



Final Report



PTP
No.0002

NFI-PTM 01-2026: Aerobic Plate Count (CFU/g)

in Freeze Dried Chicken

Issue Date 16 February 2026

Foundation for Industrial Development
National Food Institute



Proficiency Testing Report

Microbiological Analysis

NFI-PTM 01-2026: Aerobic Plate Count (CFU/g)

in Freeze Dried Chicken

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SUMMARY

The program summarizes the microbiological proficiency testing of NFI-PTM 01-2026: Aerobic Plate Count (CFU/g) in Freeze Dried Chicken. The test materials were quality-controlled to ensure consistent levels were achieved throughout the batch by conducting the homogeneity test before dispatch. Stability testing was performed at the end of shelf life, which was the deadline for all laboratories to run the test to ensure the integrity of the test materials.

This program had 99 participants assessed statistically in the form of the *Z-Score* for performance evaluation of each laboratory. The overall competency evaluation was that 90 laboratories (90.9%) had satisfactory performance with $|Z| \leq 2.00$, while 5 laboratories (5.1%) had questionable performance with $2.00 < |Z| < 3.00$, and 4 laboratories (4.0%) had unsatisfactory performance with $|Z| \geq 3.00$.

This proficiency testing program accomplished with smooth operation as expected, and every participating laboratory benefits and acquires valuable information for advancement, whatever the performance result is.

1. INTRODUCTION

1.1 Proficiency Testing

Proficiency testing (PT) is a valuable quality assurance tool for testing and measurement. Accreditation to ISO/IEC 17025 requires laboratories to participate in proficiency testing schemes. PT involves interlaboratory comparisons to determine laboratory performance to produce more reliable results. Whatever the performance result is, every participating laboratory benefits and acquires valuable information for further advancement in all degrees of its current performance.

For the improvement and satisfaction to the requirement of ISO/IEC 17025 of laboratories, hence the Division of Proficiency Testing Laboratory, Department of Laboratory Services, Foundation for Industrial Development National Food Institute (NFI) provides PT program to follow the international standard ISO/IEC 17043: 2023, Conformity Assessment – General Requirements for the Competence of Proficiency Testing Providers. This program was named “Microbiological Analysis NFI-PTM 01-2026: Aerobic Plate Count (CFU/g) in Freeze Dried Chicken” with a focus on aerobic plate count since it is one of the most common tests.

To ensure performance confidentiality of all participants, the Laboratory Number is used in place of participant’s name. A unique Laboratory Number is assigned to each laboratory.

NFI offers Internet access for proficiency testing at ‘<https://pt.nfi.or.th>’ for fast, convenient, and easy access for participants to register, submit forms for received samples / data / test results / test method / other information, view and communicate with the provider. All participants are encouraged to utilize all online features and more for complete and obvious action for their own advantage.

1.2 Aerobic Plate Count

Enumeration of microorganisms by Aerobic plate count (APC) is one of the most common methods to indicate microbiological quality in food with the commonly practiced conditions: 30 - 35 °C and 48 - 72 hours for incubation. The aerobic plate count is also called the total plate count (TPC), standard plate count (SPC), total viable count (TVC), or mesophilic aerobic count, represents the number of colony forming units (CFU) per g (or per mL) of growing microorganisms such as bacteria, yeast, and mold on a non-specific solid bacteriological growth medium under the specified conditions. Temperature, incubating time, medium type, and any other conditions used in the enumeration vary on reference standards and laboratory objectives. Laboratories participating in the program choose their routine conditions.

2. TEST MATERIALS

2.1 Sample Preparation

The overall duration of sample preparation was between 11 to 23 December 2025, starting with the bulk of test materials by using diced, skinless, fat-free chicken breasts, blending them into small pieces, and freeze-drying. After that, blending the dried chicken, sifting it through 200 and 400 μm sieves to recover dried chicken of size between 200-400 μm , and thoroughly mixing it. Then, 2.00 grams of the chicken powder was weighed into the tight-sealing-cap plastic tubes. Each was labeled with an ID number and stored at 2-8°C to use for the homogeneity test, stability test, and further steps. In the enumeration calculation, the test material weight of 2.00 grams was equivalent to 10.00 grams of the initial chicken weight.

2.2 Homogeneity

To insure that consistent levels of organisms were achieved throughout the batch of test materials, the homogeneity test was conducted on 24 December 2025. The random number generator from the website 'random.org' was used to randomize the order of the samples. Ten out of all the plastic tubes were randomly picked for homogeneity test by carrying out enumeration of aerobic plate count (CFU/g) in duplicate prior to dispatch of the sample.

2.3 Stability

To ensure the constancy of the test, materials not being diminished over time and the transport effect, stability testing was conducted at the end of shelf life. Therefore, five samples of the test materials at NFI were packaged using the same types of materials (boxes, ice packs, etc.) and conditions (temperature, length of time, etc.) as those delivered, leaving the selected-random sample in the box for 24 hours, and then keeping at 2-8°C until the final test or after this date. On 13 January 2026, the test materials were examined in duplicate for enumeration of aerobic plate count (CFU/g).

The work on homogeneity and stability tests was conducted by the external service provider – Division of Microbiological Laboratory, Foundation for Industrial Development National Food Institute (ISO/IEC 17025: 2017: DMSc Acc. No. 1005/42) which using the FDA-BAM standard method according to Chapter 3, 2001. The homogeneity and stability data were shown in Table 3 in the Appendix.

2.4 Sample Distribution

Upon completion of homogeneity test, foam boxes of test materials with ice packs, and documents were dispatched on 6 January 2026 to each participant by an Inter Express Logistics Company with 24-hour guaranteed delivery. Documents enclosed in the box were as follows:

- 1) Letter of Introduction
- 2) Test Instruction Sheet
- 3) Receipt Form
- 4) Results Form
- 5) Technical Form

Note:

- Filling online preferred for 3), 4) and 5).
- Using test methods (materials, procedures, conditions, etc.) consistent with each laboratory routine practice.
- One plastic tube of test material delivered for each participant.

Participants were required to report and submit their result of the test material in CFU/g by the date of deadline report – “21 January 2026”.

3. REPORTING

The participating laboratory finished testing PT samples and submitted the test results by the date of deadline report through the online system to the PT provider to gather information for the summary report, statistical analysis of participants' results, homogeneity test, stability test, and others carried out according to the standard ISO 13528: 2022.

The statistics summarized are given in Table 1, and Table 2 summarizes the participants' results. Technical data of methods used by each laboratory about accreditation, reference, and others are summarized in Table 4 in the Appendix.

4. STATISTICAL EVALUATION OF RESULTS

Statistical use for this proficiency testing program is the *Z-Score*, which is based on ISO 13528: 2022.

4.1 Calculation of the assigned value (x_{pt}), kernel density plot, and standard uncertainty of the assigned value ($u(x_{pt})$)

4.1.1 Assigned value, x_{pt} (assigned value for proficiency assessment), was set as the consensus of the results submitted by participants. The procedure used to derive this consensus involved the following:

4.1.1.1 Check whether the data have reported as “Not Submitted” and, or “0” and, or values marked with mathematical symbols $>$ or $<$ and, or values classified as Blunder or not. Delete such values first and take the data for statistical evaluation.

4.1.1.2 The participants’ results transform from CFU/g to $\log_{10}$ CFU/g.

4.1.1.3 Arrange the test results from lowest to highest values and create the kernel density of the original and fixed bandwidth plotted from all participants’ results shows a smooth curve and the unimodal mode, indicating that the different participant methods do not effect the performance evaluation.

4.1.1.4 Derivation of the robust mean (x^*) of the final data set using a robust statistical procedure that calculate by Algorithm A.

4.1.2 Assessment of the standard uncertainty of the assigned value, $u(x_{pt})$

$$u(x_{pt}) = 1.25 \times \frac{s^*}{\sqrt{p}} \dots\dots\dots(1)$$

Where s^* is the robust standard deviation calculated by Algorithm A

and p is number of result.

When the assigned value is calculated from the consensus value of the participants’ results, the standard uncertainty $u(x_{pt})$ of the assigned value is calculated according to equation (1). The standard uncertainty of the assigned value is usually compared with a criterion (2), that $u(x_{pt})$ shall be smaller than $0.3\sigma_{pt}$, then the uncertainty of the assigned value is negligible and need not be included in the interpretation of the results of the proficiency test.

$$u(x_{pt}) < 0.3\sigma_{pt} \dots\dots\dots(2)$$

4.2 Standard deviation for proficiency assessment, σ_{pt}

The standard deviation for proficiency assessment used here has been estimated from the previous standard deviation of NFI-PT microbiological enumeration program (CFU/g) and the technical and statistical experts have agreed that an appropriate value is $0.3 \log_{10} \text{CFU/g}$. This value for σ_{pt} has been used to calculate *Z-Score* in this assessment.

4.3 Calculation of the *Z-Score*

The *Z-Score* for a proficiency test result is calculated as follows *Z-Score* equation (3)

$$Z\text{-Score} = \frac{(X_i - X_{pt})}{\sigma_{pt}} \dots\dots\dots(3)$$

Where X_i is the participant's reported result,

X_{pt} is the assigned value

and σ_{pt} is the standard deviation for proficiency assessment.

4.4 *Z-Score* assessment criteria

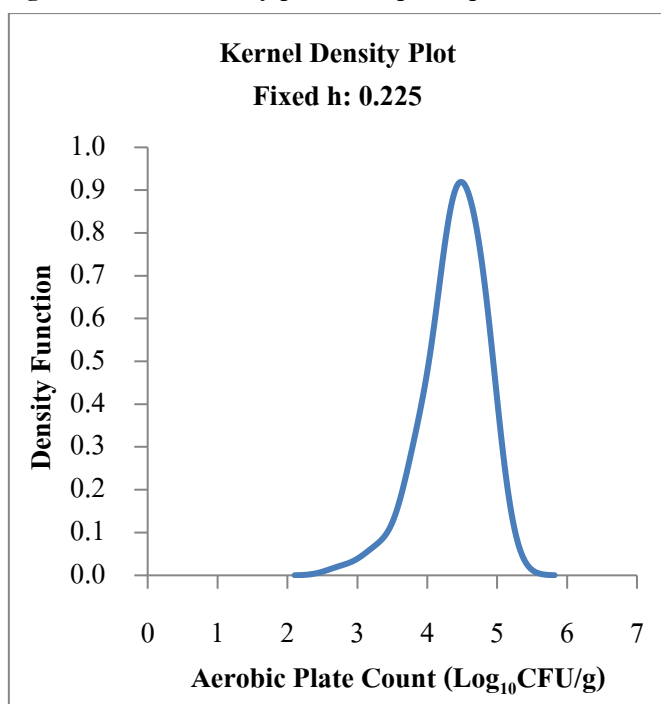
$|Z| \leq 2.00$ is Satisfactory

$2.00 < |Z| < 3.00$ is Questionable

$|Z| \geq 3.00$ is Unsatisfactory

5. RESULTS

Figure 1 Kernel density plot of all participant results



Note: The Kernel Density Plot of 99 participants in the program is displayed in one mode, indicating that the different measurement or test methods used by the participants did not affect the distribution of the data and the participant performance evaluation.

Table 1 Statistic summary

Statistic Data					Standard Deviation for Proficiency Assessment		
Number of Result	Assigned Value, $x_{pt}(\log_{10}\text{CFU/g})$	Robust Standard Deviation, s^*	Standard Uncertainty, $u(x_{pt})$	Coefficient of Variation, (%CV)	Derived from	σ_{pt}	$0.3\sigma_{pt}$
99	4.413	0.391	0.049	8.9	Retrospective Data	0.3	0.090
Conclusion: $u(x_{pt}) < 0.3\sigma_{pt}$; the performance evaluation uses the Z-Score.							

Table 2 Result summary of participants' *Z-Score* for aerobic plate count (CFU/g) in freeze dried chicken

Laboratory Number	Result CFU/g	Result Log ₁₀ CFU/g	<i>Z-Score</i>
1	13300	4.124	-0.96
2	60,000	4.778	1.22
3	17000	4.230	-0.61
4	53000	4.724	1.04
5	47000	4.672	0.86
6	54000	4.732	1.06
7	22000	4.342	-0.24
8	80,000	4.903	1.63
9	31,000	4.491	0.26
10	3800	3.580	-2.78
11	40000	4.602	0.63
12	9533	3.979	-1.45
13	7200	3.857	-1.85
14	18000	4.255	-0.53
15	8500	3.929	-1.61
16	43,000	4.633	0.73
17	66,000	4.820	1.36
18	30,000	4.477	0.21
19	23000	4.362	-0.17
20	58,000	4.763	1.17
21	49000	4.690	0.92
22	20,000	4.301	-0.37
23	71,000	4.851	1.46

Note: *Z-Score* values outside the satisfactory range are shown in bold.

Table 2 Result summary of participants' *Z-Score* for aerobic plate count (CFU/g) in freeze dried chicken (continued)

Laboratory Number	Result CFU/g	Result Log ₁₀ CFU/g	<i>Z-Score</i>
24	6,900	3.839	-1.91
25	52,000	4.716	1.01
26	28500	4.455	0.14
27	59000	4.771	1.19
28	26,000	4.415	0.01
29	36,000	4.556	0.48
30	90000	4.954	1.80
31	65,000	4.813	1.33
32	55200	4.742	1.10
33	42,800	4.631	0.73
34	11100	4.045	-1.23
35	24200	4.384	-0.10
36	90,000	4.954	1.80
37	48000	4.681	0.89
38	13,000	4.114	-1.00
39	7,000	3.845	-1.89
40	7,800	3.892	-1.74
41	6700	3.826	-1.96
42	14900	4.173	-0.80
43	80500	4.906	1.64
44	25000	4.398	-0.05
45	22400	4.350	-0.21

Note: *Z-Score* values outside the satisfactory range are shown in bold.

Table 2 Result summary of participants' *Z-Score* for aerobic plate count (CFU/g) in freeze dried chicken (continued)

Laboratory Number	Result CFU/g	Result Log ₁₀ CFU/g	<i>Z-Score</i>
46	55,795	4.747	1.11
47	140,000	5.146	2.44
48	19000	4.279	-0.45
49	1,600	3.204	-4.03
50	29000	4.462	0.16
51	73,000	4.863	1.50
52	67,000	4.826	1.38
53	27500	4.439	0.09
54	18400	4.265	-0.49
55	18,000	4.255	-0.53
56	27,000	4.431	0.06
57	2,000	3.301	-3.71
58	29,300	4.467	0.18
59	24600	4.391	-0.07
60	28000	4.447	0.11
61	38,000	4.580	0.56
62	27000	4.431	0.06
63	84,000	4.924	1.70
64	33,000	4.519	0.35
65	74000	4.869	1.52
66	20,000	4.301	-0.37
67	25,000	4.398	-0.05

Note: *Z-Score* values outside the satisfactory range are shown in bold.

Table 2 Result summary of participants' *Z-Score* for aerobic plate count (CFU/g) in freeze dried chicken (continued)

Laboratory Number	Result CFU/g	Result Log ₁₀ CFU/g	<i>Z-Score</i>
68	9000	3.954	-1.53
69	20000	4.301	-0.37
70	19,000	4.279	-0.45
71	75,000	4.875	1.54
72	62000	4.792	1.26
73	84,000	4.924	1.70
74	20,000	4.301	-0.37
75	7,300	3.863	-1.83
76	32,000	4.505	0.31
77	18000	4.255	-0.53
78	25,000	4.398	-0.05
79	28,000	4.447	0.11
80	17,500	4.243	-0.57
81	10,000	4.000	-1.38
82	57000	4.756	1.14
83	5,000	3.699	-2.38
84	35000	4.544	0.44
85	37,000	4.568	0.52
86	1,970	3.294	-3.73
87	21000	4.322	-0.30
88	23,000	4.362	-0.17
89	70,000	4.845	1.44

Note: *Z-Score* values outside the satisfactory range are shown in bold.

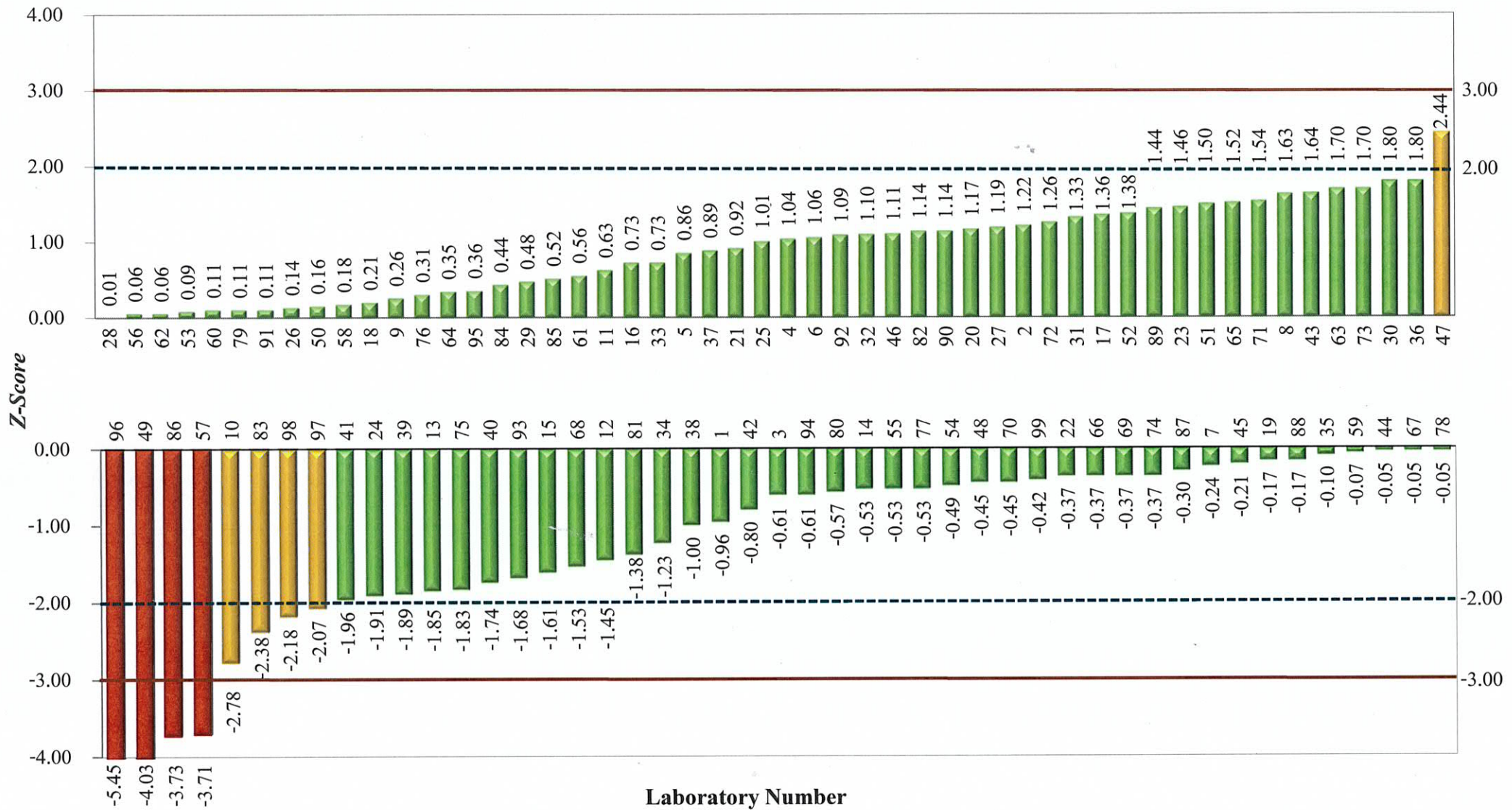
Table 2 Result summary of participants' *Z-Score* for aerobic plate count (CFU/g) in freeze dried chicken (continued)

Laboratory Number	Result	Result	<i>Z-Score</i>
	CFU/g	Log ₁₀ CFU/g	
90	57,000	4.756	1.14
91	28,000	4.447	0.11
92	55,000	4.740	1.09
93	8,100	3.908	-1.68
94	17,000	4.230	-0.61
95	33,200	4.521	0.36
96	600	2.778	-5.45
97	6,200	3.792	-2.07
98	5750	3.760	-2.18
99	19300	4.286	-0.42

Note: *Z-Score* values outside the satisfactory range are shown in bold.

Figure 2 Z-Score values for aerobic plate count (CFU/g) in freeze dried chicken

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Note: The range of Z-Score values between 0.01 to 2.44 and -0.05 to -5.45

6. METROLOGICAL TRACEABILITY

The PT provider requires participants to report their test results in CFU/g. In this program, the metrological traceability to the measurement and the uncertainty of the assigned value (X_{pt}) is not applicable because the X_{pt} is calculated from the consensus value of the participant's results, which use different test methods. The matrix of this PT sample was prepared by the freeze dried chicken, which is natural contaminated with microorganisms.

7. TECHNICAL COMMENTS

Participant's Laboratories No. 10, 47, 83, 97, and 98 having questionable, while Laboratories No. 49, 57, 86, and 96 having unsatisfactory performance are recommended to find the cause of their errors and correct them. For this proficiency testing program, there are three main viewpoints to be considered by those in need of improvement:

7.1 Analytical technique

The laboratory must be careful with all details in the testing process, such as verifying the volume of the diluent before using serial dilution, using filter bag, transferring the sample to growth media, counting the colonies (Be cautious about the appearance of colonies that similar to the sample, and the laboratory should count colonies by the colony counter.), incubation temperature and time are critical. Contamination prevention is the highest priority, and aseptic techniques must be utilized in all testing procedures. Furthermore, the laboratory should prepare the sample following the PT provider's instruction document. By taking these instructions, the laboratory can ensure the reliability and accuracy of the test results, providing the best possible outcomes for participants.

7.2 Sample mixing

Mixing is the significant step used to spread the microorganism evenly. The PT sample dissolved in the buffer has turbidity; be careful when transferring it by pipette to the dilution, as it affects microorganisms' enumeration. If the laboratory is not careful in this step, the quantity of microorganisms will incur either less or more than the actual quantity.

7.3 Reporting, calculation of the test result, and the data transfer

The laboratories must carefully calculate the test result, e.g., multiplication of the dilution and checking the data transfer before reporting.

NFI is pleased to provide further details and welcomes any discussion regarding the proficiency testing.

8. CONTACT DETAILS

8.1 Any Question and Complaint

Upon receiving the final report, if there is any questions or complaints regarding the proficiency testing assessment incurred, the participant can contact the program coordinator through the following channels:

Miss Thatsanee Kansan (Program coordinator)
Division of Proficiency Testing Laboratory,
Department of Laboratory Services,
Foundation for Industrial Development National Food Institute,
2008 Soi 36, Arun Amarin Rd., Bang Yi Khan, Bang Phlat, Bangkok
10700 THAILAND.

Tel: +66(0) 2422-8688 Ext. 5600-5604

E-mail: pt@nfi.or.th

Website: <https://pt.nfi.or.th>

8.2 Appeal

Upon receiving the final report, if there is an appeal regarding the proficiency testing assessment incurred, written notification should be submitted to the President of the Foundation for Industrial Development National Food Institute (NFI) within thirty days by the following channel:

President of Foundation for Industrial Development National Food Institute,
2008 Soi 36, Arun Amarin Rd., Bang Yi Khan, Bang Phlat, Bangkok
10700 THAILAND.

9. APPENDIX

Table 3 Homogeneity and stability data

Aerobic Plate Count ($\log_{10}$ CFU/g)					
Sample No.	Homogeneity (y_1)		Sample No.	Stability (y_2)	
	Replicate 1	Replicate 2		Replicate 1	Replicate 2
1	4.591	4.505	1	4.857	4.792
2	4.699	4.833	2	4.851	4.857
3	4.633	4.748	3	4.732	4.681
4	4.699	4.672	4	4.863	4.820
5	4.845	4.820	5	4.623	4.748
6	4.699	4.806	-	-	-
7	4.771	4.857	-	-	-
8	4.763	4.820	-	-	-
9	4.699	4.806	-	-	-
10	4.681	4.568	-	-	-
mean	4.726			4.782	
S_s	0.076			-	
$ \bar{y}_1 - \bar{y}_2 $	-			0.056	
σ_{pt}			0.3		
$0.3\sigma_{pt}$			0.090		
$S_s \leq 0.3\sigma_{pt}$	Adequately Homogeneous			-	
$ \bar{y}_1 - \bar{y}_2 \leq 0.3\sigma_{pt}$	-			Adequately Stable	

Table 4 Technical information in relation to the methods

Test Method Accredited by ISO/IEC 17025	Laboratory Number
Accredited	1 2 13 15 17 19 20 32 36 38 39 40 43 46 51 55 61 62 65 67 69 70 71 73 76 79 81 83 84 87 89 90 92 93 95 97
Not Accredited	3 4 5 6 7 8 9 10 11 12 14 16 18 21 22 23 24 25 26 27 28 29 30 31 33 34 35 37 41 42 44 45 47 48 49 50 52 53 54 56 57 58 59 60 63 64 66 68 72 74 75 77 78 80 82 85 86 88 91 94 96 98 99
Reference Method	Laboratory Number
AFNOR Validated Methods No. 3M 01/01-09/89	8 74
AOAC 990.12	1 2 3 6 7 9 11 23 29 31 32 35 39 40 46 49 50 53 54 60 61 64 68 78 79 83 84 87 88 89 93 94 99
AOAC RI Certificate No. 010401	86
AOAC RI Certificate No. 010404	12
AOAC RI Certificate No. 121204	16 41
Compendium of Methods for the Microbiological Examination of Foods (APHA) Chapter 8	62 70
FDA-BAM Chapter 3	4 5 10 13 14 15 17 19 20 21 22 24 25 26 27 30 33 34 37 38 42 43 44 45 47 48 51 55 57 58 63 65 66 67 69 72 75 76 77 80 81 82 85 90 91 92 96 97 98
ISO 4833-1	36 52 59 73 95
JETRO	71
JETRO, MHLW	56
MicroVal Certificate No.: 2007LR01	28
USP 47	18

Table 4 Technical information in relation to the methods (continued)

Sample Preparation by using the Filter Bag	Laboratory Number
Used	1 10 13 23 27 29 32 38 39 40 41 43 54 59 65 70 76 83 85 86 87 92 93 95
Unused	2 3 4 5 6 7 8 9 11 12 14 15 16 17 18 19 20 21 22 24 25 26 28 30 31 33 34 35 36 37 42 44 45 46 47 48 49 50 51 52 53 55 56 57 58 60 61 62 63 64 66 67 68 69 71 72 73 74 75 77 78 79 80 81 82 84 88 89 90 91 94 96 97 98 99
Media: Growth Media	Laboratory Number
Compact Dry TC	12 26 28 58 64 80 86
Petrifilm	1 2 3 6 7 8 9 11 23 29 31 32 35 39 40 46 49 50 53 54 60 61 68 74 78 79 83 84 87 88 89 93 94 99
Plate Count Agar	4 5 10 13 14 15 17 19 20 21 22 24 25 27 30 33 34 36 37 38 42 43 44 45 47 48 51 52 55 56 57 59 62 63 65 66 67 69 70 71 72 73 75 76 77 81 82 85 90 91 92 95 96 97 98
Soybean-Casein Digest Agar (TSA)	18
TEMPO [®] AC	16 41

Table 4 Technical information in relation to the methods (continued)

Incubation Temperature (°C)	Laboratory Number
30	8 28 36 52 59 73 74 95
35	1 2 3 4 5 6 7 9 10 11 13 14 15 16 17 18 20 21 22 23 24 25 26 27 29 30 31 32 33 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 53 54 55 56 57 58 60 61 62 63 64 65 67 68 69 70 71 72 75 76 77 78 79 80 81 82 83 84 85 86 87 89 90 91 92 93 94 96 97 98
36	12
37	19 34 66 88 99
Incubation Time (Hrs.)	Laboratory Number
24	16 26 41 56 71
48	1 2 3 4 5 6 7 9 10 11 12 13 14 15 17 19 20 21 22 23 24 25 27 28 29 30 31 32 33 34 35 37 38 39 40 42 43 44 45 46 47 48 49 50 51 53 54 55 57 58 60 61 62 63 64 65 67 68 69 70 72 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 96 97 98 99
72	8 18 36 52 59 66 73 74 95

10. REFERENCES

ISO/IEC 17043: 2023. Conformity assessment – General requirements for the competence of proficiency testing providers.

ISO 13528: 2022. Statistical methods for use in proficiency testing by interlaboratory comparison.

Maturin, L. (ret.) and J.T. Peeler (ret.). 1998. Chapter 3 – Aerobic Plate Count, *in the* Bacteriological Analytical Manual – *Online* (January 2001), Food and Drug Administration.

<https://www.fda.gov/food/laboratory-methods-food/bam-chapter-3-aerobic-plate-count> (February 2026).

COMMITTEE**Program Coordinator**

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| 1. Miss Tanaporn Borisut | Manager, Division of Proficiency Testing Laboratory
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| 2. Miss Kuntida Duangsee | Specialist, Division of Proficiency Testing Laboratory |
| 3. Miss Thatsanee Kansan | Analyst, Division of Proficiency Testing Laboratory |
| 4. Miss Waranya Ngamphakwaen | Scientist, Division of Proficiency Testing Laboratory |
| 5. Miss Ariya Nontajak | Scientist, Division of Proficiency Testing Laboratory |

Proficiency Testing Provider Accreditation

ISO/IEC 17043: 2023: BLA-DSS Acc. No. PTP-0002

Approved by


(Ms. Tanaporn Borisut)

Technical Manager

16 February 2026



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