Effect of acids on sensory, chemical, and physical characteristics of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk

By

Mr. Samatcha Krungkaew

ID. 4918737

A special project submitted to the Faculty of Biotechnology, Assumption University in part of fulfillment of the requirement for the degree of Bachelor of Science

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Title	: Effect of acids on sensory, chemical, and physical characteristics of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk
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Level of Study	: Bachelor of Science
Department	: Food Technology
Faculty	: Biotechnology
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Napida S. Advisor

(A. Napida Supbornsug)

Abstract

Ricotta cheese was produced by using three types of milk that were cow's milk, goat's milk, and buffalo's milk, and four types of acid that were acetic acid, citric acid, malic acid, and tartaric acid. Yield of ricotta cheese made from cow's milk and buffalo's milk using acetic acid had the highest value, whereas yield of ricotta cheese made from goat's milk was not significant different among four acids used. Fat and protein of ricotta cheese made from cow's milk using tartaric acid had the highest value, whereas fat and protein of ricotta cheese made from goat's milk using acetic acid had the highest value. Ash, lactose, moisture content, pH, and titratable acidity of ricotta cheese made from cow's milk were significant different among four acids used ($P<0.05$). Lactose, moisture content, titratable acidity of ricotta cheese made from goat's milk were significant different among four acids used ($P<0.05$). Fat, protein, and titratable acidity of ricotta cheese made from buffalo's milk were significant different among four acids used ($P<0.05$). The increasing fat content in ricotta cheese made from cow's milk resulted in decreasing hardness in the cheese. Ricotta cheese made from cow's milk and goat's milk using acetic acid had the highest value of hardness and the lowest value of adhesiveness among four acids used. Ricotta cheese made from buffalo's milk using citric acid had the highest value of hardness. Taste of ricotta cheese made from cow's milk was significant different among four acids ($P<0.05$). Sensory properties of ricotta cheese made from goat's milk and buffalo's milk were not significant different.

Acknowledgement

This study was carried out at the Department of Food Technology, Faculty of Biotechnology, Assumption University. A. Napida Supbornsug offered me a great opportunity to study the effects of acids on chemical and physical characteristics of ricotta cheese. She gave me suggestions and helped me solving some problems occurring during doing the project to complete the project on time. Therefore, I am grateful to her for all help and suggestions.

I also sincerely thank Asst. Prof. Dr. Wunwisa Krasaekoopt and A. Nootrudee Siriboon for their support during my studies. Both of them guided me on chemical and physical analysis, and provided the useful information and suggestions for the study.

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November 2010

Samatcha Krungkaew

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CHAPTER 1
INTRODUCTION

Ricotta cheese is probably the oldest and the best known whey cheese, in which protein is recovered by heat precipitation. It can be produced using cheese whey or milk, or a mixture of both. If made from whole milk it is soft and creamy with a delicate texture and pleasant, slightly caramel, flavour. The quality of cheese is determined by its flavour, rheological properties, visual appearance and nutritional constituents.[23]

Ricotta cheese is unique in that it is made from whey instead of milk. However, it can be made from whole milk. It is usually made using the whey that is a by-product in the creation of mozzarella or provolone cheeses. It takes a lot of this liquid to make a little ricotta cheese. To create it the whey is boiled so that the remaining proteins curdle and then the resulting solids are removed. The process is simple enough that ricotta cheese can be made at home.[24] Like mascarpone in northern-Italian cuisine, ricotta is a favorite component of many Italian desserts, such as cheesecakes and cannoli. There are also kinds of cookies that include ricotta as an ingredient.[30]

The appearance of a food product, its consistence and flavour (more or less intense) determine its attraction to the consumer. In particular, flavour plays a central role in influencing consumer preference. Cow-milk, goat-milk, and buffalo-milk products have different specific odour and flavour, which have been subject of several investigation.[23] With the increased consumption and popularity of milk products, including ricotta cheese, an investigation and resolution of some of the factors influencing the sensory, chemical, and physical properties of ricotta cheese have become important. Acid, as an important raw material for cheesemaking, may have an effect on the properties and characteristics of ricotta cheese. However, the effect of acids on the sensory, chemical, and physical characteristics of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk has not been investigated elsewhere.

OBJECTIVES

1. To find the effect of four acids on chemical composition of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk
2. To find the effect of four acids on yield of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk
3. To find the effect of four acids on physical characteristics of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk
4. To find the effect of four acids on sensory properties of ricotta cheese made from cow's milk, goat's milk, and buffalo's milk

CHAPTER 2
LITERATURE REVIEW

2.1 Ricotta cheese

Ricotta is produced from whey, the liquid separated from the curds when cheese is made. Most of the milk protein (especially casein) is removed when cheese is made, but some protein remains in the whey, mostly albumin. This remaining protein can be harvested if the whey is first allowed to become more acidic by additional fermentation (by letting it sit for 12–24 hours at room temperature). Then the acidified whey is heated to near boiling. The combination of low pH and high temperature denatures the protein and causes it to precipitate out, forming a fine curd. Once cooled, the curd is separated by passing through a fine cloth.[30]

After realizing that whey cannot be safely dumped in large concentrations as it creates an environmental nuisance, Pecorino Romano makers discovered that when the protein-rich substance is heated, whey protein particles fuse and create a curd. This curd, after drainage, is ricotta. Because ricotta is made from whey, rather than milk, it is technically considered a whey cheese.[30]

Ricotta is a fresh cheese (as opposed to ripened or aged), grainy and creamy white in appearance, slightly sweet in taste, and contains around 13% fat. In this form, it is somewhat similar in texture to some cottage cheese variants, though considerably lighter.[30]

Ricotta cheese is what is known as a fresh cheese meaning that it is not salted, smoked or treated by any other processes to lengthen its shelf life. Ricotta cheese is highly perishable. The cheese should be snowy white in color. Yellowing is an indication of age and deterioration.[14] It is not good to try to remove the mold that is seen on the cheese and use the rest of it. While this may work in some cases by the time mold shows up on ricotta cheese it has gone bad. This cheese freezes very well so its shelf life can be extended if the cheese is stored in the freezer.[24]

Ricotta cheese has a very mild even sweet flavor which makes it a perfect choice for desserts. Ricotta cheese can be used as an ingredient in cheesecake and

ricotta cheese that has been beaten smooth and mixed with sugar and other ingredients creates the filling for a cannoli. In an Italian dessert called a cassata ricotta is put in between layers of cake like frosting for a layered cake in the United States. Though ricotta cheese is good for desserts it's also great in savory dishes as well. Some lasagna recipes call for the use of ricotta adding its mild flavor to the mix. Its flavor and its softness also have made it an ideal choice for many stuffed pastas from ravioli to variations like manicotti and stuffed shells.[24]

Though ricotta is a fresh cheese, there are ways to prepare it that gives it a longer shelf life. Salted and pressed like a regular cheese it becomes a hard cheese that's best suited for grating or shaving slices off of. Ricotta cheese can be also baked which gives it a brown crust sometimes going all the way through the cheese. Another similar method uses smoking instead of baking in order to give ricotta a flavorful crust that aids in storage.[24] Typical compositions for ricotta cheese are shown in Table 2.1.[21]

Table 2.1:Typical compositions for ricotta cheese

Variety	Moisture	Protein	Fat	Carbohydrate	Ash
Whole milk ricotta cheese	72%	11%	13%	3%	1%
Part skim ricotta cheese	74.5%	11.5%	8%	5%	1%

2.1.1 Study about ricotta cheese

Pizzillo *et al.* (2005) reported the effect of goat breed on the sensory, chemical and nutritional characteristics of ricotta cheese. Goat cheese exhibited a higher fat content compared to cow and ewe whey cheeses. Heating time and heating temperature affect the fat content of the cheese. The lower value of adhesiveness, detected in ricotta cheese made from whey of Local breed, may be linked to the higher fat/protein ratio exhibited by the product. Differences in sensory properties of

ricotta cheese made with different whey may be due to variations in fat content. As the fat content of the ricotta cheese decreased, the sample was less greasy. The higher value of granulosity may be linked to the lower level of fat and the higher protein content of the product.[23]

Hydamaka *et al.* (2000) reported that homogenized milk is not used in the manufacture of cheese due to adverse effects on curd forming properties. Studies have reported that homogenization of milk for direct acidified cheese resulted in decreased fat losses. The type of acid used in coagulation had an effect on both cheese composition and yield. Acetic acid produced the driest cheese, which was significant lower ($P<0.05$) than cheese from citric acid. However, recovery of solids, solid components of fat and protein, and yield was also significantly lower ($P<0.05$) in cheese from acetic acid. Cheese produced from lactic and tartaric acid showed similar composition and recovery of solid components as cheese from citric acid.[16]

2.2 Heat-acid coagulation

This process permits recovery of caseins and whey proteins in a single step. The basic principle is that whey proteins which are normally acid stable, become sensitive to acid coagulation after heat treatment. Acidification causes the casein micelles to destabilize or aggregate by decreasing their electric charge to that of the isoelectric point. The acidity of the milk increases the solubility of minerals, so that organic calcium and phosphorus contained in the micelle gradually become soluble in the aqueous phase. Casein micelles disintegrate and casein precipitates. The casein is least soluble at its isoelectric point pH 4.6.[9] This principle is exploited in the manufacture of ricotta cheese, Paneer and Channa cheese, and in the manufacture of "co-precipitated" milk protein concentrates.[11] The basic process for heat-acid coagulation is:

- Heat milk or milk-whey blends to at least 80°C for at least five minutes to completely denature (unfold) the whey proteins and encourage association of whey proteins with casein micelles.[11]

- Continue heating and acidify slowly with gentle agitation. The caseins and whey proteins will coagulate together and form either sinking or floating curds.[11]

2.3 Milk

Milk is a translucent white liquid produced by the mammary glands of mammals. It provides the primary source of nutrition for young mammals before they are able to digest other types of food. The early lactation milk is known as colostrum, which carries the mother's antibodies to the baby, thus reducing the risk of many diseases. The exact components of raw milk vary by species, but they contain significant amounts of saturated fat, protein and calcium as well as vitamin C. Milk often is homogenized, a treatment which prevents a cream layer from separating out of the milk. The milk is pumped at high pressures through very narrow tubes, breaking up the fat globules through turbulence and cavitation. A greater number of smaller particles possess more total surface area than a smaller number of larger ones, and the original fat globule membranes cannot completely cover them. Casein micelles are attracted to the newly exposed fat surfaces; nearly one-third of the micelles in the milk end up participating in this new membrane structure. The casein weighs down the globules and interferes with the clustering that accelerated separation. Milk composition analysis is shown in Table 2.3.[34]

Table 2.3: Milk composition analysis per 100 grams

Constituents	unit	Cow	Goat	Buffalo
Water	g	87.8	88.9	81.1
Protein	g	3.2	3.1	4.5
Fat	g	3.9	3.5	8.0
Carbohydrate	g	4.8	4.4	4.9
Energy	kcal	66	60	110
Sugars (lactose)	g	4.8	4.4	4.9
Cholesterol	mg	14	10	8

Constituents	unit	Cow	Goat	Buffalo
Calcium	IU	120	100	195
Saturated fatty acids	g	2.4	2.3	4.2
Monounsaturated fatty acids	g	1.1	0.8	1.7
Polyunsaturated fatty acids	g	0.1	0.1	0.2

2.3.1 Cow's milk

Cow's milk, the basis for all other dairy products, promotes strong bones by being a significant source of vitamin D and calcium, and a good source of vitamin K--three nutrients essential to bone health. In addition, cow's milk is very good sources of iodine, a mineral essential for thyroid function; and riboflavin and vitamin B12, two B vitamins that are necessary for cardiovascular health and energy production.[27]

Milk is available in a variety of forms that are differentiated by their fat content. The 2% designation refers to the percent of fat by weight that the milk contains. 2% milk is often referred to as reduced-fat milk since it contains less fat than whole milk, which is 3.5% fat.[27]

High-fat dairy products such as cheese, butter and cream contain saturated fat. Saturated fat is the most important dietary factor involved in raising blood cholesterol levels. The consumption of high-fat dairy products has also been found to cause atherosclerosis, heart disease and stroke. Finland which has a death rate from heart disease that is among the highest in the world, also has one of the highest rates of dairy product consumption.[26]

Cow's milk is not recommended by the American Academy of Pediatrics for children under 1 year old. Infants fed whole cow's milk do not get enough vitamin E, iron, and essential fatty acids. They also get too much protein, sodium, and potassium. These levels may be too high for the infant's system to handle. Also, whole cow's milk protein and fat are more difficult for an infant to digest and absorb.[20]

2.3.2 Goat's milk

Goat's milk contains around ten grams of fat per eight ounces compared to 8 to 9 grams in whole cow's milk, and it's much easier to find low-fat and non-fat varieties of cow's milk than it is to purchase low-fat goat's milk. Unlike cow's milk, goat's milk does not contain agglutinin. As a result, the fat globules in goat's milk do not cluster together, making them easier to digest. Goat milk protein forms a softer curd (the term given to the protein clumps that are formed by the action of stomach acid on the protein), which makes the protein more easily and rapidly digestible.[5]

Unlike cow's milk, there is no need to homogenize goat's milk. While the fat globules in cow's milk tend to separate to the surface, the globules in goat's milk are much smaller and will remain suspended in solution.[28]

Goat's milk was found to help with the digestive and metabolic utilization of minerals such as iron, calcium, phosphorus and magnesium. Research carried out at the Department of Physiology of the University of Granada has revealed that goat's milk has more beneficial properties to health than cow's milk. Among these properties it helps to prevent ferropenic anaemia (iron deficiency) and bone demineralisation (softening of the bones).[25]

Cheese, made from goat's milk, is probably one of the earliest dairy products. Goat cheese is simply made by allowing raw goat's milk to naturally curdle, and then draining and pressing the curds. Other techniques are the uses of acids (such as vinegar or lemon juice) or rennet to coagulate the milk. If the cheese is to be aged, it is often brined, so it will form a rind. Then, it is stored in a cool cheese cave for several months to cure.[33] Cheese, made from goat's milk, is often higher in protein and lower in fat than cheese, made from cow's milk.[15]

2.3.3 Buffalo's milk

Buffalo's milk is a totally natural product that can be consumed like any other milk. Buffalo's milk is very white and beautifully smooth. It is significantly lower in cholesterol and higher in calcium than cow's, sheep's or goat's milks. Unlike the array of industrially produced soya and other cereal milks, it is totally free of

additives and chemical formulations. In addition to the significant cholesterol and calcium benefits, buffalo's milk is also a rich source of iron, phosphorus, vitamin A and of course protein. Buffalo's milk also contains high level of the natural antioxidant tocopherol. Peroxidate activity is normally 2-4 times higher than that of cow's milk. The number of people who suffer from cow's milk allergy (cma) is increasing. However, this is not the case with buffalo's milk which is suitable for many suffers from cma. It is not clear from scientific research studies exactly why some people can better tolerate buffalo's milk. Some initial studies suggested that specific proteins known to cause allergic reactions may present in cow's milk in significant quantities, but they absent in buffalo's milk. The alpha-casein proteins, including alpha s1-casein, and the beta-casein proteins are both considered in this regard.[8]

Cheese made from buffalo's milk displays typical body and textural characteristics. More specifically, where chewing and stringing properties are specially desired as in the case of mozzarella cheese, buffalo's milk is technologically preferable over cow's milk. In Italy, recently legislation has been introduced to restrict use of term "Mozzarella" only to those products exclusively made from buffalo's milk. Certain traditional cheese varieties, such as *paneer* in India or pickled cheeses from the Middle-East countries, are best made from buffalo's milk.[17]

2.4 Acetic acid

Acetic acid is a clear, colorless organic acid, CH_3COOH, with a distinctive pungent odor, used as a solvent and in the manufacture of rubber, plastics, acetate fibers, pharmaceuticals, and photographic chemicals. It is the chief acid of vinegar.[1]

Acetic acid also known as ethanoic acid, is an organic acid that gives vinegar its sour taste and pungent smell. It is a weak acid, in that it is only a partially dissociated acid in an aqueous solution. Pure, water-free acetic acid (*glacial acetic acid*) is a colourless liquid that absorbs water from the environment (hygroscopy), and freezes at 16.5 °C to a colourless crystalline solid. The pure acid and its concentrated solutions are very corrosive. Properties of acetic acid are shown in Table 2.4.[30]

Table 2.4: Properties of acetic acid

Molecular formula	$C_2H_4O_2$
Molar mass	60.05 g mol^{-1}
Appearance	Colourless liquid
Density	1.049 g/cm^3 (l) 1.266 g/cm^3 (s)
Melting point	16.5 °C, 290 K, 62 °F
Boiling point	118.1 °C, 391 K, 245 °F
Solubility in water	miscible
Acidity (pK_a)	4.76
Viscosity	1.22 mPa·s at 25 °C

2.5 Citric acid

Citric acid is a Colourless, crystalline organic compound ($C_6H_8O_7$), one of the carboxylic acids. It presents in almost all plants (especially citrus fruits) and in many animal tissues and fluids. It is one of a series of compounds involved in the physiological oxidation of fats, proteins, and carbohydrates to carbon dioxide and water. It has a characteristic sharply sour taste and is used in many foods, confections, and soft drinks.[2] Citric acid is used as a flavoring in many preparations of Vitamin C, and has a wide variety of other uses.[36] It is added to certain foods to improve their stability in metal containers. Industrially, it is used as a water conditioner, cleaning and polishing agent, and chemical intermediate.[2] Citric acid is a weak organic acid. Properties of citric acid are shown in Table 2.5.[31]

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Table 2.5: Properties of citric acid

Molecular formula	$C_6H_8O_7$
Molar mass	192.124 g/mol (anhydrous) 210.14 g/mol (monohydrate)
Appearance	crystalline white solid
Density	1.665 g/cm^3
Melting point	153 °C
Boiling point	decomposes at 175 °C
Solubility in water	73 g/100 ml (20°C)
Solubility in THF, ethanol, methanol	anhydrous: THF 1.80 M, ethanol 1.6 M, methanol 3.08 M monohydrate: THF 1.52 M, ethanol 1.78 M, methanol 2.27 M
Acidity (pK_a)	pK_{a1}=3.09 pK_{a2}=4.75 pK_{a3}=5.41

2.6 Malic acid

Malic acid is a colorless, crystalline compound, COOH·CH_2·CHOH·COOH, that occurs naturally in a wide variety of unripe fruit, including apples, cherries, and tomatoes, and is used as a flavoring and in the aging of wine.[3] This carboxylic diacid is the active ingredient in many sour or tart foods. Malic acid has two stereoisomeric forms (L- and D-enantiomers), though only the L-isomer exists naturally. The salts and esters of malic acid are known as malates. The malate anion is an intermediate in the citric acid cycle. Properties of malic acid are shown in Table 2.6.[32]

Table 2.6: Properties of malic acid

Molecular formula	$C_4H_6O_5$
Molar mass	134.09 g mol^{-1}
Density	1.609 g/cm^3
Melting point	130 °C, 403 K, 266 °F
Solubility in water	558 g/l (at 20 °C)
Acidity (pK_a)	$pKa_1 = 3.40$, $pKa_2 = 5.20$

2.7 Tartaric acid

Tartaric acid is a white crystalline diprotic organic acid. It occurs naturally in many plants, particularly grapes, bananas, and tamarinds, and is one of the main acids found in wine. It is added to other foods to give a sour taste, and is used as an antioxidant. Salts of tartaric acid are known as tartrates. It is a dihydroxy derivative of succinic acid. Tartaric acid has some use as an acidulant in foods and also as a chelating agent.[4] The monopotassium salt of tartaric acid, commonly called cream of tartar, is obtained from wine casks, where it crystallizes as a hard.[7] Potassium hydrogen tartrate (cream of tartar) is an ingredient of baking powder. The potassium sodium salt, commonly called Rochelle salt, was the first compound used as a piezoelectric crystal.[4] Properties of tartaric acid are shown in Table 2.7.[35]

Table 2.7: Properties of tartaric acid

Molecular formula	$C_4H_6O_6$ (Basic formula) $HO_2CCH(OH)CH(OH)CO_2H$ (Structural formula)
Molar mass	150.087 g/mol
Appearance	white powder
Density	1.79 g/mL (H_2O)
Melting point	171–174 °C (*L*-tartaric) 206 °C (*DL*, racemic) 146–148 °C (*meso*)
Acidity (pK_a)	$pKa_1 = 2.96$, $pKa_2 = 4.16$
Solubility in water	133 g/100ml (20°C)

CHAPTER 3
MATERIALS AND METHODS

3.1 Cheese preparation

The experiment was divided into three groups according to three types of milk. Meiji-CP fresh milk was used for cow's milk. Sirichai fresh milk was used for goat's milk. Murrah fresh milk was used for buffalo's milk. Four types of acid: acetic acid, citric acid, malic acid, and tartaric acid, were used in the experiment. "Gold mountain" brand vinegar was used as acetic acid while other acids were prepared to meet the concentration of 5% w/v. Each experimental group had 4 treatments (acids). Three ricotta cheesemaking trials for each treatment were conducted as three replications.

A simplified flowchart of ricotta cheese making process is shown in Fig. 3.1. The milk was heated to 93°C and then heat was turned to low flame. 12 mL of 5% w/v acid was added. Following coagulation, the ricotta cheese was stood for 10 minutes. After that, it was drained and hanged with cheesecloth for 1 hour. Finally, 100 g of ricotta cheese was packaged in plastic box and then kept in refrigerator.[19]

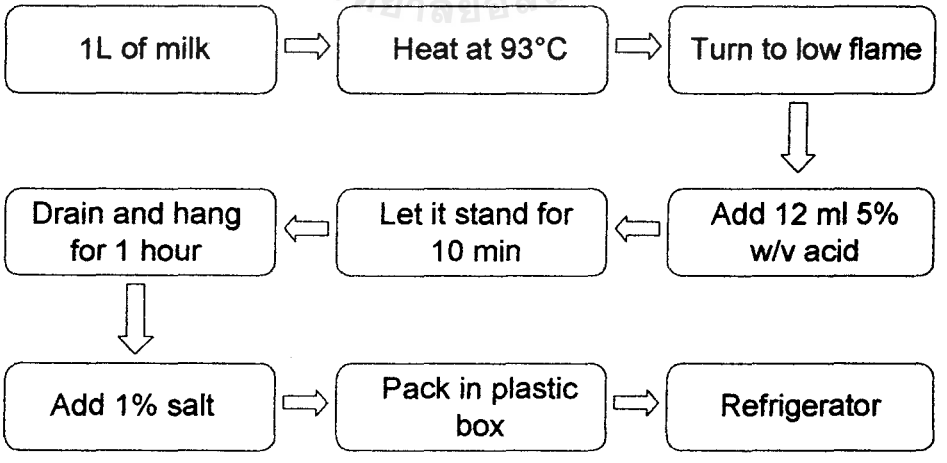

Fig. 3.1. Flowchart of ricotta cheesemaking process

3.2 Chemical composition

Thirty-six samples of ricotta cheese were analysed for chemical features. Protein contents were determined by in-house method based on AOAC (2005). A nitrogen conversion factor of 6.38 was used to calculate protein content. Fat contents were determined by NFI T 967 method based on AOAC (2005). Moisture content and ash contents were determined by methods based on food chemistry laboratory manual (2008) of the faculty of Biotechnology, Assumption University.[12],[13] Dry matter percentage was calculated by subtracting moisture content from a hundred.[13] The amount of lactose in samples was calculated as the difference between the corresponding dry matter and the sum of protein, fat and ash. Titratable acidity was determined by titrating 10 g of sample with 0.1N NaOH to a pink endpoint using phenolphthalein indicator. pH was measured with pH 211 microprocessor pH meter. Yield percentage was calculated as grams of cheese obtained from 100 mL of milk. All analyses of ricotta cheese samples were done in duplicate.

3.3 Texture profile analysis

The samples were measured at Charpa Techcenter Co., Ltd. Hardness and adhesiveness were obtained at room temperature, using a texture analyzer (TA-XT plus) equipped with a 2.5-cm diameter aluminium cylindrical probe. The penetration speed of the probe was 2 mm/s to a distance of 10 mm from the surface.

3.4 Sensory analysis

30 panelists including staff and students in Assumption University evaluated ricotta cheese samples at room temperature. Each attribute was evaluated on 9-point hedonic scale using liking preference test. The major sensory attributes were appearance, color, odor, texture, taste, and overall.

3.5 Statistical analyses

The results from chemical, physical, and sensory analysis of ricotta cheese were processed by analysis of variance. Data were analysed by randomized complete block design with one factor (acid); mean values were compared by Fisher's LSD test. Significance was declared at $P<0.05$. Duncan's test was used to determine the groups significantly different from each other.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Ricotta cheese made from cow's milk

Compositional characteristics of ricotta cheese, made from cow's milk and different type of acids, are shown in Table 4.1.1.

Table 4.1.1: Effect of acids on yield, pH and chemical composition of ricotta cheese made from cow's milk (mean±S.E.)

cid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
ield (%)	9.57±0.74[a]	5.68±0.74[b]	8.02±0.74[a]	8.60±0.74[a]
at (g/100g DM)	38.76 ±1.81[a]	43.87±1.81[b]	43.43±1.81[b]	46.26±1.81[b]
rotein (g/100g M)	30.49±0.49[a]	31.21±0.49[a]	33.16±0.49[b]	33.67±0.49[b]
sh (g/100g M)	6.01±0.17[b]	5.24±0.17[a]	4.84±0.17[a]	5.83±0.17[b]
ıctose (g/100g M)	23.76±2.42[b]	16.17±2.42[a]	16.96±2.42[a]	12.67±2.42[a]
M (%)	37.89±0.48[b]	36.65±0.48[a]	37.74±0.48[ab]	37.07±0.48[ab]
C (%)	62.11±0.48[a]	63.35±0.48[b]	62.26±0.48[ab]	62.93±0.48[ab]
I	5.52±0.07[a]	5.57±0.07[a]	5.67±0.07[ab]	5.75±0.07[b]
idity (% w/w)	0.98±0.16[a]	3.51±0.16[c]	1.62±0.16[b]	1.586±0.16[b]

[a,b,c]Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

The effects of acids were found in all chemical composition of ricotta cheese made from cow's milk ($P<0.05$). Ricotta cheese made from acetic acid showed the highest yield percentage whereas ricotta cheese made from citric acid showed the lowest yield percentage. Different acids gave the different yield percentage that might come from the different strength of acids. If 12 mL of 5% w/v of acids were converted into mole value, it would show the strength of each acid. Acetic acid had

approximately 0.01 mol; citric acid had approximately 0.003 mol; malic acid had approximately 0.004 mol; tartaric acid had approximately 0.004 mol. Acetic acid had the highest mole value, so it provided the highest yield percentage. Citric acid had the lowest mole value, so it provided the lowest yield percentage. Malic acid and tartaric acid had the same mole value, so it provided almost the same yield percentage.

Fat content, protein content, ash content, and lactose content are expressed as percentage of dry matter. Fat contents were significant different among four acids used ($P<0.05$). Ricotta cheese made from tartaric acid had the highest fat content and ricotta cheese made acetic acid had the lowest fat content. There was an effect of acids on protein content of ricotta cheese made from cow's milk ($P<0.05$). Ricotta cheese made from tartaric acid had the highest protein content and ricotta cheese made from acetic acid had the lowest protein content. Ash content was significant different among four acids used ($P<0.05$). Ricotta cheese made from acetic acid had the highest ash contents and ricotta cheese made from malic acid had the lowest ash contents. Lactose contents were significant different among four acids used ($P<0.05$). Ricotta cheese made from acetic acid had the highest lactose content which was resulted from the low value of fat content and protein content. Lactose content was calculated by using fat content, protein content, and ash content. Fat and protein are the major components of cheese, so lactose content depended on the value of fat content and protein content. Ricotta cheese made from tartaric acid had the lowest lactose content which was resulted from the high value of fat content and protein content. Dry matter (DM) percentage related to moiture content (MC) percentage because the percentage of dry matter was calculated by using moiture content value. Both dry matter percentage and moisture content percentage were significant different among four acids used ($P<0.05$). Ricotta cheese made from citric acid had the highest value of moisture content whereas ricotta cheese made from acetic acid had the lowest value of moisture content. pH of ricotta cheese, made from cow's milk, was affected by four acids ($P<0.05$). Ricotta cheese made from tartaric acid had the highest pH value whereas ricotta cheese made from acetic acid had the lowest pH value. Titratable acidity of ricotta cheese made from cow's milk is shown as percentage of weight by weight. It was affected by acids ($P<0.05$). Ricotta cheese made from citric

acid had the highest acidity percentage whereas ricotta cheese made from acetic acid had the lowest percentage. Molecular weight of each acid was used for acidity percentage calculation, thus, acidity percentage of ricotta cheese, made from different acid, depended on the molecular weight of each acid. The molecular weight of acetic acid is 60.05; The molecular weight of citric acid is 192.12; the molecular weight of malic acid is 134.09; the molecular weight of tartaric acid is 150.09. Citric acid had the highest value of molecular weight, so it affected the acidity percentage of ricotta cheese made from citric acid to become the highest value. Acetic acid had the lowest value of molecular weight, so it affected the acidity percentage of ricotta cheese made from acetic acid to become the lowest value.

Table 4.1.2: Effect of acids on textural properties of ricotta cheese made from cow's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Hardness (g)	1341.83 ± 101.21^{c}	1000.79 ± 101.21^{ab}	1242.43 ± 101.21^{bc}	938.68 ± 101.21^{a}
Adhesiveness (g·sec)	32.03 ± 3.97^{a}	48.66 ± 3.97^{b}	67.78 ± 3.97^{c}	56.86 ± 3.97^{b}

[a,b,c]Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

Textural properties of ricotta cheese made from cow's milk are shown in Table 4.1.2. Hardness of ricotta cheese made from cow's milk was affected by acids ($P<0.05$). It was compared to fat content in the cheese and pK_a value of acid. Ricotta cheese made from acetic acid, which had the highest pK_a value, had the highest value of hardness but the lowest fat content. Ricotta cheese made from tartaric acid, which had the lowest pK_{a1} value, had the lowest value of hardness but the highest value of fat content. Hardness value decreased as pK_a value of acid decreased and the fat content increased. Thus, hardness may be linked to pK_a value of acid and the fat content of the ricotta cheese made from cow's milk.[6]

Adhesiveness of ricotta cheese made from cow's milk was affected by acids ($P<0.05$). Adhesiveness value was compared to fat and protein contents. It showed that as the fat content and protein content increased, adhesiveness increased.

Table 4.1.3: Effect of acids on sensory properties of ricotta cheese made from cow's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Appearance	7.60±0.18	7.43±0.18	7.47±0.18	7.53±0.18
Color	7.70±0.16	7.57±0.16	7.43±0.16	7.67±0.16
Odor	7.13±0.21	7.20±0.21	7.07±0.21	7.43±0.21
Texture	7.40±0.17	7.30±0.17	7.23±0.17	7.57±0.17
Taste	$7.40±0.23^{ab}$	$7.30±0.23^{ab}$	$6.93±0.23^{a}$	$7.57±0.23^{b}$
Overall	7.40±0.22	7.13±0.22	7.30±0.22	7.50±0.22

^{a,b}Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

The sensory properties are shown in Table 4.1.3. Acids affected only taste of ricotta cheese made from cow's milk ($P<0.05$). Ricotta cheese made from tartaric acid had the highest score. A lower score of taste was from ricotta cheese, made from malic acid, compared to other acids. Differences in taste of ricotta cheese made with different acids may be due to variations in fat entrapped during protein coagulation by

different acid used in cheese. It may be also due to the different acidic flavor in the ricotta cheese made from different acids.

4.2 Ricotta cheese made from goat's milk

Compositional characteristics of ricotta cheese, made from goat's milk and different type of acids, are shown in Table 4.2.1.

Table 4.2.1: Effect of acids on yield, pH and chemical composition of ricotta cheese made from goat's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Yield (%)	17.23±0.87	18.07±0.87	18.10±0.87	18.57±0.87
Fat (g/100g DM)	42.73±1.26^{b}	34.90±1.26^{a}	36.06±1.26^{a}	41.78b±1.26^{b}
Protein (g/100g DM)	39.16±0.91^{b}	33.44±0.91^{a}	38.93±0.91^{b}	36.99±0.91^{b}
Ash (g/100g DM)	7.56±0.52	7.06±0.52	7.19±0.52	7.75±0.52
Lactose (g/100g DM)	10.01±2.28^{a}	22.91±2.28^{c}	16.52b±2.28^{b}	11.93±2.28^{ab}
DM (%)	38.66±0.97^{b}	39.36±0.97^{b}	37.49±0.97^{ab}	35.38±0.97^{a}
MC (%)	61.34±0.97^{a}	60.64±0.97^{a}	62.51±0.97^{ab}	64.62±0.97^{b}
pH	5.95±0.09	5.88±0.09	5.88±0.09	6.07±0.09
Acidity (% w/w)	0.54±0.09^{a}	1.69±0.09^{c}	1.30±0.09^{b}	1.54±0.09^{c}

^{a,b,c}Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

Yield percentage, ash content, and pH of ricotta cheese, made from goat's milk, were not affected by acids. Yield percentage of ricotta cheese, made from goat's milk, was much higher than yield percentage of ricotta cheese made from cow's milk. It showed that the strength of acid was not required for goat's milk to make protein coagulated, compared to cow's milk.

Fat content of ricotta cheese, made from goat's milk, was affected by acids ($P<0.05$). Ricotta cheese, made from acetic acid, had the highest fat content whereas

ricotta cheese, made from citric acid, had the lowest fat content. Protein content of ricotta cheese, made from goat's milk, was affected by acids ($P<0.05$). Ricotta cheese, made from acetic acid, had the highest protein content whereas ricotta cheese, made from citric acid, had the lowest protein content. Lactose content of ricotta cheese, made from goat's milk, was affected by acids ($P<0.05$). Ricotta cheese, made from citric acid, had the highest lactose content which was resulted from the low value of fat content and protein content. Ricotta cheese, made from acetic acid, had the lowest lactose content which was resulted from the high value of fat content and protein content. Dry matter percentage and Moisture content percentage of ricotta cheese, made from goat's milk, were affected by acids ($P<0.05$). Ricotta cheese made from tartaric acid had the highest moisture content percentage whereas ricotta cheese made from citric acid had the lowest moisture content percentage. Acidity percentage of ricotta cheese, made from goat's milk, were affected by acids ($P<0.05$). Ricotta cheese made from citric acid had the highest acidity percentage whereas ricotta cheese made from acetic acid had the lowest percentage. It had the same trend as acidity percentage of ricotta cheese made from cow's milk. Acidity percentage depended on the molecular weight of each acid.

Table 4.2.2: Effect of acids on textural properties of ricotta cheese made from goat's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Hardness (g)	1183.09 ± 97.43^{b}	1005.48 ± 97.43^{ab}	1048.07 ± 97.43^{ab}	848.73 ± 97.43^{a}
Adhesiveness (g·sec)	35.48 ± 10.38^{a}	104.30 ± 10.38^{c}	77.90 ± 10.38^{b}	63.25 ± 10.38^{b}

[a,b,c]Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

Textural properties of ricotta cheese made from goat's milk are shown in Table 4.2.2. Hardness of ricotta cheese made from goat's milk was affected by acids (P<0.05). Ricotta cheese made from acetic acid had the highest value of hardness whereas ricotta cheese made from tartaric acid had the lowest value of hardness. Hardness of ricotta cheese made from goat's milk was compared to its fat content. Ricotta cheese made from acetic acid had the highest value of hardness and the highest fat content. The correlation between hardness and fat content of ricotta cheese made from goat's milk, which was different from the ricotta cheese made from cow's milk, could not be found. It may be due to the different κ-casein variants and different genotype of β-lactoglobulin in goat's milk, compared to cow's milk.[22] It may be also caused by the properties of fat in goat's milk. Sirichai goat's milk did not pass homogenization process which could affect the structure of ricotta cheese and mechanisms during protein coagulated. Hardness of ricotta cheese made from goat's milk was also compared to pK_a value of acid. There was a relationship between hardness and pK_a value of acid. Hardness value increased as pK_a value of acid increased. Thus, hardness may be linked to pK_a value of acid for the ricotta cheese made from goat's milk.

Adhesiveness of ricotta cheese made from goat's milk was affected by acids (P<0.05). Adhesiveness value was compared to fat content. It showed that as the fat content decreased, adhesiveness increased. Ricotta cheese made from citric acid had very high value of adhesiveness. It may be resulted from the lowest value of fat, protein, and moisture content.

Table 4.2.3: Effect of acids on sensory properties of ricotta cheese made from goat's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Appearance	7.23±0.15	7.17±0.15	7.47±0.15	7.30±0.15
Color	7.53±0.12	7.57±0.12	7.67±0.12	7.60±0.12
Odor	7.10±0.20	7.20±0.20	6.83±0.20	7.03±0.20
Texture	7.17±0.17	7.20±0.17	7.43±0.17	7.17±0.17
Taste	6.97±0.25	7.37±0.25	7.10±0.25	7.07±0.25
Overall	7.10±0.19	7.37±0.19	7.13±0.19	7.10±0.19

Means in the row were not significantly different ($P>0.05$).

The sensory properties of ricotta cheese, made from goat's milk, are shown in Table 4.2.3. All sensory attributes of ricotta cheese, made from goat's milk, were not affected by acids.

4.3 Ricotta cheese made from buffalo's milk

Compositional characteristics of ricotta cheese, made from buffalo's milk and different type of acids, are shown in Table 4.3.1.

Table 4.3.1: Effect of acids on yield, pH and chemical composition of ricotta cheese made from buffalo's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Yield (%)	10.74 ± 0.46^{c}	5.35 ± 0.46^{a}	7.49 ± 0.46^{b}	7.22 ± 0.46^{b}
Fat (g/100g DM)	37.88 ± 8.12^{b}	21.07 ± 8.12^{ab}	27.24 ± 8.12^{ab}	16.73 ± 8.12^{a}
Protein (g/100g DM)	40.58 ± 6.68^{a}	56.37 ± 6.68^{ab}	49.79 ± 6.68^{ab}	58.85 ± 6.68^{b}
Ash (g/100g DM)	5.64±0.62	6.93±0.62	6.20±0.62	7.23±0.62
Lactose (g/100g DM)	14.61±3.08	13.31±3.08	15.06±3.08	15.33±3.08
DM (%)	39.38±2.30	36.03±2.30	36.34±2.30	35.54±2.30
MC (%)	60.62±2.30	63.97±2.30	63.66±2.30	64.46±2.30
pH	5.71±0.15	5.61±0.15	5.91±0.15	5.85±0.15
Acidity (% w/w)	0.62 ± 0.15^{a}	2.33 ± 0.15^{c}	1.72 ± 0.15^{b}	1.87 ± 0.15^{b}

^{a,b,c}Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

Ash content, lactose content, dry matter percentage, moisture content percentage and pH of ricotta cheese, made from buffalo's milk, were not affected by acids.

Yield percentage of ricotta cheese, made from buffalo's milk, was affected by acids ($P<0.05$). Ricotta cheese, made from acetic acid, showed the highest yield percentage whereas ricotta cheese, made from citric acid, showed the lowest yield percentage. The trend of yield percentage of ricotta cheese, made from buffalo's milk, was the same as the trend of yield percentage of ricotta cheese, made from cow's milk. Yield percentage of ricotta cheese, made from buffalo's milk depended on the strength of each acid.

Fat content of ricotta cheese, made from buffalo's milk, was affected by acids ($P<0.05$). Ricotta cheese, made from acetic acid, had the highest fat content whereas ricotta cheese, made from tartaric acid, had the lowest fat content. There was high variation in fat content of ricotta cheese, made from buffalo's milk. It may be due to the fat content and fat properties of buffalo's milk. Buffalo's milk had high fat content and fat globules of buffalo's milk are large.[8],[34] Murrah buffalo's milk did not pass homogenization process. Consequently, fat globules may be not distributed evenly, so it could affect the fat content in ricotta cheese. Protein content of ricotta cheese, made from buffalo's milk, was affected by acids ($P<0.05$). Ricotta cheese, made from tartaric acid, had the highest protein content whereas ricotta cheese, made from acetic acid, had the lowest protein content. Acidity percentage of ricotta cheese, made from buffalo's milk, was affected by acids ($P<0.05$). Ricotta cheese made from citric acid had the highest acidity percentage whereas ricotta cheese made from acetic acid had the lowest percentage. It had the same trend as acidity percentage of ricotta cheese made from cow's milk and goat's milk. Acidity percentage depended on the molecular weight of each acid.

Table 4.3.2: Effect of acids on textural properties of ricotta cheese made from buffalo's milk (mean±S.E.)

Acid	**Acetic** ($pK_a = 4.76$)	**Citric** ($pK_{a1} = 3.09$)	**Malic** ($pK_{a1} = 3.40$)	**Tartaric** ($pK_{a1} = 2.96$)
Hardness (g)	1030.27±70.04^{ab}	1203.47±70.04^{b}	1142.32±70.04^{b}	913.81±70.04^{a}
Adhesiveness (g·sec)	51.23±10.09	58.76±10.09	57.68±10.09	71.76±10.09

^{a,b}Means with superscripts in the row and without a common superscript were significantly different at $P<0.05$.

Textural properties of ricotta cheese made from buffalo's milk are shown in Table 4.3.2. Hardness of ricotta cheese made from buffalo's milk was affected by acids ($P<0.05$). Ricotta cheese, made from citric acid, had the highest value of hardness whereas ricotta cheese, made from tartaric acid, had the lowest value of hardness. Hardness of ricotta cheese made from buffalo's milk was compared to its fat content and protein content. The relationship of hardness and fat content, and the relationship of hardness and protein content of ricotta cheese made from buffalo's milk could not be found. It may be due to the different κ-casein variants and different genotype of β-lactoglobulin in buffalo's milk, compared to cow's milk.[22] It may be also caused by the properties of fat in buffalo's milk. Murrah buffalo's milk did not pass homogenization process and large fat globules of buffalo's milk were not distributed evenly which could affect the structure of ricotta cheese and mechanisms during protein coagulated.

Table 4.3.3: Effect of acids on sensory properties of ricotta cheese made from buffalo's milk (mean±S.E.)

Acid	Acetic ($pK_a = 4.76$)	Citric ($pK_{a1} = 3.09$)	Malic ($pK_{a1} = 3.40$)	Tartaric ($pK_{a1} = 2.96$)
Appearance	7.43±0.12	7.27±0.12	7.40±0.12	7.43±0.12
Color	7.53±0.13	7.77±0.13	7.73±0.13	7.60±0.13
Odor	7.17±0.15	7.27±0.15	7.23±0.15	7.17±0.15
Texture	7.13±0.13	7.07±0.13	7.30±0.13	7.27±0.13
Taste	7.63±0.17	7.83±0.17	7.60±0.17	7.53±0.17
Overall	7.40±0.15	7.37±0.15	7.30±0.15	7.33±0.15

Means in the row were not significantly different ($P>0.05$).

The sensory properties of ricotta cheese, made from buffalo's milk, are shown in Table 4.3.3. All sensory attributes of ricotta cheese, made from buffalo's milk, were not affected by acids.

CHAPTER 5
CONCLUSION

5.1 Ricotta cheese made from cow's milk

Chemical composition of ricotta cheese, made from cow's milk, varied according to acids (P<0.05). Ricotta cheese, made from acetic acid, had the highest yield percentage whereas ricotta cheese, made from citric acid, had the lowest yield percentage. Hardness of the ricotta cheese, made from cow's milk, may be linked to fat content in the cheese and pK_a value of acid. Adhesiveness of the ricotta cheese, made from cow's milk, may be associated with fat and protein contents exhibited by the product. Taste of ricotta cheese, made from cow's milk, varied according to acids (P<0.05).

5.2 Ricotta cheese made from goat's milk

Fat content, protein content, moisture content, lactose content, and acidity percentage of ricotta cheese, made from goat's milk, varied according to acids (P<0.05). Hardness of ricotta cheese, made from goat's milk, may be linked to pK_a value of acid. Adhesiveness of ricotta cheese, made from goat's milk, was affected by four acids (P<0.05). Acids showed no effect on sensory properties of ricotta cheese, made from goat's milk.

5.3 Ricotta cheese made from buffalo's milk

Fat content, protein content, and acidity percentage of ricotta cheese, made from buffalo's milk, were affected by four acids (P<0.05). Ricotta cheese, made from acetic acid, had the highest yield percentage whereas ricotta cheese, made from citric acid, had the lowest yield percentage. Hardness of ricotta cheese, made from buffalo's milk, was affected by four acids (P<0.05). Sensory properties of ricotta cheese, made from buffalo's milk, were not affected by four acids.

CHAPTER 6
RECOMMENDATION

After a thorough analysis of data, there should be further studies of ricotta cheese as the following:

- The microstructure development of ricotta cheese during protein coagulation of milk should be studied because it may affect the textural properties of cheese. However, it has not been fully explained.
- The effect of different acids and pK_a value on protein coagulation mechanisms, which may affect the chemical and textural properties of ricotta cheese, should be studied.

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APPENDIX A

STATISTICAL ANALYSIS

Appendix Table 1: Differences in yield percentage of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	27.691[a]	5	5.538	6.735	.019
Intercept	761.884	1	761.884	926.531	.000
TRT	24.533	3	8.178	9.945	.010
REP	3.157	2	1.579	1.920	.227
Error	4.934	6	.822		
Total	794.509	12			
Corrected Total	32.624	11			

a. R Squared = .849 (Adjusted R Squared = .723)

Appendix Table 2: Differences in fat content of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	94.265[a]	5	18.853	3.856	.065
Intercept	22271.774	1	22271.774	4555.020	.000
TRT	88.552	3	29.517	6.037	.030
REP	5.714	2	2.857	.584	.586
Error	29.337	6	4.890		
Total	22395.376	12			
Corrected Total	123.602	11			

a. R Squared = .763 (Adjusted R Squared = .565)

Appendix Table 3: Differences in protein content of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	22.738[a]	5	4.548	12.743	.004
Intercept	12387.625	1	12387.625	34713.11	.000
TRT	20.882	3	6.961	19.505	.002
REP	1.856	2	.928	2.600	.154
Error	2.141	6	.357		
Total	12412.504	12			
Corrected Total	24.879	11			

a. R Squared = .914 (Adjusted R Squared = .842)

Appendix Table 4: Differences in ash content of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.622[a]	5	.524	11.867	.005
Intercept	360.467	1	360.467	8156.093	.000
TRT	2.608	3	.869	19.672	.002
REP	.014	2	.007	.160	.856
Error	.265	6	.044		
Total	363.354	12			
Corrected Total	2.888	11			

a. R Squared = .908 (Adjusted R Squared = .832)

Appendix Table 5: Differences in lactose content of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	205.049[a]	5	41.010	4.674	.044
Intercept	3629.056	1	3629.056	413.649	.000
TRT	193.778	3	64.593	7.362	.020
REP	11.271	2	5.635	.642	.559
Error	52.640	6	8.773		
Total	3886.745	12			
Corrected Total	257.689	11			

a. R Squared = .796 (Adjusted R Squared = .625)

Appendix Table 6: Differences in dry matter percentage of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4.254[a]	5	.851	2.488	.149
Intercept	16728.425	1	16728.425	48928.50	.000
TRT	3.030	3	1.010	2.954	.120
REP	1.224	2	.612	1.790	.246
Error	2.051	6	.342		
Total	16734.730	12			
Corrected Total	6.305	11			

a. R Squared = .675 (Adjusted R Squared = .404)

Appendix Table 7: Differences in moisture content percentage of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4.254[a]	5	.851	2.488	.149
Intercept	47120.145	1	47120.145	137820.4	.000
TRT	3.030	3	1.010	2.954	.120
REP	1.224	2	.612	1.790	.246
Error	2.051	6	.342		
Total	47126.450	12			
Corrected Total	6.305	11			

a. R Squared = .675 (Adjusted R Squared = .404)

Appendix Table 8: Differences in pH of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.126[a]	5	.025	3.361	.086
Intercept	379.350	1	379.350	50556.60	.000
TRT	.097	3	.032	4.295	.061
REP	.029	2	.015	1.960	.221
Error	.045	6	.008		
Total	379.521	12			
Corrected Total	.171	11			

a. R Squared = .737 (Adjusted R Squared = .518)

Appendix Table 9: Differences in acidity percentage of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10.932[a]	5	2.186	54.134	.000
Intercept	44.253	1	44.253	1095.699	.000
TRT	10.825	3	3.608	89.340	.000
REP	.107	2	.054	1.326	.334
Error	.242	6	.040		
Total	55.427	12			
Corrected Total	11.174	11			

a. R Squared = .978 (Adjusted R Squared = .960)

Appendix Table 10: Differences in hardness of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	336844.531[a]	5	67368.906	4.385	.050
Intercept	15348072.692	1	15348072.7	998.905	.000
TRT	332416.289	3	110805.430	7.212	.020
REP	4428.242	2	2214.121	.144	.869
Error	92189.361	6	15364.893		
Total	15777106.584	12			
Corrected Total	429033.891	11			

a. R Squared = .785 (Adjusted R Squared = .606)

Appendix Table 11: Differences in adhesiveness of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2146.871[a]	5	429.374	18.166	.001
Intercept	31616.970	1	31616.970	1337.675	.000
TRT	2042.588	3	680.863	28.806	.001
REP	104.283	2	52.142	2.206	.191
Error	141.815	6	23.636		
Total	33905.656	12			
Corrected Total	2288.686	11			

a. R Squared = .938 (Adjusted R Squared = .886)

Appendix Table 12: Differences in appearance for sensory properties of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	55.233[a]	32	1.726	3.512	.000
Intercept	6765.008	1	6765.008	13764.70	.000
TRT	.492	3	.164	.333	.801
REP	54.742	29	1.888	3.841	.000
Error	42.758	87	.491		
Total	6863.000	120			
Corrected Total	97.992	119			

a. R Squared = .564 (Adjusted R Squared = .403)

Appendix Table 13: Differences in color for sensory properties of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	54.533[a]	32	1.704	4.568	.000
Intercept	6916.008	1	6916.008	18537.39	.000
TRT	1.292	3	.431	1.154	.332
REP	53.242	29	1.836	4.921	.000
Error	32.458	87	.373		
Total	7003.000	120			
Corrected Total	86.992	119			

a. R Squared = .627 (Adjusted R Squared = .490)

Appendix Table 14: Differences in odor for sensory properties of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	43.833[a]	32	1.370	2.056	.004
Intercept	6235.208	1	6235.208	9359.536	.000
TRT	2.292	3	.764	1.147	.335
REP	41.542	29	1.432	2.150	.003
Error	57.958	87	.666		
Total	6337.000	120			
Corrected Total	101.792	119			

a. R Squared = .431 (Adjusted R Squared = .221)

Appendix Table 15: Differences in texture for sensory properties of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	40.767[a]	32	1.274	2.816	.000
Intercept	6526.875	1	6526.875	14427.39	.000
TRT	1.892	3	.631	1.394	.250
REP	38.875	29	1.341	2.963	.000
Error	39.358	87	.452		
Total	6607.000	120			
Corrected Total	80.125	119			

a. R Squared = .509 (Adjusted R Squared = .328)

Appendix Table 16: Differences in taste for sensory properties of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	68.367[a]	32	2.136	2.597	.000
Intercept	6351.075	1	6351.075	7721.582	.000
TRT	6.692	3	2.231	2.712	.050
REP	61.675	29	2.127	2.586	.000
Error	71.558	87	.823		
Total	6491.000	120			
Corrected Total	139.925	119			

a. R Squared = .489 (Adjusted R Squared = .300)

Appendix Table 17: Differences in overall for sensory properties of ricotta cheese made from cow's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	42.867[a]	32	1.340	1.886	.011
Intercept	6453.333	1	6453.333	9084.790	.000
TRT	2.200	3	.733	1.032	.382
REP	40.667	29	1.402	1.974	.008
Error	61.800	87	.710		
Total	6558.000	120			
Corrected Total	104.667	119			

a. R Squared = .410 (Adjusted R Squared = .192)

Appendix Table 18: Differences in yield percentage of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	8.321[a]	5	1.664	1.475	.322
Intercept	3884.401	1	3884.401	3443.448	.000
TRT	2.769	3	.923	.818	.529
REP	5.552	2	2.776	2.461	.166
Error	6.768	6	1.128		
Total	3899.490	12			
Corrected Total	15.089	11			

a. R Squared = .551 (Adjusted R Squared = .178)

Appendix Table 19: Differences in fat content of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	147.882[a]	5	29.576	12.360	.004
Intercept	18125.750	1	18125.750	7574.658	.000
TRT	140.977	3	46.992	19.638	.002
REP	6.905	2	3.452	1.443	.308
Error	14.358	6	2.393		
Total	18287.990	12			
Corrected Total	162.240	11			

a. R Squared = .912 (Adjusted R Squared = .838)

Appendix Table 20: Differences in protein content of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	68.783[a]	5	13.757	11.173	.005
Intercept	16546.420	1	16546.420	13438.38	.000
TRT	62.939	3	20.980	17.039	.002
REP	5.844	2	2.922	2.373	.174
Error	7.388	6	1.231		
Total	16622.590	12			
Corrected Total	76.170	11			

a. R Squared = .903 (Adjusted R Squared = .822)

Appendix Table 21: Differences in ash content of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.615[a]	5	.323	.798	.588
Intercept	655.437	1	655.437	1620.563	.000
TRT	.928	3	.309	.765	.554
REP	.687	2	.343	.849	.474
Error	2.427	6	.404		
Total	659.478	12			
Corrected Total	4.041	11			

a. R Squared = .400 (Adjusted R Squared = -.101)

Appendix Table 22: Differences in lactose content of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	323.225[a]	5	64.645	8.308	.011
Intercept	2825.371	1	2825.371	363.128	.000
TRT	295.957	3	98.652	12.679	.005
REP	27.268	2	13.634	1.752	.252
Error	46.684	6	7.781		
Total	3195.279	12			
Corrected Total	369.909	11			

a. R Squared = .874 (Adjusted R Squared = .769)

Appendix Table 23: Differences in dry matter percentage of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.428[a]	5	7.086	5.056	.037
Intercept	17078.077	1	17078.077	12186.22	.000
TRT	27.328	3	9.109	6.500	.026
REP	8.101	2	4.050	2.890	.132
Error	8.409	6	1.401		
Total	17121.914	12			
Corrected Total	43.837	11			

a. R Squared = .808 (Adjusted R Squared = .648)

Appendix Table 24: Differences in moisture content percentage of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	35.428[a]	5	7.086	5.056	.037
Intercept	46538.157	1	46538.157	33207.72	.000
TRT	27.328	3	9.109	6.500	.026
REP	8.101	2	4.050	2.890	.132
Error	8.409	6	1.401		
Total	46581.994	12			
Corrected Total	43.837	11			

a. R Squared = .808 (Adjusted R Squared = .648)

Appendix Table 25: Differences in pH of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.126[a]	5	.025	2.283	.172
Intercept	423.879	1	423.879	38338.36	.000
TRT	.072	3	.024	2.180	.191
REP	.054	2	.027	2.439	.168
Error	.066	6	.011		
Total	424.071	12			
Corrected Total	.193	11			

a. R Squared = .656 (Adjusted R Squared = .368)

Appendix Table 26: Differences in acidity percentage of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.387[a]	5	.477	36.188	.000
Intercept	19.270	1	19.270	1460.546	.000
TRT	2.369	3	.790	59.849	.000
REP	.018	2	.009	.696	.535
Error	.079	6	.013		
Total	21.736	12			
Corrected Total	2.466	11			

a. R Squared = .968 (Adjusted R Squared = .941)

Appendix Table 27: Differences in hardness of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	245477.628[a]	5	49095.526	3.448	.082
Intercept	12517715.647	1	12517715.6	879.113	.000
TRT	170774.236	3	56924.745	3.998	.070
REP	74703.392	2	37351.696	2.623	.152
Error	85434.168	6	14239.028		
Total	12848627.443	12			
Corrected Total	330911.796	11			

a. R Squared = .742 (Adjusted R Squared = .527)

Appendix Table 28: Differences in adhesiveness of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7874.736[a]	5	1574.947	9.736	.008
Intercept	59184.647	1	59184.647	365.867	.000
TRT	7427.870	3	2475.957	15.306	.003
REP	446.866	2	223.433	1.381	.321
Error	970.592	6	161.765		
Total	68029.975	12			
Corrected Total	8845.328	11			

a. R Squared = .890 (Adjusted R Squared = .799)

Appendix Table 29: Differences in appearance for sensory properties of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	69.533[a]	32	2.173	6.461	.000
Intercept	6380.208	1	6380.208	18971.62	.000
TRT	1.492	3	.497	1.478	.226
REP	68.042	29	2.346	6.977	.000
Error	29.258	87	.336		
Total	6479.000	120			
Corrected Total	98.792	119			

a. R Squared = .704 (Adjusted R Squared = .595)

Appendix Table 30: Differences in color for sensory properties of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	54.033[a]	32	1.689	7.749	.000
Intercept	6916.008	1	6916.008	31737.64	.000
TRT	.292	3	.097	.446	.721
REP	53.742	29	1.853	8.504	.000
Error	18.958	87	.218		
Total	6989.000	120			
Corrected Total	72.992	119			

a. R Squared = .740 (Adjusted R Squared = .645)

Appendix Table 31: Differences in odor for sensory properties of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	145.700[a]	32	4.553	7.461	.000
Intercept	5950.208	1	5950.208	9750.459	.000
TRT	2.158	3	.719	1.179	.323
REP	143.542	29	4.950	8.111	.000
Error	53.092	87	.610		
Total	6149.000	120			
Corrected Total	198.792	119			

a. R Squared = .733 (Adjusted R Squared = .635)

Appendix Table 32: Differences in texture for sensory properties of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	72.233[a]	32	2.257	5.492	.000
Intercept	6293.008	1	6293.008	15310.88	.000
TRT	1.492	3	.497	1.210	.311
REP	70.742	29	2.439	5.935	.000
Error	35.758	87	.411		
Total	6401.000	120			
Corrected Total	107.992	119			

a. R Squared = .669 (Adjusted R Squared = .547)

Appendix Table 33: Differences in taste for sensory properties of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	86.500[a]	32	2.703	2.991	.000
Intercept	6091.875	1	6091.875	6740.771	.000
TRT	2.625	3	.875	.968	.412
REP	83.875	29	2.892	3.200	.000
Error	78.625	87	.904		
Total	6257.000	120			
Corrected Total	165.125	119			

a. R Squared = .524 (Adjusted R Squared = .349)

Appendix Table 34: Differences in overall for sensory properties of ricotta cheese made from goat's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	70.567[a]	32	2.205	3.935	.000
Intercept	6177.675	1	6177.675	11022.89	.000
TRT	1.492	3	.497	.887	.451
REP	69.075	29	2.382	4.250	.000
Error	48.758	87	.560		
Total	6297.000	120			
Corrected Total	119.325	119			

a. R Squared = .591 (Adjusted R Squared = .441)

Appendix Table 35: Differences in yield percentage of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	45.493[a]	5	9.099	29.074	.000
Intercept	711.985	1	711.985	2275.086	.000
TRT	45.187	3	15.062	48.130	.000
REP	.307	2	.153	.490	.635
Error	1.878	6	.313		
Total	759.356	12			
Corrected Total	47.371	11			

a. R Squared = .960 (Adjusted R Squared = .927)

Appendix Table 36: Differences in fat content of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1234.331[a]	5	246.866	2.498	.148
Intercept	7943.047	1	7943.047	80.378	.000
TRT	758.278	3	252.759	2.558	.151
REP	476.053	2	238.027	2.409	.171
Error	592.927	6	98.821		
Total	9770.305	12			
Corrected Total	1827.258	11			

a. R Squared = .676 (Adjusted R Squared = .405)

Appendix Table 37: Differences in protein content of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	840.085[a]	5	168.017	2.507	.147
Intercept	31697.702	1	31697.702	472.980	.000
TRT	598.993	3	199.664	2.979	.118
REP	241.092	2	120.546	1.799	.244
Error	402.102	6	67.017		
Total	32939.889	12			
Corrected Total	1242.188	11			

a. R Squared = .676 (Adjusted R Squared = .407)

Appendix Table 38: Differences in ash content of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7.659[a]	5	1.532	2.645	.134
Intercept	507.296	1	507.296	875.983	.000
TRT	4.644	3	1.548	2.673	.141
REP	3.015	2	1.508	2.603	.153
Error	3.475	6	.579		
Total	518.430	12			
Corrected Total	11.133	11			

a. R Squared = .688 (Adjusted R Squared = .428)

Appendix Table 39: Differences in lactose content of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	28.907[a]	5	5.781	.405	.830
Intercept	2549.281	1	2549.281	178.580	.000
TRT	7.239	3	2.413	.169	.913
REP	21.668	2	10.834	.759	.508
Error	85.652	6	14.275		
Total	2663.840	12			
Corrected Total	114.559	11			

a. R Squared = .252 (Adjusted R Squared = -.371)

Appendix Table 40: Differences in dry matter percentage of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	50.332[a]	5	10.066	1.267	.385
Intercept	16270.972	1	16270.972	2048.111	.000
TRT	27.082	3	9.027	1.136	.407
REP	23.250	2	11.625	1.463	.304
Error	47.666	6	7.944		
Total	16368.970	12			
Corrected Total	97.999	11			

a. R Squared = .514 (Adjusted R Squared = .108)

Appendix Table 41: Differences in moisture content percentage of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	50.332[a]	5	10.066	1.267	.385
Intercept	47896.392	1	47896.392	6028.966	.000
TRT	27.082	3	9.027	1.136	.407
REP	23.250	2	11.625	1.463	.304
Error	47.666	6	7.944		
Total	47994.390	12			
Corrected Total	97.999	11			

a. R Squared = .514 (Adjusted R Squared = .108)

Appendix Table 42: Differences in pH of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.174[a]	5	.035	.980	.498
Intercept	399.284	1	399.284	11267.05	.000
TRT	.160	3	.053	1.504	.306
REP	.014	2	.007	.194	.829
Error	.213	6	.035		
Total	399.670	12			
Corrected Total	.386	11			

a. R Squared = .450 (Adjusted R Squared = -.009)

Appendix Table 43: Differences in acidity percentage of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4.856[a]	5	.971	27.696	.000
Intercept	32.001	1	32.001	912.545	.000
TRT	4.752	3	1.584	45.168	.000
REP	.104	2	.052	1.488	.299
Error	.210	6	.035		
Total	37.067	12			
Corrected Total	5.067	11			

a. R Squared = .958 (Adjusted R Squared = .924)

Appendix Table 44: Differences in hardness of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	163064.889[a]	5	32612.978	4.432	.049
Intercept	13802158.028	1	13802158.0	1875.583	.000
TRT	146976.397	3	48992.132	6.658	.025
REP	16088.492	2	8044.246	1.093	.394
Error	44153.169	6	7358.861		
Total	14009376.085	12			
Corrected Total	207218.057	11			

a. R Squared = .787 (Adjusted R Squared = .609)

Appendix Table 45: Differences in adhesiveness of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	889.377[a]	5	177.875	1.166	.422
Intercept	42994.026	1	42994.026	281.746	.000
TRT	666.402	3	222.134	1.456	.318
REP	222.975	2	111.487	.731	.520
Error	915.592	6	152.599		
Total	44798.995	12			
Corrected Total	1804.969	11			

a. R Squared = .493 (Adjusted R Squared = .070)

Appendix Table 46: Differences in appearance for sensory properties of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	49.933[a]	32	1.560	7.365	.000
Intercept	6541.633	1	6541.633	30874.62	.000
TRT	.567	3	.189	.892	.449
REP	49.367	29	1.702	8.034	.000
Error	18.433	87	.212		
Total	6610.000	120			
Corrected Total	68.367	119			

a. R Squared = .730 (Adjusted R Squared = .631)

Appendix Table 47: Differences in color for sensory properties of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	48.333[a]	32	1.510	6.361	.000
Intercept	7038.008	1	7038.008	29639.70	.000
TRT	1.092	3	.364	1.532	.212
REP	47.242	29	1.629	6.860	.000
Error	20.658	87	.237		
Total	7107.000	120			
Corrected Total	68.992	119			

a. R Squared = .701 (Adjusted R Squared = .590)

Appendix Table 48: Differences in odor for sensory properties of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	114.767[a]	32	3.586	10.750	.000
Intercept	6235.208	1	6235.208	18689.51	.000
TRT	.225	3	.075	.225	.879
REP	114.542	29	3.950	11.839	.000
Error	29.025	87	.334		
Total	6379.000	120			
Corrected Total	143.792	119			

a. R Squared = .798 (Adjusted R Squared = .724)

Appendix Table 49: Differences in texture for sensory properties of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	104.933[a]	32	3.279	12.059	.000
Intercept	6206.408	1	6206.408	22823.14	.000
TRT	1.092	3	.364	1.338	.267
REP	103.842	29	3.581	13.168	.000
Error	23.658	87	.272		
Total	6335.000	120			
Corrected Total	128.592	119			

a. R Squared = .816 (Adjusted R Squared = .748)

Appendix Table 50: Differences in taste for sensory properties of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	78.800[a]	32	2.462	5.565	.000
Intercept	7022.700	1	7022.700	15869.48	.000
TRT	1.500	3	.500	1.130	.342
REP	77.300	29	2.666	6.023	.000
Error	38.500	87	.443		
Total	7140.000	120			
Corrected Total	117.300	119			

a. R Squared = .672 (Adjusted R Squared = .551)

Appendix Table 51: Differences in overall for sensory properties of ricotta cheese made from buffalo's milk using different type of acids

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	58.967[a]	32	1.843	5.285	.000
Intercept	6482.700	1	6482.700	18593.24	.000
TRT	.167	3	.056	.159	.923
REP	58.800	29	2.028	5.815	.000
Error	30.333	87	.349		
Total	6572.000	120			
Corrected Total	89.300	119			

a. R Squared = .660 (Adjusted R Squared = .535)

APPENDIX B

Questionnaire

Name_____ **Date**_____

Product: Ricotta cheese from cow's milk

Instruction

1. Please rinse your mouth with water before starting. You may rinse again at anytime during the test you need to.
2. Please taste the samples in the order presented, from left to right.
3. Please rate the samples in each attribute from most preferred to least preferred by putting number in these following table.

9 = like extremely **8 = like very much** **7 = like moderately**

6 = like slightly **5 = neither like nor dislike** **4 = dislike slightly**

3 = dislike moderately **2 = dislike very much** **1 = dislike extremely**

Attributes	**147**	**314**	**598**	**843**
Color				
Texture				
Appearance				
Odor				
Taste				
Overall				

***** Thank you *****

Questionnaire

Name_____ **Date**_____

Product: Ricotta cheese from goat's milk

Instruction

1. Please rinse your mouth with water before starting. You may rinse again at anytime during the test you need to.
2. Please taste the samples in the order presented, from left to right.
3. Please rate the samples in each attribute from most preferred to least preferred by putting number in these following table.

9 = like extremely **8 = like very much** **7 = like moderately**

6 = like slightly **5 = neither like nor dislike** **4 = dislike slightly**

3 = dislike moderately **2 = dislike very much** **1 = dislike extremely**

Attributes	**235**	**349**	**782**	**937**
Color				
Texture				
Appearance				
Odor				
Taste				
Overall				

***** Thank you *****

Questionnaire

Name_____ **Date**_____

Product: Ricotta cheese from buffalo's milk

Instruction

1 Please rinse your mouth with water before starting. You may rinse again at anytime during the test you need to.

2 Please taste the samples in the order presented, from left to right.

3 Please rate the samples in each attribute from most preferred to least preferred by putting number in these following table.

9 = like extremely **8 = like very much** **7 = like moderately**

6 = like slightly **5 = neither like nor dislike** **4 = dislike slightly**

3 = dislike moderately **2 = dislike very much** **1 = dislike extremely**

Attributes	**198**	**216**	**619**	**764**
Color				
Texture				
Appearance				
Odor				
Taste				
Overall				

***** Thank you *****