INFLUENCE OF ALTERNATE-DAY COLLECTION ON THE BACTERIOLOGICAL QUALITY OF REFRIGERATED FARM BULK MILK

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SUMMARY

An investigation was undertaken to determine the effect of extended farm storage arising from alternate-day collection on the bacteriological quality of milk held in refrigerated bulk tank units on farms in Queensland. It was found that no significant bacterial deterioration occurs in hygienically produced milk during 2 days of farm storage in these units. The collection of this milk on an alternate-day basis, therefore, will not result in lower bacteriological quality.

I. INTRODUCTION

The collection of milk from refrigerated farm bulk tank units on an alternate-day basis (every other day), instead of daily, has important economic implications, as the cost of tanker transportation can be substantially reduced. This method of collection is only satisfactory, however, if the raw milk does not deteriorate in quality during the additional storage period.

The general opinion of investigators is that alternate-day collection of milk from these units is satisfactory provided the milk is hygienically produced and kept at a sufficiently low temperature during storage (Atherton and Bradfield 1957; Smillie, Orr, and McLarty 1958; Higginbottom 1962).

These investigations were carried out in countries with cold or temperate climates and the results need not necessarily have applied under subtropical conditions. Therefore, an investigation was undertaken to determine the effect

of an extended period of storage arising from alternate-day collection on the bacteriological quality of milk held in refrigerated bulk tank units on farms in Queensland.

II. MATERIALS AND METHODS

Five farms on which refrigerated bulk tank units had been installed were selected for this investigation. Routine quality control tests carried out by the processing factory had shown the milk produced on each of these farms to be of good bacteriological quality.

Two samples of milk were obtained from each farm at weekly intervals over a period of 4 weeks during the late summer. The first sample was collected when the tanks contained two milkings (p.m. and a.m.) and a second sample was taken on the following day at the time of tanker collection, when each bulk tank unit held four milkings. The bulk milk was agitated for at least 5 min in the tank units before sampling. All the samples of milk were taken aseptically and stored on ice until they arrived in the laboratory. The interval between sampling and examination in the laboratory was never more than 4 hr.

The thermostat settings used to control the temperature of the milk held in the bulk tank units were not altered throughout the period of the investigation. Variation during the sampling period was less than $0 \cdot 5\,°F$.

A laboratory experiment was performed to ascertain the bacteriological changes which take place during the low-temperature storage of milk for extended periods. Composite samples were taken from the daily milk supplies of four farms. Each sample consisted of mixed evening's and morning's milk which had been bulked and stored under refrigeration in a farm tank unit. This milk could be regarded, therefore, as having had 1 day of refrigerated farm storage at the time of initial examination.

These composite samples were stored in the laboratory for 7 days at 3-5°C. This temperature was chosen because it appears to be the highest temperature at which milk is held in refrigerated bulk tank units.

Upon arrival in the laboratory, each sample was examined for raw milk plate count, thermoduric bacteria count, and psychrophile count. These tests were repeated after 1, 2, 4 and 7 days of refrigerated laboratory storage. They were carried out in the manner described by Smith and Mitchell (1966).

III. RESULTS

The results of the bacteriological tests are shown in Table 1.

TABLE 1

BACTERIAL COUNTS OF BULK FARM MILK STORED FOR ALTERNATE–DAY COLLECTION

Date of Sampling	Test	Plate Count ('00/ml)									
		Farm									
		A		B		C		D		E	
		First Day	Second Day	First Day	Second Day	First Day	Second Day	First Day	Second Day	F'rst Day	Second Day
Feb. 12–13	RPC	180	110	140	170	150	150	150	190	1,700	1,700
	TBC	20	30	70	150	5	2	5	100	150	150
	PBC	70	50	40	40	60	40	40	3	100	90
Feb. 20–21	RPC	120	170	440	660	90	120	180	160	560	1,300
	TBC	2	10	8	30	2	20	3	20	40	440
	PBC	60	140	240	40	80	40	10	10	150	130
Feb. 26–27	RPC	110	180	670	2,600	110	210	200	100	960	500
	TBC	10	20	150	830	40	30	10	40	680	460
	PBC	10	10	50	70	3	10	1	2	30	5
Mar. 6–7	RPC	200	230	130	190	110	150	180	730	2,500	1,900
	TBC	30	30	20	6	5	20	4	510	340	640
	PBC	10	50	4	1	60	20	6	3	20	90
Temperature of milk at time of sampling (°F)		36		38		37		37		35	

RPC = Raw milk plate count.
TBC = Thermoduric bacteria count.
PBC = Psychrophilic bacteria count.

There were very few large increases in bacterial counts on the second day of farm storage in the bulk tank units and in several instances the counts were lower.

The changes which occurred in counts during the low-temperature storage of milk under laboratory conditions are shown in Table 2.

TABLE 2

BACTERIAL COUNTS OF RAW MILK DURING LABORATORY STORAGE AT 3–5°C

Sample	Test	Plate Counts (Micro-organisms/ml)				
		Number of Days of Laboratory Storage				
		0	1*	2	4	7
1	RPC	12,000	11,000	20,000	120,000	3,000,000
	TBC	1,200	900	1,100	1,500	8,000
	PBC	3,800	5,000	11,000	280,000	> 10,000,000
2	RPC	6,000	5,000	19,000	3,100,000	> 10,000,000
	TBC	900	800	600	900	12,000
	PBC	800	1,800	14,000	> 10,000,000	> 10,000,000
3	RPC	9,000	12,000	16,000	530,000	3,000,000
	TBC	700	500	600	600	1,300
	PBC	2,400	4,400	8,100	600,000	> 10,000,000
4	RPC	5,000	9,000	30,000	980,000	> 10,000,000
	TBC	300	300	300	500	4,100
	PBC	1,700	2,100	36,000	1,500,000	> 10,000,000

RPC = Raw milk plate count

TBC = Thermoduric bacteria count

PBC = Psychrophilic plate count

* One day of laboratory storage may be regarded as equivalent to 2 days of farm storage associated with alternate-day collection from bulk tank units.

IV. DISCUSSION

From the results of the laboratory experiment (Table 2) it appears that, although some bacterial growth will take place within 2 days in raw milk held below 5°C, this does not significantly affect bacteriological quality when low numbers of micro-organisms are present in the milk initially. Also, as the thermoduric counts remained approximately constant over 4 days, it is apparent that those organisms which began to proliferate within this time were destroyed by pasteurization. Therefore, milk that is hygienically produced, and kept at a temperature below 5°C in refrigerated bulk tanks, should suffer no bacteriological deterioration when held for alternate-day collection. This milk would have to be pasteurized as soon as possible after collection, however, as the contaminant bacteria, especially psychrophiles, begin to multiply rapidly after this time.

The results of the bacteriological tests performed on the samples of milk taken from the refrigerated farm bulk tank units on the first and second days of storage (Table 1) show that in most cases the raw milk plate counts and thermoduric bacteria counts were higher on the second day. It can be seen from Table 2, however, that thermoduric bacteria do not begin to multiply in refrigerated raw milk until after 4 days of storage. Therefore, the increase in the thermoduric counts of bulk tank milk on the second day would have been due to the presence of greater numbers of these organisms in milk subsequently added to the bulk tank unit after the first sample was taken. This indicates that the equipment used for milking was in a poorer state of hygiene on the second day, as the thermoduric content of milk supplies is mainly influenced by the sanitary condition of the farm dairy utensils (Thomas *et al.* 1950; Smillie, Orr, and McLarty 1958). Table 1 also shows that in some cases the samples taken on the second day contained lower bacterial counts than those taken on the first day. This is probably due to a dilution effect, i.e. the addition of fresh milk containing fewer organisms to the milk already held in the tanks.

It appears, therefore, that the hygienic condition of the milking equipment is the most important factor contributing to the number of micro-organisms in the raw milk held for 2 days in refrigerated farm bulk tank units and outweighs the small amount of bacterial growth which occurs during the extra day of farm storage.

Olsen, Parker, and Mueller (1955) and Thomas *et al.* (1963) have stated that psychrophiles may be of major importance in causing flavour deterioration in milk stored at low temperatures, and special attention needs to be given to the presence of these organisms in milk held for alternate-day collection. If a psychrophile count of not more than 10,000 organisms per ml is taken as indicative of good quality milk (Orr, McLarty, and Baines 1960) then 90% of farm samples (Table 1) would have been of acceptable quality on both the first and the second days. Also, organoleptic tests carried out at the time of tanker collection gave no evidence of off-flavour development. As psychrophilic bacteria are destroyed by pasteurization (Olsen, Parker, and Mueller 1955; Storgards 1961), the potential hazard due to the presence of these organisms in raw milk is effectively removed by this process. Therefore, provided the milk is pasteurized soon after collection, psychrophilic bacteria should cause no quality deterioration in bulk tank milk collected on alternate days.

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