Venezuelan White Cheese: Composition and Quality

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(Received for publication March 4, 1983)

ABSTRACT

A survey was made at the retail level in the Venezuelan market to study the basic compositional and microbial characteristics of queso blanco, the most typical cheese in Venezuela. The commercial type labeled as pasteurizado blando "soft" was characterized by a high moisture content (50.6%), 2.5% sodium chloride, 21.4% fat and 19.2% protein, and a pH of 5.7. A second commercial type labeled as duro "hard" was characterized by lower moisture content (39%), 5.0% sodium chloride, 27.4% fat and 19.2% protein, and a pH of 5.3. Significant variation was found in these major compositional factors indicating a general lack of quality and/or extreme diversity of the manufacturing conditions used. Microbiological analysis revealed the presence of: (a) Salmonella, (b) extremely high numbers of total fecal coliforms and Escherichia coli, (c) high numbers of Staphylococcus aureus and enterotoxigenic S. aureus, and (d) other microorganisms including Bacillus cereus, Clostridium perfringens, Lactobacillus and yeast and molds. A statistical relationship between growth and numbers, and the presence of other indicators, pathogens, and compositional factors was investigated.

Queso blanco is a native Venezuelan cheese and is considered to be the most popular in the country. It is made from whole or partially skimmed cow’s milk, which may or may not be pasteurized. Reconstituted nonfat dry milk is occasionally used or mixed with whole milk. Its origin can be traced to "Los Llanos," or the flat south-central region in Venezuela, and its overall characteristics have been described as the same or similar to "Queso Americano," since it is produced in both Central and South America (46).

Queso blanco is an unripened cheese which is consumed fresh, with a short shelf-life. Unlike other Latin American white cheeses, the milk coagulation process is essentially enzymatic: commercial rennet or rennet extracted directly from a calf is normally used. In other Latin American white cheeses, the milk coagulation process is generally by direct acidification (25). In queso blanco, no starter culture is used and the resultant cheese lacks flavor and is characterized by a high moisture and salt content.

In spite of its high consumption and increased production in Venezuela, several researchers (4,12) have shown that there does not exist a defined, standardized, industrial technology for queso blanco production. Presently there are many different types of this cheese with a high percentage still made at the dairy farmer level.

Variability in queso blanco composition and sanitary quality exists, but progress is being made toward development and use of proper industrial technology. This report presents results on the basic compositional and microbiological characteristics of Venezuelan queso blanco. Suitability of these results for regulatory purposes is also discussed.

MATERIALS AND METHODS

Sampling

One hundred and forty-two samples of queso blanco were collected at random from markets in Caracas and central areas in Venezuela. The samples were transported in ice chests to the laboratory, coded, stored at 7 ± 1°C and analyzed within 48 h.

Chemical and physical analysis

Samples were analyzed for moisture, sodium chloride, fat, total and soluble proteins, pH, and titratable acidity (25). Samples were sliced with a mechanical cutter to consistent thickness (3 mm) and texture was evaluated using an Instron Apparatus, Model 1101, adjusting the scale to 3,000 x g and using a 3-mm diameter spindle.

Microbiological samples

Eleven grams of each cheese sample were aseptically homogenized for 1 min in a Stomacher 400 (A. J. Seward & Co., Ltd., London) with 99 ml of 2.0% sodium citrate solution at 45°C. From this, serial dilutions, using the same diluent, were prepared.

Enumeration of indicator microorganisms

Coliforms, fecal coliforms, Escherichia coli and fecal streptococci were enumerated using most-probable number (MPN) procedures according to the Bacteriological Analytical Manual (15).

Isolation and identification of Salmonella

Samples were analyzed for Salmonella using enrichment, enrichment, biochemical and serological identification techniques according to the American Public Health Association (43).
Enumeration of *Staphylococcus aureus*

Serial dilutions of the cheese samples were plated on Baird-Parker agar (1). *Staphylococcus aureus* coagulase-positive colonies were identified and enumerated (13).

The ability of the *S. aureus* isolates to produce enterotoxins was determined by the immunodiffusion method of Casman and Bennett (9). Enterotoxigenic strains of *S. aureus*, reference enterotoxins and anti-enterotoxins were generously supplied by Dr. R. Bennett, Bureau of Foods, FDA, Washington, D.C.

**Enumeration of Bacillus cereus**

Serial dilutions of the cheese samples were plated on phenol red-egg yolk polymyxin agar (MYP) (13). Characteristic colonies were counted and further identified according to the following reactions: gram stain; shape and position of spores; glucose, sucrose, glycerol and salicin fermentations; nitrate reduction tests; litmus milk reactions; Voges-Proskauer test; and action on gelatin and starch agar (13).

**Enumeration of Clostridium perfringens**

Serial dilutions of the samples were plated on tryptose-sulfite-cyto­­liserine agar (TSC) (19). Typical colonies were counted and further confirmed by the following reactions: motility-nitrate; and lactose, salicin, and raffinose fermentations (13).

**Enumeration of Lactobacillaceae**

Serial dilutions of the cheese samples were plated on MRS Agar (adjusted to pH 4.5) (27). Isolates were further identified using the following criteria: growth temperature, gram stain, catalase, oxidase, deamination of arginine, and fermentation of maltose, amigdaline, arabinose, cellobiose, galactose, lactose, mellobiose, mannitol, raffinose, rhamnose, saccharose, salicin, sorbitol, trehalose and xylose.

**Enumeration of yeasts and molds**

Yeasts and molds were enumerated on potato dextrose agar plus tartaric acid (24). Mold identification was according to Barnett and Hunter (3). Auxanograms and xymograms were performed on yeast, and final identification was determined according to Loder (26).

**Statistical analysis**

To estimate variability in composition (physical-chemical indices) and microbial quality of queso blanco manufactured in Venezuela, statistical parameters including mean, standard error, range, standard deviation, and coefficient of variation for each index and microbial group studied were determined. Frequency of distribution histograms were made for several of the physical-chemical indices with the idea of establishing associations or a tentative classification of cheese based on objective analysis.

In addition, correlation and regression analyses (22) were used to establish the possible relationship between: (a) growth of the microbial groups, i.e., indicator organisms; (b) presence of indicators and pathogens; and (c) growth of indicator organisms, pathogens and cheese composition.

**RESULTS AND DISCUSSION**

Samples were grouped initially by a commercial market characterization, i.e., cheese commercially labeled “Pasteurizado Blando” (soft) and “Pasteurizado Duro” (hard). Over 140 individual samples were obtained at retail and analyzed in this phase of the study.

Table 1 summarizes the composition of the soft type, “Pasteurizado Blando” which is characterized by: (a) a high moisture, X = 50.6%; (b) a light salt concentration, X = 2.5%; and (c) a fat content averaging 21.4%. The queso blanco labeled as “Duro” or hard (Table 2) is characterized by: (a) a lower moisture content, X = 38.8%; (b) a higher salt content, X = 5.0%; and (c) a higher fat content, X = 27.4%. Perhaps the most important observation that can be realized from Tables 1 and 2 is the extreme variability of Venezuelan queso blanco. For example, the moisture content of the “hard” type ranged from 22.4 to 49.2% (Table 2). Additionally, there is considerable overlapping between the ranges of one type to the other. This point is exemplified by comparing the range of percent moisture in the “soft” type to that of the “hard” type.

In general, the indexes which define the specific composition of queso blanco independently of the type of cheese, are represented by significant variation, indicating the lack of quality control and/or the diversity of the manufacturing conditions used. It is concluded, therefore, that: (a) considerable variation in the composition and/or manufacture of the product exists; and (b) that the commercially applied grouping or labeling of “hard” (Duro) versus “soft” (Blando) is extremely questionable.

An attempt was made to establish a grouping of the cheese (homogenous population) based on the compositional factors analyzed. First, several histograms were constructed for the major factors. Figure 1 illustrates the distribution frequency of the moisture content. Based on 144 samples of the Venezuelan queso blanco, it is not possible to establish any functional grouping for this cheese based on moisture because of the diversity of the population observed. However, this does reflect the actual condition of Venezuelan queso blanco available at the retail level.

**TABLE 1. The composition of Venezuelan queso blanco commercially labeled “Pasteurizado Blando.”**

<table>
<thead>
<tr>
<th>Statistical parameter</th>
<th>Moisture</th>
<th>Ash</th>
<th>NaCl</th>
<th>Fat</th>
<th>Total Protein</th>
<th>Soluble Protein</th>
<th>Acidity</th>
<th>pH</th>
<th>Texture (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50.6</td>
<td>4.3</td>
<td>2.5</td>
<td>21.4</td>
<td>19.9</td>
<td>0.02</td>
<td>0.43</td>
<td>5.67</td>
<td>308.6</td>
</tr>
<tr>
<td>Range</td>
<td>35.8-</td>
<td>0.7-</td>
<td>0.2-</td>
<td>8.8-</td>
<td>12.5-</td>
<td>0.003-</td>
<td>0.04-</td>
<td>4.90</td>
<td>101.6-</td>
</tr>
<tr>
<td>S.E. <strong>X</strong>&lt;sup&gt;b&lt;/sup&gt;</td>
<td>58.5</td>
<td>7.3</td>
<td>4.5</td>
<td>32.5</td>
<td>28.5</td>
<td>0.06</td>
<td>1.08</td>
<td>6.50</td>
<td>791.6</td>
</tr>
<tr>
<td><strong>s</strong>&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.58</td>
<td>0.11</td>
<td>0.10</td>
<td>0.37</td>
<td>0.35</td>
<td>0.001</td>
<td>0.028</td>
<td>0.035</td>
<td>40.1</td>
</tr>
<tr>
<td>C.V. <strong>&lt;sup&gt;d&lt;/sup&gt;</strong></td>
<td>5.32</td>
<td>1.01</td>
<td>0.88</td>
<td>3.40</td>
<td>3.24</td>
<td>0.013</td>
<td>0.26</td>
<td>0.32</td>
<td>188.4</td>
</tr>
<tr>
<td>n&lt;sup&gt;e&lt;/sup&gt;</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>22</td>
</tr>
</tbody>
</table>

<sup>a</sup>Mean.

<sup>b</sup>Standard error of the mean.

<sup>c</sup>Standard deviation.

<sup>d</sup>Coefficient of variation.

<sup>e</sup>Number of samples analyzed.
### TABLE 2. The composition of Venezuelan queso blanco commercially labeled "Pasteurizado Duro."

<table>
<thead>
<tr>
<th>Statistical parameter</th>
<th>Moisture</th>
<th>Ash</th>
<th>NaCl</th>
<th>Fat</th>
<th>Total Protein</th>
<th>Soluble Protein</th>
<th>Acidity</th>
<th>pH</th>
<th>Texture (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X²</td>
<td>38.8</td>
<td>6.8</td>
<td>5.0</td>
<td>27.4</td>
<td>24.5</td>
<td>0.03</td>
<td>0.84</td>
<td>5.28</td>
<td>1,029.6</td>
</tr>
<tr>
<td>Range</td>
<td>22.4-</td>
<td>4.0-</td>
<td>2.1-</td>
<td>15.0-</td>
<td>17.3-</td>
<td>0.01-</td>
<td>0.18</td>
<td>4.90-</td>
<td>489.0-</td>
</tr>
<tr>
<td>S.E. X²</td>
<td>0.85</td>
<td>0.15</td>
<td>0.14</td>
<td>0.65</td>
<td>0.50</td>
<td>0.002</td>
<td>0.048</td>
<td>0.005</td>
<td>136.8</td>
</tr>
<tr>
<td>s²</td>
<td>6.4</td>
<td>1.1</td>
<td>1.1</td>
<td>4.9</td>
<td>3.8</td>
<td>0.02</td>
<td>0.35</td>
<td>0.37</td>
<td>656.1</td>
</tr>
<tr>
<td>C.V. d</td>
<td>16.6</td>
<td>16.3</td>
<td>21.1</td>
<td>18.1</td>
<td>15.6</td>
<td>71.69</td>
<td>42.42</td>
<td>7.09</td>
<td>63.7</td>
</tr>
<tr>
<td>n e</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>57</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

*a* Mean.  
*b* Standard error of the mean.  
*c* Standard deviation.  
*d* Coefficient of variation.  
*e* Number of samples analyzed.

Figure 2 illustrates the frequency of distribution for texture measurements. Two populations could be distinguished. The first could be considered a "hard" type, or less than 1,410 g/cm², and the second, "soft," or those within 1,410 to greater than 3,160 g/cm². However, these wide limits of the second population would also make classification based on texture of questionable practical significance. Similarly, the frequency of distribution for protein and fat suggests that neither of these two compositional factors could be used for any practical classification of currently available market queso blanco.

Many of the compositional factors analyzed could be related or at least could interact. For example, a higher salt content would also be reflected in a higher ash content. Table 3 summarizes the correlations between the factors studied. As might be expected, there exists a statistically significant negative correlation between fat content, protein, texture, and moisture. There was a negative correlation between protein content and fat, and a positive correlation between salt content and ash. Likewise, there was a negative correlation between acidity and pH.

The extreme variability in the composition of queso blanco also suggests that it is not possible to group the cheese into a homogenous population based on objective analysis. Thus it is difficult to classify the cheese into a regularly recognized type of cheese. However, the regression analysis shows the statistical possibility of estimating the relative dependence among the main physical-chemical indices of the cheese.

With a strong intent to establish categories for queso blanco, consideration was given to the limits proposed by the Codex Alimentarius (10). The grouping is based on the percentage of moisture without fat matter and the percentage of fat in dry matter. For example, four levels of percent fat (on a dry weight basis) are suggested: (a) cheese with fat contents less than 10% are considered "lean;" (b) cheese with fat contents between 10 and 25% are considered "low fat;" (c) fat contents between 25 and 45% "semi-fat;" and (d) fat contents between 45 and 60%, "fat." These four categories plus four categories of moisture can be used to form a matrix consisting of sixteen dif-
TABLE 3. Correlation between the various compositional parameters of Venezuelan queso blanco.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Type of cheese&lt;sup&gt;3&lt;/sup&gt;</th>
<th>All samples (144)</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>Moisture</td>
<td>-.41&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total protein</td>
<td>Moisture</td>
<td>-.10</td>
</tr>
<tr>
<td>Texture</td>
<td>Moisture</td>
<td>-.83&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total protein</td>
<td>Fat</td>
<td>-.40&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Salt</td>
<td>Ash</td>
<td>+.61&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Acidity</td>
<td>pH</td>
<td>-.30&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Using the commercial label, i.e., Duro (hard) and Blando (soft).
<sup>b</sup>Number in parenthesis is number of samples analyzed.
<sup>c</sup>Correlation coefficient of the corresponding y and x.
<sup>d</sup>Significant at the p<.05 level.
<sup>e</sup>Significant at the p<.01 level.

Figure 3 illustrates the three dimensional presentation of fat, moisture and the frequency of occurrence. Six of the possible sixteen categories were not represented by any of the 144 samples analyzed (Fig. 3). These were very hard, lean fat; very hard, fat; hard, fat; hard, lean-fat; semi-hard, fat; and soft, lean-fat. Additionally, four samples or less were classified as either very hard, semi-fat; very hard, fat; semi-hard, lean-fat or soft-fat. Less than 10% of samples could be categorized into the 10 groups just listed. This meant that all the other samples could be grouped into the remaining six categories (Fig. 3). The predominant types of queso blanco in the Venezuelan market, according to Codex Alimentarius are hard, semi-fat (8.5%); hard, fat (7.0%); semi-hard, semi-fat (24.7%); semi-hard, fat (19.3%); soft, semi-fat (13.1%); and soft, fat (19.0%). The fact that these six types of queso blanco were the predominant ones in the Venezuelan market was considered important, because these results could be used as a basis for the discussion of the cheese categories or types that might be regulated by standards of quality if they were established by governmental agencies.

TABLE 4. Microbiological quality of Venezuelan queso blanco.

<table>
<thead>
<tr>
<th>Organism</th>
<th>&quot;Soft&quot;&lt;sup&gt;3&lt;/sup&gt;</th>
<th>&quot;Hard&quot;&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X&lt;sup&gt;b&lt;/sup&gt;</td>
<td>CV&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>5.9</td>
<td>4.5-7.</td>
</tr>
<tr>
<td>Fecal coliforms</td>
<td>5.6</td>
<td>4.0-6.9</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>5.5</td>
<td>3.8-6.9</td>
</tr>
<tr>
<td>Fecal streptococci</td>
<td>6.0</td>
<td>4.5-7.0</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>5.6</td>
<td>2.8-6.2</td>
</tr>
<tr>
<td>Clostridium perfringens</td>
<td>2.2</td>
<td>1.0-3.8</td>
</tr>
<tr>
<td>Bacillus cereus</td>
<td>6.0</td>
<td>5.0-7.5</td>
</tr>
<tr>
<td>Lactic acid bacteria</td>
<td>6.1</td>
<td>3.0-7.0</td>
</tr>
<tr>
<td>Mold</td>
<td>4.2</td>
<td>3.0-5.8</td>
</tr>
<tr>
<td>Yeast</td>
<td>5.0</td>
<td>3.0-6.8</td>
</tr>
</tbody>
</table>

<sup>a</sup>Using commercial label of Blando (soft) and Duro (hard).
<sup>b</sup>Geometric mean.
<sup>c</sup>Coefficient of variation (%).
<sup>d</sup>Number of the sample analyzed.
<sup>e</sup>Percent sample with negative growth.
There is little question that some standardization is desirable, particularly for those components that represent: (a) a public health hazard; (b) an important biological value, i.e., fat, protein or total solids; or (c) an economic value, i.e., fat, moisture, or protein.

### Indicator microorganisms in Venezuelan Queso Blanco

Table 4 summarized the incidence of the total coliforms, fecal coliforms, *E. coli* and fecal streptococci in Venezuelan queso blanco samples. In general, the number of these organisms was high, and with the exception of *E. coli*, the relatively low coefficient of variations indicates this level is consistently high (Table 4). A comparison of the means also shows that the incidence of these organisms was significantly higher (P<.01) in the “soft” than in the “hard” type cheese.

However, about 15% of the samples were negative for these organisms. The incidence of negative samples was higher in the “hard” than in the “soft” type (Table 4). Considering the high overall numbers and incidence, it is reasonable to suspect that the lack of recovery from a low percent of the samples might be explained by the presence of an antimicrobial substance, i.e., additives or antibiotics in these samples.

Correlation analysis between the different indicator organisms in each cheese type showed that there exists a positive and significant correlation (p<0.01) between the levels of each organism or group to the others. This correlation was independent of the type of cheese.

The respective regression equations for the number of fecal streptococci, fecal coliforms and *E. coli* (y) versus the number of total coliforms (x) is illustrated in Fig. 4. Statistically, the levels of the fecal streptococci (over the range seen) in queso blanco could be predicted by the level of total coliforms present. Therefore, either a total coliform determination or a fecal streptococcus determination would serve as a good indicator of sanitary quality. Interestingly, if it is assumed that the procedure for total coliforms, fecal coliforms, and *E. coli* recovered all of their respective microorganisms, then over 94% of the coliforms present were fecal coliforms (Table 4).

Table 5 presents the correlation analysis between the level of the indicator organisms and cheese composition. In

### Table 5. Correlation coefficients between the various indicator microorganisms, staphylococci and composition of Venezuelan queso blanco.

<table>
<thead>
<tr>
<th>Indicator microorganisms</th>
<th>Type of cheese</th>
<th>Total of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Soft&quot;&lt;sup&gt;a&lt;/sup&gt;</td>
<td>&quot;Hard&quot;&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Moisture</td>
<td>pH</td>
</tr>
<tr>
<td>Total coliforms (TC)</td>
<td>.456&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.263</td>
</tr>
<tr>
<td>Fecal coliforms (FC)</td>
<td>.452</td>
<td>.197</td>
</tr>
<tr>
<td><em>E. coli</em> (EC)</td>
<td>.501</td>
<td>.202</td>
</tr>
<tr>
<td>Fecal streptococci (FS)</td>
<td>.395</td>
<td>.281</td>
</tr>
<tr>
<td>Organisms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococci/g</td>
<td>.230</td>
<td>.208</td>
</tr>
<tr>
<td>Compositional factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococci/g</td>
<td>.013</td>
<td>.113</td>
</tr>
</tbody>
</table>

<sup>a</sup>Using the commercial label of Blando (soft) and Duro (hard).

<sup>b</sup>Correlation coefficient significant at the p<0.1 level.

<sup>c</sup>Correlation coefficient significant at the p<.05 level.
the working range there was a significant correlation between the number of these organisms and the moisture content, pH, acidity and salt content of the cheese. This correlation became significant as the cheese samples analyzed increased (combined soft and hard samples). The significant correlations are presented graphically in Fig. 5.

The high coliform population found in hard as well as in soft queso blanco reveals the sanitary quality of this cheese. This condition requires special consideration since almost all of the total coliform population was of fecal origin, specifically *E. coli*. In addition, visual and organoleptic problems were commonly observed in the cheese (such as excessive holes and objectionable flavor). Pathogenic strains of *E. coli* can cause outbreaks of food-borne illness (2,28,41). Although a general decline in the coliform population has been observed during the ripening process in cheese (14,17,36) it should be remembered that queso blanco is an unripened cheese, so a potential problem remains a high possibility.

The sanitary quality could be expressed either by the total coliform determination or by a fecal streptococcus count. This may be important under certain conditions (high acidity and high salt concentration), since fecal streptococci are more resistant than the coliform group (22,35).

**Salmonella incidence in Venezuelan queso blanco**

Salmonella enteritidis was recovered from only one of 25 queso blanco samples analyzed for *Salmonella*. Most of these samples were collected from retail markets. However, the sample positive for *Salmonella* was collected from a cheese manufacturing plant. This plant was functioning with a failure in its pasteurizing equipment, so the resulting cheese was made from unpasteurized milk.

The occurrence of *Salmonella* in milk has been demonstrated (29) and outbreaks of salmonellosis have been associated with the consumption of different cheeses (8,16,38). Most cheese contaminated with *Salmonella* is made from unpasteurized milk and is young cheese. The recovery of *Salmonella enteritidis* and other serotypes from 524 samples of different types of cheese in Mexico has been reported (39).

**Staphylococcus aureus incidence**

The incidence of *staphylococci* in queso blanco varied and was dependent on the type of cheese. However, the numbers were relatively high, averaging over 10,000/g (Table 4). The number of staphylococci recovered in “soft” cheese were almost two log cycles higher than in the “hard” type queso blanco. The number of staphylococci were also more variable in the “hard” than the “soft” cheese (Table 4). This can be explained by the higher moisture and lower acidity and salt content in the “soft” cheese as compared to the “hard” cheese.

The results in Table 6 present the relationship between the incidence of enterotoxigenic strains and the characteristics of the substrate. Enterotoxigenic strains were isolated from 28 of 103 total cheese samples analyzed. A little over 23% of the *S. aureus* isolates were enterotoxigenic. Of the 35 enterotoxin producing isolates, most of them elaborated type A enterotoxin. No strains were found to produce enterotoxins B or E. One-third of the “soft” cheese samples and about 20% of the “hard” cheese samples contained strains capable of producing enterotoxin (Table 6). This demonstrates the high incidence of enterotoxin-producing organisms in the cheese, and suggests the possible existence of the enterotoxins in retail samples.

Even though the occurrence of enterotoxin producing strains required a high population of *S. aureus* in the samples (log$_{10}$x = 5.03), this occurrence could not be related to a particular compositional factor of the cheese. The cheese samples positive for enterotoxin-producing strains varied in their acidity (CV = 63.0%), moisture (CV = 20.2%) and salt content (CV = 61.7%) (Table 6).

**TABLE 6. Relationship between enterotoxin producing staphylococci and compositional factors of Venezuelan queso blanco.**

<table>
<thead>
<tr>
<th>Characteristics of samples yielding enterotoxin producing staphylococci$^a$</th>
<th>X$^b$, Range</th>
<th>C.V.$^c$ %</th>
<th>n$^d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococci/g</td>
<td>5.0, 2.9 - 6.2</td>
<td>20.5</td>
<td>32</td>
</tr>
<tr>
<td>pH</td>
<td>5.57, 4.48 - 6.25</td>
<td>7.5</td>
<td>28</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>0.526, 0.15 - 1.12</td>
<td>63.0</td>
<td>28</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>45.6, 22.4 - 58.0</td>
<td>20.2</td>
<td>28</td>
</tr>
<tr>
<td>NaCl (%)</td>
<td>3.2, 0.5 - 5.5</td>
<td>61.7</td>
<td>28</td>
</tr>
</tbody>
</table>

$^a$(27%) 28/103 were positive, (33%) 18/54 “soft” cheese types were positive and (20%) 10/49 hard cheese types were positive.

$^b$Mean.

$^c$Coefficient of variation (%).

$^d$Number of samples analyzed.

$^e$log$_{10}$ geometric mean.
The correlation between staphylococci and indicator organisms and some physical-chemical indices is presented in Table 5. There was a significant (p<.05) correlation between the incidence of staphylococci and the various indicator organisms in the "hard" type and in the pooled cheese samples analyzed. The regression between this pathogen and moisture, pH, acidity and salt content in the total cheese samples analyzed was also significant (p<.05). The regression analysis between organisms of fecal origin and S. aureus is illustrated in Fig. 6. These results show that either total coliforms or fecal streptococci in cheese are significantly related to the occurrence of staphylococci.

The regression analysis between the incidence of staphylococci and pH, acidity, salt and moisture contents in the total samples of queso blanco is illustrated in Fig. 7. Cheese has been considered an excellent substrate for staphylococcal growth and outbreaks following ingestion of cheese contaminated with S. aureus have been reported in several countries: Italy, Germany, France, Canada, Great Britain, and the U.S.A. (23,34,40,44,45,47). The incidence of pathogenic staphylococci in several types of cheese has been attributed to use of unpasteurized milk, poor sanitary manufacturing conditions, failure of the starter culture and consumption of young cheese (32).

In regard to staphylococci in queso blanco, it has been shown that: (a) there was a high incidence and number of these organisms in "hard" as well as in "soft" queso blanco; (b) almost one of every three cheese samples analyzed contained enterotoxin-producing strains; (c) there was a significant correlation between the incidence of this pathogen and the level of indicator organisms; and (d) there existed a significant correlation between the level of this organism and the variation of the pH, acidity, salt and moisture content of the cheese.

Bacillus cereus incidence in Venezuelan queso blanco

The absence of B. cereus in about one-third of the samples analyzed (Table 4) may be related to the presence of antimicrobial substances. This is suspected because of the high numbers obtained and the relative consistency of these numbers (a low coefficient of variation) in samples where B. cereus growth was obtained.

Several defects such as: "sweet curdling" and "bitty cream" are attributed to B. cereus. The organism can grow and multiply in cheese and can survive (spores) in Cheddar cheese for 53 weeks during curing (31). Besides these potential organoleptic alterations produced in dairy products, high numbers of B. cereus (10^6 to 10^9/g) in foods have been associated with outbreaks of illness (18).

Clostridium perfringens incidence in Venezuelan queso blanco

Examination of 80 queso blanco samples for C. perfringens revealed a fairly high incidence rate (65% positive). However, the average number per gram was about 10^2. Also, there were minimal differences between the "soft" and "hard" types (Table 4).

C. perfringens has been recognized as one of the causes of bacterial food poisoning (20,21,33). This microorganism has been reported in processed cheese (36), in Iranian cheese (30), and in several cheese samples from the Egyptian markets (12). The number of C. perfringens per gram and the percent of the cheese samples positive for C. perfringens reported by the above authors were all lower.
than those reported here for queso blanco. The high incidence may constitute a health hazard. In addition, the abundant gas production and proteolytic activity of this organism can produce appearance defects and objectionable flavors in cheese.

Incidence of lactic acid bacteria in Venezuelan queso blanco

Table 4 summarizes the incidence of lactic acid bacteria in queso blanco. These organisms were recovered from about 63% of the samples examined at levels usually more than 10^6/g. However, there was a much higher isolation frequency from the "soft" type cheese as compared to the "hard" type. Only one sample of "soft" queso blanco was found to be negative for lactic acid bacteria. Again, the complete absence of lactic acid bacteria from some samples may be explained by the possible presence of antimicrobial substances.

Lactobacillus casei and Lactobacillus plantarum were identified as the most frequently occurring colonies of MRS agar plates. Interestingly, they seemed to be mutually exclusive, i.e., when L. plantarum was found, no L. casei could be isolated and vice versa. No lactic streptococci were isolated from the samples analyzed.

Since queso blanco is an unripened cheese and no starter cultures are used in its manufacture, lactic acid bacteria remaining in this cheese either survive pasteurization or enter later during its manufacture and storage. These organisms, along with the rest of the microflora, i.e., coliforms, micrococcii, bacilli, etc., are responsible for the normal spoilage of the cheese.

Mold and yeast incidence in Venezuelan queso blanco

Significantly (p<.05) higher mold and yeast populations were found in the "soft" type cheese than the "hard" cheese (Table 4). The most commonly occurring yeast and molds in Venezuelan queso blanco were identified as follows: Aspergillus spp., Cladosporium spp., Montiellia spp., Paecilomyces spp., Penicillium spp., Torulopsis candida, Torulopsis globrata, Candida parapsilosis, Rhodotorula rubra, Candida guillermondii, Debaryomyces hansenii, and Pichia polymorpha.

The incidence of molds and yeast has been considered a common and recurrent problem during aging and refrigerated storage of cheese (15). Additionally, several species belonging to the genera Aspergillus and Penicillium have been isolated from cheese and are considered mycotoxin producers (5,6,7).

In this report, several microbial parameters of queso blanco have been investigated. These evaluations clearly indicate a possible public health problem or at least the lack of quality control and satisfactory sanitary conditions during the manufacture and/or storage of the cheese. Even the survey of the composition of the cheese dramatically supports this conclusion. Visitations to factories and a survey of the retail outlets suggest that a major source of contamination and product abuse occurs after the product leaves the manufacturing facility. As a result of this study, attempts were made to: (a) standardize the process to ensure the public's health; and (b) develop labeling requirements to differentiate between "soft" and "hard" types.

REFERENCES