Microbial Quality Assessment of Milk in the Pasteurization Plant

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ABSTRACT

Milk samples collected at different stages from a high temperature short time (HTST) pasteurisation plant were subjected to microbiological analysis to examine the efficacy of various control points in the process. Standard plate counts (SPC) in the milk samples collected at pre-pasteurisation stages i.e. from milk cans, receiving tank and float control balance tank were 7.03, 7.23 and 7.38 log₁₀ cfu/ml, respectively. HTST heat processing reduced the SPC levels to 4.09 log₁₀ cfu/ml in the pasteurized milk but its recontamination was revealed during packaging process, which raised the SPC to 5.35 log₁₀ cfu/ml in packed milk. Coliform counts in the raw milk were high (4.64 log₁₀ cfu/ml) suggesting unhygienic production at the dairy farm. The heat process successfully eliminated the coliforms but the packed milk again revealed 4.02 log₁₀ cfu/ml in the packaged milk. Similarly, psychrophilic bacteria in the raw milk (5.15 log₁₀ cfu/ml) were also eliminated but again detected in the packed milk (5.19 log₁₀ cfu/ml). Faulty pasteurization poses great health risk to consumers apart from reducing the shelf life of the product.

Keywords: Critical points, microbial analysis, milk, pasteurization

Milk enjoys special significance in the human diets due to its nutritive value and universal acceptance. It is highly desirable that milk supplied to the consumers is safe and has long shelf life. It is generally accepted that despite all the hygienic precautions, varying levels of microbial contamination of milk takes place at the dairy farms from dairy animals, farm workers and environmental sources. Clearly, the milk processing plants have the responsibility to eliminate the pathogens and reduce the levels of spoilage organisms in milk by adequate hygienic processing. Hazard analysis and critical control point system (HACCP) is universally accepted and recommended procedure to evaluate and characterize the microbiological hazards associated with foods and to eliminate it or reduce it to an acceptable level. Pasteurization of milk has got wide acceptance in terms of consumers’ safety and enhanced shelf life, however the microbiological quality of pasteurized milk is influenced by the initial flora of raw milk, the processing conditions, post-heat treatment contamination and the storage conditions provided to the final product (Richter et al., 1992). The pasteurization process involves a series of processing steps that affect the microbiological status and keeping ability of milk. It is essential that effective controls are in place at all the processing steps, especially at the critical control points, to improve the microbial quality of pasteurized milk.

Standard plate counts (SPC) and coliform bacteria counts are widely accepted methods to evaluate the sanitary conditions prevalent in the dairy production units. Food Safety and Standards Regulations (FSSAI, 2011) specify the maximum upper limit of the total plate counts (TPC) as 30,000 cfu/g and coliform counts as <10 cfu/g in pasteurized milk in India. As the pasteurized milk is usually stored at refrigeration temperature after packaging, the status of psychrotrophic counts in it reflects its keeping quality at low temperature. The present studies were carried out to examine the efficacy of various critical control points in a small scale milk pasteurisation plant.

The study was carried out in a small scale high temperature short time (HTST) milk plant with a capacity of 1000 l/h. One sample (milk) at every point was collected aseptically from different control points in the pasteurization process, namely, from the milk can, receiving tank, float control balance tank (FCBT), pasteurized milk tank and packaged milk pouches. Where the collecting point has multiple units like cans/
pouches, random selection was done. Collected samples were processed immediately for microbiological quality. Three trials were conducted on different days and there was a gap of about a fortnight in between trials. Samples were examined for SPC, coliform counts and psychrotrophic counts (APHA, 1992). Plate count agar (HiMedia, India) was used for SPC and psychrotrophic counts while violet red bile agar medium (Hi Media, India) was used for coliform counts. The data were statistically analysed by one way analysis of variance to compare means to find significant (P<0.05) differences between different groups of samples (Snedecor and Cochran, 1980).

The milk cans received at the receiving platform had high SPC (7.03 log$_{10}$ cfu/ml), which marginally rose to 7.23 log$_{10}$ cfu/ml after pooling the milk in the receiving tank and subsequently to 7.38 log$_{10}$ cfu/ml in the FCBT. Thus the initial bacterial load in the raw milk was very high (more than 10$^7$/ml) and was evaluated as poor grade milk based on the BIS guidelines. Mosu et al. (2013) have also reported similar values of aerobic bacterial count in raw milk (7.07 log$_{10}$ cfu/ml) in their study. High SPC in raw milk indicates poor hygienic conditions during milk production and its subsequent handling. The marginal increase in SPC after receipt in the pasteurization plant might have occurred due to handling and the contacts with equipments and tanks. However, the SPC in all these pre-pasteurization stages did not differ significantly (P<0.05), showing adequate control.

Pasteurization of milk caused drastic fall of three log cycles in the SPC (4.09 log$_{10}$ cfu/ml). The values of SPC/ml recorded in three trials were 4.02, 3.06 and 4.8 log$_{10}$ cfu/ml, respectively. These values evidently reflected the presence of high levels of thermoduric bacteria in the milk. Dan et al. (2010) have also recorded similar reduction in SPC from 5.41±0.07 log$_{10}$ cfu/ml in raw milk to 2.64±0.07 log$_{10}$ cfu/ml after HTST pasteurization. The study demonstrated the evidence of post-pasteurization contamination of milk as the SPC in packed milk was significantly (P<0.05) higher than at the pasteurisation stage. The milk was thus not acceptable in view of the FSSAI Regulations (FSSAI, 2011). The studies by Agarwal et al. (2012) have shown all the pasteurized milk samples analysed by them, exceeded the specified limit of 30,000 cfu/g. SPC in the chilled water used for cooling the milk, after heat processing in the plant was 0/ml, suggesting that recontamination of milk after heat process might be during the packaging process.

Studies on coliform are much important and have more attention than other group of bacteria because of their importance as indicator organism. Irrespective of number present, merely existence of the coliform species in dairy products is suggestive of unsanitary practices adopted during production, processing and storage. Coliform counts in the milk received in the processing plant were 4.64 log$_{10}$ cfu/ml. Less than 100 coliform bacteria/ml considered acceptable, but the count less than 10/ml is achievable and desirable (Boor et al., 1998). It revealed that the milk was not of hygienically acceptable quality. The coliform bacteria in the receiving tank and FCBT showed further marginal but non significant (P<0.05) rise which might be due to handling of milk after receipt.

The coliform organisms were not detected in the milk after the heat exposure demonstrating the adequacy of thermal processing. However, subsequently, the milk after packaging revealed 4.02±0.40 log$_{10}$ cfu/ml indicating post-pasteurization contamination of milk, making it unacceptable. The FSSAI regulations prescribe that the coliform count in pasteurized milk should be less than 10/g (FSSAI, 2011).

Agarwal et al. (2012) have also reported the presence of coliforms in all the milk samples examined by them including the pasteurized milk samples. Coliforms were not detected in the chilled water used in the plant, thus ruling out the possibility of its role in the recontamination of pasteurized milk. The samples might have been contaminated in the packaging unit.

Like the SPC and coliform counts, the initial levels of psychrotrophic bacteria in raw milk (5.15 log$_{10}$ cfu/ml) reduced to undetectable levels after pasteurization, but subsequently again increased to 5.19 log$_{10}$ cfu/ml in the

<table>
<thead>
<tr>
<th>Source of samples (n=3)</th>
<th>SPC (log$_{10}$ cfu/ml)</th>
<th>Coliform count (log$_{10}$ cfu/ml)</th>
<th>Psychrotrophic count (log$_{10}$ cfu/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk can</td>
<td>7.03 ± 0.19$^c$</td>
<td>4.64±0.48$^a$</td>
<td>5.15±0.34$^a$</td>
</tr>
<tr>
<td>Receiving tank</td>
<td>7.23 ± 0.09$^c$</td>
<td>4.86±0.31$^a$</td>
<td>5.28±0.39$^a$</td>
</tr>
<tr>
<td>Float control balance tank (FCBT)</td>
<td>7.38±0.04$^c$</td>
<td>5.07±0.30$^a$</td>
<td>5.38±0.46$^a$</td>
</tr>
<tr>
<td>Pasteurized milk</td>
<td>4.09±0.52$^a$</td>
<td>Undetectable</td>
<td>Undetectable</td>
</tr>
<tr>
<td>Packed milk</td>
<td>5.35±0.64$^b$</td>
<td>4.02±0.40$^a$</td>
<td>5.19±0.35$^a$</td>
</tr>
</tbody>
</table>

N.B. The bacterial counts were not detectable in chilled water; *values with different superscripts in a column differ significantly (P<0.05)
packed milk. The absence of psychrotrophs in chilled water samples again suggested that it did not have any role in the post-pasteurization contamination of milk.

Thus, the final product contained high levels of thermoduric, coliform and psychrotrophic bacteria. The study demonstrated the post-pasteurization contamination occurring during the packaging process. The presence of coliforms and psychrotrophic bacteria, which are generally quite heat sensitive, in the final product is of great significance in relation to consumer safety because the presence of pathogens in such product cannot be ruled out. Further, psychrotrophs also have negative influence on the keeping quality of the processed and will decline the shelf life of milk, even when stored at low temperature.

On the basis of the findings, it can be concluded that it is desirable to improve the bacteriological quality of milk at the dairy farm by adopting good sanitary and phytosanitary measures. In the milk processing plant, necessary steps should be taken to prevent post-pasteurization contamination of milk in the packaging section by regularly disinfecting the packaging machine and monitoring it for any bacterial build up. As the milk filtration section showed a lot of contaminating materials like dung, hair, fodder particles hence the milk handling practices at the procurement stage were also questionable. The personnel training is an important aspect to improve the sanitary quality of milk. This is a sample study and is the indicator of pathetic situation prevalent among the milk handlers throughout the country.

References