Three Major Areas That Cause Defects In Cultured Dairy Products

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In preparation of this paper I tried to find statistical information on the defects of cultured dairy products. The American Cultured Dairy Products Institute does evaluate and score products submitted, but currently they haven't statistically analyzed these scores as to the severity of the defects. Even if they did, these figures would not represent the whole industry. Both master dairies and quality chekd dairy products associations evaluate and score their member's products. The good news is all these associations felt that overall the quality of cultured products was better and more consistent than in years past. The judges' comments were that most of the products had the same defects but their defects were not as severe and the scores were higher.

It was a consensus of opinion that the body and texture on all cultured products was better. The increased use of H.T.S.T. processing is contributing to the smoother body. Parnell-Clunies and Associates (10) investigated different heating systems of milk for yogurt's physical properties. They concluded that the most viable heating system investigated was the H.T.S.T. method with a residence time of, at least, 1.87 minutes. Although firmness and apparent viscosity were higher by vat heating methods, this yogurt had low water retention properties and consequently, displayed syneresis and grainy texture. Of course, the H.T.S.T. is more consistent than vat pasteurizing which is affected by batch size, condition of heating surface by cook-on and the condition of the vat itself. It is thought that these same advantages in body and texture from H.T.S.T. are also applicable to buttermilk.

There are more improvements in quality control that are certainly helping companies to produce more consistent cultured products. First, more companies are using the new, more sensitive screening tests for antibiotics in the milk. These tests are picking up a broader spectrum of the medication being used to treat cows that may find its way into the milk. Of course, these low level inhibitors will affect how lactic bacteria metabolize.

More plants are now using the newer component testing equipment and standardizing butterfat protein and total solids using a computer. This has to be a tremendous help in making more consistent products and controlling costs. Another important improvement in quality control is more plants are paying quality bonuses for their raw milk.

How are these important changes that are improving the overall quality cultured products impacting the total sales? If we look at the milk industry foundation latest *Milk Facts 1988,* we see that yogurt sales continued to increase to 4.6 pounds per capita for 1987, which is 110% higher than ten years earlier; the largest increase of any dairy product. Sour cream and dip sales are continuing to increase to 2.43 pounds per capita. Low fat cottage cheese sales were up 1.9%, but the bad news is that total cottage cheese sales continued on a downward trend decreasing 2.6% for 1987 and there were 46 million pounds less cultured buttermilk sold in 1987 than the previous year.

The cultured products judges at the ACDPI all commented that the most mentioned defect on the buttermilk score sheets was "lacks flavor". It is felt that this is caused by management wanting better efficiencies: the buttermilk is bottled before the flavor is developed or by culturing the buttermilk at a higher temperature where the acid producers out grow the flavor producing organisms. It also may be caused by the desire to have a heavier body at a lower cost.

Now that we have mentioned some areas where cultured products have improved, let's get into a more indepth discussion in the three areas where management can improve their cultured products.

Psychrotrophic Bacteria

Every cultured product manufacturer knows that the quality of raw milk is the first and most important aspect in manufacturing superior cultured products. We know when the milk is rancid, oxidized, has an antibiotic present or over 300,000 standard plate count (SPC); this milk should not be used and we have to go about correcting the problem. We also know that psychrotrophs are becoming the predominant microorganism in raw milk. There has been a tremendous amount of research on psychrotrophic bacteria showing that a relatively low number can have a lasting detrimental effect on cultured products. The *Cultured Dairy Products Journal* has a three part article by Mikolajcik (8) on "Psychrotrophic Bacteria and Dairy Product Quality". Mikolajcik reviewed 128 recent research papers covering most aspects of psychrotrophs.

Cousin (1) reviewed 385 papers to write "Presence and Activity of Psychrotrophic Microorganisms in Milk and Dairy Products." We learn from these reviews that psychrotrophs are widely distributed in nature in soil, water, plants and animals. So it is easy to see how these organisms get into raw milk. Now refrigeration becomes very important; the psychrotrophic bacteria count (PBC) can increase by a factor of 100 to 1000 during three days of storage at 5 C (41 F). They will become a major problem to quality milk when the storage temperature exceeds 7 C (44.6F). Psychrotrophs produce proteolytic and lipolytic enzymes that are very heat stable and resistant to pasteurization. Ultra-high temperature processing of milk will not inactivate all proteases produced by pseudomonas organisms. (8) The heat stable lipases have been shown to eventually procuce rancidity in dairy products. The heat stable proteases are capable of protein degradation producing flavor defects in cultured products as unclean, bitter, fruity, and putrid. (2) These proteases also cause body defects and the loss of yield in cottage cheese. (2,9)

Now what should cultured product managers be doing to help keep these heat stable enzymes from affecting their fine products? There are areas where the manager has influence: the load or number of psychrotrophs in the raw milk, the temperature at which the raw milk is stored, and the elapsed time until the milk is processed.

First and most important is to recognize and define the areas that can make a difference. If plants are paying a quality bonus, it makes more sense to have bacterial quality based on PBC count instead of SPC. It does not cost any more or take any more man hours to run standard method PBC over SPC, only a lot more incubator space. The plants should be, at least, running some type of screening test for psychrotrophs in the raw milk. This is because psychrotrophs are the predominant flora of poorly cleaned farm bulk tanks and are made worse by poor cooling (1,8). These tests certainly give the fieldman more information about the farms that need attention.

There is concern as milk becomes in short supply, the culture plants need to transport their milk from farther away, which means the plant does not have direct control. It is important that the seller is as concerned about the age and psychrotrophic condition of the milk as we are. After all, we are all making our living on the quality of dairy products in the market place. Stricter receiving temperature standards can be set by the buyer and agreed to by the seller. The milk will not be received above 6 C (43 F).

Management certainly has control over the raw milk at the plant. Of course, rotation and temperature is very important. We should remember that the optimum growth temperature of most psychrotrophs is 20 C (68 F). We cannot control the temperature of the foam above the milk or the milk surface of the silos. This temperature can approach the optimum for psychrotrophs. Therefore milk should never be stored in a tank over a surface that has had milk and air contact.

We must not lose sight of post pasteurization contamination with psychrotrophs. We have increased quality practices and sanitation to control listeria. Keeping raw milk and raw milk equipment out of the finished product area and the cleaning of walls, floors and drains will have a positive impact on post pasteurization contamination by psychrotrophs.

Effects of Cleaning Residuals in Milk

There are far more cleaners and sanitizers being used and a much more thorough job of cleaning and sanitizing since the lysteria hysteria. These total cleaning programs of the plant and the environment should also have a positive impact on lowering the phage titer which causes culturing failures. But management had to be concerned about keeping cleaner and sanitizer residuals out of the milk. In a series of experiments at Cornell, Zall and Brown (12,13) collected milk from a farm that was thought to have cleaning residuals in the milk. The samples were promptly made into buttermilk and yogurt. They found that small amounts of cleaning additives do upset fermentation and cause flavor defects in buttermilk and yogurt and slow the growth of the starter organisms in yogurt. It was pointed out that alkaline cleaning compounds solubilize proteins which decrease cheese yields. We must not be fooled by the work of Liewen and Marth (5) who added cleaners and sanitizers (0.1%) to milk and incubated with lactics for 12 hours. They concluded that low concentration will probably have little or no effect on acid production. Since these tests do not represent normal culturing, it is hard to agree with their conclusions. They did not check for taste, body or texture.

Zall went on and suggested a simple test for inhibitory substances in milk using a commercial yogurt starter. They found that this screening test showed more inhibitors in milk than the Sarcina Lutea method. They suggested that this screening test be used for all milk going to cultured products since it is easy and uses materials that the plants have.

In the last couple of years, it has been observed that on occasion cottage cheese skim coagulates at a lower pH. The set time may be a little longer. An example: a plant usually cutting the vats in 4 hours + or − 10 minutes at a pH of 4.6 and then one day, the vats are still milky at 4.6 pH in 4½ hours. The coagulum is cut at 4.55 pH with a weak body. The curd is weak and shatters and reacts much the same as cooking the curd from high pryshrotrophic contaiminated milk. The curd produced is soft and shattered and has at least ½% less yield. It is felt that it is the wetting agents from cleaner and sanitizers that have contaminated the milk causing this problem. If wetting agent contaminated milk is used, then there will be both body and flavor problems in all the cultured products as Zall's work shows.

Frozen Concentrated Cultures

Frozen concentrated cultures have contributed to the ease of manufacturing good quality cultured products. When I started in this business, carrying culture was an art and often when the person doing the job was absent, the quality of the cultured products suffered. Today the wide use of frozen concentrated cultures has enabled all plants to make better products. There are two basic types of frozen concentrated cultures: the bulk set and the direct vat set. The bulk set is used to set a bulk starter. These cultures are made so the different strains of bacteria stay in balance through the transfer. The direct vat sets are made to inoculate the finished products. They should not be used to set a bulk starter without the advice of the supplier because the strain balance may not be maintained through the transfer.

It is very important to work with and follow the recommendations of the culture supplier. These companies have different methods of growing, concentrating and freezing these cultures. Some of the companies use cryoprotective agents to improve their ability to survive freezing and frozen storage. We must remember that these bacteria are alive and frozen for storage and we want them to come to life at our command to make our product. Because of this, it is very important to follow the suppliers recommendations for storage and thawing. When these cultures first became available to the industry, plants stored these cultures in liquid nitrogen −196 C (−320 F). Today most companies are receiving the frozen cultures in dry ice and storing in mechanical refrigerators. Some of the culture suppliers recommend that frozen cultures can be stored at −20 F (−28 C) for two weeks and at −40 C & F for up to a month. Storage for longer periods of time could result in activity loss unless stored at lower temperatures. There are freezer cabinets made for storing frozen cultures at −80 F.

There has been a lot of research to find the best practical storage temperature and the effects on the cultures at different storage temperatures. Lloyd (6) concluded that concentrated cultures stored at −30 C (−22 F) showed appreciable loss of activity after three months, but at −40, the viability and activity were similar to those stored in liquid nitrogen. It has been shown that there is a 42% to 45% destruction of cells at storage temperatures of −20 C (−4 F) in one to two months (7,11), but cell numbers are not the only important factor.

Lloyd (6) pointed out that different strains of cultures reacted differently to high storage temperatures. Some strains showed a drop in viability with no effect on the

acid production of the survivors. Some strains showed no change in cell numbers but a drop in acid production and others showed a drop in both.

In most cases, frozen concentrate cultures are a mixture of strains of bacteria. The mesophillc strains used for buttermilk, sour cream and cottage cheese will usually contain different strains of acid producers and maybe some flavor producer leuconostocs. The thermophillc culture used for yogurt usually contain both rod and coccus. The rods (Lactobacilli) are very sensitive to freezing and thawing (4). It has been shown that the differential survival and recovery from freezing and storing of cultures are factors in alteration of mixed strain starter cultures (3).

It should be easy to see that the consistent storage temperature and thawing of frozen cultures is very.important to consistent culture products. The lack of proper storage of frozen cultures is one of the major contributors to defects in culture products. In buttermilk and sour cream, the defects are: lacks flavor, green flavor and poor body. In yogurt the body is weaker and we only get acid flavor. In cottage cheese and all culture products, one of the causes of slow acid production is high storage temperature of frozen cultures.

To produce consistent culture products we must have consistent starter bacterial growth. We, as culture products managers, must control the stress conditions that contribute to variations in growth of starter cultures. The presence of antibiotics, cleaners and sanitizers, incubation below and above optimum growth temperatures, freezing and thawing, and growth in poor quality milk contribute to the stress conditions (3).

The manufacture of fine, consistent cultured products is only half of the job. We must get out and market these great products to keep our market share.

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