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SURFACE AND CHEESY FLAVORS IN BUTTER

by

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What is Surface Flavor? It is a defect that sometimes appears in butter as a result of the action of certain bacteria. It is called Surface Flavor because it first appears upon the surface of the butter affected, but it may later work its way throughout the entire body of the butter. Surface Flavor or Surface Taint is the outward manifestation of a putrid condition in the butter. Butter that is affected by Surface Flavor is absolutely unsalable. It is exceedingly unpleasant to the smell and the taste.

Cheesiness is closely associated with Surface Flavor. It is a protein decomposition defect, but is usually not quite so disagreeable to the consumer as is Surface Flavor. Frequently cheesiness in the butter is the forerunner of Surface Flavor.

Prevalence of Surface and Cheesy Flavors

For a number of years, the Butter Industry has been punctuated by intermittent and sporadic outbreaks of a flavor defect in butter, to which defect various names have been applied. Comparison of the descriptions of the variously named defects indicate that they are one and the same thing or are very closely related. A defect of spasmodic occurrence in New South Wales, Australia, called disagreeable aroma, has been studied and reported by Brown and is referred to by Derby and Hammer. (2) A similar defect found in New Zealand is referred to there as foetid odor. In Denmark it is referred to as putrid. In the United States, it is referred to by some as Limburger cheese, by others as putrid, and by still others as Surface Taint; the latter name being the common one attached to it in Canada. Some writers, according to Maey (1), refer to it simply as cheesy. From this it can be seen that the occurrence of surface taint in butter is by no means a localized defect, from the geographical point of view. Nor should it be considered as a minor defect of only passing importance, for though it breaks out only now and then and is more or less scattered it is perhaps to be feared with a view of doing everything possible to prevent its occurrence. It is a defect which ordinarily makes the product absolutely unmarketable if the defect has progressed to any marked degree. Several outbreaks have occurred in Oregon during the past few years.

Occurrence

According to Derby and Hammer (2), most of the lots of surface taint butter with which they have had any experience have been made from cream that has been pasteurized. The pasteurizing exposure has usually been fairly high, according to them. They indicate an average of 10 minutes exposure at 76.7° C. (170° F.) particularly in several Canadian plants. It has also been their experience that much of surface taint butter has had a rather low salt content and has been made without the use of starter.

In several cases of putrid butter mentioned by Eckles (6), one of which was reported in detail, the cream from which the butter was made was not pasteurized.

Derby and Hammer (2) showed by experiment that "Achromobacter putrefaciens failed to grow in skim milk acidified with lactic acid to 0.30 or 0.31 percent but did develop when the milk was acidified to 0.27, 0.28 or 0.29 percent."

Causative Organisms

Derby and Hammer (2) refer to work by Gilruth, in New Zealand, in which he found *Bacillus fluorescens liquefaciens* to be the organism causing what he called footid odor.

Eckles (6) in 1900 found two bacterial organisms to be responsible alone or jointly for a putrid butter outbreak in Iowa. One of these he identified as *Bacterium fluorescens liquefaciens* and the other he did not identify. Virtanen (7) includes *Bacterium punctatum* among the causative organisms.

Derby and Hammer (2) refer to findings of both Cordes and Macy in which they invariably found surface taint butter to contain large numbers of bacteria and yeasts and assumed these to be responsible for the defect. According to this reference, Macy believed that the defect was due to the associative action of a large coccus form of bacteria and various yeasts, but the reference fails to name any of them.

Hood and White (10), also referred to by Derby and Hammer, found large numbers of bacteria, yeasts, and molds to be present in samples of surface taint butter. A considerable number of the bacteria were of the liquefying or curd decomposing type.

Shutt (8), in Canada found large numbers of putrefactive bacteria to be present in putrid butter. The chief of these was *Pseudomonas fluorescens*, which was found by experiment to produce surface taint when inoculated into cream and the cream churned.

Herreid, Macy, and Combs (4) in their study of the Microbiology of Cheese-Like Flavors in Unsalted Butter found that a culture of an organism belonging to the genus *Achromobacter* produced offensive flavors and aromas, involving lipolysis and proteolysis, when the culture was inoculated into cream and churned. The flavors developed in the butter both at 41° F. and 50° F.

In contradiction of Shutt, Derby and Hammer (2) maintain that *Pseudomonas fluorescens* has in no case been found to be the cause of surface taint in their experiments. According to them, rancidity was the resultant defect where *Pseudomonas fluorescens* was present.

Nature of Surface Taint and Cheesy Flavor

The observations and conclusions of all the investigators of the subject of Surface Taint and Cheesy Flavor in butter are quite strikingly in agreement that the defect is the result of proteolytic decomposition in the butter brought about by the action either directly or indirectly of certain organisms on the protein in the butter at least some of which have been previously mentioned.

Herreid, Macy, and Combs (4) report some studies concerning the constituents of cream involved in the production of cheesy flavors the results of which seem to furnish rather conclusive evidence that surface taint or flavor and cheesiness in general are the result of proteolytic decomposition.

They found that the inoculation of pure cultures of bacteria, obtained from specimens of cheesy butter, into cream that was later churned, did not always reproduce a cheesy or surface taint defect. They state that, "the flora of the infected butters were not observed to undergo any morphological or dissociative change," and on this ground express the more or less theoretical possibility "that the manifestation of cheesy flavors and aromas is an expression of the physiological functions and properties of bacteria," and that the inconsistencies in results might be explained on such a basis of physiological variations of one sort or another. They go on to submit the possibility that "the protoplasm was of such a nature that the metabolic processes of the cells were changed to the extent that by-products of a non-cheesy nature were formed."

The same investigators found that a considerable number of organisms--bacteria, yeasts, and molds--could usually be isolated from samples of cheesy flavored butter. 450 cultures were isolated from such samples of butter and from suspected specimens of water. 68 of these cultures produced flavors suggesting some type of cheese. Some of the 68 cultures were divided into 8 groups on the basis of their physiological reactions and morphology. All three of the cultures falling in group 8 (the only one of the eight groups which consistently produced Cheddar flavor in butter) were yeasts, which were Gram positive, gelatin liquifying, produced proteolysis in litmus milk, and acidified glucose, lactose, and sucrose broth.

Virtanen (7) divides butter defects into two main groups in accordance with whether they are caused (1) by non-enzymatic reactions, or (2) by enzymatic reactions. Under the non-enzymatic group he places defects such as oily and fishy, and under the enzymatic group such defects as he calls fermented, boiled, cheese-sour, putrefied, and rank.

Herreid, Macy, and Combs (4) also express the possibility that the manifestation of the objectionable cheesy and like or related flavors and aromas may be due to the action of mixed cultures of organisms, and base this conclusion on the fact that pure cultures of organisms seldom, if ever, occur in raw milk or cream. "There are, however, conditions under which a pure culture might be distinctly localized in some portion or unit of the creamery equipment, water or other central point in the plant." There is also the possibility that a single species of bacteria might resist pasteurization or be introduced after pasteurization and thus give a pure culture which may produce an undesirable flavor in the butter.

Experiments reported by Herreid, Macy, and Combs (4), that were made to study the effects of the enzyme galactase and of the udder bacteria on the keeping quality of butter indicated that there was no connection between the action of the enzyme and the udder flora and the manifestation of cheesy or related flavors and aromas in the product, butter. They refer to work by Heiduschka and Komm, in which they showed experimentally that aseptic milk did not contain an inherent protease enzyme. Other experiments reported by Herreid, Macy and Combs (4) showed that when certain animal proteases (Pepsin, trypsin, and rennin) were added individually or in different combinations, to sterile butter, cheesiness was not produced.

From these reported researches, it would seem to be conclusive that the cheesy and related flavors found in butter are caused only by micro-organisms, or enzymes produced by them, and that certain types of the bacteria and their enzymes are primarily responsible; a number of different bacteria having been isolated and found to quite consistently produce the defect under study, either in pure culture or in mixed culture.

Herreid, Macy, and Combs (4) attempted to reproduce the defect in rather concentrated mixtures of the major components of butter. It was found that where the flavors appeared no single substrate, but in every case more than one substance was used. Therefore, the experimenters were unable to lay the source of the defect to any one of the substances alone. Because the qualitative mixtures of substances did not imitate the natural conditions the experimenters decided to try to reproduce the defect using washed cream as a base and adding the remaining substances in more or less purified form. The washing of the cream with pure water removed the plasma colloids and when this cream was inoculated with bacteria and churned, the cheesy defect could not be produced. This definitely showed that it is the protein compounds removed by the washing that are acted upon by the organisms or their enzymes.

When different constituents were added in various combinations to the washed creams, inoculated with a mixed culture of bacteria, and churned, the results showed that "no single constituent of cream can be indicted as being the source of cheesy flavors in butter. The simplest combination showing any degree of cheesiness was that containing casein and lactose." Casein was always one of the constituents of butters exhibiting any manifestations of cheesy flavors. Three samples that showed distinct putrid or limburger flavors and aromas contained lactalbumin and one of them contained lactose in addition. The lactalbumin in two of the samples was freed of lactose by dialyzing it. In one of these the lactose-free lactalbumin was added alone. In the other lactose was added as well. In the third, undialyzed lactalbumin was used. The undialyzed lactalbumin contained 35.37% protein, 0.195% ash, and 64.44% lactose. The addition of calcium caseinate alone to the washed cream, did not result in either a cheesy or surface taint manifestation.

The above appears to have been the only work done on the substrates affected in the development of cheesiness and surface taint in butter. Though nothing definitely conclusive was found as to just what substance or substances in butter were affected in the development of these defects other than that it is the plasma (milk serum) colloids, the work does bear out the previous conclusions that the defects of cheesiness and surface taint are the results of protein decomposition.

Experimental work done by Hammer and Patil (9) on the effect of proteolysis by *Streptococcus lactis* in butter indicates that the making of butter with a proteolytic strain of *Streptococcus lactis* results in no different flavors in the butter than those obtained from the use of a non-proteolytic strain of *S. lactis*. "It is quite apparent," according to them, "that *S. lactis* strains causing proteolysis in milk are of no significance from the standpoint of the keeping quality of butter."

Derby and Hammer (2) found that "Surface taint could not be produced in butter by inoculating a normal product, either salted or unsalted, with surface taint butter, but could be developed by inoculating the defective butter into pasteurized cream and churning the cream; from 2 to 4 days were required for the surface taint to develop at 15.6° C. (60° F.) and from 7 to 10 days at 5° C. (41° F.)."

All investigators have found that surface taint may develop in commercial butter held at temperatures favorable for bacterial growth, and that in the large majority of cases the butter that develops surface taint is either unsalted or has a low salt content.

Sources of Causative Organisms

Olson and Hammer (3) in studying the influence of organisms isolated from churns on the keeping qualities of butter found four cultures of organisms of the genus *Bacillus* which produced cheesiness or surface taint, one micrococci which produced cheesiness, and one mixed culture which produced surface taint.

The contamination of churns and other equipment from the air was found by Olson and Hammer to be a possible source of some of the organisms causing cheesiness or surface taint.

A large proportion of the writers mention the wash water used in the creameries as an exceedingly important source of the organisms causing surface taint. Hood and White, according to Derby and Hammer (2), reported the sources of organisms causing surface taint to be shallow or seeping wells in many cases. Shutt (8) noted that all samples of surface taint butter encountered commercially by him had had their origin at creameries where the water supplies were anything but pure. He also noted that practically all the outbreaks of surface taint about which he knew had followed periods of heavy rainfall, and that the waters involved were contaminated with large numbers of putrefactive bacteria.

Virtanen (7) states that, " - the enzymes causing the defects (in flavor and aroma) are as a rule produced by gelatin liquifying water bacteria." He also states that molds and yeasts may be the cause of these defects.

Methods of Prevention and Control of Surface Taint and Cheesy Flavor in Butter

Shutt (8) recommends (a) " - the substituting of pure water for contaminated," (b) " - subjecting contaminated water to 87.8 degrees C. (190 degrees F.) for 10 minutes" and (c) " - neutralizing the cream to not less than 0.35% acid."

Derby and Hammer (2) found that, "The organisms which would produce surface taint were greatly restrained by the use of medium salt percentages or butter culture in the making of butter."

Virtanen (7) states that the bacteria causing butter defects are unable to withstand very acid media and that they are susceptible to the influence of salt.

Shutt (8) states:

- "1. No samples of surface flavor butter have ever been received from creameries where the water supplies were known to be pure.
- "2. All samples of surface flavor butter have had their origin at rural creameries, or at city creameries where the water supplies have not been pure.
- "3. Very few samples of surface flavor butter have been received during the winter months. The great majority has always come during the spring and summer.
- "4. Several samples of surface flavor butter appeared to be over-neutralized.
- "5. Surface flavor has never been found in sour cream butter, but always in sweet cream or neutralized cream butter."

After making certain of the purity of the water supply, observing efficiency in neutralization and pasteurization followed possibly by the use of butter culture and the addition of a moderate percentage of salt should, with proper sterilization of the equipment, assure freedom from the development of surface, putrid, or cheesy flavor.

It should not, of course, be forgotten that careful grading of the cream received, is necessary, and that all cream showing a decided cheesy or putrid flavor or aroma should be graded out and under no circumstances used in the making of first grade butter. This grading in itself should assure freedom from cheesy flavor in the butter if there is no contamination at a later stage in the manufacturing process.

Hunziker, at the annual Buttermakers Short Course and Convention held at Corvallis, Oregon, in February, 1935, stated that, "An epidemic of surface taint is liable to spell financial disaster to a creamery unless it is brought under control immediately. Any creamery can afford to go the limit in its efforts to prevent the outbreak of surface taint. The source of the contamination is often hidden and difficult to find. Surface flavor may result from one or more of the following: too low a salt content in the butter, favoring the development of undesirable bacteria; too low an acidity of the cream at the time of churning, which favors development of protein digesting bacteria; inefficient pasteurization; the introduction of raw cream into the pasteurized cream between pasteurizing and churning--possibly because of a leak in the cream lines; the use of contaminated wash water; inefficient sterilization of the equipment; leaks in the linings of vats; improper treatment of wraps; storing the butter at too high a temperature, thus favoring the development of any bacteria present."

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