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LACTO:
A FROZEN DAIRY PRODUCT

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE AND
THE MECHANIC ARTS

Dairy Section

Ames, Iowa

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LACTO

BY M. MORTENSEN AND B. W. HAMMER.

Interest in sour milk drinks has become quite general in recent years through the work and teaching of Metchnikoff, who believes that their use will aid materially in prolonging life and delaying the changes incident to old age. However, most people dislike sour milk and will not use it, so several years ago the writer undertook to prepare sour milk drinks so flavored with fruit juices as to make them more palatable. The dairy section of the Iowa Agricultural Experiment station took up these experiments and produced a frozen sour milk product of the consistency of ice cream and possessing a delicate and agreeable flavor. This frozen product was called "lacto" and as such became widely known, not merely in this country but in other countries as well.

The results of the experiments which produced lacto were first published in January, 1911, in Bulletin No. 118. Inasmuch as two editions of that bulletin were promptly exhausted and applications for it continue to be frequent, the Iowa Agricultural Experiment station publishes this new bulletin. It includes a portion of the former report rewritten and such new material as has been accumulated.

THE METCHNIKOFF THEORY.

The foundation of the Metchnikoff belief in the value of sour milk drinks is that the putrefaction which ordinarily occurs in the large intestine results in the formation of products that are absorbed by the body with a harmful effect. The portions of the food material not taken up by the body during the passage down the digestive tract collect in the large intestine and may remain there for considerable periods, during which putrefactive bacteria are growing and producing their characteristic products. It is the absorption of these products, as well as the passage of some of the bacteria through the intestinal wall and into the organs of the body, that is supposed to play an important part in bringing on old age.

Any preventive measure must then, of necessity, attempt to do away with this putrefaction. At birth the intestinal tract is sterile, but bacteria very soon appear therein and it is evident that it is impossible to keep this canal free from micro-organisms. The use of sterile or nearly sterile food is of no avail in keeping down the bacterial content of the intestinal material because of the rapid growth of bacteria under the favorable conditions existing.

It has been known for a long time that acids prevent putrefaction by stopping the growth of putrefactive bacteria. This

fact has been extensively employed in the household in the preservation of food with vinegar (acetic acid). The souring of milk is essentially a preservative change and sour milk does not undergo putrefaction because of the acid (lactic) which has been produced by certain bacteria growing in the milk. If exposed to the growth of molds which are capable of destroying lactic acid, sour milk will begin to putrefy as soon as its lactic acid is reduced to an amount which the putrefactive bacteria are capable of withstanding.

It seems reasonable to suppose then, that if some method could be devised by which acid could be produced in the large intestine the growth of the putrefactive bacteria could be greatly reduced or possibly entirely prevented. The acid taken in the food or secreted by the stomach must be neutralized in the small intestine if normal digestion is to occur because the digestive juices here require an alkaline reaction. Accordingly such acid can have no inhibitory influence on the putrefactive changes that take place in the large intestine.

METCHNIKOFF PROPOSES TO USE LACTIC ACID BACTERIA.

Metchnikoff conceived the idea of having the acid produced in the large intestine by lactic acid bacteria which could be introduced with the food and which he believed would find conditions here suitable for growth. This investigator considered that the acid thus formed would be sufficient to exert a restraining influence on the putrefactive bacteria and that as a result the body would not absorb the harmful products that are ordinarily elaborated by these micro-organisms in their growth. In support of this idea, Metchnikoff pointed out that in certain countries where the inhabitants use large quantities of sour milk there are many extremely old persons and that in other countries, certain individuals, who have attained an exceptionally old age, have used sour milk in large quantities.

From the different lactic acid forming organisms studied by Metchnikoff, he selected one which he considered to be particularly well suited to the purpose which he had in mind. This organism, *bacillus bulgaricus*, grows well at the temperature of the human body, produces exceptionally large amounts of acid, but sometimes gives a disagreeable flavor to milk fermented by it. This disagreeable flavor can be overcome in part at least by the use of the ordinary lactic acid organism that is employed by the buttermaker in conjunction with *bacillus bulgaricus*.

EXPERIMENTS PRODUCE "LACTO."

When the writer undertook to overcome popular dislike for sour milk he experimented in flavoring sour milk drinks with fruit juices. At one time such products were placed on the

market, but on account of the lack of time for advertising no great demand for them was created.

The dairy section of the Iowa Experiment station in taking up these experiments froze the product to the consistency of ice cream. At first the experiments were conducted with buttermilk flavored with various fruit juices, but thus far it has been impossible to produce a combination of flavors with the buttermilk that is absolutely satisfactory, although the buttermilk has been of good quality. Later, skimmed milk which has been soured by a commercial lactic acid culture was substituted for the buttermilk. This combined with eggs and the various fruit flavors gave a product which possessed a delicate flavor. It was found that many people who disliked the flavor of sour milk relished this product, which was called "lacto."

PREPARATION OF MILK USED FOR MANUFACTURE OF LACTO.

The milk for lacto is prepared in a similar manner to the starter which is used for cream ripening. A commercial lactic acid culture is used. This is added to a pint of skimmed milk which has been pasteurized at a temperature of 85 degrees C. (185 F.) for twenty minutes, and after pasteurization cooled to from 20 to 22 degrees C. (68-72 F.). The lactic acid culture is mixed thoroughly with the milk and left at 20 degrees C. (68 F.) until the milk has coagulated. Then another bottle of skimmed milk is pasteurized and cooled in the same manner, but instead of the commercial culture, a part of the coagulated milk is added to insure the souring of the milk inside of eighteen hours. This operation is repeated until the final batch of soured milk obtained has lost the undesirable flavor due to the substance in which the commercial culture was preserved. After this point has been reached, which requires from four to six days, the last sample of soured milk obtained is added to a larger amount of pasteurized skimmed milk. This is then treated the same as the former lots. In this way an amount of milk sufficient to work with is obtained.

Where lacto is to be made in the household on a small scale it may prove too expensive to buy commercial lactic cultures. A family recipe then would be as follows:

Take a bottle of good clean fresh milk which has not been heated, set it away at a temperature of from 68 to 70 degrees F. until it coagulates. If it coagulates as a smooth solid curd without pin holes, if the aroma is clean and pleasant, and the flavor nice and creamy, it can be used as a starter for a larger amount of pasteurized whole or skimmed milk.

The milk when ready to be used for lacto has an acidity of .7 to .8 of 1 per cent expressed in terms of lactic acid. It must be of a mild and clean acid flavor. The curd must be thoroughly

broken up. This is accomplished by pouring it from one pail to another until it is as smooth and velvety as rich cream. From this milk, which in this connection will be called "lacto milk," the various lactos are prepared by the following formulas:

FORMULAS FOR LACTO.

Each of the following formulas will make 5 gallons of the finishd product.

Cherry Lacto.
- 3 gallons lacto milk,
- 9 pounds sugar,
- 12 eggs,
- 1 quart of cherry juice or concentrated cherry syrup,
- 1½ pints lemon juice.

Orange Lacto.
- 3 gallons lacto milk,
- 11 pounds sugar,
- 12 eggs,
- 2½ quarts orange juice,
- 1½ pints lemon juice.

Mint Lacto.
- 3 gallons lacto milk,
- 9 pounds sugar,
- 12 eggs,
- 1 pint concentrated Creme de Menthe syrup,
- 2½ pints lemon juice.

Pineapple Lacto.
- 3 gallons lacto milk,
- 9 pounds sugar,
- 12 eggs,
- 1½ gallons grated pineapple,
- 1½ pints lemon juice.

Maraschino Lacto.
- 3 gallons lacto milk,
- 9 pounds sugar,
- 12 eggs,
- 1 quart maraschino cherries grated,
- 1½ pints cherry juice or concentrated cherry syrup,
- 1½ pints lemon juice.

Raspberry Lacto.
- 3 gallons lacto milk,
- 9 pounds sugar,
- 12 eggs,
- 1 quart red raspberry juice or concentrated syrup,
- 1½ pints lemon juice.

Grape Lacto.
- 3 gallons lacto milk,
- 9 pounds sugar,
- 12 eggs,
- 1 quart grape juice,
- 1½ pints lemon juice.

PREPARING THE MIXTURE.

The sugar is first dissolved in the lacto milk. The eggs are then prepared. The whites and yolks are kept in separate containers and each lot is beaten with an egg beater. Both the yolks and whites are then added to the milk. The mixture is thoroughly stirred and strained through a fine wire gauze. The fruit juices are added last. The freezer is now run until it turns with difficulty, when the paddle is removed. The brine is removed and the freezer repacked with ice and salt and left for an hour before the contents are served.

In the previous report, bacteriological analyses of lacto were published which showed that large numbers of the lactic acid producing bacteria survive the freezing process. A decrease in their number begins, however, soon after this and continues slowly until eventually but few of these organisms are living. There is apparently no change in the amount of contained acid during the storage of lacto.

THE VALUE OF LACTO AS FOOD.

As to whether or not any beneficial action will result from the use of lacto it is of course impossible to say. If sour milk is valuable, however, there seems to be no reason why lacto should not be, and it has the advantage of being more agreeable to many people than sour milk in any other form. Since the publication of the previous report numerous requests have been sent in for information in regard to the value of lacto in the treatment of certain diseases. The Station can make no recommendations in cases of this sort and all such questions should be decided by the physician in charge. The only claim that is made is that lacto supplies sour milk in an agreeable form. During the past two years the demand for this product among the students of Iowa State College of Agriculture and Mechanic Arts has been greater than the demand for ice cream.

A consideration of the materials used in its manufacture shows that lacto is nutritious. If it is desired to increase the fat content this can be done by the addition of cream. The low fat content, however, seems to be one of the advantages of this product because, as a result, lacto can be eaten without the disagreeable after effect that is so common with ice cream. Its low fat content also makes lacto a valuable dish for hot weather.

EXPERIMENTS WITH BACILLUS BULGARICUS.

Recently experiments have been undertaken to see what sort of a product could be obtained by the use of milk fermented

with *bacillus bulgaricus*. This organism is capable of forming considerably more acid than the organism ordinarily used for starter making, and accordingly it is advisable to watch the acid formation. By ripening the milk up to an acidity of about 0.9 per cent and using the formulas as previously given, a very good product was obtained. The growth of *bacillus bulgaricus* results in a slimy condition of the milk, the sliminess being so marked with some cultures that the milk can be pulled out in strings several feet long. This stringy condition can be greatly reduced or entirely eliminated by violent agitation. Although this slimy condition is objected to by some persons when the milk is to be used as a drink, it is an advantage when the milk is to be used for making lacto because it improves the body of the product to a considerable extent.

Bacillus bulgaricus grows best at a temperature considerably higher than the temperature ordinarily used for propagating starters. While the best temperature is not exactly known it probably lies above 100 degrees F. A temperature of 99 degrees F., which is one of the temperatures commonly employed in bacteriological laboratories, gives very good results. Cultures can be propagated at room temperatures, but growth is quite slow. Whatever temperature is employed, however, considerable attention must be given to the milk to be used. If exceptionally clean milk is available, little trouble should be experienced when careful pasteurization is practised, but if the milk is badly contaminated considerable difficulty is likely to be encountered. An exposure to a steam pressure of five pounds for fifteen minutes gave good results with milk that was highly contaminated and with which pasteurization at 180 degrees F. for two hours was of no avail in stopping the undesirable changes.

Facilities for heating milk under pressure are, however, seldom available outside of laboratories, so some other method must be resorted to. Another method commonly employed in laboratories consists in heating the milk to the temperature of boiling water for from twenty to forty minutes on each of three successive days. In this procedure, the bacterial spores are supposed to germinate between heatings and, in the vegetative stage, the micro-organisms are killed by the succeeding exposure. This continued heating of course darkens the milk and imparts a cooked taste, but the cooked taste is not as noticeable after fermentation with *bacillus bulgaricus* as before.

Cultures of *bacillus bulgaricus* can be obtained from a number of commercial firms. The Dairy Department of the Experiment Station will send out cultures of this organism to a limited number of persons writing in for them on condition that a report of the results obtained will be made to the Department.

In various places in the United States a certain micro-organism has been found that is closely related to *bacillus bulgaricus*. This bacterium produces more acid than the organisms used for starter making, although not so much as *bacillus bulgaricus*. Moreover, some of the cultures are slimy. Milk fermented by it has an exceptionally clean acid flavor. This organism has also been used to ferment milk for making lacto and an excellent product obtained. It is rather difficult to propagate without the facilities of a laboratory.

This organism has been found in a large percentage of the samples of milk investigated and also in a number of specimens of human feces. It would seem then that the intestine would have abundant opportunity to become seeded with acid producing organisms of a type closely related to *bacillus bulgaricus*. In this connection it may be of interest to note that some investigators consider that the type of bacteria which are to develop in the intestine is largely determined by the nature of the food eaten. Foods which supply material capable of being changed into acids (fermentable carbohydrates such as the milk sugar) will favor the acid producing organisms, and may lead to the production of acid in the intestine. The probability, recently suggested, that the fermentable carbohydrates are absorbed before they reach the large intestine has presented a new view to the theory of acid production therein and shown the need of additional experimental work before the importance of the question can be definitely stated.