AVOID ECONOMIC LOSSES BY EFFECTIVE CONTROL OF BACTERIA

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Great strides have been made over the years in producing ice cream of better quality from the bacteriological point of view, but the problem of control of bacteria continues to be of major concern to many manufacturers. All too often a high bacterial count or coliform count is encountered in ice cream, and frequently, ice cream mixes do not possess the desired keeping quality. In other instances, off-flavors are encountered in ice cream which may be the result of bacterial growth in the ingredients used in making the ice cream mix or subsequent growth in the pasteurized mix. Plant personnel must be kept constantly aware of the problem because a temporary relaxation in any operation which results in difficulties of microbiological nature may cause hardship and economic loss to the plant.

Control in Making the Mix

Bacterial control should begin with the ingredients used in making the mix. It is a well known fact that bacteria cause raw milk to sour by producing lactic acid. It is argued at times that a slight increase in acidity is not detectable by taste in ice cream and it is, therefore, not necessary to use dairy products of highest quality. While it may be true that an ice cream made from partially soured ingredients still possesses a refreshing quality, its flavor is almost invariably adversely affected. Defects of ice cream which are traceable to a bacteria origin in the ingredients are not limited to a high acid flavor. It must be remembered that raw milk may contain numerous types of undesirable organisms some of which produce flavors and odors other than sour. A malty flavor is a common by-product of certain acid producing bacteria and its presence in ice cream is certainly undesirable. Other forms of bacteria produce an unclean or barny flavor which detracts from the quality of the finished product. Some bacteria may cause fat hydrolysis giving rise to rancidity. Since all raw milk may become rancid even in the absence of bacteria, a combination of milk and bacterial lipase may be involved in the development of rancidity.

In order to produce detectable off-flavors, the bacterial count must ordinarily be higher than a million per gram. Milk with a count of five million per
gram will usually have a detectable off-flavor. The important point is that the high count may generally be reduced to an acceptable low level by pasteurization.

**Bacteria Surviving Pasteurization**

A bacterial count taken immediately following pasteurization of the mix reveals essentially those bacteria which have been able to survive the applied heat treatment. Unless the sanitary conditions are extremely poor, contaminants which had gained entrance into the mix following pasteurization, other than those which can be detected on differential media, should be present in such small numbers that it would be difficult to demonstrate their presence. The bulk of the organisms encountered are spore formers along with some highly heat resistant nonspore formers. The number of the nonspore formers which will remain depends on their heat resistance and on the size of the original inoculum. Few, if any, of the spore-forming organisms are destroyed by pasteurization. Since pasteurization does not destroy all bacteria at the same rate, these facts serve to further emphasize the importance of quality of ingredients as they affect the bacterial count of the mix.

The organisms surviving pasteurization are usually not of the type that would cause rapid spoilage of the mix. As long as the mix temperature is maintained at 40 degrees F or below, growth would be extremely slow and the mix should have an excellent keeping quality. It is probably safe to state that an excellent keeping quality may be expected when a mix is properly pasteurized, cooled, stored at a temperature of 40 degrees F or below, and kept free of post-pasteurization contamination.

**Post-Pasteurization Contamination**

Perhaps the most troublesome bacteria encountered in ice cream are those that are picked up after pasteurization. These organisms come from equipment that was improperly cleaned and sanitized, the water supply, plant workers coming in contact with the product and the air. While many types of bacteria may be post-pasteurization contaminants, the greatest concern is over disease producing and spoilage organisms.

The coliform count is commonly used as a test for post-pasteurization contamination. There is a very small likelihood that organisms belonging to this group could survive mix pasteurization, so it is the result of undesirable contamination. There seems to be no reason to question the validity of this argument. It is well to keep in mind, however, that a negative coliform test does not guarantee freedom from contamination, it simply implies that less than one coliform was found per gram of product. If the product tested were ice cream samples out of a package, the bacterial quality control record would be closed with a large degree of satisfaction over the fact that legal requirements had been successfully met. On the other hand, if the product tested were freshly pasteurized mix, there would still be no guarantee of success. If allowed sufficient time and/or a favorable temperature for incubation, bacterial growth could occur and give rise to numerous difficulties, such as a substantially higher coliform count or spoilage due to psychrophilic organisms. The latter group of bacteria give rise to very undesirable off-flavors, such as unclean, rancid, bitter, fruity, putrid, etc., and thus render the mix unusable. Spoilage by psychrophilic bacteria is not necessarily accompanied by acid production, so the mix really does not sour, but it spoils, nevertheless. These organisms grow very well at 45 degrees F or higher, but are able to grow at 40 degrees also, although at a slower rate.

Yeasts and molds may also be encountered in an ice cream mix as a result of post-pasteurization contamination. The presence of these organisms is a strong
indication of unsanitary conditions because they are easily destroyed by pasteurization.

It becomes clear that post-pasteurization contamination may be heavy, in which case the coliform count as well as the standard plate count may be high shortly after pasteurization, or it may be so light that no increase in the bacterial count can be observed immediately. In either case, however, the bacteria can multiply and cause off-flavor production and spoilage.

Finding the Source of the Difficulty

When difficulties are encountered with high bacterial counts, the presence of coliforms, bacterial off-flavors or spoilage a certain amount of detective work is required to find the source of the problem. All phases of quality control should have the active support of top management so that close cooperation between plant, laboratory and all concerned may be enlisted to eliminate the difficulty without delay.

A high bacterial count may be the result of a large number of organisms following pasteurization, or a light to heavy post-pasteurization contamination with an opportunity for additional growth before the product is frozen. A direct microscopic examination may reveal to an experienced laboratory technician whether the organisms present are of the type which may be expected to survive pasteurization. The information may be obtained quickly in this manner, but the evidence is only presumptive and should be confirmed by other means. The product may be laboratory pasteurized to determine the extent to which the high count may be reduced. A very small reduction in count would present strong evidence for the presence of highly heat resistant bacteria in some or all of the ingredients. If the difficulty persists, the ingredients should be laboratory pasteurized to locate the offending ones. A high count may also be due to the introduction of excessive numbers of bacteria by the ingredients added to the mix after pasteurization, such as flavors and coloring. The bacterial count of the mix immediately after pasteurization may be compared to that of the finished product to determine the significance of this source of bacteria.

In the majority of cases, a high bacterial count in the ice cream may be significantly reduced by laboratory pasteurization, which would indicate post-pasteurization contamination with possible subsequent growth. Coliform organisms also would be usually present, although in some cases they may be absent. The reverse situation may also occur in which the total bacterial count may still be within legal limits but the number of coliforms could be excessive. In either case the steps taken to remedy the situation are essentially the same in that the source of the contamination must be located and steps taken to eliminate it.

Any organism found in ice cream is either a survivor of pasteurization or a post-pasteurization contaminant. Once it has been established that the organisms are incapable of surviving pasteurization, a systematic line check must be made of all areas with which the mix and the ice cream come in contact following contamination. This includes the lines, valves, pumps, homogenizer, cooler, holding tanks, cans, flavor tanks, freezers, fillers, packaging machines, fruit feeders and, where HTST pasteurization is employed, the pasteurized side of the regenerator.

Thorough Equipment Examination

As the first step, all equipment should be thoroughly examined for the presence of milk stone and deposits of milk solids. Pitting and corrosion of metal as well
as mechanical damage such as dents and grooves should be noted at the same time. All joints should be disassembled and the condition of gaskets noted. Paper gaskets should never be reused. The homogenizer, pumps and freezer should be disassembled and the condition of gaskets, packings, valves and metal surfaces noted. The cleaning and sanitizing procedure must be critically reviewed to ensure that all surfaces are adequately treated.

If the bacterial problem is not eliminated by corrective measures taken following visual inspection, line samples of product may have to be taken for bacteriological examination. Samples should be obtained at as many points as practicable and plated for both total and coliform counts. By this procedure it is possible to pin-point areas of gross contamination. A slight build-up in bacterial count is more difficult to ascertain and requires that the samples taken be incubated for several days, preferably the length of time that the mix is expected to keep at the same temperature at which it is stored or for a shorter period of time at a somewhat higher temperature. For example, if the mix is expected to keep seven days at a temperature averaging 42 degrees F, the samples may be incubated at 47 degrees F for about four days in the hope of yielding quicker results. It would be well to plate line samples regularly as part of the quality control program in order to be able to anticipate difficulties and take corrective action before the situation reaches the crisis stage.

The following points are well to remember in regards to sanitation: Bacterial contaminants come from equipment, water, people and air; organic deposits anywhere in the plant provide a breeding ground for microorganisms; sterilization of equipment is not adequate unless the germicidal solution is of the proper strength, the surfaces are free of organic or other deposits, and the solution comes in contact with the entire surface for the required period of time; and good house-keeping is conducive to good sanitation.

To the man charged with the clean-up operation, it is often incomprehensible that any contamination could come from the equipment, after all, he had worked on it diligently, scrubbed and polished it until it was cleaner than anything in his own home. Surely those few inaccessible spots that comprise less than 0.1 per cent of the total area could not be the cause of all these problems. Unfortunately, the spots that are inaccessible to the cleaning brush are most accessible to bacteria. In general, problems arise not only as the result of gross negligence in sanitation but also because of some seemingly insignificant omission, such as one paper gasket that was not replaced or one connection that was not disassembled.

Contamination in Cans

Very likely sources of contamination of mix are cans and holding tanks. Plants that sell mix in cans often find it necessary to hand wash and steam the cans in order to maintain the mix in satisfactory condition. Pasteurized mix holding tanks require very thorough cleaning and sanitizing to prevent a buildup of coliform and psychrophilic organisms. Temperature control is also extremely important at this stage of the operation. Holding the mix at 35 degrees F to 40 degrees F will effectively slow down the rate of growth of bacterial contaminants.

Personal habits of plant personnel also play an important role in a plant sanitation program. This subject is as old as the ice cream business itself, but some people still need to be reminded that hands should not come in contact with the product or sterilized surfaces and that wet, dirty hands should be washed and dried with a sanitary towel rather than wiped on one's clothing.
No clue should be overlooked in an attempt to locate the source of bacterial contamination. Instances have been reported where a minute seepage of sweet coolant into the pasteurized mix had created an elusive coliform and psychrophical problem. In other instances, the practice of using melted ice cream from the previous day created an undesirable situation.

In summary, it may be said that sanitation is definitely a part of the quality control program which implies continuous vigilance, repeated admonition and whole hearted cooperation. The fact that some plants have very little difficulty in maintaining good control over bacteria provides reassurance that the job may and can be done right.