; by product; **run**;
proc sort; by label;**run**;
proc freq; table label *(overall appear color flavor
vanflav strvan sweet strsweet)*product/ norow nopercent; **run**;
proc glm; class product judge label ; model overall appear color flavor
vanflav strvan sweet strsweet = product label product*label
judge ; lsmeans product label product*label/pdiff;
run;
quit;

Appendix D
ANOVA Tables

Experiment IA

Dependent Variable: overall

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	78	379.772869	4.868883	1.56	0.0028
Error	495	1541.371731	3.113882		
Corrected Total	573	1921.144599			

R-Square	Coeff Var	Root MSE	overall Mean
0.197681	26.78899	1.764620	6.587108

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	30.5618805	10.1872935	3.27	0.0210
time	1	2.6621179	2.6621179	0.85	0.3556
product*time	3	18.7532971	6.2510990	2.01	0.1120
judge	71	327.5480659	4.6133530	1.48	0.0096

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	78	379.746528	4.868545	3.37	<.0001
Error	497	717.487847	1.443638		
Corrected Total	575	1097.234375			

R-Square	Coeff Var	Root MSE	appear Mean
0.346094	16.68046	1.201515	7.203125

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	7.8107639	2.6035880	1.80	0.1456
time	1	1.4600694	1.4600694	1.01	0.3151
product*time	3	17.8663194	5.9554398	4.13	0.0066
judge	71	352.6093750	4.9663292	3.44	<.0001

Dependent Variable: color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	78	309.5972222	3.9691952	3.13	<.0001
Error	497	629.7291667	1.2670607		
Corrected Total	575	939.3263889			

R-Square	Coeff Var	Root MSE	color Mean
0.329595	15.35688	1.125638	7.329861

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	4.3958333	1.4652778	1.16	0.3259
time	1	0.5625000	0.5625000	0.44	0.5055
product*time	3	6.8125000	2.2708333	1.79	0.1477
judge	71	297.8263889	4.1947379	3.31	<.0001

Dependent Variable: flavor

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	78	403.690972	5.175525	1.51	0.0053
Error	497	1703.098958	3.426758		
Corrected Total	575	2106.789931			

R-Square	Coeff Var	Root MSE	flavor Mean
0.191614	28.81013	1.851151	6.425347

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	50.6718750	16.8906250	4.93	0.0022
time	1	7.3350694	7.3350694	2.14	0.1441
product*time	3	26.2690972	8.7563657	2.56	0.0547
judge	71	319.4149306	4.4988018	1.31	0.0535

Dependent Variable: vanilla

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	78	406.569444	5.212429	1.42	0.0155
Error	497	1825.923611	3.673891		
Corrected Total	575	2232.493056			

R-Square	Coeff Var	Root MSE	vanilla Mean
0.182115	30.08289	1.916740	6.371528

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	52.4513889	17.4837963	4.76	0.0028
time	1	4.6944444	4.6944444	1.28	0.2589
product*time	3	17.1805556	5.7268519	1.56	0.1985
judge	71	332.2430556	4.6794797	1.27	0.0760

Dependent Variable: sweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	78	344.314143	4.414284	1.54	0.0038
Error	489	1403.388322	2.869915		
Corrected Total	567	1747.702465			

R-Square	Coeff Var	Root MSE	sweet Mean
0.197010	26.15490	1.694082	6.477113

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	6.7239138	2.2413046	0.78	0.5050
time	1	0.1208368	0.1208368	0.04	0.8375
product*time	3	8.6384842	2.8794947	1.00	0.3910
judge	71	328.5135126	4.6269509	1.61	0.0021

Experiment IA with Ideal

Dependent Variable: strong

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	80	650.317453	8.128968	2.99	<.0001
Error	637	1731.069734	2.717535		
Corrected Total	717	2381.387187			

R-Square	Coeff Var	Root MSE	strong Mean
0.273083	29.90448	1.648495	5.512535

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	4	258.4979210	64.6244803	23.78	<.0001
time	1	29.2790421	29.2790421	10.77	0.0011
product*time	4	14.8743127	3.7185782	1.37	0.2434
judge	71	347.1894601	4.8899924	1.80	0.0001

Dependent Variable: ssweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	80	493.688889	6.171111	2.47	<.0001
Error	639	1599.372222	2.502930		
Corrected Total	719	2093.061111			

R-Square	Coeff Var	Root MSE	ssweet Mean
0.235869	28.57719	1.582065	5.536111

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	4	90.4777778	22.6194444	9.04	<.0001
time	1	1.4222222	1.4222222	0.57	0.4512
product*time	4	16.3277778	4.0819444	1.63	0.1648
judge	71	385.4611111	5.4290297	2.17	<.0001

Experiment IB

Dependent Variable: overall

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	325.750598	4.123425	1.90	<.0001
Error	495	1072.795489	2.167264		
Corrected Total	574	1398.546087			

R-Square	Coeff Var	Root MSE	overall Mean
0.232921	21.32763	1.472163	6.902609

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	41.5530412	13.8510137	6.39	0.0003
time	1	6.5687461	6.5687461	3.03	0.0823
product*time	3	7.9512973	2.6504324	1.22	0.3007
judge	72	270.7592845	3.7605456	1.74	0.0004

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	266.2875587	3.3707286	2.93	<.0001
Error	496	570.9346635	1.1510780		
Corrected Total	575	837.2222222			

R-Square	Coeff Var	Root MSE	appear Mean
0.318061	14.43880	1.072883	7.430556

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	6.4722222	2.1574074	1.87	0.1330
time	1	0.7042254	0.7042254	0.61	0.4345
product*time	3	1.1388889	0.3796296	0.33	0.8038
judge	72	258.2320031	3.5865556	3.12	<.0001

Dependent Variable: flavor

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	347.607076	4.400090	1.72	0.0003
Error	496	1270.502299	2.561497		
Corrected Total	575	1618.109375			

R-Square	Coeff Var	Root MSE	flavor Mean
0.214823	23.61951	1.600468	6.776042

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	57.0746528	19.0248843	7.43	<.0001
time	1	2.9595070	2.9595070	1.16	0.2829
product*time	3	3.3385417	1.1128472	0.43	0.7284
judge	72	285.0671459	3.9592659	1.55	0.0044

Dependent Variable: color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	330.0347764	4.1776554	3.28	<.0001
Error	495	629.5547888	1.2718279		
Corrected Total	574	959.5895652			

R-Square	Coeff Var	Root MSE	color Mean
0.343933	15.27941	1.127753	7.380870

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	4.8925395	1.6308465	1.28	0.2797
time	1	1.0229667	1.0229667	0.80	0.3702
product*time	3	2.2581140	0.7527047	0.59	0.6206
judge	72	322.1423943	4.4741999	3.52	<.0001

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	266.2875587	3.3707286	2.93	<.0001
Error	496	570.9346635	1.1510780		
Corrected Total	575	837.2222222			

R-Square	Coeff Var	Root MSE	appear Mean
0.318061	14.43880	1.072883	7.430556

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	6.4722222	2.1574074	1.87	0.1330
time	1	0.7042254	0.7042254	0.61	0.4345
product*time	3	1.1388889	0.3796296	0.33	0.8038
judge	72	258.2320031	3.5865556	3.12	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	394.222806	4.990162	2.21	<.0001
Error	494	1113.379981	2.253806		
Corrected Total	573	1507.602787			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.261490	27.01341	1.501268	5.557491

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	40.9154776	13.6384925	6.05	0.0005
time	1	2.0449015	2.0449015	0.91	0.3413
product*time	3	1.7266426	0.5755475	0.26	0.8575
judge	72	349.9748702	4.8607621	2.16	<.0001

Dependent Variable: vanilla

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	410.258014	5.193139	1.95	<.0001
Error	494	1316.092160	2.664154		
Corrected Total	573	1726.350174			

R-Square	Coeff Var	Root MSE	vanilla Mean
0.237645	24.58400	1.632224	6.639373

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	85.2405809	28.4135270	10.67	<.0001
time	1	3.4188624	3.4188624	1.28	0.2578
product*time	3	4.0426386	1.3475462	0.51	0.6784
judge	72	318.7196555	4.4266619	1.66	0.0011

Dependent Variable: sweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	79	335.538114	4.247318	2.08	<.0001
Error	492	1006.704893	2.046148		
Corrected Total	571	1342.243007			

R-Square	Coeff Var	Root MSE	sweet Mean
0.249983	21.18068	1.430436	6.753497

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	35.4747323	11.8249108	5.78	0.0007
time	1	5.7339217	5.7339217	2.80	0.0948
product*time	3	2.8613836	0.9537945	0.47	0.7060
judge	72	292.4291058	4.0615154	1.98	<.0001

Experiment IB with Ideal

Dependent Variable: strength

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	80	728.082743	9.101034	3.45	<.0001
Error	637	1682.502215	2.641291		
Corrected Total	717	2410.584958			

R-Square	Coeff Var	Root MSE	strength Mean
0.302036	27.88951	1.625205	5.827298

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	4	260.1332420	65.0333105	24.62	<.0001
time	1	0.5078199	0.5078199	0.19	0.6612
product*time	4	22.4585098	5.6146274	2.13	0.0761
judge	71	386.4293189	5.4426665	2.06	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	80	358.018911	4.475236	2.02	<.0001
Error	637	1409.758247	2.213121		
Corrected Total	717	1767.777159			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.202525	26.25706	1.487656	5.665738

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	4	92.1287585	23.0321896	10.41	<.0001
time	1	5.9264253	5.9264253	2.68	0.1022
product*time	4	23.5507285	5.8876821	2.66	0.0318
judge	71	279.5410483	3.9371979	1.78	0.0002

Experiment IC

Dependent Variable: overall

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	740.623773	4.628899	2.48	<.0001
Error	438	815.933823	1.862863		
Corrected Total	598	1556.557596			

R-Square	Coeff Var	Root MSE	overall Mean
0.475809	20.07749	1.364867	6.797997

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	2.9407691	0.9802564	0.53	0.6645
label	2	25.7828683	12.8914342	6.92	0.0011
product*label	6	13.5210746	2.2535124	1.21	0.3000
judge	149	687.8396464	4.6163735	2.48	<.0001

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	756.575965	4.728600	5.53	<.0001
Error	438	374.739561	0.855570		
Corrected Total	598	1131.315526			

R-Square	Coeff Var	Root MSE	appear Mean
0.668758	12.96647	0.924970	7.133556

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	19.9047292	6.6349097	7.75	<.0001
label	2	15.7629145	7.8814572	9.21	0.0001
product*label	6	5.0444815	0.8407469	0.98	0.4364
judge	149	722.7824795	4.8508891	5.67	<.0001

Dependent Variable: color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	902.031896	5.637699	5.93	<.0001
Error	439	417.561437	0.951165		
Corrected Total	599	1319.593333			

R-Square	Coeff Var	Root MSE	color Mean
0.683568	13.80760	0.975277	7.063333

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	48.9528642	16.3176214	17.16	<.0001
label	2	7.3823258	3.6911629	3.88	0.0213
product*label	6	5.4596375	0.9099396	0.96	0.4543
judge	149	843.9185632	5.6638830	5.95	<.0001

Dependent Variable: flavor

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	754.206578	4.713791	2.19	<.0001
Error	439	942.966755	2.147988		
Corrected Total	599	1697.173333			

R-Square	Coeff Var	Root MSE	flavor Mean
0.444390	21.78793	1.465602	6.726667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	0.4365507	0.1455169	0.07	0.9770
label	2	19.8412201	9.9206100	4.62	0.0104
product*label	6	10.8457519	1.8076253	0.84	0.5383
judge	149	715.5532450	4.8023708	2.24	<.0001

Dependent Variable: vanilla

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	837.422254	5.233889	2.23	<.0001
Error	439	1030.202746	2.346703		
Corrected Total	599	1867.625000			

R-Square	Coeff Var	Root MSE	vanilla Mean
0.448389	23.47732	1.531895	6.525000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	5.8630387	1.9543462	0.83	0.4763
label	2	31.8152194	15.9076097	6.78	0.0013

product*label	6	4.0013008	0.6668835	0.28	0.9444
judge	149	769.4172541	5.1638742	2.20	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	856.110166	5.350689	3.35	<.0001
Error	439	701.848167	1.598743		
Corrected Total	599	1557.958333			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.549508	22.95457	1.264414	5.508333

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	22.7243685	7.5747895	4.74	0.0029
label	2	0.8995445	0.4497723	0.28	0.7549
product*label	6	3.2010709	0.5335118	0.33	0.9191
judge	149	822.6118326	5.5208848	3.45	<.0001

Dependent Variable: strength

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	1089.028709	6.806429	3.19	<.0001
Error	438	935.906182	2.136772		
Corrected Total	598	2024.934891			

R-Square	Coeff Var	Root MSE	strength Mean
0.537809	27.83218	1.461770	5.252087

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	73.7711175	24.5903725	11.51	<.0001
label	2	14.7418166	7.3709083	3.45	0.0326
product*label	6	17.2805331	2.8800889	1.35	0.2345
judge	149	996.1905525	6.6858426	3.13	<.0001

Dependent Variable: sweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	160	736.973159	4.606082	2.45	<.0001
Error	437	822.439884	1.882013		
Corrected Total	597	1559.413043			

R-Square	Coeff Var	Root MSE	sweet Mean
0.472597	20.55563	1.371865	6.673913

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	1.0593937	0.3531312	0.19	0.9048
label	2	8.7389958	4.3694979	2.32	0.0993
product*label	6	5.8124845	0.9687474	0.51	0.7973
judge	149	704.9205241	4.7310102	2.51	<.0001

Experiment IIB

Dependent Variable: overall

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	306.689272	4.792020	1.81	0.0006
Error	283	748.655556	2.645426		
Corrected Total	347	1055.344828			

R-Square	Coeff Var	Root MSE	overall Mean
0.290606	24.76001	1.626477	6.568966

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	38.3637384	19.1818692	7.25	0.0008
day	1	0.1071429	0.1071429	0.04	0.8406
product*day	2	1.3522441	0.6761221	0.26	0.7746
judge	59	266.1527778	4.5110640	1.71	0.0023

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	308.5510126	4.8211096	2.85	<.0001
Error	283	479.2650794	1.6935162		
Corrected Total	347	787.8160920			

R-Square	Coeff Var	Root MSE	appear Mean
0.391654	18.65199	1.301352	6.977011

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	15.2316366	7.6158183	4.50	0.0119
day	1	0.7619048	0.7619048	0.45	0.5029
product*day	2	11.8293377	5.9146689	3.49	0.0317
judge	59	278.9587302	4.7281141	2.79	<.0001

Dependent Variable: color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	270.2610290	4.2228286	3.06	<.0001
Error	283	391.1412698	1.3821246		
Corrected Total	347	661.4022989			

R-Square	Coeff Var	Root MSE	color Mean
0.408618	16.52351	1.175638	7.114943

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	22.8053640	11.4026820	8.25	0.0003
day	1	1.7142857	1.7142857	1.24	0.2664
product*day	2	5.9547893	2.9773946	2.15	0.1179
judge	59	239.3111111	4.0561205	2.93	<.0001

Dependent Variable: flavor

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	359.575718	5.618371	1.76	0.0010
Error	283	901.904167	3.186941		
Corrected Total	347	1261.479885			

R-Square	Coeff Var	Root MSE	flavor Mean
0.285043	27.89626	1.785200	6.399425

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	42.7775862	21.3887931	6.71	0.0014
day	1	0.1458333	0.1458333	0.05	0.8308
product*day	2	2.8465517	1.4232759	0.45	0.6403
judge	59	313.7922619	5.3185129	1.67	0.0034

Dependent Variable: strvan

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	351.685304	5.495083	1.73	0.0013
Error	283	897.242857	3.170469		
Corrected Total	347	1248.928161			

R-Square	Coeff Var	Root MSE	strvan Mean
0.281590	28.94172	1.780581	6.152299

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	1.7591954	0.8795977	0.28	0.7579
day	1	0.1071429	0.1071429	0.03	0.8543
product*day	2	11.2419540	5.6209770	1.77	0.1717
judge	59	338.2916667	5.7337571	1.81	0.0008

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	302.629748	4.728590	1.89	0.0002
Error	283	706.298413	2.495754		
Corrected Total	347	1008.928161			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.299952	26.26703	1.579796	6.014368

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	1.1712096	0.5856048	0.23	0.7910
day	1	8.0476190	8.0476190	3.22	0.0736
product*day	2	0.5275315	0.2637657	0.11	0.8997
judge	59	295.1051587	5.0017824	2.00	<.0001

Dependent Variable: vanflav

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	362.625910	5.666030	1.73	0.0014
Error	283	926.693056	3.274534		
Corrected Total	347	1289.318966			

R-Square	Coeff Var	Root MSE	vanflav Mean
0.281254	28.71543	1.809567	6.301724

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	37.7210454	18.8605227	5.76	0.0035
day	1	0.0744048	0.0744048	0.02	0.8803
product*day	2	5.5371374	2.7685687	0.85	0.4304
judge	59	319.2212302	5.4105293	1.65	0.0040

Dependent Variable: sweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	336.477696	5.257464	1.98	<.0001
Error	283	752.174603	2.657861		
Corrected Total	347	1088.652299			

R-Square	Coeff Var	Root MSE	sweet Mean
0.309077	25.61366	1.630295	6.364943

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	20.9386973	10.4693487	3.94	0.0205
day	1	1.7142857	1.7142857	0.64	0.4226
product*day	2	3.0076628	1.5038314	0.57	0.5685
judge	59	310.9944444	5.2710923	1.98	0.0001

Experiment IIB with Ideal

Dependent Variable: strvan

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	66	353.096280	5.349944	1.86	0.0002
Error	397	1139.591220	2.870507		
Corrected Total	463	1492.687500			

R-Square	Coeff Var	Root MSE	strvan Mean
0.236551	27.38193	1.694257	6.187500

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	3.6223727	1.2074576	0.42	0.7383
day	1	0.1808036	0.1808036	0.06	0.8020
product*day	3	13.5534072	4.5178024	1.57	0.1952
judge	59	335.4325893	5.6852981	1.98	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	66	284.872568	4.316251	1.80	0.0004
Error	397	954.108036	2.403295		
Corrected Total	463	1238.980603			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.229925	25.80979	1.550256	6.006466

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	1.2808190	0.4269397	0.18	0.9115
day	1	6.0357143	6.0357143	2.51	0.1138
product*day	3	1.6428879	0.5476293	0.23	0.8770
judge	59	277.2288690	4.6987944	1.96	<.0001

Experiment IIC

Dependent Variable: overall

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	276.7777778	4.3246528	2.16	<.0001
Error	295	590.2194444	2.0007439		
Corrected Total	359	866.9972222			

R-Square	Coeff Var	Root MSE	overall Mean
0.319237	20.79263	1.414477	6.802778

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	42.5722222	21.2861111	10.64	<.0001
day	1	0.0027778	0.0027778	0.00	0.9703
product*day	2	2.7055556	1.3527778	0.68	0.5094
judge	59	231.4972222	3.9236817	1.96	0.0001

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	267.3000000	4.1765625	2.91	<.0001
Error	295	423.1000000	1.4342373		
Corrected Total	359	690.4000000			

R-Square	Coeff Var	Root MSE	appear Mean
0.387167	16.94712	1.197596	7.066667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	1.8166667	0.9083333	0.63	0.5315
day	1	1.8777778	1.8777778	1.31	0.2535
product*day	2	0.2055556	0.1027778	0.07	0.9309
judge	59	263.4000000	4.4644068	3.11	<.0001

Dependent Variable: color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	269.7333333	4.2145833	2.90	<.0001
Error	295	428.2416667	1.4516667		
Corrected Total	359	697.9750000			

R-Square	Coeff Var	Root MSE	color Mean
0.386451	16.98968	1.204851	7.091667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	0.4166667	0.2083333	0.14	0.8664
day	1	0.0250000	0.0250000	0.02	0.8957
product*day	2	0.1500000	0.0750000	0.05	0.9497
judge	59	269.1416667	4.5617232	3.14	<.0001

Dependent Variable: flavor

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	313.500000	4.898438	2.07	<.0001
Error	295	698.400000	2.367458		
Corrected Total	359	1011.900000			

R-Square	Coeff Var	Root MSE	flavor Mean
0.309813	23.13766	1.538654	6.650000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	43.5166667	21.7583333	9.19	0.0001
day	1	0.9000000	0.9000000	0.38	0.5380
product*day	2	2.5166667	1.2583333	0.53	0.5883
judge	59	266.5666667	4.5180791	1.91	0.0003

Dependent Variable: strvan

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	362.777778	5.668403	2.54	<.0001
Error	295	659.444444	2.235405		
Corrected Total	359	1022.222222			

R-Square	Coeff Var	Root MSE	strvan Mean
0.354891	23.81618	1.495127	6.277778

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	27.3388889	13.6694444	6.11	0.0025
day	1	0.0444444	0.0444444	0.02	0.8880
product*day	2	1.5055556	0.7527778	0.34	0.7144
judge	59	333.8888889	5.6591337	2.53	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	265.5333333	4.1489583	2.09	<.0001
Error	295	586.8416667	1.9892938		
Corrected Total	359	852.3750000			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.311522	23.34494	1.410423	6.041667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	1.1166667	0.5583333	0.28	0.7555
day	1	13.2250000	13.2250000	6.65	0.0104
product*day	2	0.3166667	0.1583333	0.08	0.9235
judge	59	250.8750000	4.2521186	2.14	<.0001

Dependent Variable: vanflav

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	400.911111	6.264236	2.53	<.0001
Error	295	730.619444	2.476676		
Corrected Total	359	1131.530556			

R-Square	Coeff Var	Root MSE	vanflav Mean
0.354309	24.07771	1.573746	6.536111

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	43.0388889	21.5194444	8.69	0.0002
day	1	3.4027778	3.4027778	1.37	0.2421
product*day	2	1.1055556	0.5527778	0.22	0.8001
judge	59	353.3638889	5.9892185	2.42	<.0001

Dependent Variable: sweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	64	263.6777778	4.1199653	2.10	<.0001
Error	295	578.5194444	1.9610829		
Corrected Total	359	842.1972222			

R-Square	Coeff Var	Root MSE	sweet Mean
0.313083	21.20905	1.400387	6.602778

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	10.0722222	5.0361111	2.57	0.0784
day	1	0.0250000	0.0250000	0.01	0.9102
product*day	2	2.2166667	1.1083333	0.57	0.5689
judge	59	251.3638889	4.2604049	2.17	<.0001

Experiment IIC with Ideal

Dependent Variable: strvan

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	66	324.483333	4.916414	2.19	<.0001
Error	413	925.483333	2.240880		
Corrected Total	479	1249.966667			

R-Square	Coeff Var	Root MSE	strvan Mean
0.259594	23.60510	1.496957	6.341667

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	33.2166667	11.0722222	4.94	0.0022
day	1	2.4083333	2.4083333	1.07	0.3005
product*day	3	6.6416667	2.2138889	0.99	0.3983
judge	59	282.2166667	4.7833333	2.13	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	66	290.104167	4.395518	2.33	<.0001
Error	413	778.877083	1.885901		
Corrected Total	479	1068.981250			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.271384	22.91188	1.373281	5.993750

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	3	4.4229167	1.4743056	0.78	0.5046
day	1	12.3520833	12.3520833	6.55	0.0108
product*day	3	1.7229167	0.5743056	0.30	0.8221
judge	59	271.6062500	4.6034958	2.44	<.0001

Experiment IID

Dependent Variable: overall

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	620.843434	3.954417	1.99	<.0001
Error	292	580.554344	1.988200		
Corrected Total	449	1201.397778			

R-Square	Coeff Var	Root MSE	overall Mean
0.516768	21.22837	1.410035	6.642222

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	46.5672434	23.2836217	11.71	<.0001
label	2	3.7099786	1.8549893	0.93	0.3945
product*label	4	6.1027610	1.5256903	0.77	0.5472
judge	149	563.2656563	3.7803064	1.90	<.0001

Dependent Variable: appear

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	668.6286077	4.2587809	5.97	<.0001
Error	292	208.2958367	0.7133419		
Corrected Total	449	876.9244444			

R-Square	Coeff Var	Root MSE	appear Mean
0.762470	11.98197	0.844596	7.048889

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	4.4431433	2.2215716	3.11	0.0459
label	2	1.6217647	0.8108824	1.14	0.3223
product*label	4	3.6363424	0.9090856	1.27	0.2801
judge	149	656.6241633	4.4068736	6.18	<.0001

Dependent Variable: color

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	694.7180095	4.4249555	6.31	<.0001
Error	292	204.7131016	0.7010723		
Corrected Total	449	899.4311111			

R-Square	Coeff Var	Root MSE	color Mean
0.772397	11.90099	0.837301	7.035556

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	6.0679536	3.0339768	4.33	0.0141
label	2	1.0176044	0.5088022	0.73	0.4848
product*label	4	4.2362244	1.0590561	1.51	0.1991
judge	149	681.6868984	4.5750799	6.53	<.0001

Dependent Variable: flavor

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	736.380852	4.690324	1.96	<.0001
Error	292	699.399148	2.395203		
Corrected Total	449	1435.780000			

R-Square	Coeff Var	Root MSE	flavor Mean
0.512879	23.95734	1.547644	6.460000

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	62.5017414	31.2508707	13.05	<.0001
label	2	4.6132520	2.3066260	0.96	0.3829
product*label	4	5.1942121	1.2985530	0.54	0.7049
judge	149	673.4208522	4.5196030	1.89	<.0001

Dependent Variable: vanflav

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	786.853211	5.011804	2.13	<.0001
Error	292	685.511234	2.347641		
Corrected Total	449	1472.364444			

R-Square	Coeff Var	Root MSE	vanflav Mean
0.534415	23.82483	1.532201	6.431111

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	58.3074821	29.1537410	12.42	<.0001
label	2	8.4178405	4.2089203	1.79	0.1683
product*label	4	4.5196944	1.1299236	0.48	0.7495
judge	149	722.8887663	4.8516025	2.07	<.0001

Dependent Variable: strvan

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	940.772612	5.992182	2.56	<.0001
Error	292	684.171832	2.343054		
Corrected Total	449	1624.944444			

R-Square	Coeff Var	Root MSE	strvan Mean
0.578957	25.55906	1.530704	5.988889

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	8.8921528	4.4460764	1.90	0.1518
label	2	4.1993644	2.0996822	0.90	0.4093
product*label	4	3.4797542	0.8699386	0.37	0.8290
judge	149	913.9281676	6.1337461	2.62	<.0001

Dependent Variable: sweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	673.839145	4.291969	2.39	<.0001
Error	292	524.225300	1.795292		
Corrected Total	449	1198.064444			

R-Square	Coeff Var	Root MSE	sweet Mean
0.562440	20.71276	1.339885	6.468889

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	17.1062160	8.5531080	4.76	0.0092
label	2	2.0534819	1.0267409	0.57	0.5651
product*label	4	5.9130304	1.4782576	0.82	0.5111
judge	149	648.1947002	4.3503000	2.42	<.0001

Dependent Variable: strsweet

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	157	732.947087	4.668453	3.15	<.0001
Error	292	432.750691	1.482023		
Corrected Total	449	1165.697778			

R-Square	Coeff Var	Root MSE	strsweet Mean
0.628763	19.96438	1.217384	6.097778

Source	DF	Type III SS	Mean Square	F Value	Pr > F
product	2	4.2735989	2.1367995	1.44	0.2382
label	2	6.1908472	3.0954236	2.09	0.1257
product*label	4	7.5311291	1.8827823	1.27	0.2817
judge	149	709.9293088	4.7646262	3.21	<.0001

Appendix E
Demographic Frequencies

Demographic and frequency information from all panels

		Experiment							
		IA	IB	IC	IIA Natural	IIA Artificial	IIB	IIC	IID
Gender	Male	45	45	49	35	37	52	54	68
	Female	99	99	101	61	59	64	66	82
Age	Younger than 20	9	4	10	0	0	0	0	2
	20-29	83	83	88	63	54	73	65	86
	30-39	12	19	14	13	9	15	12	16
	40-49	17	17	17	9	17	13	17	23
	50-59	21	19	20	10	14	12	23	19
	60-69	0	1	1	1	2	3	3	4
Frequency of eating ice cream	Once a week or more often	53	56	59	31	35	39	49	47
	Every 2-3 weeks	55	46	46	49	35	40	40	68
	Once a month	24	27	31	12	17	23	23	23
	Once every 2-3 months	12	12	12	3	6	7	4	8
	Once every 6 months	2	3	1	1	3	7	4	2
	Once a year	1	0	1	0	0	0	0	1

		Experiment							
		IA	IB	IC	IIA Natural	IIA Artificial	IIB	IIC	IID
Frequency of eating vanilla ice cream	Once a week or more often	22	28	27	19	25	13	26	25
	Every 2-3 weeks	44	45	45	43	26	48	34	64
	Once a month	35	37	32	16	17	26	32	33
	Once every 2-3 months	27	23	32	13	17	13	11	16
	Once every 6 months	10	10	7	5	10	14	6	7
	Once a year	2	1	4	0	0	2	1	3
	Less than once a year	4	0	1	0	0	0	0	1
	Never	0	0	2	0	0	0	0	0
Participation in dairy products evaluation training	Yes	26	34	31			17	18	31
	No	117	109	119			99	102	118

		Experiment							
		IA	IB	IC	IIA Natural	IIA Artificial	IIB	IIC	IID
Brands of ice cream eaten	Edy's	37	37	35			35	40	40
	Blue Bell	13	17	15			23	21	24
	Breyers	115	95	109			75	82	100
	Country-Club	15	17	11			5	11	14
	Haagen-Dazs	41	39	36			34	36	48
	Ben and Jerry's	58	47	54			49	54	70
	Mayfield	129	134	135			98	106	130
	Store brand	60	47	71			46	50	52
	Purity	52	44	63			35	35	52
	Texas Gold	25	19	17			13	11	11
	Private Selection	9	9	7			6	10	10
	Marble Slab	47	53	58			52	53	66
	Baskin Robbins	92	82	91			60	61	73
	Godiva	13	11	16			12	16	17
	Other	17	16	16			9	7	11

Vita

April Rae Parker was born in Jackson, Tennessee on April 24, 1979, the daughter of William G. (Jerry) and Elaine Parker of Ripley, Tennessee. April has one brother, Brain Parker. April lived and attended school in Ripley where she graduated as Valedictorian in 1997 from Ripley High School. She graduated magna cum laude with a Bachelor of Science degree in Agriculture from The University of Tennessee in the spring of 2001. The following fall she accepted a graduate research assistantship and began study toward a Master of Science degree in Food Science and Technology at The University of Tennessee.

April is a member of the Delta Gamma sorority, Institute of Food Technologists, and UT's Food Science Club. She has been involved in Alpha Zeta Agricultural Honor Society and the Collegiate Dairy Products Evaluation Team, where she placed 12th as an individual in all-products in 1999 at the national competition in Chicago, IL. April also had the opportunity to travel to Thailand and Austria for international studies.