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AN EPIDEMIC OF ROPY MILK

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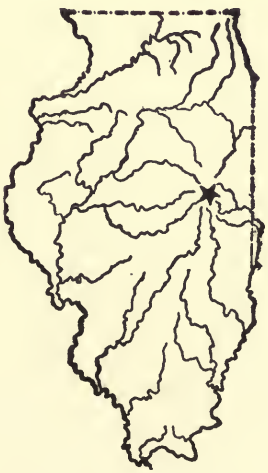

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Summary of Bulletin No. 228

Ropy milk is due to the growth in the milk of certain germs, and this growth results in an increased viscosity of the milk. There is no evidence that these germs produce any changes which affect either the healthfulness or the flavor of the milk, but the change in consistency is unusual and on this account is objectionable to the consuming public.

The source from which an outbreak of ropy milk actually starts has not been accurately determined. In practically all outbreaks in connection with large milk companies the trouble appears first in the milk furnished by one or two farms. This would suggest that the trouble starts at the farm rather than at the plant. At such farms the germs causing the trouble can usually be found both in the utensils and in the cooling tanks. It is frequently reasoned that the cooling tanks have been infected from the utensils, but the observed facts suggest that the utensils may have been infected from the water in the cooling tank. Altho one of the most common of the ropy milk germs was originally isolated from water which was not known to be in any way connected with milk, there is little known regarding the distribution of ropy milk germs in water supplies. In the cases here reported, in which the ropy milk germs were recovered from the coat of the cow, the recent infection of the coat by infected water was also noted.

A thoro application of a disinfecting solution to the cooling tank, the utensils, and the milk house usually results in the disappearance of the trouble at the farm, tho in some cases it may be desirable to extend the treatment to the coat of the cows and to the stables.

The outbreak here described was unusual in that it took on the characteristics of an epidemic involving practically an entire dairy community.

While the production of a satisfactory milk from a supply heavily infected with ropy milk germs presents some practical difficulties, it is not impossible. None of the germs causing ropy milk, which have thus far been studied, are able to withstand a heating to 140° F. for thirty minutes. Accordingly, if the milk is properly pasteurized for this time and at this temperature and is protected from reinfection with the germs of ropy milk, it will be satisfactory to the trade. This result may be accomplished under commercial conditions by giving careful attention to the details of pasteurization and by daily treating all parts of the milk-handling machinery with flowing steam.

AN EPIDEMIC OF ROPY MILK

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INTRODUCTION

Outbreaks of ropy milk involving a single or a few farms occur frequently, but during the past season the attention of the authors was drawn to a severe outbreak involving more than one hundred farms and presenting the general picture of an epidemic. As both the germ causing the trouble and the epidemic nature of the outbreak were somewhat unusual, it seems desirable to bring the known facts to the attention of the dairy industry.

In presenting the details of this epidemic of ropy milk the authors have drawn freely upon the observations and experience of men in the milk industry and particularly upon certain of these men who are well trained in dairy bacteriology. It would be a pleasure to make more detailed and specific acknowledgement of these contributions were it not for the expressed wish of the commercial firms involved that no mention of their companies or their men appear in the publication.

WHAT IS ROPY MILK

The term *ropy* or *slimy* is applied to milk which has become noticeably more viscous than ordinary milk. When this ropiness is only slightly developed it is ordinarily overlooked. It is sometimes noticed from the fact that the milk pours more slowly or because the last portion drips from the container with the formation of an evident thread of milk.

Where the viscosity is more pronounced, the milk may be drawn out by means of a fork, or similar object, into threads. In extreme cases these threads may be fine and silky and more than a foot long, tho more frequently they break when only an inch or less in length.

In extreme cases the milk takes on almost the consistency of a sticky, stiff dough, and a cup of it may be inverted without the milk being spilled.

Ropy milk should not be confused with the results of garget. Garget is an inflamed condition of the udder of the cow, and milk as it comes from such inflamed udders frequently contains white masses or strings of coagulated material. Milk which becomes ropy, on the other hand, comes from healthy udders and is normal when drawn, but the ropiness may appear at any time after twelve hours.

WHAT CAUSES ROPY MILK

There are at least three common and distinct types of ropy milk: (1) the ropiness produced in milk drinks by the Bulgarian bacillus; (2) the ropiness in starter for butter-making, resulting from the degeneration of the starter culture; and (3) the ropiness which appears in sweet milk.

In the preparation of buttermilk for the city trade difficulties arise from the tendency of the solids of the buttermilk to settle to the bottom, leaving the thin whey on top. In order to check, if not entirely prevent this settling, it is customary to add to the buttermilk a viscous culture of bulgaricus—"the bacillus of long life." This organism not only gives an attractive acid flavor to the buttermilk, but also makes it quite viscous and gives it a pleasing smoothness to the tongue.

Again in the propagation of an entirely different type of acid-producing bacteria in connection with the ripening of cream for butter-making, it not infrequently happens that on continued cultivation these cultures take on the habit of making the ripening cream quite viscous. This change is generally considered undesirable in the making of butter, and such cultures are accordingly rejected.

It should be noted that from the standpoint of business one of the above types of ropiness is useful and is accordingly encouraged, and the other is undesirable and is discarded, and that both types of ropiness appear in sour milk or cream. The viscosity in the sour milk or cream develops uniformly thruout the entire mass or even better toward the bottom of the container, and it develops most rapidly at relatively high temperatures. The best growth of the bulgaricus organisms occurs at or above blood heat.

The ropiness with which this publication is primarily concerned makes trouble in connection with city milk. It appears in sweet, well-cared for milk, and ordinarily as soon as the milk begins to sour the viscosity disappears. Moreover, this ropiness in sweet milk develops most markedly at the surface in contact with the air, and rarely appears unless the milk is kept relatively cold. When the milk is held at higher temperatures, acid develops and destroys the viscosity.

Because of the outstanding differences between the development of viscosity in the sour and in the sweet milk it is clear that the viscosity in the two cases must arise from distinctly different causes.

Since the ropiness is not present in the milk as drawn, but develops when the milk is one or two days old, it seems plain that it must be due to something which grows in the milk. Studies of the germ life in such milk have shown the presence of germs which are the cause of the ropiness. These germs can be separated from the milk, can be cultivated in the laboratory on gelatin and other sub-

stances for months, and when returned to samples of sterile milk will reproduce the ropiness in the usual way.

For nearly a hundred years outbreaks of ropy milk have been reported occasionally, and a number of different germs have been found which are able to bring about this change in the milk.

WHY IS ROPY MILK OBJECTIONABLE

With milk, as with other foods, custom is a large factor in establishing market demands. There is no question but that our retail milk trade calls for a sweet milk of normal consistency and taste. While the growth of the ropy milk germs ordinarily produces little change in the taste of the milk, these organisms do change its consistency so noticeably as to arouse the suspicions of the consumer.

The agitation of recent years for milk of low germ content has made the consumer very suspicious of any evidence of germ growth in milk and doubly so of unusual appearances.

While there is no evidence nor any reason to believe that the growth of the ropy milk organism is in any way harmful to the consumer, such milk is not acceptable to the American consuming public, and accordingly is neither profitable nor desirable in the city milk supply.

WHY IS ROPY MILK SO COMMON A TROUBLE

It should be remembered that the germs of ropy milk which ordinarily make trouble in connection with the city supply do not thrive in connection with the ordinary acid-producing germs. When milk is produced with a lack of care as to the utensils and is handled without proper regard to cooling, the rapid development of the acid-producing germs interferes with the activity of the ropy milk organisms even if present.

Before the cause of ropy milk was clearly understood, a treatment often recommended was to rinse all utensils with sour milk and allow them to stand some hours before washing. In this case the remedy was worse than the trouble it aimed to cure because it resulted in the quick souring of the milk, but it was efficient in checking the development of the ropiness. The germs producing ropy milk thrive at a temperature much below that most favorable for the growth of the ordinary acid-producing germs. Accordingly, when the ropy milk germs are present, cooling of the milk checks them but little and in such cooled milk they have an advantage over the acid producers.

It is a matter of common knowledge that during the warm summer weather the acid-producing germs develop quickly in the milk and unless considerable care is exercised the milk does not remain sweet for twenty-four hours. On the other hand, in the winter the low

temperatures are favorable to the development in the milk of quite a different class of germ life, with the result that if the milk is kept cold it will frequently remain sweet for two weeks and even then will not become sour but will undergo other undesirable changes.

In the spring when winter is changing to summer conditions, and again in the fall when the reverse change takes place, the germ life in the milk is quite variable. At these times of the year a majority of the outbreaks of ropy milk appear. In case an outbreak at such a time becomes well established it may persist for some weeks or months.

AT WHAT POINT DO ROPY MILK GERMS GET INTO THE MILK

Knowing that ropiness in milk is due to the growth in it of certain germs, the first step is to locate the sources from which such germs enter the milk. Where time permits and where some thoroly boiled or steamed bottles are at hand, the point at which the ropy milk germs enter the milk may be readily determined by collecting and observing samples of the milk. These samples may be taken by milking from each cow directly into bottles, and by collecting samples of milk at the emptying of each pail as the milk flows from the strainer, and by pouring from each can. Hair, dust, and dandruff from the coat of each cow, and water from the cooling tank should likewise be collected and freshly boiled milk added so that any ropy germs present may have a chance to show themselves. Samples collected in this way are best stoppered with cotton to prevent further contamination and to provide an abundant supply of air to the surface of the milk. These milk samples should also be kept fairly cool since high temperatures will favor the growth of the acid-forming germs which may overgrow the ropy ones.

Naturally suspicion was early directed to the udder of the cow as a possible source of ropy milk germs. While it is a fact that the milk as it comes from the udder of the cow ordinarily contains about 500 bacteria per cubic centimeter (about 20 drops), the past studies of the germ content of normal udders and the studies of the sources of the outbreaks of ropy milk have uniformly failed to show that the germs coming from the udder are ever the cause of ropy milk.

During the act of milking some foreign matter falls into the milk and there is always the possibility that this material will carry on it the germs which produce ropy milk. It has been repeatedly shown that the germs causing ropy milk live in water, and when cows wade in infected water there is always the possibility of their getting the germs upon their coats. Observations have been made by different investigators to determine whether these germs have been actually

introduced into the milk from the coat of the cow. In a few instances, and two of these were in connection with the present outbreak, there is strong evidence that this may have occurred. On the other hand, it is the usual experience that when attention is given to certain other possible factors the trouble immediately stops without any attention being paid to the coat of the cow. Such results would suggest that only in rare cases is the coat of the cow a source from which ropy milk organisms are brought into the milk.

Samples taken in the manner above described, in connection with many different outbreaks on farms, have ordinarily shown that the utensils are the source from which the ropy germs enter the milk. Since the utensils on the farm are commonly all washed together it is to be expected, and it is common experience, that where one is infected, the ropy germs are present on many or all of the utensils. It should be noted in this connection that in an outbreak studied by one of the authors (H) in New York, the ropy germs were found only in the cans, and the indications were that in this outbreak the cans were being contaminated while being washed at the milk plant.

The source from which the first utensil became contaminated in the outbreaks which have been studied has not been made clear. The germ which has been most commonly found in ropy milk was originally found in water, and in outbreaks on the farm it is often found in the water in the cooling tanks. As in such outbreaks the germs are also found on the utensils it is customary to explain the presence of the germ in the cooling tank as resulting from the infected cans having been put in the tank. Where no definite information is at hand to explain how the utensils became infected it is quite as logical to assume that they became infected from the water. Ground water always carries a fair amount of germ life of kinds best fitted to thrive under such conditions. However, the studies which have been made of the germ life of ground water have not shown the ropy milk organism to be one of the forms common in water. On the other hand, the knowledge of the germ life of ground water is not sufficiently complete to show that this germ is not one of the less common water forms. The assumption that it is a form occurring occasionally in water and that it occasionally finds its way into milk is supported by many of the known facts. Such an assumption also serves to explain the wide distribution of this trouble as well as its occasional appearance without any known connection with any previous outbreak.

ORDINARY TREATMENT ON FARMS

While studies as outlined above will give accurate information as to the point at which the germs are entering the milk supply in any particular outbreak and will indicate how this infection can be cut

off with greatest certainty and least expense, the dairymen are usually most interested in promptly removing the source of infection, even if this summary treatment involves perhaps a little unnecessary work.

Under ordinary conditions the trouble is most effectively attacked by emptying the cooling tank, scrubbing it and filling it with clean water to which some active disinfectant is added. A twelve-ounce can of good strength bleaching powder (chlorinated lime) added to a 100-gallon tank will give a powerful disinfecting solution. In case the tank has a capacity of more than 200-gallons, additional bleaching powder should be added.

All pails, strainers, stirrers, cloths, brushes, and other utensils which come into contact with the milk are then put into this solution and allowed to remain fifteen to twenty minutes. The tank and floor of the milk house are then scrubbed with the disinfecting solution. Where facilities are at hand, the interior of the milk house may be whitewashed, or it may be drenched with the solution from the tank.

Where a cooling tank is not used, but a large iron kettle or food cooker is available, the same result may be attained by filling this with boiling water and giving all cloths, brushes, and utensils a thoro treatment with hot water.

Where the dairy is located near a canning factory, all these utensils may be placed in a large steam kettle and an exposure to the influence of steam under pressure will promptly destroy the ropy milk germs.

Bottling plants are often provided with steam chambers in which these dairy utensils may be quickly and thoroly treated.

Bringing all parts of these utensils to the temperature of boiling water, or exposing them to the action of a strong disinfectant for a few minutes, will kill all germs of ropy milk. Accordingly a single treatment of the cooling tank and the utensils usually puts an end to an outbreak on a farm.

It should be understood that this exposure to heat or to disinfectants followed by thoro washing leaves nothing on the utensils which will prevent the growth of ropy milk organisms if they find their way to the utensils after treatment. In actually carrying out such a disinfecting campaign at the farm it occasionally happens that some pail, dipper, or other object which has been in contact with the ropy milk, is overlooked. If in connection with the handling of the milk the germs on this one utensil spread to the others, the result of the disinfection is lost and the trouble will reappear in the milk. Fortunately in the actual handling of outbreaks the trouble rarely reappears where the work is carefully done. This latter fact is perhaps the strongest bit of evidence against the theory of the natural water supply being the starting point of the outbreak.

THE EPIDEMIC

About the middle of June, 1919, complaints of ropy milk from customers of a large dairy company led to observations at the bottling plant handling this portion of its supply. Ropy milk is not an uncommon experience in connection with the city milk trade, and when it appears a prompt study of the source of supply usually shows that milk infected with ropy organisms is being furnished by one or two farms. The treatment of the utensils and cooling tanks at these farms as already outlined quite regularly results in the disappearance of the trouble. Since more or less of this trouble appears every season its treatment has become practically a routine matter.

In the present instance samples from each patron's milk were collected in well-steamed bottles as the cans were being emptied, and these bottles, capped or stoppered with cotton, were held at low temperature and observed for the development of ropiness.

Unless the infection is fairly heavy the ropiness will not be evident before twenty-four hours and may not appear before forty-eight hours. Where the germs are fairly abundant, the entire upper surface of the cream becomes noticeably viscous. Examinations are best made with a small bent platinum wire which is heated to redness and cooled before the examination of each bottle so as to prevent the transfer of germs from one bottle to the next. When this wire is thrust below the surface of the cream and is withdrawn, the viscous milk is drawn out into a thread, the length and thickness of which varies with the degree of ropiness. In making such examinations of milk in bottles which have been stoppered with cotton, care should be exercised not to be misled by the presence in the milk of cotton fibers. When such a fiber is caught by the wire it often closely resembles a thread of ropy milk. Where such a wire is lacking, wooden toothpicks or forks may be used. However, unless a fresh one is used for each bottle, examinations on succeeding days may lead to wrong conclusions because of the transfer of germs from one bottle to another.

Where the infection is not abundant, the ropiness of the cream may be confined to small islands or even to very small points on the surface. At these points there is evidently the development of colonies of the germs causing the trouble. The experienced observer can often locate these points of ropiness by observing the presence of what appear to be small drops of fat in the cream. In many cases the milk surrounding these drops of fat is very ropy. On the other hand, in an occasional bottle these drops are evident and the milk is not ropy, while in many cases the milk is ropy without the presence of these drops of fat. While the relation of these drops of fat to the germs causing the trouble is not entirely clear, the connection between these

drops and the ropiness is too regular to be a mere accident.

Samples were taken and examined in this way from the milk of each of the 140 patrons bringing milk to the bottling plant in question, and ropiness was noted one or more times in samples from 116 of these farms. Late in the season when a neighboring cheese factory closed and a number of its patrons transferred their product to the bottling plant, they also were found to be bringing the ropy organisms. Inquiries in the community in a few cases where a cow was kept by a family that was not otherwise connected with the dairy business showed that here too trouble was being experienced with ropy milk. In short it appeared that here was a community-wide epidemic of ropy milk which not only included the larger part of the patrons of the bottling plant, but also included people not directly connected with the milk shipping industry.

OBSERVATIONS ON THE FARMS

The finding of ropy milk organisms in the milk as delivered at the bottling plant was followed by a collection of samples at the farms.

These samples ordinarily showed the presence of the ropy organisms in the utensils and in many cases also showed their presence in the water in the cooling tank.

The observations made at one farm are sufficiently important to deserve special mention. At this farm the germs were repeatedly shown to be present on the utensils and in the water of the cooling tank. From the cooling tank the water flowed to the stock watering tank located in the barn yard, and the presence of the ropy milk germs was repeatedly demonstrated in the water from the stock tank.

The stock tank overflowed and leaked into the barn yard, forming considerable mud thru which the cows came to drink.

In drinking the cows rubbed against the wet sides of the tank and their coats also became moistened by the noses of their companions. Some mud also got upon their coats.

On two different occasions material collected from the flank and udder of these cows and put into sterile milk produced characteristic ropiness, indicating the presence of the ropy milk germs. Both of these tests were made by the bacteriologist of the milk company. At one of the tests one of the authors (H) was present and observed the conditions of the barn yard and the details of the test, and he sees no reason to doubt that under these conditions the ropy germs were present on the coat of the cow and from it could have been transferred to the milk.

TREATMENT OF THE CANS AT THE BOTTLING PLANT

At the bottling plant the cans, after being emptied, were well washed by a revolving brush machine. They were then passed suc-

cessively over two steam jets and two air blasts. The can covers were also given a similar treatment with steam and air.

When careful attention was given to the steaming, the cans were undoubtedly heated sufficiently to very materially reduce the number, it not totally destroy, any ropy milk germs in them. On the other hand, it is very doubtful whether as much could be said of the treatment of the can covers. The covers are much more difficult to steam properly and even more difficult to dry over the air blast. It is rare indeed that the present available can-drying machinery delivers a dry can, and the result is that the moist cans as usually returned to the farms, permit a marked development in them of such germ life as survives the steaming process.

At the beginning of the outbreak the washing of all the cans at the bottling plant in a single vat probably offered a chance of passing the germs of ropy milk from the cans of one farm to those of another. All that then prevented the extension of the trouble to other farms was the action of the steam jet and, as has just been pointed out, the steaming and drying process was hardly equal to killing all of the germ life in the cans.

As soon as the seriousness of the situation was realized the treatment of the washed cans by steam was followed by the immersing of the cans and their covers in a tank containing a strong solution of bleaching powder. After this practice was adopted there is little probability that the mingling of the cans at the bottling plant was longer a factor in spreading the trouble among the dairies.

DISINFECTION AT THE FARMS

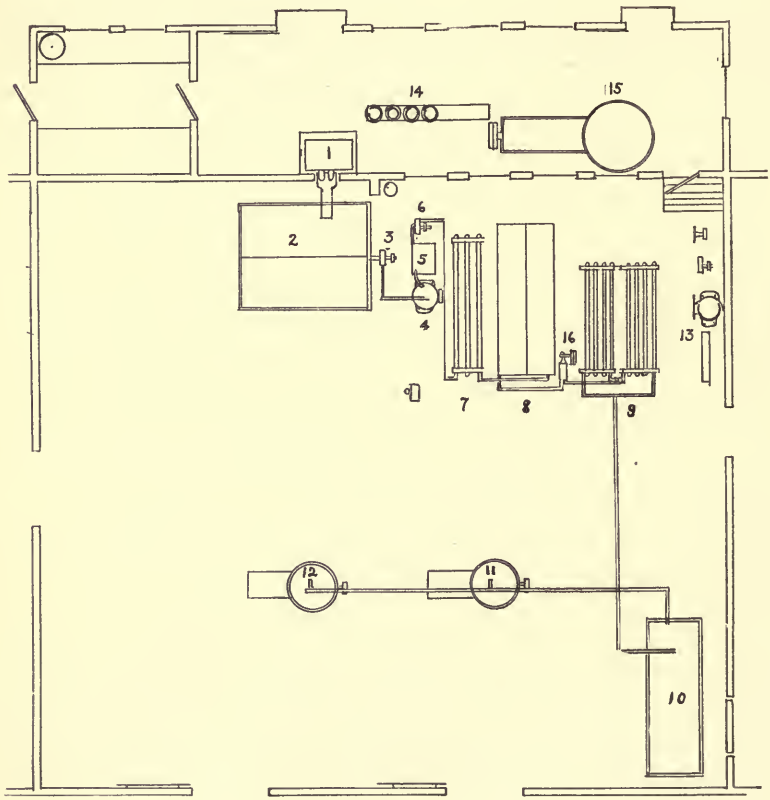
The disinfection of the cooling tanks and utensils at the farms which were bringing ropy milk to the bottling plant was carried out in the routine manner, bleaching powder being used as a disinfectant. Later, in addition, the interior of the milk house and the cow stable was thoroly sprayed with whitewash containing bleaching powder. In a considerable number of instances the coat and udder of the cows were also moistened with the bleaching powder solution.

While this treatment ordinarily resulted in the disappearance of the ropy milk germs from the milk produced at such farms, occasionally the trouble reappeared. Particularly was this true in the earlier part of the epidemic when the trouble was most abundant and when facilities for thoro treatment were not so well developed.

As this treatment progressed, the amount of ropy milk coming to the bottling plant decreased, but as it is the nature of an epidemic to die out, this decrease cannot be attributed with entire certainty to the treatment.

Observations at the Bottling Plant

Since the arrangement of machinery differs considerably in various milk plants, a discussion of the problem presented by this particular plant and its treatment will be made clearer by reference to the accompanying floor plan.



1 Weigh Tank
2 Receiving Tank
3, 6, 16 Milk Pumps
4, 5 Clarifier and Tank
7 Heating Coils
8 Holding Section
9 Cooling Coils
10 Storage Tank
11, 12 Fillers and Cappers
13 Separator and Cream Cooler
14 Can Rinse
15 Can Washer and Sterilizer

The room in which the incoming milk is weighed and the cans washed and returned to the patrons is ten feet above the floor of the milk-handling room. Accordingly the milk flows by gravity from the weighing can to the receiving tank and from this is pumped to the clarifier. The clarifier discharges into a small tank from which

a pump drives the milk thru a tubular heater and a tubular holder. This milk holder discharges into a small tank from which a second pump forces the milk thru a tubular cooler and into an elevated storage tank. From this storage tank the milk flows by gravity to two rotary bottlers and thence into the bottles. All necessary connections are with so-called "sanitary pipe" and fittings which can be taken down for cleaning.

While this floor arrangement provides ample working space it should be noted that the receiving tank, in which the untreated milk from the farms is being collected, is only about twenty feet from the point where the milk is being bottled. While there is no evident direct connection between these points except thru the pasteurizer, the presence and activities of six or more workmen, each intent on completing the work of the day, offers some chance of cross infection.

MILK-HANDLING PROBLEM AT THE BOTTLING PLANT

With a considerable proportion of the patrons bringing milk well seeded with ropy milk germs, the problem of supplying satisfactory city milk was a difficult one for the bottling plant.

The available method of solving this problem was to thoroly pasteurize all the milk and then to protect the pasteurized milk so carefully that no more of the ropy milk germs could get into it. The thoro pasteurization and the complete after-protection each presented difficulties which are not always appreciated.

Careful laboratory studies of the ropy milk germs from this and from a number of other outbreaks showed that when milk containing a heavy inoculation of such germs was held at 140° F., a number of the ropy milk germs were alive at the end of 10 minutes, a few (including the germ from this epidemic) were alive at the end of 20 minutes, but all of them were dead at the end of 30 minutes. Accordingly, if the pasteurizing process is to totally destroy the germs of ropy milk, it is necessary that every particle of the milk shall be held at or above 140° F. for 30 minutes.

The details of pasteurization vary considerably with the different types of machines. However, with most types of pasteurizers it requires careful management to ensure that the first milk thru the machine is heated neither too much nor too little. If heated too much the milk tends to lose its cream line and may acquire a cooked taste. Knowing this, the operator of the pasteurizer is prone to err, if at all, on the side of too low rather than too high heating of the first milk. From the time the pasteurizer is completely in operation until the close of the process, there is less difficulty in accurately controlling the temperature, tho the possibility of leaky valves should always be considered. However, at the end of the process there is often

difficulty in being sure that the last milk thru the pasteurizer has received its allotted amount of heating. Accordingly, unless the plant foreman gives personal attention to these details, a portion of the first or of the last milk may slip past the pasteurizer without receiving a heating sufficient to destroy the ropy milk germs. If any of them pass this point alive, there is no means available for preventing their development in the bottled milk.

Even where the pasteurizing process is all that could be desired, as soon as the milk is sufficiently cool it is liable to reinfection. Experience with utensils at the farm shows that the germs of ropy milk grow readily upon dairy utensils. If in any way these germs get into the piping, storage vat, or upon the cooler, the bottlers, or other utensils, they are able to grow and they are in a position to reinfect even properly pasteurized milk.

As a protection against such reinfection it is not enough to thoroly clean all piping and utensils — a further thoro treatment should be given them with boiling water, or preferably with steam. In the case of sanitary piping and small utensils this is relatively easy, provided there is a sufficiently large steam chamber in which they may be treated. Bringing all parts of such utensils to 200° F. even for a few seconds is sufficient. In the absence of such a steam chamber a large vat may be used. If a fairly heavy canvas (10 ounce) is fastened snugly over such a vat containing the utensils, and steam is passed freely into the vat, the cover will retain practically all of the steam. If at the close of the treatment the canvas cover is removed and suspended while still hot, it will usually dry promptly. A canvas cover may be used in a similar way to facilitate the steaming of the bottlers, and with slight modifications the horizontal coolers may also be steamed. In the case of an unusually large cooler it may be more convenient to cover and steam the sections separately.

The steaming of horizontal coolers should always be undertaken carefully. In many cases pipes are not strongly held at the ends and if the cooler is unevenly heated the uneven expansion of the metal may result in leaks.

In practice it is difficult to bring about so thoro a treatment of the utensils as to include all parts of the cream and fermented-milk divisions, and unless these are included there is always the chance of a slight reinfection. Perhaps the greatest practical difficulty in this connection is with the steaming of milk pumps. While their working parts may be easily removed and steamed, the remaining portion of some of the pumps cannot be readily steamed with these parts removed, and when they are in place the valves prevent a flow of steam and mechanically protect a portion of the pump. Likewise, the steam may not enter the air chamber above the pump.

Even where the cleaning process of the day includes as thoro a steaming as suggested above, it is well to begin operations the following day by flushing out the piping and machinery with an abundance of hot water or steam.

It is a common practice to bottle cream before beginning to bottle milk. The cream adhering to the bottler mixes with the milk and slightly increases its fat content. While this slightly increases the food value of the milk it also increases its germ content and thereby hastens the souring of the milk. In an outbreak of ropy milk, which came under our observation some years since, this practice was the means of carrying over a culture of ropy milk germs and thus infecting the bottler which had previously been carefully steamed. As a result even where all the milk handling machinery had been properly treated, the milk supplied to the trade continued to become ropy until this infection of the bottler was recognized and stopped. In this case the cream cans became infected in the common washing vat and were not sufficiently steamed to free them of the ropy organisms. When later filled with cream and held in storage until the following morning, the ropy germs grew in cold storage, forming a starter which heavily infected the bottler. The difficulty would probably have been avoided by properly steaming the cans in which the cream was held, but as a more certain precaution the bottling of the cream was delayed until after the bottling of the milk. Had an earlier bottling been necessary it might have been followed by a washing and steaming of the bottler, which is the present practice in some milk plants.

Another avenue thru which milk is infected is the bottles. Wherever there is complaint from the consumer concerning ropy milk, the empty bottles are certain to be infected with the ropy milk germs. Where hand washing is practiced the wash water is not hot enough to destroy these germs. Accordingly the washing vat becomes infected with the germs mechanically removed from the bottles and the infection passes to other bottles in much the same manner as with cans washed in a common vat. Unless the washed bottles are steamed sufficiently to destroy the ropy milk germs upon them, milk put into these bottles may become ropy even where the milk has been properly pasteurized and otherwise well handled. The treatment of the bottles with steam, if short as in the mechanical washers, should bring the bottles to approximately 200° F., but this temperature may be lower if the period of heating is longer.

RESULTS OF TREATMENT AT THE BOTTLING PLANT

As the milk company was operating under a municipal ordinance requiring a thoro pasteurization of all the milk, there was little im-

provement needed in the pasteurizing process beyond giving close attention to the details of handling the milk at the beginning and at the end of the process. The difficulty with the product evidently arose from the ropy milk germ growing in the milk line beyond the pasteurizer. Liberal applications of steam and hot water to the pipes, tanks, and utensils promptly decreased the infection to the point where only an occasional complaint was received thru the retail department, altho careful observations showed a small number of ropy milk germs in some of the bottled milk. A routine treatment of all the milk line and the utensils coming into contact with the milk was then established, and apparently the trouble disappeared.

With the passing of the emergency, the methods of handling the plant tended to revert toward the earlier routine, and after a few weeks complaints of ropy milk again came from the consumers. The prompt reestablishment of a thoro steaming of all portions of the milk line and utensils, special attention being given to the milk pumps, was followed by an immediate disappearance of the trouble in the bottled milk.

OBSERVATIONS IN OTHER MILK PLANTS

Since ropy milk is coming to be a frequent experience in the routine of the milk business, a number of additional opportunities have presented themselves for observing similar outbreaks in connection with other milk plants. These observations agree in emphasizing two points:

(1) An outbreak of ropy milk which is creating dissatisfaction on the part of the milk consumers can be immediately reduced to a level where it will cease to be the occasion of complaints when attention is given to proper pasteurization and where the milk is protected from the introduction of the ropy milk germs between the pasteurizer and the bottle.

(2) When the milk plant has been thoroly inoculated, particularly if the milk producers continue to furnish the germs with the milk supply, the final and complete removal of the last traces of the ropy milk organisms is quite difficult and likely to be a time-consuming process.

CONCLUSIONS

The conclusions will be found embodied in the Summary at the front of the bulletin.