

Acceptability of Queso Fresco Cheese by Traditional and Nontraditional Consumers

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Four replicate batches of high- and low-salt queso fresco cheeses were made to compare consumer preferences. Seven trained panelists judged specific attributes of the eight cheeses. Untrained consumers (395) at three Washington state locations noted how much they liked or disliked the same cheeses. Thirty-three percent of the surveyed population was Hispanic, and 45% were familiar with queso fresco. All cheeses, except the one containing the highest percent salt and the highest pH, were liked slightly to moderately. Traditional consumers (either Hispanic or those familiar with queso fresco) preferred high-salt/high-pH cheeses to a greater extent than nontraditional consumers. Nontraditional consumers preferred low-salt/low-pH cheeses. The same preference trends were noted for all ages and at all three geographical locations. Queso fresco with 1.4–2.4% salt and a pH between 5.4–6.1 was most acceptable to the widest range of consumers.

Key Words: queso fresco, cheese, sensory analysis, preference, consumers

Se elaboraron dos lotes de queso fresco, de cuatro unidades cada uno, con alto y bajo contenido de sal para comparar preferencias de los consumidores. Siete jueces entrenados evaluaron atributos específicos de los ocho quesos. Trescientos noventa y cinco consumidores de algunas localidades del estado de Washington dieron su opinión respecto a la apreciación de los quesos. El treinta y tres por ciento de la población entrevistada era de origen hispano y el 45% estaba familiarizada con el queso fresco. Todos los quesos, excepto el que contenía el mayor porcentaje de sal y el mayor pH, gustaron de ligera a moderadamente. Los consumidores tradicionales, tanto hispanos como los familiarizados con el queso fresco, prefirieron quesos con alto contenido de sal y pH bajo. Se obtuvieron las mismas tendencias, en cuanto a preferencias, para todas las edades y localidades. El queso fresco con un contenido de sal entre el 1,4 y 2,4% y un pH entre el 5,4 y el 6,1 fue el más aceptado entre la mayor parte de consumidores.

Palabras Clave: queso fresco, análisis sensorial, preferencias, consumidores

INTRODUCTION

Queso fresco is a fresh, high moisture, crumbly, salty, white cheese that is traditionally made in Latin-American countries from raw cow's milk. This cheese is particularly popular in southern and western United States, where a significant portion of the population is Hispanic. Approximately 11% of the U.S. population is Hispanic, with highest concentrations of Hispanic populations in (descending order) California, Texas, New York, Florida, Illinois, Arizona, New Jersey, New Mexico, Colorado, Massachusetts and Washington (U.S. Census Bureau, 1999a). In California

alone, in 1998, 31% of the population was Hispanic (U.S. Census Bureau, 1999a). In 1998, 6.2% of the population in Washington was Hispanic, up from 6.0% in 1997 and 5.8% in 1996. Individual Washington counties with highest concentration of Hispanics include Adams (43%), Franklin (39%), Yakima (32%), Grant (24%), Thurston (21%), Columbia (16%), Douglas (14%), Chelan and Walla Walla (13%) and Benton and Okanagen (11%) (U.S. Census Bureau, 1999b).

Because of the high moisture content and high pH of queso fresco, contaminating bacteria such as *Salmonella typhimurium* and *Listeria monocytogenes* can proliferate to high numbers in the cheese (Geilman and Herfurth-Kennedy, 1992; Kasrazadeh and Genigeorgis, 1994). Both pathogens have been implicated in foodborne illness outbreaks (Kasrazadeh and Genigeorgis, 1994; Villar et al., 1999). Between 1990 and 1992, the mean incidence of human *Salmonella typhimurium* infections in Yakima County, Washington, was 5.4 cases per 100,000 person-years (Villar et al., 1999). In 1996, the number of cases increased to 29.7, and in 1997, the number jumped to 64.8 cases per 100,000 person-years (Villar et al., 1999). During that same period of

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time, the incidence of culture-confirmed salmonellosis for the rest of Washington remained at 3.5 cases per 100,000 person-years (Villar et al., 1999). In a case-controlled investigation, infections with *Salmonella typhimurium* were primarily associated with eating raw milk Mexican-style soft cheese purchased from unknown street vendors, friends or relatives (Villar et al., 1999). Two outbreaks in California in 1997 were linked to consumption of raw milk Mexican-style cheese contaminated with multidrug-resistant *Salmonella typhimurium* DT104 (Cody et al., 1999). Although not officially documented in Washington, the Dairy Institute of California estimated in 1988 that 40% of the soft cheeses in California were manufactured and sold illegally (Kasrazadeh and Genigeorgis, 1994). These alarming statistics motivated organization of the "Abuela Project" by Cooperative Extension of Washington (Bell et al., 1999). Washington State University (WSU) developed a safe manufacturing method for producing queso fresco, involving sanitation, milk pasteurization, the use of buttermilk and vinegar and refrigeration (Bell et al., 1999). *Abuelas* (grandmothers) along with other educators have successfully introduced the pasteurized milk recipe to over 1,000 Latin-Americans in Yakima County, Washington.

The recipe of queso fresco made of pasteurized milk was created for home production and has been widely accepted. As a result, entrepreneurs have requested a commercial queso fresco recipe. Development of an authentic commercial queso fresco is important because of the cheese's versatility and growing popularity. In addition, increased availability of acceptable commercial products may reduce the number of people who make queso fresco at home with potentially harmful raw milk. However, when a home-cooked process is scaled up to commercial scale, the home-style quality can be lost.

The primary objective of this research was to determine the concentration of salt and pH in queso fresco that would be most acceptable to traditional and nontraditional consumers. Preliminary research in our laboratory indicated that a salt level between 1 and 3% would be most desirable, but specifics had not been determined. Personal communication indicated that some acidity in the product would also be desirable, but again no specifics were outlined. It was postulated that queso fresco preferences may differ regionally, so it was proposed that taste tests be conducted in different cities in Washington.

MATERIALS AND METHODS

Cheesemaking Procedure

Duplicate batches of queso fresco cheese were made following two different recipes on four different days. The eight batches of cheese were made using 91 kg pasteurized and homogenized Vitamin D milk obtained from Vitamilk Dairy (Seattle, WA). Milk was heated to 32 °C (90 °F) in 200

L cheese vats (WSU Creamery, Pullman, WA) then maintained at 32 °C. Lactic starter culture that had been propagated in Acclaim Grade A medium (Gist-Brocades, Milville, UT) was added at a rate of 0.25% based on milk weight. Ten mL (0.01%) double-strength Chy-Max coagulator (Chris Hansen Laboratories, Milwaukee, WI), diluted 1:40 with water, was added to the 32 °C milk either immediately (high-salt/high-pH recipe) or after 15 minutes incubation (low-salt/low-pH recipe) and stirred 1 min. The cheese-milk was allowed to set for approximately 20 min.

After adequate set was obtained, the curd was cut with 0.64 cm knives and allowed to heal 5 min prior to cooking. Curd and whey were heated to 35 °C over 15 min (stirring continuously), then the temperature was maintained and curd was stirred continuously for an additional 20 min. Approximately 66% of the whey was drained through a vat strainer. Morton top flake coarse salt (Morton Salt, Chicago, IL) was added in three uniform applications to the remaining whey-curd mixture at 5-minute intervals, with stirring (low-salt recipe utilized 0.9 kg salt; high-salt recipe utilized 1.8 kg salt).

Two modified Longhorn hoops were filled with curd and pressed at 1.8 kg/cm² for one hour at room temperature. The pressed curd was then removed from hoops and wrapped in salted (10% salt solution) cheesecloths for a second pressing at 1.8 kg/cm² at room temperature, overnight. The next day, cheeses were removed from the hoops and cut into 1/2-inch cubes for analysis.

Methods

Cheese Analysis

Cheeses were analyzed, in duplicate, for pH, moisture and salt two days after manufacture. Moisture was determined by the oven drying method (Marshall, 1993) in a forced-air draft oven (Blue M Batch Oven OV-472A-3, Blue Island, IL). The pH was determined with a Corning pH meter (flat surface 476551, Corning, NY), and salt was measured with a Corning Chloride Analyzer 926 (Medfield, MA).

Microbiological Analysis

Microbiological analysis of cheeses was done to confirm the absence of indicator organisms. Coliform bacteria were enumerated following the standard methods for the examination of dairy products (Marshall, 1993). If colonies were found, confirmation tests were done in test tubes containing Durham tubes and Brilliant Green Bile broth (VWR Scientific Products, Willard, OH).

Sensory Analysis

Two sets of duplicate batches of cheese (a total of eight cheeses, made three weeks apart) were tasted by trained sensory panelists and untrained consumer panelists. Sensory analysis was approved by the WSU Institutional Review

Board. Seven students and staff members from WSU were trained to evaluate queso fresco. Panelists met on two occasions for one-hour training sessions.

During the first training session, examples of queso fresco were tasted, and terms were generated to describe the cheeses. The most appropriate descriptive terms were selected, and a ballot was created using the following attributes: white, open, off-flavor, salty, acid, moist, crumbly, particles and sticky/pasty. A 9-point scale was used, with 1 being low and 9 being high for each attribute. In the second session, to calibrate the panelists to the ballot, anchors were set with a variety of cheeses. Feta cheese was used to set high open, high salt, high white, high crumbly and low moist attributes. Monterey Jack cheese was used to set low open, low salt and low white attributes. In subsequent tasting sessions, cheeses assigned three-digit random numbers were tasted in random order.

Untrained sensory panels were conducted at fairs in Connell and Pasco (cheeses made September 9 and 10) and Yakima (cheeses made September 28 and 29), WA. These locations were selected because they contain a significant Hispanic population (up to 31%). Signs advertising "Queso Fresco Cheese Tasting" drew fair-goers to the tasting sessions. If over 18 years of age, individuals were asked if they would like to participate, and the decision to do so was entirely voluntary. Panelists were handed a form that asked them demographic information. Survey forms were available in English and Spanish and questions were general, created to be quick and easy to fill out by volunteers. The following questions were asked of each participant:

1. How old are you? 18–29 30–45 46+
2. Are you familiar with the Latin-American cheese queso fresco? Yes No
3. Do you have Hispanic heritage? Yes No
4. In which county do you live? Whitman Yakima
Walla Walla Benton Franklin Other

A day prior to the tasting sessions, cheeses were cut into 1/2" × 1/2" cubes. A table of random numbers was consulted for labeling of each cheese. Each cheese received two sets of three-digit random numbers. Cheeses were bagged separately and refrigerated overnight. Nine-inch plates were randomly labeled with numbers representing the four different cheeses. Each panelist tasted each cheese once, in random order. During the fairs, bagged cheeses were held in insulated coolers containing ice packs. Investigators wore gloves and placed cheeses on labeled plates. Water was available for panelists to drink during the tasting session. Panelists were asked to indicate how much they disliked or liked each cheese using a seven-point scale (dislike very much = 1; neither like nor dislike = 4; like very much = 7).

Statistical Analysis

The analysis was based upon a completely randomized design (two treatments with four replications each) embedded in the randomized block design (panelists = blocks). No

incubation-high salt was one treatment, and 15 min incubation-low salt was the second treatment. Each batch of cheese was treated as a replicate because two recipes were made on four separate occasions. Trained and untrained panelists were the units of replication in the experiment and panelists were treated as random effects. One-way ANOVA was used to detect differences; differences were considered significant when resultant *p*-values were less than or equal to 0.05.

RESULTS AND DISCUSSION

The pH and salt of samples was influenced by the recipe followed (Table 1). Treatment 1 cheeses (A, C, E and G) that were incubated for 15 minutes prior to rennet addition and received low salt application had low salt level (1.2–1.5%) and low pH (5.0–5.4). Treatment 2 (B, D, F and H) cheeses were not incubated prior to rennet addition and received high salt application, thus consequently, had high salt levels (2.3–3.0%) and high pH (6.1–6.3). Measured pH, percent salt and percent salt in moisture (SIM) varied between duplicates and manufacture dates due to slight differences in salt application and cheese pressing. Salt level in cheeses was highly correlated (data not shown) with salt in moisture (0.99), pH (0.97) and moisture (0.55). Cheese pH was highly correlated with salt (0.97), salt-in-moisture (0.96) and moisture (0.58).

Sensory Analysis

All eight cheeses were devoid of coliform bacteria and deemed safe for consumption by panelists.

Trained Panels

Panelists were able to distinguish differences between

Table 1. Summary of the chemical analysis of queso fresco.

Cheese	pH	Salt (%)	Moisture (%)	Salt in Moisture (%)
Treatment 1				
A	5.36	1.48	51.91	2.85
C	5.03	1.17	47.03	2.49
E	5.07	1.35	47.78	2.83
G	5.11	1.53	48.33	3.16
Overall Average	5.14 ^a	1.38 ^a	48.76 ^{a,b}	2.83 ^a
Treatment 2				
B	6.32	3.01	52.18	5.77
D	6.05	2.33	48.56	4.83
F	6.07	2.59	49.00	5.29
H	6.18	2.42	51.53	4.69
Overall Average	6.16 ^b	2.59 ^b	50.24 ^{a,b}	5.15 ^b

Treatment 1: 15 min incubation prior to rennet addition, low salt; Treatment 2: no incubation, high salt.

Means within the same column having different superscripts differ significantly (*p* < 0.05).

Table 2. Average of scores for queso fresco from trained sensory panelists (from a 9-point scale).

Cheese	Acid	Salty	Crumbly	White	Particles	Off-flavor	Sticky
Treatment 1							
A	6.17 ^b	4.67 ^b	6.33 ^{a,b}	7.67 ^{a,b}	5.83 ^a	1.17 ^c	4.00 ^{a,b,c}
C	6.67 ^b	4.50 ^b	7.50 ^a	7.83 ^{a,b}	6.17 ^a	1.50 ^{b,c}	3.00 ^c
E	7.17 ^b	4.33 ^b	3.83 ^c	7.00 ^{a,b}	3.00 ^b	2.33 ^{a,b}	6.00 ^a
G	5.83 ^b	4.50 ^b	3.75 ^c	7.17 ^{a,b}	3.58 ^b	2.60 ^a	5.17 ^{a,b}
Average	6.54 ^b	4.61 ^b	5.41 ^b	7.50 ^b	4.55 ^b	1.75 ^{a,b}	4.36 ^b
Treatment 2							
B	3.33 ^a	7.50 ^a	7.50 ^a	8.00 ^{a,b}	5.50 ^a	1.17 ^c	2.67 ^c
D	2.33 ^a	7.50 ^a	7.50 ^a	8.17 ^{a,b}	6.17 ^a	1.00 ^c	2.17 ^c
F	3.40 ^a	6.80 ^a	5.60 ^b	8.00 ^{a,b}	4.60 ^{a,b}	1.33 ^c	3.80 ^{b,c}
H	3.50 ^a	7.33 ^a	5.17 ^b	8.17 ^{a,b}	4.50 ^{a,b}	1.33 ^c	3.17 ^{b,c}
Average	3.25 ^a	7.37 ^a	6.53 ^a	8.05 ^a	5.08 ^a	1.23 ^{a,b}	2.64 ^a

Treatment 1: 15 min incubation prior to rennet addition, low salt; Treatment 2: no incubation, high salt.

Means within the same column having different superscripts differ significantly ($p < 0.05$).

cheeses (Table 2). Cheeses made on the first two processing days (A, B, C and D) were perceived as more salty, moist, open and crumbly, and to have more particles than duplicate cheeses made three weeks later (E, F, G and H). This could be due to slight differences in milk composition, make procedure or sensory panelist assessment precision. The inability of panelists to differentiate other small differences could be due to the limited amount of training they received rather than actual tasting ability.

No significant differences in the white attribute were found because all cheeses tended to be very white (non-yellow). No significant differences in the open attribute were found, but open was highly correlated with moist, crumbly and particles (Table 3). Open cheeses retained more moisture and had a tendency to break apart during handling (crumbly). Crumbly was also highly correlated with particles and negatively correlated with sticky. It is understandable that crumbly cheeses would leave a more pronounced sensation of particles than less crumbly cheeses and would be less sticky.

Salty and acid were highly negatively correlated. Higher salt concentrations inhibited the growth of starter and non-starter lactic acid bacteria, thus acid development was inhibited, and pH was higher. Generally low scores were assessed for the off-flavor category, but two low-salt cheeses (G and E) had higher off-flavor scores, suggesting that salt

levels were inadequate to fully mask off-flavors. Off-flavor was also positively correlated with sticky, while salt was negatively correlated with sticky. The sticky attribute could be a result of proteolysis by starter and non-starter lactic acid bacteria. Thus, when bacterial growth was inhibited by salt, proteolysis was also inhibited.

Consumer Preference

Untrained fair-goers (a total of 395: 56 from Connell, 150 from Pasco and 189 from Yakima) voluntarily participated in sensory analysis. The sensory panel population was made up of 131 (33%) Hispanic individuals, and 179 panelists (45%) were familiar with queso fresco. All cheeses at all locations received average scores between 4.8 and 5.4 (Table 4). A score of 4 corresponded to "neither like nor dislike," 5 to "like slightly" and 6 to "like moderately." Only the cheese with the highest salt/highest pH (B) scored below 5.

Consumers self-categorized their age as 18–29, 30–45 or 46+. The sampled population represented a relatively balanced distribution of 115 (29%), 157 (40%) and 109 (28%), in each group, respectively. Queso fresco preference was not influenced by age (data not shown). When data were analyzed by county (data not shown), no significant regional preference differences were observed, and the same intermediate salt/pH preferences were noted. The general nature

Table 3. Correlations of queso fresco attributes judged by results of trained sensory panel.

	White	Open	Off-flavor	Salty	Acid	Moist	Crumbly	Particles
Sticky	-0.19	-0.17	0.44**	-0.38	0.36*	-0.33	-0.51**	-0.34*
White	-	0.34*	-0.20	0.42**	-0.25	0.28	0.54**	0.48**
Open	-	-	-0.09	0.16	-0.14	0.58**	0.60**	0.70**
Off-flavor	-	-	-	0.47**	0.08	-0.24	-0.29	-0.02
Salty	-	-	-	-	-0.65**	0.22	0.31*	0.10
Acid	-	-	-	-	-	-0.03	-0.33*	-0.25
Moist	-	-	-	-	-	-	0.55**	0.51**
Crumbly	-	-	-	-	-	-	-	0.81**

*Significant correlation between factors ($p < 0.05$).

**Significant correlation between factors ($p < 0.005$).

Table 4. Average scores (from 7-point scale) assigned to queso fresco by consumer sensory panelists, comparing location of testing (towns in Washington state).

Cheese	Overall			
	Average	Connell	Pasco	Yakima
Treatment 1				
A	5.39	5.52 ^a	5.36 ^a	—
C	5.15	5.02 ^{a,b}	5.19 ^{a,b}	—
E	5.42	—	—	5.42 ^a
G	5.34	—	—	5.34 ^a
Average	5.27 ^a			
Treatment 2				
B	4.77	4.21 ^b	4.65 ^b	—
D	5.29	5.40 ^a	5.25 ^a	—
F	5.13	—	—	5.13 ^{a,b}
H	5.08	—	—	5.08 ^a
Average	5.05 ^b			

Treatment 1: 15 min incubation prior to rennet addition, low salt; Treatment 2: no incubation, high salt.

Means within the same column having different superscripts differ significantly ($p < 0.05$).

of the survey questions allowed consumers to self-categorize their heritage and familiarity with queso fresco based upon their own definition. Frequency of queso fresco consumption was not requested. Panelists indicated their county of residence.

When age, familiarity and heritage were controlled in the model, the low-salt/low-pH cheese (Treatment 1) was significantly preferred over the high-salt/high-pH cheese (Treatment 2). Familiarity with queso fresco significantly influenced cheese preferences (Table 5). For example, most Hispanic panelists were familiar with queso fresco (92%). These 92% preferred cheeses that had intermediate to high salt levels and intermediate pH (cheeses F, D and H). In contrast, 31% of the non-Hispanic panelists were familiar with

queso fresco. The favorite cheeses of non-Hispanic and nonfamiliar consumers contained low to intermediate salt levels and low pH (cheeses E, G and A).

Cheese B, the highest-salt/highest-pH queso fresco (3.0% salt and 6.3 pH) received the lowest score of all cheeses, regardless of familiarity or heritage. But, it is notable that traditional panelists were more forgiving of high salt levels than nontraditional panelists. On average, non-Hispanic and nonfamiliar panelists gave average scores of 4.5 and 4.4, respectively, to the highest-salt/highest-pH cheese B, while Hispanics and familiar consumers scored the same cheese significantly higher (average 5.1 and 5.2, respectively). Cheese F, the highest-salt cheese evaluated in Yakima, was also ranked significantly lower by non-Hispanic and nonfamiliar consumers than Hispanic and familiar consumers (4.8 and 4.7 vs. 5.7 and 5.5, respectively). Nontraditional consumers preferred a queso fresco with some acid development and not too much salt.

Consumers were invited to write additional comments on sensory ballots, but no word prompts were given. Apparently, flavor played a bigger role than texture, mouthfeel or appearance in cheese preferences. Most consumer comments related to "salty," and some were related to "sour." This is not surprising because flavor is the most frequently cited reason for liking or disliking a food (Cardello, 1994). It is not clear whether salt or acid was the most deciding factor for cheese preference, because the two were highly correlated. Very few consumers commented about texture or mouthfeel, and no consumers mentioned appearance attributes. It has been suggested that texture is very important to people, but rarely is it noted unless it does not meet expectations (Cardello, 1994). Texture is more frequently cited as a reason for disliking a food than a reason for liking it (Cardello, 1994).

Geilman and Herfurth-Kennedy (1992) suggested that non-Hispanic consumers liked and would use Hispanic

Table 5. Average scores (from 7-point scale) assigned to queso fresco by consumer sensory panelists.

Cheese	Overall Average	Heritage		Familiarity	
		Non-Hispanic	Hispanic	Nonfamiliar	Familiar
Treatment 1					
A	5.39	5.45 ^{a,b}	5.28 ^{a,b}	5.35 ^{a,b}	5.40 ^{a,b}
C	5.15	5.18 ^{a,b}	5.08 ^{a,b}	5.13 ^{a,b}	5.15 ^{a,b}
E	5.42	5.57 ^{a,b}	5.01 ^{a,b}	5.56 ^{a,b}	5.22 ^{a,b}
G	5.34	5.51 ^{a,b}	4.84 ^{a,b}	5.49 ^{a,b}	5.13 ^{a,b}
Average	5.27 ^A				
Treatment 2					
B	4.77	4.49 ^b	5.07 ^a	4.35 ^b	5.17 ^a
D	5.29	5.10 ^{a,b}	5.58 ^{a,b}	5.10 ^{a,b}	5.53 ^{a,b}
F	5.13	4.84 ^b	5.73 ^a	4.72 ^b	5.51 ^a
H	5.08	4.82 ^b	5.53 ^a	4.75 ^b	5.39 ^a
Average	5.05 ^B				

Treatment 1: 15 min incubation prior to rennet addition, low salt; Treatment 2: no incubation, high salt.

Means within the same row having different small type superscripts differ significantly ($p < 0.05$).

Means within the same column having different capitals type superscripts differ significantly ($p < 0.05$).

cheeses if the cheeses were available, and they were supplied with information about how to use the cheeses. Considering the acceptability of the queso fresco made in our pilot plant and the growing demand for a commercial product, we recommend making a commercial queso fresco with a salt level of approximately 1.4–2.4% and pH between 5.4–6.1, and supplying information about how to use the cheese. In May, 2000, a follow-up study was conducted in Pasco, WA, with 104 untrained volunteers. Queso fresco with 1.8% salt and pH 6.0 was presented to the volunteers and they indicated how much they disliked or liked the cheese. Fifty-nine percent of the volunteers were Hispanic, and 73% of the Hispanics were very familiar with queso fresco. Fifty-six percent of all panelists were very familiar with queso fresco. The flavor and texture of this queso fresco was liked moderately to very much. Sixty-four percent of all tasters indicated they would buy the cheese if sold for \$3.99/lb. This follow-up study confirms that 1.8% salt, pH 6.0 queso fresco will likely appeal to a wide range of consumers.

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