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THE DEVELOPMENT OF METALLIC FLAVOR IN BUTTERMILK

M. P. BAKER AND B. W. HAMMER

INTRODUCTION

An objectionable flavor commonly referred to as metallic is sometimes noted in butter and other dairy products. The name applied to it indicates that it suggests the presence of absorbed metals. A characteristic odor ordinarily accompanies the flavor and the abnormal condition can ordinarily be detected by the odor almost as well as by the flavor.

In butter where the metallic flavor causes the greatest economic loss, it is most often noted at the time of making or shortly after, and is not to be classed with the flavors developing during storage. Buttermilk frequently goes metallic on standing and in this product the flavor is often very pronounced. The flavor is also rather common in cream in which there has been some acid development; it is encountered especially during the spring and fall, rather than when the cream temperatures are unusually high or unusually low.

The object of this paper is to discuss some work done at the Iowa Agricultural Experiment Station in an effort to determine the relationship of bacteria to the development of metallic flavor. The trials were carried out with buttermilk for the most part because of the extent to which the flavor develops in this product and the ease with which it can be sterilized and handled.

In the study of any objectionable flavor in dairy products it should be recognized that there may be more than one cause. A soapy flavor may be due to soap carried into milk from utensils, etc., but may also be due to bacterial action. Various flavors such as feed, barn, etc., have been caused by bacteria as well as by absorption from the surroundings or from the body of the animal. Accordingly any conclusions drawn with reference to the development of metallic flavor by the action of bacteria do not exclude other possible causes for this flavor.

According to Guthrie the factors influencing the development of the metallic flavor are as follows: Low temperature, direct absorption of metals, bacteria, high fat content except in the case of buttermilk, high acidity of the medium and possibly enzymes. Guthrie produced metallic flavor in cream in sterilized glass bottles in 79 out of 241 trials by inoculating with metallic-flavored butter-
milk. He says and, "The organism that causes metallic flavor is a member or a strain of the *Bacterium lactis acidi* group."

**WORK DONE**

In connection with experiments carried out to determine the influence of the growth of *S. citrovorus* and *S. paracitrovorus* in the cream on the flavor and aroma of butter it was observed that raw cream allowed to sour in a glass container frequently developed a metallic flavor. Sometimes this flavor was very intense. The development of this flavor in glass suggested the action of bacteria as a cause and led to the attempt to prove definitely that bacteria may cause metallic flavor.

Buttermilk from various churnings was allowed to stand in glass containers and was observed from time to time. It was drawn from the churn directly into glass flasks from which it was transferred into pint milk bottles which were stoppered with cotton. Some of these were left at room temperature and some were put into the laboratory cooler in which for the most part a temperature of about 12°C. was maintained. The samples kept in the cooler usually became metallic in from three to seven days while those kept at room temperature seldom became metallic but rather developed bad odors of various kinds. This is in accordance with the theory that low temperature is a factor which favors the development of metallic flavor. It is also evidence that the flavor is not due to metals because if it were the samples held at room temperature should have developed the flavor as readily as those held in the cooler.

The organisms that are most numerous in buttermilk are those coming from the starter, and accordingly, starters were selected for the first inoculation experiments. Buttermilk, secured by churning low acid cream, was sterilized in milk bottles stoppered with cotton, by heating in an autoclave and then inoculated with very small amounts of starter; some of the containers were held at room temperature and some in the laboratory cooler.

Seventeen trials were made where sterile buttermilk was inoculated with starter and incubated in the laboratory cooler. Of these, twelve became definitely metallic, one was questionable and four did not develop a metallic flavor. The flavor usually developed in about ten to fourteen days. The four trials that did not develop the flavor were carried out at a time when the temperature of the cooler was lower than usual.

Of twenty-one trials where buttermilk was inoculated with starter and incubated at room temperature, fourteen became defi-
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nately metallic and the other seven were questionable. Here the flavor usually developed in from one to five days.

The development of metallic flavor more quickly at room temperature than in the cooler in the case of sterile buttermilk inoculated with starter does not agree with the results obtained with the unsterilized buttermilk which went metallic more readily at the cooler temperature. It seems probable that in the case of the unsterilized buttermilk there were organisms present that overgrew at room temperature those organisms important in the development of metallic flavor, while at the cooler temperature this did not occur.

Mixtures of pure cultures of the starter organisms (\textit{S. lactis}, \textit{S. citrovorus} and \textit{S. paracitrovorus}) were also tried in sterile buttermilk. Of eight trials at the cooler temperature, buttermilk inoculated with \textit{S. lactis} and \textit{S. paracitrovorus} became metallic two times, was questionable two times and showed no tendency toward the flavor four times. At room temperature only one out of four trials became metallic.

Buttermilk inoculated with \textit{S. lactis} and \textit{S. citrovorus} and held at the cooler temperature developed a metallic flavor only once out of four trials, while out of three trials held at room temperature one became metallic and the other two were questionable.

Buttermilk inoculated with all three of the starter organisms and held at the cooler temperature became metallic three times out of five trials. At room temperature one of three trials became metallic, one was questionable and one was negative.

A considerable number of trials were made with each of these organisms alone in sterilized buttermilk but in no case did a metallic flavor develop. With each of these trials, samples of buttermilk containing mixtures of the starter organisms gave the usual metallic flavor.

The results obtained with combinations of lactic acid organisms in sterile buttermilk suggested that the products of growth of one organism together with another organism might be sufficient for the production of the metallic flavor. Accordingly small amounts of sterile lactic acid were added to sterile buttermilk with each of the three organisms concerned and with combinations of the three. There was no metallic development in any sample containing only one organism. Two samples, containing all three organisms, held at room temperature became metallic while two duplicate samples held in the cooler were negative. One of the two samples containing \textit{S. lactis} and \textit{S. citrovorus} only, held at room temperature became metallic while the cooler samples did not. None of the
samples containing only *S. lactis* and *S. paracitrovorus* developed the flavor.

From these results it seems evident that the production of lactic acid is not the only thing of importance as far as *S. lactis* is concerned; at any rate combinations of lactic acid and one of the associated organisms did not have the same effect as combinations of *S. lactis* and one of these organisms.

Small amounts of acetic acid were tried in the same way as was the lactic acid, but in no case did a metallic flavor develop. This may have been due to the failure of the organisms to grow in the presence of the acetic acid.

Starters were used in an effort to produce metallic flavor in sterile whole milk, sterile skimmed milk and sterile cream. In whole milk, ten trials failed. In skimmed milk eight trials failed and in cream two trials out of four produced a questionable flavor. These results indicate the suitability of buttermilk for the production of a metallic flavor.

It is well to note that in every series of trials, uninoculated checks were run with the inoculated samples and none of these checks became metallic.

**CONCLUSIONS**

While this work can not be considered as being complete the data already obtained allows some conclusions, as follows:

Metallic flavor can be produced in buttermilk that is held in glass containers.

Buttermilk as drawn from the churn goes metallic more frequently if held at 12°C than if held at room temperature.

Metallic flavor can be produced in sterile buttermilk by inoculating with starter.

Metallic flavor can be produced in sterile buttermilk by inoculating *S. lactis* with either *S. paracitrovorus* or *S. citrovorus* or both.

When buttermilk is sterilized and inoculated with starter or starter organisms it develops a metallic flavor more frequently at room temperature than at 12°C.

The addition of small amounts of lactic acid to buttermilk does not effect the development of metallic flavor.

Metallic flavor develops more readily in buttermilk than in other dairy products.

**BIBLIOGRAPHY**


Dairy Department, Iowa State College.