

Evaluation of Quick Bacterial Count Methods for Assessment of Food Plant Sanitation

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ABSTRACT

Four methods to detect microbial contamination on food plant equipment surfaces were compared to determine the accuracy, precision, cost and time required to do each test. A standard method for swabbing; a simplified swab test (Millipore Corporation); a contact-transfer method (Con-Tact-It, Birko Chemical Corporation) and a direct method using Rodac plates (BBL) were evaluated. The equipment surfaces were found to be highly contaminated indicating the necessity for regular microbial testing. Under conditions of the test, there was good agreement in enumeration of bacteria between the standard swab test and both the Millipore swab method and the Con-Tact-It system; the standard swab method and Rodac plates showed the best precision. The contact methods were by far the quickest tests to do, and the Con-Tact-It system was the least expensive.

Equipment used in any food processing operation plays a major role in control of contamination in final products. Many small plants have neither the facilities to conduct chemical and microbiological tests nor any provisions to have these done routinely. This makes some form of quality control difficult, and as a result, many small establishments are blind to the sanitation of their facility, equipment and subsequent safety of their product. As an alternative, simplified testing procedures, that do not require a sophisticated laboratory and highly qualified personnel, are available for the small food processor. While these methods may not be definitive, they are reported to be indicative of plant sanitation (2,3,5,8,9). Our objective was to compare three tests — Millipore Swab Test Kit, Rodac Procedure of Surface Sampling and Con-Tact-It System Bacteria Detection Unit with the standard swabbing procedure (1).

MATERIALS AND METHODS

The deboning table tops, hamburger pattie and steaking line conveyors of a local meat cutting plant were selected as surfaces for the work. Locations for each test on the surface were randomized, as were days and times for sampling. However, samplings were mostly done during night after washing the equipment or in the morning before start up. Each test was conducted in duplicated on 20 different occasions.

Falcon brand swabs (Swube, in a 17 × 100-mm tube) were obtained from Fisher Scientific Company. The swab test kit for total bacterial count (Total-Count Sampler) was obtained from Millipore Ltd., Mississauga, Ontario, Canada. Rodac plates were the product of BBL (Division of Becton, Dickinson and Company). The Con-Tact-It System Bacteria Test Unit was obtained from Birko Chemical Corporation, Denver, Colorado.

Standard microbiological procedures were followed for enumeration of microorganisms on equipment surfaces by the swab method (1). A sterile 4-inch² glass template was used as a guide to swab the area. For the other procedures, manufacturers' instructions were followed. Incubation was at 35 C for 2 days.

RESULTS AND DISCUSSION

The results from the trials are presented as ranges in Table 1. The counts are high but could be considered typical of a food operation where there are no provisions for microbial testing. Table 2 shows the relative precision of the four testing methods, and correlation coefficients between the Swab test and each of the Millipore, Rodac and Con-Tact-It tests. The calculated values for relative precision, as described by Kramer and Twigg (6), indicates that the order of precision for the test methods would be Rodac > Swab > Millipore > Con-Tact-It. Correlation coefficients between both the Millipore and Swab test and, the Con-Tact-It system and Swab method were significant, while the *r* value calculated from the results of Rodac plates and the Swab test was not significant. If the Swab test were considered to be standard, then these results indicate that, under the conditions of our trials, the Millipore and Con-Tact-It tests are more accurate than is the use of Rodac plates. A possible explanation for the failure of the Rodac results to agree with those of the Swab test might be in the population numbers on the equipment surfaces tested. Very often the Rodac plates were covered by colonies, which severely diminished their accurate enumeration. Favero et al. (4) and Baldock (3) also pointed out that agar contact procedures are quantitative only if the level of contamination is low. A recent report (7) suggested that accuracy was lower above 200 colonies per cm² using the Con-Tact-It procedure.

TABLE 1. *Microbial counts per sq in area from two replicates on food plant equipment surfaces using four methods of testing.*

Test no.	Swab Method ($\times 100$)		Millipore ($\times 100$)		Rodac ($\times 10$)		Con-Tact-it ($\times 10$)	
1	250	570	270	540	2.5	6	—	—
2	1.5	8.7	0.4	16	6	14	4	7.2
3	850	1100	180	220	20	37	72	150
4	2.2	16	0.6	12	1.2	13	8.6	15
5	21	32	0.4	0.7	9	22	6.7	13
6	400	500	190	220	120	150	83	110
7	150	320	130	160	90	120	45	54
8	170	270	45	130	45	50	31	34
9	25	35	13	27	20	25	14	20
10	72	95	58	150	45	55	54	94
11	5	20	8.1	15	15	15	5	20
12	16	95	53	65	26	74	70	72
13	1.2	2	0.1	0.5	1.5	7	0	1.4
14	19	47	11	19	28	33	4	10
15	7	11	1.1	1.4	4.5	22	17	41
16	2.7	3	1	5.4	13	21	4.7	5.8
17	2.5	3.2	0.4	0.5	15	19	16	23
18	2.2	2.7	1.8	2.9	0.7	2.7	0	0.4
19	0.5	7	0.2	0.3	0.7	1.2	0.2	2
20	13	23	4.5	19	16	37	13	14

TABLE 2. *Correlation coefficient (r) and relative precision¹ of Swab, Millipore, Rodac and Con-Tact-It procedures.*

	Swab	Millipore	Rodac	Con-Tact-It
r ²	—	0.75* *	0.37	0.81* *
Rp (%)	9.1	15.3	8.6	17.4

¹Relative precision. Rp = sd/Rs where sd = standard deviation of difference between two duplicates and Rs = range of means of the duplicates, a smaller value indicates greater precision.

²r Calculated with the swab test as the independent variable.

* * p < 0.01

A control experiment in which a laboratory bench top area was spread with about 100 *Pseudomonas aeruginosa* colony forming units per inch² was used to assess the variability of each testing method. The standard deviations and coefficients of variability calculated from this trial (Table 3) show that the Swab test was the least variable and Con-Tact-It was the most, the order being Swab > Rodac > Millipore > Con-Tact-It.

TABLE 3. *Estimation of microbial populations by the Swab, Millipore, Rodac and Con-Tact-It procedures on a prepared surface¹.*

Swab	Millipore	Rodac	Con-Tact-It
550	30	110	5
550	27	126	2
620	18	83	9
820	23	74	1
750	14	124	6
121.9	6.5	23.8	3.2
C ² V ² (%)18.5	29.0	23.0	69.8

¹Surface swabbed with approximately 100 *Pseudomonas aeruginosa* colony forming units per inch².

²CV = $\frac{100s}{\bar{X}}$ where s = standard deviation
CV = coefficient of variability

The time or labor required to do each of the tests in this study, and cost per test are given in Table 4. As expected, the Swab test was the most labor-intensive; Millipore, which follows similar principles, was slightly faster and easier to do, but considerably more expensive.

TABLE 4. *Time, in minutes, taken to conduct the Swab, Millipore, Rodac and Con-Tact-It tests, and the cost of materials per test.*

Test	Time Required (min)	Const./Test (\$)
Swab	7	0.25
Millipore	5	2.95
Rodac	1.5	0.72
Con-Tact-It	1.5	0.10 ¹

¹This cost is based on the utilization of all 9 spaces/plate. If less than 9 tests were done at one time, the cost/test would increase \$0.09/space left.

The number of contaminants detected per unit area of the surface using Con-Tact-It and Rodac procedures were consistently low, indicating that these methods recovered fewer contaminants than swabbing methods. Consequently, agar contact methods should be used only as quick indicators of bacterial numbers. The Con-Tact-It system was slightly faster to count as a smaller contact area was involved. With respect to skill required to carry out the tests, they could be ranked as follows: Swab > Millipore > Con-Tact-It > Rodac.

The finding that the meat processing plant under study consistently showed heavily contaminated food contact surfaces stresses the need for monitoring the equipment for sanitation. This will indicate to management if sanitation is adequate, and areas that require attention. Since these plants need only some indication of relative numbers of contaminants present, they could adopt a method which is inexpensive and does not require highly skilled workers or elaborate laboratory facilities. It was our observation that except for the standard swab procedure, the methods studied during this investigation were relatively simple and could be conducted by a technician with little training.

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