



Final Report



PTP
No.0002

NFI-PTC 01-2026: NaCl (g/100g) in Food

(Tuna in Brine)

Issue Date 13 February 2026

Foundation for Industrial Development
National Food Institute



Proficiency Testing Report

Chemical Analysis

NFI-PTC 01-2026: NaCl (g/100g) in Food

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SUMMARY

The program summarizes the chemical proficiency testing of NFI-PTC 01-2026: NaCl (g/100g) in Food (Tuna in Brine). 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.

The participant's results were 70 laboratories which 69 laboratories were calculated by Algorithm A because one blunder data were removed from data analysis. The results were assessed statistically in the form of the *Z-Score* for performance evaluation for each laboratory. The overall competency evaluation was that there were 55 laboratories (78.6%) had satisfactory performance with $|Z| \leq 2.00$, while 8 laboratories (11.4%) had questionable performance with $2.00 < |Z| < 3.00$, and 7 laboratories (10.0%) 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 “Chemical Analysis NFI-PTC 01-2026: NaCl (g/100g) in Food (Tuna in Brine)” with a focus on %NaCl since it is one of the most common tests for food products in brine.

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 NaCl

Sodium chloride is a compound formed from the ionic bonding of sodium and chloride that the result is a salt that is very important biologically and commercially. The chemical formula for sodium chloride is NaCl that has a molar mass of 58.44 grams per mole. It appears as a solid, clear crystal with little or no odor. As a salt, sodium chloride dissolves well in water, and the ions in the crystals will separate when in solution.

2. TEST MATERIALS

2.1 Sample Preparation

Test materials were produced by blending tuna in brine. Twenty grams of the test materials were placed in plastic tube, and tightly sealed with cap. The sample was prepared on 12 December 2025. Each was labeled with ID numbers and stored at below -18°C to use for homogeneity test, stability test, and further steps.

2.2 Homogeneity

To insure that consistent levels of %NaCl was achieved throughout the batch of test materials, the homogeneity test was conducted on 15 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 NaCl (g/100g) 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, four 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 below -18°C until the final test or after this date. On 19 January 2026, the test materials were examined in duplicate for NaCl (g/100g).

The work on homogeneity and stability tests was conducted by the external service provider - Division of Chemical Laboratory, Foundation for Industrial Development National Food Institute (ISO/IEC 17025: 2017: DMSc Acc. No. 1005/42) which using the AOAC official method according to No. 937.09, 2023. 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 5 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 results of the test material in g/100g by the date of deadline report – “19 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 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.

4.1.1.3 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 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 Calculation of standard deviation for proficiency assessment, σ_{pt}

The standard deviation for proficiency assessment used in this proficiency testing program was obtained by calculating from *RSD pooled* of the competent laboratory from previous rounds (over 5 years) of the same proficiency testing schemes.

Pooled standard deviation is the standard deviation remaining after removing the effect of special cause variation as calculated by equation (3).

$$RSD_{pooled} = \frac{\sqrt{(n_1-1)RSD_1^2 + (n_2-1)RSD_2^2 + \dots + (n_k-1)RSD_k^2}}{n_1 + n_2 + \dots + n_k - k} \dots\dots\dots(3)$$

Where k is number of Proficiency Testing Rounds
 $RSD_1, RSD_2, \dots, RSD_k$ is relative standard deviations of competent laboratory ($Z\text{-Score} \leq 2.00$) from each Proficiency Testing Rounds
 and $n_1, n_2, \dots, n_k$ is numbers of competent laboratory ($Z\text{-Score} \leq 2.00$) from each Proficiency Testing Rounds

This *Pooled RSD* is applied to σ_{pt} , which are calculated by equation (4)

$$\sigma_{pt} = \frac{(\%Pooled\ RSD) \times (x_{pt})}{100} \dots\dots\dots(4)$$

4.3 Calculation of the Z-Score

The *Z-Score* for a proficiency test result is calculated as follows *Z-Score* equation (5)

$$Z\text{-Score} = \frac{(x_i - x_{pt})}{\sigma_{pt}} \dots\dots\dots(5)$$

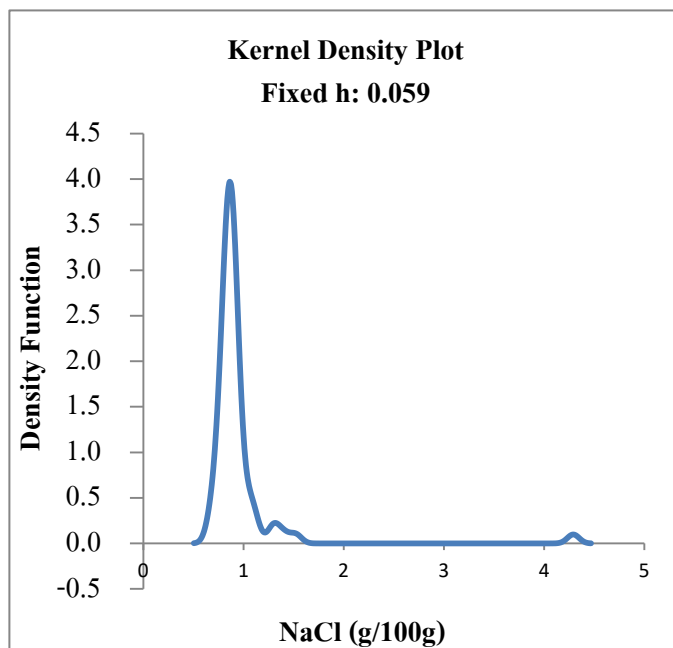
Where x_i is the participant's reported result,
 x_{pt} is the assigned value
 and σ_{pt} is the standard deviation for proficiency assessment

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 69 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} (g/100g)	Robust Standard Deviation, s^*	Standard Uncertainty, $u(x_{pt})$	Coefficient of Variation, (%CV)	Derived from	σ_{pt}	$0.3\sigma_{pt}$
69	0.88	0.087	0.013	9.9	9% (RSD Pooled)	0.079	0.024
Conclusion: $u(x_{pt}) < 0.3\sigma_{pt}$; the performance evaluation uses the Z-Score.							

Note: σ_{pt} derived from 9% Pooled RSD ; $\sigma_{pt} = \frac{9 \times (x_{pt})}{100}$

Where x_{pt} is the assigned value

Table 2 Result summary of participants' *Z-Score* for NaCl (g/100g) in food (tuna in brine)

Laboratory Number	Result (g/100g)	<i>Z-Score</i>
1	0.94	0.76
2	1.12	3.04
3	0.84	-0.51
4	0.82	-0.76
5	1.07	2.41
6	0.85	-0.38
7	0.83	-0.63
8	4.29	43.16
9	1.40	6.58
10	0.84	-0.51
11	0.88	0.00
12	0.88	0.00
13	0.94	0.76
14	0.80	-1.01
15	0.72	-2.03
16	0.95	0.89
17	0.84	-0.51
18	0.86	-0.25
19	0.80	-1.01
20	0.94	0.76
21	1.30	5.32
22	0.98	1.27
23	0.79	-1.14

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

Table 2 Result summary of participants' *Z-Score* for NaCl (g/100g) in food (tuna in brine) (continued)

Laboratory Number	Result (g/100g)	<i>Z-Score</i>
24	0.84	-0.51
25	0.90	0.25
26	0.88	0.00
27	0.78	-1.27
28	1.52	8.10
29	0.87	-0.13
30	0.89	0.13
31	0.88	0.00
32	9.20 [*]	105.32
33	0.71	-2.15
34	0.87	-0.13
35	0.85	-0.38
36	0.86	-0.25
37	0.80	-1.01
38	0.79	-1.14
39	0.78	-1.27
40	0.91	0.38
41	0.96	1.01
42	0.88	0.00
43	0.88	0.00
44	0.86	-0.25
45	0.91	0.38
46	0.91	0.38
47	1.30	5.32

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

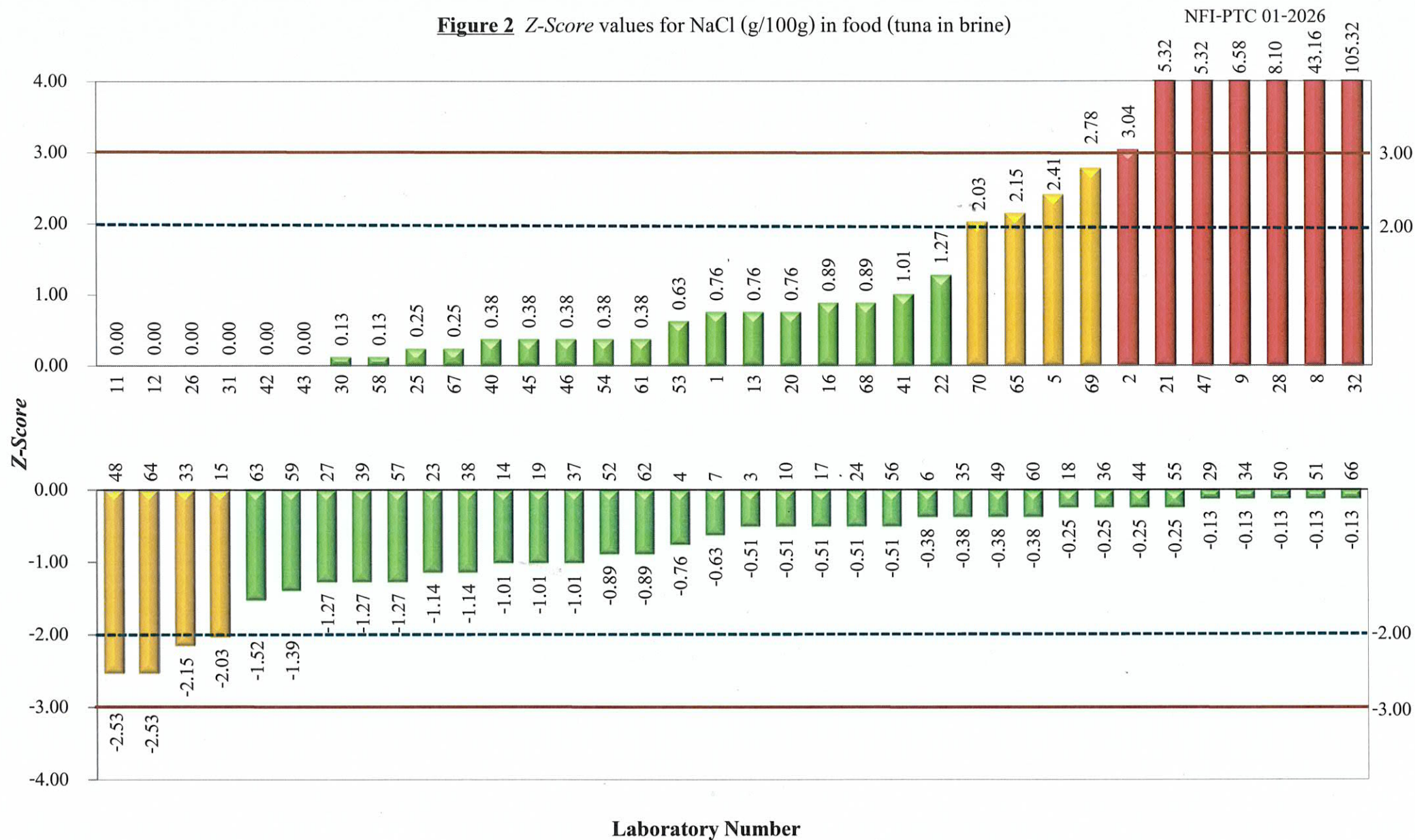
* Laboratory No. 32: the result is a blunder.

Table 2 Result summary of participants' *Z-Score* for NaCl (g/100g) in food (tuna in brine) (continued)

Laboratory Number	Result (g/100g)	<i>Z-Score</i>
48	0.68	-2.53
49	0.85	-0.38
50	0.87	-0.13
51	0.87	-0.13
52	0.81	-0.89
53	0.93	0.63
54	0.91	0.38
55	0.86	-0.25
56	0.84	-0.51
57	0.78	-1.27
58	0.89	0.13
59	0.77	-1.39
60	0.85	-0.38
61	0.91	0.38
62	0.81	-0.89
63	0.76	-1.52
64	0.68	-2.53
65	1.05	2.15
66	0.87	-0.13
67	0.90	0.25
68	0.95	0.89
69	1.10	2.78
70	1.04	2.03

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

Figure 2 Z-Score values for NaCl (g/100g) in food (tuna in brine)



Note: The range of Z-Score values between 0.00 to 105.32 and -0.13 to -2.53

6. METROLOGICAL TRACEABILITY

The PT provider requires participants to report their test results in g/100g. 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.

7. TECHNICAL COMMENTS

The result reported by Laboratory No. 19 was identified as a blunder based on statistical evaluation. The value was excluded from the calculation of the assigned value and performance statistics in accordance with the PT scheme procedures. Consequently, it did not influence the consensus value or the overall performance assessment of participating laboratories. The participant's Laboratories No. 5, 15, 33, 48, 64, 65, 69 and 70 having questionable, while Laboratories No. 2, 8, 9, 21, 28, 32 and 47 having unsatisfactory performance are recommended to find the cause of their errors, and correct them. Their consideration should be quality control to check the accuracy of the test result. It is always advisable to do sample replication and have the control sample in all tests.

The laboratory that used manual titration should examine its titration closely, especially regarding the following points: titration reagent concentration, endpoint reading, and burettere solution selection. Moreover, the laboratory shall add 0.1 M AgNO_3 in the PT sample, which is more than enough to precipitate all Cl^- as AgCl . The titration with 0.1 M NH_4SCN shall be titrated until it becomes permanently light brown. Additionally, it is recommended to use a burette with a clear schellbach strip or an automatic burette for clear reading at the meniscus.

The laboratory that used the auto titration technique for this program should check % recovery and use CRM for quality control. The electrode of the auto titrator may not only measure Cl^- but also other interfering material that affects NaCl value more than the manual titration technique. Thus, laboratories that use auto-titration techniques have to make standard additions. Moreover, the laboratories should ensure that using sodium analyses to confirm the salt and sodium levels, not chloride levels.

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 Kuntida Duangsee (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

NaCl (g/100g)					
Sample No.	Homogeneity (y_1)		Sample No.	Stability (y_2)	
	Replicate 1	Replicate 2		Replicate 1	Replicate 2
1	0.91	0.89	1	0.91	0.89
2	0.91	0.89	2	0.89	0.91
3	0.92	0.92	3	0.91	0.90
4	0.89	0.92	4	0.88	0.89
5	0.92	0.91	-	-	-
6	0.89	0.91	-	-	-
7	0.91	0.92	-	-	-
8	0.90	0.91	-	-	-
9	0.92	0.91	-	-	-
10	0.89	0.88	-	-	-
mean	0.91			0.90	
S_s	0.008(0.9% <i>RSD</i>)			-	
$ \bar{y}_1 - \bar{y}_2 $	-			0.01	
σ_{pt}				0.079 (9% <i>RSD</i>)	
$0.3\sigma_{pt}$				0.024	
$S_s \leq 0.3\sigma_{pt}$	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	3 4 24 27 35 41 51 58 61 62 63 65 66
Not Accredited	1 2 5 6 7 8 9 10 11 12 13 14 15 16 17
	18 19 20 21 22 23 25 26 28 29 30 31
	32 33 34 36 37 38 39 40 42 43 44 45
	46 47 48 49 50 52 53 54 55 56 57 59
	60 64 67 68 69 70
Reference Method	Laboratory Number
AOAC 935.47 (2023)	3
AOAC 937.09	2 4 5 15 19 23 24 27 28 29 33 35 46
	49 50 51 52 54 57 59 63 64 65 66 68
	70
AOAC 960.29	55
AOAC 971.27 (2016), Chapter 42 (Page 7-8)	25
Auto Titrator	1 6 7 10 11 12 14 16 17 18 20 26 30
	31 34 36 37 38 39 40 41 42 43 44 45
	56 60 62
Customer Method	13
In-House Method based on AOAC 971.27 (2023)	58
In-House Method: W-QA-025 based on AOAC Official	61
Method of Analysis, 22 nd ed., 2023, Method 983.14	
Modified from AOAC 937.09, 16 th Edition, Revised 4 (1998)	48
Mohr's Method	8 22 53
“Pocket” Salt Meter	47 67 69
Refractive Index	32
Salt Meter	9 21

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

Sample Weight (g)	Laboratory Number
0.01-1.00	6 8 10 18 22 28 32 34 40 45 47 54 60 65
1.00	41
1.00-1.09	42
1.00-2.00	48
1.01-2.00	1 5 7 11 14 16 17 26 30 36 37 38 39 43 46 58 61 62
2.01-3.00	2 3 12 19 20 23 25 31 44 57 63 70
3.01-4.00	15 51 66
4.01-5.00	9 24 27 50 53 55 64
5.01-6.00	29 52 56
>6.00	4 33 59 67
9.98-10.02	21
10.00	13 35 49 68 69
Titration Reagents	Laboratory Number
Ammonium Thiocyanate	3 4 5 15 23 24 27 35 48 49 51 52 57 59 63 64 65
Potassium Thiocyanate	19
Silver Nitrate	1 2 6 7 8 10 11 12 13 14 16 17 18 20 22 25 26 28 29 30 31 33 34 36 37 38 39 40 41 42 43 44 45 46 50 53 54 55 56 58 60 61 62 66 68 70
Unused	9 21 32 47 67 69
Titration Technique	Laboratory Number
Auto Titration	1 6 7 10 11 12 14 16 17 18 20 25 26 30 31 34 36 37 38 39 40 41 42 43 44 45 51 54 56 58 60 61 62
Manual Titration	2 3 4 5 8 13 15 19 22 23 24 27 28 29 33 35 46 48 49 50 52 53 55 57 59 63 64 65 66 68 70
Unused	9 21 32 47 67 69

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

Quality Control: CRM	Laboratory Number
Yes	1 2 4 6 10 13 19 20 24 26 32 36 38 41 44 46 51 54 58 61
No	3 5 7 8 9 11 12 14 15 16 17 18 21 22 23 25 27 28 29 30 31 33 34 35 37 39 40 42 43 45 47 48 49 50 52 53 55 56 57 59 60 62 63 64 65 66 67 68 69 70
Quality Control: Standard Addition	Laboratory Number
Yes	1 2 4 6 9 10 12 13 15 18 20 22 26 27 28 31 32 35 37 38 39 40 41 43 44 45 46 49 51 54 56 57 58 61 62 63 64 66 67
No	3 5 7 8 11 14 16 17 19 21 23 24 25 29 30 33 34 36 42 47 48 50 52 53 55 59 60 65 68 69 70
Quality Control: Duplicate	Laboratory Number
Yes	1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 18 19 20 22 23 24 25 26 27 28 29 30 31 32 33 35 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 56 57 58 60 61 62 63 64 65 66 67 68 69 70
No	8 21 34 36 55 59

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.

AOAC Official Method 937.09, 2023. Salt (Chlorine as Sodium Chloride) in Seafood. Volumetric Method.

COMMITTEE**Program Coordinator**

- | | |
|--------------------------|--|
| 1. Miss Kuntida Duangsee | Specialist, Division of Proficiency Testing Laboratory |
|--------------------------|--|

Technical Experts

- | | |
|----------------------------------|---|
| 1. Miss Preeyaporn Jaengkarnkit | Vice President, Department of Laboratory Services |
| 2. Mrs. Nitaya Pirapatrungsuriya | Executive Advisor, Foundation for Industrial Development
National Food Institute |
| 3. Miss Panida Khamnoon | Manager, Division of Chemical Laboratory |
| 4. Miss Saijai Kiatkittisorn | Specialist, Division of Chemical Laboratory |
| 5. Miss Sarisara Worawong | Specialist, Division of Chemical Laboratory |

Statistical Expert

- | | |
|--|--|
| 1. Assoc. Prof. Dr. Kunchit Judprasong | Institute of Nutrition, Mahidol University |
|--|--|

Operators

- | | |
|------------------------------|---|
| 1. Miss Tanaporn Borisut | Manager, Division of Proficiency Testing Laboratory
(Statistician) |
| 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

13 February 2026



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