A COMPARATIVE BACTERIOLOGICAL STUDY OF BULK MILK VS. BOTTLED MILK

Thesis for the Degree of M. S.

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Maurice C. Laug

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This is to certify that the

thesis entitled

A Comparative Bacteriological Study of Bulk Milk Versus Bottled Milk

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of the requirements for

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W. H. Hallmann
Major professor

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A COMPARATIVE BACTERIOLOGICAL STUDY OF BULK MILK VS. BOTTLED MILK

By

Maurice C. Laug

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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INTRODUCTION

The greater amount of the market milk sold in the United States today is required either by law or regulation to be sold or dispensed only in sealed containers filled at the dairy (7). The primary reason for the enactment of such laws or regulations is to assure the consumer whole milk, not skim or partly skim milk.

Twenty years ago it was common practice to sell bulk milk to retail merchants for resale to the public. The methods used for dispensing the milk to the individual were usually one of two: (1) dipping the milk from the bulk container and pouring into the patron's container, or (2) pouring the milk into an urn and dispensing through a faucet at the bottom. In either case if the milk were not stirred frequently, the cream would rise to the top and some patrons would not receive whole milk.

The milk bottle was introduced to expedite retail distribution and to show the cream line (4). This assured the patron that he was getting milk with a good cream content and not skim milk. In other words, the milk bottle helped to prevent fraud in the sale of milk. It was not until later that regulatory measures for the sale of milk were incorporated into some villages and city codes.

As early as 1896 an Ohio circuit court upheld an ordinance prohibiting the sale of bulk milk (6). However, it was not until 1915 that the State of Michigan recorded on its statute books an act which had reference to milk bottles (1).

Two years previous Act 222, Session Laws, 1913, of the State of Michigan, was adopted which provided for the prevention of the sale of unclean and insanitary milk and cream. This is the first reference to action taken in connection with milk in the interest of the public health by the State of Michigan.

It was not until 1919 that a State Council of Health was authorized (2). Thus it would appear that in the State of Michigan the use of the individual milk bottle was not initiated because bulk milk was considered a public health hazard, but rather, as a convenience for the processor. To further substantiate this, Bulmer (4) states that when the milk bottle was first introduced "many public health officials ... ...gravely frowned upon this departure from the dip milk."

In 1931 it was the opinion of sanitarians and public health authorities that milk dipped from large containers for sale to individuals "is a potential menace to health (5)." Today it is generally accepted that milk drawn through faucets or valves or dispensed from milk pumps, is a potential menace to the public health, the reason being that the seal of pasteurization has been broken. This is done when the milk is either exposed to the dipping utensil or is passed through a valve or milk pump. If the equipment were properly sanitized no public health hazard would result, unfortunately such equipment is generally improperly sanitized. In addition, if the milk is mixed and poured from the can into a pitcher, and then into glasses, it is thrice exposed to possible contamination.

In the above cases there is either one or more breaks in the seal of pasteurization, exposing the milk to the possibility of contamination with harmful bacteria (3).

The first definite reference requiring that milk be served to the restaurant trade in the original container is found in Regulation 784, adopted July 25, 1939 by the Michigan Department of Agriculture.

In 1943 Regulation 784 was replaced by Regulation 500 which now states (paragraph V) "Milk shall be served to the customer in the original individual container ....." not simply the original container. This regulation was rescinded July 12, 1949 by the adoption of "Regulation No. 525 Governing Food Establishments."

These regulations were promulgated under the authority given to the Commissioner of Agriculture, The State Health Commissioner, and the Michigan Liquor Control Commissioner, by the following enactments of the Michigan Legislature: Act No. 344, Public Acts of 1917, as ammended, Act No. 146, Public Acts of 1919, as ammended, and Act No. 8, Public Acts of 1933, Extra Session, as ammended.

It is well established that the original individual container guards against both fraud and public health hazard. With the introduction of homogenized milk, it would be possible to use bulk milk without danger of fraud as it pertains to skimming or uneven distribution of milk fats due to mechanical separation. If homogenized milk were dispensed from a properly sanitized can, stored in a refrigerated unit, it

would seem that the product from such a container would be equal to that obtained from an individual container or bottle as measured by either quality or sanitary significance.

The researches presented in this thesis were planned to obtain some of the answers using equipment available on the market at the present time.

DESCRIPTION OF MATERIAL AND PHASES OF STUDY

To undertake this study two dispensers were used. Dispenser "A" and Dispenser "B" both used refrigerated units for storage of the can while in use.

Dispenser "A" (Plate I) uses a can fitted with a recessed compression joint (1) with a lock nut (2) on the side at the bottom. A stainless steel tube (3) is used in the dispensing apparatus with a single service rubber compression gasket (4) and a single service rubber stopper(5). These parts are assembled as shown in Plate I, (6).

The assembled parts (6) are inserted into the can and secured in place with the wrench (7). Having been secured in the can a dust cap (8) is snapped over the exposed end of the dispensing tube.

To put the dispenser into operation the can is set in the refrigerated unit (1) shown in Plate II. The dust cap is taken off and the tube is retracted with tool (9) shown in Plate I. The tube is placed

in the dispensing mechanism (2) Plate II and the metal tabs on the rubber stopper are secured with traction claws to the control handle (3).

Dispenser "B" (Plate III) uses a can fitted with a small nipple (1) in the bottom. The single service rubber tube (2) which is plugged at both ends and wrapped in a plastic envelope, is cut in half. One half of this tube is attached to the nipple and secured in brackets around the bottom of the can (3).

The dispenser is put into operation by setting the can into the refrigerated unit (1) Plate IV. The rubber tube is taken from the brackets and threaded through the dispensing mechanism (2) which consists of a weighted pinch-cock arrangement. The protruding end of the tube is then cut off flush with the bottom of the mechanism.

The first phase of the experimental work involved the use of the dispensers in a student dormitory. Dispenser "A" was tested first and Dispenser "B" at a later date. Both machines were operated by the same people and under identical conditions. The cans were washed, sanitized and filled at Dairy "M". Milk was refrigerated at the dormitory in the cold boxes until ready for use. The cans were then placed as needed into the refrigerated units and the milk dispensed. Homogenized milk was used.

The second phase of this work consisted of checking the every day run of bulk milk in comparison to the bottled milk at four dairies; namely, "A", "H", "L" and "M". This was done in order to determine whether the

Plate I

Photograph of Dispenser Parts for Dispenser "A"

1 Compression joint
2 Lock nut
3 Stainless steel tube
4 Rubber compression gasket
5 Rubber stopper
6 Assembled parts
7 Wrench
8 Dust cap
9 Retraction toll

Plate II

Photograph of Refrigeration Unit for Dispenser "A"

1 Refrigeration Unit
2 Dispensing mechanism
3 Dispensing handle

Plate III

Photograph of Dispenser Parts for Dispenser "B"

1 Nipple
2 Double length dispenser tube
3 Dispensing tube in place

Plate IV

Photograph of Refrigeration Unit for Dispenser "B"

1 Refrigeration Unit
2 Dispensing mechanism

ordinary methods of washing and sanitizing milk cans would yield a product of comparable quality to bottled milk.

EXPERIMENTAL PROCEDURE

Samples were taken periodically and during each period two or more samples were taken from the dispenser and two or more bottles of homogenized milk were collected at the dairy. The bottled and bulk milks were of the same day's processing at the same dairy and were taken in this manner in order to remove as many variables as possible. The samples were immediately refrigerated after collection.

The same method of collection was used in phase two.

The bacterial counts were made according to the procedure set forth in Standard Methods for the Examination of Dairy Products, Ninth Edition.

Following the accepted procedure for averaging the data obtained, the logarithmic average counts were determined for each test period.

REVIEW OF DATA

Phase I

Dispenser "A"

During the first 11 periods of comparison, the dispenser cans were washed in the ordinary manner. The stainless steel tubes were

washed by hand, then placed in a pail of sanitizer (quaternary ammonium compound) with the single service parts. The parts were assembled while wet and secured in the can. The cans were then filled and delivered to the dormitory.

The data for these 11 periods are shown in Table I and Graph I.

During these 11 periods, the bacterial counts of the dispenser samples were higher than the bottle samples in 9 (81.8%) of the test periods. The average count for the bulk milk in the 11 periods was 33,000 bacteria per ml. and for the bottled milk the count was 15,000 bacteria per ml. The bulk milk had an average count 120 percent higher than that for bottled milk.

The increase in count of the bulk milk was assumed likely to be due to improper washing and sanitising of the dispenser cans. Based on this assumption the dairy was asked to change their handling procedures. After the cans had been washed and steamed in the can washer, each one was rinsed with the same type of sanitizer used in the assembly of the parts. The reason for doing this was to insure proper sanitizing of the cans. This procedure is termed "special treatment."

The data for the 15 test periods following the change to "special treatment" are presented in Table II and Graph II.

The bacterial counts of the dispenser samples were higher than those of the bottled samples in 9 (60%) of the test periods, thus a

drop of 21.8 percentage points over the counts obtained without "special treatment." The average count for bulk milk in these 15 periods was 47,000 bacteria per ml. compared with 41,000 per ml. for the bottled milk. The average count of the bulk milk was only 14.6 percent higher than the average count for the bottled milk. This demonstrated that with a properly sanitized can the bacterial counts were comparable to the counts for bottled milk.

As a consequence of the above results, it was considered advisable to continue the "special treatment" during the test periods involving Dispenser "B".

Dispenser "B".

The data for the 31 test periods are shown in Table III and Graph III. The dispenser samples gave higher bacterial counts than did the bottled samples in 6 (19.3%) of the test periods. On the other hand the counts of the bottled samples were higher than those for the dispenser samples in 13 (41.9%) of the test periods and in 1.2 (38.7%) of these periods the counts were comparable. The average count of the 31 periods for bottled milk was 32,000 bacteria per ml. and that for bulk milk was also 32,000 bacteria per ml.

The results obtained with these two dispensers when the cans were properly washed and sanitized indicate that the quality of the milk delivered to the consumer was identical to that of bottled milk, from a public health standpoint.

Phase II

The second phase of the experimental work was to determine whether the can washing and sanitizing procedure now generally practiced will yield cans properly sanitized so that milk put in these cans will be comparable in sanitary quality to bottled milk.

The four dairies selected were not chosen for any definite reason. They represent the leading dairies in the area under study.

Dairy "A"

The bulk milk handled by this dairy is standard pasteurized. The samples were taken within 15 minutes after the cans or bottles were filled to avoid cream separation.

The data obtained are shown in Table IV and Graph IV.

The results of the 13 test periods show bulk milk to be higher in bacterial count than the bottled milk in 4 (30.7%) of the test periods. The bottled milk counts were higher than those for the bulk milk in 8 (61.5%) of the test periods and of comparable counts in 1 (7.79%) of the test periods.

The average count for the 13 periods was 28,000 bacteria per ml. for the bulk milk and 36,000 bacteria per ml. for the bottled milk. These data show that the average count for bottled milk is 28.5 percent higher than the average for the bulk milk.

Dairy "H"

The bulk milk at this dairy was homogenized. Samples were collected within one hour after filling of the cans or bottles.

During these 13 test periods 2 (15.3%) show bulk milk to be higher in count than bottled milk, 8 (61.5%) of the test periods show bottled milk to be higher in count than bulk milk, while 3 (23.1%) periods were of comparable counts.

In the 13 test periods 5 (38.4%) show bulk milk to be higher in count than bottled milk. The bottled milk counts were higher than bulk milk also in 5 (38.4%) of the test periods, while 3 (23.1%) periods were of comparable counts. The average counts were 23,000 bacteria per ml. for the bulk milk and 24,000 bacteria per ml. for the bottled milk. These averages are comparable.

Dairy "M"

This dairy used standard pasteurized milk for bulk shipment, therefore, prompt sampling was again practiced.

Table VII and Graph VII show the data collected.

These results of the 44 test periods show the bulk milk to be higher in bacterial count than the bottled milk in 16 (36.3%) of the test periods, while bottled milk counts were higher than those for bulk milk in 22 (50%) of the test periods, with 6 (13.6%) periods

showing comparable counts. The average count for the bottled milk in these 44 periods was 21,000 bacteria per ml. and for the bulk milk the average is 19,000 bacteria per ml.

The data collected from these four dairies show that the bacterial counts of the bulk milk were lower or at least comparable to the bottled milk. Therefore, if these four dairies had handled bulk milk in dispenser cans at this time the sanitary quality would be comparable or better than the bottled product.

DISCUSSION

The study of the two bulk milk dispensers show exactly what one would expect. That is, if a good quality of milk is put into a properly washed and sanitized container it will retain its original quality when properly stored.

These studies demonstrate also that in many cases the bulk milk was of better sanitary quality than the quality of the corresponding bottled milk. This may be due to better washing and sanitizing of the cans than of the bottles. If washing and sanitizing of cans and bottles are comparable the bulk milk would carry less organisms than would the

bottled milk. This would be due to the fact that there would be less surface area in contact with the bulk milk per volume than with the bottled milk.

The four dairies used in this study were selected due largely to the fact that they are the leaders in this area. Even though they show excellent results it cannot be assumed that all dairies will do the same. There are some dairies in the country that do not do as good a job of washing and sanitizing as the four studied.

The question of the use of bulk milk dispensers resolve down to the fact that the container is not the important element in producing a quality product but rather that the washing and sanitizing of the container into which the milk is placed is the paramount issue.

The acceptance or rejection of a bulk milk dispenser in any area should be on the basis of how well the dairies of the area handle the washing and sanitizing of their cans. It is also necessary to consider the personal hygiene of the milk handlers in each dairy.

In the final evaluation the machine which is to be accepted should be selected on the basis of single service parts. These so called single service parts must be absolutely single service. They must be so designed that after one usage it is impossible to use them

again. Dispenser "A"'s single service parts were not of this kind, for it was possible for them to be re-used. It was noted that if the milk handlers are rushed, it is very easy for them to leave the once used single service parts in the dispenser can and re-use them.

Also in the final evaluation of the machine it should be considered whether the dispenser cans must be used in the refrigerated cabinet or if it is possible for these dispenser cans to be used without the cabinet.

There is yet one final consideration, that is, will the volume of milk be too large for the establishment which uses the dispenser. All milk delivered should be served within 72 hours after pasteurization. All cans should be labeled with the date of filling.

All milk used in bulk dispensers must be homogenized.

CONCLUSIONS

The results of the comparisons of the dispensers and bottled milk indicate that if the dispenser cans are not properly cleaned and sanitized the product will be of higher bacterial count than that in the bottles.

If properly cleaned and sanitized a can with the least possible number of avenues of contamination will yield a product equal to that of bottled milk, as measured by either quality or sanitizing significance.

The problem of producing a good quality product resolves itself to the fact that proper washing and sanitizing of the containers, regardless of whether they are bottles or cans, is an absolute necessity. Therefore, if single service dispensing equipment is used, the cans must be properly washed and sanitized and the product must be properly refrigerated. Under these conditions it will be possible to dispense bulk milk of the same quality as bottled milk.

Table 1. The Comparative Bacterial Counts of Homogenized Bottled Milk and Milk Dispensed from Bulk Milk Dispenser "A" Washed and Sanitized Without "Special Treatment" From Dairy "M"

Test Period	Bulk Log Average	Bottled Log Average
1	18,000	10,000
2	16,000	64,000
3	28,000	7,000
4	50,000	7,000
5	24,000	6,000
6	69,000	22,000
7	34,000	5,000
8	63,000	46,000
9	58,000	75,000
10	27,000	13,000
11	25,000	8,000
Average	33,000	15,000

Graph I

Dispenser "A"

Without Special Treatment

Homogenized Milk

Dairy "M"

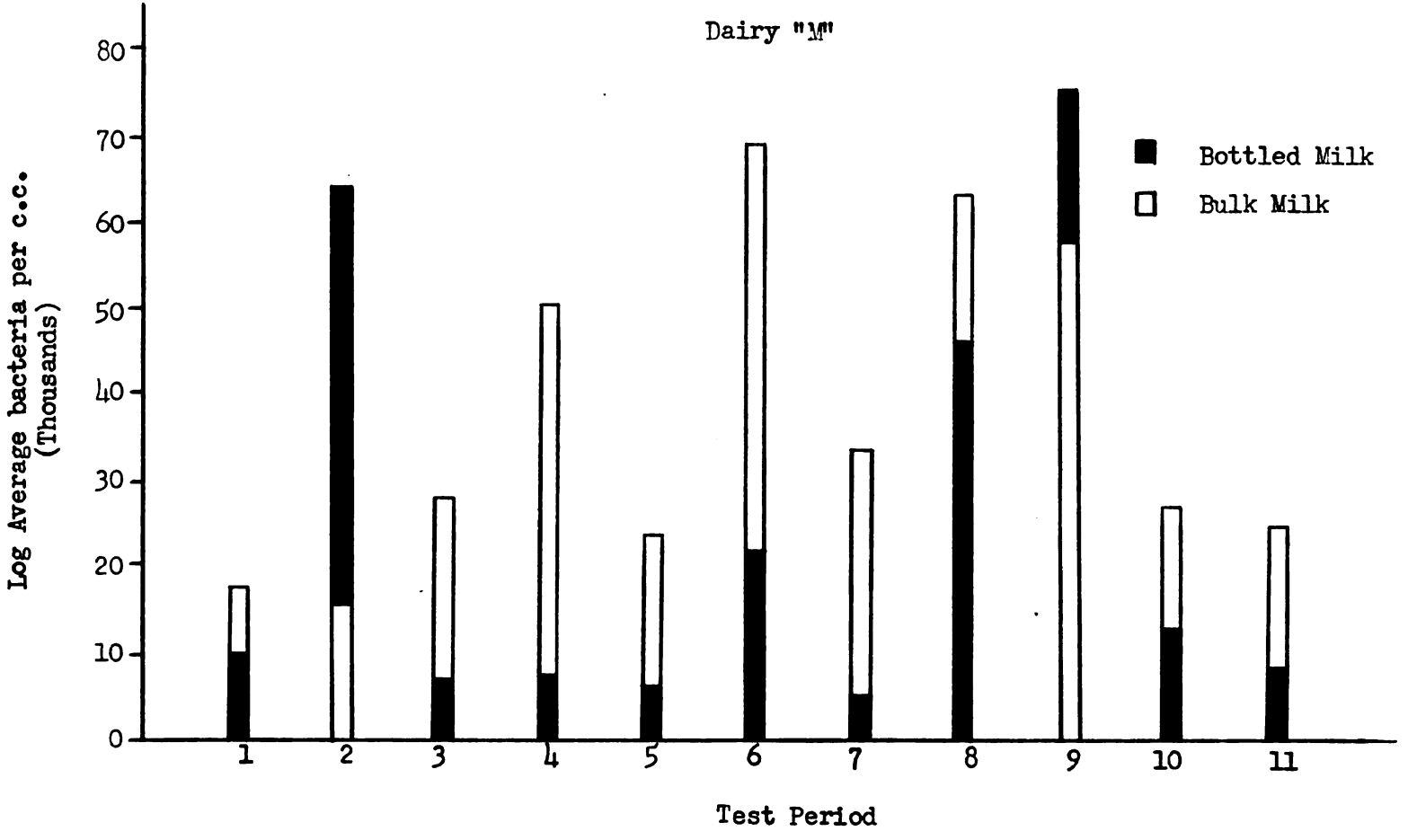


Table 2. The Comparative Bacterial Counts of Homogenized Bottled Milk and Milk Dispensed from Bulk Milk Dispenser "A" Washed and Sanitized "With Special Treatment" from Dairy "M"

Test Period	Bulk Log Average	Bottled Log Average
1	31,000	46,000
2	73,000	64,000
3	41,000	25,000
4	54,000	44,000
5	27,000	44,000
6	103,000	69,000
7	57,000	34,000
8	55,000	48,000
9	41,000	46,000
10	30,000	35,000
11	34,000	19,000
12	58,000	28,000
13	88,000	84,000
14	151,000	202,000
15	14,000	27,000
Average	47,000	41,000

Graph II

Dispenser "A"

With Special Treatment

Homogenized Milk

Dairy "M"

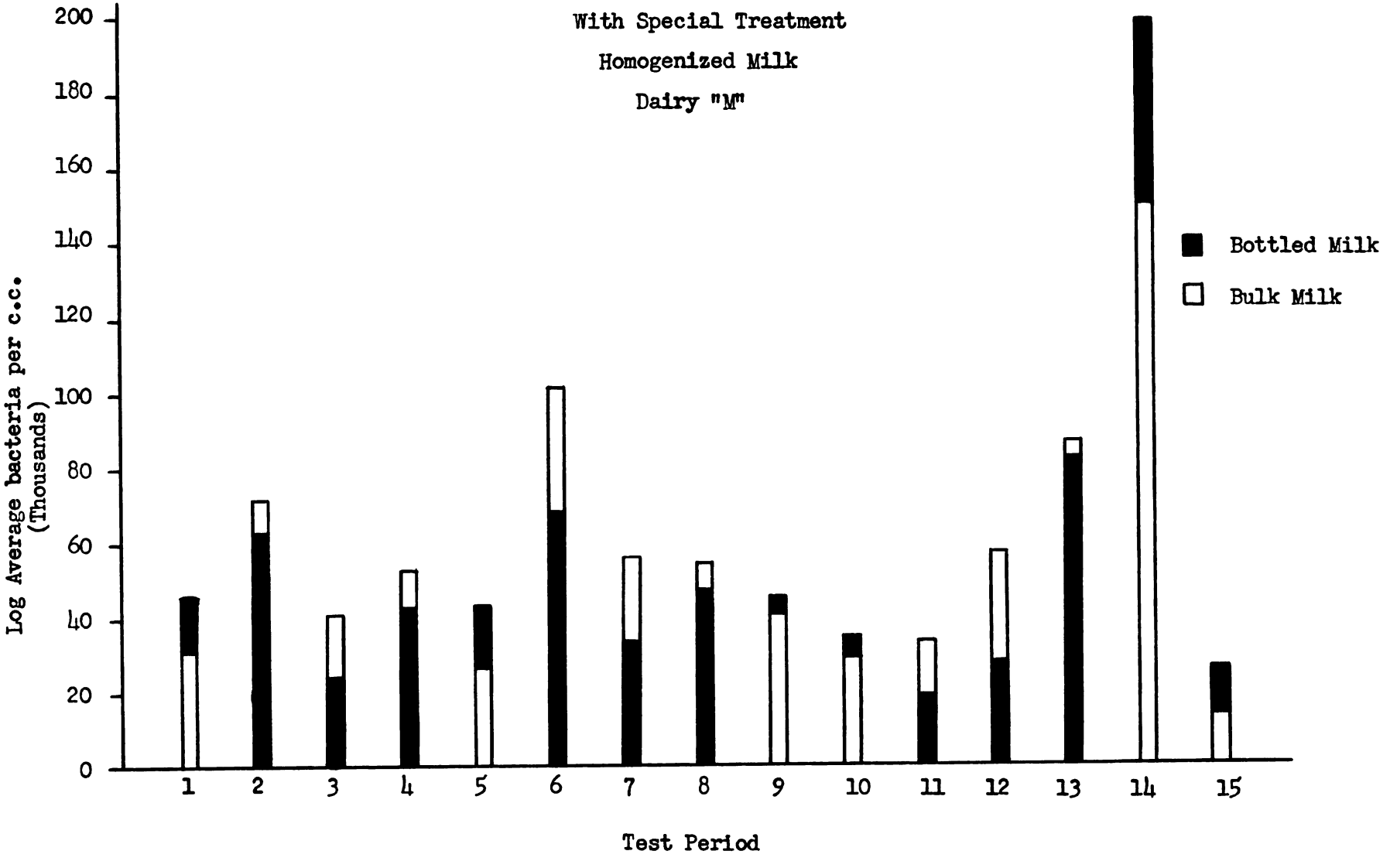


Table 3. The Comparative Bacterial Counts of Homogenized Bottled Milk and Milk Dispensed from Bulk Milk Dispenser "B" Washed and Sanitized "With Special Treatment" From Dairy "M"

Test Period	Bulk Log Average	Bottled Log Average
1	49,000	48,000
2	19,000	27,000
3	36,000	48,000
4	34,000	46,000
5	34,000	36,000
6	37,000	36,000
7	31,000	28,000
8	21,000	29,000
9	77,000	28,000
10	48,000	48,000
11	22,000	26,000
12	77,000	16,000
13	61,000	16,000
14	9,000	13,000
15	17,000	18,000
16	13,000	18,000
17	28,000	11,000
18	34,000	36,000

Table 3 (continued).

Test Period	Bulk Log Average	Bottled Log Average
19	16,000	91,000
20	25,000	25,000
21	27,000	26,000
22	39,000	76,000
23	16,000	17,000
24	36,000	47,000
25	15,000	42,000
26	15,000	14,000
27	53,000	53,000
28	50,000	48,000
29	83,000	92,000
30	46,000	41,000
31	48,000	53,000
Average	32,000	32,000

Graph III

Dispenser "B"

With Special Treatment

Homogenized Milk

Dairy "M"

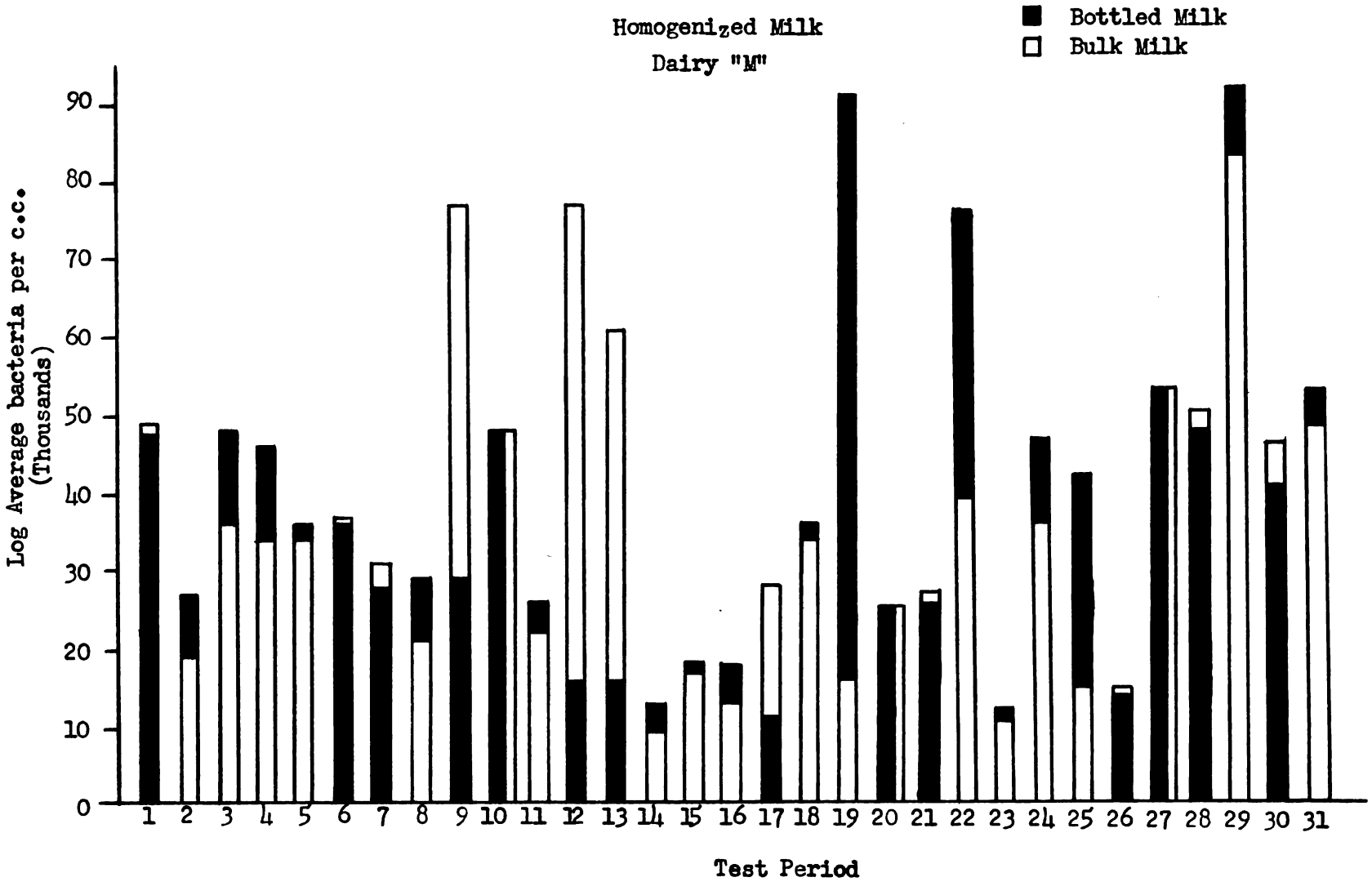


Table 4. The Comparative Bacterial Counts of Pasteurized Bottled Milk and Bulk Milk from Dairy "A"

Test Period	Bulk Log Average	Bottled Log Average
1	43,000	15,000
2	55,000	59,000
3	77,000	45,000
4	112,000	194,000
5	1,500	45,000
6	49,000	127,000
7	17,000	13,000
8	57,000	58,000
9	28,000	17,000
10	8,500	11,000
11	18,000	21,000
12	20,000	24,000
13	48,000	88,000
Average	28,000	36,000

Graph IV

Dairy "A"

Pasteurized Milk

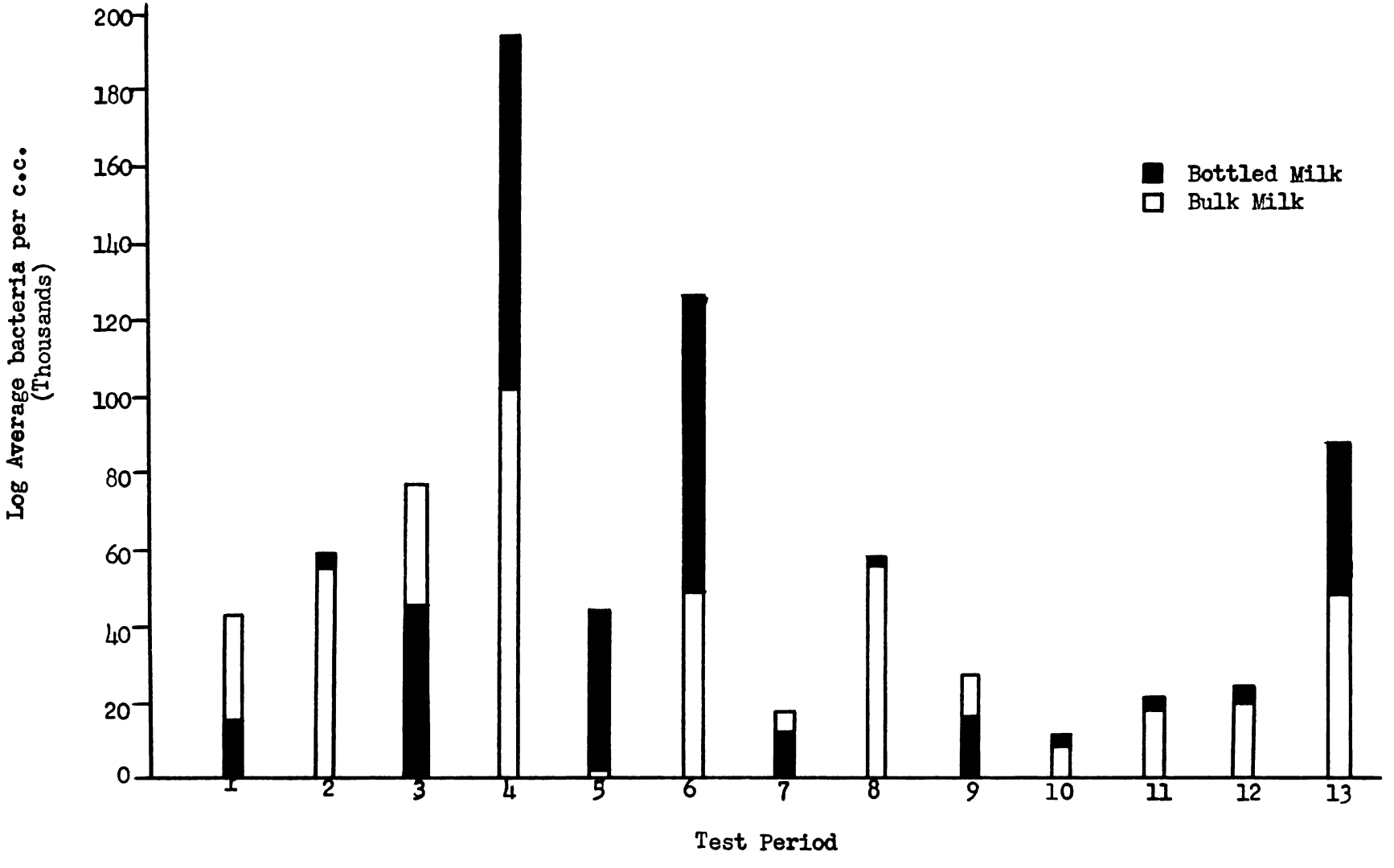


Table 5. The Comparative Bacterial Counts of Homogenized Bottled Milk and Bulk Milk From Dairy "H"

Test Period	Bulk Log Average	Bottled Log Average
1	20,000	20,000
2	24,000	23,000
3	127,000	15,000
4	48,000	21,000
5	800	3,000
6	600	12,000
7	2,000	42,000
8	42,000	50,000
9	17,000	28,000
10	26,000	40,000
11	14,000	21,000
12	16,000	34,000
13	12,000	12,000
Average	14,000	20,000

Graph V

Dairy "H"

Homogenized Milk

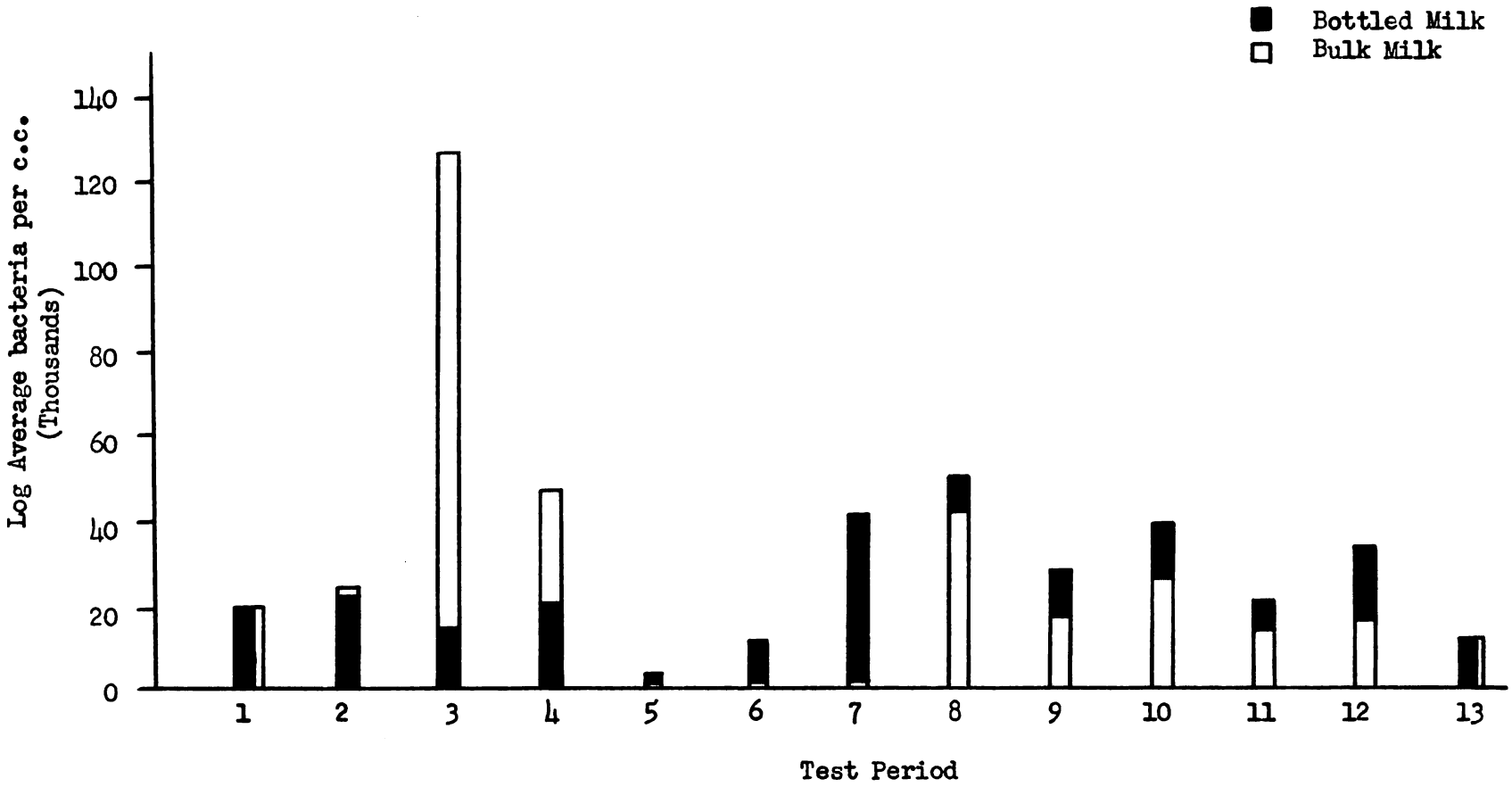


Table 6. The Comparative Bacterial Counts of Homogenized Bottled Milk and Bulk Milk from Dairy "L"

Test Period	Bulk Log Average	Bottled Log Average
1	13,000	37,000
2	72,000	75,000
3	113,000	45,000
4	48,000	42,000
5	5,000	2,000
6	5,000	27,000
7	9,000	9,000
8	6,000	47,000
9	25,000	27,000
10	171,000	41,000
11	91,000	21,000
12	8,000	13,000
13	10,000	11,000
Average	23,000	24,000

Graph VI

Dairy "L"

Homogenized Milk

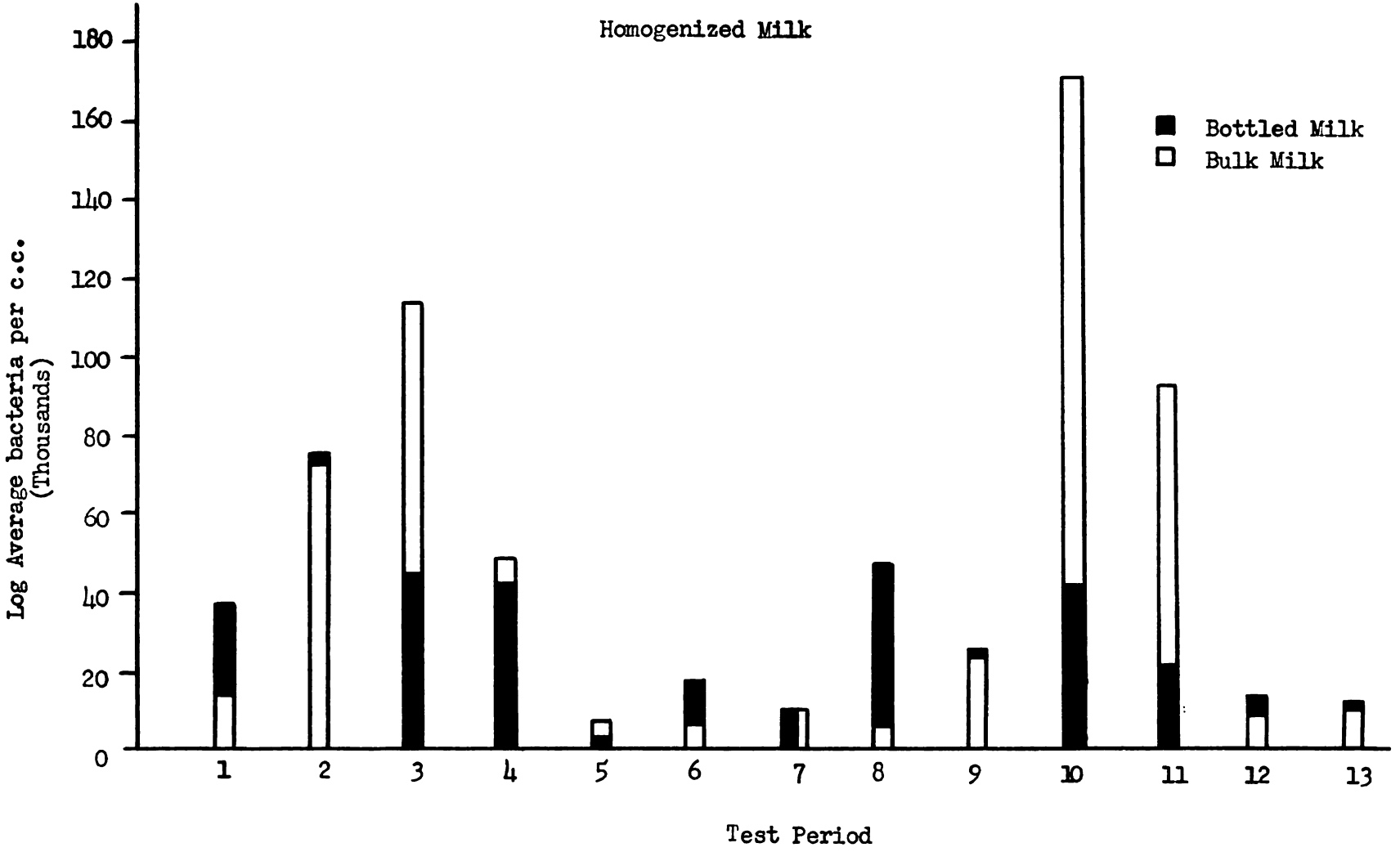


Table 7. The Comparative Bacterial Counts of Pasteurized Bottled Milk and Bulk Milk from Dairy "M"

Test Period	Bulk Log Average	Bottled Log Average
1	22,000	16,000
2	24,000	7,000
3	18,000	9,000
4	104,000	105,000
5	163,000	3,000
6	35,000	7,000
7	36,000	6,000
8	26,000	28,000
9	50,000	33,000
10	27,000	33,000
11	19,000	43,000
12	7,000	9,000
13	28,000	105,000
14	17,000	20,000
15	23,000	55,000
16	16,000	44,000
17	33,000	16,000
18	17,000	14,000
19	52,000	66,000
20	87,000	66,000

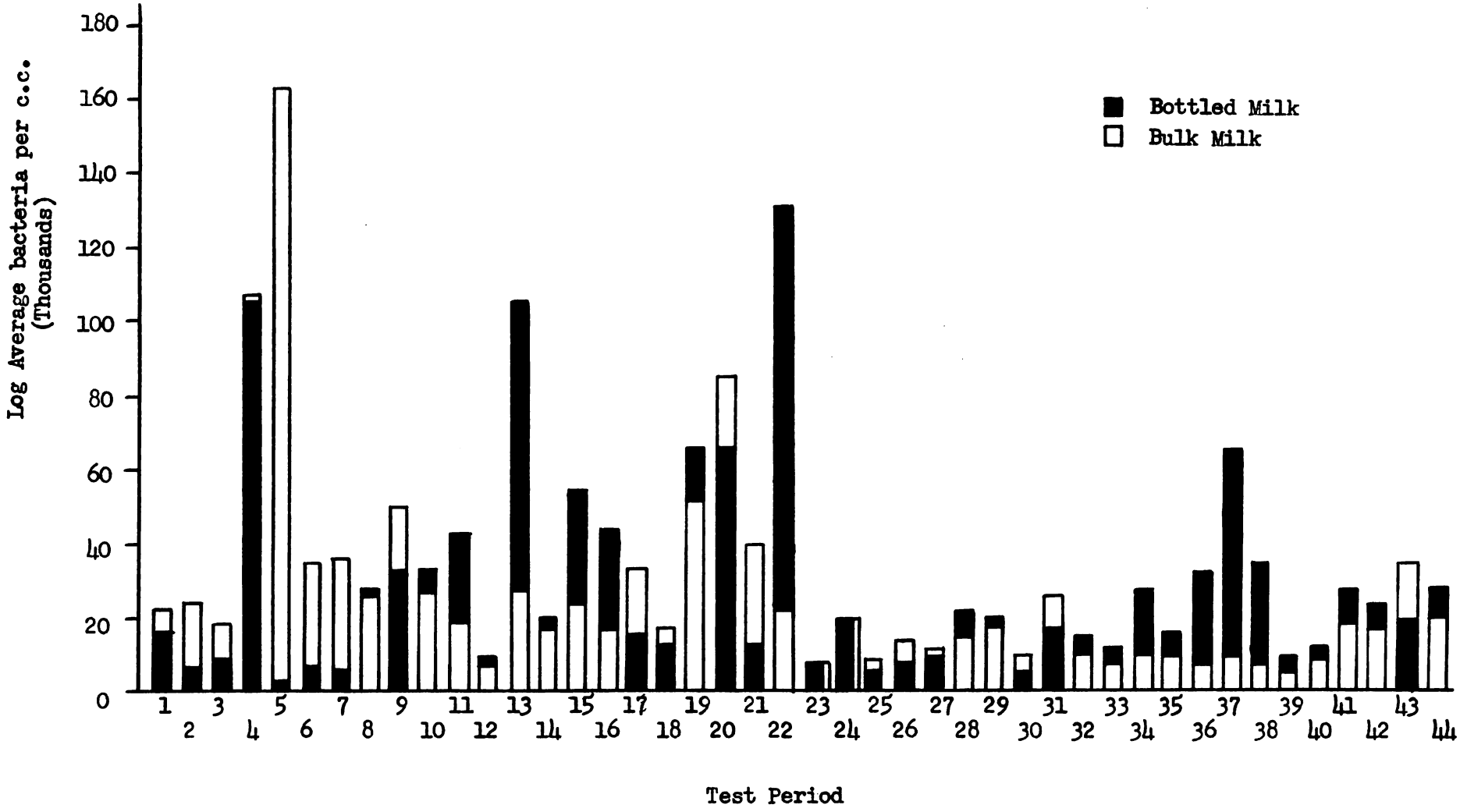
Table 7 (continued)

Test Period	Bulk Log Average	Bottled Log Average
21	40,000	13,000
22	22,000	131,000
23	8,000	8,000
24	20,000	20,000
25	9,000	6,000
26	14,000	8,000
27	11,000	10,000
28	15,000	22,000
29	17,000	20,000
30	10,000	5,000
31	26,000	18,000
32	10,000	15,000
33	7,000	12,000
34	10,000	28,000
35	10,000	16,000
36	7,000	33,000
37	9,000	65,000
38	7,000	35,000
39	5,000	10,000
40	9,000	12,000
41	19,000	28,000
42	17,000	24,000
43	35,000	20,000
44	20,000	28,000
Average	19,000	21,000

Graph VII

Dairy "M"

Pasteurized Milk



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