Production and Sensory Evaluation of Pasteurized Milk Cheese vs. Raw Milk Cheese Using "Estero Gold" from Valley Ford Cheese Company

A Senior Project

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by

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Abstract

The objective of this experiment was to determine whether converting from raw milk cheese production to pasteurized milk cheese production would have a positive or negative business impact for Valley Ford Cheese Company, based on consumer acceptance. The project began by making two batches of Estero Gold cheese, one with raw milk and one with pasteurized milk. The raw milk cheese was produced at Valley Ford Cheese Company, with the milk provided from its usual source, Mountain View Jersey Dairy, composed of 100% Jersey cows. The pasteurized cheese was produced at the Cal Poly Creamery, with the milk provided from the Cal Poly Dairy. The two cheeses were then aged for 6 months in a controlled environment of 50 degrees Fahrenheit and 88% humidity. Upon completion of the required aging period, sensory was conducted with 48 random college students. It was important to recognize that none of the participants had prior experience in the area of cheese evaluation. The participants were asked to complete the two sensory tests. 1) The preference test provided two random samples (one pasteurized cheese and one raw cheese) to determine which one they preferred. 2) The Triangle test asked the participants sample three cheeses, two being the same and one different, and determine the odd sample. The results of the study found that 41 out of 48 participants successfully determined the odd sample in the triangle test, and 34 out of 46 preferred the pasteurized milk sample over the raw milk sample. The resulting data indicated a significant preference in pasteurized milk cheese over raw milk cheese and a difference in taste as indicated by the triangle test. In conclusion, on the basis of purely sensory attributes, Valley Ford Cheese Company would not suffer a business setback by the conversion of raw milk cheese production to pasteurized milk cheese production and should consider this change.

Table of Contents

Section Page

ACKNOWLEDGMETNS …… ii

ABSTRACT...…….....iii

TABLE OF CONTENTS ……...iv

LIST OF FIGURES …… v – vi

LIST OF TABLES ……... vii

INTRODUCTION ….…….. 1

LITERATURE REVIEW
- Pasteurization and its importance …….……....2
- Technique of pasteurization specific to the project……....3
- Raw milk cheese and the debate behind it ……..4-6
- Laws and regulations of raw milk cheese …… ……...6-7
- Farmstead, artisan, and specialty cheeses and their important in today's dairy industry ……7-9
- Demand for specialty cheese ……...9-11
- Sensory Evaluation and its importance ……11-13

MATERIALS AND METHODS
- Cheese making flowchart ……14
- Raw Milk Cheese Production ……...15-24
- Pasteurized Milk Cheese Production ……24-25
- Sensory Evaluation ……...26-27

RESULTS ……28

CONCLUSION ……29

REFERENCES ……30-31

APPENDIX
- Triangle Test Results ……32
- Preference Test Results…….33

List of Figures

Figure Page

1. Temperature-Time Pasteurization Requirements For fluid milk ……2
2. Basic Flow: HTST Pasteurization ……3
3. Estimated percentage of drink pasteurized and Raw milk in the U.S., milkborne disease outbreaks ……...5
4. State by state review of milk laws ……..6
5. Class 4 Milk Prices …….....7
6. Mountain View Jersey Dairy ……..8
7. U.S. Cheese Production by state, 2008 ……..9
8. Sensory Evaluation facility and panel ……..13
9. Flowchart of cheese making procedure ……14
10. Collecting Milk ……15
11. Adding milk to the vat ……16
12. Monitoring pH ……17
13. Stirring ……19
14. Draining whey ……20
15. Collecting curds into molds ……21
16. Pressing curds …….....22
17. Removing wheels from brine tank ……..23
18. Aging cheese for 5 – 6 months ……...23
19. High Temperature Short Time Pasteurization Unit ……24

20. Setting values and tests on sensory computers ……...26

21. Preparing cheese samples for test ……..26

22. Preparing full tray for evaluation ……27

23. Handing samples to participants through window ……...27

List of Tables

Table Page

TRIANGLE TEST RESULTS ……... 32

PAIRED COMPARISON RESULTS …… 33

Introduction

Raw milk cheese and its legality has been a topic of debate for years as the majority of cheeses are made from pasteurized milk. Studies have been done to show the benefits of raw milk cheese as well as the downfalls of them. None of these studies have ever found enough reason from a quality standpoint to force the government to ban the products. At Valley Ford Cheese Company, all products are made from 100% raw Jersey milk. However, as the business is rapidly expanding, it may be useful to pasteurize the milk in order to shorten the required aging period before sell. But before investing in a pasteurizing system, it is important to run test batches of pasteurized cheese and compare it to the current raw milk cheese from the consumers' perspective. Therefore, a sensory evaluation based on texture, flavor, and appearance characteristics is the only way to accurately predict the outcome of the potential transition from raw milk cheese to pasteurized milk cheese.

Before pasteurization was even an option, all cheeses were made from raw milk. The only way to minimize pathogens was to keep the plant as clean and efficient as possible. Today, however, processers have the option of pasteurizing the milk to eliminate pathogens, extend shelf life, and minimize required aging time. The downfall though is the cheese can tend to have a cooked flavor and by the elimination of certain bacteria can ultimately end up with a different flavor than raw milk cheese. If the sensory tests indicate that the consumers will not be turned away by the potential new change in product, a recommendation will be made to Valley Ford Cheese Company to invest in a pasteurizing system.

Literature Review

Pasteurization and its importance

In 1865, Louis Pasteur found in his research of wine that organisms that were causing the product to spoil could be minimized or even eliminated if heated to a high temperature for a specific period of time below its boiling point. As this new technology gained national attention, it was applied to milk, and is one of the most important innovations in history.

Pasteurization is the heating of every particle of milk or milk product to a specific temperature for a specified period of time without allowing recontamination of that milk or milk product during the heat treatment process ("Pasteurization," 2010). There are two main purposes of pasteurizing milk: public health and keeping quality.

In order to produce a safer product for the consumer, the milk is heated with the intent of destroying all pathogenic organisms. In order to determine the exact time and temperature required to accomplish this destruction, scientists based their experiments on eliminating the most heat resistant pathogen in milk, *Coxelliae burnettii*. The table to the left shows the required times and temperatures found at the conclusion of these studies. If at any point during the process the product is not held to these standards (indicated by a flow chart), the product cannot be labeled as pasteurized. In the state of California, only someone who has successfully passed the California Milk Pasteurizers Test can

Temperature-Time Pasteurization Requirements for Fluid Milk

Temperature	*Time*
• 150°F (66°C) (vat pasteurization)	30 minutes
• 161°F (72°C) (high temperature, short-time pasteurization)	15 seconds
• 191°F (89°C)	1 second
• 212°F (100°C)	0.01 second

Figure 1 Temperature & Time Requirements for Pasteurization of fluid milk

legally operate pasteurization equipment. The certification is for further insurance that the milk has been properly treated by an experienced operator.

The other purpose of pasteurization is to extend the shelf life of the product while keeping product quality. Some of the spoilage bacteria are destroyed during the process and therefore pasteurization can extend shelf life from 7 to 16 days. Pasteurization is the most important step in the operation of dairy product manufacturing.

Technique of pasteurization specific to the project

There are two main methods used for pasteurization, batch and continuous. Batch pasteurization is when the milk is heated in the vat to 150 degrees F for 30 minutes. The milk is heated by a water steam jacket or heating coils. This is often used on small-scale operations and not on large-scale plants due to the length of time required. The Continuous process method will be used, specifically High Temperature Short Time (HTST). This is the most common technique of pasteurizing due to its energy efficiency, performance history, and small time requirement. As opposed to other methods such as Ultra High Temperature (UHT) and Ultra Pasteurization which may require

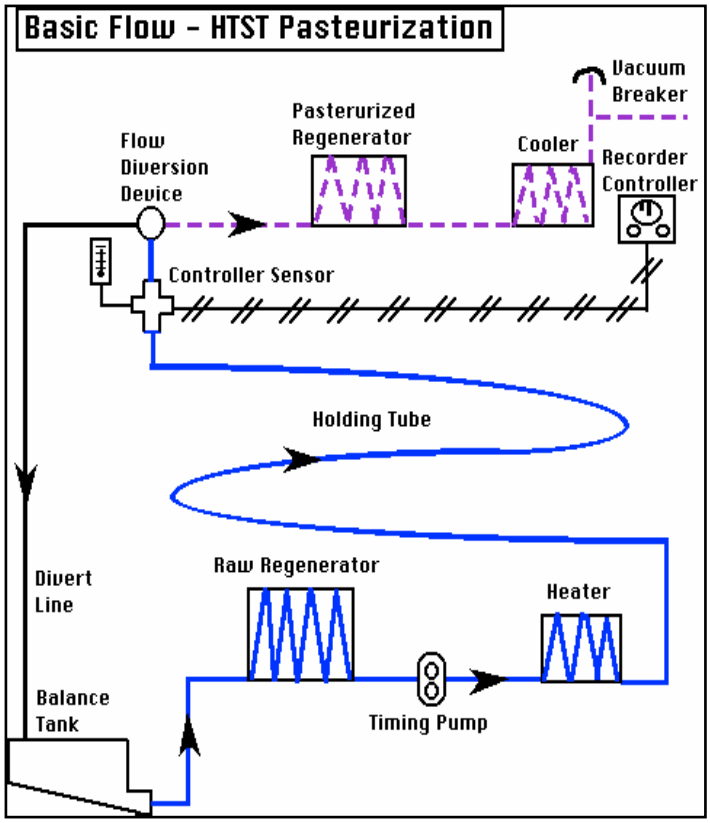

Figure 2: Flow of HTST Courtesy of http://foodscience.uoguelph.ca/dairyedu/pasteurization.html

higher temperatures leading to off flavors, HTST requires the milk to be heated by a plate heat exchanger to 161 degrees F for 15 seconds. The diagram on the right shows the basic flow of a typical HTST pasteurizing system.

Raw milk cheese and the debate behind it

Raw milk is described as milk that has not been processed via pasteurization (heating) or homogenization before consumption by humans. The milk is collected from the cow and pumped through filters to remove any direct bacteria that may be in the milk. The milk is then pumped into raw milk holding tank where it is typically held for 4 to 12 hours until the milk transportation truck arrives. Typically, the first process that milk goes through when it arrives at a processing plant is pasteurization. However, an increasing demand for raw milk and raw milk products has escalated the popular debate over whether or not the production and distribution of raw milk dairy products should be legal. Advocates for the legality of these products argue the following points:

- The beneficial bacteria (probiotics) promote good health by moving out bad bacteria and help prevent yeast overgrowth in the intestinal tract, such as of Candida.
- Enzymes are destroyed by pasteurization which would aid in digestion. Lactase is an enzyme in raw milk that aids digestion of the milk sugar lactose, and so some lactose intolerant individuals can drink raw milk.
- Raw milk will sour naturally due to the lactic acid consuming bacteria, and still be healthy, whereas pasteurized milk, which lacks the healthy bacteria, will only putrefy.
- Pasteurized milk converts the protein casein into Beta-casomorphin-7, which has been linked to autism.

- People with genetic Connective Tissue Disorders, such as Ehlers-Danlos syndrome that prevent them from making at least one protein in human collagen may or may not be able to absorb this from raw animal sources such as raw milk. In other words, it isn't known whether these diseases represent recent unfavorable mutations, or the survival of genes common before cooking and food processing. ("WordIQ", 2010)

People who believe that raw milk products should not be legal claim that consumers should not be able to purchase a product that has not been processed to the maximum capacity to ensure the products safety. The whole purpose of pasteurizing the milk is to destroy pathogens, and by doing this, advocates say that it significantly reduces the amount of dairy caused sicknesses each year.

The pie chart on the top of the image to the right shows the amount of people who actually consume raw milk or raw milk cheese. The numbers of people who actually consume these products are very minimal, around 1% of milk/cheese consumers. The chart on the bottom indicates the amount of milk borne disease outbreaks reported CDC by food category in the United States from 1973 – 2005. Advocates for raw milk

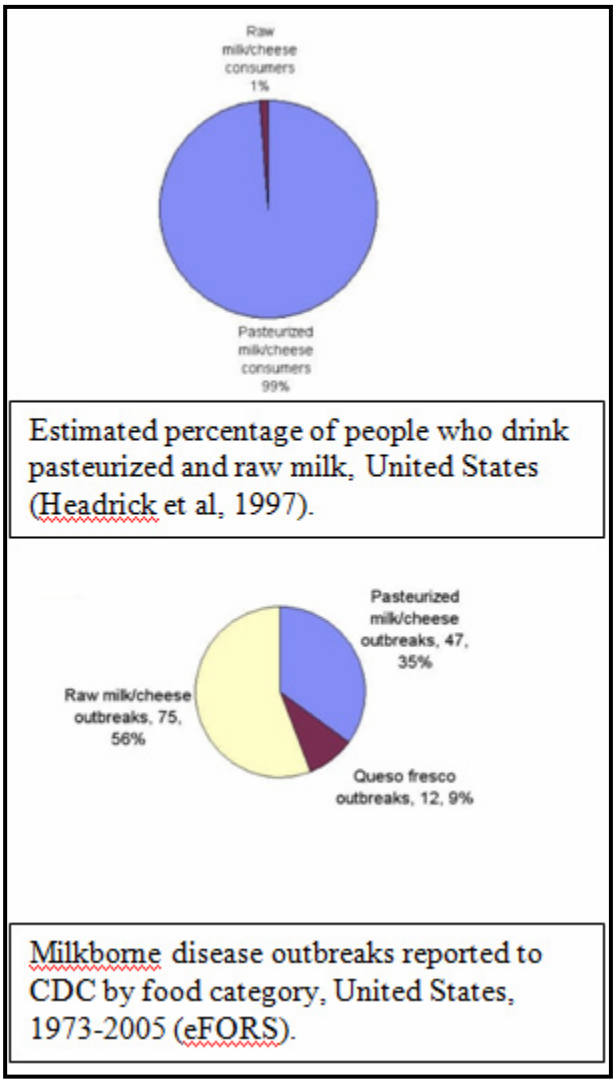

Figure 3: (top chart) Estimated % of people who drink pasteurized and raw milk, (bottom chart) milk borne disease outbreaks

products would argue that while there were 28 more outbreaks for raw milk products over this time, there have been significant production restrictions and quality regulations implemented since 1973 on the production of raw milk products and therefore these numbers may be skewed as opposed to what they would actually be today. Advocates against these products would argue that statistics from the CDC and State Health Departments comparing raw and pasteurized dairy products linked to reported food borne disease outbreaks (1973-2006) show that raw milk and Mexican-style queso fresco soft cheeses (usually made from raw milk) caused almost 70% of the reported outbreaks even though only 1-3% of the population consumes raw dairy products. If raw and pasteurized milk were equally risky, it would be expected that there would be far more pasteurized outbreaks since the number of people drinking conventional milk is so much higher. ("Real Raw Milk Facts," 2010)

It may be years until there is enough "concrete" scientific evidence to prove both sides to be correct, so for now the debate will go on and it will be up to the consumer to determine if they want to take the "risk" of putting raw milk dairy products in their bodies.

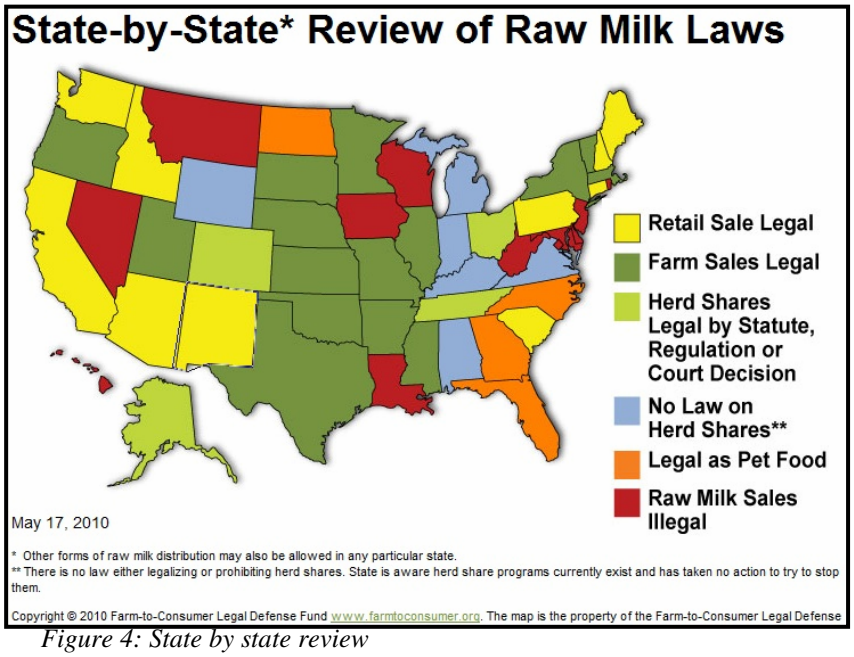

Figure 4: State by state review of milk laws

Laws and regulations for raw milk cheese

The ability to produce and sell raw milk cheese varies throughout the United States. In some states it is illegal to obtain any products, and some states allow it under strict supervision

and regulation. It is illegal for any raw milk to be transported across any state border unless to be processed for something other than human consumption. In the states where these cheeses are legal they have to be aged at least 60 days in a storage room held at 35 degrees Fahrenheit. During the aging process, the cheese becomes more acidic, killing most potential sources of bacterial infection ("WiseGEEK," 2010). California is one of the states that allow raw milk cheese as long as it has been aged under the above conditions. Most of the raw milk cheese producers are typically on the small, farmstead level. There is currently no large dairy manufacturing company in California that produces raw milk cheese.

Farmstead, artisan, and specialty cheeses and their importance in today's dairy industry

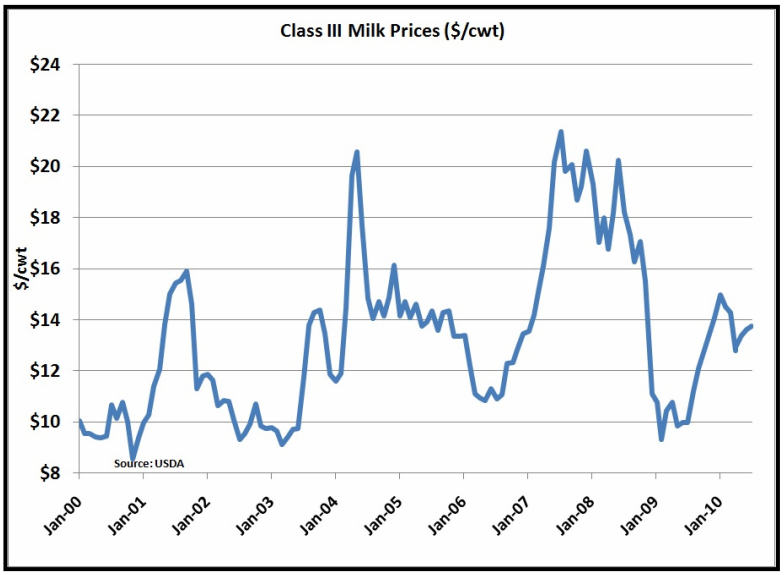

Figure 5: Class 4 milk prices http://milkprice.blogspot.com /2010/08/july-milk-prices-are-up-

During the 2008-2009 recession, the dairy industry was hit just as hard as any other industry. The price of milk was less than the value of the food to feed the animals, leading dairymen across the United States to sell their business, tighten their budgets, minimize labor and miscellaneous costs, or in some cases, turn to value added products. With the price dairymen were receiving for their fluid milk so low (as indicated by figure 5); many smaller scale operations began to explore the idea of producing a value-added product directly on their farms. Instead of shipping the milk to a large

manufacturing plant and receiving anywhere from $9 per hundred-weight, the dairymen could theoretically up their paychecks to over $20 per hundred-weight by making cheese and selling it directly for retail. For years, entrepreneurs such as Larry Peter (Spring Hill Farmstead Cheese Company, Petaluma, California) and Bob Giacommini (Point Reyes Farmstead Blue Cheese Company, Point Reyes, California) had tapped into this specialty cheese market and had been successful. However, these are two of the rare companies who had begun prior to the economic downturn. Today, there are over 50 small, farmstead cheese companies throughout California, and that number is only trending upward. The terms "farmstead, specialty, and artisan" are claims on labels that are becoming an important aspect in the dairy industry.

The term "farmstead" refers to a product that was produced directly on the farm in which the milk was obtained. The cheese is typically transferred from the bulk milk tank directly to the cheese making facility on the same day. Keeping product safety is a huge priority especially on the farmstead level due to the amount of bacteria in the manure, animals, and feeds. The picture on the left is from Mountain View Jersey Dairy, which works in partnership with Valley Ford Cheese Company on the same farm in Valley Ford, California.

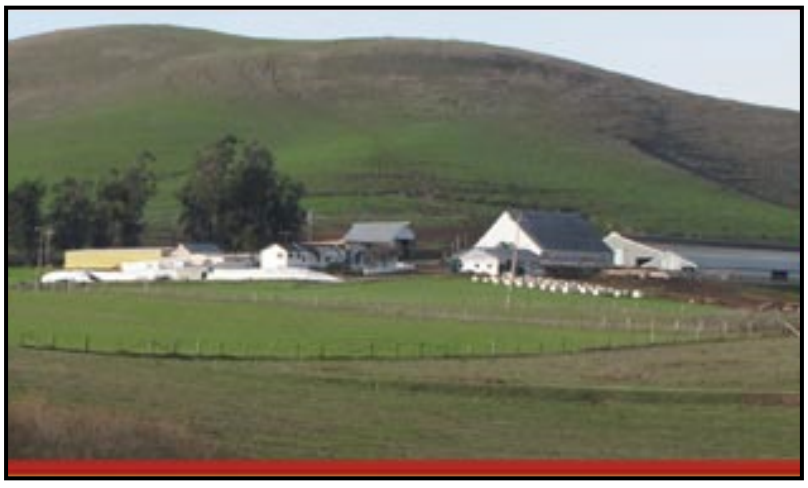

Figure 6: Mountain View Jersey Dairy

Specialty cheeses are those in which are not parts of the mainstream market. These may be foreign cheeses, combination cheeses of two different types, newly developed cheeses, or cheeses with a certain addition such as herbs or spices. These cheeses are typically found in a separate section of the grocery store than bulk type cheeses such

as Cheddar, Jack, and Mozzarella. Specialty cheeses are very popular on the farmstead level, as it is typically too hard for farmstead operations to compete in the mainstream style cheese markets.

The term "artisan" cheese refers to cheese that has typically been made with a minimal amount of new technology or machinery. These cheeses have been hand made and it gives the consumer a sense of aspiration towards the hard work that went into making it.

Demand for specialty cheese

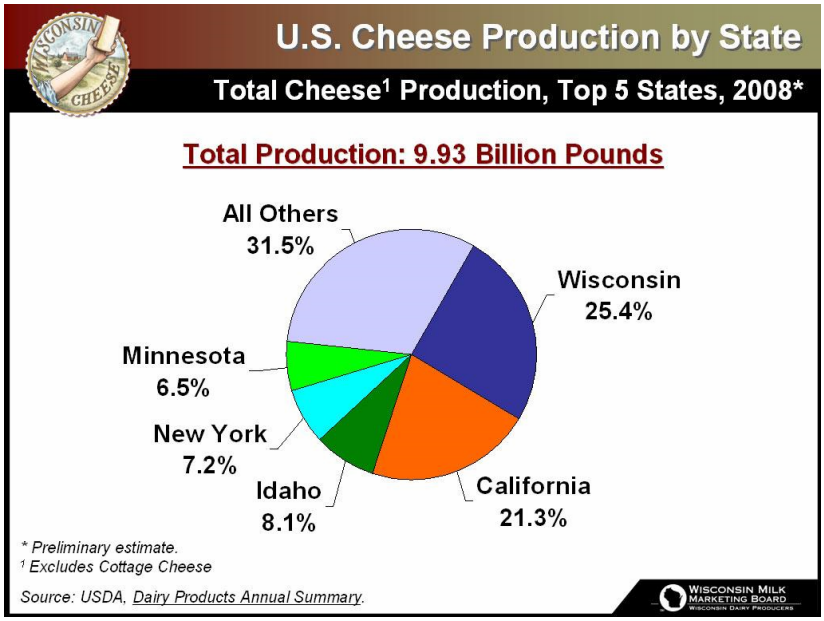

Figure 7: U.S. Cheese production by state, 2008
Courtesy of:
http://media.eatwisconsincheese.com/ag_media/statistics/cheeseStatistics.aspx

One of the most important factors in this rise in farmstead cheese making is the fact that cheese production on a national scale has steadily risen over the past ten years. Total cheese consumption in 2009 (excluding cottage cheese) was up 10.1 billion pounds, or 2% from 2008. Of the rising production, American style cheese was up 4.2 billion pounds or 2.3%, and Italian style cheese was up 1.4% or 4.18 billion pounds. The leading state was Wisconsin, producing 26% of the United States cheese, second was California, producing 2.06 billion pounds, followed by Idaho, New York, and Minnesota.

Another important factor to this rise in production of farmstead cheeses is the average upward trend of consumption of cheese over the past decade. Besides the slight decrease from 2008 to 2009, people have been eating more and more cheese year after year. This may be due to the increasing variety of foreign cheeses now produced domestically, newly developed products (which are more convenient in today's fast paced society), or new and better marketing strategies by promotional entities. But no matter what the reasoning, people are eating a lot of cheese. The average American consumes about 32 pounds of cheese yearly, including 10 pounds of Cheddar and 10.6 pounds of Mozzarella. Another reason for the rising popularity of cheese in the United States has been the increase in ethnic cooking, such as Italian and Mexican, which uses more cheese than other foods. Demand for traditional pizza has shifted to other segments such as submarine shops and quick-casual chains, resulting in increased demand for new types of cheese (Geisler. 2010). As the public continues to demand more cheese, there will be a continued need for more cheeses.

While these yearly statistics show an upward trend in consumption and production of mainstream cheeses on a national level, why is it that there is such an increasing demand for specialty products? According to research done at Iowa State University by (Geisler, 2010) there are five basic reasons explaining this. They include:

- More U.S. citizens traveling abroad and trying unique varieties of cheese.
- U.S. restaurants offering a cheese course (a time honored European tradition).
- Greater access to a wide variety of cheese.
- An increased interest in ethnic food
- The overall trend of U.S. consumers desiring more variety and robust flavor in food.

- Education from retailers, foodservice and cheese organizations on the use of unique cheese. Successful merchandising of specialty cheese is a key factor in the growth of the cheese market for specialty cheese.

Also, because of the fact that most of the Raw Milk Cheese in United States is imported, there is a great opportunity for growth in this market domestically. Only a small fraction is actually produced domestically, therefore there is plenty of room for domestic cheese makers to increase their market share (Kindstedt, 2010). If each of these points continue on the pace they are currently on, the future is looking bright for any farmstead cheese operation with aspirations of value-added products. And in some cases, this may be the only way for a dairy to survive.

Sensory evaluation and its importance

A company does not want to put forth a newly developed product without finding out whether or not people will even like it. Therefore, most companies will go through some sort of sensory evaluation process to analyze the publics' perception. The sensory evaluation incorporates smell, taste, and texture characteristics into a series of studies where panels of trained or untrained cheese tasters describe their reaction to new food products. In order to produce a quality dairy product, it is important that the evaluator takes into consideration the appearance, texture, and flavor of their potential new product (Brown, et al. 2003).

While there are many different kinds of sensory evaluation tests, there are three that are most common: difference tests, descriptive analysis, and consumer acceptance tests. The first difference test is the triangle test, where two of the samples are the same, one is different, and the participant is asked to identify which two samples are the same. The other common difference test is the duo-trio test, where the participants are given a standard sample, followed by two other

samples and asked to identify which one is different then the standard sample. While these tests are generally beneficial, they do not explain the level if difference between samples, leading evaluators to typically use descriptive sensory analysis as well.

> "Descriptive sensory analysis refers to a collection of techniques that seek to discriminate between a range of products based on their sensory characteristics and to determine a quantitative description of the sensory differences that can be identified, not just the defects. Unlike traditional quality judging methods, no judgment of good or bad is made because this is not the purpose of the evaluation. The panel operates as a powerful instrument to identify and quantify sensory properties." ("Innovate with Dairy", 2010)

Some of the possible flavor attributes include: cooked, whey, diacetyl, lactone, brothy, sulfur, nutty, sweet, sour, salty, and bitter. With descriptive analysis, the participants are trained by a professional. They are taught how to identify flavor attributes, how to judge differences between attributes with minimal discrepancy, and how to properly relay their analysis in a productive manner to the evaluation team. Because training can be costly and time consuming, the typical panel size during descriptive analysis is eight to 12 prescreened participants.

Perhaps the most important factor in a quality sensory evaluation is minimizing outside influences on the participants. No participant shall have contact with another outside individual or with other participants during the evaluation. The project should be held in a controlled room which has closed-off individual panels with lighting favorable to a proper random sample appearance. The participants should also be prevented from witnessing the preparation of the samples. If each of these measures is taken, it will provide a conclusion with a more accurate analysis of the consumer acceptance ratings of the products.

For this experiment, only the duo-trio and triangle difference tests were used.

Figure 8: Sensory evaluation facility and panel

Valley Ford Cheese Company – Basic Cheese Making Procedure for "Estero Gold"

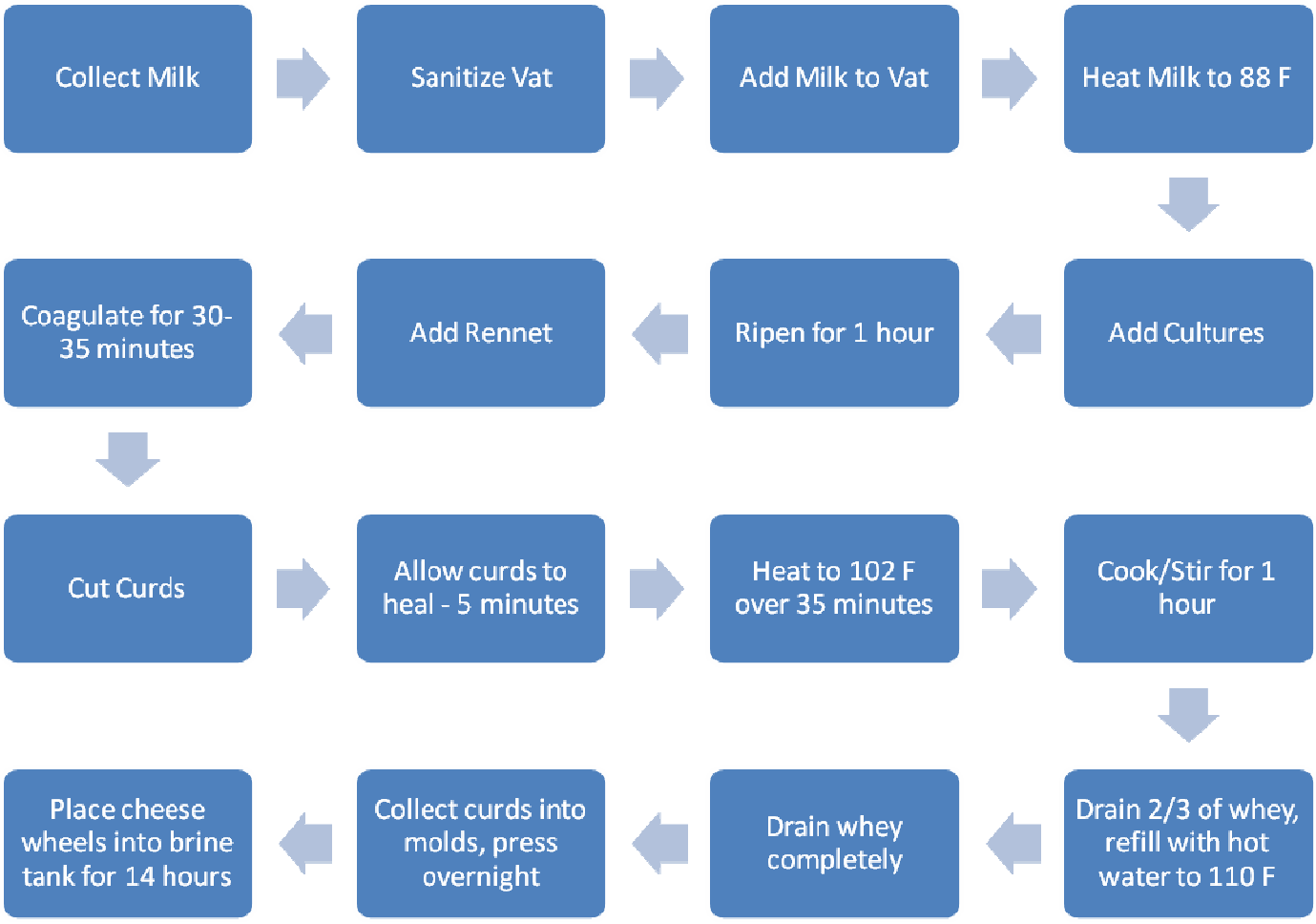

Figure 9: Flow chart of cheese making procedure for "Estero Gold" from Valley Ford Cheese Company

Materials and Methods:

Materials:

Materials for cheese making:

- Milk buckets
- High Temperature Short Time (HTST) pasteurizer
- Cheese vat
- Stirring Rod
- pH Meter
- Temperature gauge
- Vat milk fill-level stick
- Soap and Chlorinated water
- Sponges and cleaning brushes
- Scale
- Non-Chlorinated water
- Cultures
- Rennet
- Cheese curd filter
- Buckets
- Cheese curd sampling knife
- Cheese cutting knife – horizontal blades
- Cheese cutting knife – vertical blades
- Cheese clothes
- Cheese molds
- Air-line cheese press
- Brine tank solution
- Aging room

Figure 10: Collecting milk

Methods:

Procedure to make raw milk Estero Gold Cheese (at Valley Ford Cheese Company)

<u>Collect Milk</u> **–** 10 gallon milk buckets, soap and chlorinated water

Ten gallon plastic buckets are used for collecting the milk. The cans should properly be sanitized previously to contact with product. Valley Ford Cheese Company receives its milk from Mountain View Jersey Dairy which uses 100% Jersey milk.

Sanitize vat – Cheese vat, sponges and brushes, soap and chlorinated water, non-chlorinated water, vat milk fill level stick

Figure 11: Add milk to vat

Before the milk is added to the cheese making vat, it is essential that the vat and any materials to be used (temperature gauges, pH meters, curd filter, hoses, stirring rods) are properly washed and sanitized. The proper chlorination level for sanitation should be approximately 200 ppm (parts per million).

Add to 100 gallon vat – 10 gallon milk buckets, cheese vat

Four ten-gallon buckets will be filled completely and added to the vat directly by lifting the buckets and dumping the milk.

Add cultures, check pH – Cheese vat, temperature gauge, hot water/steam jacket supply, cultures, pH meter

The milk should first be heated to 88 degrees F, which is temperature in which the specific cultures will be activated. Due to privacy purposes, the names of the specific cultures will not be mentioned at any point in the experiment. The cultures used for cheese making are lactic acid bacteria which are used to convert milk sugar (lactose) into the desired product, lactic

acid. There are many different cultures that can be used to produce different desired textural and flavor outcomes in the final curd.

> "Starter cultures are used early in the cheese making process to assist with coagulation by lowering the pH prior to rennet addition. The metabolism of the starter cultures contribute desirable flavor compounds, and help prevent the growth of spoilage organisms and pathogens. Typical starter bacteria include *Lactococcus lactis* subsp. *lactis* or *cremoris*, *Streptococcus salivarius* subsp. *thermophilus*, *Lactobacillus delbruckii* subsp. *bulgaricus*, and *Lactobacillus helveticus*. (Grigg, K., 2010)"

Ripen, check pH – pH meter

The first stage in cheese making is to ripen the milk. During this time-period, the milk sugar is converted into lactic acid. Cheese makers use starter cultures to control this ripening process. The changes in the pH that occur during ripening are dependent on the effectiveness of the conversion of lactose to lactic acid as well as whether or not calcium is added to the milk. For this experiment, no calcium chloride will be added to the milk.

Figure 12: It is important to constantly monitor the pH level

Add rennet, check pH – rennet (diluted 10x with water), pH meter

Rennet is added to the milk after the ripening period has

completed. Rennet contains many enzymes, such as protease, to coagulate the milk, causing it to separate into curds and whey. The enzyme in rennet is called chymosin but there are also other important enzymes in it such as lipase. There are typically three different kinds of rennet used in cheese making. These three are microbial, vegetable, and genetically engineered. For the purpose of this experiment, microbial cultures will be used. The rennet is added in small amounts and diluted in water before added directly to the vat. The rennet should be slowly added into the vat, using a stirring rod to evenly distribute the rennet for approximately one minute. Too much stirring will cause the rennet to not fully coagulate.

Let milk coagulate

While the rennet is coagulating the milk, it is essentially separating the curds from the whey. By doing this, the lactose content in the curd is lowered and the lactic acid content is multiplied. During the coagulation stage, the vat should not be disturbed.

Cut curds, check pH – Cheese curd sampling knife, horizontal curd cutting knife, vertical curd cutting knife, pH meter

Before cutting the curds, the effectiveness of the rennet should be checked with a knife by cutting slits in the curd and determining if it is firm enough. In the case that the curd is still too soft, it is ok to wait the additional amount of time needed for a proper coagulation to occur. This should typically not take longer than 45 minutes. Once the curd has got the approval of the cheese maker, it is time to take the knives and cut the curds. There are two different knives to be used, one with horizontal blades and one with vertical blades. It is important that the horizontal blades be used first in order to minimize the amount of fat being lost into the whey. Once the curds have been cut into even, small, and square curds, the vat

should be left alone for approximately 5 minutes. This gives the freshly cut curds a chance to heal before the cooking process begins.

<u>Heat to 102 degrees F, then cook/stir for one additional hour, check pH</u> – hot water/steam supply, temperature gauge, stirring rod, pH meter

The purpose of the cooking/stirring portion of the process is to develop acidity and to expel he whey from the curds. Different cheeses require different cooking times and temperatures, so therefore it is not unusual to find other methods that call for much different processes. For the Estero Gold cheese, the required cooking process calls for the curds to be heated via the provided steam jacket to 102 F over the duration of 35 minutes. This allows a slow and well distributed cook without damaging the milk fat globule membrane with too high of an immediate temperature.

Figure 13: Stirring

> "The temperature must be increased very slowly, no more than 2°F every 5 to 7 minutes. The curds should be stirred very slowly and gently to prevent the matting of the curds and to aid in the expulsion of whey from the curds. Prior to draining of the whey, the curd can be tested for proper consistency by placing some in the palm of your hand. If you squeeze them together, they should mat into a mass and

be somewhat firm and resilient; however you should also be able to separate them by agitating them with your thumb or finger." (Robinson, L. and R., 2010)

Drain whey until 1/3 is left in vat then refill with hot water while increasing temperature to 110 degrees F. – Hot water/steam supply, cheese curd filter

This step is commonly referred to as the "curd washing" step. The curd filter is added to the vat in order to separate the curds and whey by expelling the way through a drain. For this specific process, 2/3 of the whey is removed, followed by re-filling with hot (non-chlorinated) water. This allows for lactose removal, strengthening of the milk fat globule membrane for moisture control, and assists in expelling the whey from the curd. This step is specific to certain cheeses, typically hard cheeses, as not all types of cheese require this step. After the addition of the hot water and the determined degrees of 110 degrees has been met, the vat should be let alone to sit for 5 to 10 minutes, allowing the curds to settle on the bottom of the vat.

Figure 14: Drain whey completely

Drain whey completely, check pH – in-vat cheese curd filter, out-of-vat cheese curd filter, pH meter

This is the final step of the cheese making process and can ultimately determine the quality of the cheese. The curd filter is re-inserted into the vat, the valve is opened, and the whey is expelled from the vat,

leaving only the curds. The most important aspect of draining is controlling the moisture content. There are too important things to remember when considering moisture content, the possible bacteria that water possesses and the positive business impacts of maximizing water content while keeping quality. Water may potentially contain some bacteria that could affect the safeness of the cheese, however, water is free in most cases and it makes business sense to sell the most amount of water possible. So there needs to be a middle ground met to satisfy both sides. In some cheeses there may be specific strategies of "trenching" or "chopping" the curds to expel moisture, however for Estero Gold, the curds are simply taken directly into the molds.

Collect curds into molds, press for 12 – 14 hours – cheese molds, air-line cheese press, scale

The curds are put into small, 5 to 6 pound round molds where they will press overnight. The molds are outlined with disposable cheese clothes so the outside texture of the cheese is desirable. Each of these molds and clothes has been properly sanitized prior to touching the product. The molds are then pressed under an air-press in which the targeted moisture content is obtained. The expelled whey should be obtained for further testing if necessary.

Figure 15: Collecting curds into molds

"When curds are squeezed, their surfaces are stretched and the very thin layer of fat that surrounds them is split open. This exposes the milk protein matrix within. When exposed to one another they will bond. To the cheese maker this is known as knitting. This is the process where loose cheese curds become solid cheese. To the novice, it may appear that the curds are simply 'pressed' or mechanically packed together. The atomic bond between molecules is far stronger than any created by pressure alone." ("Pressing Cheese," 2010)

Figure 16: Pressing curds for 14 hours

<u>Remove wheels from molds, place in brine tank for 12 – 14 hours</u> – brine tank

For Estero Gold production, the cheese molds are put into a brine tank where they will soak in salt solution for 12 – 14 hours. This is contrary to direct application of salt that may be used in cheeses such as cheddar or jack. While the obvious reason of adding salt to the cheese is for flavor development, another important aspect to consider is that salt is used to slow down the bacteria from converting lactose to lactic acid.

Figure 17: Remove wheels from brine tank

"At the time of brining most of the lactose is removed but if the cheese were not salted, the residual moisture contains enough lactose to produce more acid than is ideal for a proper curd ripening. This salting of the cheese will also pull moisture from the surface and begin forming the rind of the cheese. This will also tend to inhibit the growth of many molds ("Brining Details." 2010)." It is important that the temperature of the brine solution is the temperature similar to that of refrigeration.

<u>Remove wheels from brine tank, place on shelf for 5 – 6 months</u> – Temperature/humidity controlled aging room

While the pasteurized cheese used in this experiment could legally be sold upon completion of the brining, it will be aged the same exact period of time as the raw milk cheese for Valley Ford Cheese Company is typically aged 5 to

Figure 18: Aging for 5 – 6 months in a controlled environment

6 months. It is a requirement for all raw milk cheeses to be aged for a minimum of 60 days prior to sell. “As a cheese ages, microbes and enzymes transform texture and intensify flavor. This transformation is largely a result of the breakdown of casein proteins and milk fat into a complex mix of amino acids, amines, and fatty acids.” (Grigg, K. 2010)

Procedure to make Pasteurized raw milk Estero Gold (at Cal Poly Creamery)

**The steps not explained in further detail are the same as previously stated in the “raw milk Estero Gold cheese procedure”*

Collect Milk

Only Jersey milk will be used. While the components of the milk from the Cal Poly Jersey cows might slightly vary from the cows from Mountain View Jersey Dairy (the source of milk for Valley Ford Cheese Co.), it is essential for Holstein milk to be excluded from the experiment. The average milk fat content for Jersey cows is approximately 5.2%, as opposed to Holstein milk, which averages about 3.6%.

Figure 19: Pasteurize 40 gallons of Jersey milk using HTST method

Pasteurize 40 gallons – HTST pasteurization system

The High Temperature Short Time (HTST) method will be used which requires the milk

to be heated to 161 degrees F for 15 seconds. The purpose of pasteurizing milk is to destroy pathogenic bacteria, specifically the deactivation of coxiella burnetti. The efficiency of the pasteurizer is inspected and indicated by the alkaline phosphatase test which is deactivated at the similar point of the target pathogen. In order for the milk to be legally pasteurized, the process must be approved by a person who is certified as a legal pasteurizer.

Add Milk to 100 gallon vat, check pH

Once the milk has been legally pasteurized, it is pumped into a 100 gallon vat. The vat used is the exact replica used at Valley Ford Cheese Company. It provides a steam jacket to heat/cool the product, temperature gauges for both the steam and the actual product itself, and a sanitary stainless steel exterior for quality control.

**All of the steps following the "add milk to vat" step are the same as the procedure for raw milk cheese production.*

Sensory Evaluation preparation and procedure:

Human Protocol Form

In order to perform the sensory evaluation at the Cal Poly facility, a Human Protocol Form must be created and accepted by campus. The purpose of the form is to inform the participants of the project, the risks of participating if any, and to ensure that the proper steps have been taken to ensure their safety. Each participant must read the form prior to taking part in the evaluation. The protocol was approved by campus administrators.

Figure 20: Setting values and tests on sensory computers

Set sensory evaluation computer program to proper tests

Participants will first do the triangle test. For this test, three different codes for each of the two different types of samples will be used to minimize bias. Different combinations of the two similar samples will be used throughout the experiment. The computer screen should explain the test in specific and easy to read terms. The question should read "two of the following samples are the same and one is different. Please identify the odd sample."

The second and final test for the evaluation will be the preference test. For this test, the participants will receive two samples. One sample will be pasteurized milk cheese and one will be raw milk cheese. The participant will not be informed of which product is which.

Figure 21: Preparing samples for test

Prepare Samples and Trays

Cut samples into 1 x 2 inch squares. It is important that the samples are of even size and shape to ensure a consistent sample for both types. If a sample of one is bigger than another, the participant may unintentionally be biased one way or the other. Due to the supply of product, a minimal amount of cheese will be provided.

The cheese samples will be provided on small paper plates. The samples will also consist of a cup of water and a saltine cracker for the participant to clear their taste buds. The plates will be labeled with their specific numbers according to the sensory evaluation computer program.

Figure 22: Preparing full tray for evaluation

Administer Tests

The Dairy Products Technology Center facility has four sensory booths available. As people are waiting to participate, it is important that they remain as silent as possible to minimize outside influence on the current evaluations. While handling samples and materials, gloves must be worn. When a participant finishes the first test and is waiting to receive the samples for the second test, the small window should be shut so that he/she cannot view the preparation of the samples. Upon completion of all evaluations, the facility should be cleaned so that it is in the condition as it was prior to use and all cheese products should be discarded.

Figure 23: Handing samples to participants

Results

48 people participated in the triangle test and 46 participated in the paired-comparison test. In the triangle test, 41 of the 48 participants successfully recognized the odd sample, indicating a significant difference ($\alpha = 0.05$) in the two types of samples. For the paired comparison test, out of the 46 participants, 34 preferred the pasteurized milk cheese over the raw milk cheese, indicating a significant difference ($\alpha = 0.05$) in the preference of pasteurized milk cheese over raw milk cheese. It is important to note that there may have still been some other factors influencing the results of the tests, such as color (the sensory panel lighting was not functioning), and noise (the participants waiting in line were not as quiet as requested). The results are based heavily on flavor and texture. The results indicate that the conversion of raw milk cheese to pasteurized milk cheese would be a positive business decision based on consumer acceptance of sensory attributes alone. Refer to the appendix for results of the data from the evaluation.

Conclusion

After completion of the sensory evaluation, the data shows that a significant amount of the participants were able to recognize which sample was the odd sample in the triangle test, and preferred the pasteurized milk cheese over the raw milk cheese. These results indicate that if Valley Ford Cheese Company was to convert from raw milk cheese production to pasteurized milk cheese production, either by regulation or by choice, the consumers will not be negatively affected on the basis of sensory attributes. While the study does indicate positive results in the sensory evaluation of the pasteurized milk cheese, it does not take into consideration the idea that consumers may be purchasing the raw milk cheese over pasteurized milk cheese for purposes other than flavor or texture. Many consumers purchase certain products over others based on reputation, personal affections and ideas, a desire for a more "natural" product (there is no federally regulated definition for the term "natural"), or any other variety of reasons. However, while these other reasons for purchase may heavily influence a consumers desire to buy the product, ultimately if the product does not taste good, they will not buy it. Therefore, with all the potential benefits which include less required aging time, a reduction of potential bacterial issues, and a longer shelf life, Valley Ford Cheese Company should seriously consider the conversion of raw milk cheese to pasteurized milk cheese.

References

Adhikari, K. "Textural Characteristics of Low fat, Full fat and Smoked Cheeses: Sensory and Instrumental Approaches." *Food Quality and Preference* 14.3 (2003): 211-218. Print.

"Brining Details." *CheeseMaking - Online Store*. Web. 27 Nov. 2010. <http://www.cheesemaking.com/BriningDetails.html>.

Brown, J., C.R. Daubert, M.A. Drake, A.E. Foegeding. 2003. "Sensory and Mechanical Aspects of Cheese Texture." *International Dairy Journal* 13.8: 585-591. Print.

Geisler, By Malinda. "Cheese Industry Profile." *Agricultural Marketing Resource Center*. Web. 27 Nov. 2010. <http://www.agmrc.org/commodities__products/livestock/dairy/cheese_industry_profile.cfm>.

"Innovations in Dairy: Dairy Industry Technology Review, Sensory Evaluation of Dairy Products." Dairy Management Inc. Web. 27 Nov. 2010. <www.innovatewithdairy.com>.

"Is Raw Milk Cheese Really Illegal in the United States?" *WiseGEEK: Clear Answers for Common Questions*. Web. 27 Nov. 2010. <http://www.wisegeek.com/is-raw-milk-cheese-really-illegal-in-the-united-states.htm>.

Kindstedt, Paul S. "Views on Raw Milk Cheeses: Why Raw Milk Cheeses Are Worth Saving." *Cheese Reporter*. 27 Aug. 2004. Web.

(kurt.grigg@virgin.net), By Kurt. "Cheese Production." *Index*. Web. 27 Nov. 2010. <http://www.milkfacts.info/Milk Processing/Cheese Production.htm>.

"Pasteurization." *Food Science | University of Guelph*. Web. 27 Nov. 2010. <http://www.foodscience.uoguelph.ca/dairyedu/pasteurization.html>.

"Pressing Cheese." *..:: Welcome to Leeners.com ::..* Web. 27 Nov. 2010. <http://www.leeners.com/cheese-about-pressing.html>.

"Raw Milk - Definition." *Dictionary, Encyclopedia and Thesaurus - WordIQ Dictionary*. Web. 27 Nov. 2010. <http://www.wordiq.com/definition/Raw_milk>.

Recipes, Published. "The General Cheesemaking Process." *Rick and Lynne Robinson Personal Web Site*. Web. 27 Nov. 2010. <http://www.rickandlynne.com/cheese/process/index.html#cooking>.

State, By. *Real Raw Milk Facts - Information on Raw Milk*. Web. 27 Nov. 2010. <http://www.realrawmilkfacts.com/#RawMilkFacts6>.

Project: 111810 JOE MOREDA 2

Question Number:1
Question Number:1
Question Type:Triangle
Question Title:Q#1
Design:T=2, K=3, B=120

Products

Products	Code	Name
Products	Code	Name
1 - 517	517, 662	Raw
2 - 989	989, 474	Pasteurized

Tabulated Results

Correct = Odd Sample Selected

Test 1 Samples -->	A=Sample 1 B=Sample 2
Test 1 Samples -->	A=Sample 1 B=Sample 2
Incorrect	7
Correct	41
Total	48
Confidence	1.000
Significance (p-value)	0.000

Triangle Test

Number of correct answers necessary to establish level of significance.

No. of Judgements		*	**	***
	10%	5%	1%	0.1%
No. of Judgements		*	**	***
	10%	5%	1%	0.1%
48	21	22	25	27

Project: JOE MOREDA 3

Question Number:1
Question Number:1
Question Type:Paired Comparison (Directional)
Question Title:Q#1
Design:T=2, K=2, B=120

Products

Products	Code	Name
Products	Code	Name
1 - 236	236	Raw
2 - 710	710	Pasteurized

Tabulated Results

Test 1 Samples -->	A=Sample 1 B=Sample 2
Test 1 Samples -->	A=Sample 1 B=Sample 2
Selected A	12
Selected B	34
No Preference/Difference	0
Total	46

Directional Paired Comparison

Minimum agreeing judgements necessary to establish significant differentiation.

No. of Judgements	10%	One * 5%	Sided ** 1%	*** .1%		10%	Two * 5%	Sided ** 1%	*** .1%
No. of Judgements	10%	One * 5%	Sided ** 1%	*** .1%		10%	Two * 5%	Sided ** 1%	*** .1%
46	28	30	32	34		30	31	33	35