A Productivity Analysis of the 3M™ Petrifilm™ Plate Reader Advanced

Introduction

Artificial intelligence (AI) systems have enabled businesses to see gains in productivity and profitability, increasing output of manual tasks while permitting technicians to perform more value-added activities where their skills are better applied.[1] In food safety testing, automated colony enumeration systems[2] can replace traditional manual counting by technicians.

Automated colony enumeration systems like the 3M™ Petrifilm™ Plate Reader Advanced can provide colony counts that are equivalent to human-derived counts.[3] The 3M Petrifilm Plate Reader Advanced may increase a laboratory's efficiency, productivity, and capacity.

To examine differences in productivity using manual colony counting versus counting with an automated system, a study was conducted using 3M™ Petrifilm™ Plates and the 3M Petrifilm Plate Reader Advanced. The study compared the time required for technicians to manually count 3M™ Petrifilm™ Aerobic Count Plates and 3M™ Petrifilm™ Rapid Aerobic Count Plates that contained low, medium, and high levels of colonies with the time required for the 3M Petrifilm Plate Reader Advanced to count the same 3M Petrifilm Plates.

3M™ Petrifilm™ Plates

3M™ Petrifilm™ Plates facilitate time and labor savings, eliminating the time-consuming agar plate preparation process. 3M™ Petrifilm™ Plates provide consistent, reliable results and third-party validations confirm the method is repeatable and has performed equal to or better than the reference method to which it was compared.

3M Petrifilm Plates have more than 100 global recognitions and validations including:
- AOAC® Official Methods of Analysis℠
- AOAC® Performance Tested Methods℠
- MicroVal Certification
- NF VALIDATION by AFNOR Certification
- Numerous regional and local approvals

Methods

This protocol was repeated for each of the three 3rd party laboratories that participated in the study. Technicians 1 - 3 are from lab A, technicians 4 - 6 are from lab B, technicians 7 - 9 are from lab C and technicians 10 - 12 are from 3M Food Safety.

Sample Preparation
- One to three colonies of *Staphylococcus aureus* (ATCC 6538) were placed into 5 mL of tryptic soy broth and incubated at 32°C for 18-24 hours.
- Six samples of skim milk were diluted in Butterfield's phosphate-buffered dilution water to achieve 1:10, 1:100 and 1:1000 dilutions.
- Two sets of the diluted samples were spiked using the overnight culture of *Staphylococcus aureus* (ATCC 6538) at a low inoculum level, two sets at a medium inoculum level and two sets at a high inoculum level. The inoculum levels were designed to target approximately 37 CFU/mL, 100 CFU/mL and 275 CFU/mL when plated on to the 3M Petrifilm Aerobic Count Plates and 3M Petrifilm Rapid Aerobic Count Plates.

Inoculation and Incubation
- One set of the diluted samples was used to inoculate 75 3M Petrifilm Aerobic Count Plates for each dilution.
- The other set of the diluted samples was used to inoculate 75 3M Petrifilm Rapid Aerobic Count Plates for each dilution.
- The 3M Petrifilm Aerobic Count Plates were incubated at 32°C for 48 ± 3 hours.
- The 3M Petrifilm Rapid Aerobic Count Plates were incubated at 32°C for 24 ± 2 hours.

Enumeration Methods (manual and automated)
- Each stack of 75 3M Petrifilm Plates per dilution *(*low, medium, high*)* was split into stacks of 25 plates—one stack for each of the three technicians (a total of 75 plates per technician).
- Each stack of 25 3M Petrifilm Plates per dilution was fed through the 3M Petrifilm Plate Reader Advanced and the time was recorded from the first plate entering to the last plate exiting the device.
- The same stacks of 25 3M Petrifilm Plates per dilution were manually counted by the same technician that had fed them through the 3M Petrifilm Plate Reader Advanced; the time was recorded from when the technician counted the first colony on the first plate until the technician counted the last colony on the last plate.

Deviations
- Technicians one, two and three repeated the protocol three times with the low inoculum level for both the 3M Petrifilm Aerobic Count Plate and 3M Petrifilm Rapid Aerobic Count Plate in order to achieve the target CFU/mL. Due to the preparation of one of the samples, the medium inoculum level was not achieved for technicians one, two and three. In order to supplement the data, technicians ten, eleven and twelve from 3M Food Safety conducted the study at the medium inoculum level.

Results

Comparisons were made between the time required for technicians to manually count the 3M Petrifilm Plates versus the time required for the 3M Petrifilm Plate Reader Advanced to count the same plates.

Table 1. Provides an example of the collected data from Technician 10 and the 3M Petrifilm Aerobic Count Plate at the medium inoculum level

Stack of 3M Petrifilm Plates (Each stack contains 25 plates)	Technician 1 Time to Results (Min:Sec)	3M Petrifilm Plate Reader Advanced Time to Result (Min:Sec)
Stack B, 1:10	14:38	2:21
Stack B, 1:100	14:07	2:27
Stack B, 1:1000	13:11	2:37
Total Time	41:56	7:25

Tables 2-7 summarize the analysis of the manual versus automated counting approach. The tables show the average time savings that users can achieve with the 3M Petrifilm Plate Reader Advanced compared to manual counting.

Table 2. Third-party lab results for the 3M Petrifilm Aerobic Count Plate at low inoculum levels

Technician #	Average Time Savings	Average Colony Count	Total Number of Plates
Technician 1	51 %	28	225
Technician 2	47 %	30	225
Technician 3	55 %	35	225
Technician 4	74 %	25	75
Technician 5	67 %	27	75
Technician 6	72 %	29	75
Technician 7	66 %	38	75
Technician 8	64 %	42	75
Technician 9	72 %	40	75
Average	**63 %**	**33**	**1,125**

Table 3. 3M and third-party results for the 3M Petrifilm Aerobic Count Plate at medium inoculum levels

Technician #	Average Time Savings	Average Colony Count	Total Number of Plates
Technician 4	89 %	90	75
Technician 5	91 %	90	75
Technician 6	87 %	93	75
Technician 7	86 %	95	75
Technician 8	86 %	102	75
Technician 9	88 %	107	75
Technician 10 – 3M	82 %	95	75
Technician 11 – 3M	83 %	97	75
Technician 12 – 3M	83 %	95	75
Average	**86 %**	**96**	**675**

Table 4. Third-party lab results for the 3M Petrifilm Aerobic Count Plate at high inoculum levels

Technician #	Average Time Savings	Average Colony Count	Total Number of Plates
Technician 1	94 %	286	75
Technician 2	94 %	295	75
Technician 3	94 %	312	75
Technician 4	94 %	171	75
Technician 5	94 %	157	75
Technician 6	92 %	168	75
Technician 7	94 %	202	75
Technician 8	93 %	215	75
Technician 9	94 %	222	75
Average	94 %	225	675

Table 5. Third-party lab results for the 3M Petrifilm Rapid Aerobic Count Plate at low inoculum levels

Technician #	Average Time Savings	Average Colony Count	Total Number of Plates
Technician 1	55 %	27	225
Technician 2	33 %	27	225
Technician 3	42 %	28	225
Technician 4	65 %	24	75
Technician 5	57 %	23	75
Technician 6	54 %	24	75
Technician 7	66 %	41	75
Technician 8	58 %	41	75
Technician 9	71 %	61	75
Average	56 %	33	1,125

Table 6. 3M and third-party results for the 3M Petrifilm Rapid Aerobic Count Plate at medium inoculum levels

Technician #	Average Time Savings	Average Colony Count	Total Number of Plates
Technician 4	867 %	90	75
Technician 5	86 %	84	75
Technician 6	85 %	89	75
Technician 7	83 %	92	75
Technician 8	79 %	95	75
Technician 9	85 %	99	75
Technician 10 – 3M	81 %	86	75
Technician 11 – 3M	83 %	89	75
Technician 12 – 3M	82 %	89	75
Average	83 %	90	675

Table 7. Third-party lab results for the 3M Petrifilm Rapid Aerobic Count Plate at high inoculum levels

Technician #	Average Time Savings	Average Colony Count	Total Number of Plates
Technician 1	92 %	250	75
Technician 2	91 %	260	75
Technician 3	91 %	268	75
Technician 4	91 %	148	75
Technician 5	93 %	138	75
Technician 6	89 %	156	75
Technician 7	91 %	219	75
Technician 8	90 %	202	75
Technician 9	93 %	209	75
Average	**91 %**	**206**	**675**

In addition, Table 8 shows the average time savings, average colony count and total number of plates using the 3M Petrifilm Plate Reader Advanced to count the 3M Petrifilm Aerobic Count Plate and the 3M Petrifilm Rapid Aerobic Count Plate across all inoculum levels.

Table 8. Average time savings using the 3M Petrifilm Plate Reader Advanced versus Manual Counting across all inoculum levels

3M Petrifilm Plate	Average Time Savings	Average Colony Count	Total Number of Plates
3M Petrifilm Aerobic Count Plate	81 %	118	2,475
3M Petrifilm Rapid Aerobic Count Plate	77 %	110	2,475

Discussion

The results for 3M Petrifilm Aerobic Count Plate and 3M Petrifilm Rapid Aerobic Count Plates demonstrate time savings, on average of 94% and 91%, respectively for plates with high inoculum levels. Even plates with low inoculum levels were counted in about half the time as a manual count using the 3M Petrifilm Plate Reader Advanced (See Table 9).

Table 9. Average time savings using the 3M Petrifilm Plate Reader Advanced

3M Petrifilm Plate	Average Time Savings		
	Low Level Inoculum Third-Party Results	Medium Level Inoculum 3M Results	High Level Inoculum Third-Party Results
3M Petrifilm Aerobic Count Plate	63 %	86 %	94 %
3M Petrifilm Rapid Aerobic Count Plate	56 %	83 %	91 %

Conclusion

Use of the 3M Petrifilm Plate Reader Advanced greatly reduced the amount of technician time required to count colonies on 3M Petrifilm Rapid Aerobic Count Plates and 3M Petrifilm Aerobic Count Plates.

Find more information online
www.3M.com/PetrifilmEnumeration

3M™ Petrifilm™ Plate Reader Advanced

The 3M™ Petrifilm™ Plate Reader Advanced provides results in 6 seconds or less and processes up to 900 plates per hour.

The system recognizes barcodes and allows users to determine the information to be captured by the software, such as sample ID, dilution level, food matrix, technician name, etc. In addition, the software automatically stores results, saving time and preventing transcription errors. The system also provides result trending and analysis.

The system enumerates 10 different 3M Petrifilm Plates, including the entire 3M Petrifilm Rapid Plate portfolio and the 3M™ Petrifilm™ Staph Express Disk:

- 3M™ Petrifilm™ Rapid Aerobic Count Plates
- 3M™ Petrifilm™ Rapid Coliform Count Plates
- 3M™ Petrifilm™ Rapid *E. coli*/Coliform Count Plates
- 3M™ Petrifilm™ Rapid Yeast and Mold Count Plates
- 3M™ Petrifilm™ Aerobic Count Plates
- 3M™ Petrifilm™ Coliform Count Plates
- 3M™ Petrifilm™ *Enterobacteriaceae* Count Plates
- 3M™ Petrifilm™ *E. coli*/Coliform Count Plates
- 3M™ Petrifilm™ Select *E. coli* Count Plates
- 3M™ Petrifilm™ *Staph* Express Count Plates and Disks

References and Resources:
1. M Raj, R Seamans (2018), The Economics of Artificial Intelligence. *Artificial Intelligence, Labor, Productivity, and the Need for Firm-Level Data.* National Bureau of Economic Research.
2. V Fotheringham (2006), Quality Control DPI. *A Comparison of Manual and Automated Colony Counting.*
3. 3M Technical Bulletin (2020), *Manual Microbial Interpretation vs. Automated Interpretation Using the 3M™ Petrifilm™ Plate Reader Advanced.*

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