

# THE RELATION OF OIDIUM LACTIS AND PENICILLIUM TO THE KEEPING QUALITIES OF BUTTER

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The factors involved in the deterioration of butter have received considerable study in recent years. Attention has been directed especially towards certain abnormal flavors and attempts made to connect them with the activity of particular microorganisms. Most of the work along these lines, with the exception of the extensive work of Rogers, has been in the nature of a study of the butter itself. The writers are of the opinion that a study of the cream is more likely to yield results, when the action of microorganism is suspected, than is a study of the butter.

The high acidity, the salt content and the limited amount of air make the conditions in butter unfavorable for the growth of the large majority of organisms. The changes that take place in the butter constituents so far as related to microorganisms would presumably be brought about by the activities of enzymes the action of which would not be stopped by these conditions. The cream is a far better media than butter for the growth of organisms and the enzymes produced would necessarily be carried into the butter where the effects might not be apparent until some time after the butter was made. By the time the butter has deteriorated to an appreciable extent, the organisms producing the enzymes may have all disappeared. The little success which has so far been attained in determining the causes of specific defects in butter flavor may be partially at least explained on this basis.

## RELATION OF MOLD TO DETERIORATION OF BUTTER

Rather extensive studies have been made of molds and *Oidium lactis* in connection with dairy products especially the ripening of soft cheeses. Several investigators including, Gripenberg (1),

O'Callaghan (2) and Jensen (3) have also concluded that molds and *Oidium lactis* are of importance in relation to the keeping qualities of butter. The study of this problem has, however, been confined to the butter and no attention given to the results of mold growth in cream before churning. The frequent occurrence of mold in butter packages on the market, especially tubs, is responsible for a wide interest in the relation of mold in this form to the keeping quality of butter.

Thom in a recent paper states that molds do not grow readily upon butter. The conditions necessary for its growth are a high humidity of the surrounding atmosphere, a high moisture content, and low salt content of the butter. Experiments by the present authors corroborated these results.

#### OBJECT OF EXPERIMENTAL WORK

The primary object of the experiments reported in this paper was to determine the relation of *Oidium lactis* and a mold of the *Penicillium* group to the keeping qualities of butter, especially when these organisms had developed in the cream before churning.

*Oidium lactis* was selected as one of the organisms on account of its wide distribution in dairy products and its well known relation to certain dairy products. A number of molds of the *penicillium* growth the spores of which were found present in butter were studied and a type identified as *P. Chrysogenum* selected for the experiments.

*Description of butter.* As it is practically impossible to find terms which will convey the idea of the precise flavor of butter it was thought advisable to indicate the flavor of butter examined in these experiments on a percentage basis. Where check samples of butter were compared with the experimental the flavor of the check sample was given a value of 1.00, and variations from the check sample were indicated by decimal parts of 1.00 which shows the extent the butter in question varied from the check according to the judgment of those making the examination.

Butter given a flavor of 1.00 was first class butter while that

ranging between 0.90 and 0.99 would be considered second grade, that graded from 0.75 to 0.89 rather poor, though it could possibly be sold on the market, and that graded 0.70 or below was too inferior for human consumption. The entire series of experiments included 58 separate churnings and observations on 658 samples of butter.

#### RESULTS OF *OIDIUM LACTIS* AND *P. CHRYSOGENUM* UPON BUTTER

Only a portion of the data taken is given but the results were consistent and conclusive. Pure cultures of the molds grown upon samples of sweet cream were found to be detrimental to the quality of the cream as judged from the standpoint of the practical buttermaker. However, when the same molds were grown upon sour cream no ill effects whatever upon the quality of the cream could be observed. The resulting butter, however, went off flavor very quickly in either case as is shown in table 1.

TABLE 1

*The growth of molds upon sweet and sour cream and the effect upon the resulting butter*

CONDITION OF CREAM	INOCULATION	QUALITY OF BUTTER			
		Fresh	30 days	60 days	90 days
Sweet.....	Penicillium	1.00	0.90	0.85	0.70
Sour.....	Penicillium	1.00	0.75	0.60	0.50
Sweet.....	Oidium	1.00	0.85	0.75	0.60
Sour.....	Oidium	1.00	0.70	0.65	0.55
Sweet.....	Penicillium and Oidium	1.00	0.70	0.60	0.50
Sour.....	Penicillium and Oidium	1.00	0.80	0.55	0.45
Sweet.....	None (check)	1.00	1.00	0.95	0.75
Sour.....	None (check)	1.00	1.00	1.00	1.00

The above data shows that when the molds made growth upon either sweet or sour cream the resulting butter went off in flavor very rapidly. It is also interesting to note that, though mold growth upon sour cream did not seem to affect the quality of

that cream as judged by taste the resulting butter had poorer keeping qualities than the butter made from the sweet cream on which the molds had previously been grown. The butter made from cream on which the two molds used in the experiments had been allowed to grow together in every case showed a poorer

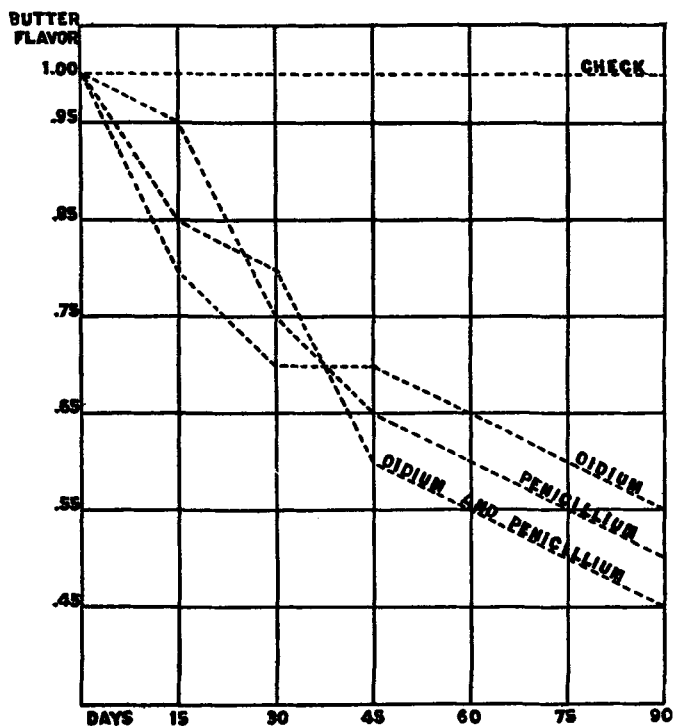


FIG. 1. THE RELATION OF PENICILLIUM AND OIDIUM GROWTH UPON SOUR CREAM TO THE KEEPING QUALITIES OF BUTTER

The growth of these organisms upon cream results in very rapid deterioration of the butter as the figure shows. The check sample, free from mold growth, showed but little deterioration in three months while the butter from the cream in which the molds had grown freely was unfit for human food.

keeping quality than the butter which was made from cream on which only one of the molds had grown. Figure 1 shows graphically the rate of deterioration of the butter made from sour cream in which Penicillium and Oidium had been allowed to grow.

The pronounced effect of mold growth in cream upon the keeping quality of the butter may be explained in two ways: The first is that the mold spores which are produced by the growing molds are carried into the butter and there grow and bring about the decomposition of the butter constituents which results in butter of very poor keeping qualities. The second possible explanation is that the molds while growing upon the cream secrete enzymes which are carried over into the butter at time of making and gradually bring about a decomposition of the butter constituents. Experimental work was conducted to determine which of these is the true explanation. A large number of cream samples were inoculated with the *Oidium lactis* and *P. Chrysogenum* and the butter churned after the molds had developed to the point of forming spores and placed in 100 cc. Erlenmeyer flasks. The flasks were placed at ice box temperature in a receptacle protected from outside contamination and in no case did the mold appear upon the butter, though the cream from which this butter was made must have contained enormous numbers of mold spores. Other trials were made by working large numbers of mold spores directly into freshly made butter but no growth of mold appeared on the surface.

The number of mold spores in a gram was also determined by the plate method for several samples of fresh butter, some of which were stored in a dry and others in a humid atmosphere. In every case there was an actual decrease in the number of mold spores contained in the butter at the end of thirty days. These results seemed to show conclusively that molds are not able to germinate or make growth within butter.

Another series of experiments was conducted to determine if the enzymes produced by the molds while growing upon cream were the cause of the rapid deterioration of the butter made from such cream.

Seven gallon lots of cream were pasteurized and a 5 per cent starter of *B. lactis acidii* added to each. Two were inoculated with *Oidium lactis*, two with *P. Chrysogenum*, two with both organisms, and one was kept for a check. All were allowed to stand at 70° F. for eight days during which an abundant growth was made by

both molds. All were then pasteurized at 145° F. for twenty minutes and cooled to the proper temperature and churned.

Another set of seven was treated in exactly the same manner except the cream samples were pasteurized at a temperature of

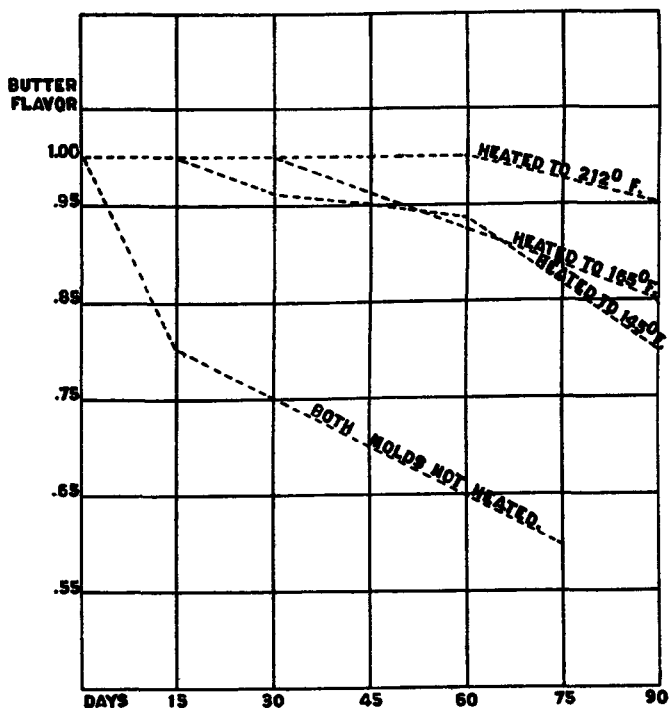


FIG. 2. THE RESULTS OF HEATING CREAM IN WHICH OIDIUM AND PENCILLIUM HAD GROWN, TO A TEMPERATURE OF 165° F.

These data show that a temperature of 165° F. for five minutes is not sufficient to entirely destroy the action of the enzymes produced in the cream by the molds. In each case the results were the most marked where both organisms had grown together.

165° F. for five minutes. A third set was also a duplicate of the first except the cream was heated to 212° F.

A fourth set of five lots of cream was prepared in a similar manner and four of them inoculated with both molds. One was heated to 145° F., a second to 165° and the third to 212°. One

check contained the mold growth but was not heated and one check was not inoculated.

The results of these experiments showed that heating to 145° F. improved the keeping qualities of the butter over that of the check lot not heated but did not prevent it from going off rapidly

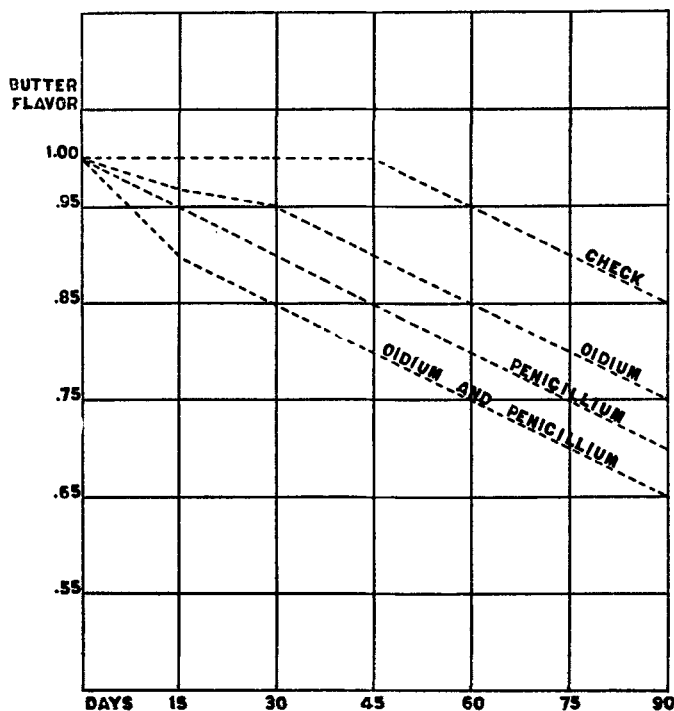


FIG. 3. THE RESULTS OF DIFFERENT TEMPERATURES UPON THE KEEPING QUALITIES OF THE BUTTER

This figure shows the results on the keeping quality of butter of heating cream on which both molds had grown. The keeping quality was greatly improved by pasteurizing at a temperature of 145°F., was still better at 165°, and the least deterioration occurred in that heated to 212°.

in flavor due to the mold growth. Pasteurizing at 165° was more effective than at 145°. At 212° the deterioration due to the presence of the mold seems to be entirely removed. The results of a temperature of 165° F. is shown in figure 2 and a comparison of results at the three temperatures in figure 3.

It will be noted from figure 3 that the butter made from that cream on which the molds were grown and which received no pasteurization went off in flavor very rapidly. By the end of forty-five days the butter from this cream was absolutely unfit for human consumption. These results must be interpreted to mean that the decidedly better keeping quality of the butter from the pasteurized cream was due to the destruction of the enzymes formed in the cream by the molds. It also suggests that the well known beneficial results of pasteurization upon the keeping qualities of butter as practiced in a commercial way is probably to be attributed, to a considerable extent at least, to the destruction of the enzymes produced by various organisms in the cream and milk from which the butter was made.

#### CONCLUSION

Molds do not grow readily upon butter, but their growth is influenced by the amount of protein, salt and moisture, the butter contains and the moisture of the surrounding atmosphere.

The quality of cream as usually judged by taste is influenced to a marked degree by the growth of *Oidium lactis* and *P. Chrysogenus* when the cream is sweet but no objectionable flavor can be detected in the cream as a result of mold growth when the cream is sour.

The growth of *Oidium lactis* or *Penicillium* upon cream exerts a decidedly detrimental effect upon the keeping qualities of the butter.

Mold spores do not germinate or make growth in butter. The growth of mold on butter is the result of a contamination from the outside.

Pasteurization at ordinary temperatures greatly improves the keeping qualities of butter made from cream upon which molds have made growth but it does not entirely check the action of the enzymes which they produce. This action may be checked entirely by heating to a sufficiently high temperature but this point is beyond the limit of practicability for commercial use.

The abnormal flavors which develop in butter, due to mold



growth on the cream, are caused by enzymes which are secreted by the mold in the cream.

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