CHARACTERISTICS OF MILKING CENTER WASTE EFFLUENT FROM NEW YORK STATE DAIRY FARMS

R. R. ZALL
Department of Food Science
Cornell University, Ithaca, New York 14850

(Received for publication September 9, 1971)

ABSTRACT

Waste profile studies were carried out on milking center (milkhouse and milking parlor) wastes from 24 New York State dairy farms selected in 20 different counties. Data show that farm-generated milking wastes should not be confused or compared with diluted aqueous sewage typical of effluents from dairy processing plants. Presence of high levels of settleable solids explain the rapid failure and fouling of traditional tile field waste systems. While many sanitarians have speculated that milking center sewerage line plugging has occurred because of milk solids and biological sludge accumulation, this field experiment suggests that manure, feed, bedding, and hoof dirt are the principal solids in milking center wastes.

This study was made to measure volumes and concentration of milk center wastes in order that one can treat them intelligently. In 1950, Roadhouse and Henderson (3) stressed the need for milkhouse convenience. The authors completed their review of milkhouse and parlor activities by merely commenting that the waste line should have a tile cleanout trap just outside the building, in the event of plugging. Two decades later, the literature is still sparse with data that define milking center effluents.

One pertinent study in 1969 by Loehr and Ruf (2), which dealt with an aerobic lagoon treatment of parlor wastes in Kansas, is remarkably substantiated by this investigation in regard to pounds of B.O.D. per cow per day. Gallons of waste produced per cow per day in the milking parlor are also within reasonable agreement.

MATERIALS AND METHODS

From May through June, 1971 State County Extension specialists were visited to establish guidelines for a milking center waste study. Waste handling training sessions were held in five areas of New York State to instruct the participating county agents on how best to obtain reliable waste samples.

Composite samples were collected from the total milking center wastes produced from single and double milkings at selected farms in plastic 8 ft in diameter by 20 inches high children's swimming pools with a capacity of approximately 640 gal. Two-quart portions in jugs were taken from impounded well mixed waste material and then packed with ice in styrofoam picnic baskets for transporting to the Cornell campus laboratories where testing was done. Biological and chemical analysis followed the procedures outlined in the 1969 F.W.P.C.A. *Methods for Chemical Analysis of Water and Wastes*. The waste volumes were physically measured on farms by actually filling and then dumping 10-gal cans.

RESULTS

Volume and strength

With the exception of one large farm sampled, the numbers of animals per dairy farm were typical of New York State milking operations. Table 1 states that the average gallons of waste per cow per day in this study was 4.05. The pounds of B.O.D. per cow per day produced in milking centers approximate an amount equal to a population equivalent of 1 (human waste load taken to be 0.17 lb. per day).

It was quite evident by observation and smell that the collected waste composite samples are diluted manure fluids. One could see a brown greenish liquid with settled feed materials such as corn and grain together with bits of straw mixed with mud and sand.

Not only were the settleable solids high, as indicated in Table 1, but the percentages of total solids and centrifuged residues suggest that substantial amounts of debris will also be carried in presettled

TABLE 1. MILKING CENTER WASTE VOLUMES AND B.O.D. POUNDS—DETERMINED FROM 24 NEW YORK STATE FARMS—JUNE 1971[1, 2]

	Highest individual farm	Lowest individual farm	Average for all farms	Total sampling
Number of cows	396	36	100	2401
Total gallons of waste generated	1608	111	405	9713
Total pounds of B.O.D./day	93.4	0.57	12.7	305.5
Settleable solids, ml/l	200	trace	49.5	1189
Gallons of waste/cow/day	16.8	1.8	4.05	—
Pounds of $B.O.D._5$/cow/day	0.38	0.01	0.127	—

[1]Odors from effluent varied from slight feed to strong manure. Colors varied from brown to olive green.
[2]If the data from the two extreme farms of highest and least number of cows are discarded, the average gallons of waste/cow/day are identical with a slight reduction in average pounds of $B.O.D._5$ to 0.107/cow/day.

TABLE 2. MILKING CENTER WASTE VOLUMES FROM 24 NEW YORK STATE FARMS GROUPED AS TO HERD SIZE. JUNE 1971

Cows/herd	No. of farms in group	Total cows in group	Avg. gal waste/farm in group	Avg. lb. B.O.D./farm in group	Avg. gal waste/cow in group
0 - 49	5	209	302	6.3	7.2
50 - 99	10	675	284	7.6	4.2
100 - 149	4	446	491	15.2	4.4
150 - 199	4	675	445	13.5	2.6
>200	1	396	1608	93.4	4.1
Total	24	2401			

milking center waste.

Generally, a linear relationship existed between the number of animals milked and the gallons of waste produced at the farm. However, Table 2 indicates that locations are sufficiently different in operation to be variable as illustrated by the slope of the line in Fig. 1 when data are plotted on normal probability grids. The measure of variation is the slope of the line where the steeper slope means variation and the flatter slope denotes less.

Nitrogen and phosphorus

It seems reasonable to expect that nitrogen and phosphorus content in milking center waste should vary as organic load levels change. Data in Tables 3 and 6 show that relatively small differences occurred in soluble phosphorus and nitrogen compounds when compared with animals per farm or with pounds of B.O.D. produced in the milking center. The high percentage of results falling into similar bands of concentration levels may indicate that some solubility or buffering control mechanism regulates the chemical system for these compounds.

The data on nitrate and nitrite are shown in Table 4 and indicate that amounts of these substances are no greater than the levels in sewage-treatment-plant effluent. The summary in Table 5 shows the enormous amount of total solids present in milking center waste effluents. Even centrifuging waste at 37,000 RCF failed to remove most of the solids which will cause waste handling problems.

TABLE 3. NITROGEN AND PHOSPHORUS LEVELS IN MILKING CENTER WASTES FROM 24 NEW YORK STATE DAIRY FARMS. JUNE 1971

Micrograms/ml[1]	Soluble PO_4P	Soluble P	Soluble NH_4-N	Soluble Kjeldahl N
	(Number of farms)			
<49	9	9	7	1
50 - 99	13	12	11	5
100 - 149	1	2	3	9
150 - 199	1	1	2	3
200 - 249	0	0	0	3
>250	0	0	1	3
Total	24	24	24	24
	(Micrograms/ml)			
Highest result	183	179	625	736
Lowest result	6	8	5	40
Average result	57.6	61.8	132.1	186.6

[1]Micrograms/ml approximates ppm

TABLE 4. NITRATE AND NITRITE LEVELS IN MILKING CENTER WASTES FROM 24 NEW YORK STATE DAIRY FARMS. JUNE 1971.

Micrograms/ml[1] Soluble	Soluble NO_2 & NO_3	NO_2
	(Number of farms)	
<0.5	1	10
.5 - 1.0	12	9
1.1 - 1.5	4	1
1.6 - 2.0	1	2
2.1 - 2.5	2	2
>2.5	4	0
Total	24	24
	(Micrograms/ml)	
Highest result	6.5	2.5
Lowest result	0.3	<.5[2]
Average result	1.6	1.1[3]

[1]Micrograms/ml approximates ppm
[2]Lowest test sensitivity
[3]Average of data for 0.5 and above

DISCUSSION

Evidently milking center wastes do not resemble typical milk plant fluid sewage. The most comprehensive review of dairy food plant wastes was recently made by Harper *(1)* who presented data from 697 plants in 38 states or about 11% of the total industry plants. The suspended solids from milk plants are mostly coagulated milk, fine particles of cheese, and residues of by-products such as nuts or fruits from ice cream manufacturing. Usually the settleable solids in fresh dairy plant wastes are present in trace amounts which differ markedly from the average of 49.5 ml/liter, as shown in Table 1. Wastes generated from milking centers are more like animal manures with large amounts of feed, bedding, and hoof dirt.

While the data show a wide variation in the high and low waste ratios, 50% of the 24 farms sampled produced approximately 4 gal of waste per cow per day from milking center operations. This also is the mean figure in the survey.

It is interesting to note that 60% of the experimental sites sampled showed a sewage load of <10 lb. of

TABLE 5. SOLIDS CONTENT IN MILKING CENTER WASTES FROM 24 NEW YORK STATE DAIRY FARMS. JUNE 1971

Grams/liter	Total solids	Centrifuged solids[1]
	(Number of farms)	
0 - 2.9	4	15
3.0 - 5.9	11	7
6.0 - 8.9	8	2
9.0 - 11.9	1	0
Total	24	24
	(Grams/liter)	
Highest result	10.4	7.8
Lowest result	0.8	0.2
Average result	5.0	2.7

[1]Centrifuged 15 min at 37,000 RCF, 10 g approximate 1%

TABLE 6. NITROGEN AND PHOSPHORUS LEVELS IN MILKING CENTER WASTE SOLIDS FROM 24 NEW YORK STATE DAIRY FARMS. JUNE 1971.

Component (Percentage)	Nitrogen in total solids	Phosphorus in centrifuged residue[1]
	(Number of farms)	
0 - 2.9	4	5
3.0 - 5.9	17	13
6.0 - 8.9	1	4
9.0 - 11.9	0	0
12.0 and above	2	2
Total	24	24
	(Percent)	
Highest result	17.7	20.2
Lowest result	2.3	2.0
Average result	4.9	5.5

[1]Centrifuged 15 min at 37,000 RCF.

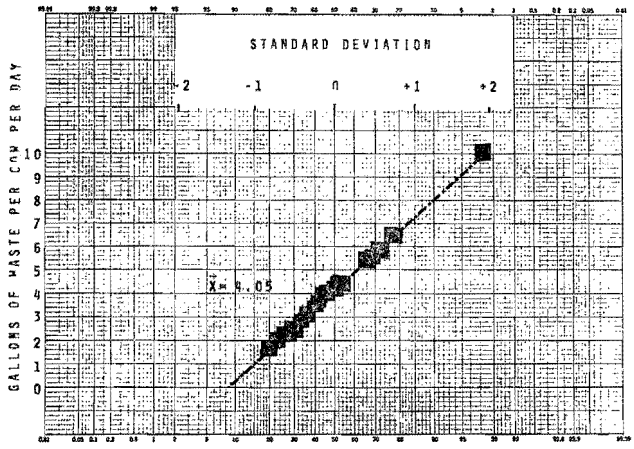

Figure 1. Distribution of data on the average gallons of waste per cow per day determined at 24 New York State farms—June 1971.

B.O.D. per day per farm. This amount is small for conventional industrial waste handling systems. If one agrees that a one-half acre lagoon can accept 10 lb. of B.O.D. per day as a manageable waste loading amount for the area, then the lagoon concept could be an attractive method for treating milking center wastes.

The question also might be raised that perhaps parlor wastes should be part of animal solids or liquid manure systems and that the milkhouse liquid wastes might best be handled in the former traditional manner. Failure and rapid plugging of cesspools and tile fields or similar systems are explained by high amounts of settleable solids, total solids, and centrifuged solids.

Further work is now underway to explore the value of separating milking center wastes into categories. These include: *(a)* milking parlor wastes separated to be discharged to solid or liquid manure handling systems; *(b)* combine aqueous milkhouse wastes with parlor sewage to be handled in traditional tile fields or cesspools; and *(c)* apply lagoon waste handling methods for treating either combined or segregated portions of milkhouse-milking parlor wastes.

The data on total solids content are presented in Table 5 and show that enormous amounts of solids can be present from milking centers. In addition, if approximately 50% of the solids cannot be settled even at 37,000 RCF then household 500-gal to 1,000-gal septic tanks currently being used for settling tanks can only provide minimal solids separation benefits at best.

It does seem reasonable that 5% levels of nitrogen and phosphorus in the waste solids (see Table 6) may make a land application of these wastes attractive, however, should the soluble material seep into water ponds then algal growth could be stimulated.

While this project is not a complete in depth study of milking center wastes, it has disclosed some interesting facts. The Agricultural Engineer may wish to review the grate sewers and trench drains in parlors to reduce the commingling of manure, hoof dirt, and feed with liquid washing solutions. Surely feed losses to sewers may be high enough to discourage animal feeding in this location. It seems that the pounds of B.O.D. per farm are generally small enough to be easily handled effectively on farm lands without elaborate waste systems if proper techniques are followed.

ACKNOWLEDGEMENT

N. Y. S. Cooperative Extension Agents volunteered both time and effort to measure and sample milking center waste.

REFERENCES

1. Harper, W. J., and J. L. Blaisdell. 1971. State of the art of dairy food plant wastes and waste treatment, p. 509-545. *In* National Symposium on Food Processing Wastes. Oregon State University, Department of Printing, Corvallis, Oregon.

2. Loehr, R. C., and J. A. Ruf. 1969. An aerobic lagoon treatment of milking parlor wastes. J. Water Pollution Control Fed. 40:83-94.

3. Roadhouse, C. L., and J. L. Henderson. 1950. The market milk industry. 2nd ed. McGraw-Hill Book Co., New York. 134 p.