STUDIES ON YEASTS IN DAIRY PRODUCTS

I. RELATIONSHIPS OF YEASTS TO DAIRY PRODUCTS*

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The budding organisms found in milk and its various derivatives are becoming of increasing concern to investigators interested in dairy products. While the known importance of these organisms in causing certain undesirable changes, such as the formation of gas in cream and in sweetened condensed milk, accounts in part for this, their possible relationship to abnormal conditions in cream not yet definitely ascribed to any particular organism, to the deterioration of butter, and to various other undesirable changes makes their study very necessary.

The ability of yeasts to grow under conditions that must be considered unfavorable for the growth of many bacteria is one of the reasons for their importance in dairy products. Certain types of molds can also withstand severe conditions such as high acid, dearth of water, etc., in the materials on which they are growing but their air requirements limit their growth in a way that the development of certain yeasts is not limited. Moreover the growth of molds, because of their development only in rather close contact with air, is usually readily evident on observation.

A number of yeasts grow in the presence of large amounts of acid. If the temperature is suitable certain yeasts can grow rapidly throughout a can of old fermented cream in which the growth of many types of bacteria has been stopped by the acid concentration, and, as a result, abnormal flavors and odors due to yeasts are extremely common in the cream coming to the creameries to which cream is shipped for considerable distances. The acid tolerance of yeasts also enables them to grow on acid curd cheeses, such as cottage and neufchatel, on certain cheeses in which ripening occurs, such as camembert, in starters, etc.

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On some of these materials, especially acid curd cheeses and starters, definite colonies or areas of growth may be formed when the products are held at temperatures that are at all favorable for growth. The lactose-fermenting yeasts are of particular importance in acid cream because they produce gas under conditions that rather effectively limit the growth of other gas-producing organisms; they cause serious losses, not only from the influence they have on the flavor and odor of the material but also because the gas commonly forces cream from the cans. In certain types of cheese, such as Swiss, the lactose-fermenting organisms also sometimes cause serious losses by producing a swelling of the product.

Some yeasts not only tolerate considerable acid but are actually favored by it and grow better in sour milk than they do in sweet milk. With certain forms the production of objectionable odors occurs much quicker and is more pronounced in milk which contains some lactic acid, either added as such or produced by S. lactis, than in milk of the same lot without acid.

Other factors that are ordinarily considered to limit the growth of microorganisms seem to have less effect on yeasts than on many other forms. Certain yeasts grow in high concentrations of NaCl and while some types of bacteria do the same thing, these latter organisms apparently are not of importance in dairy products. The production of gas in sweetened condensed milk in which the sugar is often supposed to prevent the growth of organisms is commonly due to yeasts. Although certain cocci can grow in sweetened condensed milk, their growth is comparatively slow and is of much less importance because of their usual failure to produce significant changes.

Unfavorable conditions do not seem to result in the destruction of yeasts in the way they do many bacteria. For example in butter held for considerable periods many of the bacteria may have died out while the number of yeasts may remain comparatively high and be equal to or larger than the original count. Certain cocci of course also have the ability to resist the conditions found in butter. In laboratory cultures, yeasts are commonly found in a living condition when the medium is dried until there is only a small amount along the wall of the tube.
The large size of yeast cells in comparison to that of bacterial cells suggests that a smaller number of cells would be present in material that had been fermented by yeasts than in material fermented by bacteria. This has been found to be the case and accordingly the isolation of yeasts from material showing an abnormal condition due to these organisms requires much less dilution than if bacteria are being isolated. When bacteria are present, as they are very likely to be in dairy products, and the plates are poured so as to give the usually desired distribution of colonies with these organisms, the yeasts may be largely missed. The common procedure is to restrain the bacteria by some such method as the addition of acid and then plate heavily enough to give a satisfactory number of yeast colonies per plate. The acidity which will restrain bacteria and allow yeasts to grow is however not definite. One cubic centimeter of a 1 per cent tartaric acid solution per plate (of 8 to 10 cc. of media) is commonly employed with quite satisfactory results but it does not by any means entirely limit the growth of bacteria. As amounts of acid above this are employed there is a gradual falling off in the number of yeast colonies developing and it seems that any reasonable amount of acid—that is one which will allow a good development of yeasts—will also allow the development of certain types of bacteria. Most of the bacteria encountered in yeast isolations however are types whose colonies can readily be distinguished from yeast colonies since these in general admit of the individual cells being seen along the edge of the colony with the low power of the microscope. Occasionally colonies of large cocci may be mistaken for yeast colonies but stained preparations quickly show the error by the lack of budding cells and by the smaller size.

The yeasts common in milk and its derivatives cannot be looked upon as types peculiar to these products. Although yeasts have been found in milk drawn aseptically, in general these organisms get into milk after it leaves the udder so that there must be sources of them about the stables, milk houses, etc. The yeasts common in dairy products are accordingly to be expected in other materials which have not been studied in
any detail from the standpoint of their flora, because they are products whose value is not readily influenced by microorganisms. Since such materials are important sources of microorganisms, however, their flora must eventually be studied before a clear understanding of the yeasts of dairy products can be secured.

A number of the yeasts common in dairy products do not produce visible changes when grown in milk, and this is particularly surprising because certain of them are sometimes present in very large numbers so that growth must have taken place. Whether these organisms are of no significance from the standpoint of dairying or whether their products are of importance in the deterioration of such materials as butter, etc. can only be determined after the organisms are better understood.

Among the yeasts common in dairy products there are certain groups that seem to be clearly defined as natural groups. The lactose-fermenters for example stand out quite definitely from the other yeasts; these organisms are clearly separated from the other forms because of their gas production in milk and moreover it seems that this separation is particularly significant because when gas production occurs it is very definite, and slow or questionable fermentations are not likely to occur. Accompanying the gas production there is an alcoholic odor and, in the case of litmus milk, a reddening of litmus, both of which are uncommon changes for yeasts to produce in milk. These organisms also are almost always present in milk or cream produced under the usual conditions although during the colder weather, when their growth is slow if it occurs at all, considerable amounts of the milk or cream must often be employed for the isolation.

The yeasts producing a pink color, while frequently found in materials other than dairy products, are so common in these that they are entitled to considerable attention. These organisms apparently are never present in large numbers in ordinary milk or cream but frequently form colonies on such materials as old cream, cottage cheese, starters that are being held, etc. The pink color of these forms seems always to be definite enough so that colonies can readily be detected, whether they are on dairy products or on some plating medium. This type is further characterized by the pink color occurring as a ring or sediment in
milk tubes and by the slow changes, other than the colored areas, produced in milk.

The yeasts causing a rapid digestion of milk constitute another type that is clearly defined because outside of this type the rapid digestion of milk by yeasts is not common. Moreover the colonies produced by these organisms are quite characteristic and in general the organism can readily be picked out by the colony alone.

The yeasts that are responsible for the blowing of sweetened condensed milk constitute a definite group that is perhaps most clearly characterized by the ability to grow in strong sucrose solutions. With these types should be included other organisms that can grow in concentrated sugar solutions but which have not been isolated from spoiled sweetened condensed milk. It would be expected that these organisms might be of importance in materials other than sweetened condensed milk.

While many yeasts have been isolated from dairy products and described, these descriptions are not usually based on a study of a number of cultures from different sources that are to be considered as a single species, and accordingly the descriptions commonly do not take into account the variations that occur in the particular type. Moreover, many of the descriptions are so incomplete, particularly with reference to the action of the organism on milk, that they are of little value from the standpoint of identification. As a result, it is extremely difficult to isolate yeasts from dairy products and identify them as having been previously described and named. The confusion is being increased by certain investigators designating a yeast in published results by one of its characteristics such as "the rapidly liquefying yeast," "small white yeast," etc.

The dairy section of the Iowa Agricultural Experiment Station has been interested in the yeasts of dairy products for a number of years and has published data dealing with certain of these organisms; the forms that have been considered are, however, unrelated, and have been investigated only because of some special significance attached to them. Other types of yeasts have been studied in more or less detail and it is planned to publish data and descriptions with reference to certain of these from time to time.