3 Petrifilm™ Plate Reader for the Enumeration of Petrifilm Aerobic, Coliform, and E. coli/Coliform Count Plates

Sonya Gambrel-Lenarz and Kathryn Lindberg, 3M Microbiology,
St. Paul, MN USA

ABSTRACT

The 3M™ Petrifilm™ Plate Reader has been developed in order to enumerate Petrifilm Aerobic Count Plates, Petrifilm Coliform Count Plates, and Petrifilm E. coli/Coliform Count Plates, thus increasing laboratory efficiency and reducing transcription errors and technician fatigue. The performance of the Reader was demonstrated in 3M's laboratory by comparing the counts from food samples containing bacteria using both the Petrifilm Plate Reader and human analysts. Sixty-eight Petrifilm Aerobic Count Plates, 158 Petrifilm Coliform Count Plates, and 235 Petrifilm E. coli/Coliform Count Plates were studied. The logarithm_{10} counts from the Petrifilm Plate Reader when enumerating Petrifilm Aerobic Count Plates, Petrifilm Coliform Count Plates, and Petrifilm E. coli/Coliform Count Plates were within 10% of those logarithm_{10} counts obtained manually 93%, 100%, and 96% of the time, respectively. These data indicated that the counting criterion was met. In addition, sets of samples were prepared and enumerated by outside laboratories using multiple Petrifilm Plate Readers and multiple analysts. Analysis of variance indicated no statistical difference between the Petrifilm Plate Reader and human analysts ($p>0.05$).

INTRODUCTION

In the food industry, plate counting can often become tedious and time consuming. However, for obvious reasons, productivity could never compromise the completion of those food safety tests. The 3M™ Petrifilm™ Plate Reader has been developed to read the most commonly used Petrifilm Plates [Aerobic Count (AC), Coliform Count (CC), and E. coli/Coliform Count (EC)], thereby increasing productivity, reducing costs, and providing a consistent, automated reading.

The Petrifilm Plate Reader is connected to a computer via a USB2 port. The software is loaded on to the customer's computer using a wizard for easy installation. A Petrifilm Plate is inserted into the Reader and automatically ejected when reading is complete. The count results, as well as a color image of the plate itself (see Figure 1 below), are displayed on the computer screen. The actual time to read the plates and store results is about four seconds.

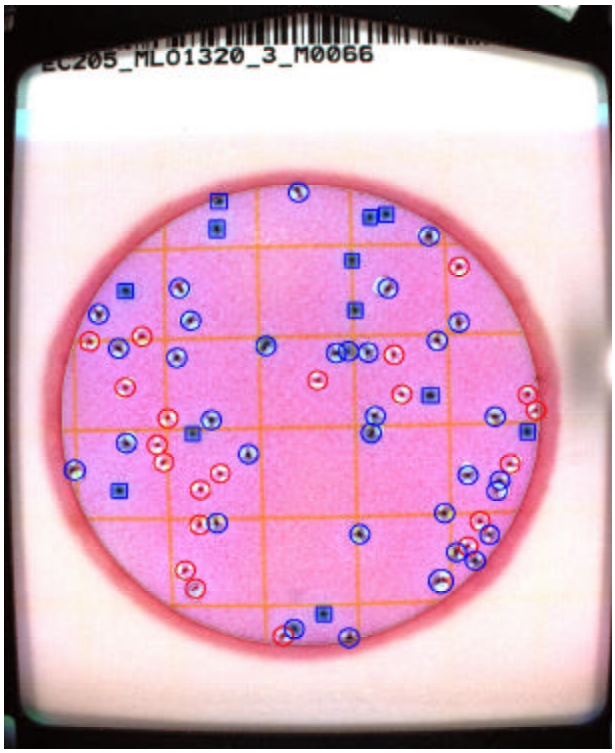

Figure 1 Color image of the Petrifilm E. coli/Coliform Count Plate

This study demonstrates the performance of the Reader using both data generated in 3M's laboratory and data generated by outside laboratories.

IN-HOUSE STUDY

Method

Raw ground beef, raw milk, pasteurized milk, strawberry yogurt, natural vanilla bean ice cream, raw milk cheese, spaghetti with red sauce, meat loaf, and fresh broccoli were tested using the Petrifilm AC Plate, the Petrifilm CC Plate, and the Petrifilm EC Plate. In addition, buttermilk, cottage cheese, and heavy whipping cream were tested using the Petrifilm CC Plate and the Petrifilm EC Plate. In the case where there were very few naturally occurring coliforms and/or *Escherichia coli*, these organisms were inoculated into the foods and then the samples were plated.

Counts were enumerated and recorded by a human and also by the Petrifilm Plate Reader. Samples whose human count was within the counting range of the method were used in the analysis. The logarithms$_{10}$ of colony counts were used for statistical analysis under the assumption that the transformed numbers would be normally distributed and of homogenous variance. Comparisons were made between the human count and the count from the Reader by finding the percent difference between the log human count and the log Reader count. It was desired to have the counts from the human and the Reader within 10% on 90% of the samples.

Results

Table 1 shows the number of samples used in the analysis, the number and percentage within the 10% criterion, and the number and percentage outside the 10% criterion for the various Petrifilm Plates and their associated colony types.

Table 1. Comparison between the human count and Reader count for various foods

Plate	Colony type	Number of samples	Within criterion*	Outside criterion*
Petrifilm AC plate	Red	68	63 (93%)	5 (7%)
Petrifilm CC plate	Red with gas	158	158 (100%)	0 (0%)
Petrifilm EC plate	Red with gas	263	248 (94%)	15 (6%)
	Blue with gas	235	225 (96%)	10 (4%)
	Red with gas plus blue with gas	305	295 (97%)	10 (3%)

*log counts from the human and the Reader are within 10%

For each Petrifilm Plate studied and for the various colony types within the method, the criterion was met.

EXTERNAL STUDIES

Method

Three separate studies were conducted to validate the results from the internal study.

Dairy samples were prepared and shipped to various state laboratories where they were plated using Petrifilm AC Plates. The counts were then enumerated by humans and by the Petrifilm Plate Reader.

Counts on the Petrifilm CC Plate were enumerated and recorded by human analysts and also by Petrifilm Plate Readers from samples prepared at customer facilities. Ice cream, yogurt, cheese, raw milk, prepared meals, salad, ground beef, and shrimp were used in the study.

Counts on the Petrifilm EC Plate were enumerated and recorded by human analysts and also by Petrifilm Plate Readers from samples prepared at three customer meat processing facilities.

Raw counts were converted to $\log_{10}$ counts to more nearly match the underlying assumption of normality. Analysis of variance was used to determine if differences existed in the human and Reader counts. In all statistical tests, a resulting value of $p<0.05$ was taken to indicate a significant difference.

Results

Table 2 shows the results from the analysis of variance performed using the data from the Petrifilm AC Plate. While the sample was significant since different dairy foods with different bacterial amounts were used, the enumeration method (human or Reader) was not significant ($p=0.35$).

Table 2. Analysis of variance studying enumeration method of Petrifilm AC Plate

Source	DF	Seq SS	Adj SS	Adj MS	F	P
sample	13	7.01240	7.01240	0.53942	33.67	0.000
enumeration	1	0.01395	0.01395	0.01395	0.87	0.351
Error	528	8.45870	8.45870	0.01602		
Total	542	15.48506				

Table 3 shows the results from the analysis of variance performed using the data from the Petrifilm CC Plate. As with the Petrifilm AC Plate, the enumeration method was not significant (p=0.59).

Table 3. Analysis of variance studying enumeration method of Petrifilm CC Plate

Source	DF	SS	MS	F	P
enumeration	1	0.49	0.49	0.29	0.588
Error	267	448.46	1.68		
Total	268	448.95			

Table 4 lists the p-values from the analysis of variance performed using the data from the Petrifilm EC Plate at three different customer facilities. The table gives the results when the Petrifilm EC Plate was used to enumerate total coliforms and *E. coli*. As in the other cases, the enumeration method was not significant.

Table 4. P-values from the analysis of variance studying enumeration method of the Petrifilm EC Plate

Site	Organism Detected	p-value
1	Total coliforms	0.76
	E. coli	0.99
2	Total coliforms	0.63
	E. coli	0.19
3	Total coliforms	0.23
	E. coli	0.97

CONCLUSION

Results from both internal and external studies have demonstrated that there is no statistical difference between the Petrifilm Plate Reader and human analysts on the food samples studied. The Reader provides consistent and accurate automated reading of the most commonly used Petrifilm Plates in 4 seconds, and as result, labor costs are reduced by increased productivity. In addition, transcription errors are minimized by the automatic data transfer capability to Microsoft® Excel and/or log files.

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3M Microbiology
3M Center, Bldg. 275-5E-05
St. Paul, MN 55144-1000
USA
1-800-228-3957
microbiology@mmm.com
www.3m.com/microbiology