Evaluating the Difference Between Organic Milk And Cheese and Inorganic Milk And Cheese Based On Sensory Perception

by

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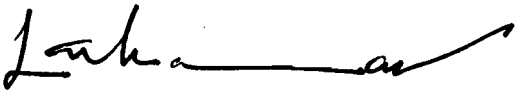

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ABSTRACT

The purpose of the study was to evaluate the difference between organic milk and cheese to inorganic milk and cheese based on moisture content, ash, protein, fat and sensory perception. For sensory analysis various attributes like color, flavor, aroma, sweetness, level/strength and overall likeness of both the products were tested. Results obtained were statistically analyzed. It was seen that the protein and fat content of organic and conventionally prepared milk and cheese was almost the same. Moisture content for milk samples were similar too but organic cheese showed a slight increase of about 7% moisture content as compared to inorganic cheese. The flavor perception in organic cheese was more significantly accepted than the inorganic cheese. However, inorganic milk was highly preferred over the organic milk in terms of flavor, sweetness, and overall likeness. Aroma of inorganic milk was also liked than organic milk, but the sweetness of both organic and inorganic cheese was almost similar showing no statistical

significance. Aroma of organic cheese was most preferred than inorganic cheese. Finally, the level/strength of organic cheese also was most preferred than inorganic cheese.

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Chapter 1: Introduction

According to National Agricultural Statistics Survey, there was a sharp increase in milk and milk products consumption during the first quarter of the year 2006 as compared to 2005. Milk could be defined as the lacteal secretion which is practically free from colostrums, and can be obtained by the complete milking of one or more healthy cows, sheep, goats, yak, water buffalo, horses or camels, and can be processed into dairy products like cream, butter, yogurt, ice-cream, whole milk, cheese, casein, whey protein lactose, condensed milk, and powdered milk (FDA, *2005*).

Milk production per cow averaged to1, 727 pounds for April, 2006 and 37% more compared to April 2005 production. The total cheese production excluding cottage cheese was 787 million pounds, 3% the above August 2005 production level, and 2.5% above July 2006 production level and the production of Italian type cheese totaled 331 million pounds, which showed a steep increase of 6.4% above August 2005 production and 4.1% above July 2006 production level.. The American type cheese production totaled 318 million pounds, which was 2.0 % above August 2006 production level, but 3.0 % below July 2006 production level. Production of frozen yogurt was 6.87 million gallons, which showed an increase of 11.8% as compared to August, 2005 production level. The two most popular single varieties of cheese in the United States are cheddar and mozzarella. Cheddar cheese production showed a major growth in 2006. Production of cheddar cheese was 274 million pounds in December 2006 as compared to the production in December 2005 which was 263 million pounds (National Agricultural Statistics Survey, 2006).

Milk, a natural liquid food, is one of the most nutritious complete foods, containing high-quality protein, fat, milk sugar, essential minerals, and vitamins in our diet (Smith, 1981). The amounts of butterfat (BF) and solids- non- fat (SNF) in the milk varies accordingly to time of year, breed of cow, and also the type of feed. There are several factors that can affect both the quality and flavor of milk. These include milking procedures, equipment, mastitis control, and antibiotic residues (Morgan, 1970). The amount of fat and the balance of proteins and total solids not only affect the flavor of the milk, but also texture and color. Flavor of milk is also influenced by the interaction of milk components during processing and storage. Flavor, texture, and color are all factors crucial to consumer choice and acceptance (Powell, n.d).

Cheddar cheese should contain a minimum milk fat content of 50 % and maximum moisture content should be 39 % wet basis. In the United States, cheddar cheese is made by pasteurizing raw, whole, low fat, or non-fat milk (Early, 1998). Under Federal guide cheese made from raw milk has to be aged for at least 60 days. If the milk is not pasteurized, the cheese is cured at a temperature of not less than 35° F (1.6°C) for at least 60 days (USDA, 2005). It is seen that pasteurization affects the flavor of the cheese as it has shown to increase the off-flavors of milk giving it a very cooked flavor (David, 1934). Different flavors of cheese are a result of blending milk from various mammals or their butterfat contents, or type of bacteria content (Kosikowski, 1997). Cheese are also classified as" soft", "semi-soft", "hard", "semi-hard" based on the texture and firmness (Lincourt, personal communication, 2006). These are important sensory attributes that influences perception and acceptance.

Sensory evaluation is the science of judging and evaluating the quality of a product by the use of human senses i.e. taste, smell, sight, touch and hearing (Meilgaard 1991). Conventional descriptive analysis has been used to characterize the attributes of liquid dairy products (Tuorila, 1986; Bom Frost et al., 2001). However, descriptive analysis also makes the subjects to utilize the same terminology and define each of these terms in the same way, thereby ignoring individual differences in perception. Additionally ranking tests were also applied to sensory panels in tests conducted to evaluate organic and in-organic milk (Zotos et al., 1999). The sensory attributes of both milk and cheese were measured using a likert scale and hedonic method of testing. Various parameters like color, flavor, aroma, strength and overall likeness of both the products were tested.

Organic Foods

Organic foods are those which do not involve the use of conventional pesticides, insecticides, herbicides, as well as fertilizers, or sewerage sludge and animals are reared without the use of antibiotics and growth hormones, plant growth regulators, live stock feed additives, and genetically modified organisms (USDA, 2005). Organic milk and cheese are produced without the use of any chemical additives, pesticides, fertilizers. Organic dairy farms also do not use artificial insecticides, fungicides, rodenticides, or herbicides on pastures where the cows graze. Consumption of organic dairy products is also dependent on the social, economic and religious aspects (Brown, 1998).

Definitions of Organic

The Organic Foods Production Act of 1990. (FDA.Part.205). This Act requires the Secretary of Agriculture to establish a National List of allowed and prohibited substances

which identify synthetic substances that may be used and the non-synthetic substances that cannot be used in organic food production and handling operations.

Labeling Organic Foods

Organic 100%. According to USDA's national organic standards, products labeled as "100 % organic "can only contain organically produced ingredients. Products containing 100% organic ingredients can display the USDA Organic logo and/ or the certifying agent's logo. To be labeled as "organic", 95% of the ingredients must be organically grown and the remaining 5% must come from non-organic ingredients that have been approved on the National List. These products can also display the USDA organic logo and/ or the certifier's logo. Food products labeled as "made with organic ingredients" must be made with at least 70% organic ingredients, three of which must be listed on the back of the package which is called Information panel and again, the remaining 30% of the non- organic ingredients must approved on the National List. These products may display the certifier's logo, on the Principal Display panel but not the USDA organic logo.

Statement of the Problem

Consuming organic foods is considered safe due to many health benefits. Official food composition tables, which when compiled by the US Department of Agriculture, reveal that since the 1940s the nutrient levels have declined substantially in conventional foods as a result of growing conditions. Researchers have also linked symptoms such as headaches, tremor, and lack of energy, depression, anxiety, poor memory, dermatitis, convulsions, nausea, indigestion and diarrhea with dietary intakes of pesticides (Diane, 2002). Organic milk and cheese products are produced without

substances that are reported to cause certain types of illness for example, growth hormones, chemical fertilizers, insecticides, herbicides and genetically modified organisms. With the growing organic industry especially dairy products very limited infrastructure is available to meet the sensory aspect of organic milk and cheese. There are many perceptions that the inorganic conventional milk and cheeses taste better than the organic milk and cheese. In this study organic milk and cheese were compared to inorganic milk and cheese. Proximate analysis was conducted to evaluate the difference in moisture, ash, protein, and fat content and sensory analysis of both the products with respect to color, flavor, aroma, sweetness, and level/strength and overall likeness.

Objectives

To evaluate the nutrients present in organic and conventionally prepared milk and cheese and compare the nutrients of both the products for sensory perception.

Limitations of the study

The limitation of the study was based on the subjective analysis of untrained panelists. Therefore the results could not be global representation of national population. Also because the age categories of the test population fell within the age range of 18-21 years old, this also limited the result of certain populations. Lack of equipment also hindered our intent to test extraneous matter.

Chapter 11: Literature Review

Introduction

This chapter will discuss various compositions and factors affecting the color, flavor, quality and other changes in milk and cheese. It will conclude with the factors that make organic farming different from conventional farming.

Milk Processing and Sensory characteristics

The production of beverage milks combines the unit operations of clarification, separation (for the production of lower fat milks), pasteurization, and homogenization. (Hui, 1993). While the fat content of most raw milk is 4% or higher, the fat content in most beverage milks are reduced to 3.4%. Lower fat alternatives, such as 2% fat, 1% fat, or skim milk (<0.1% fat) are also available (Early, 1998). Cow's milk by itself contains a number of vitamins, particularly group B vitamins like riboflavin, vitamin B12, vitamin B1 and vitamin A (Smith, 1981). Nutritional value is also dependent on the fat content of milk. Full-fat milk contains considerable quantities of vitamin A, B and D and calcium. Semi-skimmed or skimmed milk contain the same levels of proteins, calcium, magnesium, phosphorous, potassium and zinc and B vitamin as full-fat milk, but the amount of vitamin A and D is either halved or almost non-existent (Fox, 1992). Vitamin losses resulting from processing are offset by the addition of vitamins. During processing there is little physical or chemical change in the milk fat content and a denaturation of milk proteins; however the denaturation process does not affect their nutritional value (Harjinder, 2004). Milk's physical characteristics are also affected by several factors like the composition and processing conditions (Chandan, 1997). The characteristics of whole milk include appearance, color, texture, and mouth feel. Some of the flavor descriptions

include bitter, oxidized, cooked, astringent , buttery and sweet (Amerine,1965). Flavor is composed of aroma, taste, appearance and mouths feel. The flavor of pasteurized milk is more similar to that of fresh milk than that of Ultra high temperature milk as it is believed that UHT gives milk a very cooked flavor due to breakdown of sulfur groups. High heat treatment also reduces the oxidized flavor of milk due to increase in propanol and acetaldehyde which leads to a more cooked flavor that masks the oxidized flavor (Bassette et al., 1983). Studies done on milk have also shown that milk appears opaque by light scattered on fat globules. Beta-Carotene, which is a carotenoid precursurror of Vitamin A, present in milk fat is considered responsible for the creamy milk color, and the greenish color to milk is caused by riboflavin (Hui, 1993). Pasteurization also causes color changes to milk (Varnam, 1994). More intense heating also causes Maillard reactions to occur thereby resulting in brown pigments (Walstra, 1984). During homogenization, there is a tremendous increase in surface area and the native Milk Fat Globule Membrane (MFGM) is lost. MFGM also has casein micelles emulsifying proteins that reflect light and contribute to the white appearance of milk (Powell, n.d). In homogenized milk the fat particles are reduced in size and uniformly blended to prevent them from rising to the top in the form of cream (Hall, 1968). The exposed fat globules are briefly vulnerable to certain enzymes present in milk, which could break down the fats. Homogenized milk tastes blander but feels creamier in the mouth than unhomogenized; it is whiter and more resistant to developing off flavors (Early, 1998). Fat content also contributes to the perception of creaminess in dairy products. Creaminess is a highly integrated and complex perception that encompasses both flavor and texture sensations (Mela, 1988). A fundamental understanding of creaminess perception could be

obtained by decomposing creaminess into its underlying sensory components. Accomplishing this task has been difficult since changes in stimulus fat content simultaneously affect the texture of dairy products (Mela, 1988; Li et al., 1997; Richardson-Harman et al., 2000). The texture of dairy products can also be ascertained from tactile sensations produced in the mouth (Mela, 1998). These attributes also include slipperiness, greasy mouth feels (Tuorila, 1986), and creaminess and residual mouth feel (Bom Frost *et al.*, 2001). Kokini and Cussler demonstrated that texture perception in the mouth could be modeled as a mathematical function of thickness and smoothness (Kokini & Cussler, 1983). In fluid dairy products, the presence of small, even-sized fat globules coupled with adequate viscosity enhances the perception of creaminess (Richardson et al., 1993). The term creaminess is also used interchangeably to describe flavor and textural perceptions in dairy products.

Organic Milk

Organic milk is produced without the use of any chemical additives, pesticides, genetically modified organisms, artificial flavors, synthetic colors or preservatives, hydrogenated or partially hydrogenated oils, synthetic growth hormones (rBGH) and antibiotics. The use of these ingredients was prohibited by the USDA (USDA, 2005). Specifically, cows are raised on 100% certified organic feed for at least one year before producing certified organic milk . Certified feed and pasture are grown on land which is also not treated with synthetic fertilizers or pesticides for a minimum of three years and cows are kept in good health by giving them certified organic feed (Emsley, 1994). Organic animals and feeds must also not be genetically modified organisms (GMO) or products from GMO. Milks are tested for antibiotics, temperature, and bacteria when

supplied to processing plants. Organic milk processing plants are inspected for compliance to see that an organic product is not mixed with conventional product, non-conforming ingredients, or cleaning materials. Pasteurization and homogenization process is the same for both inorganic as well as organic milk.

Inorganic Cheese

Cheese making can be described as the process of removing water, lactose, and some minerals from milk to produce a concentrate of milk fat and protein. It contains essential milk solids, water, rennet (to coagulate milk), bacterial cultures (to acidify the milk and curds and to get desirable characteristics), salt, and sometimes calcium chloride. Calcium chloride is sometimes necessary in order to compensate for the loss of the free calcium in the milk resulting from the pasteurization process. Cultures like bacteria, molds, and yeasts play a major role in developing acidity and ripening process (Potter, 1995). Bacteria also play a very important role in defining the texture and flavor of most cheeses (Early, 1998). Flavor of cheese are also due to milk used from different mammals, i.e. cows, goats, sheep, water buffalo, processing treatments, ageing and the use of flavoring agents like herbs, spices, or wood smoke. Pasteurization of milk may also affect the flavor of cheese. Ultra High Processing gives milk a cooked flavor that is caused by the breaking down of sulfur groups in whey proteins .The yellow to red color of many cheeses is due to adding annatto (David, 1934). Annatto is usually added to cheese during processing to achieve the yellow reddish color. Yellow color is supposed to make the cheese look attractive. As cheddar cheese matures, a variety of chemical processes take place. The taste of matured cheese is related to the concentration of several chemicals in the final product. Harder cheese has lower moisture content than soft

cheese. Salt also gives taste to the cheese and the amount of salt to add varies, and is between 1% and 3% by weight. Flavor compounds in cheese are also formed due to the degradation of milk components like lactose, citrate, milk lipids and milk proteins which are also called caseins during ripening or ageing (David, 1934). Mild cheddar is generally aged for 1-2 months, but sharp cheddar can age for a year or more. Aging time depends on the type of cheddar being made (Aston, 1998). The physicochemical parameters like pH, water activity, and salt concentration in cheese are responsible for texture and flavor inconsistencies (Steijns, 2001). Lactose causes cheese to brown as it is cooked (Foremost Farms, 2006). Proteases from the coagulant and dying bacteria attack the protein, breaking it down into peptides and amino acids, lipases from the bacteria which break down the fat into fatty acids. As a result, the texture becomes softer and less elastic and the characteristic cheddar flavors develop (Hui, 1993).

Organic cheese

Organic cheese is made from organic milk and is free from artificial ingredients, such as coloring or flavoring. Milk used in organic cheese making is free from antibiotics, synthetic hormones or pesticides (Organic valley, 2006). In organic cheese, the enzyme rennet (used to clot the protein in the milk) is not genetically engineered or animal derived. Only vegetable rennet or rennet made from naturally occurring fungi is used in organic cheese making (OTA, 2006). Cows are fed with certified organic feed and they graze on certified organic pastures which only contain natural fertilizers and cheese is made with strict USDA organic standards (Paull, 2006).

Organic Farming

In the United States, agricultural products that claim to be "organic" must adhere to the requirements of the Organic Food Production Act of 1990 found in (U.S.D.A, 6501-22) and the regulations found in (USDA, Part 205) promulgated by the USDA through the National Organic Program ("NOP") act. These laws essentially require that any product that claims to be organic must have been manufactured and handled according to specific NOP requirementsIt relies on crop rotation and residues of the crop. Soil fertility and crop nutrients are mainly managed through tillage and cultivation practices, crop rotations, and cover crops are supplemented with manure and crop waste materials. Crop pests, weeds, and diseases are controlled through physical, mechanical, and biological methods (Emsley, 1994). Extensive studies when done on the quality of milk have shown that flavor also depends on the fat content, breed of the cow, feeding pastures, and also the pasteurization (Zotos et al., 1999). There are also claims that there is a "noticeably sweet and clean flavor" attributed to organic milk (Brown, 1998). Some cultures have been farming organically for centuries, thus leading to its development consciously in Central Europe and India in the early twentieth century (Paull, 2006). The labeling requirements of organic foods are based on the percentage of organic ingredients in a product. Agricultural products which are to be labeled as 100% organic must contain only organically produced ingredients excluding salt and water. Products to be labeled as "Organic" must contain at least 95% and products which are labeled as "made with organic ingredients" must contain at least 70% of organic ingredients.

Sensory Evaluation

Sensory evaluation is the science of judging and evaluating the quality of a product by the use of human senses i.e. taste, smell, sight, touch and hearing (Meilgaard 1991). It is used as a practical application in product development by aiding in product matching, improvements, and grading as well as research. Sensory analysis is divided into two methods, subjective and objective testing. Subjective tests involve objective panelists, while objective testing employs the use of mechanical instrumentation. Both tests are essential in sensory evaluation and necessary in a variety of conditions (Meilgaard, 1991). One of the subjective tests is the use of the Hedonic scale method. The objective of this method is to measure the level of liking for a product using a hedonic scale. Hedonic testing relates to degree of the magnitudes of like or dislike of the samples. Samples are presented in succession to the subject is to evaluate how much he likes or dislikes the product (Amerine, 1965). Hedonic testing is used with untrained people as well as with experienced trained panel members (Mahony, 1986). The instructions to the panelist are restricted to procedures, and no attempt is made at direct response. A separate scale is provided for each sample in a test session. The scales may be grouped together on a page, or on separate pages (ASTM, 1968). The Hedonic scale is anchored verbally with nine different categories ranging from like extremely to dislike extremely. These phrases are placed on a line-graphic scale either horizontally or vertically. Many different forms of the scale may be used with success, however variations in the scale form is likely to cause marked changes in the distribution of responses and ultimately in statistical parameters such as means and variances (ASTM, 1968). Hedonic ratings are converted to scores and ranked based on the analysis of

variance. The ratings labels obtained on hedonic scale may be affected by many factors other than the quality of the test samples. Factors such as character of the subjects, the test situation, attitudes or expectations of the subjects can all have a profound affect on results and a researcher must be cautious about making inferences on the bases of comparison (ATSM, 1968). Determining the type of research that is being done, and the type of evaluation that is needed is very crucial in obtaining accurate results from a sensory project. Consumer's acceptance of organic milk and factors affecting their eating habits can be determined by different methods (Brown, 1998). Ranking tests is also applied to sensory panels to evaluate organic and in-organic milk samples (Zotos et al., 1999).

Chapter 111: Methodology

Materials

Whole milk and medium cheddar cheese samples were brought from the grocery store and stored under refrigeration conditions until the experiments were conducted.

Chemical Analysis

Moisture Determination: Moisture content determination was based on AOAC 926.08 method for milk and cheese

A known amount of sample (2 g) was weighed in aluminum pans and placed into a traditional mechanical oven (Figure1) and then set at 70°C for 24 hrs. After drying, the sample was removed and placed in a dessicator to cool. The moisture content was determined by the following relationship (Equation 1)

$$Moisture\ Content(MC)_{wet\ basis} = \frac{Weight\ of\ the\ sample\ \ before\ drying - wt\ \ of\ \ the\ \ sample\ after\ drying}{Wt\ \ of\ \ the\ sample\ before\ drying} x100 \quad (1)$$

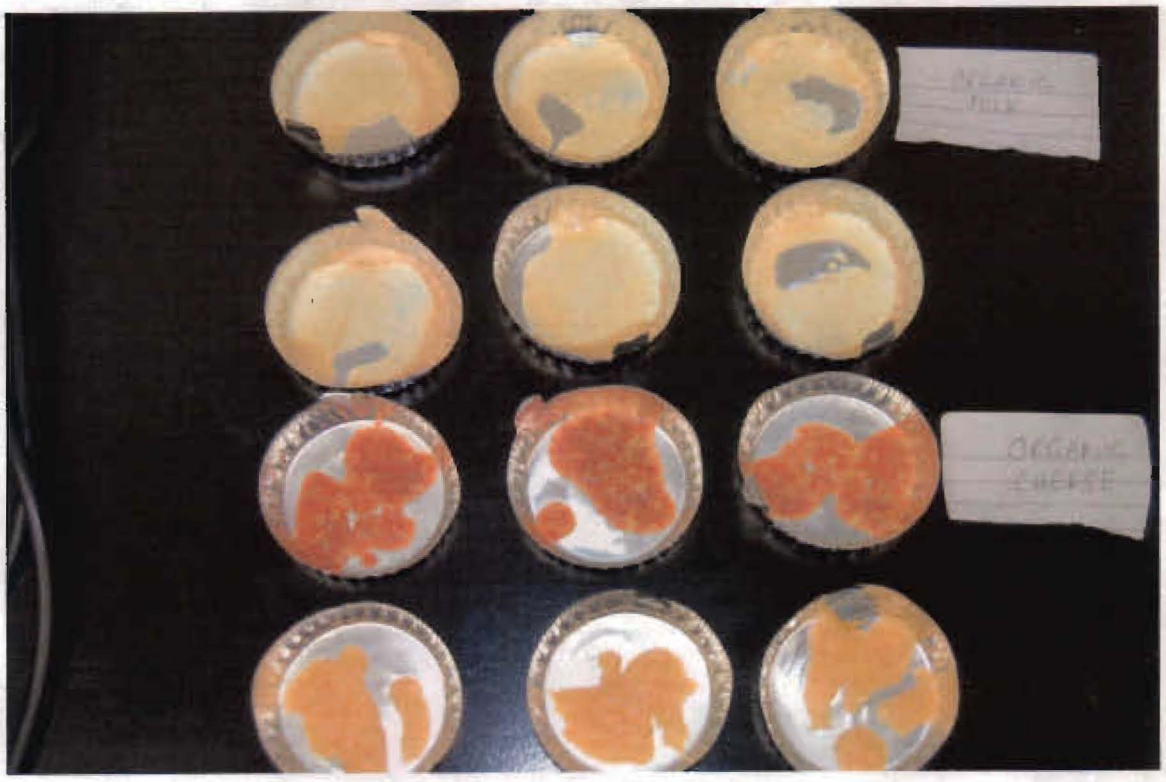


Figure1: Moisture analysis for liquid milk and cheese at 70°C

Ash Determination: AOAC 900.02 method

A sample weighing approximately 3 g was taken in a crucible and placed onto a muffle furnace and incinerated at 575°C for 24 hrs (Figure 2). It was then placed in a dessicator for cooling and then re-weighed. The initial and final weights of the sample were taken. The obtained ash weight was divided by original sample weight and expressed in percent. The ash content was determined by the following relationship (Equation 2)

$$\%\ ash\ (dry\ basis) = \frac{wt\ after\ ashing - tare\ wt\ of\ crusisble}{original\ sample\ wt \quad x \quad dry\ matter\ coefficient} \qquad (2)$$

Figure2: Muffle furnace used for ash determination of organic milk and cheese

Fat Extraction

Fat extraction was done using Accelerated Solvent Extractor (ASE). Using a pestle and mortar the sample was finely ground to small particles. Diatomaceous earth of 2g was added to an 11 mL extraction cell of ASE containing cellulose filter. Whole milk sample of 1 g was weighed and added from a plastic syringe onto the bed of ASE prepared diatomaceous earth and screwed tightly. The cells were loaded onto the tray base and extracted. Solvent used for extraction was petroleum ether and isopropanol

in the ratio 2:1 for milk and hexane and isopropanol with a ratio of 2:1 for cheese. The extraction temperature was 120°C with a pressure of 15000 psi (Figure 3).The oil got after extraction was passed through a nitrogen stream until the oil content evaporated off leaving only traces of solid fat residues. The fat residues obtained were then placed in a traditional mechanical oven for 1 hr at 70° C, cooled in a desiccator and re-weighed again. The fat content was determined by the following relationship Equation (3).

$$Fat\ content = \frac{weight\ of\ the\ sample - weight\ of\ the\ oil}{weight\ of\ the\ sample} \qquad (3)$$

Figure3: Accelerated solvent extractor used for extracting crude fat for organic milk and cheese

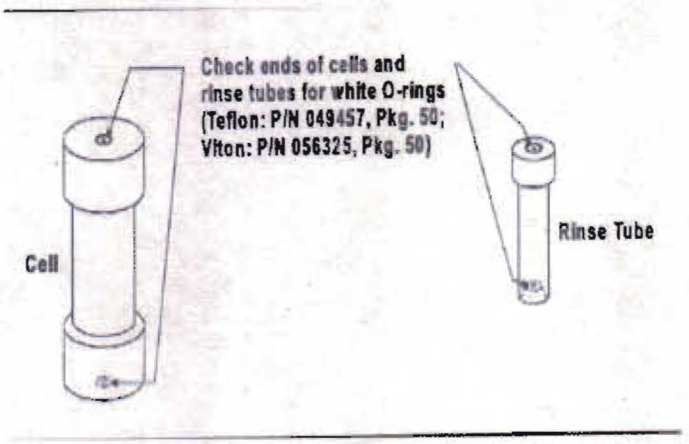
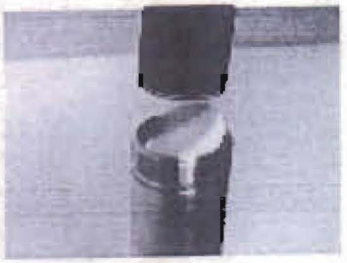


Figure 4. The cell for holding samples.
Note the Dionex logo etched on the body should be at the top.

Position the insertion tool over the filter:



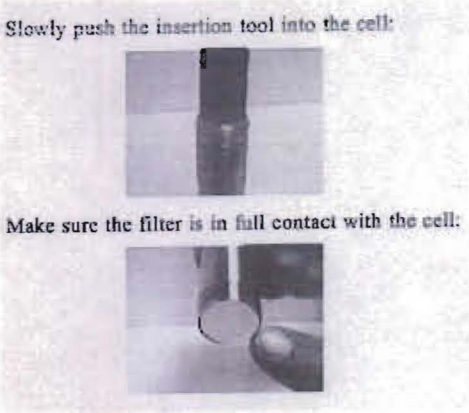


Figure 5. Installation of the filters prior to loading samples.

Protein Determination

Determination of protein was based on the AOAC 920.11. Kjeldahl method for both milk as well as cheese. The process was carried out in two stages. The samples were first digested and then distilled.

Digestion. Approximately 5 mL of warm milk sample which was heated to 38°C was weighed and placed in a kjeldahl flask containing 15 gm of potassium sulphate, 1ml copper sulphate, 8-10 boiling chips and 25 mL of sulphuric acid. The sample mixture in the flask was then heated for 3 h on the kjeldahl digester as shown in Figure 6 until it turned colorless and was subsequently allowed to cool to room temperature. For cheese it was 1 g of the sample. The digest was diluted with 300 mL water and 50 mL of boric acid. A known amount (75 mL) of 50 % sodium hydroxide was also added to the flask and mixed thoroughly. The mixture was then distilled immediately on the apparatus shown in Figure 7.

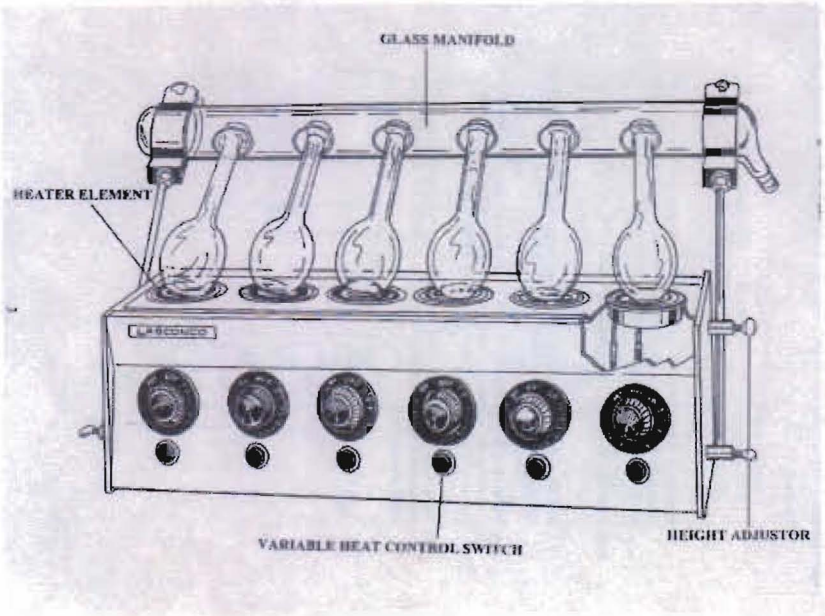


Figure 6: Kjeldahl digestor for protein estimation of organic milk and cheese

Distillation. After turning on the condensing water, a known aliquot (50 mL) of the digested sample thoroughly mixed with 75 mL of sodium hydroxide, 300 mL water and 50mL of boric acid was transferred to the sample addition funnel of the Rapid Distillation Apparatus and then introduced into the sample chamber. The ammonia released was entrapped in a receiving solution containing boric acid with bromocresol green/ methyl red indicator until the blue color appeared which took about three minutes. The solution was then titrated with 0.1 N HCl acids until the first traces of pink appeared and the readings taken. Protein % was determined by the following relationship shown in Equation 4.

$$(\%)N = \frac{mL\,(HCL)\,x\,(N\,HCL)x(0.014)}{g\ of\ sample} x \quad 100 \qquad (4)$$

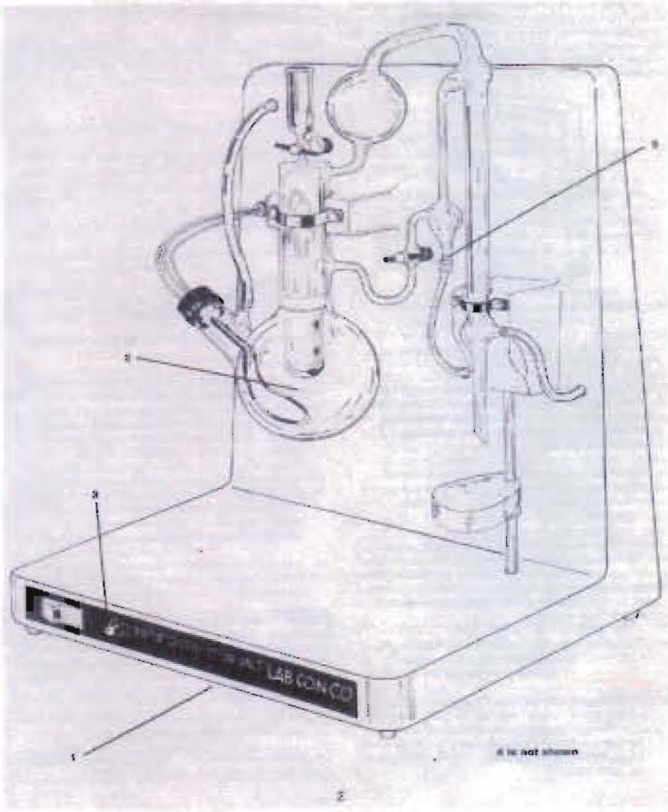


Figure 7: Distillation unit used for protein estimation of organic milk and cheese

Sensory Evaluation

Sensory panelists consisted of 140 people; all are University of Wisconsin-Stout, students. The following parameters were tested color, flavor, aroma, texture, level/strength, sweetness and final acceptability of both the milk and cheese products based on their preferences. Sensory analysis was done after getting an approval from IRB (Institutional Review Board). They were asked to taste organic as well as conventionally prepared milk and cheese based on the questionnaire. Precautionary methods were taken to verify that the participants were above 18 years of age and were not lactose intolerant or allergic to dairy products. This was done using a recruiting questionnaire. After confirming their eligibility, the subjects were asked to take the sensory test to rank their

likeness in order of preference. The sensory test done was an effective test where they ranked the most acceptable product according to their preference. The products were assigned a number/code and the data obtained was statistically analyzed as shown in table 1.

Table 1: Sample used and no assigned for sensory testing

Sample	Assigned Code Number
Organic milk	343
Inorganic milk	456
Organic Cheese	546
Inorganic Cheese	623

Questionnaire

Name:

Date:

(Name will be assigned coded number for data analysis)

Instructions: In this experiment you will be given samples of various samples of milk and 2cheese. Please answer all the questions for each of the milk and cheese samples after tasting the sample. Remember to rinse your mouth before tasting each sample.

Milk sample 343

1. How much do you like the product for sweetness?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

2. How do you like the flavor of this product?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

3. How do you like the color of this product?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

4. How do you like the aroma?

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like

Extremely Extremely

5. Please re-taste the sample, if needed and indicate the level/strength of the characteristics

0 1 2 3 4 5 6 7 8 9 10

Dislike Like

Extremely Extremely

Milk Sample 456

1. How much do you like the product for sweetness?

0 1 2 3 4 5 6 7 8 9 10

Dislike Like

Extremely Extremely

2. How do you like the flavor of this product?

0 1 2 3 4 5 6 7 8 9 10

Dislike Like

Extremely Extremely

3. How do you like the color of this product?

0 1 2 3 4 5 6 7 8 9 10

Dislike Like

Extremely Extremely

4. How do you like the aroma?

0 1 2 3 4 5 6 7 8 9 10

Dislike Like

Extremely Extremely

5. Please re-taste the sample, if needed and indicate the level/strength of the characteristics

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

Cheese Sample 546

1. How much do you like the product for sweetness?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

2. How do you like the flavor of this product?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

3. How do you like the color of this product?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

4. How do you like the aroma?

0	1	2	3	4	5	6	7	8	9	10
Dislike Extremely										Like Extremely

5. Please re-taste the sample, if needed and indicate the level/strength of the characteristics

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like
Extremely										Extremely

Cheese Sample 623

1. How much do you like the product for sweetness?

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like
Extremely										Extremely

2. How do you like the flavor of this product?

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like
Extremely										Extremely

3. How do you like the color of this product?

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like
Extremely										Extremely

4. How do you like the aroma?

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like
Extremely										Extremely

5. Please re-taste the sample, if needed and indicate the level/strength of the characteristics

0	1	2	3	4	5	6	7	8	9	10
Dislike										Like
Extremely										Extremely

Chapter IV: Results and Discussion

The moisture content, ash, fat, protein, and carbohydrates content in organic and inorganic milk, cheese respectively were indicated based on the proximate analysis and the results are discussed as follows.

Proximate analysis:

Moisture content. The results of moisture analysis are showed in figure 6. The total moisture content for organic milk was (M= 0.88, SD = 0.01) and inorganic milk had moisture content (M= 87.96, SD= 0.03). Organic cheese showed a slight increase of about 7% moisture content as compared to inorganic cheese. Organic cheese had a moisture content (M=38.39, SD=0.51) and inorganic cheese had a moisture content (M= 30.63, SD = 0.36). Rodriguez et al, (1997) stated that milk composition varies according to season, breed and also the feed of the animals. He observed that there was a reduction in moisture content, fat and protein during summer season due to hot weather. According to literature milk is made up of 87.4% water and 12.6% milk solids, 3.7% fat, and 3.4 % protein, 4.8% lactose and 0.7% minerals (Chandan , 1997).

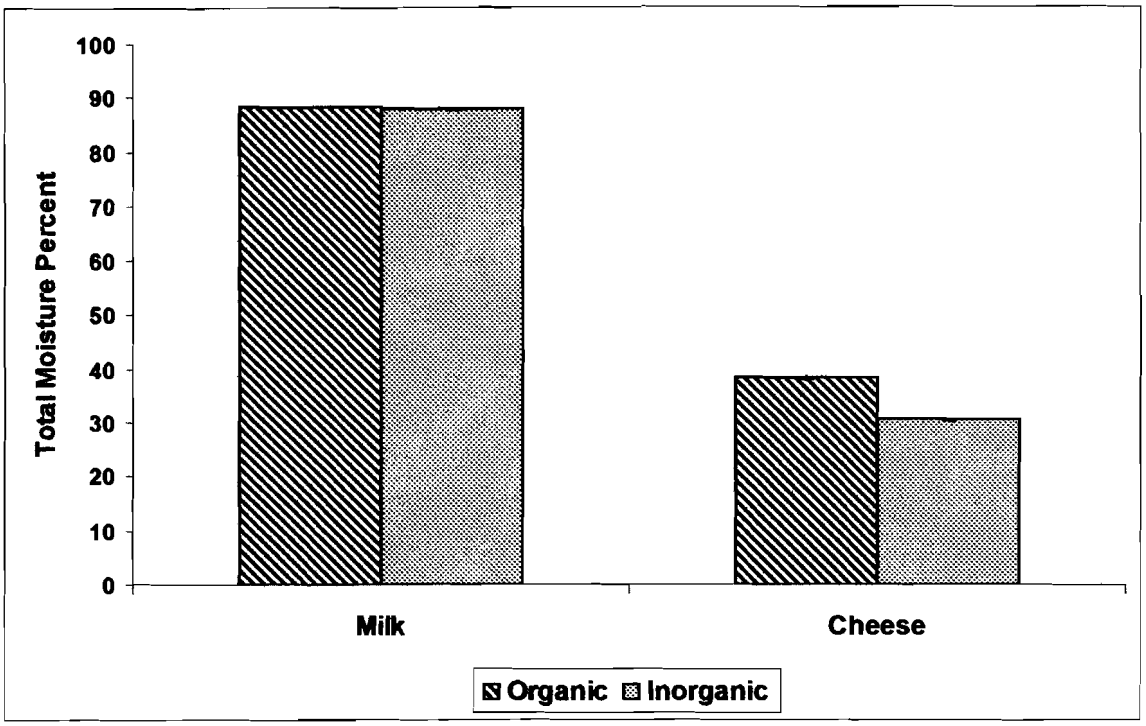


Figure 6: Total moisture content of organic and inorganic milk and cheese respectively determined by oven method.

Ash content. There was a difference in total ash percent of organic and inorganic milk and cheese. Organic milk had ash content of (M= 6.32, SD = 0.19) and inorganic milk (M=5.93, SD= 0.09). Organic cheese had ash content (M= 6.09, SD=0.02) in comparison to inorganic cheese which had (M= 5.69, SD =0.008). The widely reported value for ash is 0.7% (Jensen, 1995; Chandan, 1997; Fox, 1992). There are indications that our results were skewed from the actual reported values. This could be attributed to the method we used. Steam bath was absent from our method, that may have contributed towards the error. In steam bath method calcium and carbon content in milk and cheese are evaporated when the product is evaporated to dryness, hence resulting in lower ash content. However, the ash content can be associated with the mineral content in the sample. This indicates that organic sample is rich in minerals.

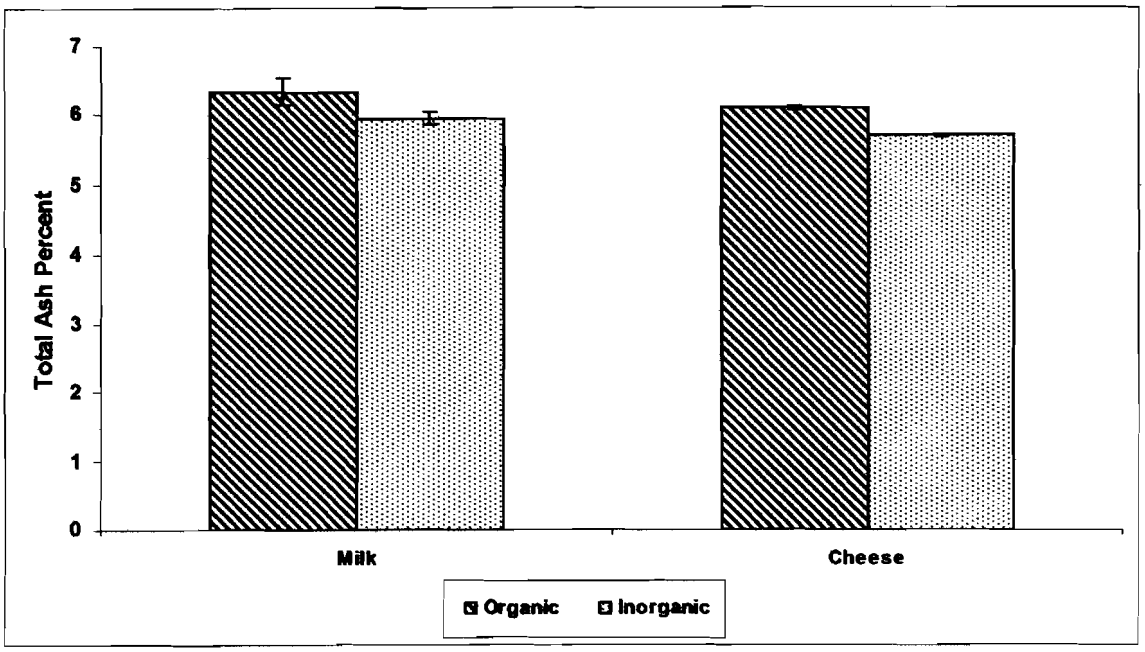


Figure 7: Total ash content of organic and inorganic milk and cheese respectively determined by dry method.

Protein content. The total protein content of organic and inorganic milk and cheese appeared to be same. Organic milk had (M=3.38%, SD= 0.01) of protein and inorganic milk had (M=3.36%, SD= 0.02). Organic and inorganic cheese had protein content of (M=23.05%, SD =0.14) and (M=22.93%, SD =0.22) protein percent respectively. (Diane, 2002) also reported the same protein and fat content values for both the organic and conventional milk.

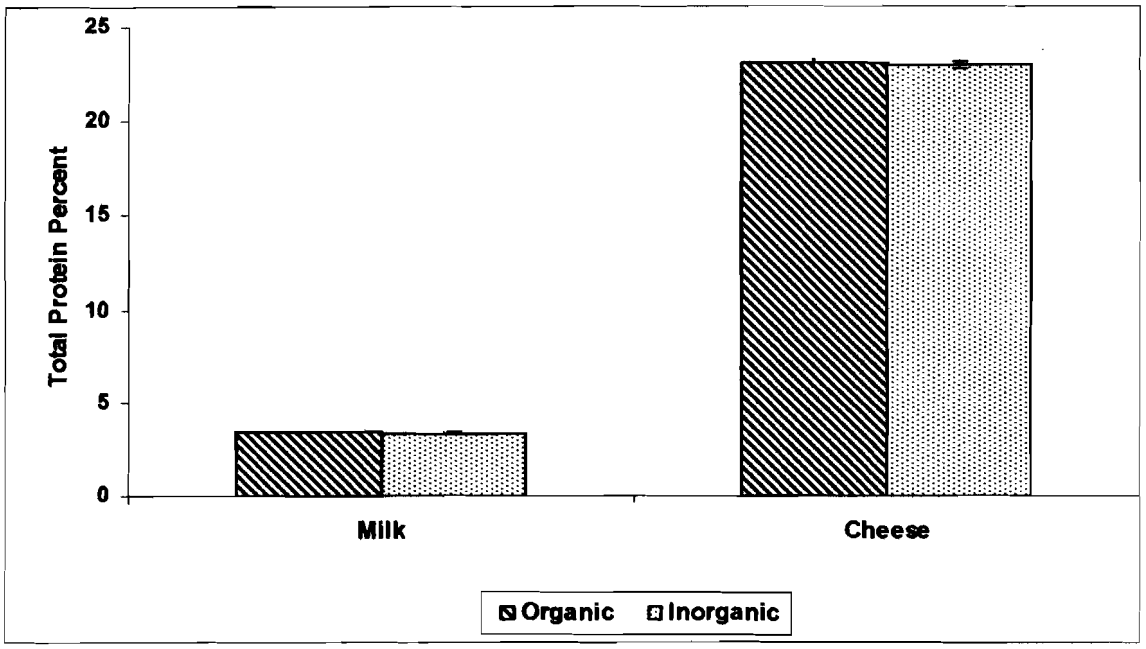


Figure 8: Total protein content of organic and inorganic milk and cheese respectively determined by kjeldahl method.

Fat content. There was no significant difference in fat values of organic and inorganic milk and cheese. Organic milk had (M=3.57%, SD= 0.09) fat percent in comparison to inorganic milk which had (M=3.52%, SD= 0.05) percent. The fat percent of organic and inorganic cheese was (M=30.34%, SD =0.58) and (M=30.45%, SD=0.29) percent respectively.

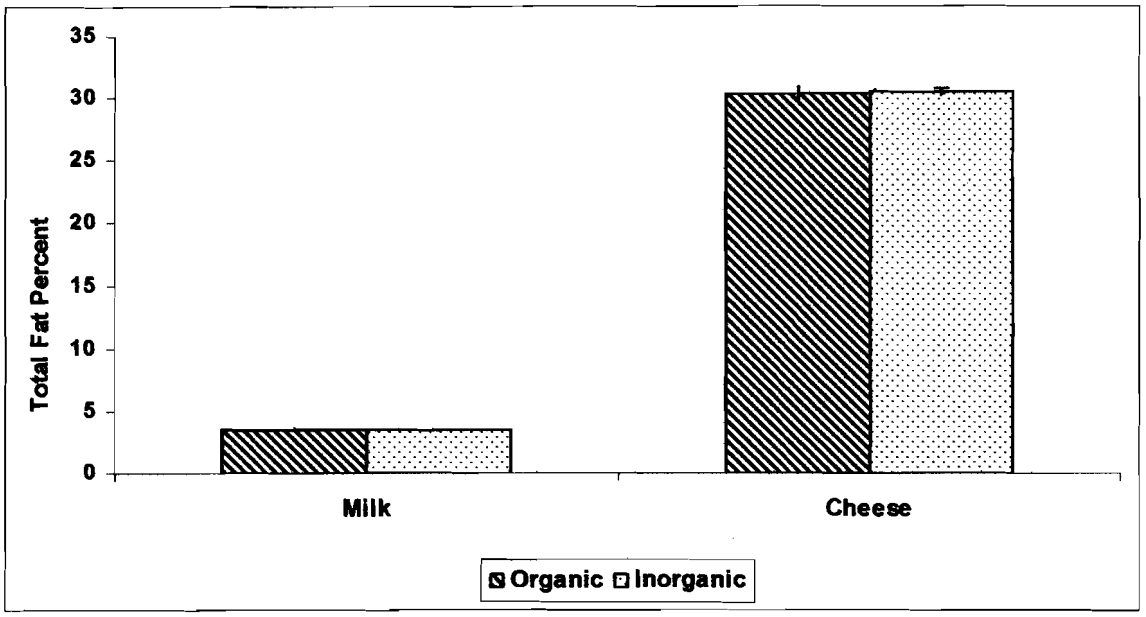


Figure 9: Total fat content of organic and inorganic milk and cheese respectively determined by accelerated solvent extraction method.

Carbohydrate content. The carbohydrate content was estimated based on the summation of moisture content, ash, fat and protein content. Since the result of ash analysis was erroneous based on dry method, this subsequently affected the carbohydrate content. . In this study organic milk had no carbohydrates present whereas inorganic milk had 0.02 % of carbohydrates percent. Organic cheese had 0.03% carbohydrates in comparison to inorganic cheese which had 0.13 %. Jensen et al (1995) stated that milk contains approximately 4.9 % of carbohydrates and one ounce of cheese contains approxiamately 0.4 g of carbohydrates.

Table 2: The result of the hedonic scores for sensory analysis results for milk

Hedonic Scale rating	Organic Milk Mean Value (Std. dev)	Inorganic Milk Mean Value (Std. dev)	t-test	DF	Significant level (P-Value)
Overall Likeness	5.76 (2.709)	7.09 (2.158)	-6.727	137	0.001***
Sweetness	5.36 (2.799)	6.26 (2.033)	-3.874	136	0.001***
Flavor	5.40 (2.929)	6.90 (2.121)	-6.567	137	0.001***
Color	7.23 (2.156)	7.54 (2.047)	-1.851	137	0.066^{ns}
Aroma	6.05 (2.337)	6.64 (2.085)	-3.065	136	0.01**
Level/Strength	5.94 (2.657)	6.50 (2.189)	-2.369	130	0.05*

**** Very highly significant statistical at $p<0.001$; *** Highly Significant at $p<0.01$; ** Significant at $p<0.05$; * Not significant (ns)

Sensory analysis

The sensory analysis was conducted on 140 panel members and the results are tabulated in Table 2. Based on preference test, the panel seems to like the inorganic milk (M= 7.09, SD= 2.158) as compared to organic milk (M=5.76, SD=2.709). The statistical analysis of the overall participants was highly significant ($p<0.001$). The mean of color for organic and inorganic milk was (M= 7.23, SD= 2.156) and (M=7.54, SD = 2.047). This showed no noticeable color difference ($p<0.05$) between the organic and inorganic milk. The results were not surprising because there was difference in likelihood of the products and the tasting panelists. Sweetness and flavor of inorganic milk was most highly significantly acceptable than organic milk($p<0.001$). Aroma of inorganic milk was also highly significantly acceptable than organic milk($p<0.01$). Wright, et al (2000) in his studies observed

that inorganic milk was more likeable than organic milk because of the appearance and taste which could be attributed to the difference in animal feed as well as processing. Studies were also conducted among the Greek and British panelists to know their preference for organic and conventionally prepared milk . Sensory analysis of milk revealed that there were no significant differences ($p>0.01$) in the taste (sweetness, freshness), odor, flavor or acceptance of neither organic or conventional samples(Zotos et al, 1999). There was a significant difference ($p<0.01$) in color which was measured using a colorimeter. (Saba et al, 1998) in her studies observed that organic milk was more preferred and this was linked to the availability of produce and the knowledge and awareness of organic foods.

Table 3. The result of the hedonic scores for sensory analysis results for cheese

Hedonic Scale rating	Organic Cheese Mean Value (STdv)	Inorganic Cheese Mean Value (STdv)	t-test	DF	Significant level (P-Value)
Overall Likeness	7.46 (2.33)	7.05 (2.235)	1.999	137	0.05*
Sweetness	5.83 (2.286)	5.66 (2.381)	0.889	137	0.376^{ns}
Flavor	7.35 (2.216)	6.94 (2.520)	1.729	135	0.086^{ns}
Color	7.52 (2.23)	7.72 (1.929)	-1.171	137	0.224^{ns}
Aroma	7.01 (2.092)	6.60 (2.292)	2.242	138	0.05*
Level/Strength	6.44 (2.378)	6.03 (2.522)	2.269	132	0.05*

** Significant at $p<0.05$; * Not significant (ns); DF= Degree of freedom; t = t statistics

The sensory analysis test results for cheese are tabulated in Table 3. Based on panel test organic cheese was most preferred for overall likeness (M= 7.46, SD= 2.33) in comparison to inorganic cheese (M= 7.05, SD= 2.235). There was noticeable differences ($p<0.05$) between the organic and inorganic cheese. Sweetness of both organic and inorganic cheese was almost similar showing no statistical significance ($p>0.05$). Flavor of organic cheese was most significantly acceptable than inorganic cheese ($p<0.05$). There was no statistical significance ($p>0.05$) in color acceptance of organic and inorganic cheese. Aroma of organic cheese was most preferred than inorganic cheese ($p<0.05$). Finally, the level/strength of organic cheese was most preferred than inorganic cheese at ($p<0.05$) also showing 95% confidence interval. From the above results it is concluded that organic cheese is most preferred than inorganic cheese which is not surprising based on our hypothesis.

Chapter V: Conclusions

Both organic and inorganic milk and cheese samples were taken and nutritionally analysed .Results of this study was analyzed based on the results obtained from various tests. Tests were done for moisture analysis, ash, fat, and protein estimation, and sensory evaluation. All the experiments were done triplicate and mean values taken. Based on the given tables and graphs the composition of total solids, moisture content, protein and fat % of organic and conventionally prepared milk was almost the same. Organic cheese showed a slight increase of about 7% moisture content as compared to inorganic cheese. Sensory tests was based on hedonic scale method of testing and various parameters like color, sweetness, flavor, strength, aroma and overall likeness of the product were taken into consideration and the results were statistically analyzed. The analysis revealed no significant difference ($p>0.05$) in color for milk and cheese. The flavor perception in organic cheese was more significantly acceptable ($p<0.1$) than the inorganic cheese. However, inorganic milk was very highly significantly acceptable ($p<0.001$) over the organic milk in terms of flavor. Sweetness, flavor, and overall likeness of inorganic milk was most highly significantly acceptable than organic milk ($p<0.001$). Aroma of inorganic milk was also highly significantly acceptable than organic milk ($p<0.01$). Sweetness of both organic and inorganic cheese was almost similar showing no statistical significance ($p>0.05$). Aroma of organic cheese was most preferred than inorganic cheese ($p<0.05$). Finally, the level/strength of organic cheese also was most preferred than inorganic cheese showing ($p<0.05$).

Recommendations for Further study

Nutritional analysis was done on a very general level to compare the nutrients of both the milk and cheese products. Further research is recommended to compare the vitamins and minerals, nitrate level contents, and presence of extraneous matter have to be done on a minute level. Sensory tests should also be conducted on unpasteurized organic farm milk as well as for the presence of extraneous matter.

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APPENDIX A

Recruiting Questionnaire

Recruiting Questionnaire

We are conducting a sensory evaluation test to know your preferences of organic and conventionally prepared milk and cheese and would like to have your feedback to know if you would be willing to take the test. Your names provided will only be used to match with the survey. The survey data will be coded so your responses will not be able to be identified hence maintaining confidentiality. Please read the questions and answer carefully. Your cooperation is greatly appreciated.

1. How old are you?

a) Less than 18 years b) Above 18 years of age

2. Are you lactose intolerant?

a) Yes b) No

3. Do you like milk?

a) Yes b) No

4. Do you like cheese?

a) Yes b) No

5. How often do you eat milk products?

a) Once a day

b) Twice a day

c) Occassionally

d) Once a week

e) 2-3 times a day

f) Never

6. Do you like organic milk and cheese?

a) Yes b) No

7. Do you like inorganic milk and cheese?

a) Yes b) No

8. If no, would you like to participate in the survey?

a) Yes b) No

If yes, based on the information given, on the consent to participate in the UW-Stout approved research and the questionnaire asked, I have agreed to participate in the survey at my own free will and have declared that milk products are safe and that I am not lactose intolerant.

APPENDIX B

ORGANIC STANDARDS

Organic production

Organic production systems emphasize proactive, knowledge- based management, on-farm resources, and working with nature. For example, diverse crop rotation interrupts most insect pest problems, thereby reducing the need for pests control products.

Organic production systems are designed for

1. Promoting maximum biological activity in the soil.
2. Maintain long-term soil health and minimize soil erosion.
3. Improve the genetic and biological system and its surroundings.
4. Provide livestock with optimal living conditions for health and well- being.
5. Recycle materials of plants and animal origin, return nutrients to the land, and minimize the use of nonrenewable resources.

Organic Certification

Organic certification verifies from country to country and involves a set of production standards for growing, processing, packaging, storage and shipping. Organic certification includes:

1. Avoidance of pesticides, fertilizers, antibiotics, food additives, and genetically modified organisms.
2. Use of farmland that has been free of chemicals for at least three years.
3. Keeping a detailed written production and sales records.
4. Undergoing periodic onsite inspections.
5. Maintaining a strict physical separation of organic products from non-certified products.

Organic Standards and the Organic USDA seal:

The new USDA regulations went into effect on October 21, 2002, thereby governing the labeling to foods using organic agriculture. Food products that contained that contained atleast 95-100% certified organic ingredients can use the USDA organic seal.(Organic Valley,2006). Organic standards also require:

1. Preventative health care practices such as adequate feed, nutritional supplements, sanitary housing, and freedom of movement to the animal.
2. Prohibits withholding of medical treatment in case of illness to the animal.
3. Access to outdoors and also accommodate the natural behavior of the animal.