THE BACTERIOLOGICAL CONTROL OF MILK PRODUCTION.

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(With 2 Charts.)

The author was recently asked to advise the Boards of two Dublin hospitals as regards the cleanliness and general suitability of the milk supplied to them. In order to find out exactly the present position of the milk supply, it was decided to investigate bacteriologically the influence of the various factors at work from the time the milk left the cows till its delivery at the hospitals. It is believed that this investigation may be of wider interest, since it demonstrates clearly the value of bacteriological control of milk production and distribution.

Milk Supply of Hospital *A*.

As a preliminary test, two samples of milk as delivered to the hospital in the morning, were examined. The first, delivered on April 27th, was found to contain 112,000 bacteria including 500 lactose fermenting bacilli per c.c. The second, delivered on April 28th, contained 74,000 bacteria with 500 lactose fermenting bacilli per c.c. It was considered that both samples contained an undesirably large number of bacteria and that the lactose fermenting bacilli were much more numerous than was permissible in a milk intended for hospital use.

The dairy, from which the milk was supplied, was visited on May 3rd. At that time the cows were still in winter quarters, in a clean, well built and well ventilated byre, with a good concrete floor and proper drainage. The cows were carefully groomed and showed no traces of adherent manure on their coats. I was present at the milking and was impressed with the efforts made, in spite of the absence of special training, to secure clean milk. Two milkers were employed and their procedure was as follows. The teats and udders of the cows were thoroughly washed with a sponge and water from a bucket. A fresh bucket full of water was obtained after washing six or seven cows. When all the cows had been washed, the central passage of the byre was cleared of bedding and faeces and was washed down. The milkers then washed their hands and arms in a basin using plenty of water and soap, and dried them on a clean towel. This hand washing was repeated after the milking of a few cows. The milkers then put on clean white coats and started to milk. Wide-mouthed open milking pails were used and wet milking was employed, the hands being moistened with jets from the teats, but the excess was not

collected. The milkers appeared to me to be well trained and, on the whole, careful. My chief criticism was the use of one-legged milking stools which soon become filthy and contaminate the milk, either by way of the milkers' hands or, as I saw in one case, by the carrying of the stool above an open pail.

The water supply of this farm, while it was originally satisfactory, was utilised in a very bad manner. The water from a spring was piped to a large trough, situated immediately outside the byre. The water in the trough was used for rinsing out the dirty buckets after the washing of the cows and by horses for drinking. It was subsequently employed to rinse out the pails and churns used to contain the milk. In this way undesirable contamination was introduced into the milk.

The method of cleaning the vessels was next examined. The washing was done near the farm-house, at some distance from the byre, on a cinder path on which the lids, taps, etc. were placed. The supply of warm water was not large and the temperature was too low. Soap was used but there was an insufficiency of scrubbing brushes and cloths and no attempt at steaming or even scalding the vessels was made. After this the vessels were removed to outside the byre where they rested on a cobble pavement which was contaminated with manure. This might easily find its way into the churns since sometimes a bucket from the ground was placed on top of an open churn. That the washing of the churns was unsatisfactory was shown by the fact that the interior of one of the churns, ready to receive the milk, showed traces of dried milk. The churns were rinsed with the possibly contaminated water from the trough before milk was placed in them. The milk was strained through clean muslin from the pails into the churns, but only one strainer was used throughout. No cooling of the milk was attempted. The following samples were taken for bacteriological examination:

1. A pail, ready for milking, was rinsed with 250 c.c. of sterile water. This was found to contain 600 bacteria per c.c. or a total of 150,000 in the pail. While this number is too large it would only introduce 17 bacteria per c.c. into two gallons of milk.

2. The interior of a 20-gallon churn (obviously imperfectly washed) was rinsed with 250 c.c. of sterile water. Each c.c. of this was found to contain 1,174,000 bacteria and 100 lactose fermenting bacilli, or a total of, at least, 293,000,000 bacteria and 25,000 lactose fermenting bacilli in the churn. Fifteen gallons of milk, placed in such a churn, would be contaminated to an extent of over 4300 bacteria per c.c. and over three lactose fermenting bacilli per 10 c.c. merely as the result of the faulty washing of the churn.

Three samples of milk were examined:

1. Milk of one cow, taken from a milking pail immediately after this cow was milked.

2. Mixed milk from a number of cows taken from a 20-gallon churn. Milk from the pails had been strained into this churn.

These two samples were taken at about 11 a.m. and examined at 12 noon.

3. Milk from the same milking delivered at the hospital at 4.30 p.m., examined at 5 p.m.

Samples 1, 2 and 3 were tested as regards total organisms, lactose fermenting bacilli and souring time when kept at 17° C. The results of this examination are given in the following table:

No.	Total bacteria per c.c.	Lactose fermenting bacilli per c.c.	No. of hours after commencement of examination when milk found to be		Estimated time before milk became sour
			Sweet	Sour	
1	6,500	5	72½	79	76 hours
2	21,800	10	52	54½	53 ,,
3	75,000	500	24	40	35 ,,

Sample 1 was a distinctly clean milk for one produced in a farmyard without any instruction in the technique of clean milk production. The effect of emptying such milk into an imperfectly cleaned churn is seen in the difference between samples 1 and 2. There had been a three-fold increase in total organisms and the number of lactose fermenting bacilli was doubled. The effect of transferring the milk to another churn and of a delay of four to five hours in delivery on a moderately warm day is seen by comparing the results of samples 2 and 3. The estimations of the souring time are parallel to the enumerations of bacteria.

The four chief factors in the production of clean milk are: (1) milking methods; (2) cleanliness of the vessels; (3) time between milking and delivery; (4) temperature. In the case of the investigation at this farm the first may be considered fairly satisfactory, although it might be considerably improved. The second is definitely bad. In the third the time might, with advantage, be decreased. The fourth factor, that of temperature, appears to have been of secondary importance in this particular case, chiefly because the day was cool. In very warm weather, since no cooling was used, the number of bacteria present in the milk delivered to the hospital would probably have been enormously larger than that recorded.

The attention of the hospital authorities and of the farmer has been called to the faults in the present procedure and it is believed that these will be remedied.

MILK SUPPLY OF HOSPITAL *B*.

Just as in the case of hospital *A*, two samples of milk delivered on the mornings of April 27th and 28th were examined. The first contained 44,600 bacteria and 500 lactose fermenting bacilli per c.c. and the second 17,900 bacteria and 50 lactose fermenting bacilli per c.c. Both these have considerably fewer bacteria than those from hospital *A*, examined on the same days. Were it not for the excessive number of lactose fermenting bacilli the second would be judged to be a good clean milk.

The farm from which the milk for the hospital was supplied was visited on May 10th. About 60 cows were being milked in a field by several men. The

weather was dry and the cows appeared to be clean, but the teats and udders were not washed or cleaned in any way, before milking.

The men washed their hands before milking and after the milking of several cows, but the only water used was a small amount in a bucket. This was not renewed and, after being used several times, became very dirty. Wet milking was practised and open, wide-mouthed, milking pails were used. The milk was poured from the pails, through a double wire gauze strainer, into 20-gallon churns. The churns appeared to be clean internally, no trace of old milk being visible, but were not dry. The churns, both before and after filling with milk, were exposed to the full heat of the sun and the day was warm. No effort was made to cool the milk.

A churn, ready to receive milk, was rinsed out with 250 c.c. of sterile water, which was subsequently found to contain 534,000 bacteria per c.c. or a total of, at least, 133,000,000 in the churn. Fifteen gallons of milk in this churn would be contaminated to the extent of about 2000 bacteria per c.c. as a result of the lack of cleanliness of the churn.

Later in the same day I visited the dairy in the city from which the milk was distributed and there met the cart by which the milk was brought from the farm. The temperature of the milk on its arrival was 31° C., and it had therefore been at between 38° C. and 31° C. for a period of between three and four hours. The milk was emptied from the churns into tanks surrounded by running water in order to cool it. The duration of this process was, however, too short and the temperature of the milk after cooling was 27° C. It was then strained through a wire gauze and muslin strainer into small cans and churns for delivery.

I witnessed the washing of the vessels, for which proper brushes and ample hot water were used. No soap or soda was, however, employed, without which thorough cleansing of milk vessels is almost impossible. The vessels were not steamed after washing. I was rather surprised, in view of the washing which the churns received, that the number of contained bacteria was so large. The explanation was, I believe, the absence of soap and soda from the washing and the fact that the churns were not inverted to drain them of the residual washing water which was left in them until the time of the next milking. This water allowed of the multiplication of bacteria in the churns.

The following samples of milk were taken for examination:

1. Milk from milking pail which contained the milk of three cows. Taken at 11 a.m.

2. Milk from milking pail which contained the milk of two cows. (Milked by a different man.) Taken at 11.10 a.m.

3. Milk from a churn containing about 15 gallons. Taken at 11.20 a.m.

Samples 1, 2 and 3 were examined at 12 noon.

4. Milk after cooling and straining in the town dairy. Taken at 2.30 p.m. and examined at 3 p.m.

5. Milk delivered at the hospital at 4.30 p.m. and examined at 5 p.m.

No.	Total bacteria per c.c.	Lactose fermenting bacilli per c.c.	No. of hours after commencement of examination when milk found to be: Sweet	Sour	Estimated time before milk became sour
1	7,400	1	69½	73½	72 hours
2	20,800	5	54½	58½	56 ,,
3	29,000	5	50½	54½	52 ,,
4	220,000	50	27	42½	38 ,,
5	398,000	50	25	40½	32 ,,

From a comparison of samples 1 and 2 it is obvious that the standard of cleanliness at the time of milking was not consistent. The variations may depend on differences in the milking methods of the two milkers or, more likely, in the cleanliness of the cows milked. Sample 1 might be allowed to pass but No. 2 is certainly to be condemned as too contaminated for a freshly obtained milk. Washing the teats and udders of the cows would undoubtedly greatly raise the level of cleanliness. The effect of averaging different samples and of the addition of the bacteria contained in the churn is seen by comparing Nos. 1 and 2 with No. 3. The enormous increase of bacteria in No. 4, as compared to Nos. 1, 2 and 3, is to be attributed to a delay of some hours during which the temperature of the milk was above 31° C. The obvious remedy is to lessen the delay and, above all, to cool the milk. The further increase between Nos. 4 and 5 illustrates the effect of further delay and the inefficiency of the present cooling method. The outstanding faults in the technique of milk production of the dairy supplying hospital *B* may be thus summarised:

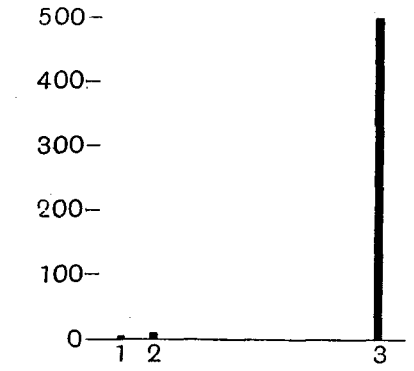
1. The milking methods were unsatisfactory, especially in that the teats and udders were not washed.

2. The vessels were imperfectly cleaned and water was left in them which permitted the growth of bacteria. They were not steamed.

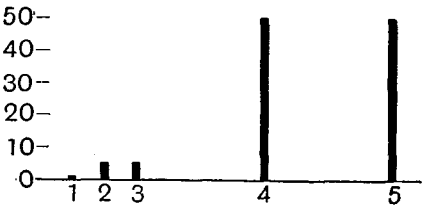
3. The delay between the milking and the delivery of the milk was excessive.

4. The cooling of the milk was applied much too late and was altogether insufficient.

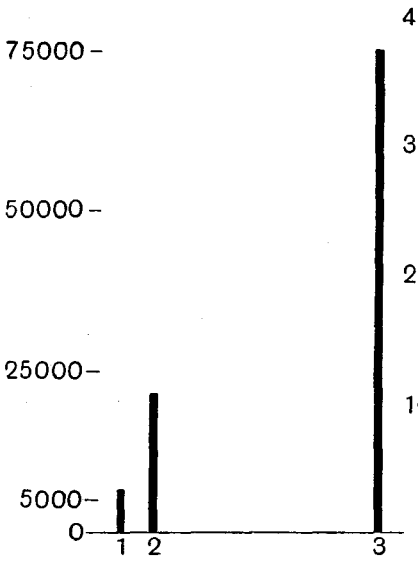
The tables and charts accompanying this paper illustrate the progressive increase in the number of bacteria in the milk on its way from cow to consumer and also the corresponding decrease in the time required for the milk to turn sour when kept at 17° C. They also enable us to decide at what stages the chief faults lie and once this has been found it is a fairly simple matter to advise what steps should be taken to correct these faults. The practical eradication of the faults is less easy but is still possible. The most important point which should be emphasised is the essential need of great care in every stage of the production and distribution of milk.



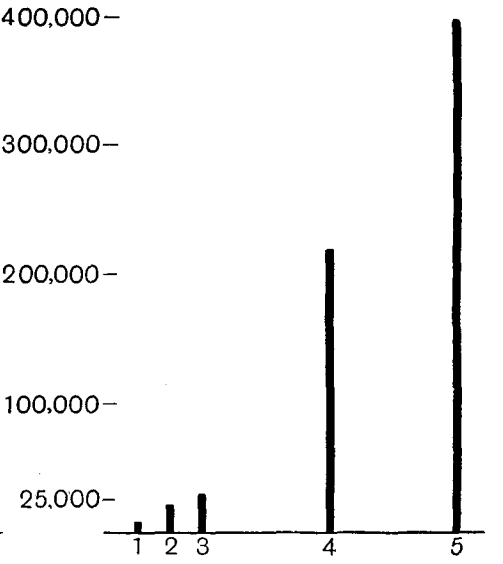
Lactose fermenting bacilli per c.c.



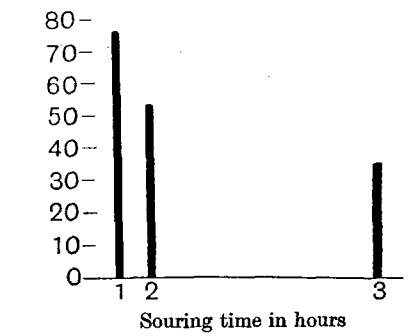
Lactose fermenting bacilli per c.c.



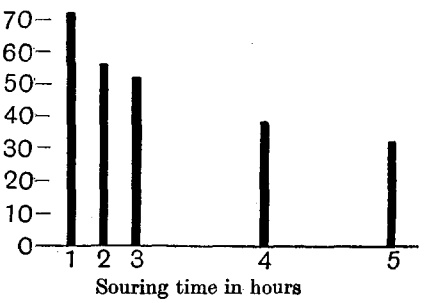
Total bacteria per c.c.



Total bacteria per c.c.



Souring time in hours



Souring time in hours

CHART I. MILK OF HOSPITAL *A*.

(1) Milk from pail, 11 a.m.
(2) Milk from churn, 11.15 a.m.
(3) Milk delivered at hospital, 4.30 a.m.

CHART II. MILK OF HOSPITAL *B*.

(1) Milk from pail A, 11 a.m.
(2) Milk from pail B, 11.10 a.m. } At farm.
(3) Milk from churn, 11.20 a.m.
(4) Milk at town dairy, 2.30 p.m.
(5) Milk delivered at hospital, 4.30 p.m.

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