CONTROLLING ROPY MILK OUTBREAKS

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C. D. KELLY

ABSTRACT

The results of an investigation of a ropy milk outbreak of two years' standing are given in detail.

An examination of the equipment and method of handling the product showed that the ropiness was due to bacteria which gained entry thru pipes that were used first for raw and then later for pasteurized milk.

The trouble was much aggravated by the practice of bringing into the plant milk returned from stores and wagons. One lot of this returned milk contained as many as 32,000 ropy bacteria per cc of milk.

When the returned milk was kept out of the plant and the other faults in handling the product were corrected, it was possible to rid the equipment of the organisms by the use of steam, hot water, and chlorine.

A short review is given of two ropy milk outbreaks on farms, together with recommendations for the correction of the trouble.

INTRODUCTION

A description of the slimy or ropy condition\(^1\) in milk, due to the growth of certain specific bacteria, has been given so often that it does not seem necessary to repeat it at this time. This change that takes place in milk on standing, providing the right organisms are present, was first studied as a matter of interest and was of slight economic importance. At a later time, when milk as such was being consumed in greater quantities, ropy milk was occasionally noticed by the consumer when the contamination with the organisms was unusually high. As milk at the time was unpasteurized, and was being sold in small amounts, it affected but few people. At the present time, where milk is being handled in large amounts in pasteurizing plants, it is not uncommon to find cases where a considerable number of consumers are affected.

\(^1\) The type of ropiness which is due to the action of bacteria after the milk has left the udder must not be confused with the stringy condition of milk coming from cows suffering from mastitis.
RECORD OF PREVIOUS OUTBREAKS

The first recorded observation of ropy milk bacteria, according to Buchanan and Hammer,2 dates back to Ehrenberg3 who examined a sample of ropy milk in 1840 and found bacteria present. Later, Haubner,4 in Germany, and Lister,5 in England, associated ropiness in milk with bacterial action, and still later numerous other investigators studied the various activities of these organisms in the roping of milk. These reports of ropy milk from many different localities demonstrate the common occurrence and widespread distribution of the organisms. According to Buchanan and Hammer,6 a number of different bacteria have been described in the literature as causing ropiness in milk. Hammer7 considers that the most common ropy milk organisms in this country are Bacterium viscosum, and organisms of the Escherichia-Aerobacter group.

Ward,8 who was one of the first to study this problem from an economic standpoint, found the former organism (Bacterium viscosum) causing ropiness in the milk of a small dairy. In two cases the organism was not found at the farm but was isolated from strainers, cans, and other utensils and from the air and cooling water at the milk plant. Numerous other workers who have investigated ropy milk on the farm or in the small milk plant have isolated the causative organism from many sources. Harrison9 made isolations of ropy bacteria from can washings and stable air, while Golding and Sadler,10 in a study of a ropy milk outbreak, found Bacterium viscosum in the drinking water and wash water. In 1920, Harding and Prucha11 reported on an outbreak of ropy milk at a bottling plant and gave clear and concise instructions on how such an outbreak might be stopped and how it might be avoided.

More recent outbreaks on farms have been studied by Sadler and

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6 Loc. cit.
7 Dairy Bacteriology, New York; John Wiley & Sons. 1928.
Mounce\textsuperscript{12} and Sadler and Middlemass,\textsuperscript{13} who found the organisms in many places in the cow stable and dairy, but in greater numbers in the well water, utensils, and bedding. Stark and Foter\textsuperscript{14} have made an extensive study of feeds and have found ropy organisms in most of them. The investigators who have examined the udder for ropy bacteria have failed to isolate any from this source, which shows the problem to be one of contamination after the milk leaves the udder.

The fact that a few strains of \textit{Aerobacter aerogenes} will produce ropiness in milk and that this characteristic may come and go has been the cause of some speculation. Stark and Stark\textsuperscript{15} have thrown light on this subject and their work should aid in explaining sudden outbreaks of ropy milk. These workers were experimenting with material (bacteriophage) which they obtained from liquids in which bacteria had grown and from soaking certain leaves and plants. The exact nature of this material is not known, but its addition to bacterial cultures is followed by the destruction of the bacteria. They found that, while certain amounts of the substance would completely destroy the bacteria, smaller amounts would cause them to become ropy.

The development in recent years of large milk plants and more particularly the widespread use of pasteurization have changed the problem somewhat. Many investigators have demonstrated that with ordinary milk plant practise the organisms are killed by pasteurization. This fact can be taken as a general rule, tho it has been shown by Stark and Stark\textsuperscript{16} and by Scales and Horton\textsuperscript{17} that where the milk has been held at a low temperature previous to pasteurization, some ropy organisms may survive. The explanation given is that at the low temperature growth is reduced to a minimum and it is known that physiologically old cells are more difficult to kill than young ones. With properly constructed and operated pasteurizing plants where the ropy organisms are killed at the pasteurizing temperature, outbreaks of ropy milk should be next to impossible.

\textsuperscript{13} \textit{Sci. Agr.}, 6, 297–302. 1926.
\textsuperscript{14} \textit{Cornell Vet.}, 21, 109–113. 1931.
\textsuperscript{15} \textit{Jour. Bact.}, 23, 59. 1932.
\textsuperscript{16} \textit{Jour. Bact.}, 18, 333–338. 1929.
When a consumer finds ropy milk, its peculiar and unappetizing appearance arouses his suspicions. This milk, even when it is ropy, is not dangerous and when fresh is quite usable. After it has become stringy, however, its undesirable appearance makes it most unsatisfactory. Ropy milk usually appears as a result of being held at a comparatively low temperature, providing the ropy bacteria are present. If this same milk had been held at a temperature a few degrees higher the probabilities are it would have soured normally. The reason for this is that at temperatures between 50° and 60°F (10° to 15.5°C) ropy bacteria grow more rapidly than the souring organisms, while above those temperatures the condition is reversed and the souring bacteria make the most rapid increase.

Some dairy workers today consider that the occurrence of ropy milk is more common than in the past and attribute the cause to the great change that has taken place in controlling the temperature of storage and the general sanitary quality of the milk. A few years ago, when less care was taken with the handling of market milk, acid-producing bacteria were present in considerable numbers. Tho the number of ropy milk bacteria was greater than is found today, the acid produced by the other group prevented the ropy condition from appearing. Better refrigeration, both on the farm and in the city, tends to encourage the growth of ropy bacteria and discourage the growth of other bacteria.

A different type of ropiness in milk which might be confusing was observed by Mattick18 where milk appeared ropy while passing over a surface cooler. It was shown that this ropiness was only temporary and due to the action of the milk on the surface of the cooler. The milk became normal after leaving the cooler.

The presence of ropy bacteria in a milk supply rarely becomes of interest until an outbreak occurs. Because of the destruction of the ropy bacteria during pasteurization, it is seldom realized that these organisms are to be found in considerable numbers in so-called normal raw market milk. Ward19 made a survey of the raw milk entering three separate milk plants and found on an average that the milk of 13 per cent of the shippers would become ropy when held at a temperature not exceeding 55°F (12.8°C). This milk did not become ropy, however, due to the fact that it was pasteurized

before these bacteria increased to numbers high enough to cause ropiness. The author has also found similar conditions in two plants widely separated from each other. Likewise, Whiting\textsuperscript{29} in a bacteriological investigation of milk cans from plants where no ropy trouble was present, found both *Bacterium viscosum* and members of the *Escherichia-Aerobacter* group to be quite common contaminants. Inasmuch as slimy strains of the very common *Aerobacter aerogenes* are a frequent cause of ropy milk, it is not surprising to find ropy milk organisms so widely distributed.

In many ropy milk outbreaks the first attempt at control is directed against the farms; but, tho the farms may need investigation, the important place for the time being is the pasteurizing plant itself. It is immediately essential, by proper plant control to prevent ropy milk from getting out to the consumer, as an outbreak is usually due to faulty plant practise, brought about by poor arrangement or handling of equipment. Then, it may be desirable by active work with the shippers to reduce to a minimum the number of ropy organisms in the milk delivered to the plant. It must be borne in mind when investigating an outbreak that, altho ropy organisms are found in some cases in the farmers' milk, these organisms may not be of the same type as those that are causing the trouble in the plant, for ropy bacteria are common in raw milk supplies.

**A STUDY OF A ROPY MILK OUTBREAK**

The description of a ropy milk outbreak seems desirable to aid in a better understanding of the problem. A very good example of such an outbreak where much of the responsibility for the trouble was due to faulty plant practise and arrangement was investigated during the past year. The milk company concerned had built a new plant 2 years previous, and after a considerable investment in a new building with modern sanitary equipment, they were surprised to get complaints of ropy milk from their customers. This condition continued thruout 2 years with outbreaks in spring and fall. It was during the spring of the third year that this investigation was carried out.

**DESCRIPTION OF EQUIPMENT**

The plant was equipped with two large nickel tanks for holding the raw milk before pasteurizing. Two types of pasteurized milk

\textsuperscript{29} *New York State Agr. Exp. Sta., Tech. Bul. No. 98, 1-36. 1923.*
were handled, the first from one large farm which was sold as a special milk for children and the other ordinary pasteurized milk. The pasteurizer was of the rotary type and held the milk at 143°F (61.7°C) for 30 minutes. After pasteurization the milk ran over a tubular surface cooler and then to the bottles. Two coil vats were used for pasteurizing the whipping cream, table cream, and an homogenized milk testing about 10 per cent. These products also ran over the tubular surface coolers and then to the bottlers.

The bottles were washed in two "soaker" type machines where they were also brushed and where both hot water and chlorine were used for sterilization.

DESCRIPTION OF OUTBREAK

A preliminary survey of the plant showed that the milk returned from the stores and delivery wagons contained a great many ropy bacteria. This milk was emptied out of the bottles and held in coil vats until separated. Two samples taken on one day gave counts of 17,000 and 32,000 ropy colonies per cc and less than 7,000 non-ropy ones. From samples taken the following day, counts of 8,000 and 3,000 ropy colonies were obtained. The presence of this returned milk in the plant being a potential source of trouble, it was recommended that it be kept out of the dairy as much as possible. The management tried to avoid the loss of this milk by shipping it to another plant and making it into cheese; but as these ropy bacteria form gas in addition to sliminess the cheese were badly blown with gas. Later the milk was used in making butter with satisfactory results.

After the third day of the investigation, this milk was brought into the plant only to be transferred to cans and then sent to another plant of the same company. As the men who operated the bottle fillers had previously dumped this milk, they were transferred to other work so they could not carry the ropy bacteria from the returned milk and back to the bottle fillers.

A GENERAL SURVEY OF THE PLANT

The arrangement and operation of the equipment for pasteurizing the milk was excellent and tests reported later show that the ropy organisms did not pass thru the pasteurizer into the bottled milk. On the other hand, as has been found in many plants, the arrangement of the equipment for processing the cream products
allowed the pasteurized product to come in contact with raw milk and made it possible for ropy organisms to be carried to the cooler and bottle filters. It might be stated here that, altho a pipe line which is used for milk containing ropy bacteria is cleaned and sterilized in the usual manner followed in milk plant practise, the pipe may still contain ropy bacteria in sufficient numbers to cause trouble. It may take several days of careful sterilizing to free a pipe line completely of these organisms and in practise no pipe which is to carry pasteurized milk or cream should be used for raw milk or cream.

At the beginning of the investigation the returned milk was held in the coil vats which were later used for pasteurizing. This milk was taken from the vats thru pipes which later were used to convey the pasteurized product to the cooler. The same pipe was used at times to convey raw milk from the storage vats to the separator or to the coil vats. Another possible source of contamination was from drippings from a pipe passing at the back of the coil vats and used to convey raw milk, while another source might have been from raw milk which was bottled in the same bottle filters that were used for pasteurized milk.

The pipes and equipment in which the cream products passed while being carried from the coil vats to the cooler held considerable milk which could only be forced out by following it with water or the next product. It was customary to let the following product force out this cream which was standing in the pipes. In order to keep the plant running smoothly it was necessary at times to speed up this process by using some of the next batch of cream, even tho it had not been held in the pasteurizer the complete time. Following this procedure some partially pasteurized cream was run thru the system from time to time.

BACTERIOLOGICAL INVESTIGATION OF THE MILK AND PLANT

Tho the type of ropy organism (Aerobacter aerogenes) found in this outbreak is usually killed by pasteurization, it was first necessary to see whether contamination was coming thru the pasteurizer. It was also necessary to find whether any contamination was coming from the washed bottles or from the bottle caps. The usual method of examination is to take samples of milk in sterile test tubes and allow them to incubate at about 58°F (14.5°C) for several days, then test for ropiness. In several instances the con-
tamination was so small that it did not show up in this way, and it was only possible to find ropiness by making streaks on glucose agar slants\textsuperscript{21} after the milk had incubated for 2 days. Samples were taken of the raw milk and later of the same milk after pasteurization. Al tho ropiness was found in a large percentage of the raw milk samples, it was not found in 35 samples taken at various times as the milk left the pasteurizer. One day samples were taken of the pasteurized milk into half-pint bottles at intervals of 15 minutes and all were negative. Seventy-one samples were taken of bottles from the bottle washers on two different days and all were negative.

Seventy bottle caps were examined by rolling them up with sterile forceps and putting them in tubes of sterile skim milk and no ropiness was found. As a final check, 10 bottles and a tube of caps were sterilized in an autoclave and used for milk early in the day. By alternating a sterile bottle with an ordinary bottle it was possible to get 10 sterile bottles with sterile caps and 10 ordinary bottles with ordinary caps. The result of the test was that four of the sterile bottles and two of the ordinary ones developed ropy organisms. This test was repeated on the following day with the last milk to be bottled, and on examination, it was found that none of these bottles contained ropy organisms in sufficient numbers to be detected.

Prior to the fifth day of the investigation 5 out of 16 samples taken from the cooler were ropy, while after that time because of more effective sterilization none out of 17 samples were ropy. Of 27 samples taken from the bottled milk, 8 were ropy. Where samples were taken into test tubes from the bottle filler only 1 sample out of 30 was found to be ropy.

Samples taken of the special milk for children as it arrived in the plant and again in the storage tanks demonstrated that this milk received contamination of ropy organisms from the pipe line and storage tanks.

Tests of condensation water on the roof of the cooler room showed it to be free of ropy bacteria.

Bacteriological examinations of the milk cans as they came from the can washer showed a few ropy organisms present.

A survey was made of the shippers' milk and 17 samples out of

\textsuperscript{21} The technic used was originally described by Burri in the\textit{ Proceedings World's Dairy Congress (London), 90–697, 1928}. It is also described by Dorner in Technical Bulletin No. 165 of this Station.
150 were found to contain ropy organisms. A more careful investigation was made of the milk of 31 suspected shippers, and the milk of 6 of these became ropy on standing 2 days at 58°F.

DISCUSSION OF THE DATA

The results of these tests demonstrated clearly that the ropy organism was to be found at many places in the plant and in the raw milk of about 10 per cent of the shippers. At no time, however, were these organisms found in the freshly pasteurized milk, tho some gained entrance as the milk passed over the coolers and thru the bottle fillers. The washed bottles and bottle caps were likewise free of the organisms. The coolers and bottle fillers were found to receive their contamination from cream products.

The evidence indicated that the number of organisms present in the newly bottled milk was small. As stated above, very few samples taken into test tubes (3.3 per cent) at the bottling machine developed ropiness, while it developed quite commonly in the bottles taken at the same time. Two bottles of milk taken directly from the bottler which later became ropy were examined for bacteria. One sample did not show any ropy colonies on plates from 1 to 100 dilutions (Table 1), while the other developed one colony. The fact that the milk contained less than 100 ropy organisms per cc may explain why 10-cc samples did not always become ropy. The ropiness was found mainly at or near the surface and, therefore, in the cream. As the fat rises in the milk it is to be expected that many bacteria will be swept up with it and will be concentrated in the cream layer (Fig. 1). With a large quantity of milk, the

<table>
<thead>
<tr>
<th>Sample taken</th>
<th>Number of colonies on plates from 1–100 dilution</th>
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<tbody>
<tr>
<td></td>
<td>Sample No. 1</td>
</tr>
<tr>
<td></td>
<td>Total count</td>
</tr>
<tr>
<td>When bottled</td>
<td>62</td>
</tr>
<tr>
<td>After 12 hours</td>
<td>38</td>
</tr>
<tr>
<td>After 24 hours</td>
<td>130</td>
</tr>
<tr>
<td>After 60 hours *</td>
<td>560</td>
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* Both samples ropy at 60 hours.
Fig. 1.—Microscopic Preparations Showing How Bacteria Tend to Concentrate in Cream.

A—Gravity cream showing many scattered organisms and some small colonies of organisms. B—Preparation made from milk drawn off without agitation from below the cream shown in A. Few bacteria could be found. A single pair is shown in the center of the picture.
concentration of ropy bacteria near the surface would be greater than where only 10 or 15 cc of milk are used. At the time ropiness appeared in these two bottles (60 hours, Table 1), the number of ropy organisms was 5,200 and 40,000 colonies per cc, respectively. This is much lower than the number found by Hammer and Hix, who reported 11,000,000 to 156,000,000 colonies per cc where sterile skimmilk was inoculated with ropy bacteria. This difference is no doubt due to the fact that in skimmilk the bacteria would probably grow evenly through the medium, while in the whole milk the organisms would tend to be concentrated in the cream. The bacteria near the surface where the ropiness was found might readily be present in the form of colonies where the number present would be in the millions. When the milk and cream were mixed, however, the bacteria would be distributed more evenly so that the count of the mixed milk would be low. (See Fig. 1.)

**REMEDIAL MEASURES**

The number of ropy organisms coming into the plant was reduced as much as possible by keeping the returned bottled milk out of the plant. The next step was to make it impossible for the organisms to get around the pasteurizer. This was accomplished by not allowing any raw milk in the pipes at the front of the coil vats or thru the coolers or bottles and by removing the pipes at the back of the coil vats so as to prevent contamination from dripping raw milk. The final step was to carry out the cleaning and sterilizing procedures as thoroly as possible. The sanitary pipes were taken down each day and after washing were immersed in chlorine solution. Because of the possibility of growth in the equipment over night, sterilization with chlorine was practiced both in the evening and in the morning just before using. It is recommended that all the many parts of the bottle filler, such as the rubber washers, corks, and drain spout, should be sterilized with chlorine solution. A check-up of returned milk during the third week showed it to be free of ropy bacteria.

A possible means of spreading the ropy organisms from farm to farm is thru the cans. This may be controlled by more effective sterilization in the can washer.

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23 Ordinarily used in a strength of at least 100 parts per million of available chlorine.
THE PROBABLE SOURCE OF THE OUTBREAK

As shown above, it is quite common for ropy organisms to come into a plant with the raw milk. By allowing raw milk to pass thru the pipe at the front of the coil vats, these organisms inoculated the pipes. Some might also pass into these same pipes from partly pasteurized cream used to force out homogenized milk. The cream products would also carry the bacteria on to the cooler and bottle filler where a few would withstand sterilization when this equipment was cleaned. In this way the plant and the bottled milk would receive its first inoculation. The bottled milk would stand in stores and wagons at a temperature where the ropy organisms, but not the souring organisms, could grow readily. The returned bottled milk would bring ropy bacteria into the plant in greater numbers than had the milk of the farmers. By allowing this milk to pass thru the pipes at the front of the coil vats to the separator, the pipes would receive fresh inoculation. By fresh inoculation of the plant each day from the farmers’ milk and the returned milk and incubation of the organisms in the bottled milk, while in stores and during delivery, the contamination of the supply would increase until ropiness would appear rather quickly in the milk held in the home.

After the recommended changes were carried out, the ropy milk ceased to appear. Altho this study was made in the spring of 1932, no recurrence of the trouble has taken place at the time this material was prepared for publication (June, 1933).

OTHER POSSIBLE SOURCES OF ROPY MILK

It has been found by other workers that contamination may come from several sources, all of which must be investigated at the time of an outbreak. Bottle washers and especially the brushes have been found as sources of contamination and in one recent case it was thought that the organisms came from the bottle caps. Dead ends in the pipes around the pasteurizer in which the milk is not sufficiently pasteurized have been known to contribute to the trouble. Trouble might also be found with a cooler enclosed in a room where the condensation water became contaminated and dripped back onto the cooler.

Often in a modern plant the bulk of the milk is handled in a pasteurizer operated and controlled in an efficient manner. At the same time, small amounts of cream and high testing milk are
pasteurized in coil vats conveniently arranged for handling a variety of milk products but poorly arranged for keeping out ropy bacteria. It is usually here that the ropy organisms get into the plant, not necessarily because of the type of the equipment, but because of the way it is arranged and operated.

ROPY MILK OUTBREAKS DUE TO FARM CONDITIONS

Tho the arrangement of equipment in a milk plant may make it possible for ropy organisms to become established, the organisms are usually considered originally to come from the farm. The responsibility for preventing ropy milk outbreaks lies largely with the milk plant, but this does not excuse the producer who should continually attempt to produce a high grade milk. The problem on the farm, like that in the pasteurizing plant, is one of proper management, and when ropy milk appears in the farm dairy it is due to some fault in the system used. The ropy milk organisms are so widely distributed that some trouble is likely to appear at any time, and it is only by proper control that the ropiness can be kept from assuming the proportions of an outbreak. ropy bacteria have been found to occur commonly in water, soil, feeds, and bedding and from these sources they become established on the utensils, the coat of the cow, and many parts of the stable and dairy. In poorly controlled dairies where the organisms that cause the souring of milk are so plentiful that they outgrow the ropy bacteria, ropy milk seldom becomes a problem, but where milk is produced with a comparatively low count and especially where the bacteria that sour milk are kept down by cooling, ropy organisms may gain the ascendancy.

In order better to illustrate the problem of ropy milk on the farm, it seems desirable to describe in some detail a specific example. Sadler and Mounce\(^\text{24}\) gave the results of some studies on two farms where ropy milk had given serious trouble. On the first farm, where the causative organism was \textit{Bacterium viscosum}, the whole place was infested. ropy organisms were isolated from well water, wash water, cooling water, the cooler, pails, strainers, and milk bottles. Tho the milk sampled directly from the udders of the 13 cows was shown to be free from ropy bacteria, it contained as many as 5,000 of these organisms per cc, after it had been strained.

The general source of the contamination seemed to be the water from the well which was poorly constructed and allowed surface

\(^{24}\text{Loc. cit.}\)
drainage. The utensils were poorly sterilized and received con-
tinued contamination from the wash water. The milk received ropy
organisms at the cooler both from a poorly sterilized surface and
from a leak which allowed infected cooling water to mingle with
milk. With the water supply such a potential source of trouble,
little could be accomplished until the well was cleared of organisms
and made safe against surface drainage. This the farmer declined
to do. The organism responsible for the trouble was found to per-
sist on the farm over a period of 3 years. Altho it did not cause
trouble during all this time, it could be isolated with little effort
from a number of places on the farm.

These results show that the trouble was aggravated by poor dairy
practise. The lack of sufficient sterilization of the utensils made it
possible for milk which was free of ropy organisms as it left the
cow to contain as many as 5,000 per cc after coming in contact
with pails and strainer.

The second farm showed a slightly different picture and here the
causative organism was found to belong to a somewhat different
type. Ropy bacteria were found in this case on the coat of the cow,
in the bedding, milk pails, strained milk, and in milk in the final
bottle.

These workers have supposed that the organisms may have come
from the feces of the cow, but it is possible that they came from the
feed as shown by Stark and Foter,25 or from bedding. However,
the important thing to the farmer is not so much the source of the
organisms as how to stop them from getting into the milk in sufficient
numbers to cause ropiness. In this particular instance the investi-
gators pointed out that the utensils acted as carriers for the organisms
and that proper sterilization and care of the utensils would go far
to clear up the trouble.

The manner of controlling ropy bacteria on the farm is practically
the same as for the control of bacteria in general. Numerous investi-
gators have demonstrated that on the ordinary farm the greatest
number of bacteria enter the milk from improperly sterilized utensils
or utensils which have been contaminated subsequent to sterilizing.
The coat of the cow is considered as a possible contributing factor
to the number of bacteria in milk. Bacteria are also added in smaller
numbers from several other sources, such as dust and dirt. Still

25 Loc. cit.
other sources, including polluted water, may make it more difficult to keep ropy bacteria out of the utensils and so out of the milk, but most of the contamination is likely to come from the two sources first mentioned.

SUGGESTIONS FOR PREVENTING AND CONTROLLING OUTBREAKS

In general, the presence of ropy milk either in the milk plant or on the farm is due to failure to observe the rules of the best dairy practise.

In the pasteurizing plant.—The prevention of ropy milk in the bottling plant is largely a matter of keeping the ropy organisms from getting around or passing thru the pasteurizer. It has been shown that, in general, ropy bacteria are killed at pasteurizing temperatures. The pasteurizer may be considered as a line of defense guarding against ropy milk, and it is highly essential that nothing be allowed to break down this defense. Milk must not be allowed to enter the equipment which is used for pasteurized milk unless it has been held at the temperature and for the time required for pasturization. When ropy milk appears in a plant it means that the organisms have managed to avoid the pasteurizer and establish themselves in the equipment which is used for pasteurized milk. The fact that the ropy bacteria may be difficult to eradicate once they have established themselves in the equipment makes it doubly necessary to keep the organisms from getting into the part of the plant where pasteurized milk is being handled. This entry of ropy bacteria may occur in several ways, but it is usually thru leaky valves, failure really to pasteurize the milk, or by raw milk passing thru equipment which is later used for pasteurized milk. The trouble may be greatly aggravated by improper handling of returned milk, but the organisms must first get around or pass thru the pasteurizer. It is taken for granted that careful cleaning and sterilization will be the accepted practise in any milk plant.

As mentioned above, ropy organisms may also enter the pasteurized milk from the bottle washer or from the bottle cap, but this is probably not as common as from contact with raw or partially pasteurized milk. When outbreaks of ropy milk occur in pasteurized milk the management of the plant must recognize that it can not be stopped by simply refusing to take the milk of certain shippers. The plant itself is involved in the development of the trouble. The
trouble should be attacked by first finding where the organisms get past the pasteurizer and correcting the fault, and then freeing the plant of the organisms by sterilization.

On the farm.—On the farm the bulk of the ropy bacteria presumably find their way into the milk from improperly sterilized wet or damp utensils. Dust and dirt from the cow may also contribute to the number. Clean cows and clean sterile dry utensils with careful handling of the milk should do much to keep ropy bacteria from becoming established in the milk. Care must also be taken to have the premises as clean as possible and to safeguard the water supply. Chlorine preparations\(^{26}\) are extensively used in ridding farm dairies of ropy bacteria. Such places as cooling tanks should be cleaned out and treated with a chlorine solution.

Ropy bacteria are often spread from farm to farm by improperly sterilized cans. The original source of the organisms on the farm is generally feeds, standing water, and possibly other sources.

\(^{26}\) See footnote 23.