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Proficiency Test Final Report AQA 26-01 Toxic and Essential Elements in Food

April 2026

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SUMMARY

This report presents the results of the proficiency test AQA 26-01 Toxic and Essential Elements in Food. The study focused on the measurement of total: Al, As, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, S, Sb, Se, Tl, V, and Zn, as well as Total Kjeldahl Nitrogen (TKN), Total Organic Carbon (TOC), and Ash, in wheat flour; of total: Ag, Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, Hg, Iodine, K, La, Mg, Mn, Mo, Na, Ni, P, Pb, Rb, Sb, Se, Sn, Sr, U, and V, as well as As (Inorganic) in seafood biota; and of total: Al, As, B, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, S, Se, Sn, V, and Zn in cinnamon.

Twelve laboratories registered to participate, and all submitted results.

The assigned values were the robust averages of participants' results. The associated uncertainties were evaluated from the robust standard deviation of the participants' results.

A number of analytes were not scored in this study because they are not included in the analytical suite of the majority of participants, resulting in insufficient data to assign values. However, laboratories that reported results were still able to compare their results with those of other laboratories, as well as with the homogeneity value and/or the information value.

The consensus of participants' results (robust average) is not traceable to any external reference. So, although expressed in SI units, the metrological traceability of these assigned values has not been established.

The outcomes of the study were assessed against the aims as follows, to:

i. *assess laboratory capabilities in measuring toxic and essential elements in food;*

Laboratory performance was assessed using both z-scores and E_n-scores.

Of 409 z-scores, 401 (98%) were acceptable with $|z| \leq 2.0$.

Of 409 E_n-scores, 377 (92%) were acceptable with $|E_n| < 1.0$.

Laboratory **8** returned the highest number of acceptable z-scores and E_n-scores (for all 51 scored tests).

ii. evaluate the laboratories' methods used in determination of toxic and essential elements in food;

Only two results were reported for inorganic arsenic and total iodine in Sample S2. In both cases, the two results were in relatively good agreement with each other and with the NMIA information value.

Aluminium measurements presented difficulty to testing laboratories. Some participants may need to reassess their extraction methods. According to Eurachem/CITAC Guide CG 4, laboratories should consider using matrix-matched control samples to assess their extraction efficiency (the bias of their analytical methods). Bias can be expressed as recovery and should be corrected for or included in the uncertainty evaluation.[1]

Reporting results with insufficient number of significant figures may be also one of the causes of poor performance. Caution should be exercised when a rounding protocol is designed by a laboratory in order to avoid inadvertent loss of important information. According to Eurachem/CITAC Guide, 'the reported result has to provide enough information in case a decision has to be made (e.g. when the result is close to the accepted guideline)'.[1]

Some laboratories should review their reporting limits, as these may not be sufficiently low to allow assessment of compliance with the relevant guideline requirements for fish type samples.

iii. compare the performance of participant laboratories with their past performance;

Laboratories' performance in the measurement of elements in food samples remain generally high even with challenging matrices in this study.

iv. develop the practical application of measurement uncertainty and provide participants with information that will be useful in assessing their uncertainty evaluations; and

Of 527 numeric results, 510 (97%) were reported with an expanded measurement uncertainty. The magnitude of these expanded uncertainties was within the range 0.001% to 4440% of the reported value.

v. produce materials that can be used in method validation and as control samples.

The test samples of this study were checked for homogeneity and are well characterised, both by in-house testing and from the results of the proficiency round. Surplus of these test samples is available for purchase from NMIA.

1 INTRODUCTION

1.1 NMI Proficiency Testing Program

The National Measurement Institute Australia (NMIA) is responsible for Australia's national measurement infrastructure, providing a range of services including a chemical proficiency testing program.

Proficiency testing (PT) is the 'evaluation of participant performance against pre-established criteria by means of interlaboratory comparisons'.[2] NMIA PT studies target chemical testing in areas of high public significance such as trade, environment, law enforcement and food safety. NMIA offers studies in:

- per- and polyfluoroalkyl substances in soil, biosolids, compost, water, biota, food, and consumables;
- hydrocarbons, phenols and other organic compounds in soil and water;
- pesticide residues in soil, water, fruit, vegetables, and herbs;
- metals in soil, water, food, filters, and paint;
- nutrients, anions and physical tests in water and soil;
- chlorophyll a in water; and
- controlled drug assay, drugs in wipes, and clandestine laboratory.

AQA 26-01 is the seventeenth NMIA proficiency test on inorganic contaminants and nutrients in food.

1.2 Study Aims

The aims of the study were to:

- assess laboratory capabilities in measuring toxic and essential elements in food;
- evaluate the laboratories' methods used in determination of toxic and essential elements in food;
- compare the performance of participant laboratories with their past performance;
- develop the practical application of measurement uncertainty and provide participants with information that will be useful in assessing their uncertainty evaluations; and
- produce materials that can be used in method validation and as control samples.

1.3 Study Conduct

The conduct of NMIA proficiency tests is described in the NMIA Study Protocol for Proficiency Testing.[3] The statistical methods used are described in the NMIA Chemical Proficiency Testing Statistical Manual.[4] These documents have been prepared with reference to ISO/IEC 17043[2] and The International Harmonized Protocol for the Proficiency Testing of Analytical Chemistry Laboratories.[5]

NMIA is accredited by National Association of Testing Authorities, Australia (NATA) to ISO/IEC 17043 as a provider of proficiency testing schemes. This study falls within the scope of NMIA's accreditation (Accreditation No. 198; Site No. 14485).

The choice of the test method was left to the participating laboratories.

2 STUDY INFORMATION

2.1 Study Timetable

The timetable of the study was:

Invitation issued:	17 December 2025
Samples dispatched:	27 January 2026
Results due:	20 February 2026
Interim report issued:	24 February 2026
Preliminary report issued:	26 February 2026

2.2 Participation and Laboratory Code

Twelve laboratories participated and submitted results. All participants were assigned a confidential laboratory code number for this study.

2.3 Selection of Matrices and Inorganic Analytes, and Test Material Specification

The eighty-one tests across the study samples represent those commonly measured in food, including toxic elements (e.g. Cd, Hg, and Pb) and nutrient elements (e.g. Na, P, and Mg). Ash, inorganic arsenic, total iodine, total Kjeldahl nitrogen, and total organic carbon were also included.

Three samples were provided for analysis:

- Sample S1 was 20 g of wheat flour;
- Sample S2 was 10 g of seafood biota (55% prawn, 22% finfish, 5% crab meat, 2% mollusc, 7% shark, 3% seaweed, and 6% oyster); and
- Sample S3 was 5 g of cinnamon.

2.4 Test Material Preparation, Analysis, Homogeneity and Stability

The same preparation procedure was followed as in previous studies. Test samples from previous studies have been demonstrated to be sufficiently homogeneous for the evaluation of participants' performance. Therefore, only a partial homogeneity test was conducted for elemental analytes in Samples S1 and S2, except for Ca and S in S1, and Cr, La, and Ni in S2. The results from the partial homogeneity test for these samples are reported in the present study as the homogeneity value. Furthermore, information values for inorganic As and total iodine in S2, and all analytes in S3 except for Al, Ca, Cr, Fe, S, and V, were determined from the analysis of two samples (S3) or one sample (S2) and are presented for information purposes only.

No stability study was carried out during the period of the present study. Stability studies conducted for the previous proficiency tests of metals and nutrients in food found no significant changes in any of the analytes' concentration over the study period. Results of this study gave no reason to question the stability of the test samples.

The preparation and analysis methods of the study samples are described in Appendix 1.

2.5 Sample Storage, Dispatch and Receipt

All three samples were stored at room temperature before dispatch. The samples were dispatched by courier on 27 January 2026.

A description of the test samples, instructions for participants, and a form for participants to confirm the receipt of the test samples, were included with the samples. An Excel spreadsheet for the electronic reporting of results was e-mailed to participants.

2.6 Instructions to Participants

Participants were instructed as follows:

- The samples should be stored during analysis at room temperature in a dry place e.g. desiccator with anhydrous calcium sulphate.
- These samples are an attempt to mime the real samples encountered by a laboratory in its routine activities. Please use appropriate Good Laboratory Practice when handling them.
- Quantitatively analyse the samples using your normal test method.
- Report the results on as received basis in units of mg/kg for:

SAMPLE S1 Wheat Flour		**SAMPLE S2 Seafood Biota (55% Prawn, 22% Finfish, 5% Crab Meat, 2% Mollusc, 7% Shark, 3% Seaweed, 6% Oyster)**		**SAMPLE S3 Cinnamon**	
TOTAL elements	**Estimated Value [mg/kg]***	**TOTAL elements**	**Estimated Value [mg/kg]***	**TOTAL elements**	**Estimated Value [mg/kg]***
Al	0.5-25	Ag	0.05-2.5	Al	25-1250
As	0.05-2.5	Al	5-250	As	0.005-0.25
Be	0.05-2.5	As (Total)	5-250	B	0.5-25
Bi	0.05-2.5	Inorganic As	0.05-2.5	Ca	NA
Ca	NA	Ba	0.5-25	Cd	0.05-2.5
Cd	0.05-2.5	B	0.5-50	Cr	0.05-2.5
Co	0.05-2.5	Ca	500-50000	Cu	0.5-25
Cr	0.05-2.5	Cd	0.05-2.5	Fe	25-1250
Cu	0.5-25	Co	0.05-2.5	K	NA
Fe	5-250	Cr	0.5-25	Mg	25-1250
Hg	0.05-2.5	Cu	5-250	Mn	25-1250
K	NA	Fe	5-250	Na	NA
Li	0.05-2.5	Hg	0.05-2.5	Ni	0.05-2.5
Mg	25-1250	Iodine (Total)	0.5-25	P	NA
Mn	5-250	K	250-25000	Pb	0.05-2.5
Mo	0.05-2.5	La	0.05-2.5	S	NA
Na	25-1250	Mg	50-5000	Se	0.005-0.25
Ni	0.05-2.5	Mn	0.5-25	Sn	0.005-0.25
P	100-10000	Mo	0.005-0.25	V	0.05-2.5
Pb	0.05-2.5	Na	500-50000	Zn	5-250
Rb	0.5-25	Ni	0.05-2.5		
S	NA	P	500-50000		
Sb	0.05-2.5	Pb	0.05-2.5		
Se	0.05-2.5	Rb	0.5-25		
Tl	0.05-2.5	Sb	0.005-0.25		
V	0.05-2.5	Se	0.5-25		
Zn	0.5-25	Sn	0.05-2.5		
TKN	>10000	Sr	5-250		
TOC	>150000	U	0.005-0.25		
Ash (at 600˚C)	NA	V	0.05-2.5		
		Zn	25-1250		

*Please note these are real samples and the given values are estimates; NA = Not Available.

- Report results using the electronic results sheet emailed to you.
- Report results as you would report to a client. For each analyte, report the expanded measurement uncertainty.
- Please send the requested details regarding the test method and the basis of your uncertainty evaluation.

2.7 Interim and Preliminary Reports

An Interim Report was e-mailed to participants on 24 February 2026.

A Preliminary Report was issued on 26 February 2026. This report included: a summary of the results reported by laboratories, assigned values, performance coefficient of variations, z-scores and E_n-scores for each analyte tested by participants. The following has been modified from the Preliminary Report:

- Although the partial homogeneity results for Sample S2 Al were consistent, this value has not been included in the final report, as additional confirmation using a different instrumental technique was required.
- An information value has now been included for Sample S3 Al.
- Reference values were not determined for Se in Samples S1 and S3. Sample S1 Se has now been set an assigned value calculated from the robust average of participants results. Reported results have now been set z-scores and E_n-scores, and a homogeneity value has been included for this test. No assigned value has been set for Sample S3 Se, so results have not been scored; an information value for this test has now been included.

3 PARTICIPANT LABORATORY INFORMATION

3.1 Test Method Summaries

Summaries of test methods for total elements are transcribed in Tables 1 to 3.

Table 1 Methodology for Total Elements in S1

Lab. Code	Method Reference	Staggered Digestion	Sample Mass (g)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)	Vol. HNO_3 (1:1) (mL)	Vol. HCl (1:1) (mL)	Vol. H_2O_2 (mL)	Other
2		Yes	0.2	200	38	10					
3	200.3 modified		0.2	120	240	6	1			2	
4	AOAC 990.08/AOAOC 986.15/AOAC9 99.10	No	~1	85	120	3	2				
5	In House		1	112.5	120	10	10				
7	In House referencing APHA 3125	No	0.4	120	60	10					
8			0.5	100	120	3	1				
9	In-House Method	No	0.5	190	45	7				1	
10	EPA (Environmental Protection Agency) 1994 Method 200.8	No	1	95	120	2	1				3 (H_2O)
11	In-House Method	Yes	0.5	160	46	4					
12	AS 4873.1 – 2005 ; USEPA Method 200.8, Revision 5.4 EMMC Version 1994.	Yes	0.5	190	60	10	2				

Table 2 Methodology for Total Elements in S2

Lab. Code	Method Reference	Staggered Digestion	Sample Mass (g)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)	Vol. HNO_3 (1:1) (mL)	Vol. HCl (1:1) (mL)	Vol. H_2O_2 (mL)	Other
2		Yes	0.2	200	38	10					
3	200.3 modified		0.2	120	240	6	1			2	
4	AOAC 990.08/AOAOC 986.15/AOAC999.10		~1	85	120	3	2				
5	In House		1	112.5	120	10	10				
6	USEPA method 200.2 Revision 2.8	Yes	2	95	60			2		2	10 (HCl 1:4)
7	In House referencing APHA 3125	No	0.4	120	60	10					
8			0.5	100	120	3	1				
10	EPA (Environmental Protection Agency) 1994 Method 200.8	No	1	95	120	2	1				3 (H_2O)
11	In-House Method	Yes	0.5	160	46	4					
12	AS 4873.1 – 2005 ; USEPA Method 200.8, Revision 5.4 EMMC Version 1994.	Yes	0.5	190	60	10	2				

Table 3 Methodology for Total Elements in S3

Lab. Code	Method Reference	Staggered Digestion	Sample Mass (g)	Temp. (°C)	Time (min)	Vol. HNO_3 (mL)	Vol. HCl (mL)	Vol. HNO_3 (1:1) (mL)	Vol. HCl (1:1) (mL)	Vol. H_2O_2 (mL)	Other
3	200.3 modified		0.2	120	240	6	1			2	
4	AOAC 990.08/AOAOC 986.15/AOAC9 99.10		~1	85	120	3	2				
5	In House		1	112.5	120	10	10				
7	In House referencing APHA 3125	No	0.4	120	60	10					
8			0.5	100	120	3	1				
10	EPA (Environmental Protection Agency) 1994 Method 200.8	No	1	95	120	2	1				3 (H_2O)
11	In-House Method	Yes	0.5	160	46	4					
12	AS 4873.1 – 2005 ; USEPA Method 200.8, Revision 5.4 EMMC Version 1994.	Yes	0.5	190	60	10	2				

3.2 Instruments Used for Measurements

The instruments and settings used by participants for all tests are presented in Appendix 4.

3.3 Additional Information

Participants had the option to report additional information for each sample analysed. These are transcribed in Table 4.

Table 4 Additional Information

Lab. Code	Additional Information
11	S1: Uncertainty for ICP-MS results calculated from QC 300 Mussel Tissue. Uncertainty for ICP-OES results calculate from QC 308 Rice Flour S2: Uncertainty for ICP-MS results calculated from QC 300 Mussel Tissue. Uncertainty for ICP-OES results calculated from QC 292 Oyster Tissue S3: Uncertainty for ICP-MS results calculated from QC 300 Mussel Tissue. Uncertainty for ICP-OES results calculated from QC 008 Fava Beans

3.4 Basis of Participants' Measurement Uncertainty Evaluations

Participants were requested to provide information about the basis of their uncertainty evaluations (Table 5).

Table 5 Basis of Uncertainty Evaluation

Lab. Code	Approach to Evaluating MU	Information Sources for MU Evaluation*		Guide Document for Evaluating MU
		Precision	Method Bias	
1	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	NMIA Uncertainty Course
2	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Laboratory Bias from PT Studies Recoveries of SS	Nordtest Report TR537
3	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - RM / Ex PT Sample Duplicate Analysis		
4	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples Duplicate Analysis	Recoveries of SS	
5	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - RM / Ex PT Sample Duplicate Analysis Instrument Calibration	CRM Instrument Calibration Recoveries of SS	NATA General Accreditation, Guidance, Estimating and Reporting MU (Replace TN 33)
6	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - RM / Ex PT Sample Duplicate Analysis		Eurachem/CITAC Guide
7	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM	Nordtest Report TR537
8	Top Down - precision and evaluations of the method and laboratory bias Coverage factor not reported	Control Samples - CRM Duplicate Analysis Instrument Calibration		Nordtest Report TR537
9	Standard deviation of replicate analyses multiplied by 2 or 3 Coverage factor not reported	Control Samples - CRM Duplicate Analysis	CRM Recoveries of SS	ISO/GUM
10	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Duplicate Analysis	Recoveries of SS	Eurachem/CITAC Guide
11	Standard deviation of replicate analyses multiplied by 2 or 3 k = 2	Control Samples	Recoveries of SS	Eurachem/CITAC Guide
12	Bottom Up (ISO/GUM, fish bone/ cause and effect diagram) k = 2	Duplicate Analysis Instrument Calibration	CRM	ISO/GUM

*CRM = Certified Reference Material, RM = Reference Material, SS = Spiked Samples.

3.5 Participant Comments on this PT Study or Suggestions for Future Studies

The study co-ordinator welcomes comments or suggestions from participants about this study or possible future studies. Such feedback may be useful in improving future studies.

There were no comments from participants on this study.

4 PRESENTATION OF RESULTS AND STATISTICAL ANALYSIS

4.1 Results Summary

Participant results are listed in Tables 6 to 85 with summary statistics. Bar charts of the results and performance scores are presented in Figures 2 to 81. An example chart with interpretation guide is shown in Figure 1.

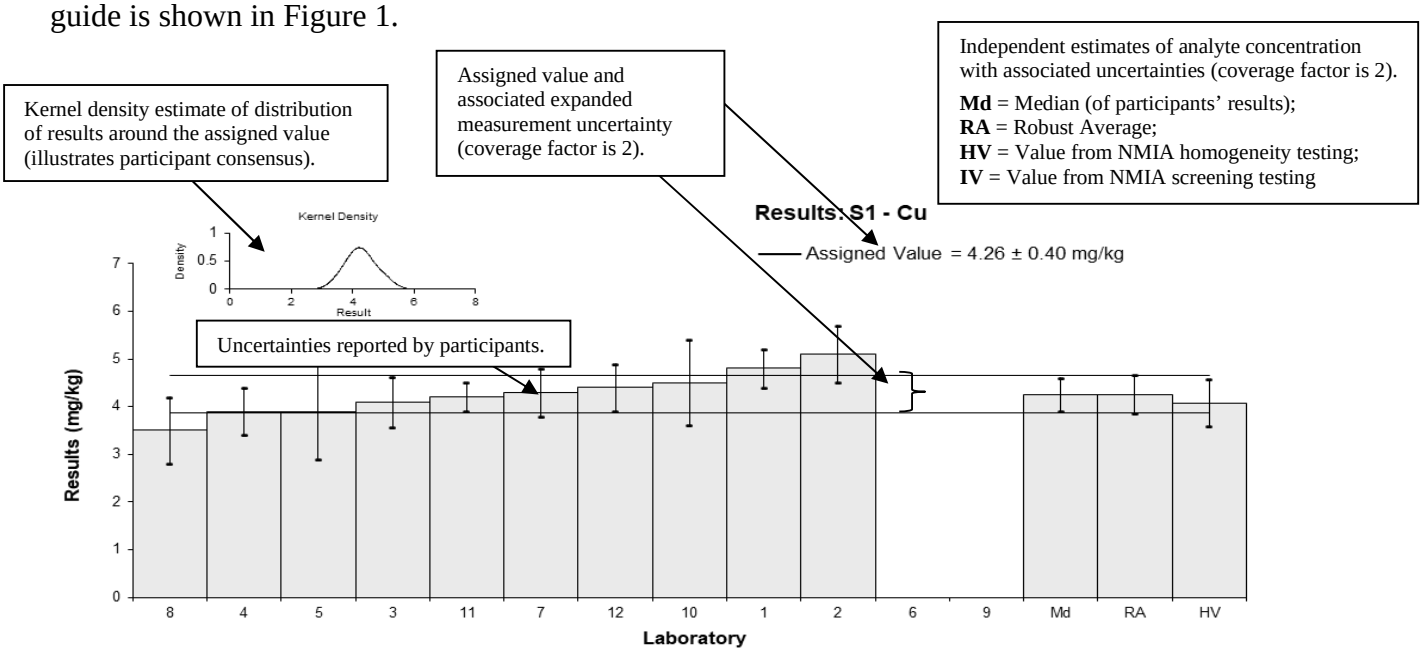


Figure 1 Guide to Presentation of Results

4.2 Outliers and Extreme Outliers

Outliers were results less than 50% and greater than 150% of the robust average and were removed before assigned value calculation. Extreme outliers (gross errors) were obvious blunders, such as those with incorrect units, decimal errors, or results from a different proficiency test item and were removed for calculation of summary statistics.[4-6]

4.3 Assigned Value

An example of the assigned value calculation using data from the present study is given in Appendix 2. The assigned value is defined as: 'the value attributed to a particular property or characteristic of a proficiency testing item'.[2] In this study the property is the mass fraction of analyte. Assigned values were the robust average of participants' results, outliers removed; the expanded uncertainties were evaluated from associated robust standard deviation.[4-6]

4.4 Robust Average and Robust Between-Laboratory Coefficient of Variation

The robust averages and associated expanded uncertainties, and robust CVs (a measure of the variability of participants' results) were calculated as described in ISO 13528.[6]

The Robust CVs as presented in the Section 5 Statistics Tables are the robust between-laboratory CV including outliers but excluding extreme outliers. Everywhere else in the report, the robust between-laboratory CV refers to the robust CV calculated with both outliers and extreme outliers removed.

4.5 Standard Deviation for Proficiency Assessment

The standard deviation for proficiency assessment (SDPA, σ) is the product of the assigned value *(X)* and the performance coefficient of variation (PCV). This value is used for calculation of participant z-score and provides scaling for laboratory deviation from the assigned value.

$$\sigma = (X) \times PCV \qquad \text{Equation 1}$$

It is important to note that the PCV is a fixed value and is not the standard deviation of participants' results. The value set for PCV is based on the existing regulation, the acceptance criteria indicated by the methods, the matrix, the concentration level of analyte and on experience from previous studies. It is backed up by mathematical models such as the Thompson Horwitz equation.[7]

4.6 z-Score

An example of z-score calculation using data from the present study is given in Appendix 2. For each participant's result a z-score is calculated according to Equation 2 below:

$$z = \frac{(\chi - X)}{\sigma} \qquad \text{Equation 2}$$

Where:

z is z-score

χ is a participant's result;

X is the assigned value;

σ is the SDPA from Equation 1.

A z-score with absolute value (|z|):

- $|z| \leq 2.0$ is acceptable;
- $2.0 < |z| < 3.0$ is questionable;
- $|z| \geq 3.0$ is unacceptable.

4.7 E_n-Score

An example of E_n-score calculation using data from the present study is given in Appendix 2. The E_n-score is complementary to the z-score in assessing laboratory performance. E_n-score includes measurement uncertainty and is calculated according to Equation 3 below:

$$E_n = \frac{(\chi - X)}{\sqrt{U_\chi^2 + U_X^2}} \qquad \text{Equation 3}$$

Where:

E_n is E_n-score;

χ is a participant's result;

X is the assigned value;

U_χ is the expanded uncertainty of the participant's result;

U_X is the expanded uncertainty of the assigned value.

An E_n-score with absolute value ($|E_n|$):

- $|E_n| < 1.0$ is acceptable;
- $|E_n| \geq 1.0$ is unacceptable.

4.8 Traceability and Measurement Uncertainty

Laboratories accredited to ISO/IEC 17025 must establish and demonstrate the traceability and measurement uncertainty associated with their test results.[8] Guidelines for quantifying uncertainty in analytical measurement are described in the Eurachem/CITAC Guide.[1]

5 TABLES AND FIGURES

Table 6

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	<10	10
2	NT	NT
3	3.82	1.15
4	2.9	0.8
5	NT	NT
6	NT	NT
7	<25	NR
8	2.7	0.54
9	NT	NT
10	4.13	1.652
11	NR	NR
12	4.410	0.930

Statistics

Assigned Value	Not Set	
Homogeneity Value	5.49	0.66
Robust Average	NA (N<6)	
Median	3.82	0.98
Mean	3.59	
N	5	
Max	4.410	
Min	2.7	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

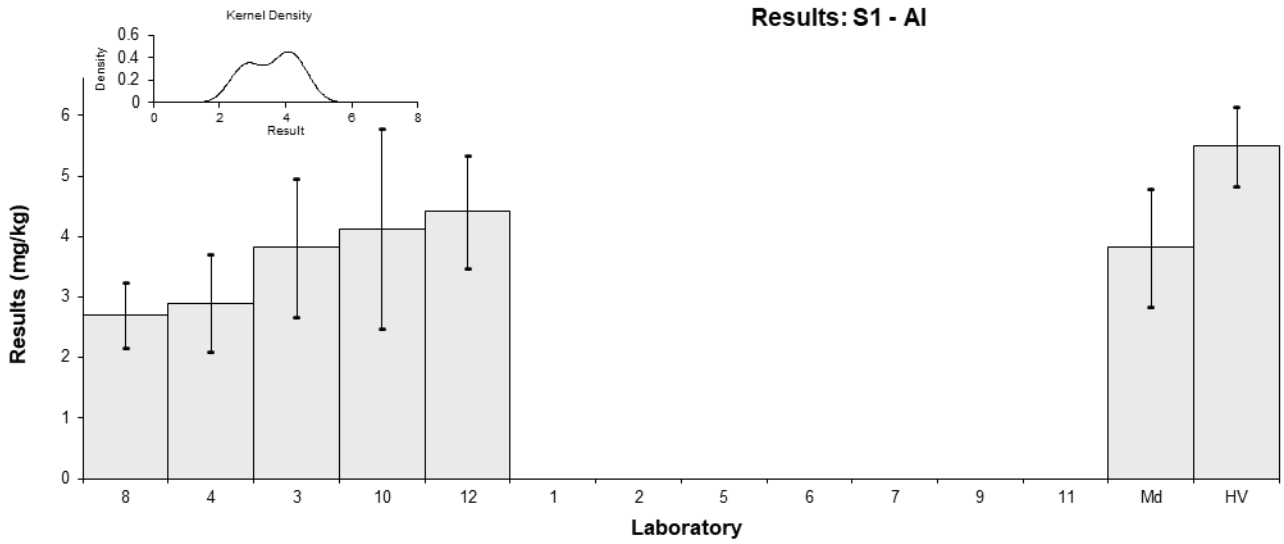

Results: S1 - Al
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8
4
3
10
12
1
2
5
6
7
9
11
Md
HV

Figure 2

Table 7

Sample Details

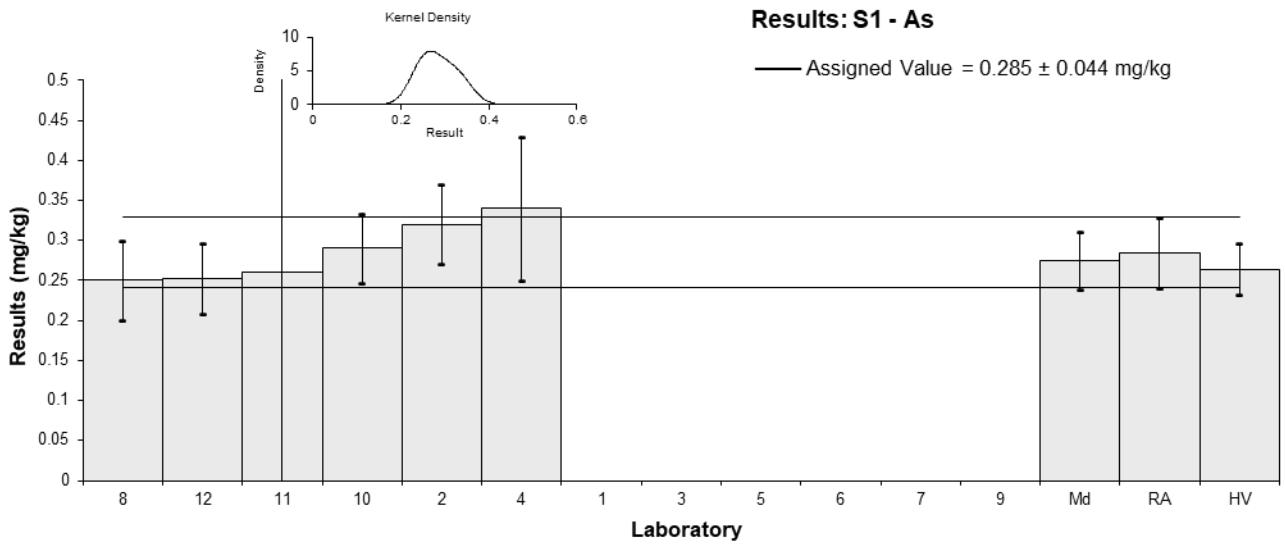
Sample No.	S1
Matrix	Wheat Flour
Analyte	As
Unit	mg/kg

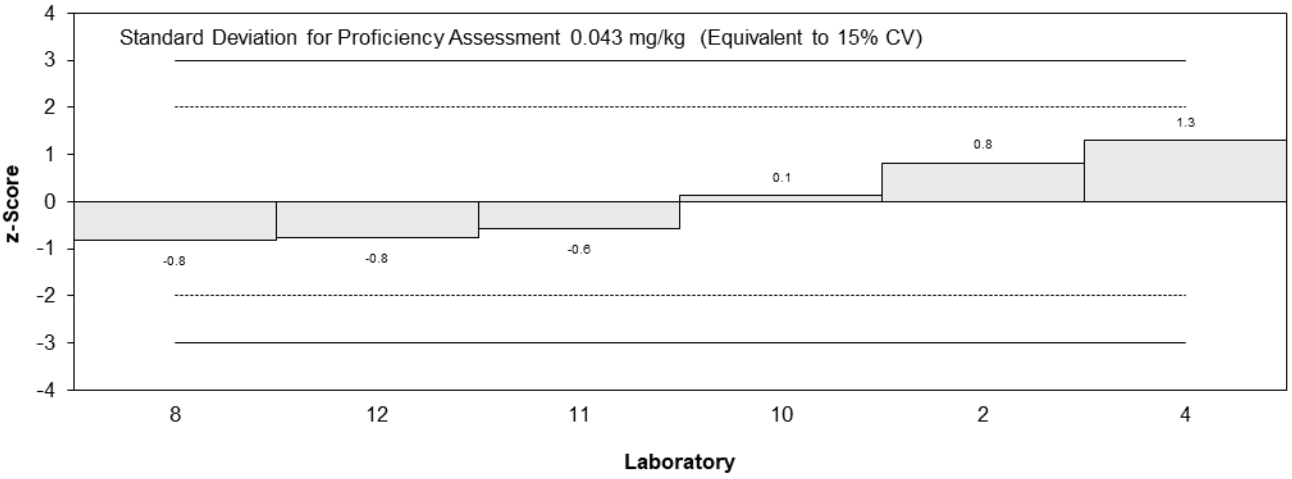
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.32	0.05	0.82	0.53
3	<2	NR		
4	0.34	0.09	1.29	0.55
5	<2.0	NR		
6	NT	NT		
7	<2	NR		
8	0.25	0.05	-0.82	-0.53
9	NT	NT		
10	0.29	0.044	0.12	0.08
11	0.26	1.11	-0.58	-0.02
12	0.252	0.044	-0.77	-0.53

Statistics

Assigned Value	0.285	0.044
Homogeneity Value	0.264	0.032
Robust Average	0.285	0.044
Median	0.275	0.036
Mean	0.285	
N	6	
Max	0.34	
Min	0.25	
Robust SD	0.043	
Robust CV	15%	


Kernel Density
Density
Result
Results: S1 - As
Assigned Value = 0.285 ± 0.044 mg/kg
Results (mg/kg)
Laboratory
8
12
11
10
2
4
1
3
5
6
7
9
Md
RA
HV


z-Scores: S1 - As
Standard Deviation for Proficiency Assessment 0.043 mg/kg (Equivalent to 15% CV)
z-Score
-0.8
-0.8
-0.6
0.1
0.8
1.3
Laboratory
8
12
11
10
2
4

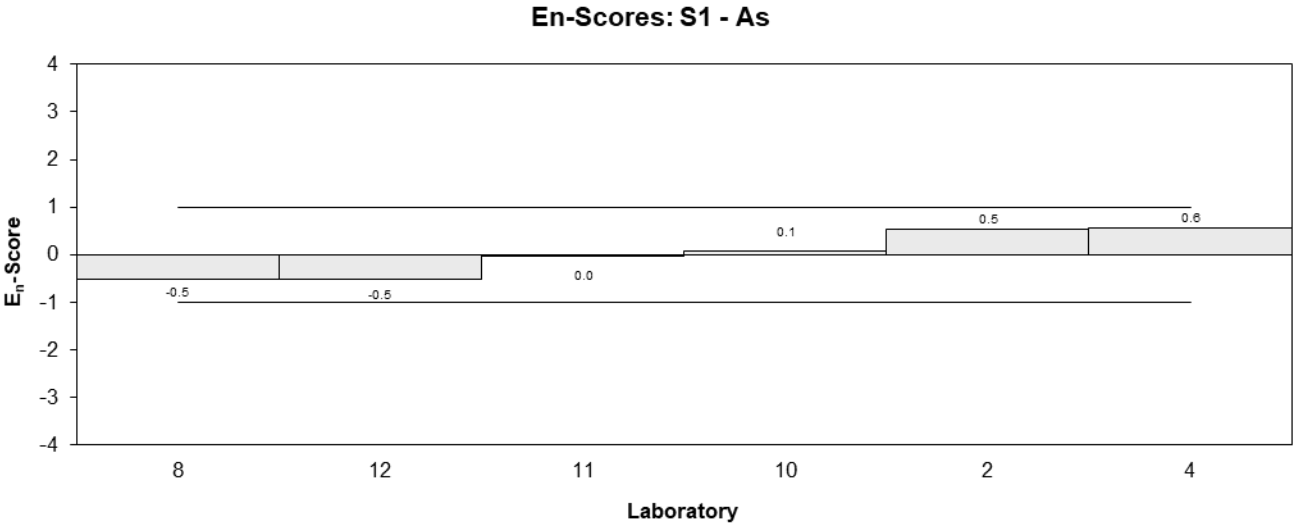

En-Scores: S1 - As
En-Score
-0.5
-0.5
0.0
0.1
0.5
0.6
Laboratory
8
12
11
10
2
4

Figure 3

Table 8

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Be
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	0.132	0.030
4	0.15	0.04
5	<1.0	NR
6	NT	NT
7	<0.5	NR
8	0.13	0.026
9	NT	NT
10	0.16	0.024
11	NR	NR
12	0.109	0.041

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.145	0.017
Robust Average	NA (N<6)	
Median	0.132	0.030
Mean	0.136	
N	5	
Max	0.16	
Min	0.109	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

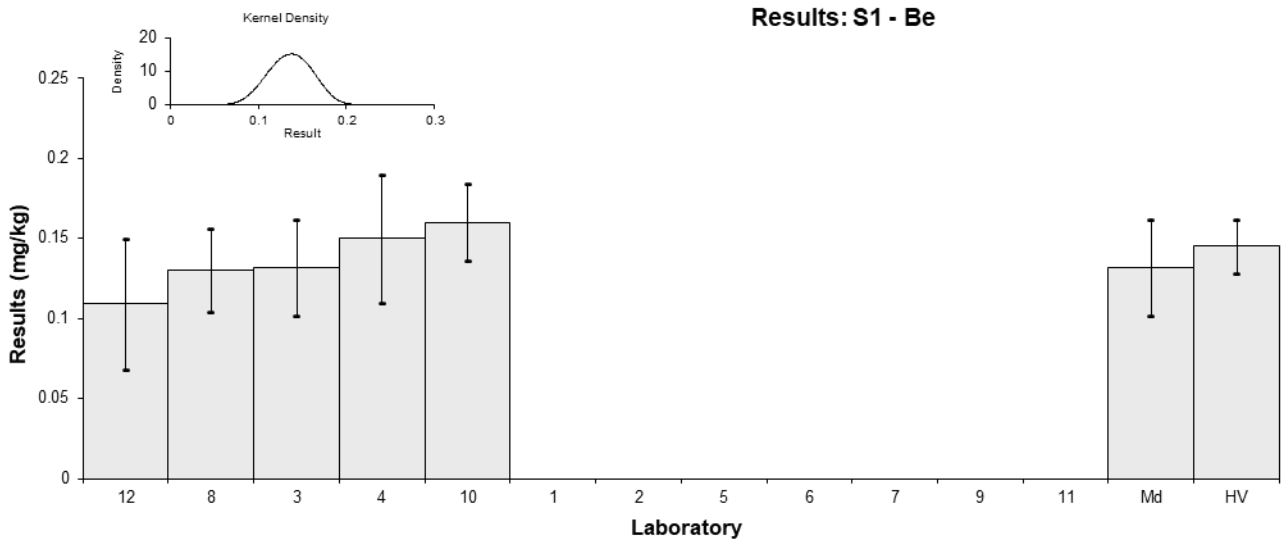

Results: S1 - Be
Kernel Density
Density
20
10
0
0
0.1
0.2
0.3
Result
Results (mg/kg)
0.25
0.2
0.15
0.1
0.05
0
12
8
3
4
10
1
2
5
6
7
9
11
Md
HV
Laboratory

Figure 4

Table 9

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Bi
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	0.26	0.07
5	NT	NT
6	NT	NT
7	<0.5	NR
8	0.27	0.054
9	NT	NT
10	0.3	0.045
11	NR	NR
12	0.277	0.057

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.265	0.032
Robust Average	NA (N<6)	
Median	0.274	0.016
Mean	0.277	
N	4	
Max	0.3	
Min	0.26	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

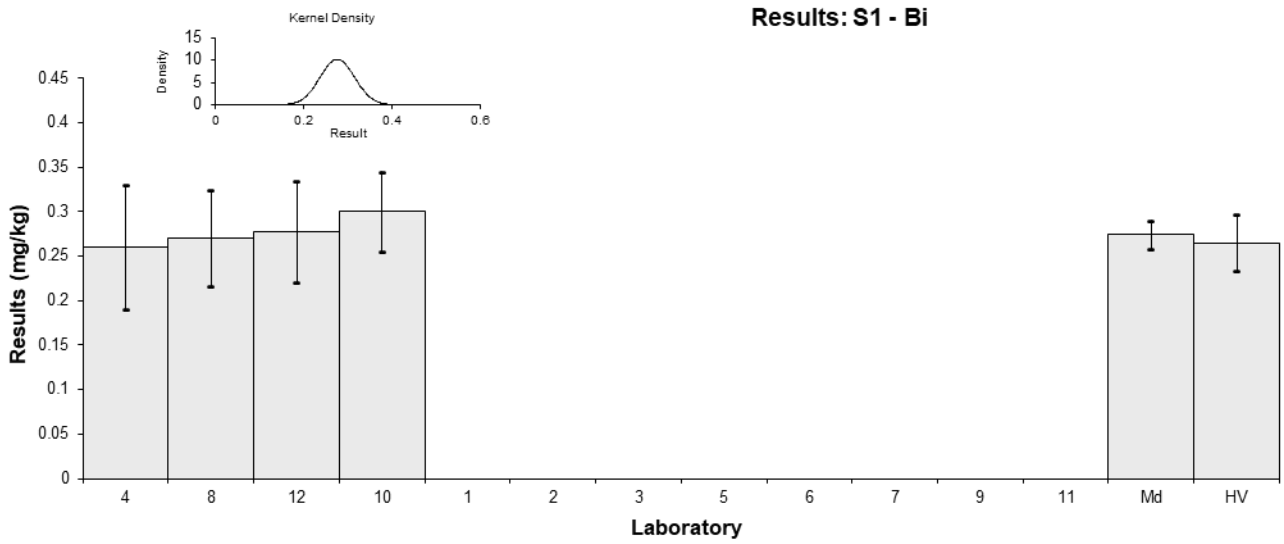

Results: S1 - Bi
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
8
12
10
1
2
3
5
6
7
9
11
Md
HV

Figure 5

Table 10

Sample Details

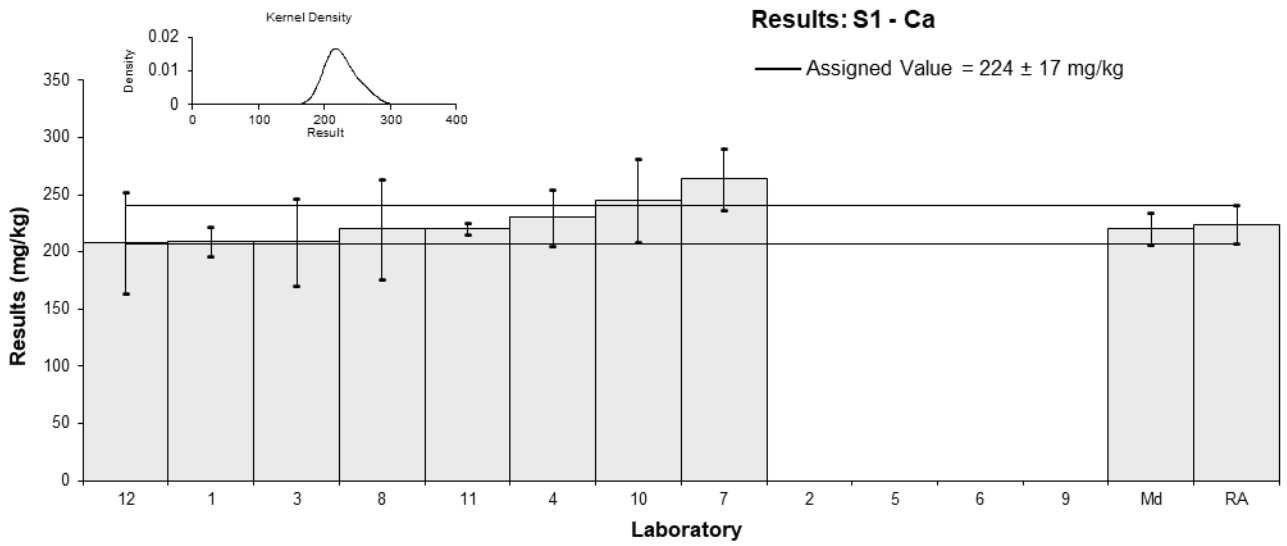
Sample No.	S1
Matrix	Wheat Flour
Analyte	Ca
Unit	mg/kg

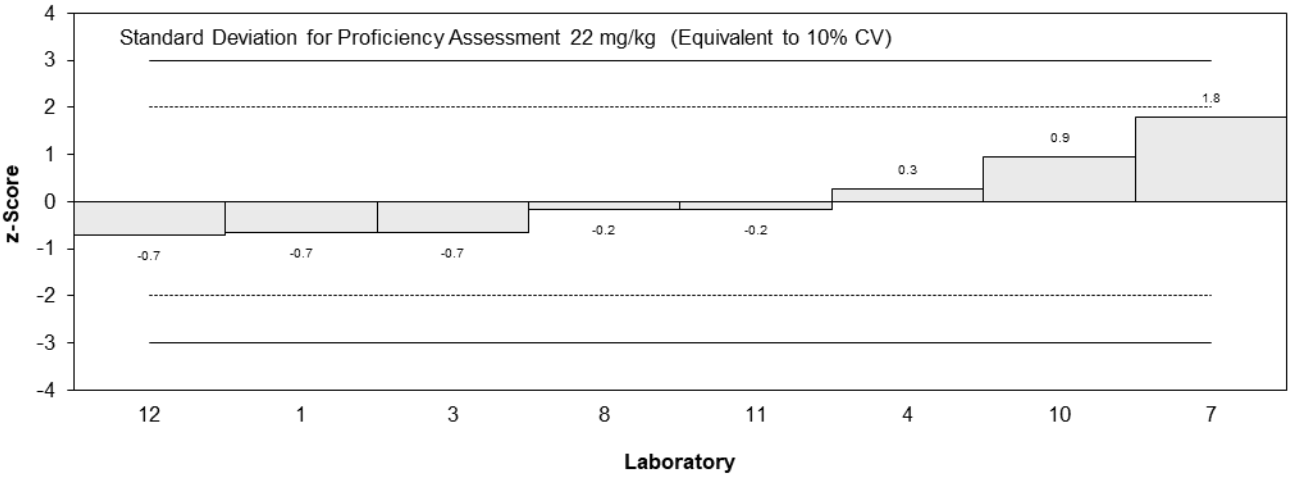
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	209	13	-0.67	-0.70
2	NT	NT		
3	209	38	-0.67	-0.36
4	230	25	0.27	0.20
5	NT	NT		
6	NT	NT		
7	264	27	1.79	1.25
8	220	44	-0.18	-0.08
9	NT	NT		
10	245	36.75	0.94	0.52
11	220	5.16	-0.18	-0.23
12	208.000	44.000	-0.71	-0.34

Statistics

Assigned Value	224	17
Robust Average	224	17
Median	220	14
Mean	226	
N	8	
Max	264	
Min	208.000	
Robust SD	20	
Robust CV	8.7%	


Kernel Density
Density
0.02
0.01
0
0
100
200
300
400
Result
Results: S1 - Ca
Assigned Value = 224 ± 17 mg/kg
Results (mg/kg)
350
300
250
200
150
100
50
0
12
1
3
8
11
4
10
7
2
5
6
9
Md
RA
Laboratory


z-Scores: S1 - Ca
Standard Deviation for Proficiency Assessment 22 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7
-0.7
-0.7
-0.2
-0.2
0.3
0.9
1.8
12
1
3
8
11
4
10
7
Laboratory

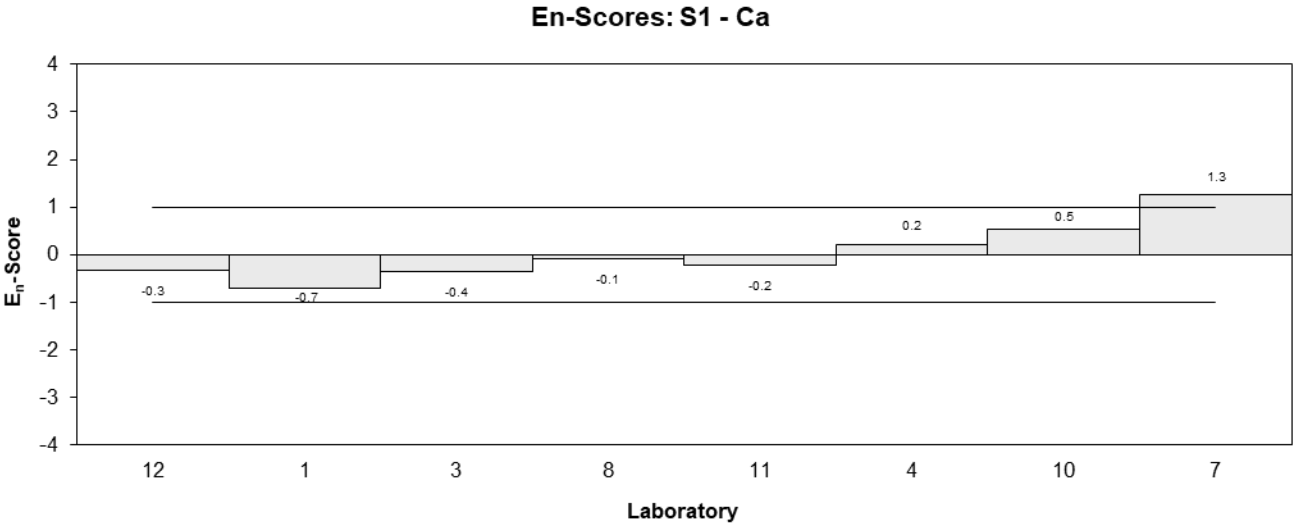

En-Scores: S1 - Ca
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.3
-0.7
-0.4
-0.1
-0.2
0.2
0.5
1.3
12
1
3
8
11
4
10
7
Laboratory

Figure 6

Table 11

Sample Details

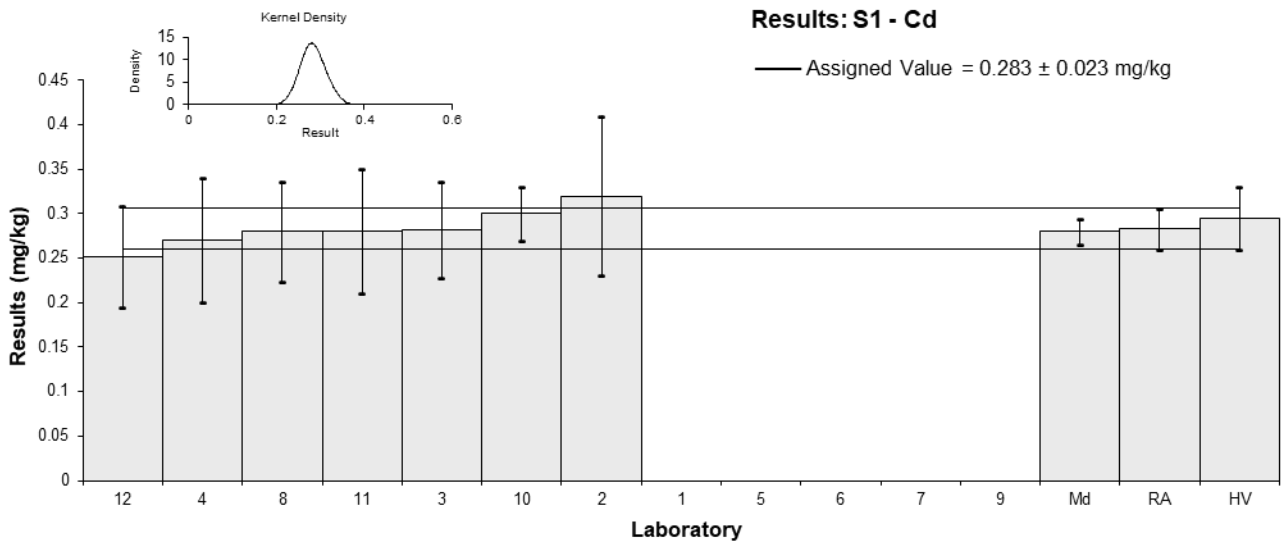
Sample No.	S1
Matrix	Wheat Flour
Analyte	Cd
Unit	mg/kg

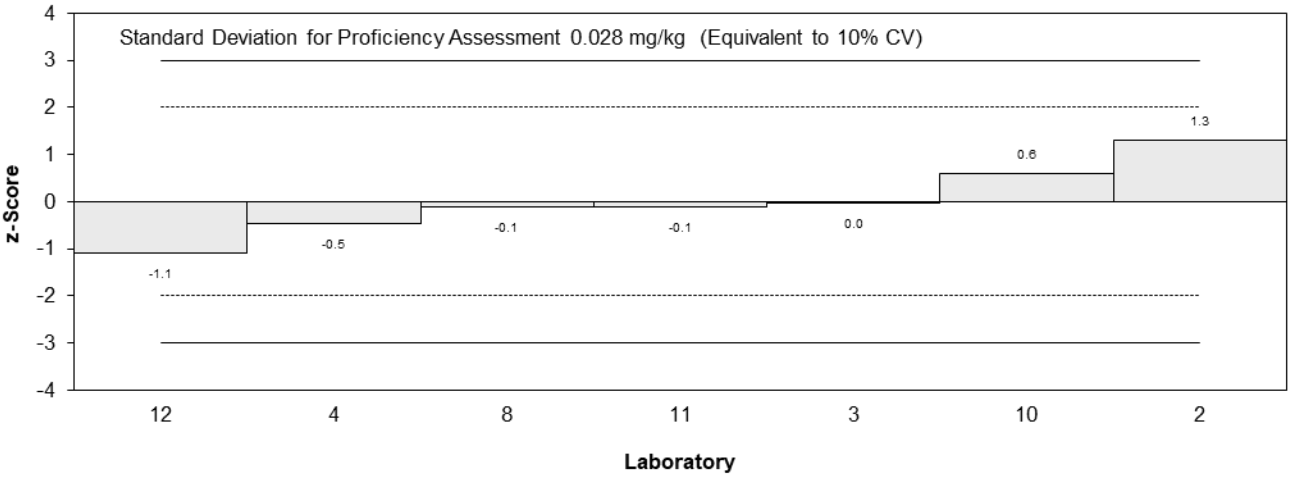
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.32	0.09	1.31	0.40
3	0.282	0.054	-0.04	-0.02
4	0.27	0.07	-0.46	-0.18
5	<1.0	NR		
6	NT	NT		
7	<0.5	NR		
8	0.28	0.056	-0.11	-0.05
9	NT	NT		
10	0.3	0.03	0.60	0.45
11	0.28	0.07	-0.11	-0.04
12	0.252	0.057	-1.10	-0.50

Statistics

Assigned Value	0.283	0.023
Homogeneity Value	0.295	0.035
Robust Average	0.283	0.023
Median	0.280	0.014
Mean	0.283	
N	7	
Max	0.32	
Min	0.252	
Robust SD	0.025	
Robust CV	8.7%	


Results: S1 - Cd
Assigned Value = 0.283 ± 0.023 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12
4
8
11
3
10
2
1
5
6
7
9
Md
RA
HV


z-Scores: S1 - Cd
Standard Deviation for Proficiency Assessment 0.028 mg/kg (Equivalent to 10% CV)
z-Score
-1.1
-0.5
-0.1
-0.1
0.0
0.6
1.3
Laboratory
12
4
8
11
3
10
2

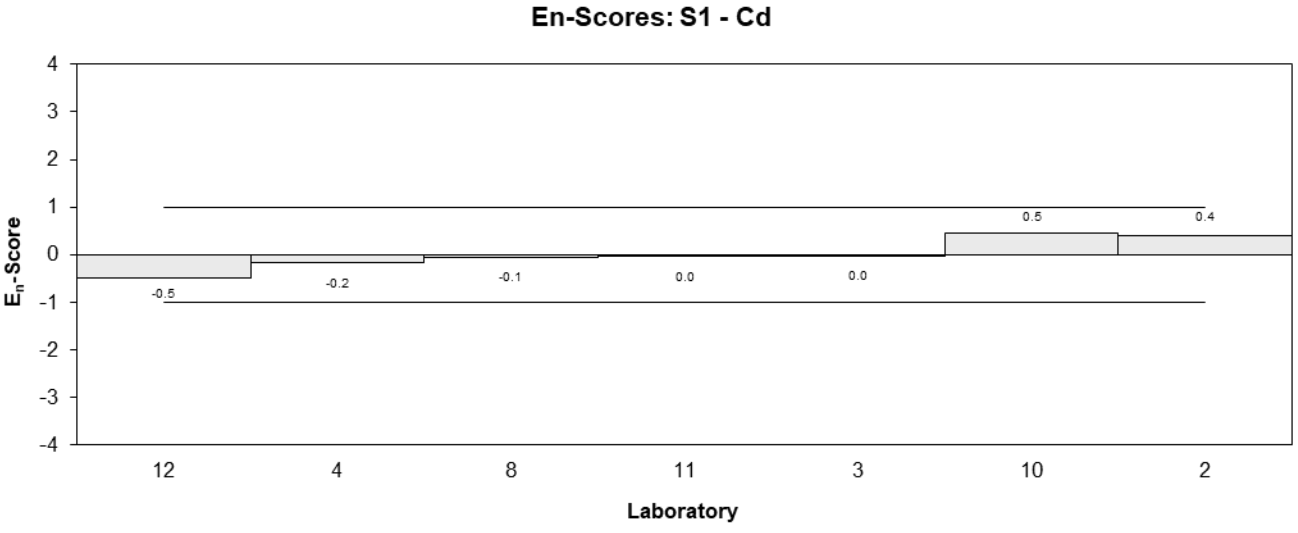

En-Scores: S1 - Cd
En-Score
-0.5
-0.2
-0.1
0.0
0.0
0.5
0.4
Laboratory
12
4
8
11
3
10
2

Figure 7

Table 12

Sample Details

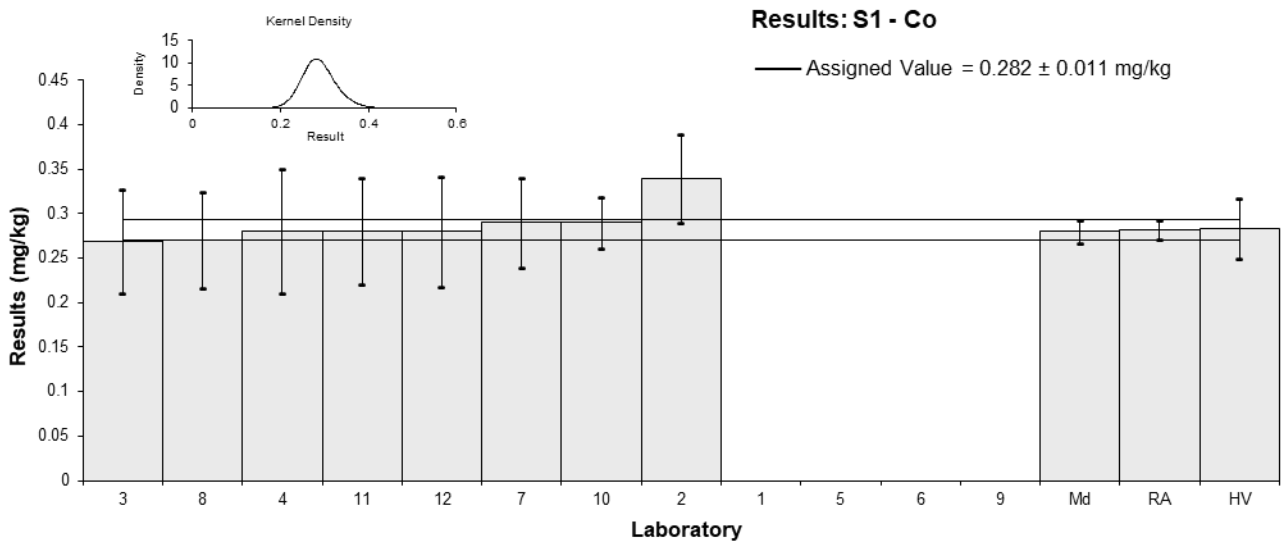
Sample No.	S1
Matrix	Wheat Flour
Analyte	Co
Unit	mg/kg

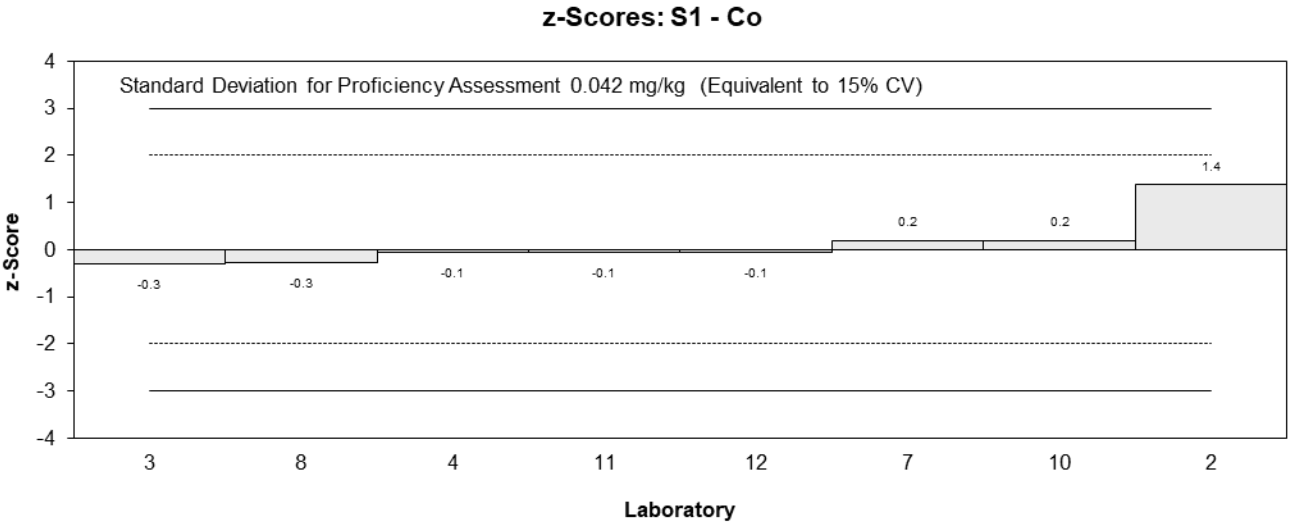
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.34	0.05	1.37	1.13
3	0.269	0.059	-0.31	-0.22
4	0.28	0.07	-0.05	-0.03
5	<1.0	NR		
6	NT	NT		
7	0.29	0.05	0.19	0.16
8	0.27	0.054	-0.28	-0.22
9	NT	NT		
10	0.29	0.029	0.19	0.26
11	0.28	0.06	-0.05	-0.03
12	0.280	0.062	-0.05	-0.03

Statistics

Assigned Value	0.282	0.011
Homogeneity Value	0.283	0.034
Robust Average	0.282	0.011
Median	0.280	0.013
Mean	0.287	
N	8	
Max	0.34	
Min	0.269	
Robust SD	0.012	
Robust CV	4.3%	


Results: S1 - Co
Assigned Value = 0.282 ± 0.011 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
3
8
4
11
12
7
10
2
1
5
6
9
Md
RA
HV


z-Scores: S1 - Co
Standard Deviation for Proficiency Assessment 0.042 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
-0.3
-0.3
-0.1
-0.1
-0.1
0.2
0.2
1.4

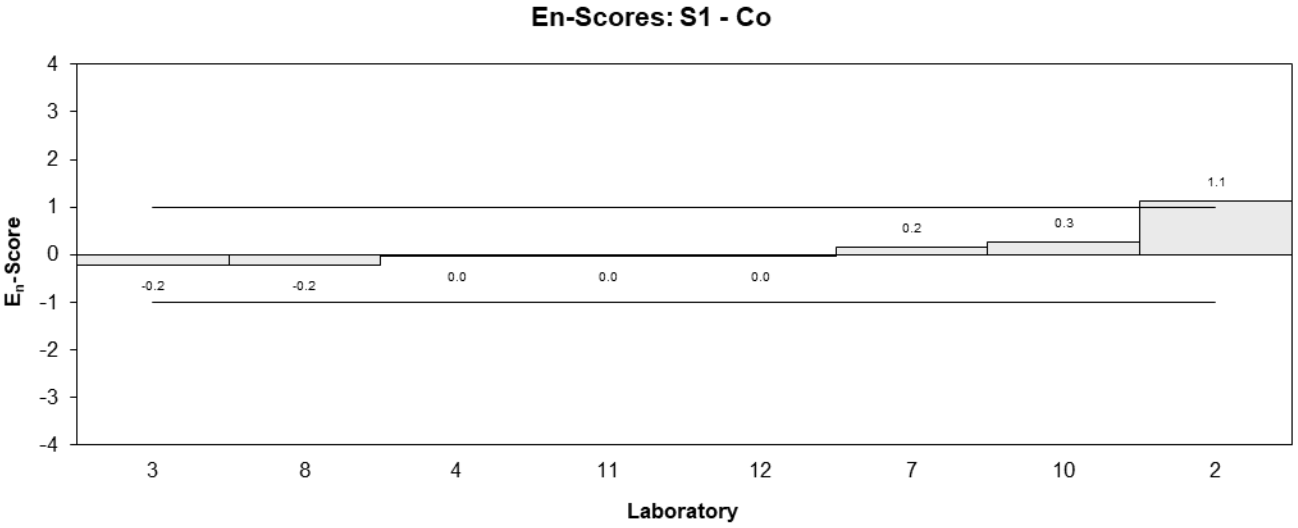

En-Scores: S1 - Co
En-Score
Laboratory
-0.2
-0.2
0.0
0.0
0.0
0.2
0.3
1.1

Figure 8

Table 13

Sample Details

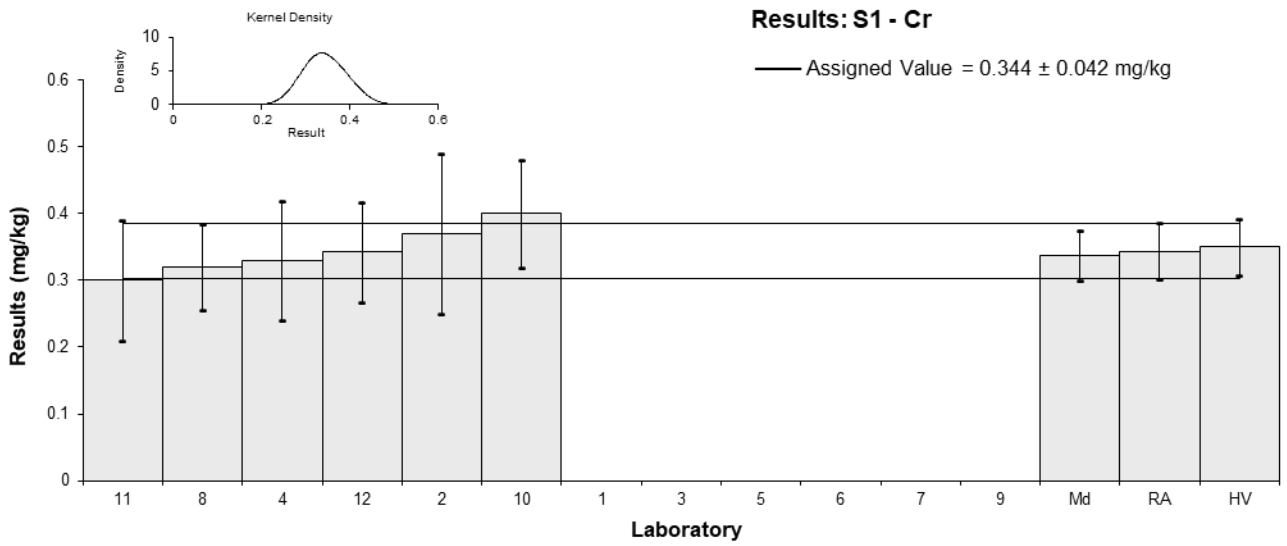
Sample No.	S1
Matrix	Wheat Flour
Analyte	Cr
Unit	mg/kg

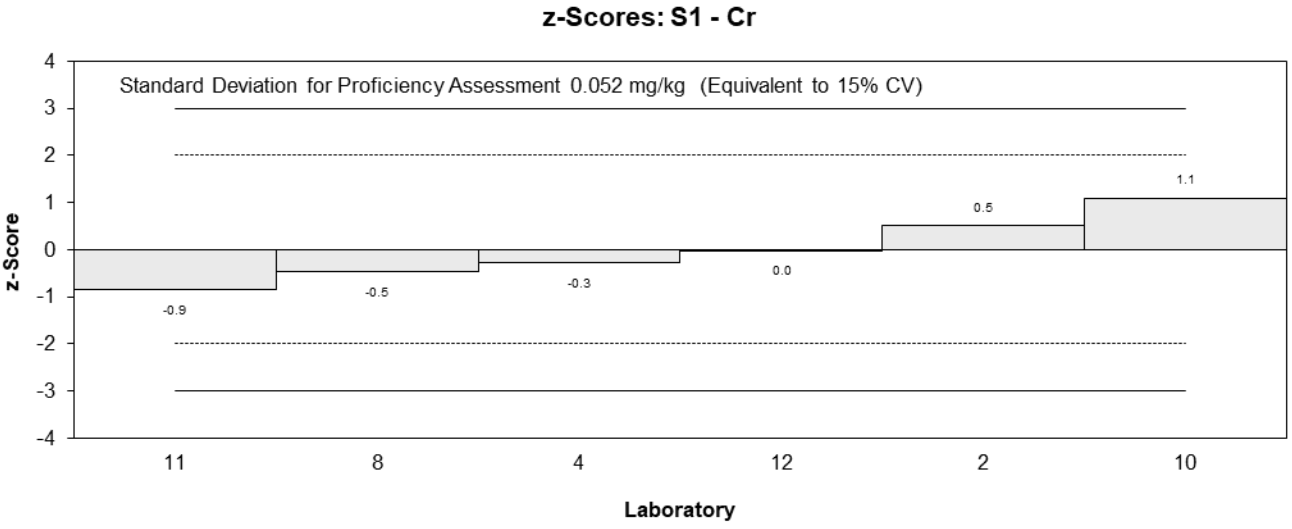
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.37	0.12	0.50	0.20
3	<0.5	NR		
4	0.33	0.09	-0.27	-0.14
5	<1.0	NR		
6	NT	NT		
7	<2	NR		
8	0.32	0.064	-0.47	-0.31
9	NT	NT		
10	0.4	0.08	1.09	0.62
11	0.30	0.09	-0.85	-0.44
12	0.343	0.075	-0.02	-0.01

Statistics

Assigned Value	0.344	0.042
Homogeneity Value	0.350	0.042
Robust Average	0.344	0.042
Median	0.337	0.038
Mean	0.344	
N	6	
Max	0.4	
Min	0.30	
Robust SD	0.041	
Robust CV	12%	


Kernel Density
Density
Result
Results: S1 - Cr
Assigned Value = 0.344 ± 0.042 mg/kg
Results (mg/kg)
Laboratory
11
8
4
12
2
10
1
3
5
6
7
9
Md
RA
HV


z-Scores: S1 - Cr
Standard Deviation for Proficiency Assessment 0.052 mg/kg (Equivalent to 15% CV)
z-Score
-0.9
-0.5
-0.3
0.0
0.5
1.1
Laboratory
11
8
4
12
2
10

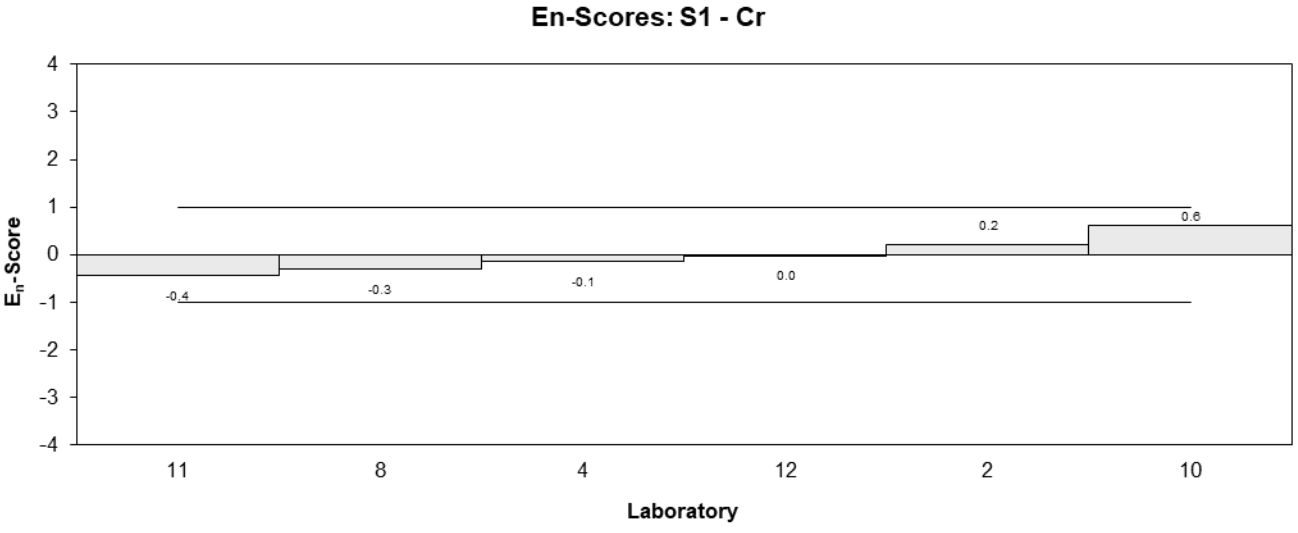

En-Scores: S1 - Cr
En-Score
-0.4
-0.3
-0.1
0.0
0.2
0.6
Laboratory
11
8
4
12
2
10

Figure 9

Table 14

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Cu
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	4.8	0.4	1.27	0.95
2	5.1	0.6	1.97	1.16
3	4.10	0.53	-0.38	-0.24
4	3.9	0.5	-0.85	-0.56
5	3.9	1.0	-0.85	-0.33
6	NT	NT		
7	4.3	0.5	0.09	0.06
8	3.5	0.7	-1.78	-0.94
9	NT	NT		
10	4.5	0.9	0.56	0.24
11	4.2	0.30	-0.14	-0.12
12	4.400	0.490	0.33	0.22

Statistics

Assigned Value	4.26	0.40
Homogeneity Value	4.08	0.49
Robust Average	4.26	0.40
Median	4.25	0.35
Mean	4.27	
N	10	
Max	5.1	
Min	3.5	
Robust SD	0.51	
Robust CV	12%	

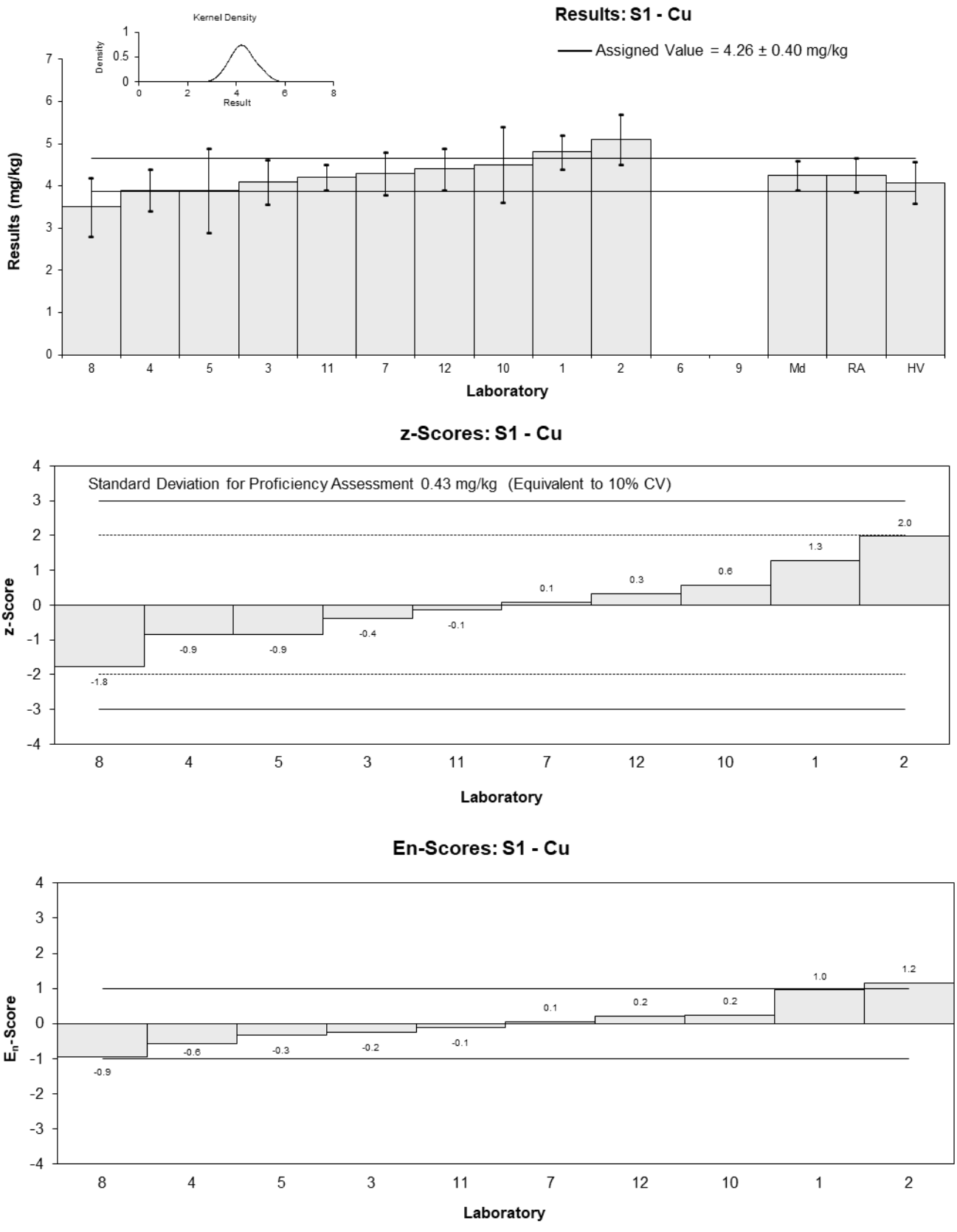

Results: S1 - Cu
Kernel Density
Density
Result
Assigned Value = 4.26 ± 0.40 mg/kg
Results (mg/kg)
Laboratory
8 4 5 3 11 7 12 10 1 2 6 9 Md RA HV
z-Scores: S1 - Cu
Standard Deviation for Proficiency Assessment 0.43 mg/kg (Equivalent to 10% CV)
z-Score
-1.8 -0.9 -0.9 -0.4 -0.1 0.1 0.3 0.6 1.3 2.0
Laboratory
8 4 5 3 11 7 12 10 1 2
En-Scores: S1 - Cu
En-Score
-0.9 -0.6 -0.3 -0.2 -0.1 0.1 0.2 0.2 1.0 1.2
Laboratory
8 4 5 3 11 7 12 10 1 2

Figure 10

Table 15

Sample Details

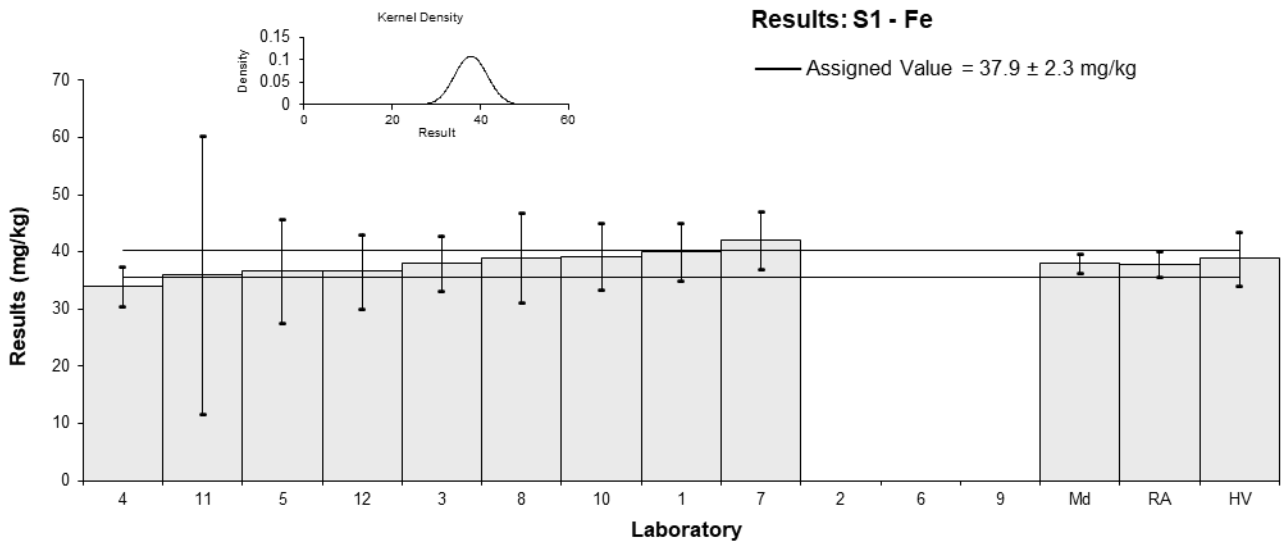
Sample No.	S1
Matrix	Wheat Flour
Analyte	Fe
Unit	mg/kg

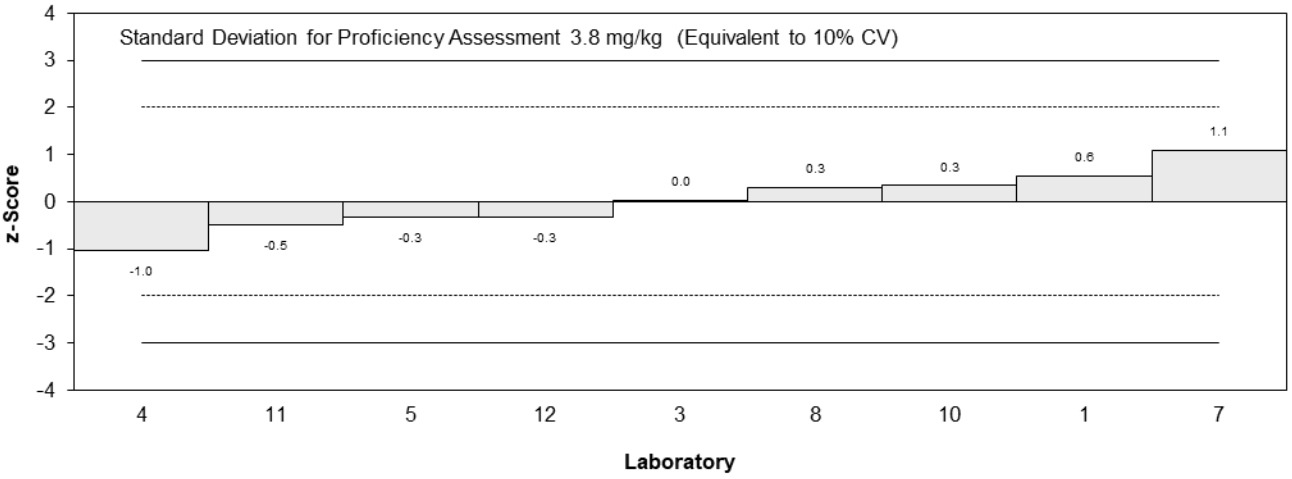
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	40	5	0.55	0.38
2	NT	NT		
3	38.0	4.9	0.03	0.02
4	34	3.4	-1.03	-0.95
5	36.6	9.1	-0.34	-0.14
6	NT	NT		
7	42	5.0	1.08	0.74
8	39	7.8	0.29	0.14
9	NT	NT		
10	39.2	5.88	0.34	0.21
11	36	24.3	-0.50	-0.08
12	36.600	6.500	-0.34	-0.19

Statistics

Assigned Value	37.9	2.3
Homogeneity Value	38.9	4.7
Robust Average	37.9	2.3
Median	38.0	1.7
Mean	37.9	
N	9	
Max	42	
Min	34	
Robust SD	2.7	
Robust CV	7.2%	


Kernel Density
Density
Result
Results: S1 - Fe
Assigned Value = 37.9 ± 2.3 mg/kg
Results (mg/kg)
Laboratory
4 11 5 12 3 8 10 1 7 2 6 9 Md RA HV


z-Scores: S1 - Fe
Standard Deviation for Proficiency Assessment 3.8 mg/kg (Equivalent to 10% CV)
z-Score
-1.0 -0.5 -0.3 -0.3 0.0 0.3 0.3 0.6 1.1
Laboratory
4 11 5 12 3 8 10 1 7

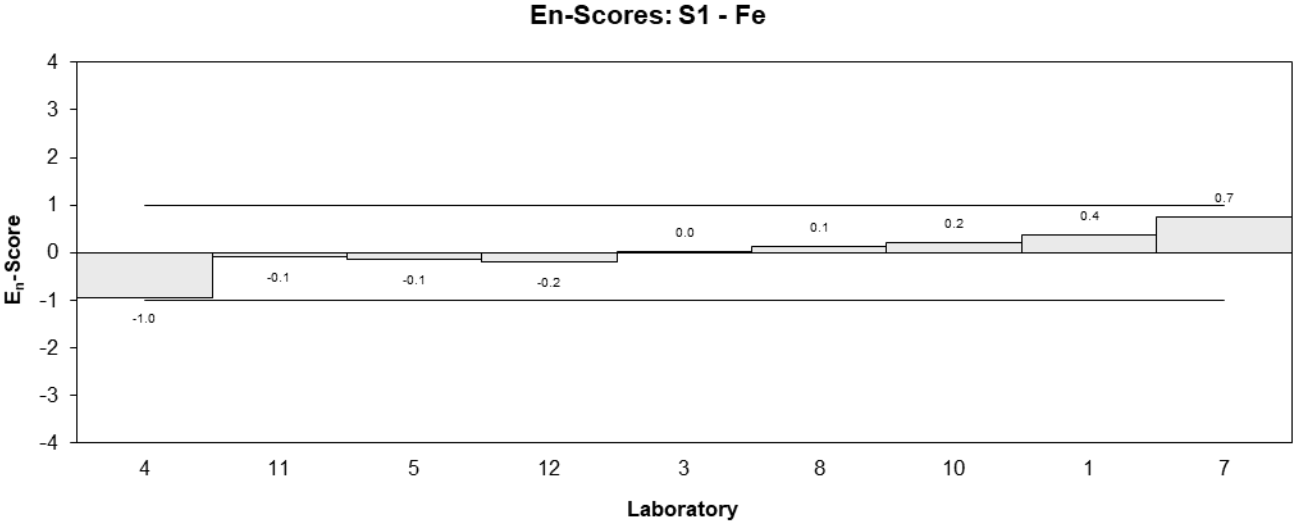

En-Scores: S1 - Fe
En-Score
-1.0 -0.1 -0.1 -0.2 0.0 0.1 0.2 0.4 0.7
Laboratory
4 11 5 12 3 8 10 1 7

Figure 11

Table 16

Sample Details

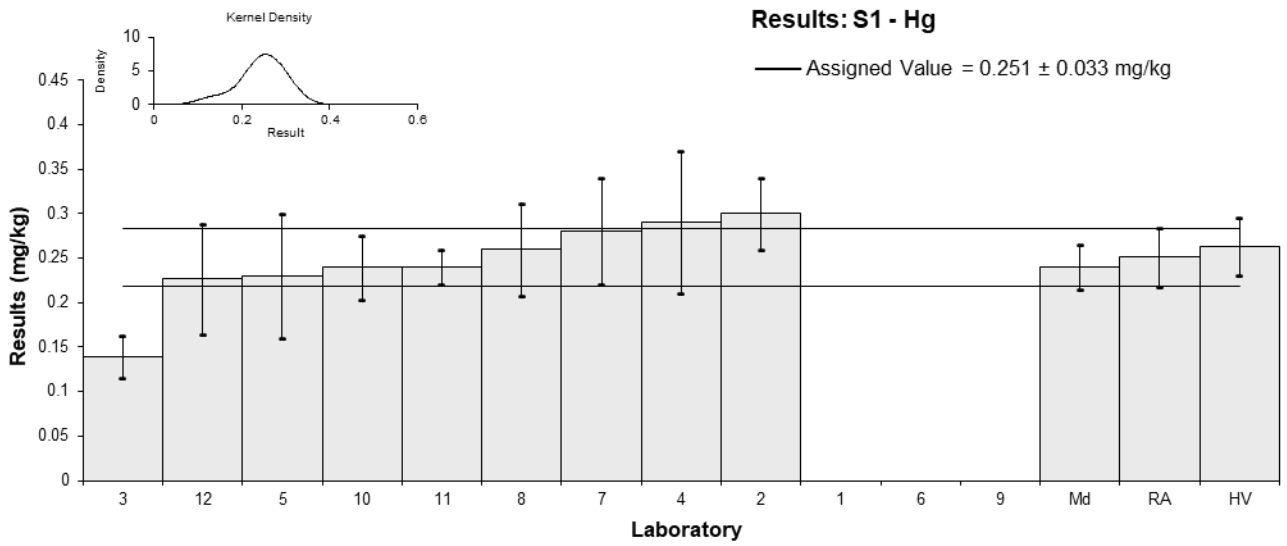
Sample No.	S1
Matrix	Wheat Flour
Analyte	Hg
Unit	mg/kg

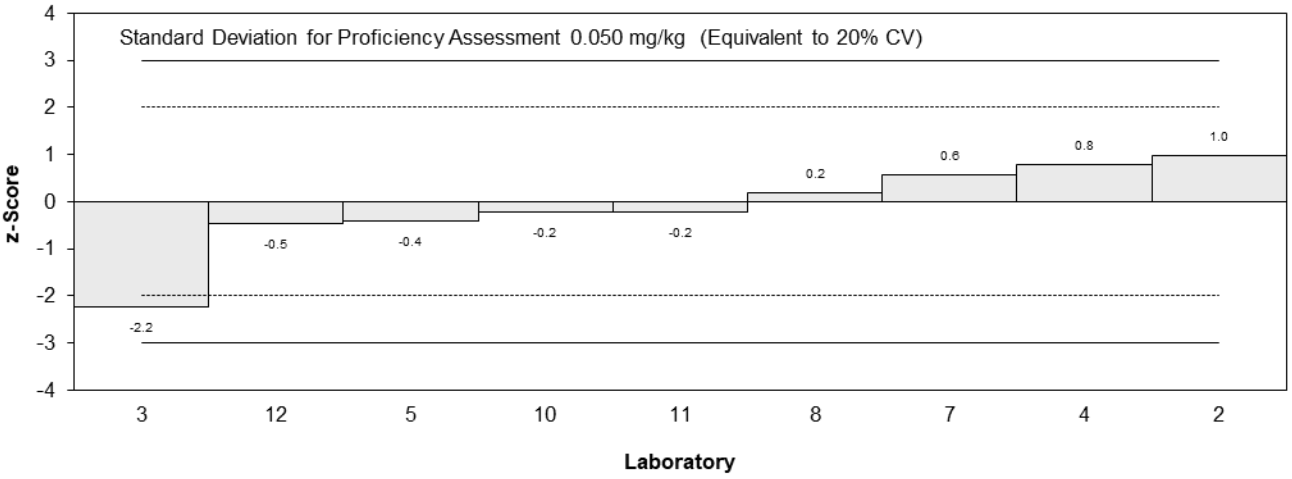
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.30	0.04	0.98	0.94
3	0.139	0.024	-2.23	-2.74
4	0.29	0.08	0.78	0.45
5	0.23	0.07	-0.42	-0.27
6	NT	NT		
7	0.28	0.06	0.58	0.42
8	0.26	0.052	0.18	0.15
9	NT	NT		
10	0.24	0.036	-0.22	-0.23
11	0.24	0.02	-0.22	-0.29
12	0.227	0.062	-0.48	-0.34

Statistics

Assigned Value	0.251	0.033
Homogeneity Value	0.263	0.032
Robust Average	0.251	0.033
Median	0.240	0.025
Mean	0.245	
N	9	
Max	0.30	
Min	0.139	
Robust SD	0.039	
Robust CV	16%	


Kernel Density
Density
Result
Results: S1 - Hg
Assigned Value = 0.251 ± 0.033 mg/kg
Results (mg/kg)
Laboratory
3 12 5 10 11 8 7 4 2 1 6 9 Md RA HV


z-Scores: S1 - Hg
Standard Deviation for Proficiency Assessment 0.050 mg/kg (Equivalent to 20% CV)
z-Score
-2.2
-0.5
-0.4
-0.2
-0.2
0.2
0.6
0.8
1.0
Laboratory
3 12 5 10 11 8 7 4 2

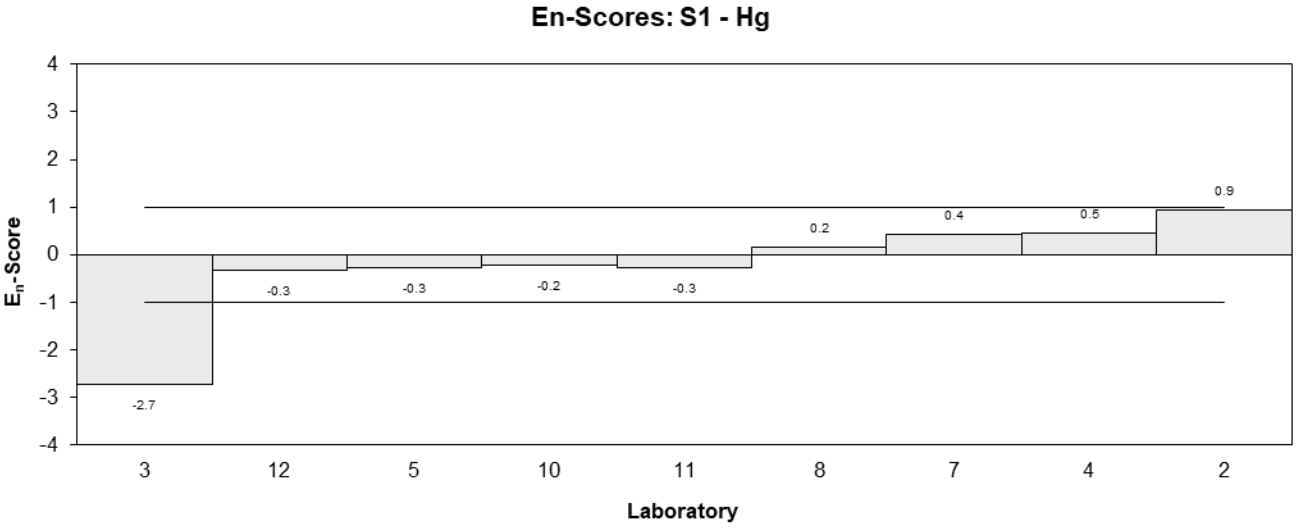

En-Scores: S1 - Hg
En-Score
-2.7
-0.3
-0.3
-0.2
-0.3
0.2
0.4
0.5
0.9
Laboratory
3 12 5 10 11 8 7 4 2

Figure 12

Table 17

Sample Details

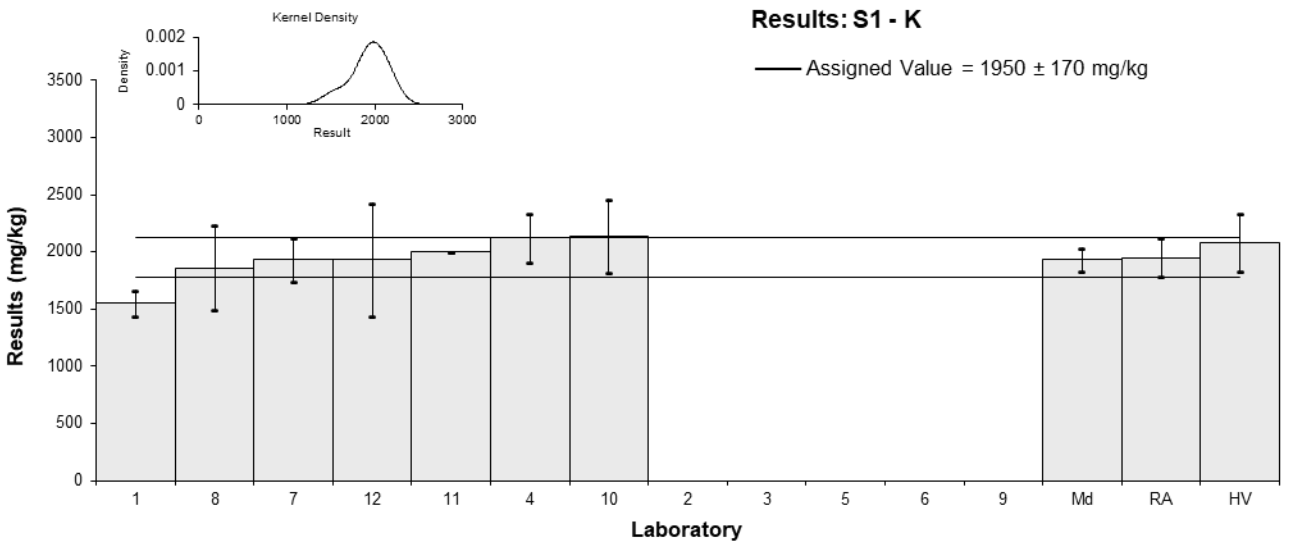
Sample No.	S1
Matrix	Wheat Flour
Analyte	K
Unit	mg/kg

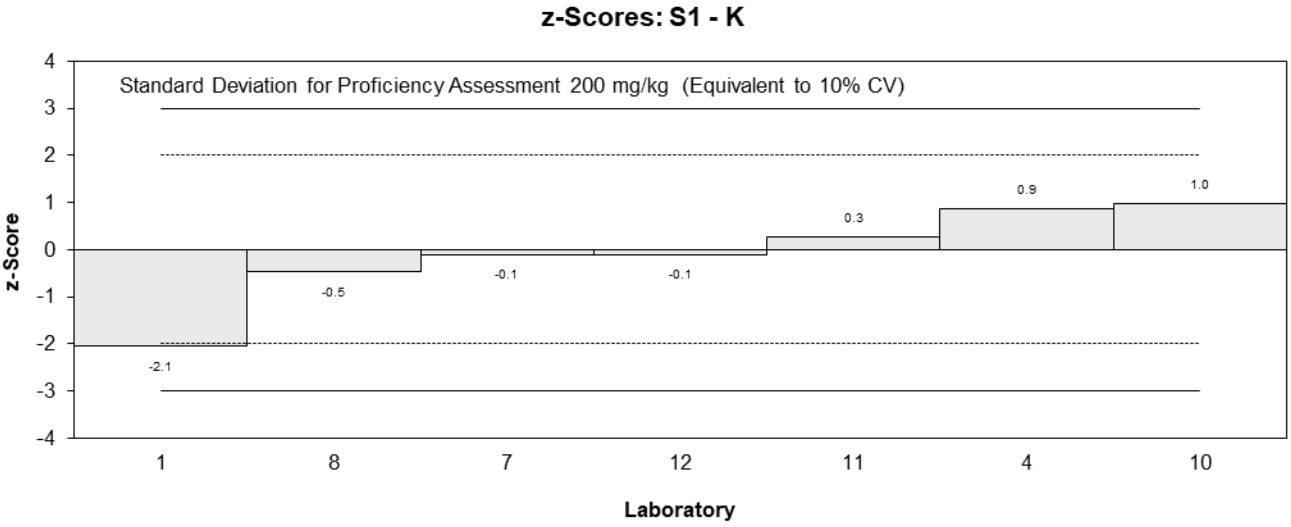
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1550	110	-2.05	-1.98
2	NT	NT		
3	NT	NT		
4	2120	212	0.87	0.63
5	NT	NT		
6	NT	NT		
7	1930	190	-0.10	-0.08
8	1860	372	-0.46	-0.22
9	NT	NT		
10	2140	321	0.97	0.52
11	2000	0.02	0.26	0.29
12	1930.000	494.000	-0.10	-0.04

Statistics

Assigned Value	1950	170
Homogeneity Value	2080	250
Robust Average	1950	170
Median	1930	100
Mean	1930	
N	7	
Max	2140	
Min	1550	
Robust SD	180	
Robust CV	9%	


Results: S1 - K
Assigned Value = 1950 ± 170 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
1
8
7
12
11
4
10
2
3
5
6
9
Md
RA
HV


z-Scores: S1 - K
Standard Deviation for Proficiency Assessment 200 mg/kg (Equivalent to 10% CV)
z-Score
-2.1
-0.5
-0.1
-0.1
0.3
0.9
1.0
Laboratory

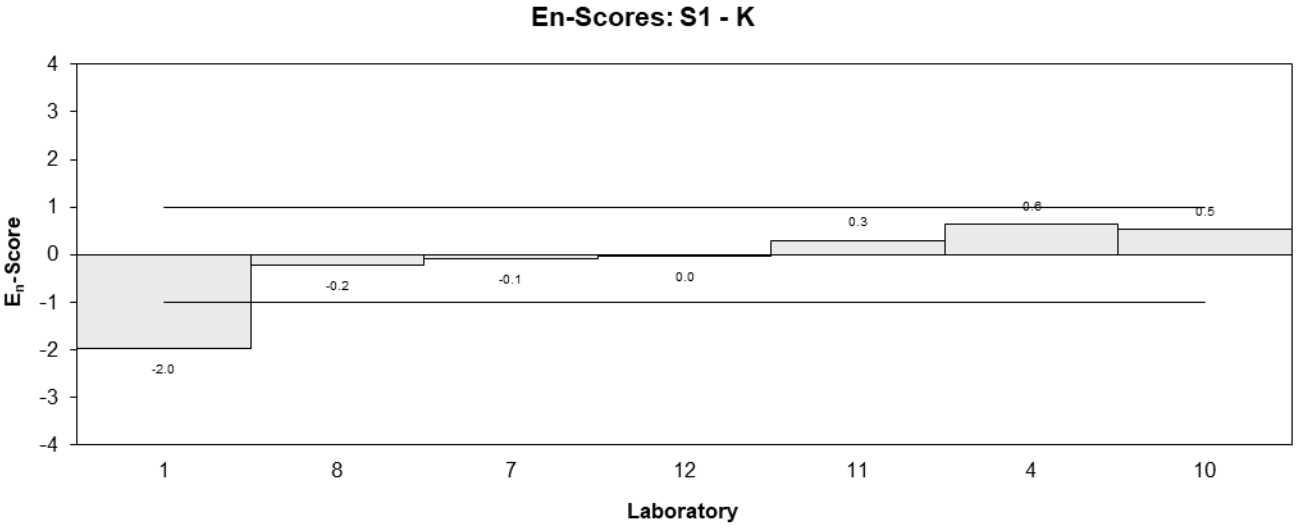

En-Scores: S1 - K
En-Score
-2.0
-0.2
-0.1
0.0
0.3
0.6
0.5
Laboratory

Figure 13

Table 18

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Li
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	0.30	0.08
5	NT	NT
6	NT	NT
7	0.31	0.06
8	0.26	0.052
9	NT	NT
10	0.31	0.047
11	NR	NR
12	0.287	0.035

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.318	0.038
Robust Average	NA (N<6)	
Median	0.300	0.017
Mean	0.293	
N	5	
Max	0.31	
Min	0.26	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

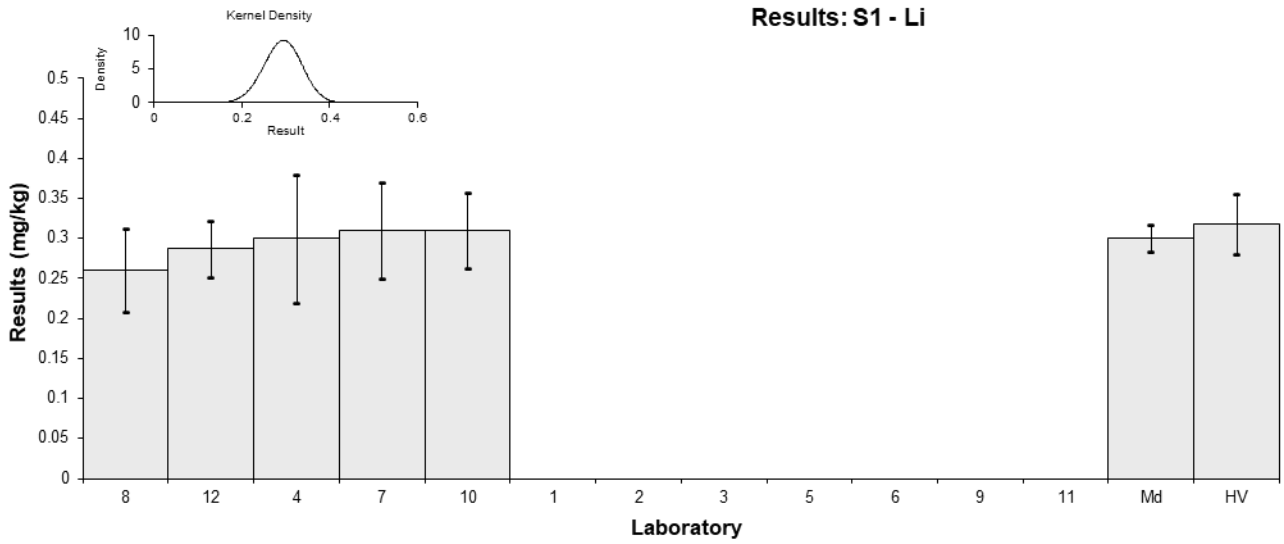

Results: S1 - Li
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8
12
4
7
10
1
2
3
5
6
9
11
Md
HV

Figure 14

Table 19

Sample Details

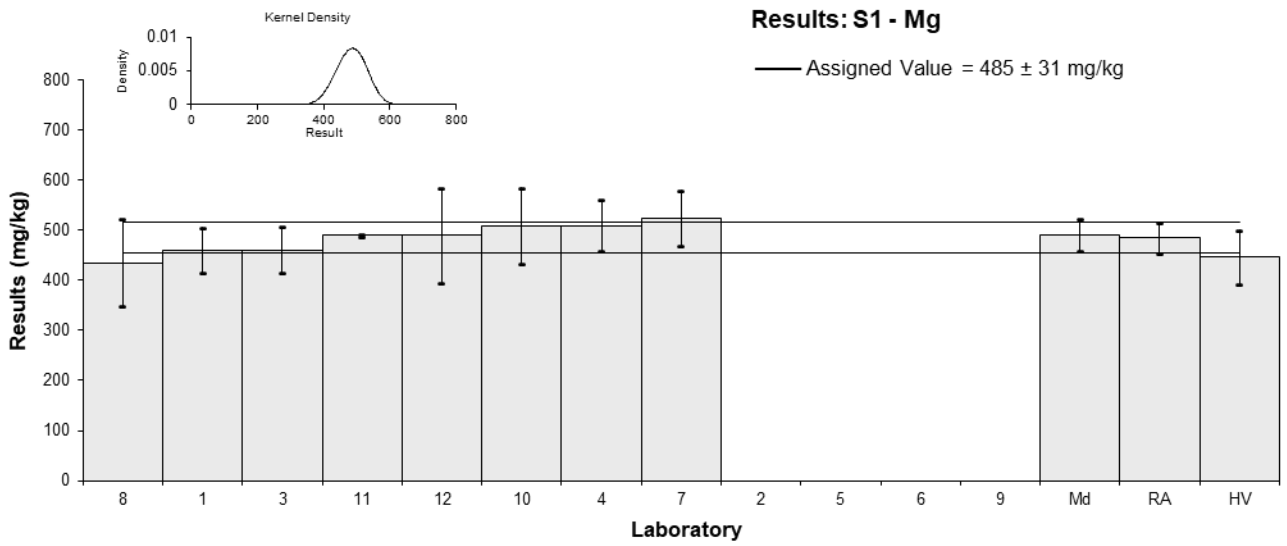
Sample No.	S1
Matrix	Wheat Flour
Analyte	Mg
Unit	mg/kg

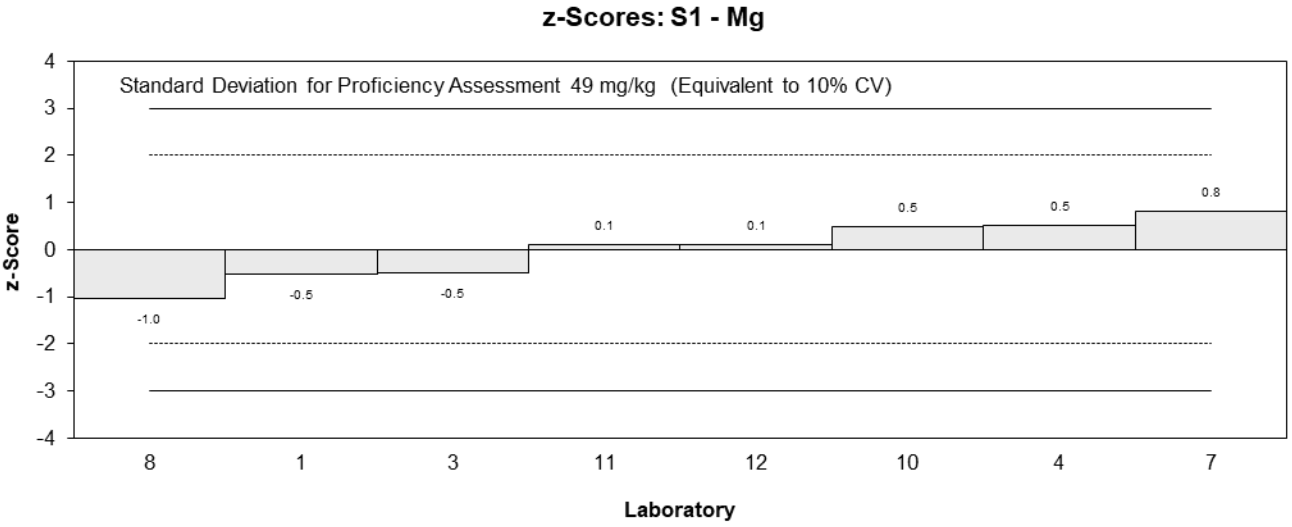
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	460	46	-0.52	-0.45
2	NT	NT		
3	461	46	-0.49	-0.43
4	510	51	0.52	0.42
5	NT	NT		
6	NT	NT		
7	525	55	0.82	0.63
8	435	87	-1.03	-0.54
9	NT	NT		
10	509	76.35	0.49	0.29
11	490	1.73	0.10	0.16
12	490.000	94.000	0.10	0.05

Statistics

Assigned Value	485	31
Homogeneity Value	447	54
Robust Average	485	31
Median	490	32
Mean	485	
N	8	
Max	525	
Min	435	
Robust SD	35	
Robust CV	7.2%	


Kernel Density
Density
0.01
0.005
0
0
200
400
600
800
Result
Results: S1 - Mg
Assigned Value = 485 ± 31 mg/kg
Results (mg/kg)
800
700
600
500
400
300
200
100
0
8
1
3
11
12
10
4
7
2
5
6
9
Md
RA
HV
Laboratory


z-Scores: S1 - Mg
Standard Deviation for Proficiency Assessment 49 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.0
-0.5
-0.5
0.1
0.1
0.5
0.5
0.8
8
1
3
11
12
10
4
7
Laboratory

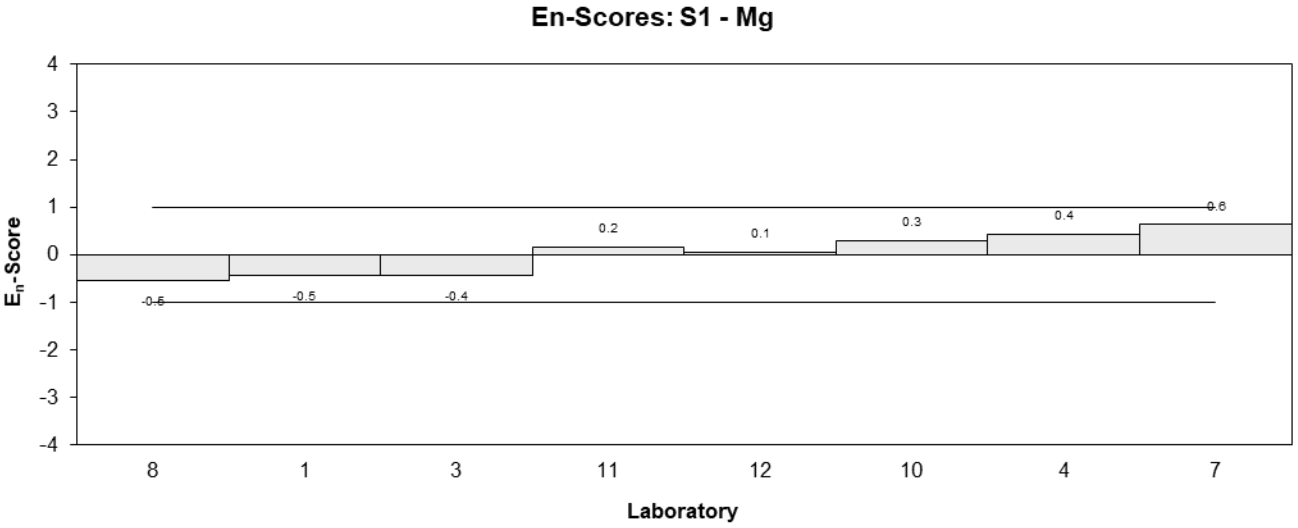

En-Scores: S1 - Mg
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.5
-0.5
-0.4
0.2
0.1
0.3
0.4
0.6
8
1
3
11
12
10
4
7
Laboratory

Figure 15

Table 20

Sample Details

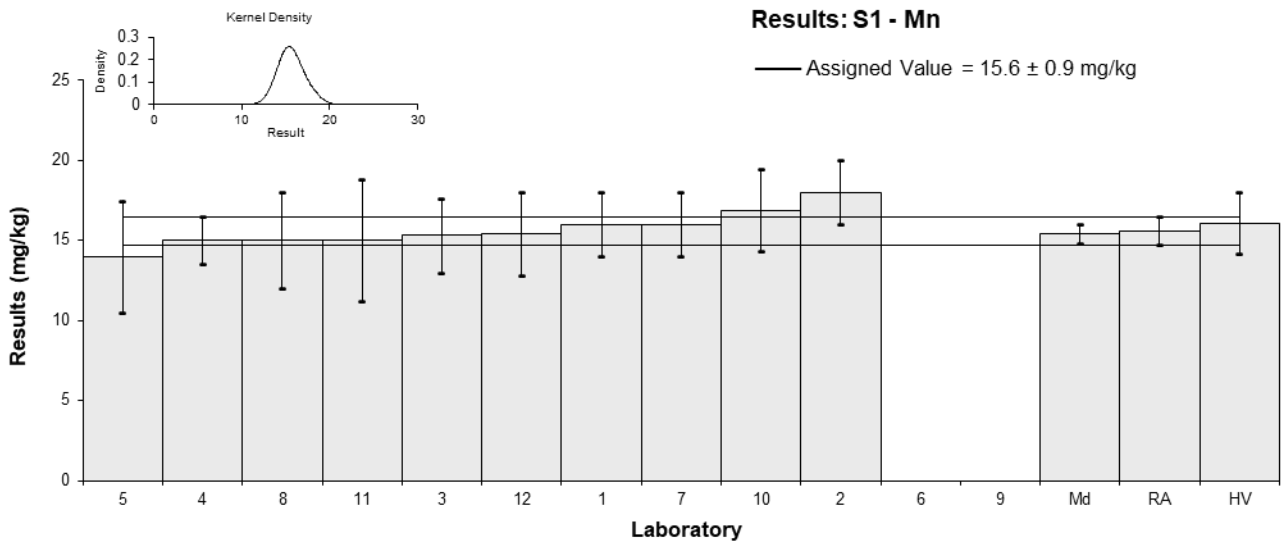
Sample No.	S1
Matrix	Wheat Flour
Analyte	Mn
Unit	mg/kg

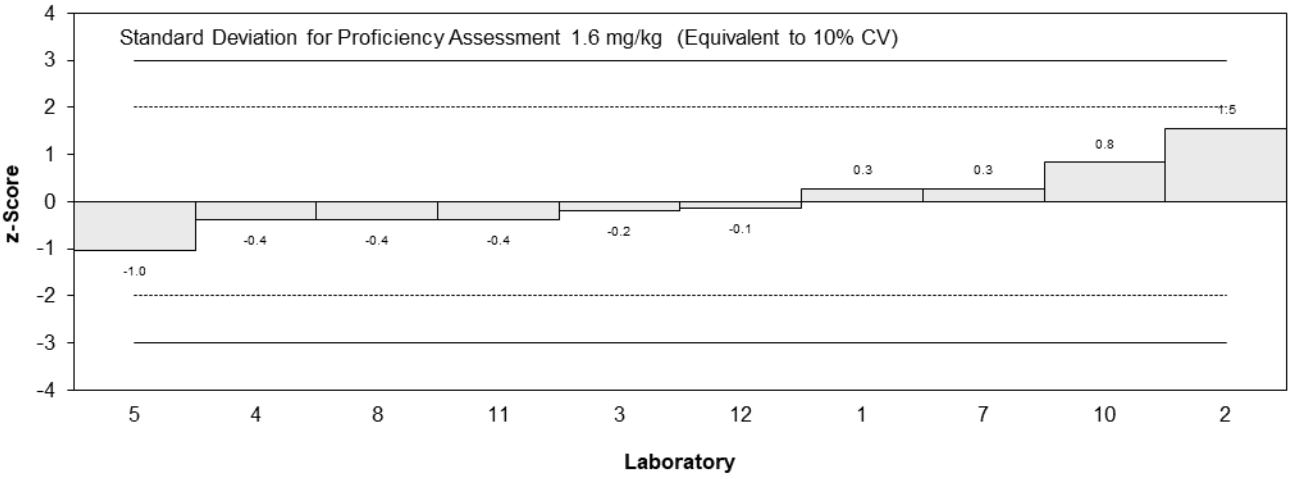
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	16	2	0.26	0.18
2	18	2	1.54	1.09
3	15.3	2.3	-0.19	-0.12
4	15	1.5	-0.38	-0.34
5	14.0	3.5	-1.03	-0.44
6	NT	NT		
7	16	2.0	0.26	0.18
8	15	3	-0.38	-0.19
9	NT	NT		
10	16.9	2.535	0.83	0.48
11	15	3.8	-0.38	-0.15
12	15.400	2.600	-0.13	-0.07

Statistics

Assigned Value	15.6	0.9
Homogeneity Value	16.1	1.9
Robust Average	15.6	0.9
Median	15.4	0.6
Mean	15.7	
N	10	
Max	18	
Min	14.0	
Robust SD	1.1	
Robust CV	7%	


Kernel Density
Density
Result
Results: S1 - Mn
Assigned Value = 15.6 ± 0.9 mg/kg
Results (mg/kg)
Laboratory
5 4 8 11 3 12 1 7 10 2 6 9 Md RA HV


z-Scores: S1 - Mn
Standard Deviation for Proficiency Assessment 1.6 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
5 4 8 11 3 12 1 7 10 2
-1.0 -0.4 -0.4 -0.4 -0.2 -0.1 0.3 0.3 0.8 1.5

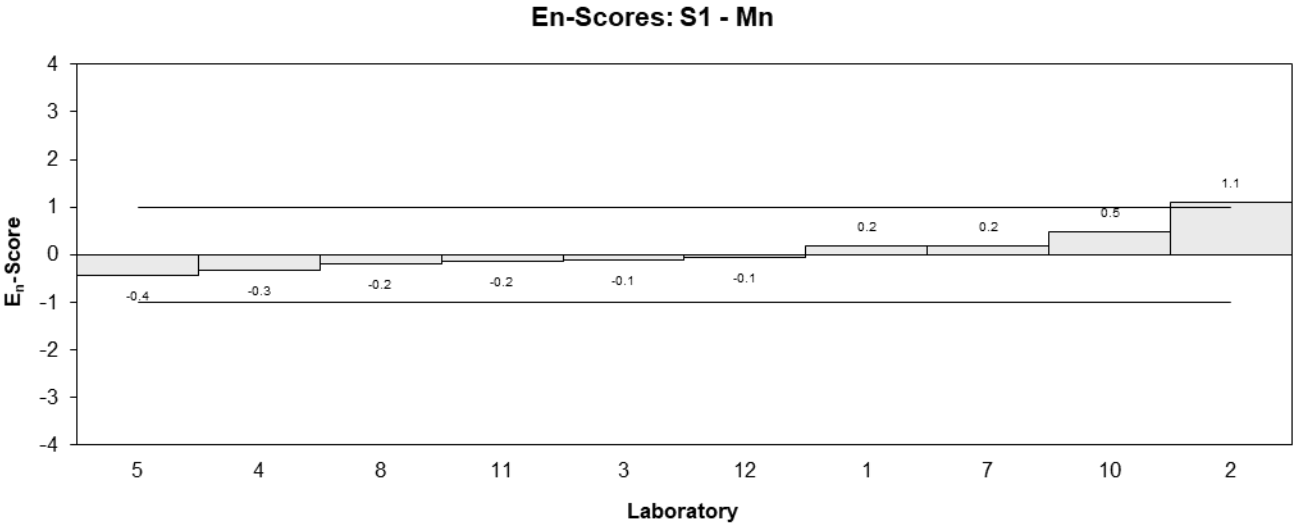

En-Scores: S1 - Mn
En-Score
Laboratory
5 4 8 11 3 12 1 7 10 2
-0.4 -0.3 -0.2 -0.2 -0.1 -0.1 0.2 0.2 0.5 1.1

Figure 16

Table 21

Sample Details

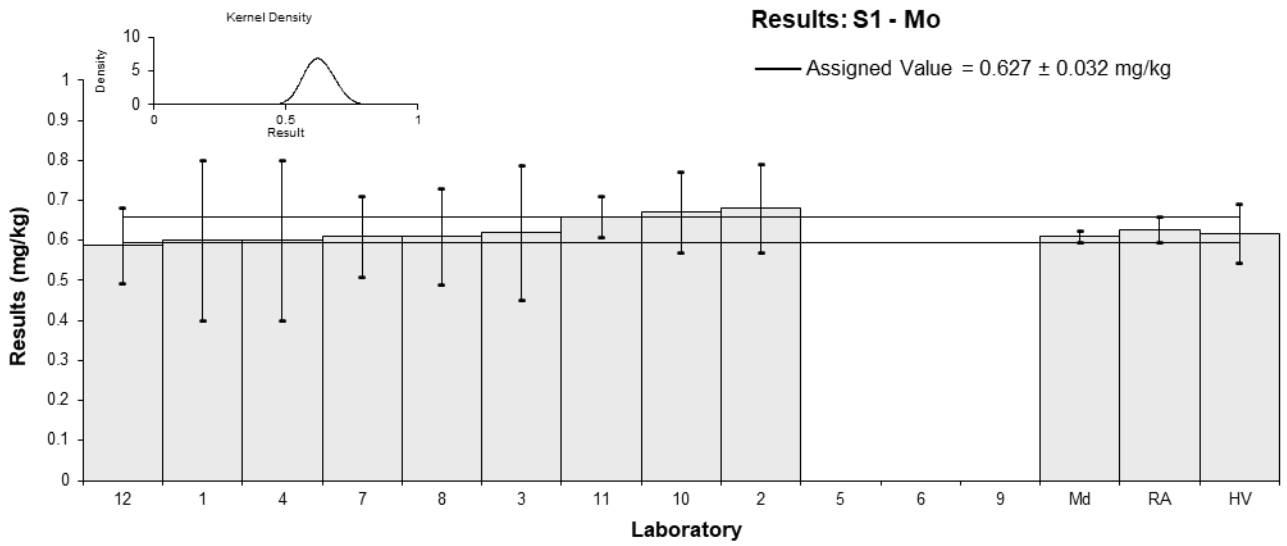
Sample No.	S1
Matrix	Wheat Flour
Analyte	Mo
Unit	mg/kg

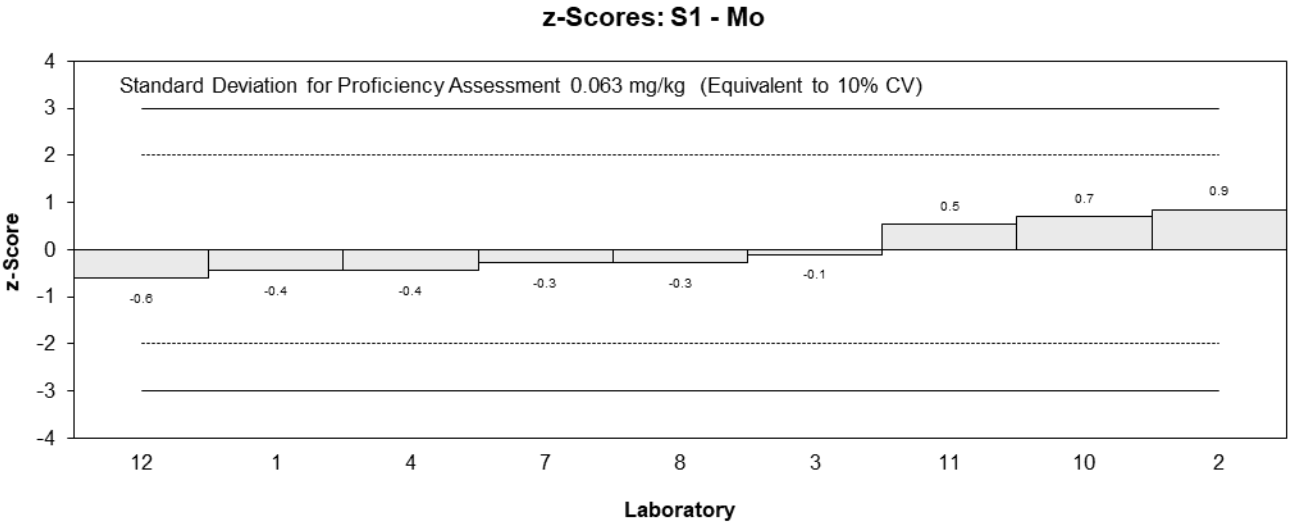
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.6	0.2	-0.43	-0.13
2	0.68	0.11	0.85	0.46
3	0.621	0.168	-0.10	-0.04
4	0.60	0.2	-0.43	-0.13
5	<1.0	NR		
6	NT	NT		
7	0.61	0.1	-0.27	-0.16
8	0.61	0.12	-0.27	-0.14
9	NT	NT		
10	0.67	0.101	0.69	0.41
11	0.66	0.05	0.53	0.56
12	0.589	0.095	-0.61	-0.38

Statistics

Assigned Value	0.627	0.032
Homogeneity Value	0.618	0.074
Robust Average	0.627	0.032
Median	0.610	0.014
Mean	0.627	
N	9	
Max	0.68	
Min	0.589	
Robust SD	0.039	
Robust CV	6.2%	


Kernel Density
Density
Result
Results: S1 - Mo
Assigned Value = 0.627 ± 0.032 mg/kg
Results (mg/kg)
Laboratory
12
1
4
7
8
3
11
10
2
5
6
9
Md
RA
HV


z-Scores: S1 - Mo
Standard Deviation for Proficiency Assessment 0.063 mg/kg (Equivalent to 10% CV)
z-Score
-0.6
-0.4
-0.4
-0.3
-0.3
-0.1
0.5
0.7
0.9
Laboratory

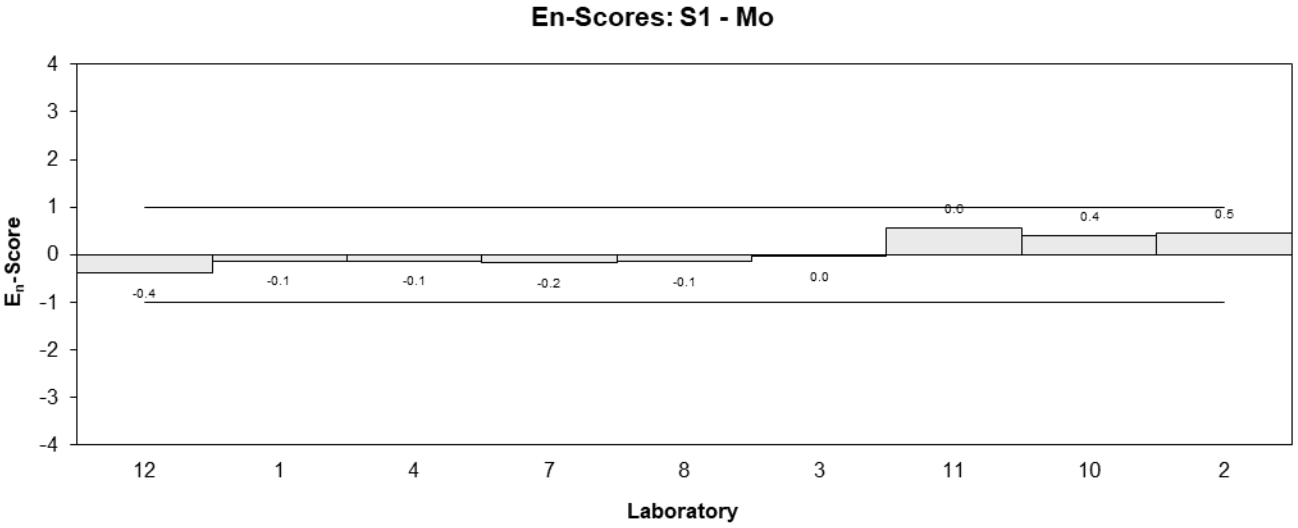

En-Scores: S1 - Mo
En-Score
-0.4
-0.1
-0.1
-0.2
-0.1
0.0
0.6
0.4
0.5
Laboratory

Figure 17

Table 22

Sample Details

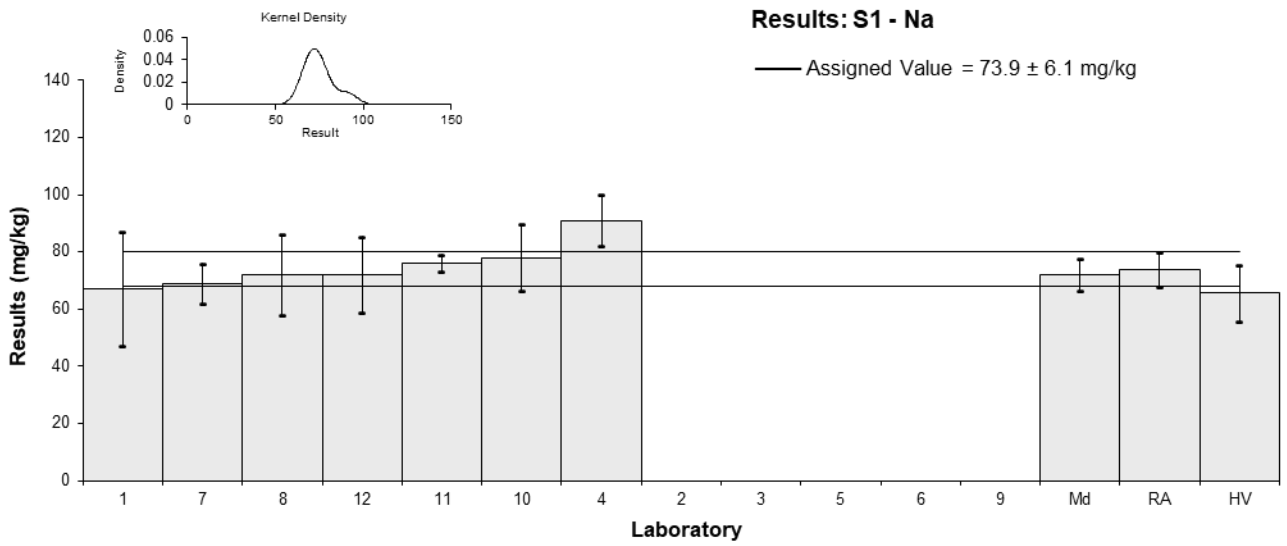
Sample No.	S1
Matrix	Wheat Flour
Analyte	Na
Unit	mg/kg

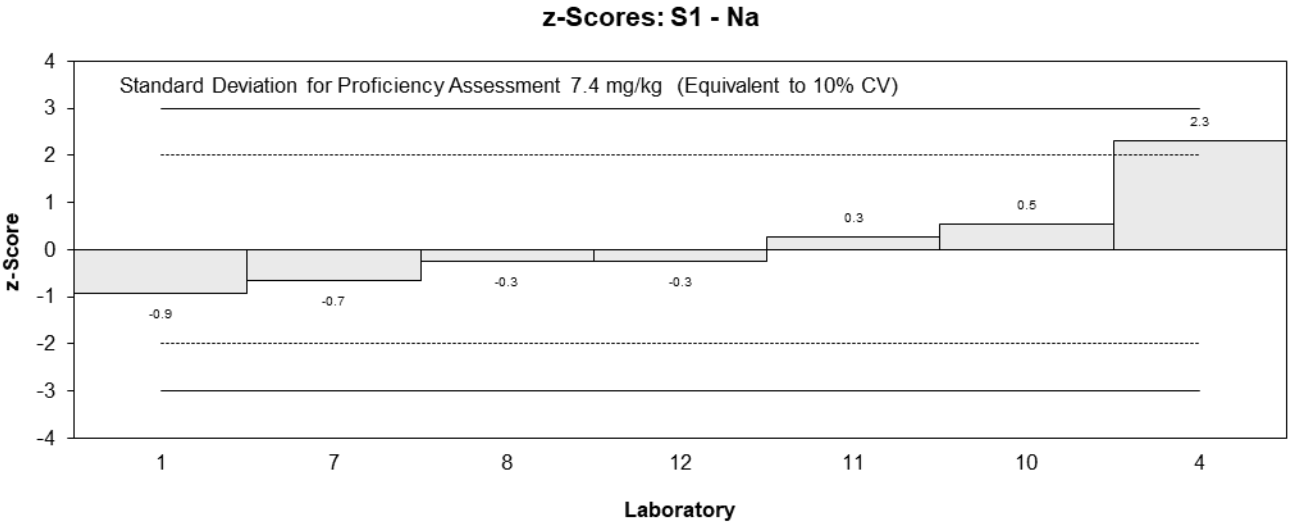
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	67	20	-0.93	-0.33
2	NT	NT		
3	NT	NT		
4	91	9	2.31	1.57
5	NT	NT		
6	NT	NT		
7	69	7.0	-0.66	-0.53
8	72	14	-0.26	-0.12
9	NT	NT		
10	77.9	11.685	0.54	0.30
11	76	3.018	0.28	0.31
12	72.000	13.400	-0.26	-0.13

Statistics

Assigned Value	73.9	6.1
Homogeneity Value	65.5	9.8
Robust Average	73.9	6.1
Median	72.0	5.6
Mean	75.0	
N	7	
Max	91	
Min	67	
Robust SD	6.4	
Robust CV	8.7%	


Kernel Density
Density
0.06
0.04
0.02
0
0
50
100
150
Result
Results: S1 - Na
Assigned Value = 73.9 ± 6.1 mg/kg
Results (mg/kg)
140
120
100
80
60
40
20
0
1
7
8
12
11
10
4
2
3
5
6
9
Md
RA
HV
Laboratory


z-Scores: S1 - Na
Standard Deviation for Proficiency Assessment 7.4 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.9
-0.7
-0.3
-0.3
0.3
0.5
2.3
1
7
8
12
11
10
4
Laboratory

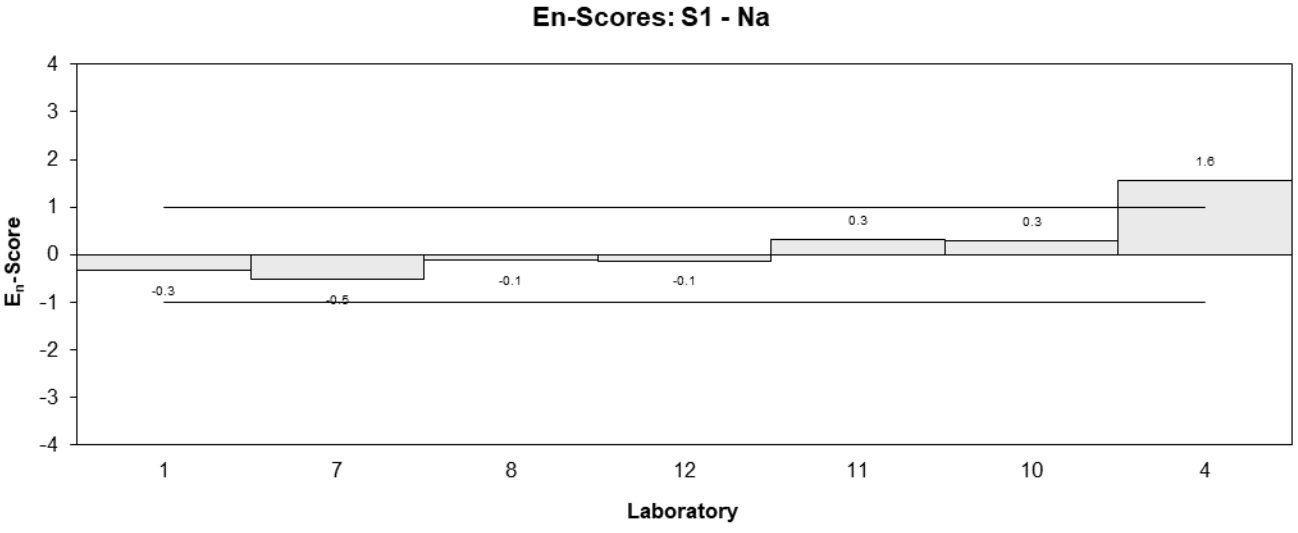

En-Scores: S1 - Na
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.3
-0.5
-0.1
-0.1
0.3
0.3
1.6
1
7
8
12
11
10
4
Laboratory

Figure 18

Table 23

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Ni
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.66	0.38	1.86	0.37
3	<0.7	NR		
4	0.50	0.13	-0.21	-0.11
5	<1.0	NR		
6	NT	NT		
7	<1	NR		
8	0.50	0.10	-0.21	-0.14
9	NT	NT		
10	0.5	0.075	-0.21	-0.16
11	0.54	0.10	0.31	0.20
12	0.446	0.106	-0.90	-0.57

Statistics

Assigned Value	0.516	0.063
Homogeneity Value	0.528	0.063
Robust Average	0.516	0.063
Median	0.500	0.030
Mean	0.524	
N	6	
Max	0.66	
Min	0.446	
Robust SD	0.061	
Robust CV	12%	

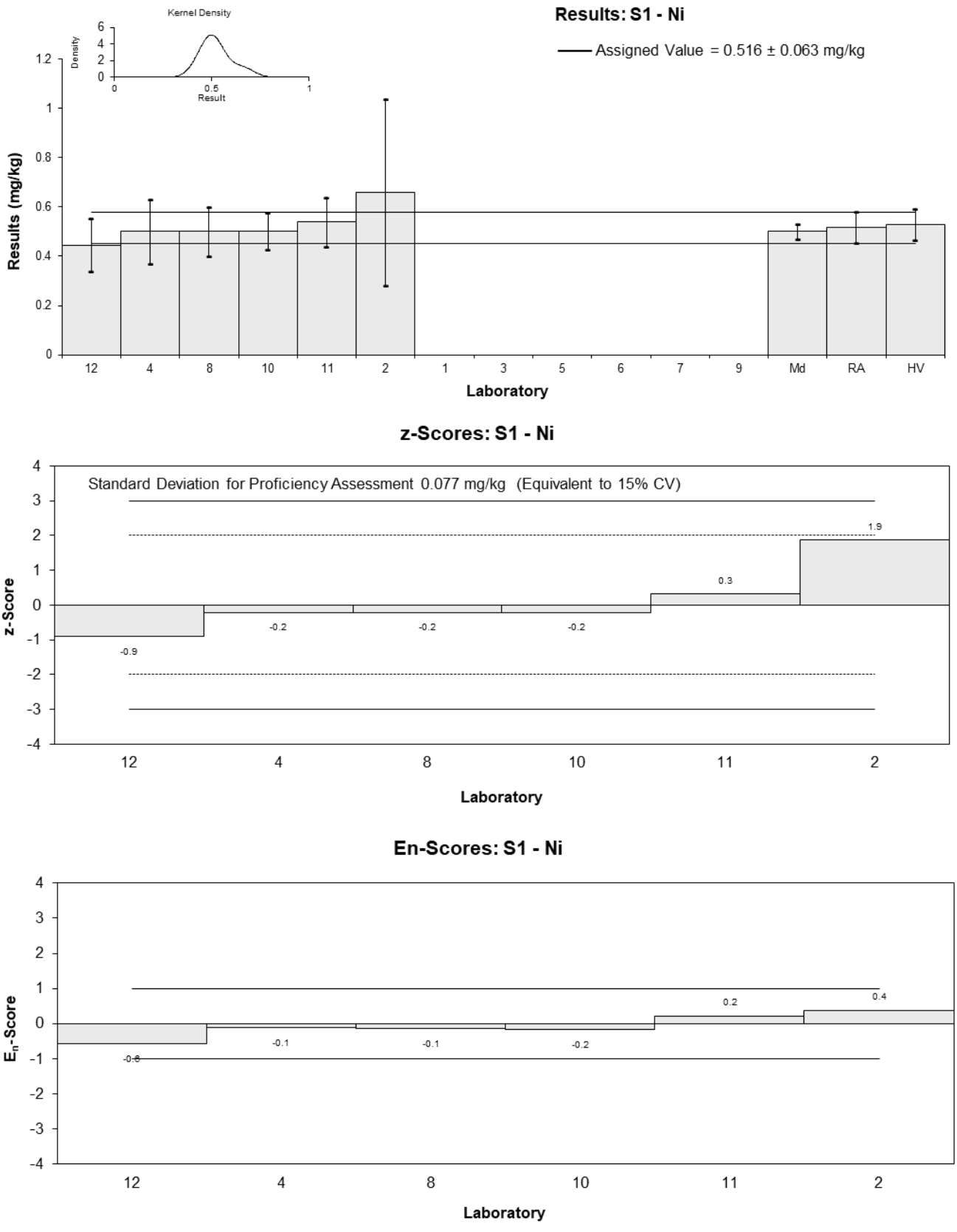

Kernel Density
Density
Result
Results: S1 - Ni
Assigned Value = 0.516 ± 0.063 mg/kg
Results (mg/kg)
Laboratory
12
4
8
10
11
2
1
3
5
6
7
9
Md
RA
HV
z-Scores: S1 - Ni
Standard Deviation for Proficiency Assessment 0.077 mg/kg (Equivalent to 15% CV)
z-Score
-0.9
-0.2
-0.2
-0.2
0.3
1.9
En-Scores: S1 - Ni
En-Score
-0.6
-0.1
-0.1
-0.2
0.2
0.4

Figure 19

Table 24

Sample Details

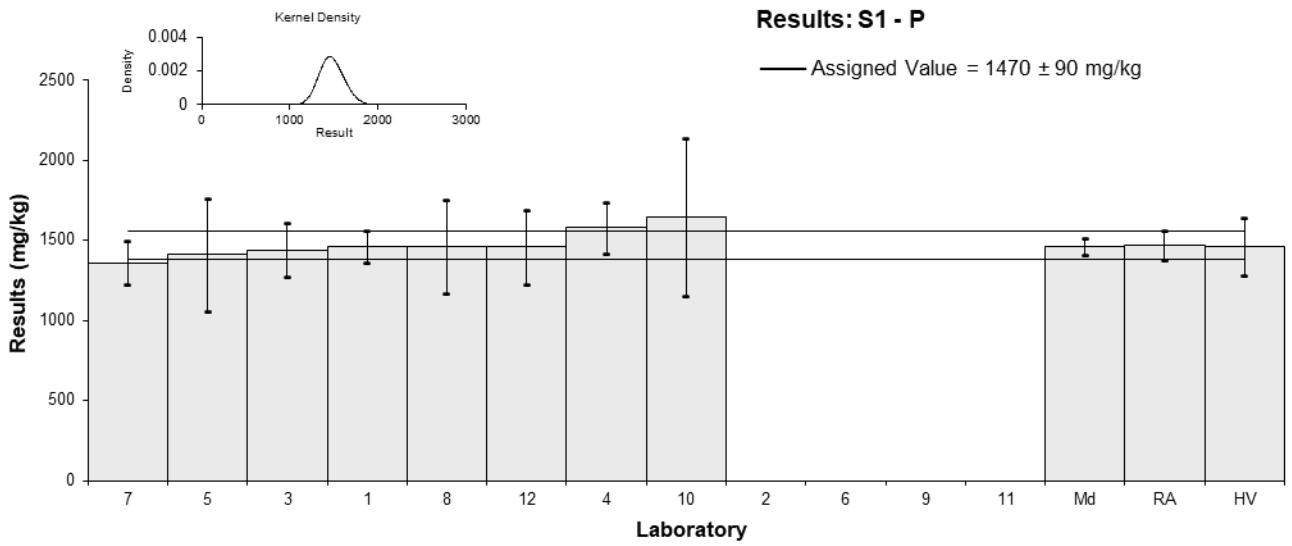
Sample No.	S1
Matrix	Wheat Flour
Analyte	P
Unit	mg/kg

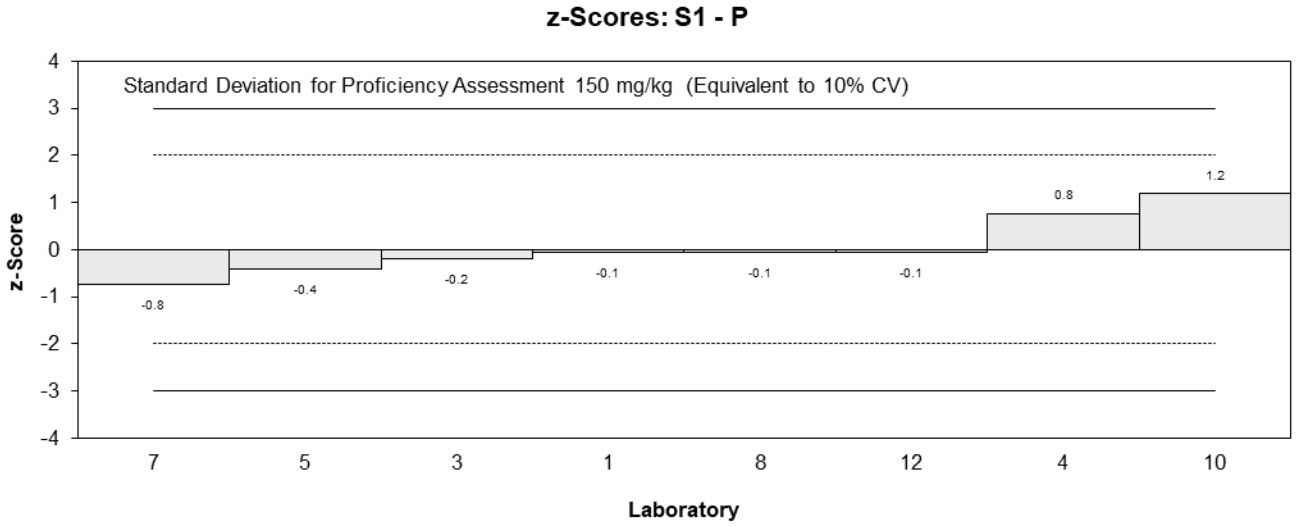
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1460	100	-0.07	-0.07
2	NT	NT		
3	1440	170	-0.20	-0.16
4	1580	160	0.75	0.60
5	1410	350	-0.41	-0.17
6	NT	NT		
7	1360	135	-0.75	-0.68
8	1460	292	-0.07	-0.03
9	NT	NT		
10	1644	493.2	1.18	0.35
11	NR	NR		
12	1460.000	232.000	-0.07	-0.04

Statistics

Assigned Value	1470	90
Homogeneity Value	1460	180
Robust Average	1470	90
Median	1460	50
Mean	1480	
N	8	
Max	1644	
Min	1360	
Robust SD	97	
Robust CV	6.6%	


Kernel Density
Density
0.004
0.002
0
0
1000
2000
3000
Result
Results: S1 - P
Assigned Value = 1470 ± 90 mg/kg
Results (mg/kg)
2500
2000
1500
1000
500
0
7
5
3
1
8
12
4
10
2
6
9
11
Md
RA
HV
Laboratory


z-Scores: S1 - P
Standard Deviation for Proficiency Assessment 150 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8
-0.4
-0.2
-0.1
-0.1
-0.1
0.8
1.2
7
5
3
1
8
12
4
10
Laboratory

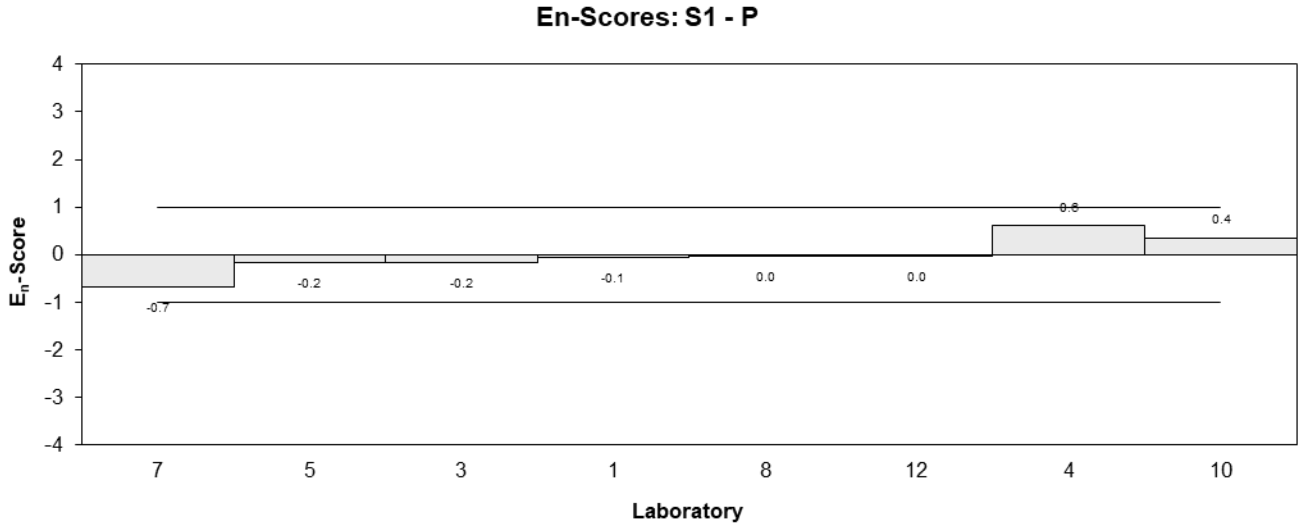

En-Scores: S1 - P
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7
-0.2
-0.2
-0.1
0.0
0.0
0.6
0.4
7
5
3
1
8
12
4
10
Laboratory

Figure 20

Table 25

Sample Details

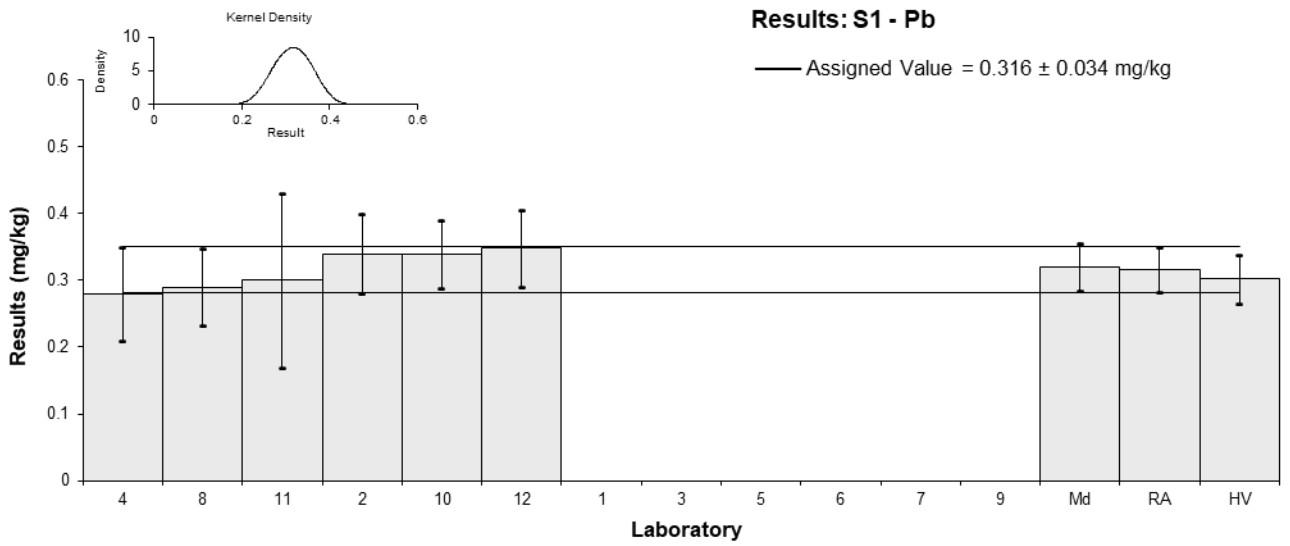
Sample No.	S1
Matrix	Wheat Flour
Analyte	Pb
Unit	mg/kg

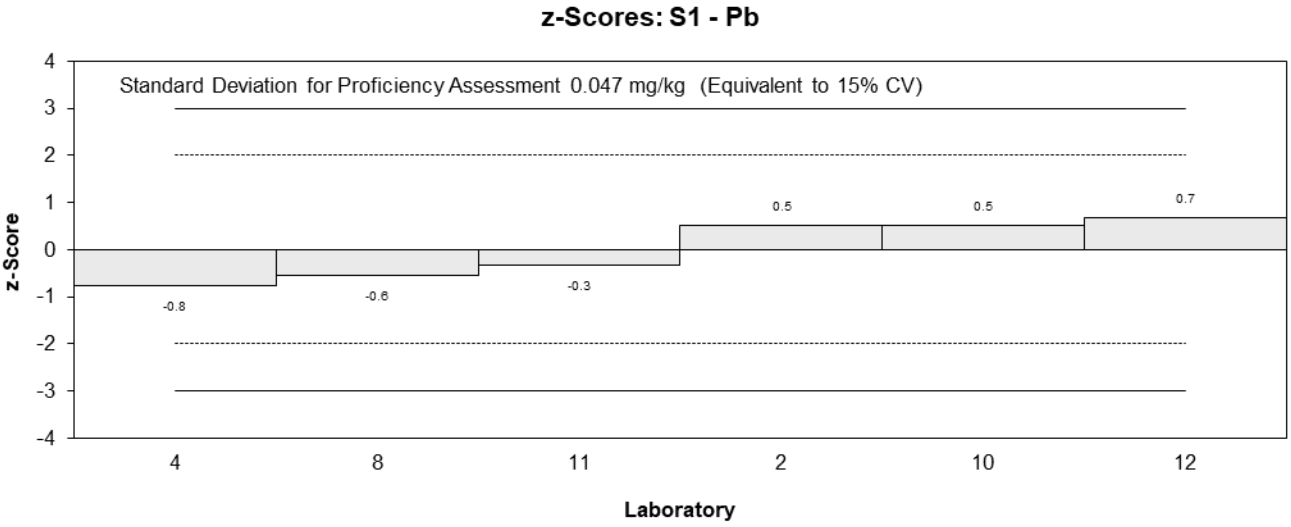
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.34	0.06	0.51	0.35
3	<1	NR		
4	0.28	0.07	-0.76	-0.46
5	<1.0	NR		
6	NT	NT		
7	<1	NR		
8	0.29	0.058	-0.55	-0.39
9	NT	NT		
10	0.34	0.051	0.51	0.39
11	0.30	0.13	-0.34	-0.12
12	0.348	0.057	0.68	0.48

Statistics

Assigned Value	0.316	0.034
Homogeneity Value	0.302	0.036
Robust Average	0.316	0.034
Median	0.320	0.036
Mean	0.316	
N	6	
Max	0.348	
Min	0.28	
Robust SD	0.034	
Robust CV	11%	


Kernel Density
Density
Result
Results: S1 - Pb
Assigned Value = 0.316 ± 0.034 mg/kg
Results (mg/kg)
Laboratory
4
8
11
2
10
12
1
3
5
6
7
9
Md
RA
HV


z-Scores: S1 - Pb
Standard Deviation for Proficiency Assessment 0.047 mg/kg (Equivalent to 15% CV)
z-Score
-0.8
-0.6
-0.3
0.5
0.5
0.7
Laboratory

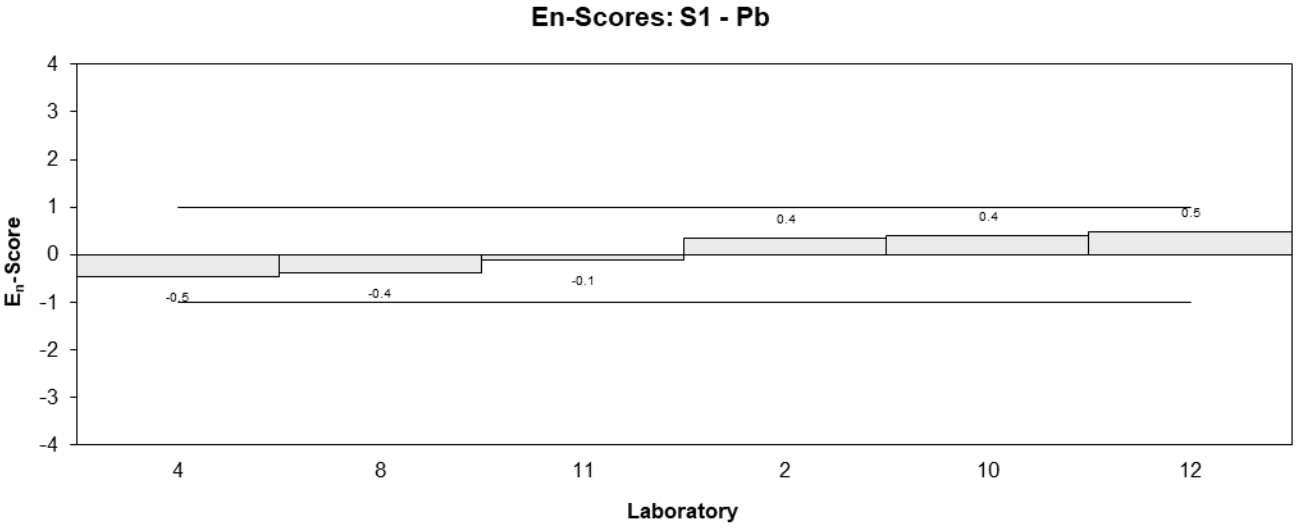

En-Scores: S1 - Pb
En-Score
-0.5
-0.4
-0.1
0.4
0.4
0.5
Laboratory

Figure 21

Table 26

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Rb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	2.4	0.6
5	NT	NT
6	NT	NT
7	NT	NT
8	2.2	0.44
9	NT	NT
10	2.4	0.24
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Homogeneity Value	2.47	0.30
Robust Average	NA (N<6)	
Median	2.40	0.11
Mean	2.33	
N	3	
Max	2.4	
Min	2.2	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

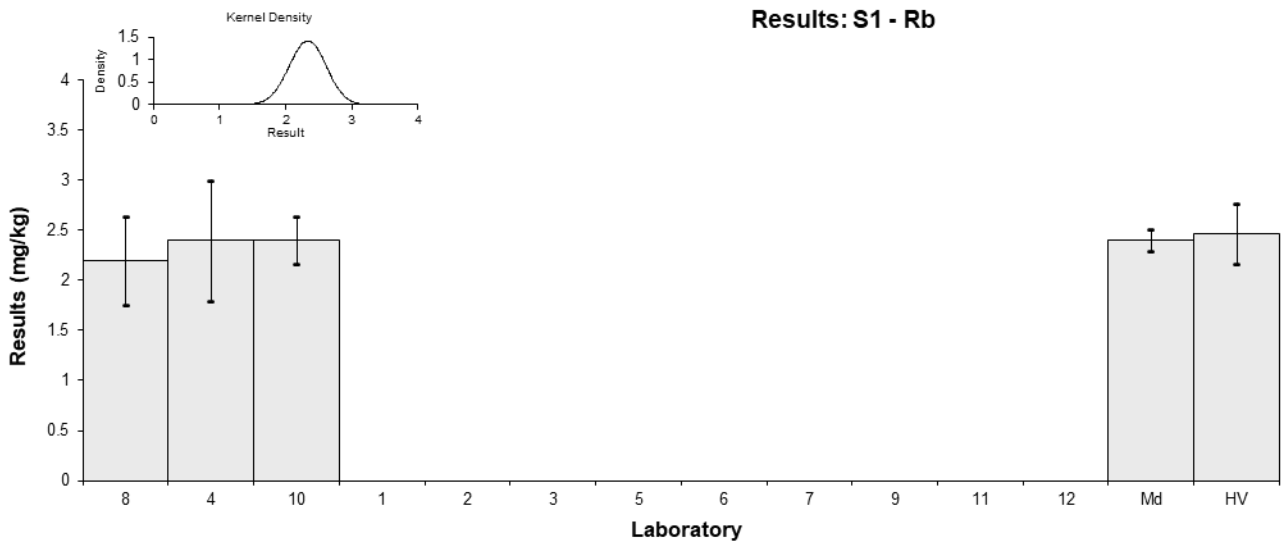

Results: S1 - Rb
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8
4
10
1
2
3
5
6
7
9
11
12
Md
HV

Figure 22

Table 27

Sample Details

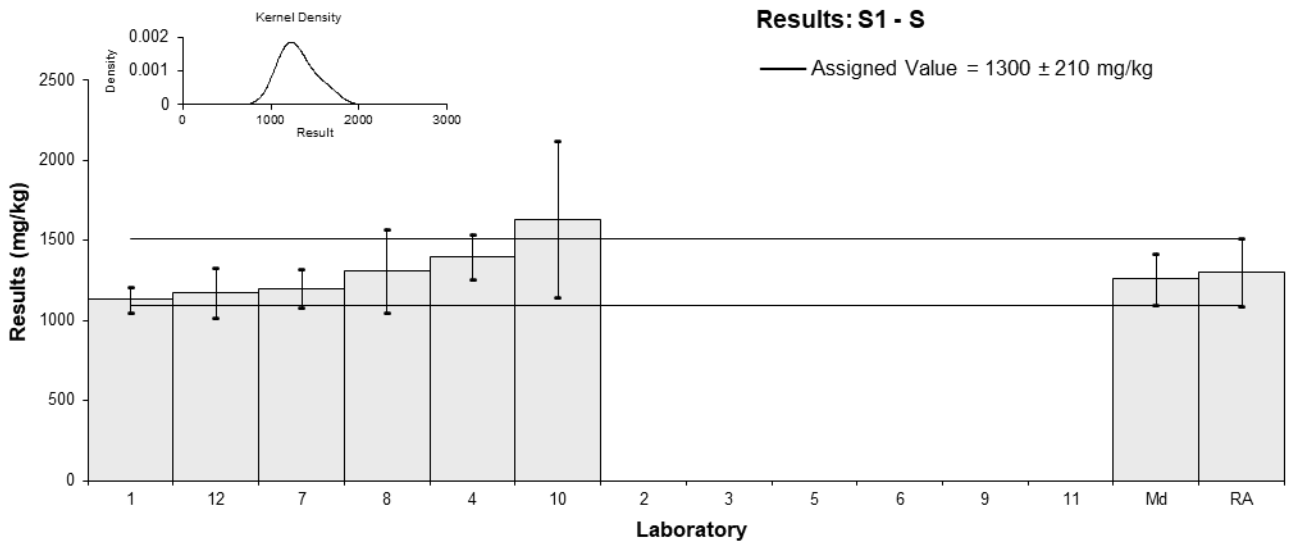
Sample No.	S1
Matrix	Wheat Flour
Analyte	S
Unit	mg/kg

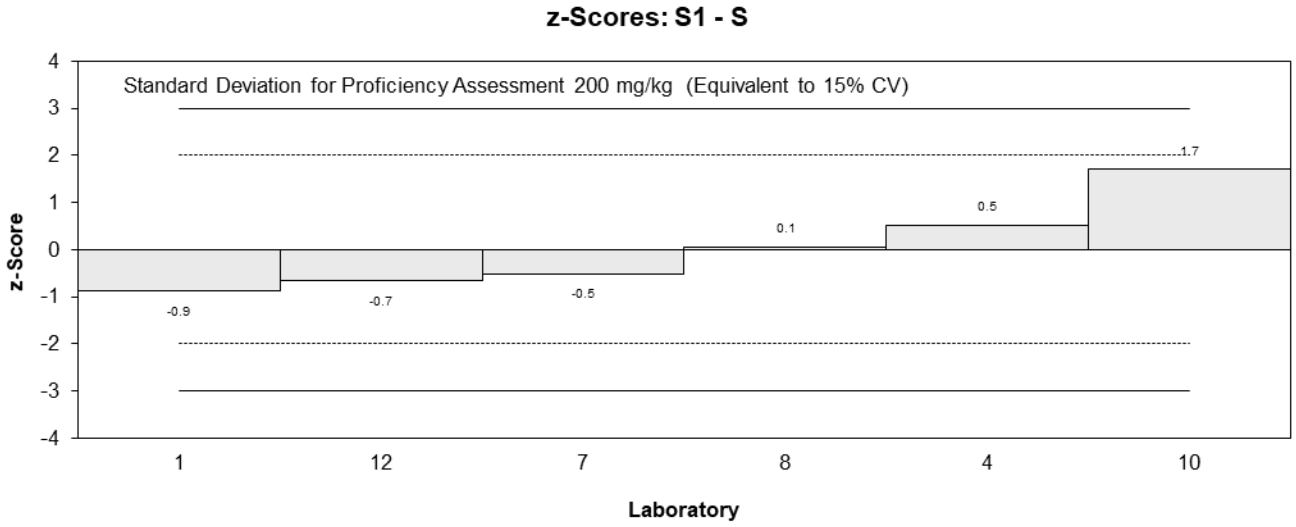
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1130	77	-0.87	-0.76
2	NT	NT		
3	NT	NT		
4	1400	140	0.51	0.40
5	NT	NT		
6	NT	NT		
7	1200	120	-0.51	-0.41
8	1310	262	0.05	0.03
9	NT	NT		
10	1632	489.6	1.70	0.62
11	NR	NR		
12	1170.000	156.000	-0.67	-0.50

Statistics

Assigned Value	1300	210
Robust Average	1300	210
Median	1260	160
Mean	1310	
N	6	
Max	1632	
Min	1130	
Robust SD	200	
Robust CV	16%	


Results: S1 - S
Assigned Value = 1300 ± 210 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
1
12
7
8
4
10
2
3
5
6
9
11
Md
RA


z-Scores: S1 - S
Standard Deviation for Proficiency Assessment 200 mg/kg (Equivalent to 15% CV)
z-Score
Laboratory
-0.9
-0.7
-0.5
0.1
0.5
1.7

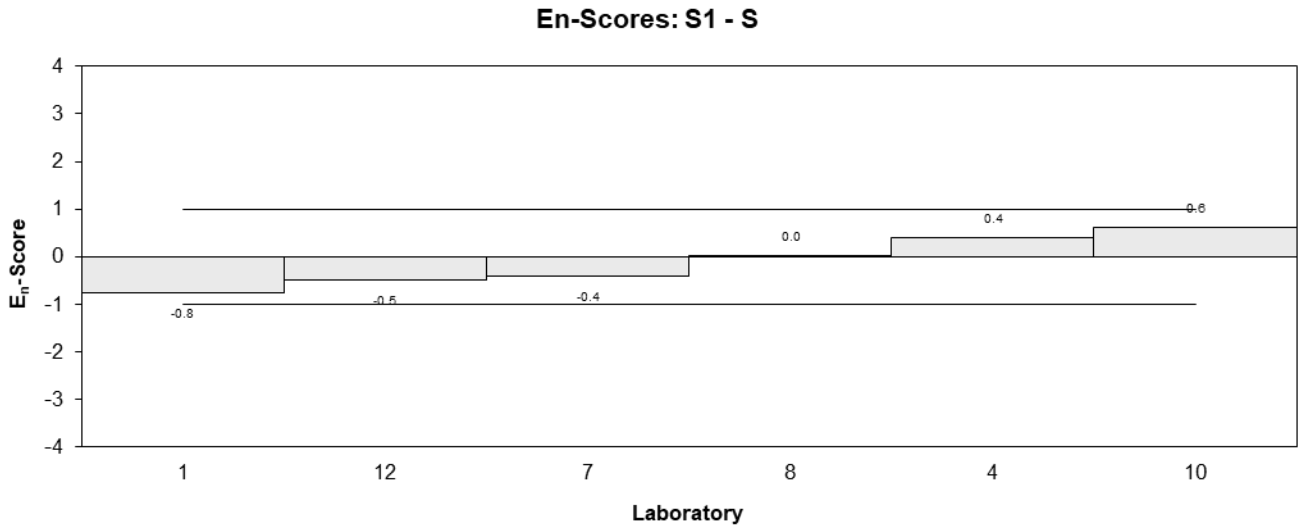

En-Scores: S1 - S
En-Score
Laboratory
-0.8
-0.5
-0.4
0.0
0.4
0.6

Figure 23

Table 28

Sample Details

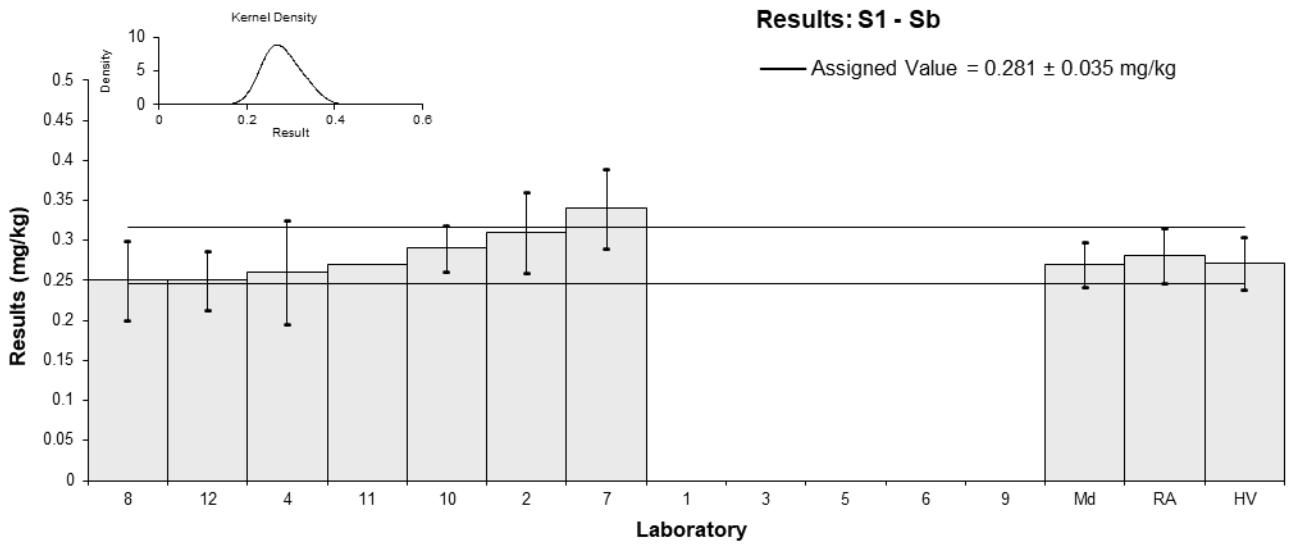
Sample No.	S1
Matrix	Wheat Flour
Analyte	Sb
Unit	mg/kg

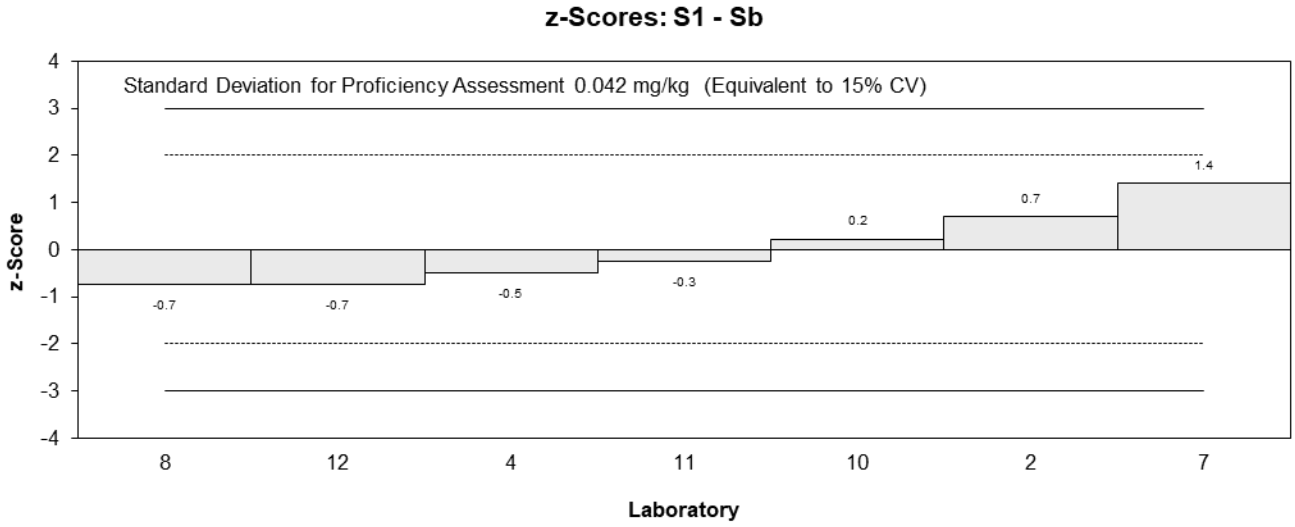
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.31	0.05	0.69	0.48
3	<2	NR		
4	0.26	0.065	-0.50	-0.28
5	NT	NT		
6	NT	NT		
7	0.34	0.05	1.40	0.97
8	0.25	0.05	-0.74	-0.51
9	NT	NT		
10	0.29	0.029	0.21	0.20
11	0.27	NR	-0.26	-0.31
12	0.250	0.037	-0.74	-0.61

Statistics

Assigned Value	0.281	0.035
Homogeneity Value	0.272	0.033
Robust Average	0.281	0.035
Median	0.270	0.028
Mean	0.281	
N	7	
Max	0.34	
Min	0.25	
Robust SD	0.038	
Robust CV	13%	


Kernel Density
Density
Result
Results: S1 - Sb
Assigned Value = 0.281 ± 0.035 mg/kg
Results (mg/kg)
Laboratory
8
12
4
11
10
2
7
1
3
5
6
9
Md
RA
HV


z-Scores: S1 - Sb
Standard Deviation for Proficiency Assessment 0.042 mg/kg (Equivalent to 15% CV)
z-Score
-0.7
-0.7
-0.5
-0.3
0.2
0.7
1.4
Laboratory

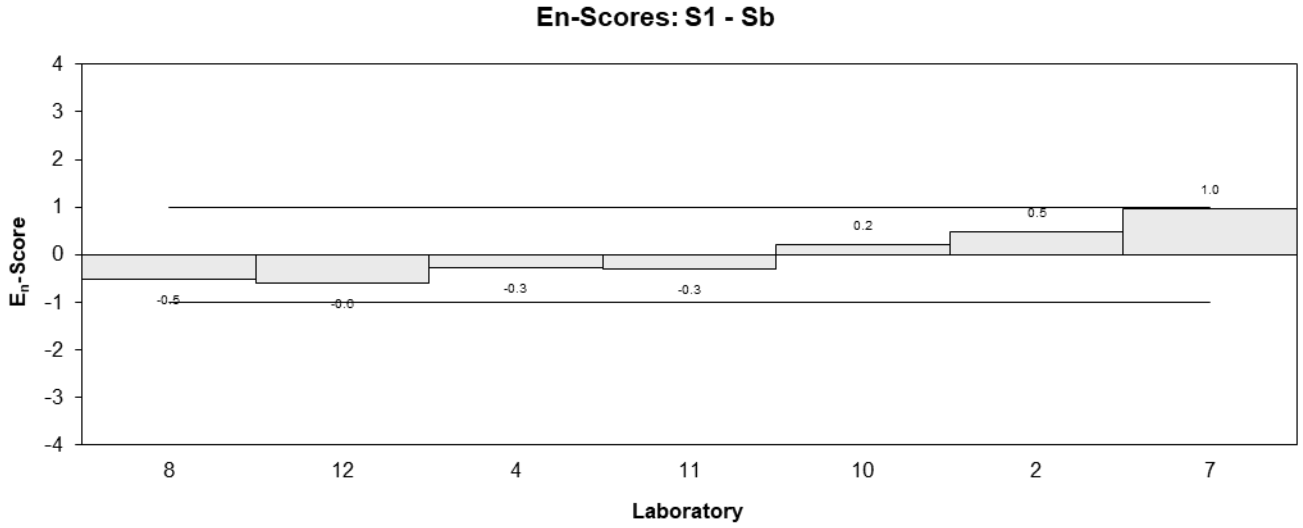

En-Scores: S1 - Sb
En-Score
-0.5
-0.6
-0.3
-0.3
0.2
0.5
1.0
Laboratory

Figure 24

Table 29

Sample Details

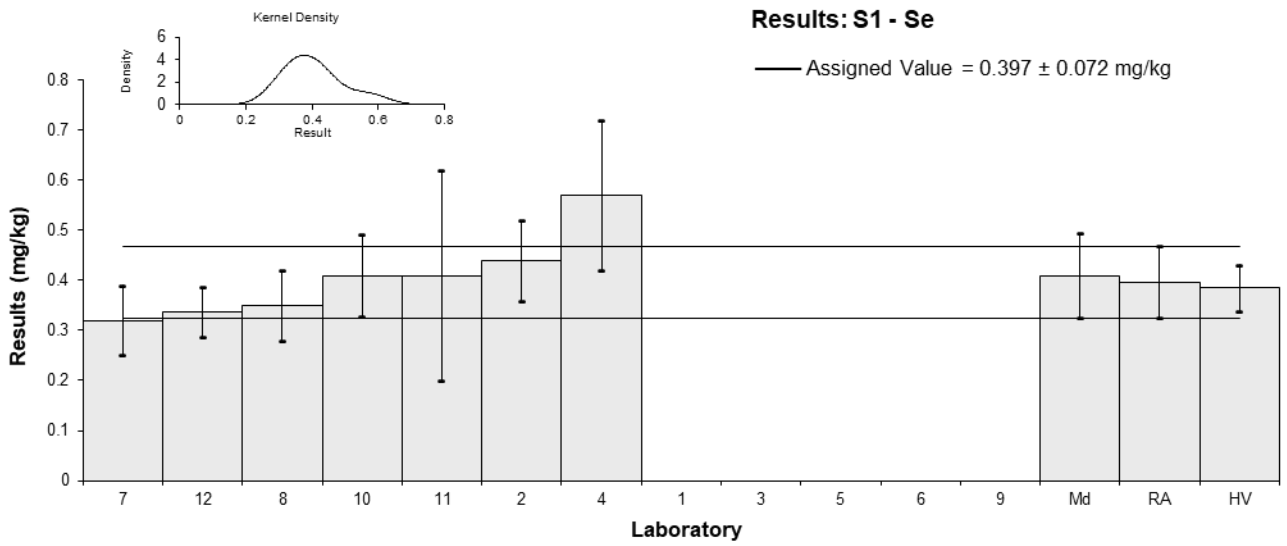
Sample No.	S1
Matrix	Wheat Flour
Analyte	Se
Unit	mg/kg

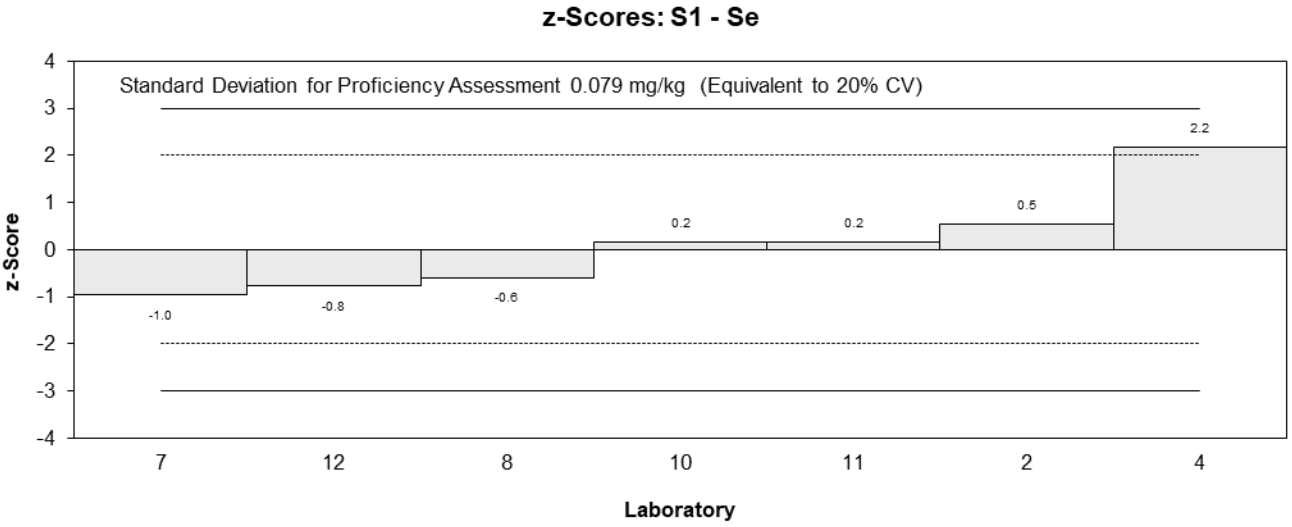
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.44	0.08	0.54	0.40
3	<2	NR		
4	0.57	0.15	2.18	1.04
5	<5.0	NR		
6	NT	NT		
7	0.32	0.07	-0.97	-0.77
8	0.35	0.07	-0.59	-0.47
9	NT	NT		
10	0.41	0.082	0.16	0.12
11	0.41	0.21	0.16	0.06
12	0.336	0.050	-0.77	-0.70

Statistics

Assigned Value	0.397	0.072
Homogeneity Value	0.385	0.046
Robust Average	0.397	0.072
Median	0.410	0.084
Mean	0.405	
N	7	
Max	0.57	
Min	0.32	
Robust SD	0.076	
Robust CV	19%	


Kernel Density
Density
Result
Results: S1 - Se
Assigned Value = 0.397 ± 0.072 mg/kg
Results (mg/kg)
Laboratory
7
12
8
10
11
2
4
1
3
5
6
9
Md
RA
HV


z-Scores: S1 - Se
Standard Deviation for Proficiency Assessment 0.079 mg/kg (Equivalent to 20% CV)
z-Score
-1.0
-0.8
-0.6
0.2
0.2
0.5
2.2
Laboratory
7
12
8
10
11
2
4

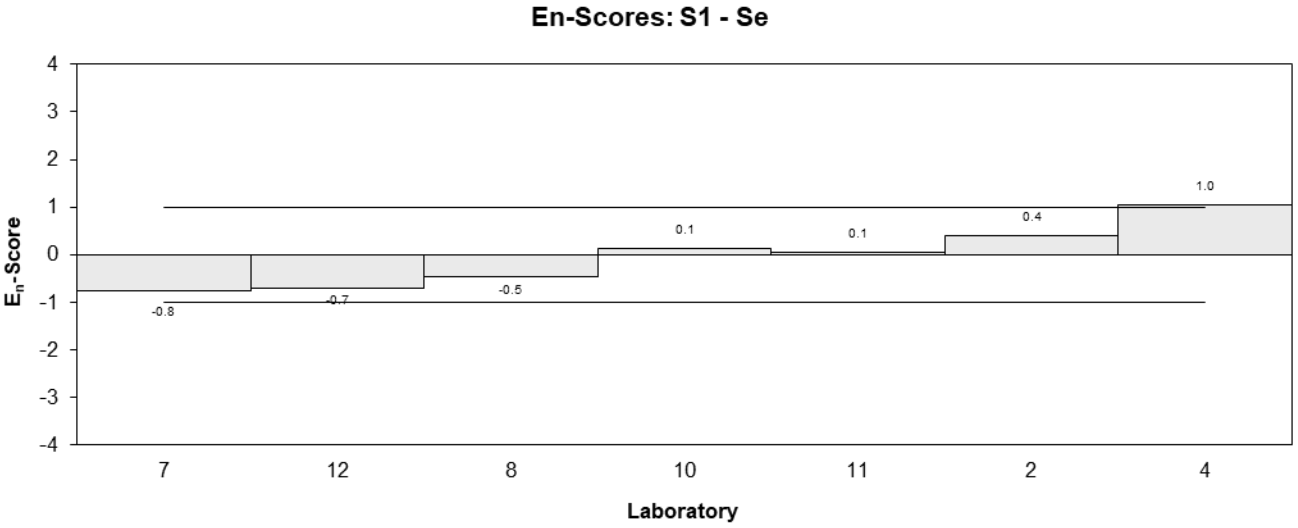

En-Scores: S1 - Se
En-Score
-0.8
-0.7
-0.5
0.1
0.1
0.4
1.0
Laboratory
7
12
8
10
11
2
4

Figure 25

Table 30

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	Tl
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	<2	NR
4	0.26	0.07
5	NT	NT
6	NT	NT
7	0.29	0.05
8	0.27	0.054
9	0.24	0.06
10	0.28	0.028
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.276	0.033
Robust Average	NA (N<6)	
Median	0.270	0.017
Mean	0.268	
N	5	
Max	0.29	
Min	0.24	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

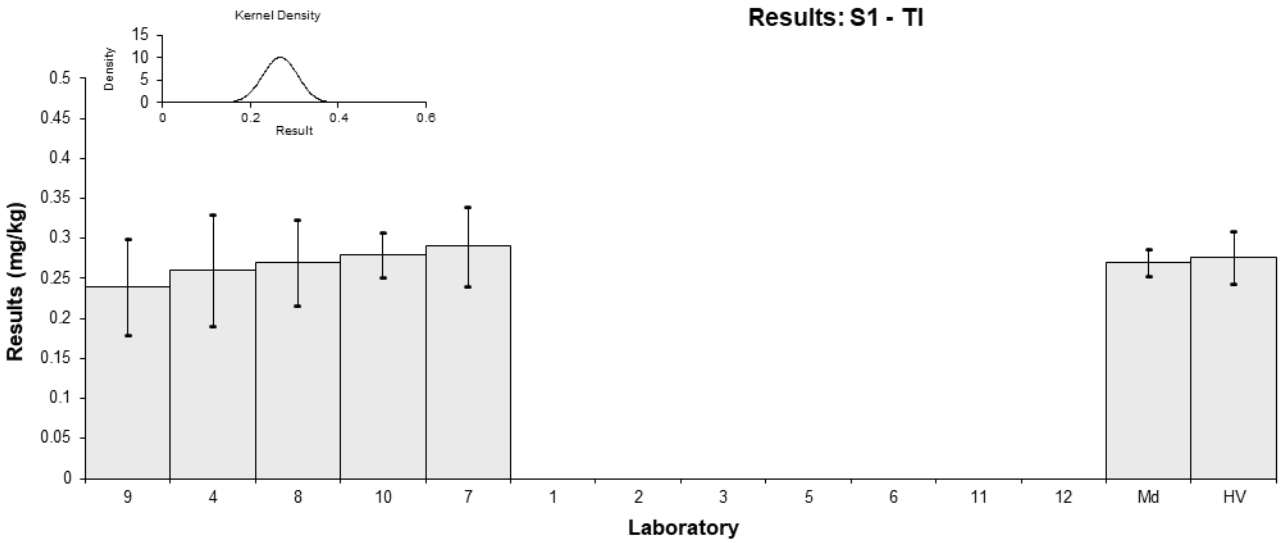

Results: S1 - Tl
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
9
4
8
10
7
1
2
3
5
6
11
12
Md
HV

Figure 26

Table 31

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	V
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2*	0.79	0.18	12.77	2.86
3	0.263	0.082	-0.20	-0.09
4	0.25	0.07	-0.52	-0.29
5	<1.0	NR		
6	NT	NT		
7	<3	NR		
8	0.26	0.052	-0.27	-0.20
9	NT	NT		
10	0.27	0.054	-0.02	-0.02
11	0.28	NR	0.22	0.43
12	0.332	0.056	1.50	1.02

* Outlier, see Section 4.2

Statistics

Assigned Value	0.271	0.021
Homogeneity Value	0.255	0.031
Robust Average	0.287	0.043
Median	0.270	0.014
Mean	0.35	
N	7	
Max	0.79	
Min	0.25	
Robust SD	0.046	
Robust CV	16%	

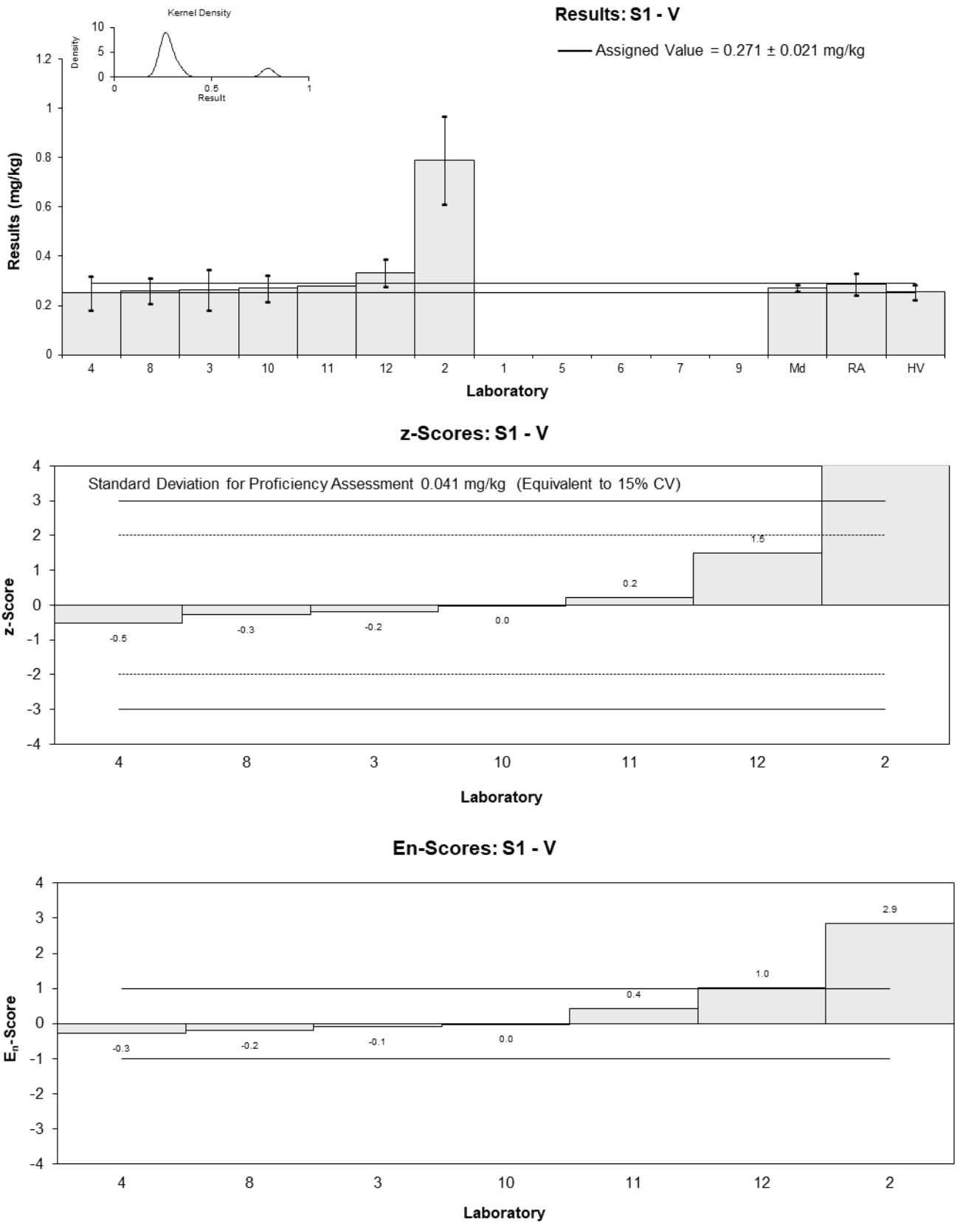

Kernel Density
Density
Result
Results: S1 - V
Assigned Value = 0.271 ± 0.021 mg/kg
Results (mg/kg)
Laboratory
4 8 3 10 11 12 2 1 5 6 7 9 Md RA HV
z-Scores: S1 - V
Standard Deviation for Proficiency Assessment 0.041 mg/kg (Equivalent to 15% CV)
z-Score
-0.5 -0.3 -0.2 0.0 0.2 1.5
Laboratory
4 8 3 10 11 12 2
En-Scores: S1 - V
En-Score
-0.3 -0.2 -0.1 0.0 0.4 1.0 2.9
Laboratory
4 8 3 10 11 12 2

Figure 27

Table 32

Sample Details

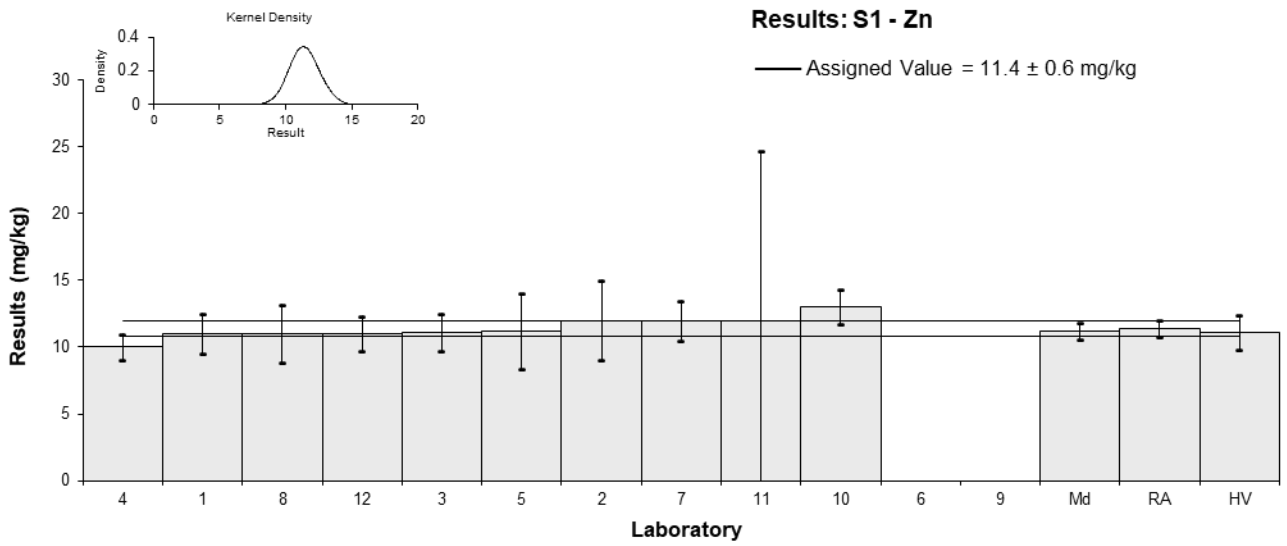
Sample No.	S1
Matrix	Wheat Flour
Analyte	Zn
Unit	mg/kg

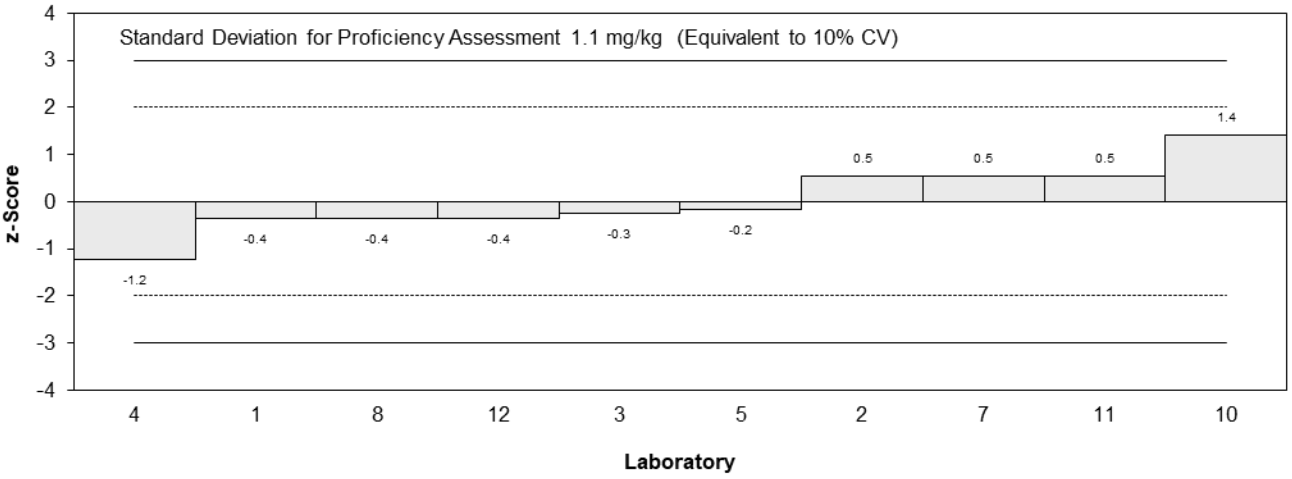
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	11	1.5	-0.35	-0.25
2	12	3	0.53	0.20
3	11.1	1.4	-0.26	-0.20
4	10	1	-1.23	-1.20
5	11.2	2.8	-0.18	-0.07
6	NT	NT		
7	12	1.5	0.53	0.37
8	11	2.2	-0.35	-0.18
9	NT	NT		
10	13	1.3	1.40	1.12
11	12	12.7	0.53	0.05
12	11.000	1.310	-0.35	-0.28

Statistics

Assigned Value	11.4	0.6
Homogeneity Value	11.1	1.3
Robust Average	11.4	0.6
Median	11.2	0.6
Mean	11.4	
N	10	
Max	13	
Min	10	
Robust SD	0.82	
Robust CV	7.2%	


Kernel Density
Density
Result
Results: S1 - Zn
Assigned Value = 11.4 ± 0.6 mg/kg
Results (mg/kg)
Laboratory
4 1 8 12 3 5 2 7 11 10 6 9 Md RA HV


z-Scores: S1 - Zn
Standard Deviation for Proficiency Assessment 1.1 mg/kg (Equivalent to 10% CV)
z-Score
-1.2
-0.4
-0.4
-0.4
-0.3
-0.2
0.5
0.5
0.5
1.4
Laboratory
4 1 8 12 3 5 2 7 11 10

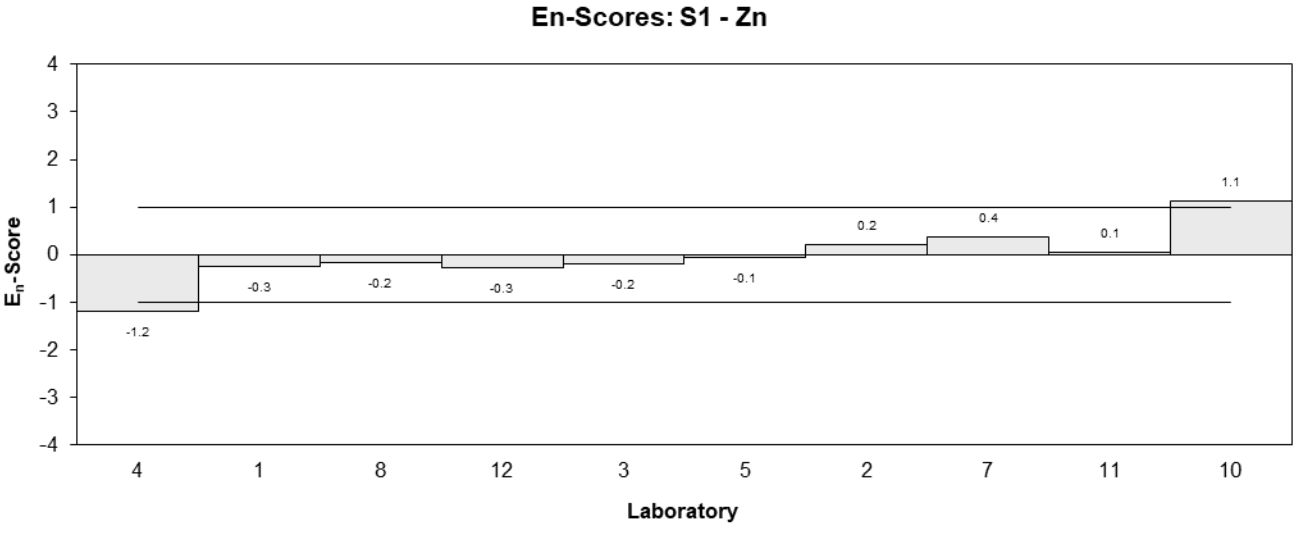

En-Scores: S1 - Zn
En-Score
-1.2
-0.3
-0.2
-0.3
-0.2
-0.1
0.2
0.4
0.1
1.1
Laboratory
4 1 8 12 3 5 2 7 11 10

Figure 28

Table 33

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	TKN
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	23000	4400
4	19700	1970
5	NT	NT
6	NT	NT
7	20100	2000
8	NR	NR
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	20100	900
Mean	20900	
N	3	
Max	23000	
Min	19700	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

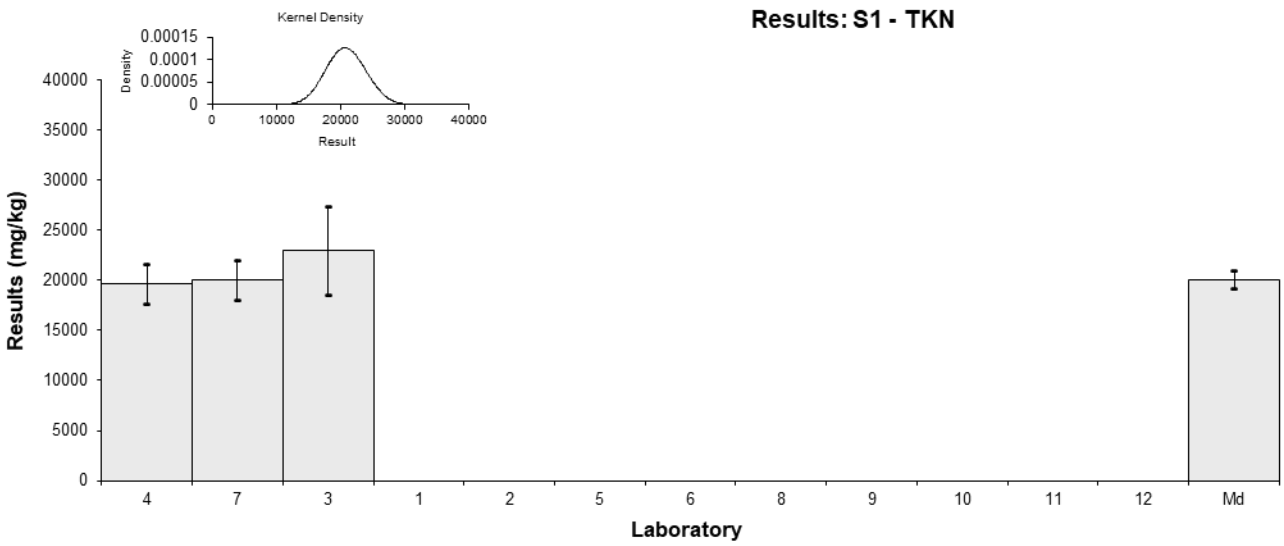

Results: S1 - TKN
Kernel Density
Density
0.00015
0.0001
0.00005
0
0
10000
20000
30000
40000
Result
Results (mg/kg)
40000
35000
30000
25000
20000
15000
10000
5000
0
4
7
3
1
2
5
6
8
9
10
11
12
Md
Laboratory

Figure 29

Table 34

Sample Details

Sample No.	S1
Matrix	Wheat Flour
Analyte	TOC
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	420000	34000
4	NR	NR
5	NT	NT
6	NT	NT
7	329000	33000
8	NR	NR
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	375000	
N	2	
Max	420000	
Min	329000	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

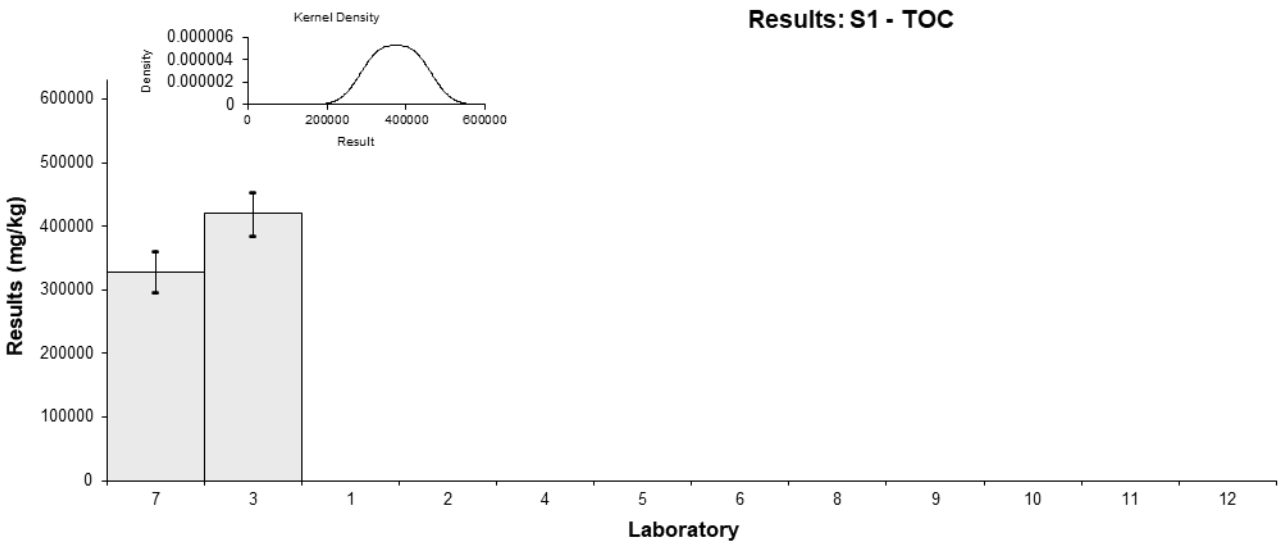

Results: S1 - TOC
Kernel Density
Density
0.000006
0.000004
0.000002
0
0
200000
400000
600000
Result
Results (mg/kg)
600000
500000
400000
300000
200000
100000
0
7
3
1
2
4
5
6
8
9
10
11
12
Laboratory

Figure 30

Table 35

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Ag
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	0.26	0.10
2	NT	NT
3	NT	NT
4	0.4	0.1
5	NT	NT
6	0.2	0.06
7	<1	NR
8	0.25	0.05
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.265	0.032
Robust Average	NA (N<6)	
Median	0.255	0.056
Mean	0.278	
N	4	
Max	0.4	
Min	0.2	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

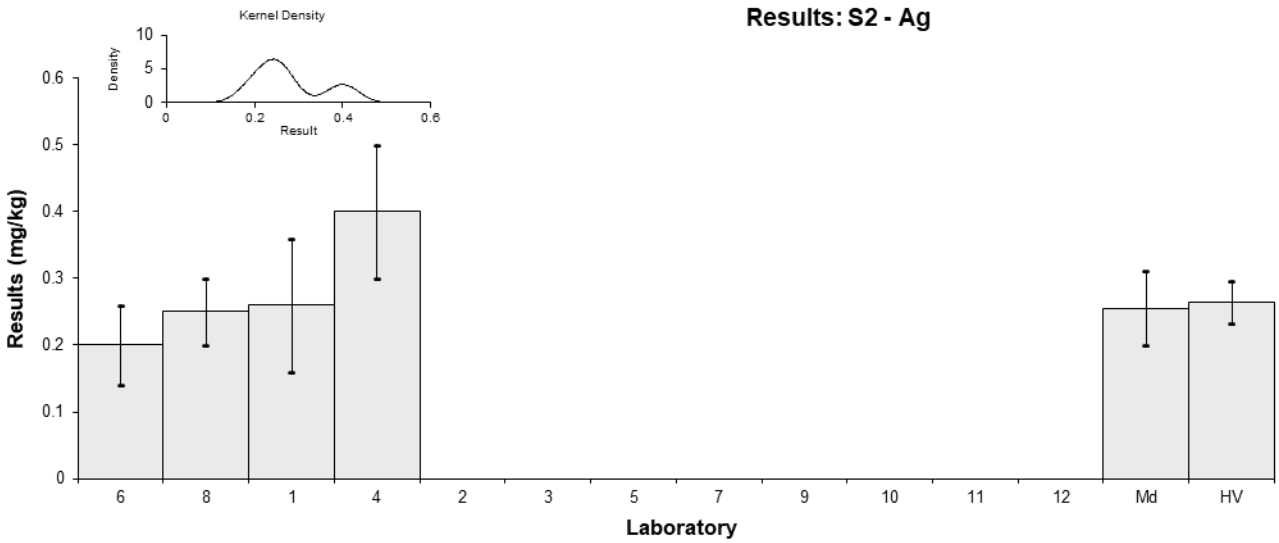

Results: S2 - Ag
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
6
8
1
4
2
3
5
7
9
10
11
12
Md
HV

Figure 31

Table 36

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	69	15
2	NT	NT
3	31.7	8.9
4	18	2
5	NT	NT
6	25.7	NR
7	<25	NR
8	33	6.6
9	NT	NT
10	38.9	11.67
11	NR	NR
12	48.300	10.100

Statistics

Assigned Value	Not Set	
Robust Average	37	15
Median	33	10
Mean	38	
N	7	
Max	69	
Min	18	
Robust SD	16	
Robust CV	44%	

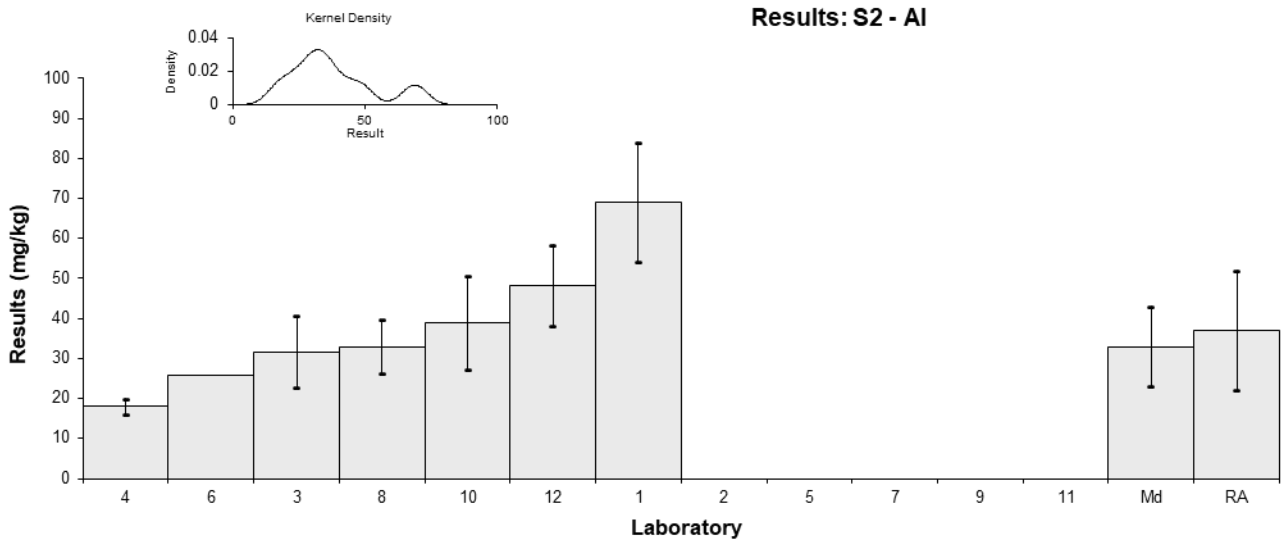

Results: S2 - Al
Kernel Density
Density
0.04
0.02
0
0
50
100
Result
Results (mg/kg)
100
90
80
70
60
50
40
30
20
10
0
4
6
3
8
10
12
1
2
5
7
9
11
Md
RA
Laboratory

Figure 32

Table 37

Sample Details

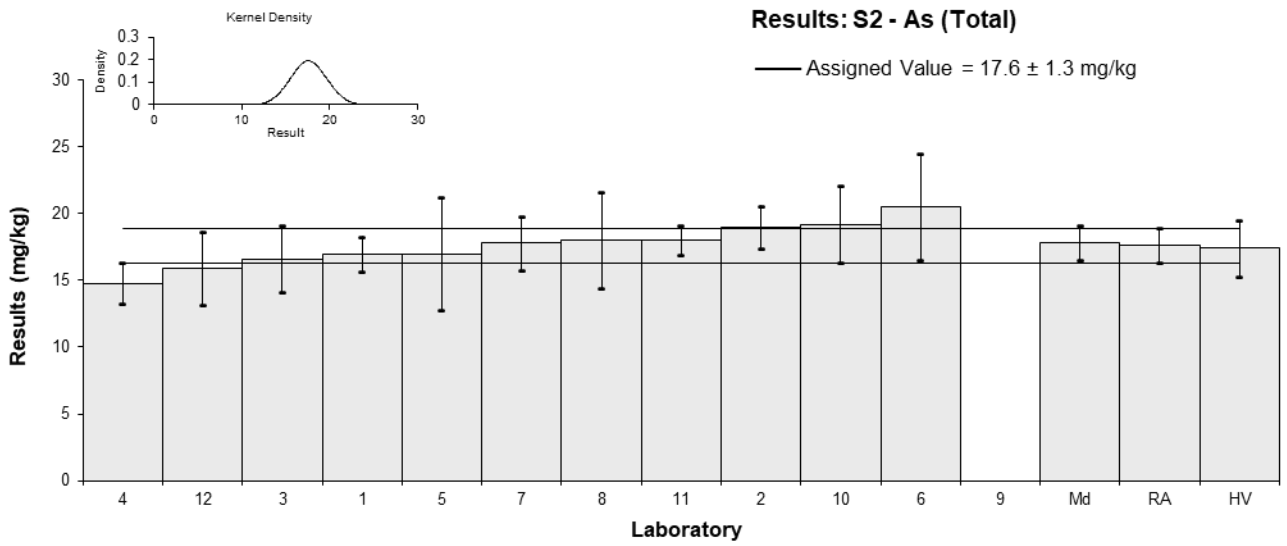
Sample No.	S2
Matrix	Seafood Biota
Analyte	As (Total)
Unit	mg/kg

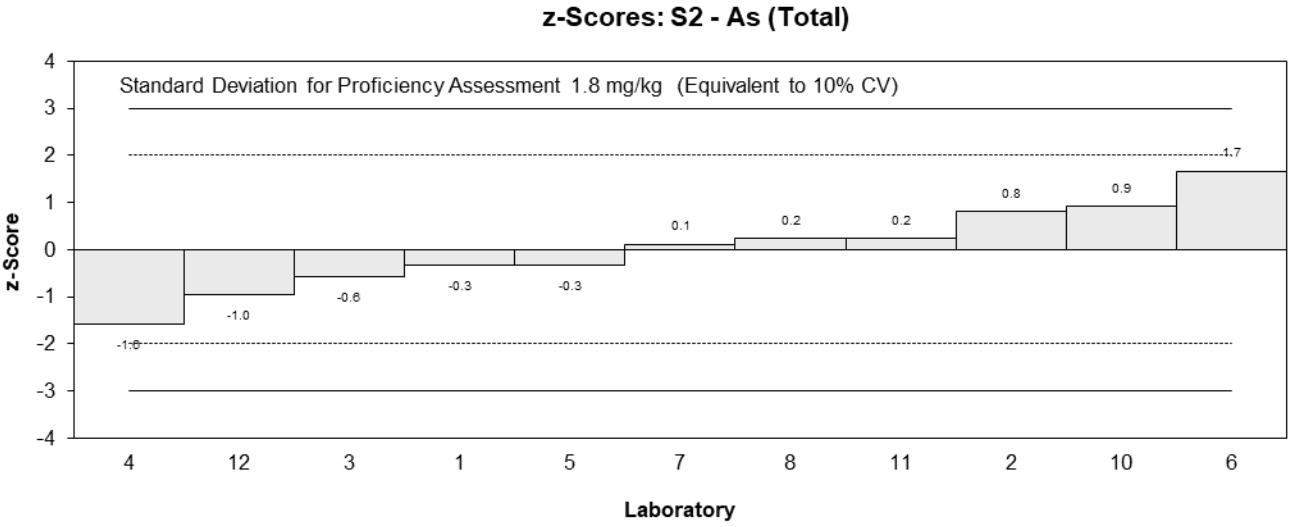
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	17	1.3	-0.34	-0.33
2	19.0	1.6	0.80	0.68
3	16.6	2.5	-0.57	-0.35
4	14.8	1.5	-1.59	-1.41
5	17.0	4.2	-0.34	-0.14
6	20.5	4.0	1.65	0.69
7	17.8	2.0	0.11	0.08
8	18	3.6	0.23	0.10
9	NT	NT		
10	19.2	2.88	0.91	0.51
11	18	1.11	0.23	0.23
12	15.900	2.750	-0.97	-0.56

Statistics

Assigned Value	17.6	1.3
Homogeneity Value	17.4	2.1
Robust Average	17.6	1.3
Median	17.8	1.3
Mean	17.6	
N	11	
Max	20.5	
Min	14.8	
Robust SD	1.7	
Robust CV	9.7%	


Kernel Density
Density
Result
Results: S2 - As (Total)
Assigned Value = 17.6 ± 1.3 mg/kg
Results (mg/kg)
Laboratory
4 12 3 1 5 7 8 11 2 10 6 9 Md RA HV


z-Scores: S2 - As (Total)
Standard Deviation for Proficiency Assessment 1.8 mg/kg (Equivalent to 10% CV)
z-Score
-1.6
-1.0
-0.6
-0.3
-0.3
0.1
0.2
0.2
0.8
0.9
1.7
Laboratory
4 12 3 1 5 7 8 11 2 10 6

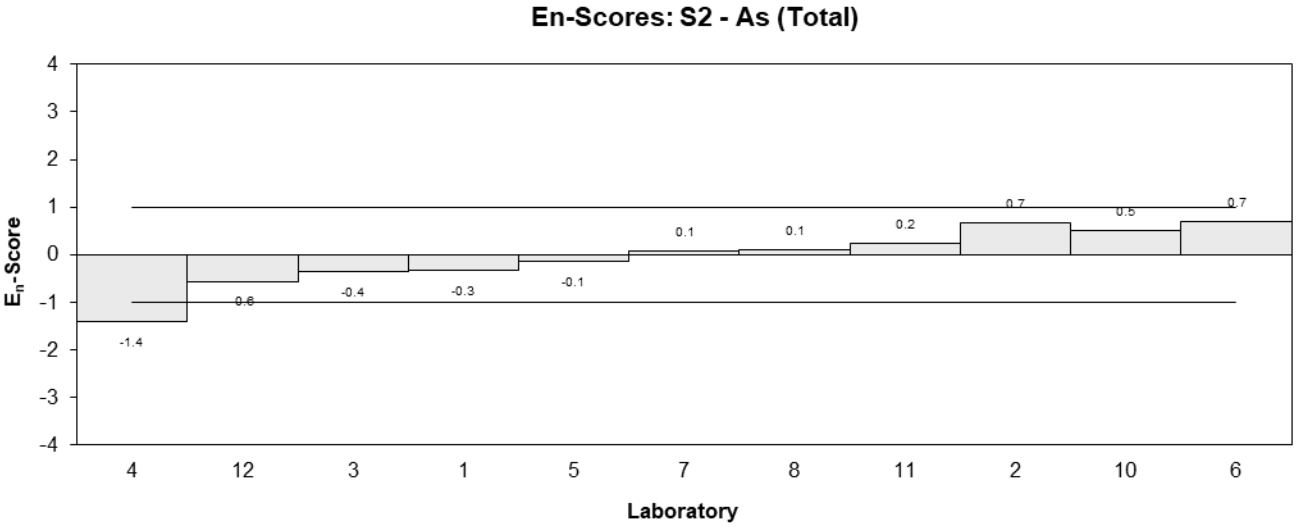

En-Scores: S2 - As (Total)
En-Score
-1.4
-0.6
-0.4
-0.3
-0.1
0.1
0.1
0.2
0.7
0.5
0.7
Laboratory
4 12 3 1 5 7 8 11 2 10 6

Figure 33

Table 38

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	As (Inorganic)
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	0.065	0.02
5	NT	NT
6	NR	NR
7	NT	NT
8	0.11	0.022
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Information Value	0.100	0.017
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	0.088	
N	2	
Max	0.11	
Min	0.065	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

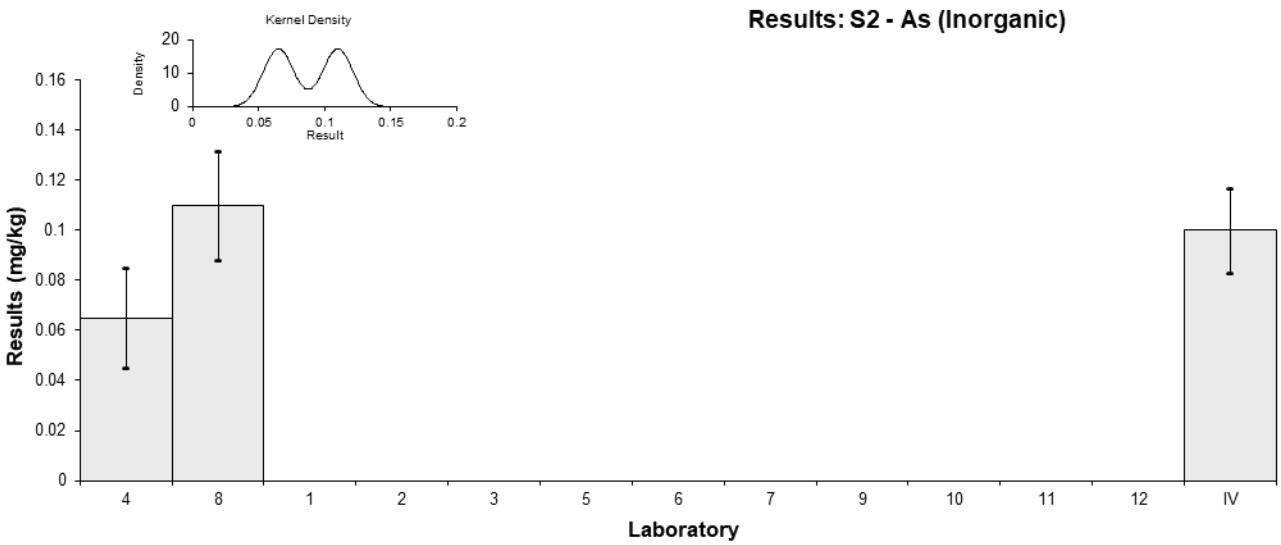

Results: S2 - As (Inorganic)
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
8
1
2
3
5
6
7
9
10
11
12
IV

Figure 34

Table 39

Sample Details

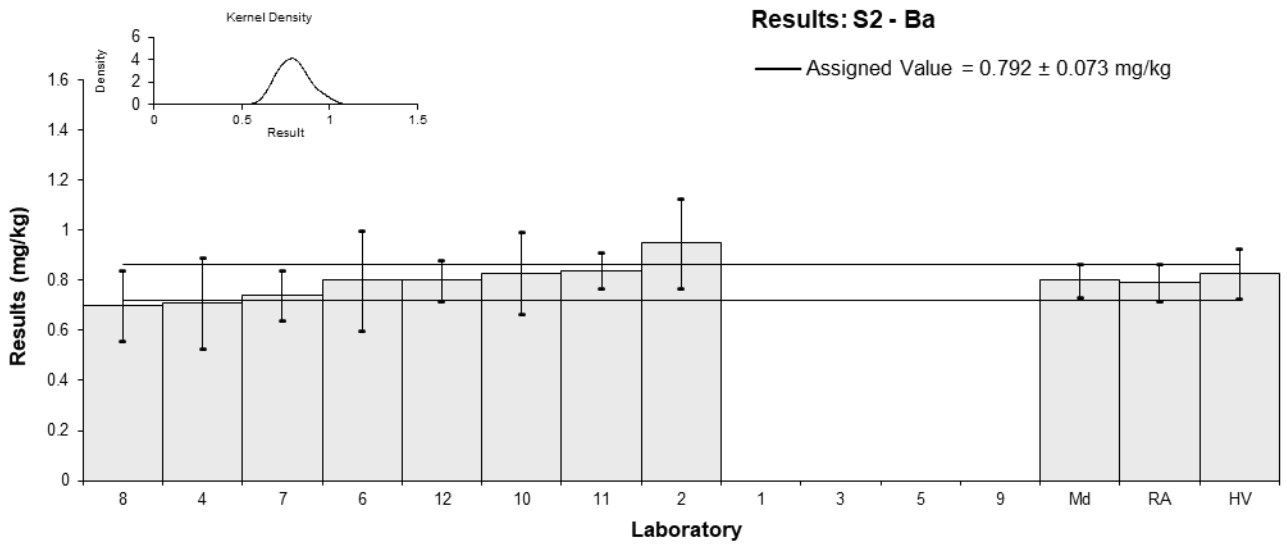
Sample No.	S2
Matrix	Seafood Biota
Analyte	Ba
Unit	mg/kg

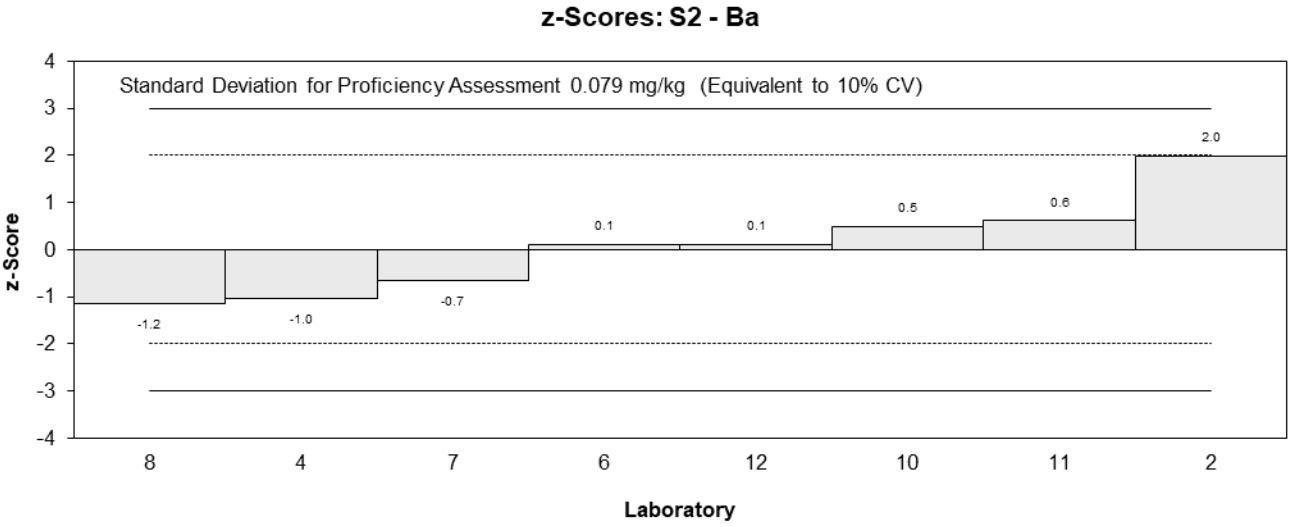
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.95	0.18	1.99	0.81
3	NT	NT		
4	0.71	0.18	-1.04	-0.42
5	<1.0	NR		
6	0.8	0.2	0.10	0.04
7	0.74	0.1	-0.66	-0.42
8	0.70	0.14	-1.16	-0.58
9	NT	NT		
10	0.83	0.166	0.48	0.21
11	0.84	0.07	0.61	0.47
12	0.800	0.081	0.10	0.07

Statistics

Assigned Value	0.792	0.073
Homogeneity Value	0.828	0.099
Robust Average	0.792	0.073
Median	0.800	0.066
Mean	0.796	
N	8	
Max	0.95	
Min	0.70	
Robust SD	0.082	
Robust CV	10%	


Kernel Density
Density
Result
Results: S2 - Ba
Assigned Value = 0.792 ± 0.073 mg/kg
Results (mg/kg)
Laboratory
8 4 7 6 12 10 11 2 1 3 5 9 Md RA HV


z-Scores: S2 - Ba
Standard Deviation for Proficiency Assessment 0.079 mg/kg (Equivalent to 10% CV)
z-Score
-1.2
-1.0
-0.7
0.1
0.1
0.5
0.6
2.0
Laboratory
8 4 7 6 12 10 11 2

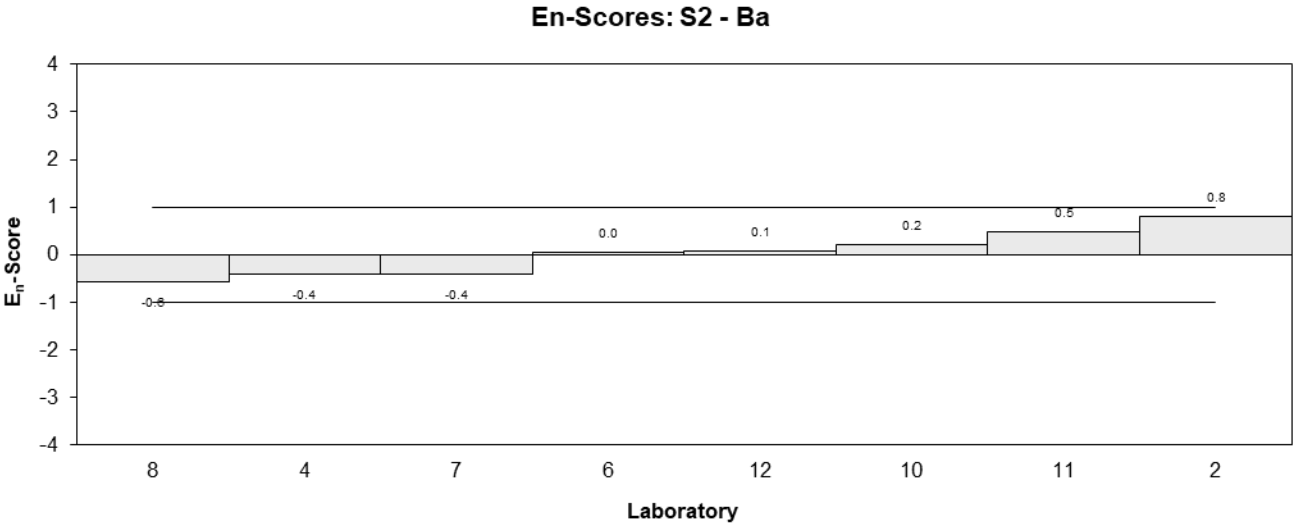

En-Scores: S2 - Ba
En-Score
-0.6
-0.4
-0.4
0.0
0.1
0.2
0.5
0.8
Laboratory
8 4 7 6 12 10 11 2

Figure 35

Table 40

Sample Details

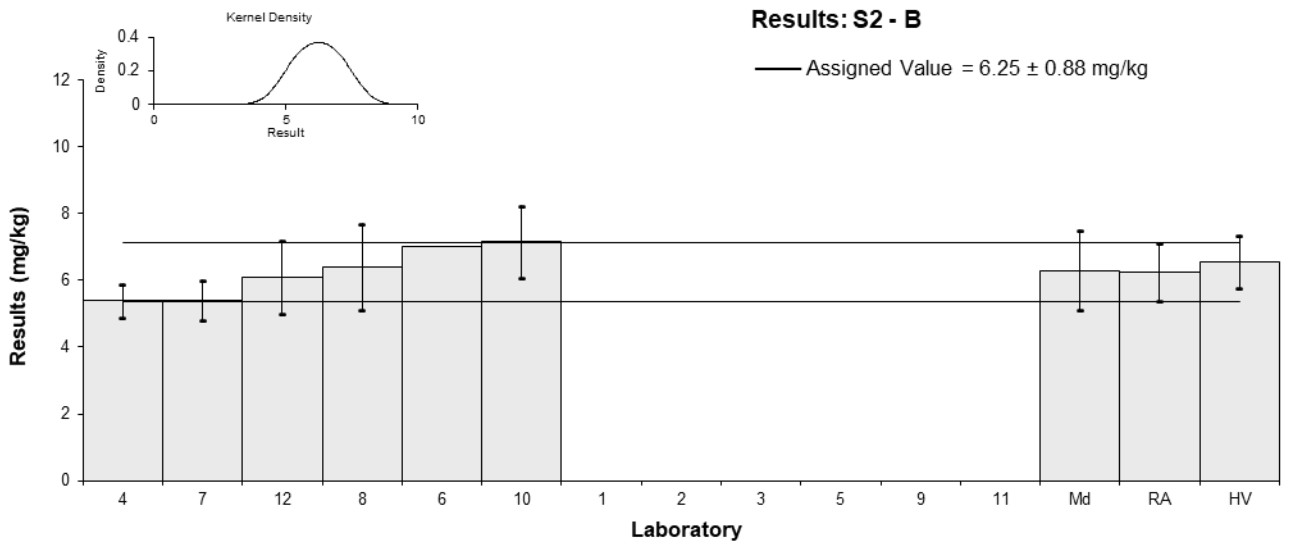
Sample No.	S2
Matrix	Seafood Biota
Analyte	B
Unit	mg/kg

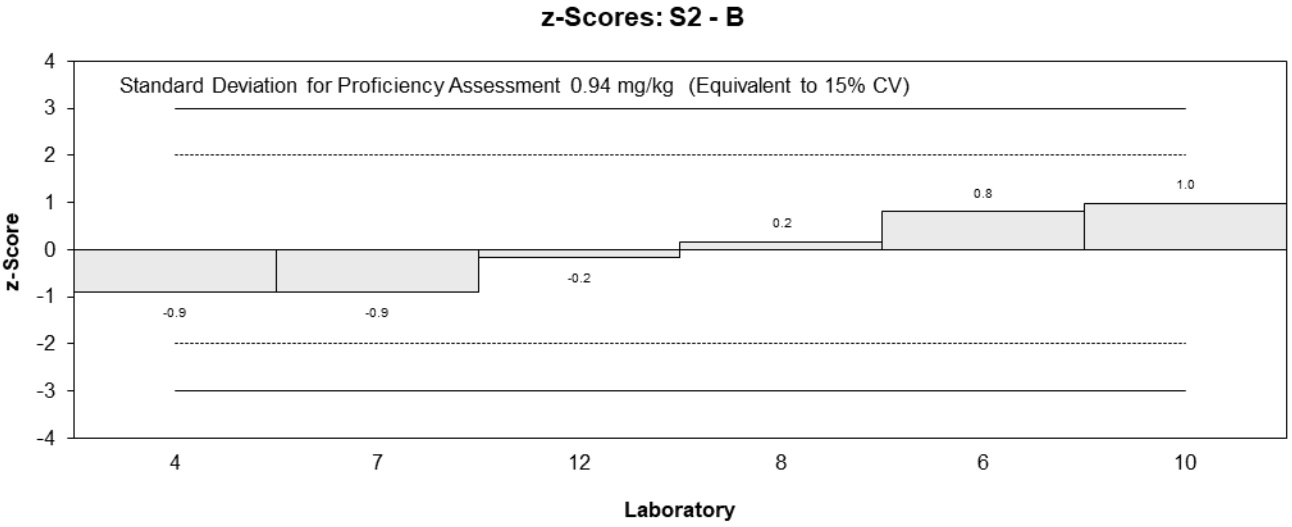
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	NT	NT		
3	NT	NT		
4	5.4	0.5	-0.91	-0.84
5	NT	NT		
6	7	NR	0.80	0.85
7	5.4	0.6	-0.91	-0.80
8	6.4	1.3	0.16	0.10
9	NT	NT		
10	7.17	1.076	0.98	0.66
11	NR	NR		
12	6.100	1.100	-0.16	-0.11

Statistics

Assigned Value	6.25	0.88
Homogeneity Value	6.56	0.79
Robust Average	6.25	0.88
Median	6.3	1.2
Mean	6.25	
N	6	
Max	7.17	
Min	5.4	
Robust SD	0.86	
Robust CV	14%	


Kernel Density
Density
Result
Results: S2 - B
Assigned Value = 6.25 ± 0.88 mg/kg
Results (mg/kg)
Laboratory
4
7
12
8
6
10
1
2
3
5
9
11
Md
RA
HV


z-Scores: S2 - B
Standard Deviation for Proficiency Assessment 0.94 mg/kg (Equivalent to 15% CV)
z-Score
-0.9
-0.9
-0.2
0.2
0.8
1.0
Laboratory
4
7
12
8
6
10

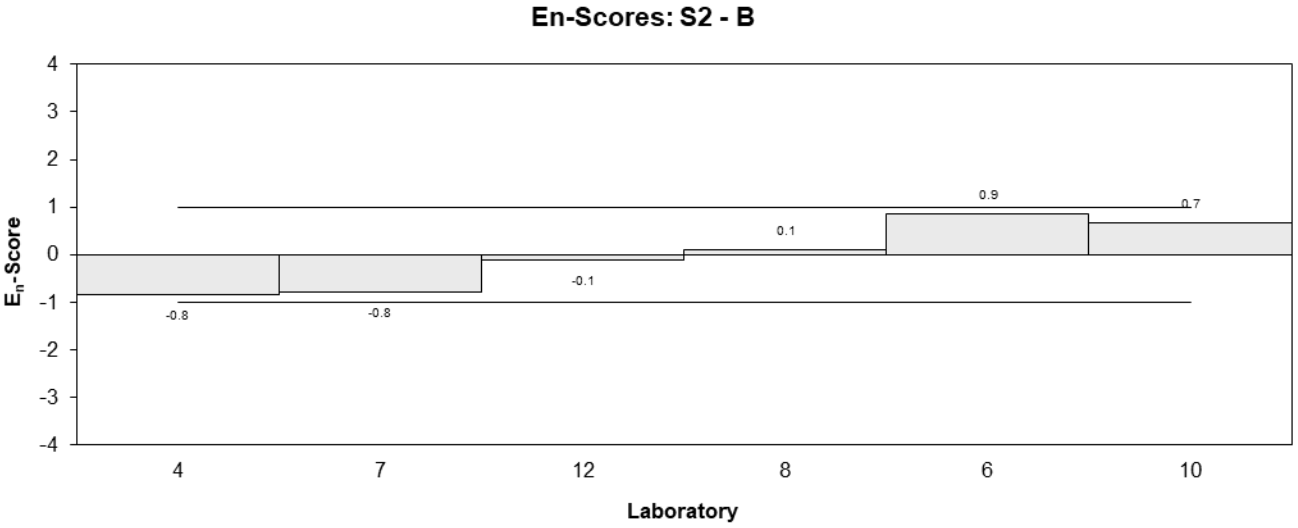

En-Scores: S2 - B
En-Score
-0.8
-0.8
-0.1
0.1
0.9
0.7
Laboratory
4
7
12
8
6
10

Figure 36

Table 41

Sample Details

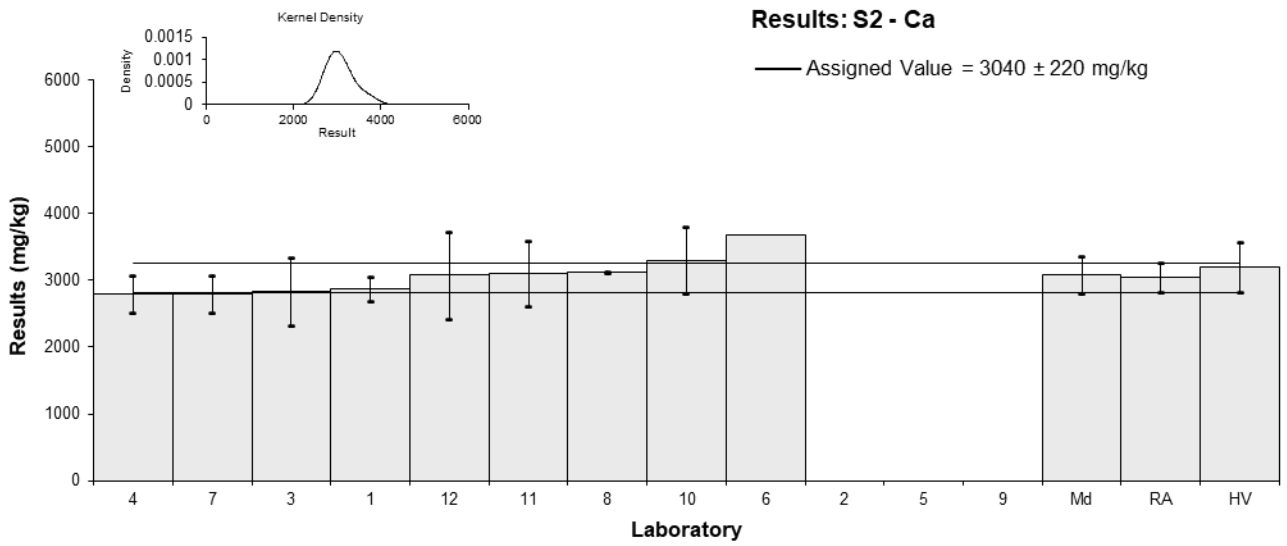
Sample No.	S2
Matrix	Seafood Biota
Analyte	Ca
Unit	mg/kg

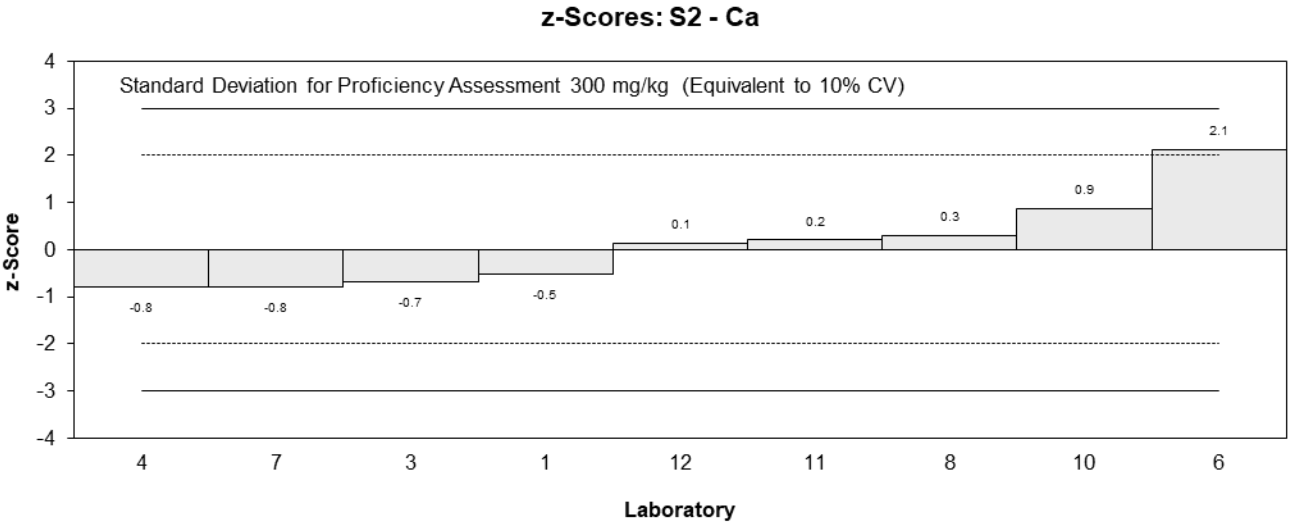
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	2880	180	-0.53	-0.56
2	NT	NT		
3	2830	510	-0.69	-0.38
4	2800	280	-0.79	-0.67
5	NT	NT		
6	3680	NR	2.11	2.91
7	2800	280	-0.79	-0.67
8	3130	6.26	0.30	0.41
9	NT	NT		
10	3303	495	0.87	0.49
11	3100	486	0.20	0.11
12	3080.000	657.000	0.13	0.06

Statistics

Assigned Value	3040	220
Homogeneity Value	3200	380
Robust Average	3040	220
Median	3080	280
Mean	3070	
N	9	
Max	3680	
Min	2800	
Robust SD	260	
Robust CV	8.5%	


Kernel Density
Density
0.0015
0.001
0.0005
0
0
2000
4000
6000
Result
Results: S2 - Ca
Assigned Value = 3040 ± 220 mg/kg
Results (mg/kg)
6000
5000
4000
3000
2000
1000
0
4
7
3
1
12
11
8
10
6
2
5
9
Md
RA
HV
Laboratory


z-Scores: S2 - Ca
Standard Deviation for Proficiency Assessment 300 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8
-0.8
-0.7
-0.5
0.1
0.2
0.3
0.9
2.1
4
7
3
1
12
11
8
10
6
Laboratory

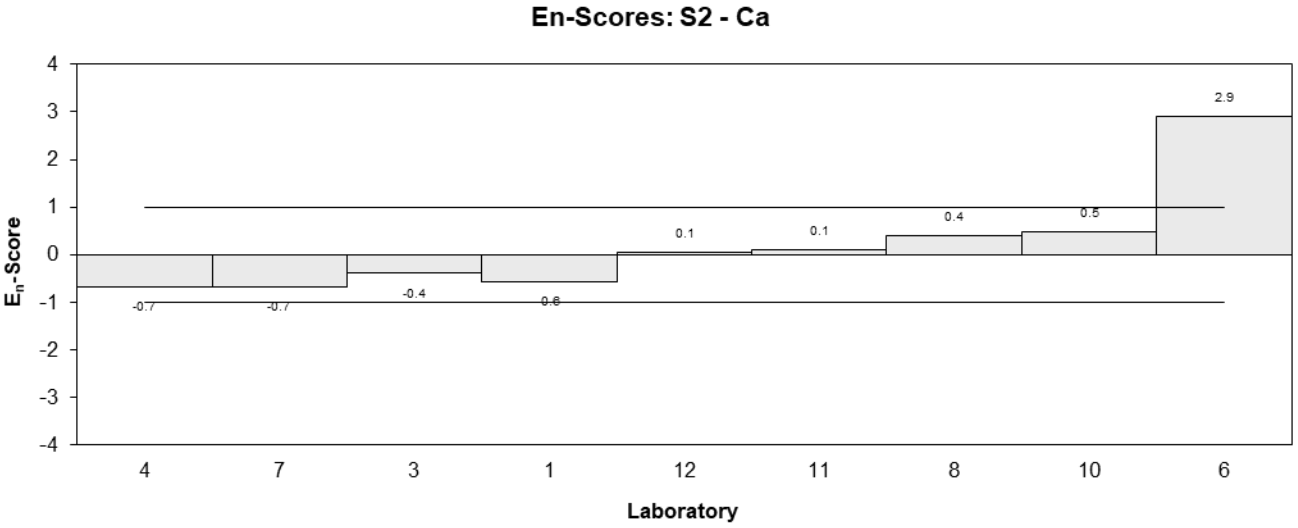

En-Scores: S2 - Ca
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7
-0.7
-0.4
-0.6
0.1
0.1
0.4
0.5
2.9
4
7
3
1
12
11
8
10
6
Laboratory

Figure 37

Table 42

Sample Details

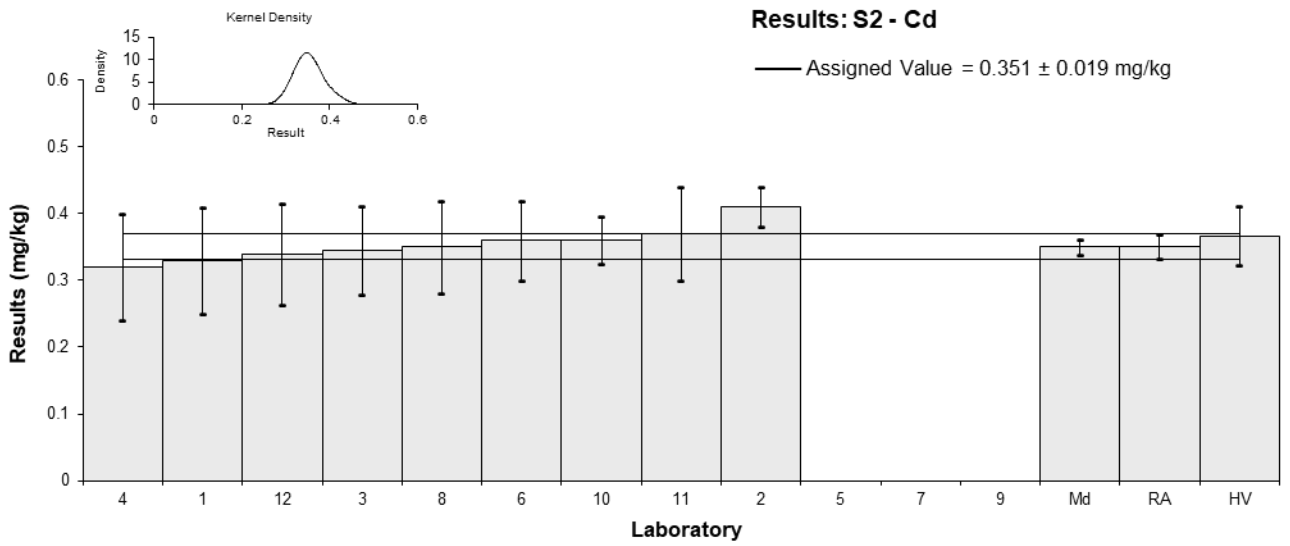
Sample No.	S2
Matrix	Seafood Biota
Analyte	Cd
Unit	mg/kg

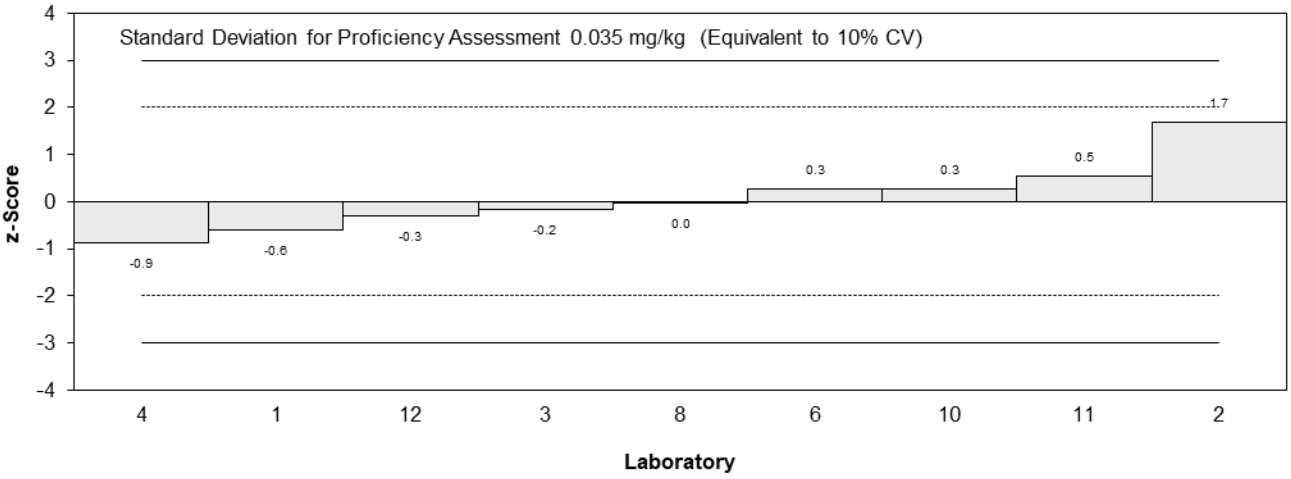
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.33	0.08	-0.60	-0.26
2	0.41	0.03	1.68	1.66
3	0.345	0.066	-0.17	-0.09
4	0.32	0.08	-0.88	-0.38
5	<1.0	NR		
6	0.36	0.06	0.26	0.14
7	<0.5	NR		
8	0.35	0.07	-0.03	-0.01
9	NT	NT		
10	0.36	0.036	0.26	0.22
11	0.37	0.07	0.54	0.26
12	0.340	0.076	-0.31	-0.14

Statistics

Assigned Value	0.351	0.019
Homogeneity Value	0.367	0.044
Robust Average	0.351	0.019
Median	0.350	0.012
Mean	0.354	
N	9	
Max	0.41	
Min	0.32	
Robust SD	0.023	
Robust CV	6.5%	


Kernel Density
Density
Result
Results: S2 - Cd
Assigned Value = 0.351 ± 0.019 mg/kg
Results (mg/kg)
Laboratory
4
1
12
3
8
6
10
11
2
5
7
9
Md
RA
HV


z-Scores: S2 - Cd
Standard Deviation for Proficiency Assessment 0.035 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
-0.9
-0.6
-0.3
-0.2
0.0
0.3
0.3
0.5
1.7

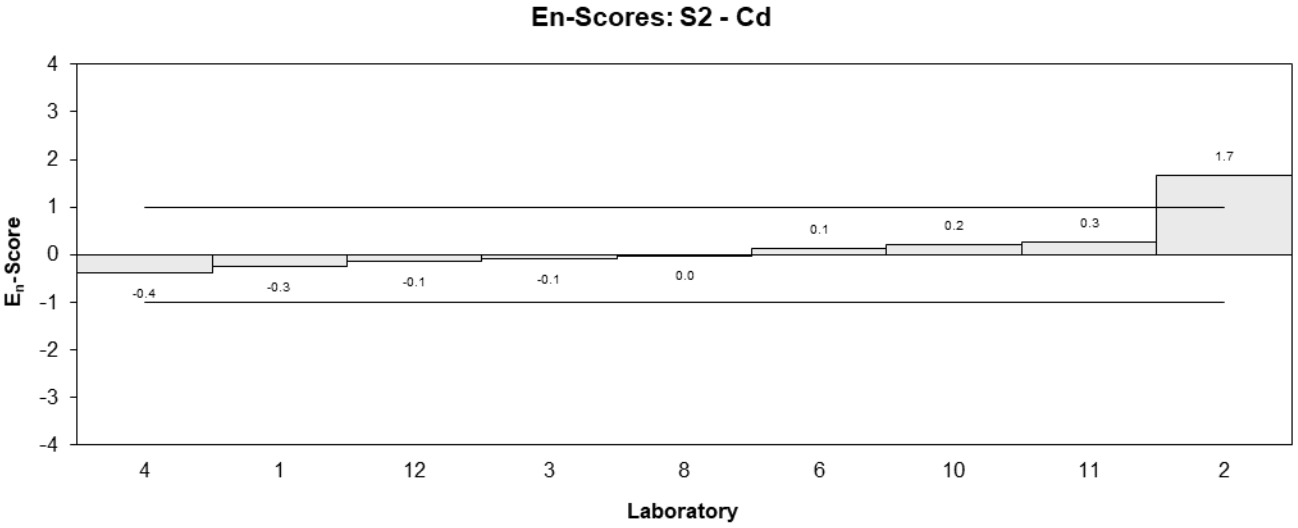

En-Scores: S2 - Cd
En-Score
Laboratory
-0.4
-0.3
-0.1
-0.1
0.0
0.1
0.2
0.3
1.7

Figure 38

Table 43

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Co
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.12	0.01	1.18	1.21
3	<0.2	NR		
4	0.091	0.02	-0.72	-0.48
5	<1.0	NR		
6	0.1	NR	-0.13	-0.18
7	0.12	0.03	1.18	0.56
8	0.096	0.019	-0.39	-0.27
9	NT	NT		
10	0.1	0.01	-0.13	-0.13
11	0.10	0.06	-0.13	-0.03
12	0.092	0.020	-0.65	-0.44

Statistics

Assigned Value	0.102	0.011
Homogeneity Value	0.113	0.014
Robust Average	0.102	0.011
Median	0.100	0.008
Mean	0.102	
N	8	
Max	0.12	
Min	0.091	
Robust SD	0.013	
Robust CV	13%	

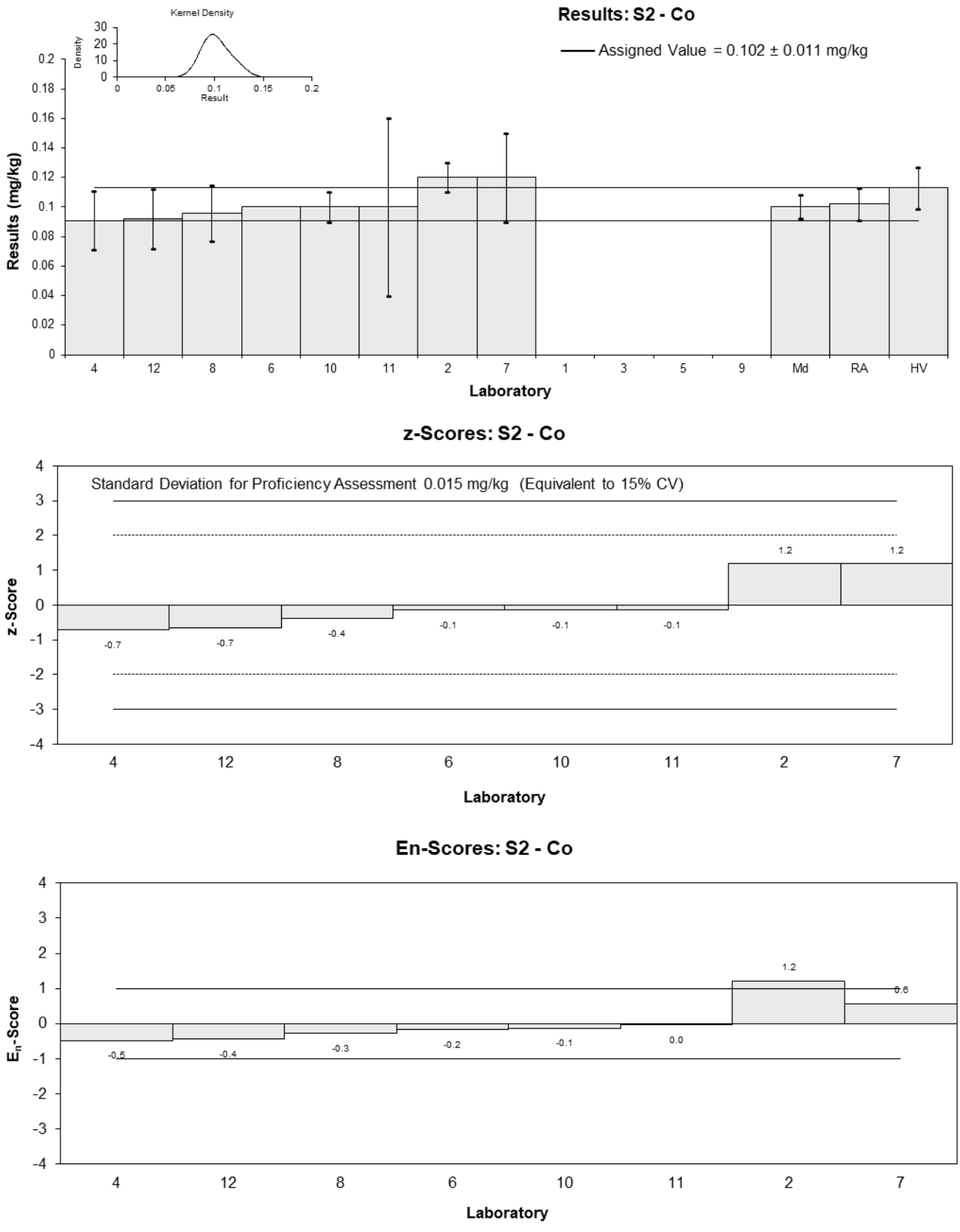

Results: S2 - Co
Assigned Value = 0.102 ± 0.011 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4 12 8 6 10 11 2 7 1 3 5 9 Md RA HV
z-Scores: S2 - Co
Standard Deviation for Proficiency Assessment 0.015 mg/kg (Equivalent to 15% CV)
z-Score
-0.7 -0.7 -0.4 -0.1 -0.1 -0.1 1.2 1.2
Laboratory
4 12 8 6 10 11 2 7
En-Scores: S2 - Co
En-Score
-0.5 -0.4 -0.3 -0.2 -0.1 0.0 1.2 0.6
Laboratory
4 12 8 6 10 11 2 7

Figure 39

Table 44

Sample Details

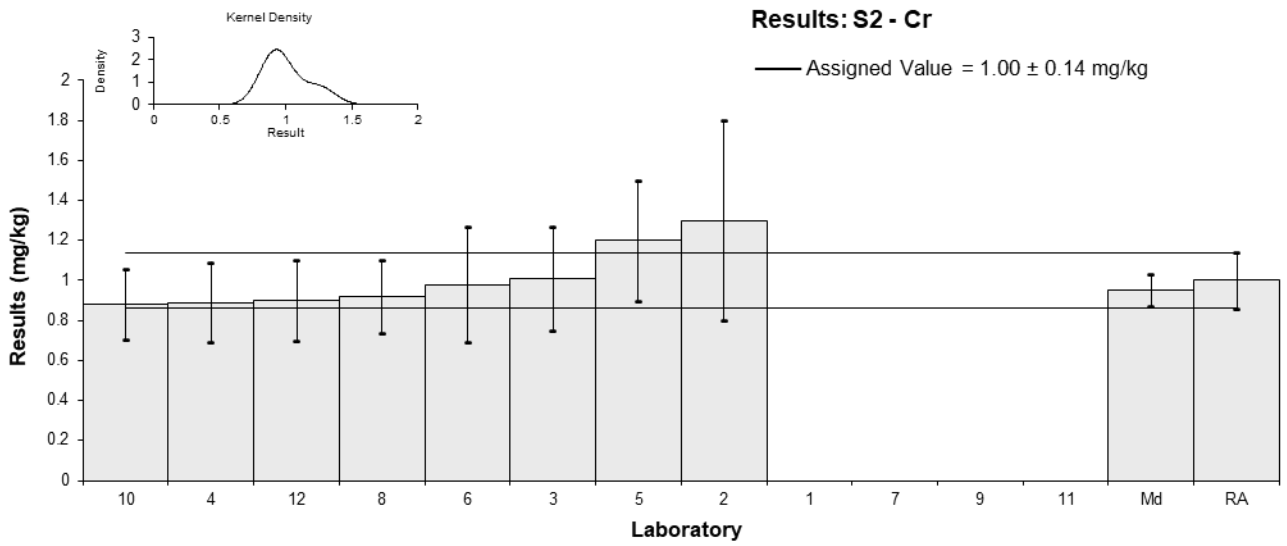
Sample No.	S2
Matrix	Seafood Biota
Analyte	Cr
Unit	mg/kg

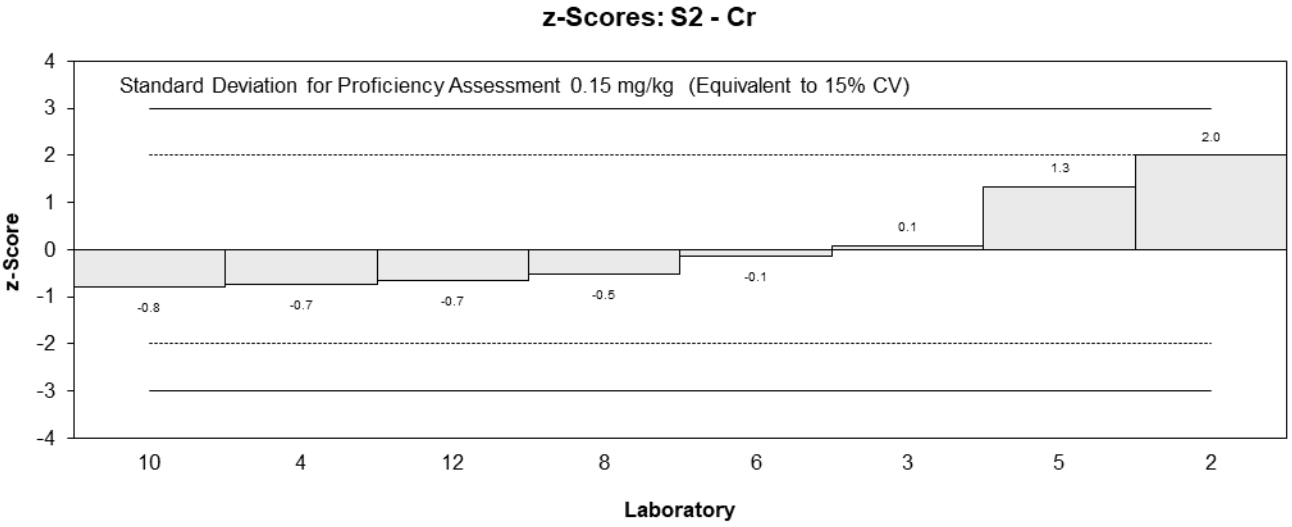
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	1.3	0.5	2.00	0.58
3	1.01	0.26	0.07	0.03
4	0.89	0.2	-0.73	-0.45
5	1.2	0.3	1.33	0.60
6	0.98	0.29	-0.13	-0.06
7	<2	NR		
8	0.92	0.18	-0.53	-0.35
9	NT	NT		
10	0.88	0.176	-0.80	-0.53
11	NR	NR		
12	0.900	0.200	-0.67	-0.41

Statistics

Assigned Value	1.00	0.14
Robust Average	1.00	0.14
Median	0.950	0.079
Mean	1.01	
N	8	
Max	1.3	
Min	0.88	
Robust SD	0.16	
Robust CV	16%	


Kernel Density
Density
Result
Results: S2 - Cr
Assigned Value = 1.00 ± 0.14 mg/kg
Results (mg/kg)
Laboratory
10
4
12
8
6
3
5
2
1
7
9
11
Md
RA


z-Scores: S2 - Cr
Standard Deviation for Proficiency Assessment 0.15 mg/kg (Equivalent to 15% CV)
z-Score
-0.8
-0.7
-0.7
-0.5
-0.1
0.1
1.3
2.0
Laboratory

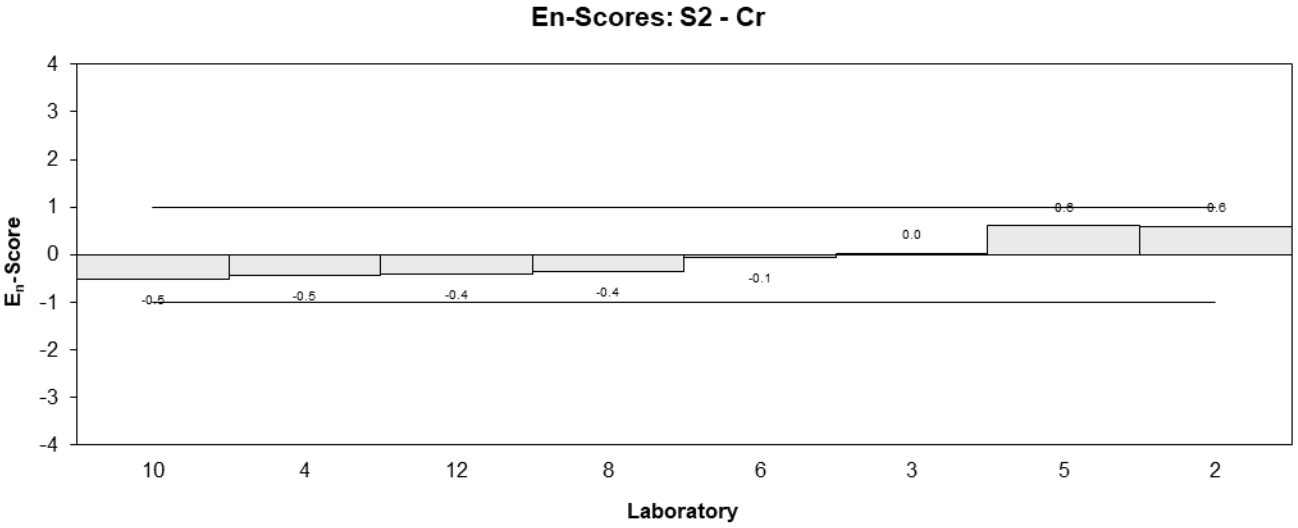

En-Scores: S2 - Cr
En-Score
-0.5
-0.5
-0.4
-0.4
-0.1
0.0
0.6
0.6
Laboratory

Figure 40

Table 45

Sample Details

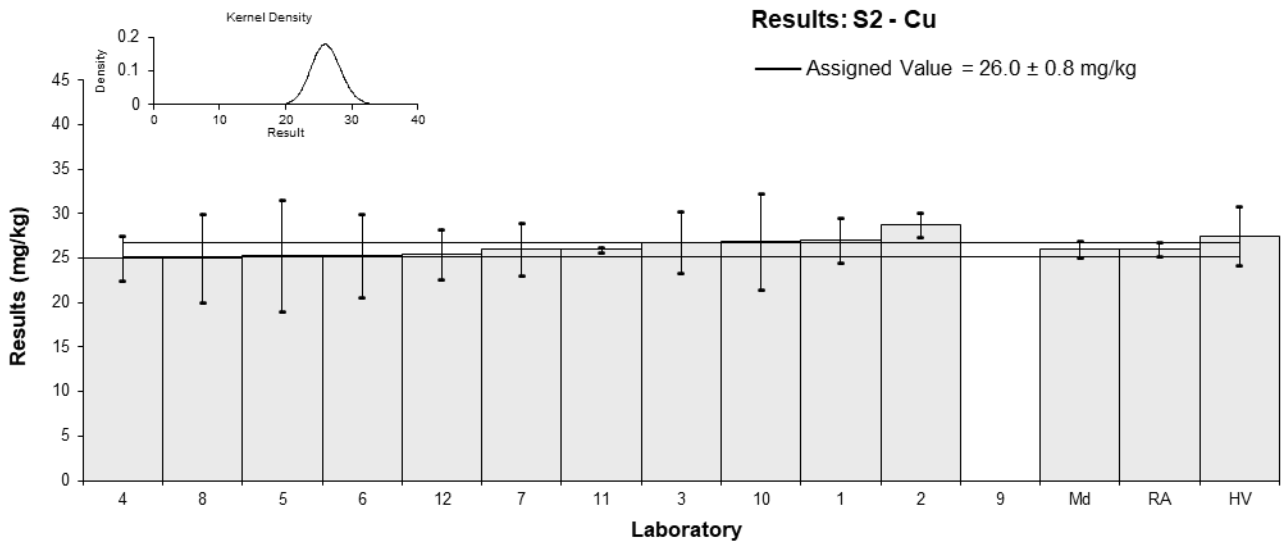
Sample No.	S2
Matrix	Seafood Biota
Analyte	Cu
Unit	mg/kg

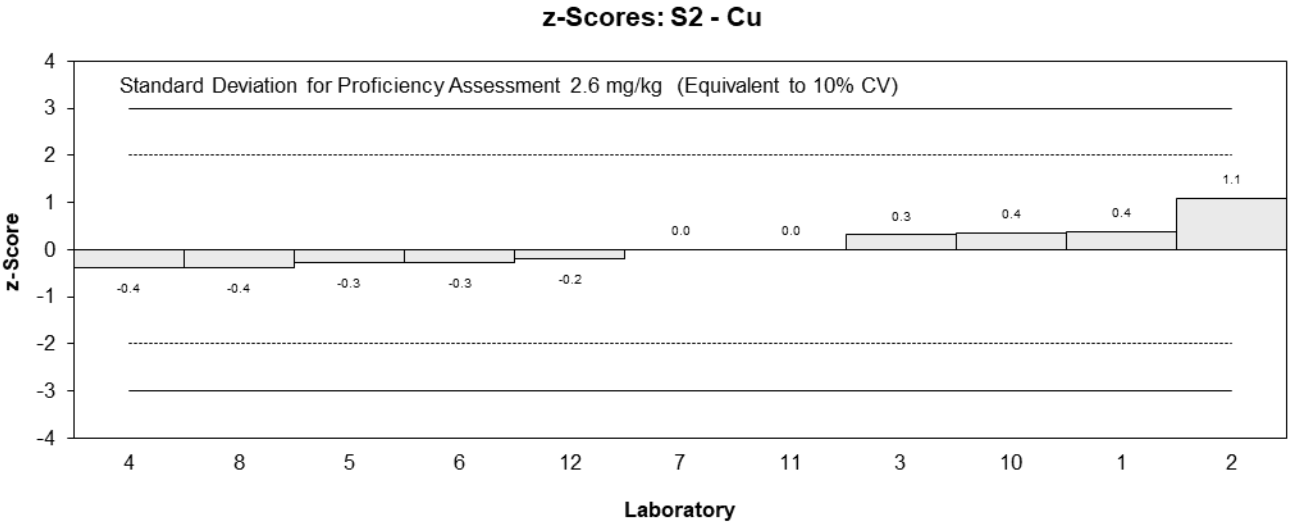
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	27	2.5	0.38	0.38
2	28.8	1.4	1.08	1.74
3	26.8	3.5	0.31	0.22
4	25	2.5	-0.38	-0.38
5	25.3	6.3	-0.27	-0.11
6	25.3	4.68	-0.27	-0.15
7	26	3.0	0.00	0.00
8	25	5	-0.38	-0.20
9	NT	NT		
10	26.9	5.38	0.35	0.17
11	26	0.30	0.00	0.00
12	25.500	2.800	-0.19	-0.17

Statistics

Assigned Value	26.0	0.8
Homogeneity Value	27.5	3.3
Robust Average	26.0	0.8
Median	26.0	0.9
Mean	26.1	
N	11	
Max	28.8	
Min	25	
Robust SD	1.0	
Robust CV	3.9%	


Kernel Density
Density
Result
Results: S2 - Cu
Assigned Value = 26.0 ± 0.8 mg/kg
Results (mg/kg)
Laboratory
4 8 5 6 12 7 11 3 10 1 2 9 Md RA HV


z-Scores: S2 - Cu
Standard Deviation for Proficiency Assessment 2.6 mg/kg (Equivalent to 10% CV)
z-Score
-0.4 -0.4 -0.3 -0.3 -0.2 0.0 0.0 0.3 0.4 0.4 1.1
Laboratory
4 8 5 6 12 7 11 3 10 1 2

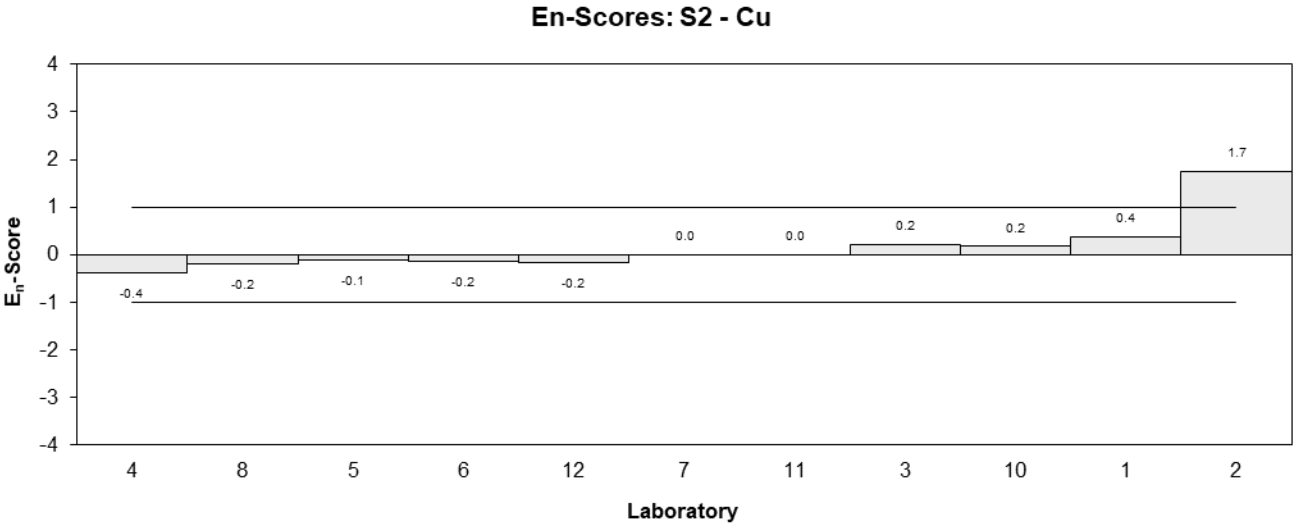

En-Scores: S2 - Cu
En-Score
-0.4 -0.2 -0.1 -0.2 -0.2 0.0 0.0 0.2 0.2 0.4 1.7
Laboratory
4 8 5 6 12 7 11 3 10 1 2

Figure 41

Table 46

Sample Details

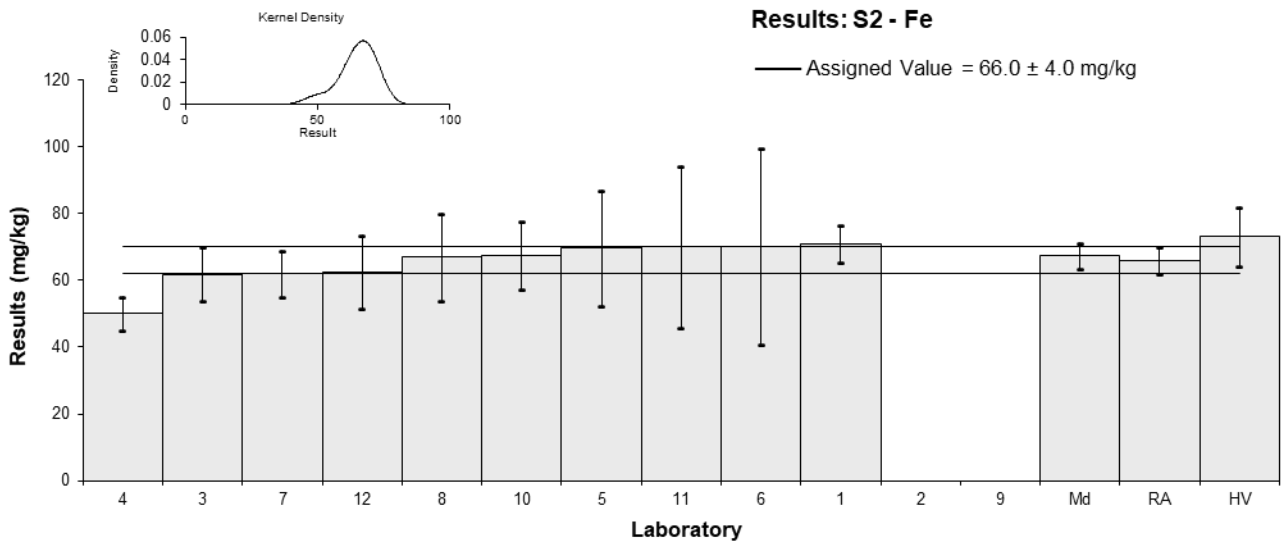
Sample No.	S2
Matrix	Seafood Biota
Analyte	Fe
Unit	mg/kg

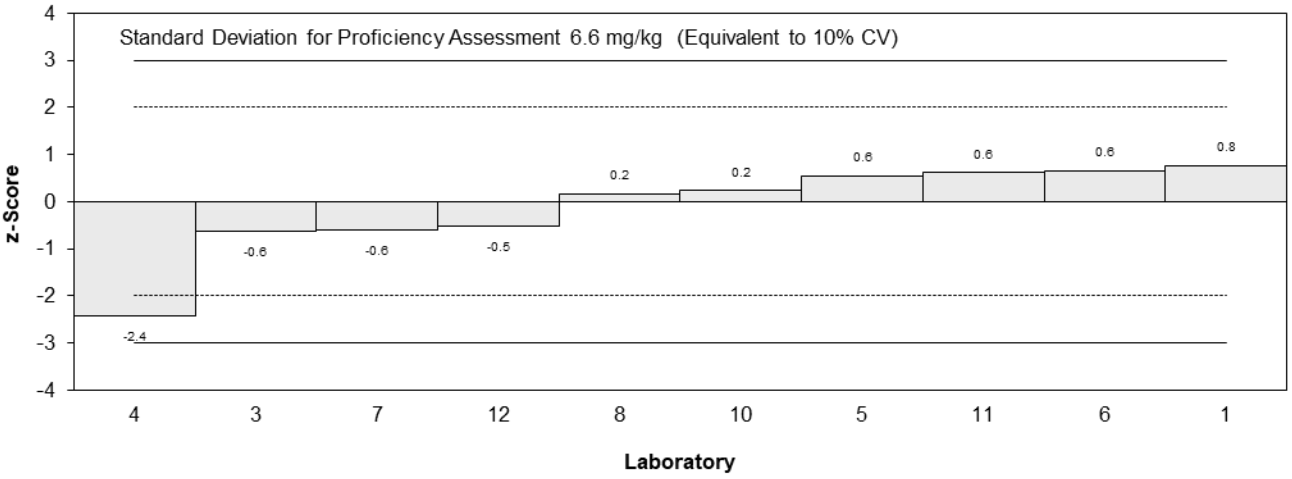
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	71	5.5	0.76	0.74
2	NT	NT		
3	61.8	8.0	-0.64	-0.47
4	50	5	-2.42	-2.50
5	69.6	17.4	0.55	0.20
6	70.2	29.3	0.64	0.14
7	62	7.0	-0.61	-0.50
8	67	13	0.15	0.07
9	NT	NT		
10	67.5	10.1	0.23	0.14
11	70	24.3	0.61	0.16
12	62.500	11.000	-0.53	-0.30

Statistics

Assigned Value	66.0	4.0
Homogeneity Value	73.2	8.8
Robust Average	66.0	4.0
Median	67.3	3.9
Mean	65.2	
N	10	
Max	71	
Min	50	
Robust SD	5.0	
Robust CV	7.6%	


Results: S2 - Fe
Assigned Value = 66.0 ± 4.0 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4 3 7 12 8 10 5 11 6 1 2 9 Md RA HV


z-Scores: S2 - Fe
Standard Deviation for Proficiency Assessment 6.6 mg/kg (Equivalent to 10% CV)
z-Score
-2.4
-0.6
-0.6
-0.5
0.2
0.2
0.6
0.6
0.6
0.8
Laboratory
4 3 7 12 8 10 5 11 6 1

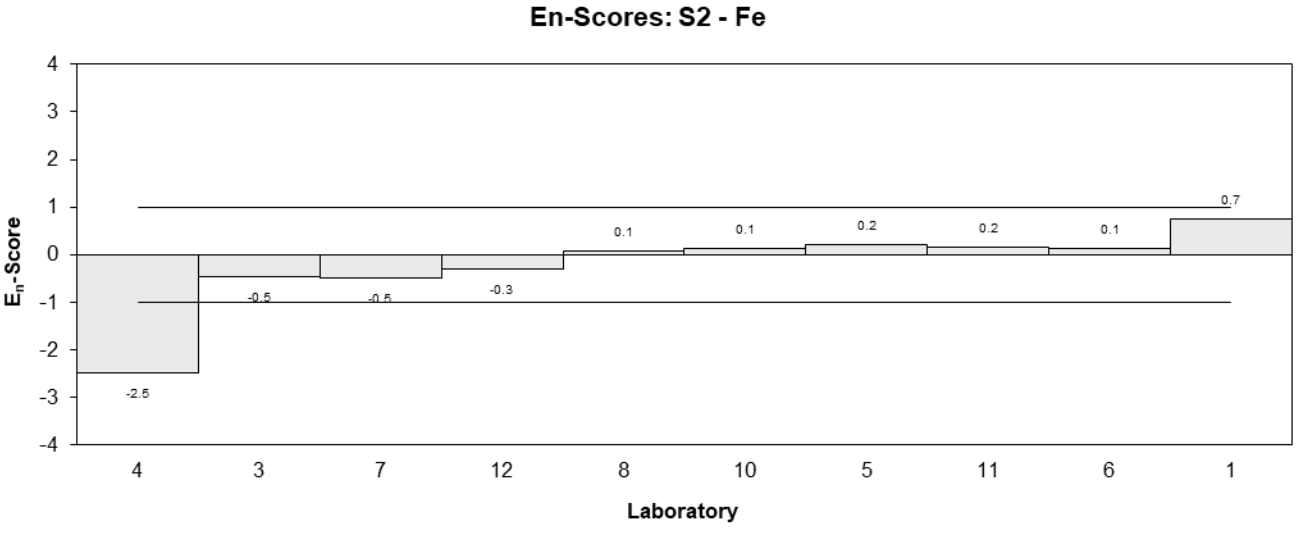

En-Scores: S2 - Fe
En-Score
-2.5
-0.5
-0.5
-0.3
0.1
0.1
0.2
0.2
0.1
0.7
Laboratory
4 3 7 12 8 10 5 11 6 1

Figure 42

Table 47

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Hg
Unit	mg/kg

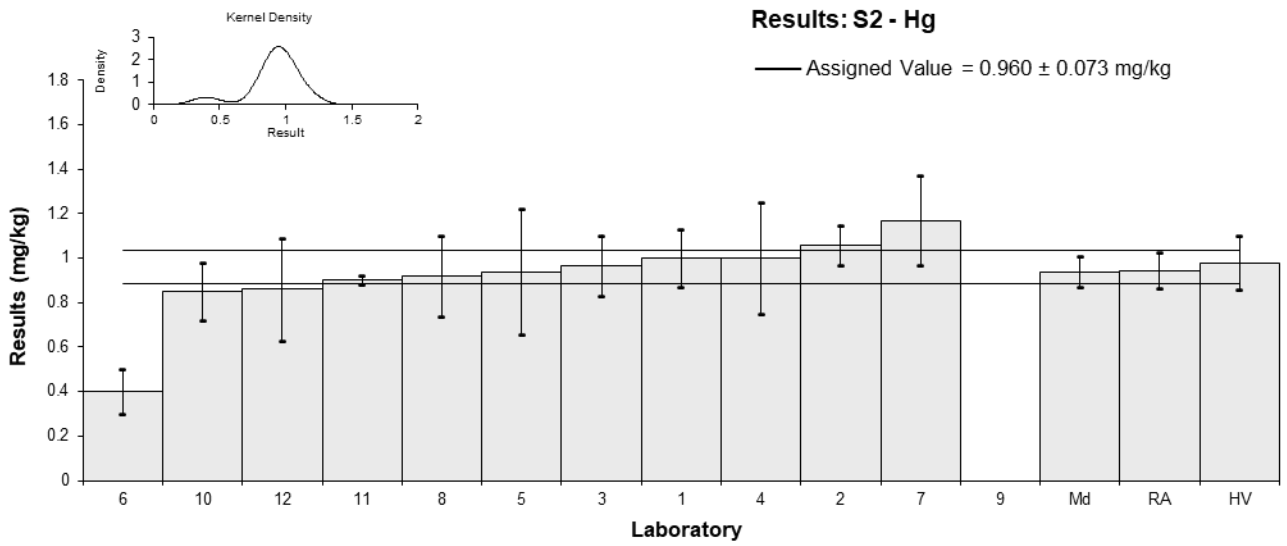
Participant Results

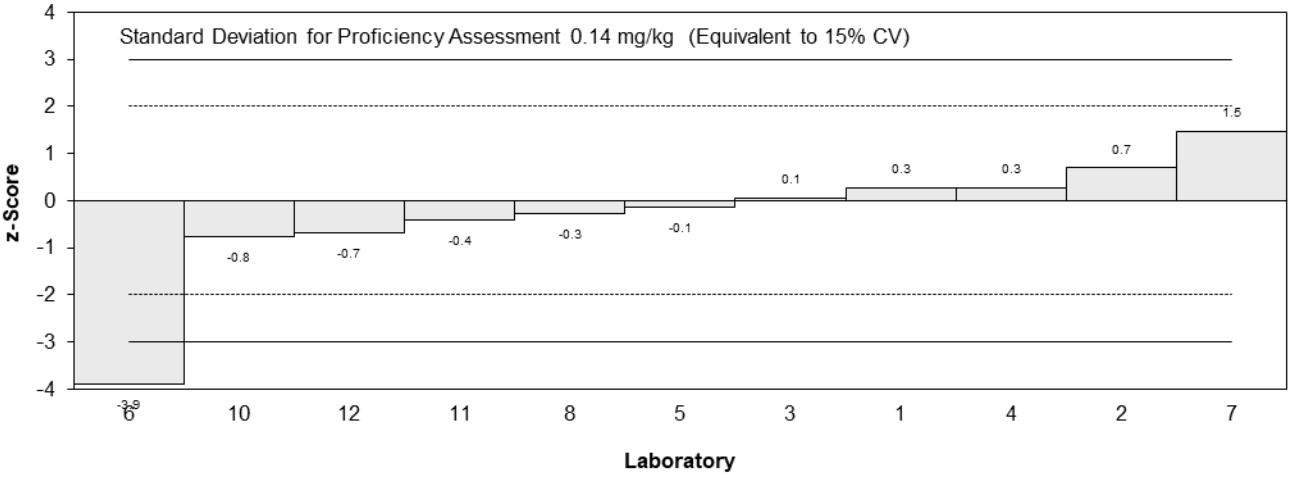
Lab. Code	Result	Uncertainty	z	E_n
1	1.0	0.13	0.28	0.27
2	1.06	0.09	0.69	0.86
3	0.968	0.135	0.06	0.05
4	1.0	0.25	0.28	0.15
5	0.94	0.28	-0.14	-0.07
6*	0.4	0.1	-3.89	-4.52
7	1.17	0.2	1.46	0.99
8	0.92	0.18	-0.28	-0.21
9	NT	NT		
10	0.85	0.128	-0.76	-0.75
11	0.90	0.02	-0.42	-0.79
12	0.860	0.230	-0.69	-0.41

* Outlier, see Section 4.2

Statistics

Assigned Value	0.960	0.073
Homogeneity Value	0.98	0.12
Robust Average	0.944	0.081
Median	0.940	0.067
Mean	0.92	
N	11	
Max	1.17	
Min	0.4	
Robust SD	0.11	
Robust CV	11%	


Kernel Density
Density
Result
Results: S2 - Hg
Assigned Value = 0.960 ± 0.073 mg/kg
Results (mg/kg)
Laboratory
6 10 12 11 8 5 3 1 4 2 7 9 Md RA HV


z-Scores: S2 - Hg
Standard Deviation for Proficiency Assessment 0.14 mg/kg (Equivalent to 15% CV)
z-Score
-3.9 -0.8 -0.7 -0.4 -0.3 -0.1 0.1 0.3 0.3 0.7 1.5
Laboratory
6 10 12 11 8 5 3 1 4 2 7

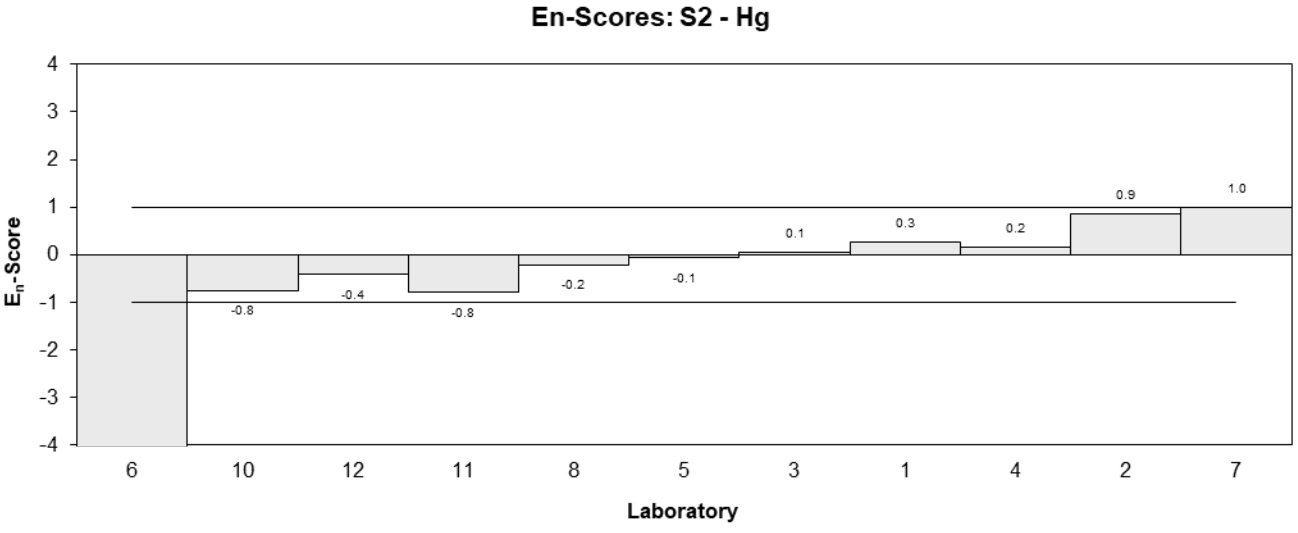

En-Scores: S2 - Hg
En-Score
-0.8 -0.4 -0.8 -0.2 -0.1 0.1 0.3 0.2 0.9 1.0
Laboratory
6 10 12 11 8 5 3 1 4 2 7

Figure 43

Table 48

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Iodine (Total)
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	3.6	0.5
5	NT	NT
6	NR	NR
7	4.0	1.0
8	NR	NR
9	NT	NT
10	NT	NT
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Information Value	3.90	0.74
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	3.80	
N	2	
Max	4.0	
Min	3.6	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

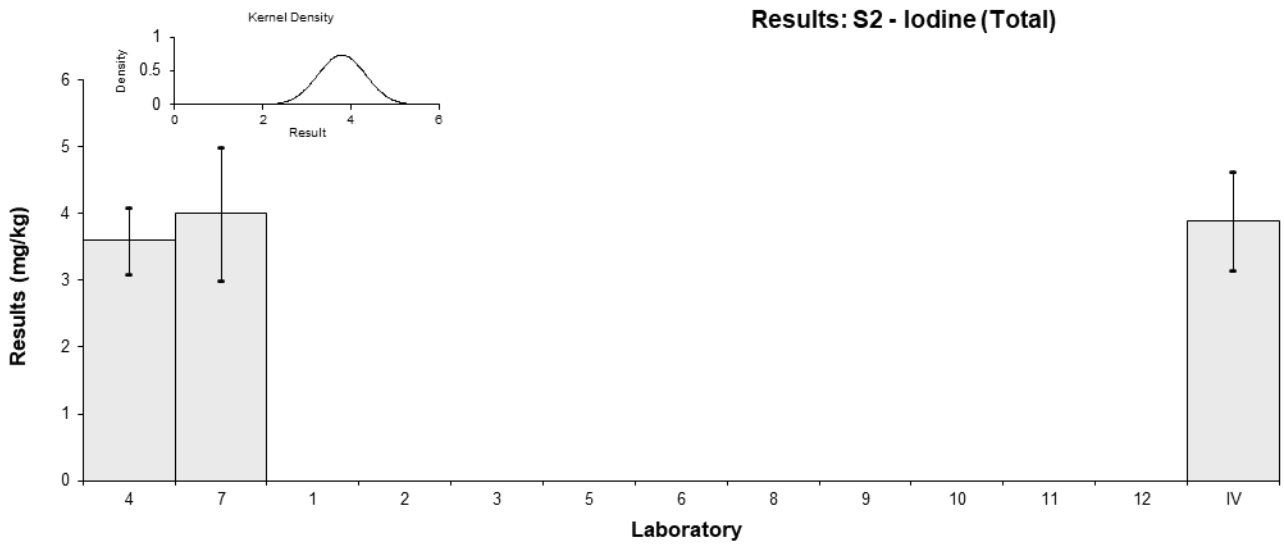

Results: S2 - Iodine (Total)
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
7
1
2
3
5
6
8
9
10
11
12
IV

Figure 44

Table 49

Sample Details

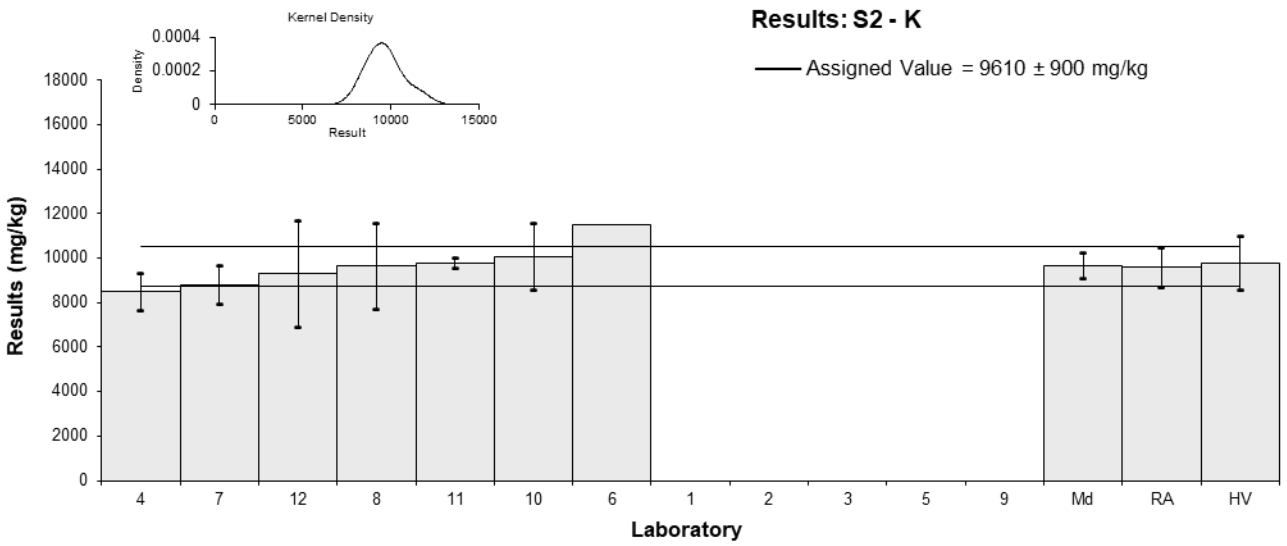
Sample No.	S2
Matrix	Seafood Biota
Analyte	K
Unit	mg/kg

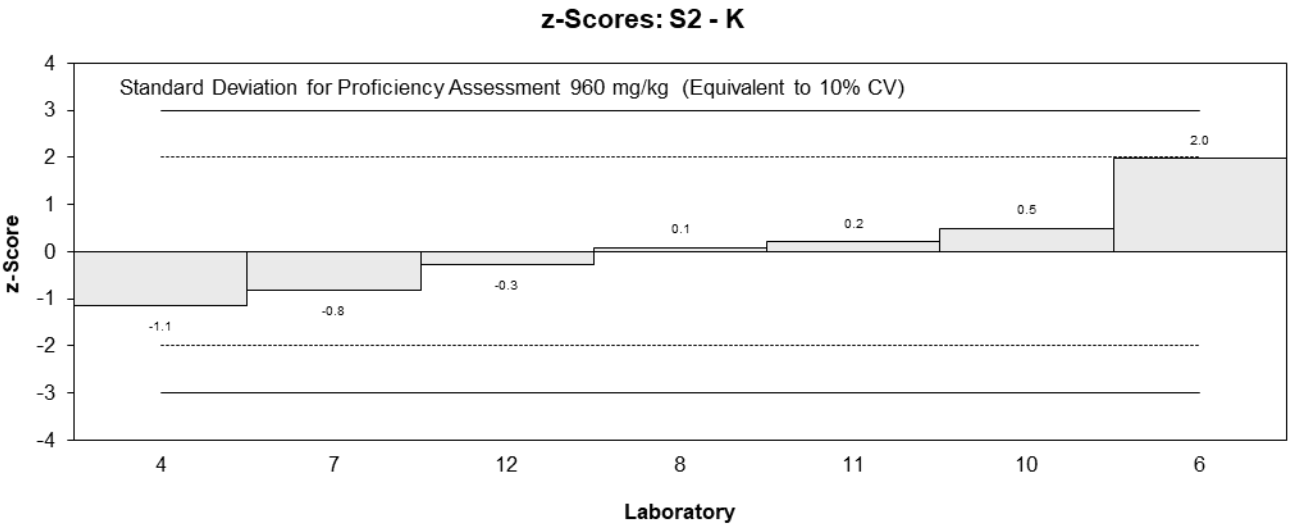
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	NT	NT		
3	NT	NT		
4	8510	850	-1.14	-0.89
5	NT	NT		
6	11500	NR	1.97	2.10
7	8820	880	-0.82	-0.63
8	9680	1936	0.07	0.03
9	NT	NT		
10	10084	1513	0.49	0.27
11	9800	236.1	0.20	0.20
12	9330.000	2390.000	-0.29	-0.11

Statistics

Assigned Value	9610	900
Homogeneity Value	9800	1200
Robust Average	9610	900
Median	9680	570
Mean	9670	
N	7	
Max	11500	
Min	8510	
Robust SD	950	
Robust CV	9.9%	


Kernel Density
Density
0.0004
0.0002
0
0
5000
10000
15000
Result
Results: S2 - K
Assigned Value = 9610 ± 900 mg/kg
Results (mg/kg)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
4
7
12
8
11
10
6
1
2
3
5
9
Md
RA
HV
Laboratory


z-Scores: S2 - K
Standard Deviation for Proficiency Assessment 960 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.1
-0.8
-0.3
0.1
0.2
0.5
2.0
4
7
12
8
11
10
6
Laboratory

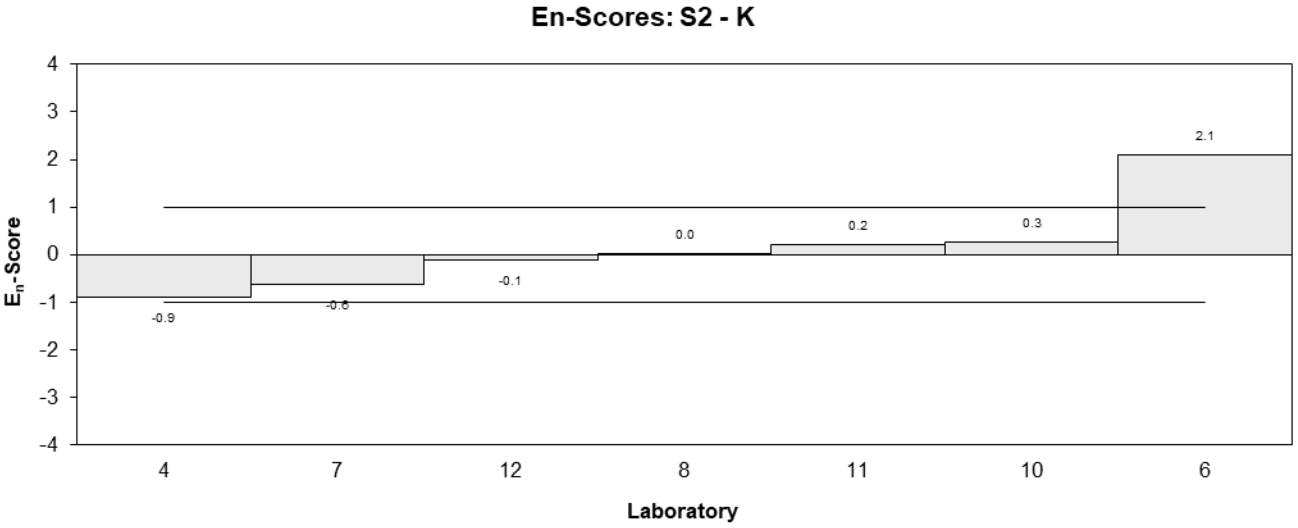

En-Scores: S2 - K
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.9
-0.6
-0.1
0.0
0.2
0.3
2.1
4
7
12
8
11
10
6
Laboratory

Figure 45

Table 50

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	La
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	<0.05	0.05
5	NT	NT
6	<0.1	NR
7	NT	NT
8	0.045	0.009
9	NT	NT
10	0.05	0.01
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	0.0475	
N	2	
Max	0.05	
Min	0.045	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

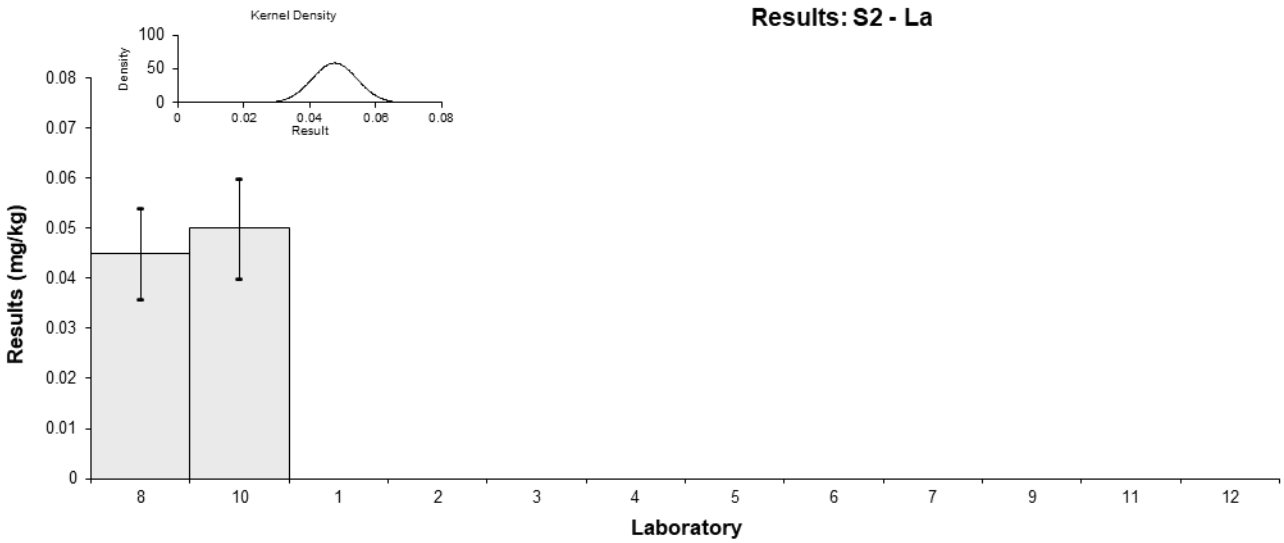

Results: S2 - La
Kernel Density
Density
100
50
0
0
0.02
0.04
0.06
0.08
Result
Results (mg/kg)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
8
10
1
2
3
4
5
6
7
9
11
12
Laboratory

Figure 46

Table 51

Sample Details

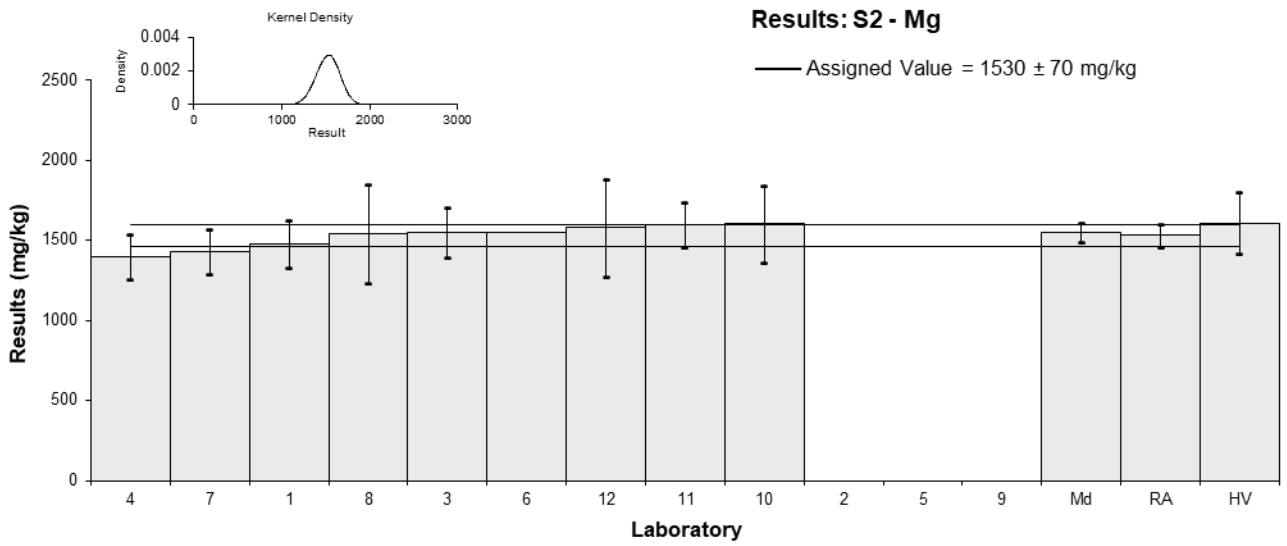
Sample No.	S2
Matrix	Seafood Biota
Analyte	Mg
Unit	mg/kg

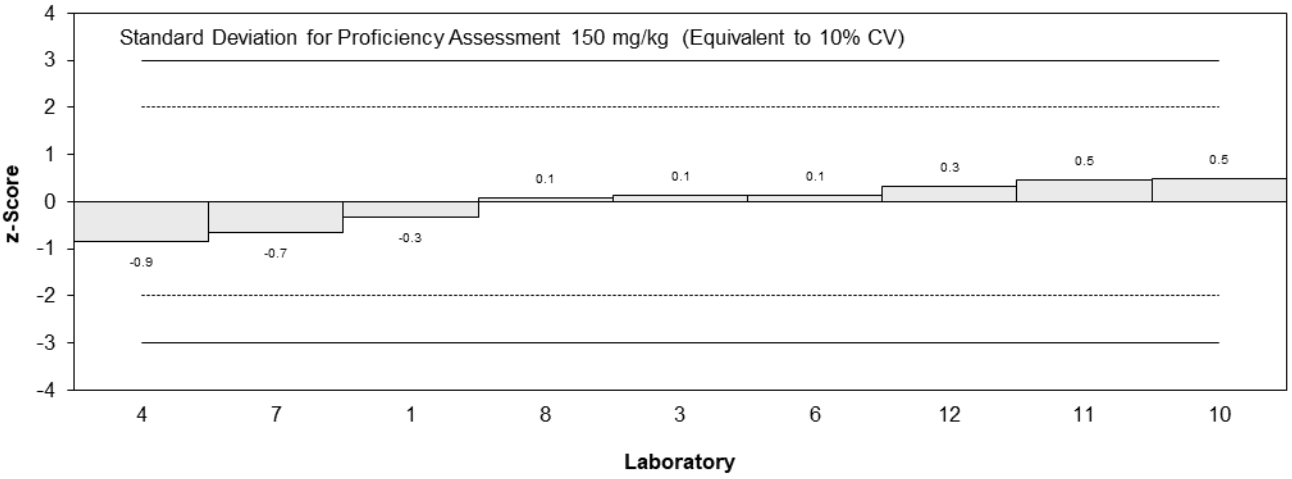
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	1480	150	-0.33	-0.30
2	NT	NT		
3	1550	160	0.13	0.11
4	1400	140	-0.85	-0.83
5	NT	NT		
6	1550	NR	0.13	0.29
7	1430	140	-0.65	-0.64
8	1540	308	0.07	0.03
9	NT	NT		
10	1603	240	0.48	0.29
11	1600	140.16	0.46	0.45
12	1580.000	304.000	0.33	0.16

Statistics

Assigned Value	1530	70
Homogeneity Value	1610	190
Robust Average	1530	70
Median	1550	60
Mean	1530	
N	9	
Max	1603	
Min	1400	
Robust SD	82	
Robust CV	5.4%	


Kernel Density
Density
0.004
0.002
0
0
1000
2000
3000
Result
Results: S2 - Mg
Assigned Value = 1530 ± 70 mg/kg
Results (mg/kg)
2500
2000
1500
1000
500
0
4
7
1
8
3
6
12
11
10
2
5
9
Md
RA
HV
Laboratory


z-Scores: S2 - Mg
Standard Deviation for Proficiency Assessment 150 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.9
-0.7
-0.3
0.1
0.1
0.1
0.3
0.5
0.5
4
7
1
8
3
6
12
11
10
Laboratory

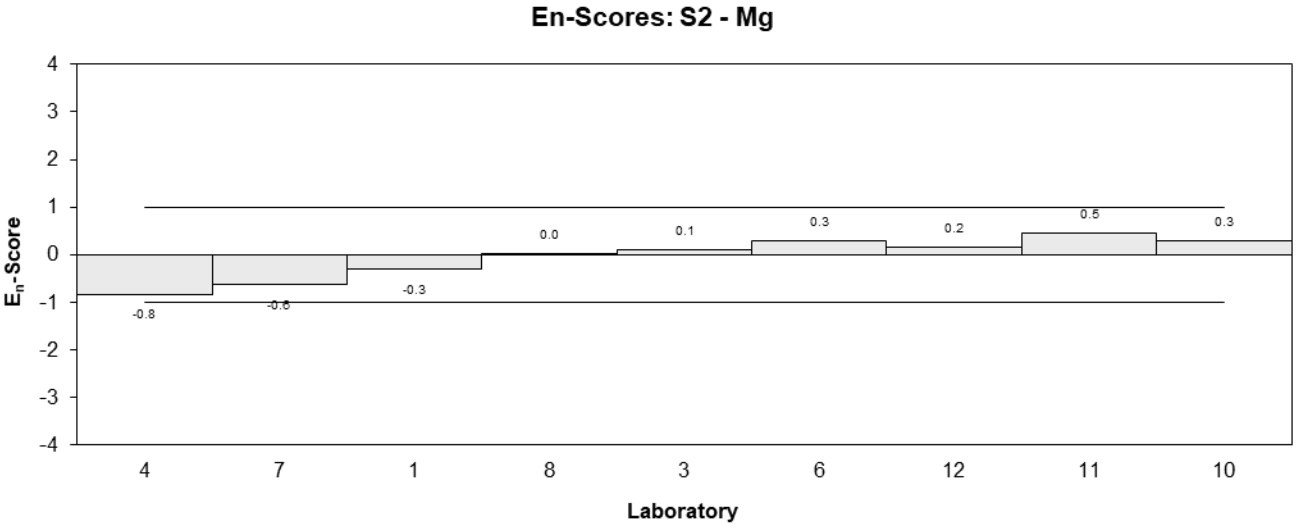

En-Scores: S2 - Mg
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8
-0.6
-0.3
0.0
0.1
0.3
0.2
0.5
0.3
4
7
1
8
3
6
12
11
10
Laboratory

Figure 47

Table 52

Sample Details

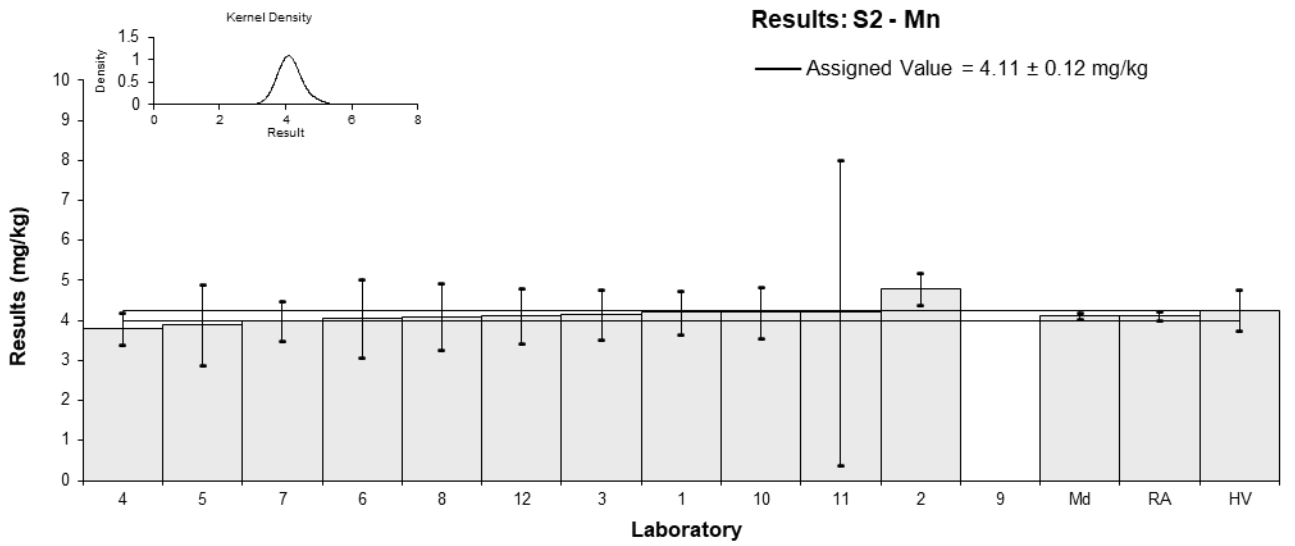
Sample No.	S2
Matrix	Seafood Biota
Analyte	Mn
Unit	mg/kg

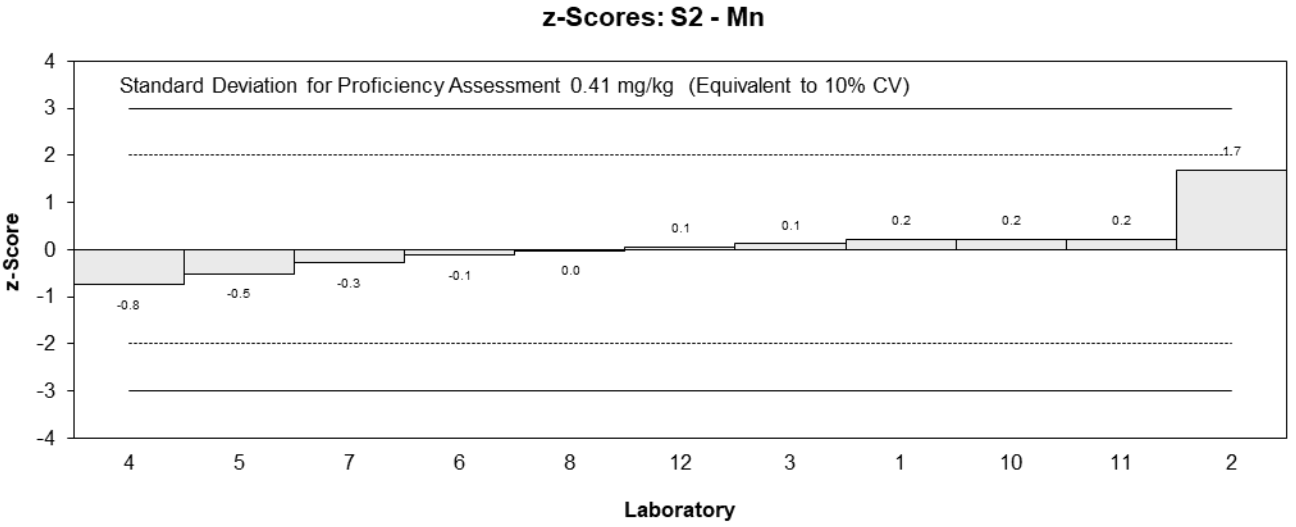
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	4.2	0.55	0.22	0.16
2	4.8	0.4	1.68	1.65
3	4.16	0.62	0.12	0.08
4	3.8	0.4	-0.75	-0.74
5	3.9	1.0	-0.51	-0.21
6	4.06	0.98	-0.12	-0.05
7	4.0	0.5	-0.27	-0.21
8	4.1	0.82	-0.02	-0.01
9	NT	NT		
10	4.2	0.63	0.22	0.14
11	4.2	3.8	0.22	0.02
12	4.130	0.690	0.05	0.03

Statistics

Assigned Value	4.11	0.12
Homogeneity Value	4.25	0.51
Robust Average	4.11	0.12
Median	4.13	0.08
Mean	4.14	
N	11	
Max	4.8	
Min	3.8	
Robust SD	0.16	
Robust CV	3.9%	


Kernel Density
Density
Result
Results: S2 - Mn
Assigned Value = 4.11 ± 0.12 mg/kg
Results (mg/kg)
Laboratory
4 5 7 6 8 12 3 1 10 11 2 9 Md RA HV


z-Scores: S2 - Mn
Standard Deviation for Proficiency Assessment 0.41 mg/kg (Equivalent to 10% CV)
z-Score
-0.8 -0.5 -0.3 -0.1 0.0 0.1 0.1 0.2 0.2 0.2 1.7
Laboratory
4 5 7 6 8 12 3 1 10 11 2

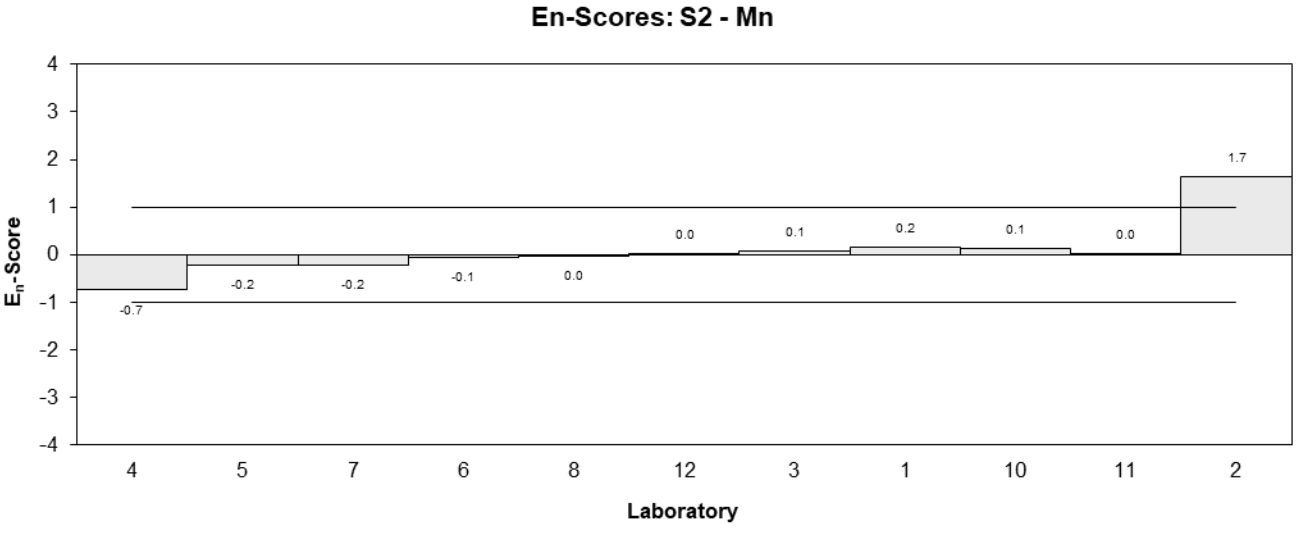

En-Scores: S2 - Mn
En-Score
-0.7 -0.2 -0.2 -0.1 0.0 0.0 0.1 0.2 0.1 0.0 1.7
Laboratory
4 5 7 6 8 12 3 1 10 11 2

Figure 48

Table 53

Sample Details

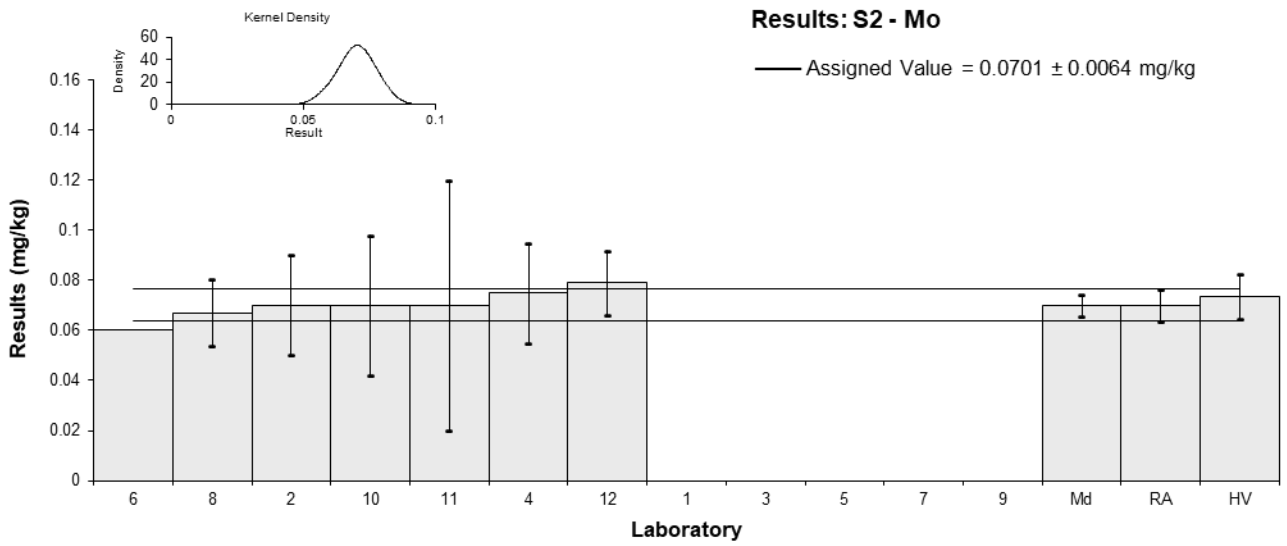
Sample No.	S2
Matrix	Seafood Biota
Analyte	Mo
Unit	mg/kg

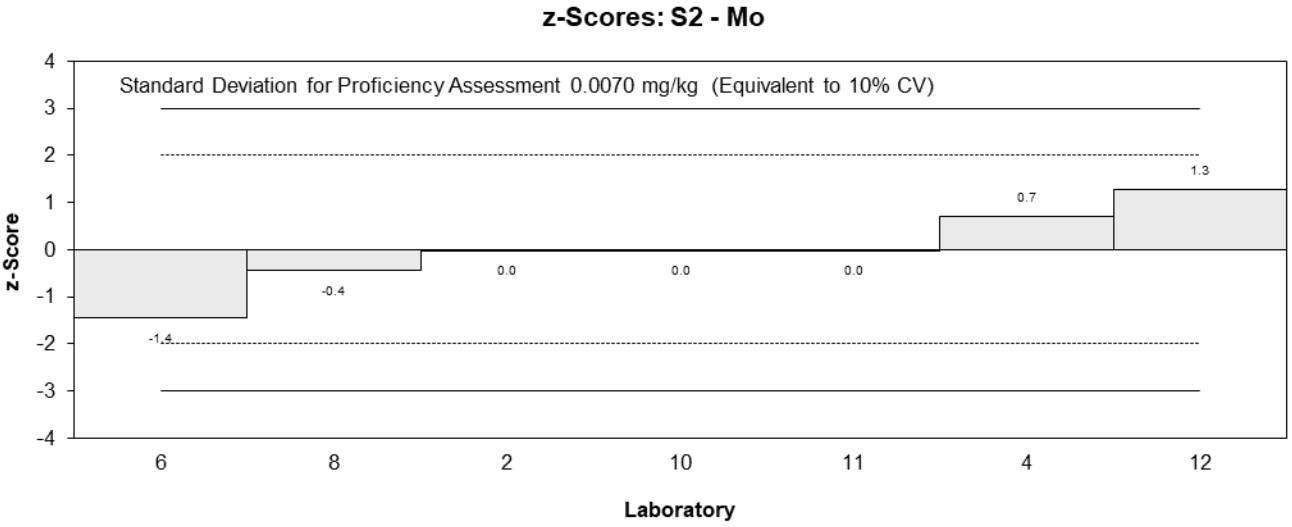
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.07	0.02	-0.01	0.00
3	<0.4	NR		
4	0.075	0.02	0.70	0.23
5	<1.0	NR		
6	0.06	NR	-1.44	-1.58
7	<0.2	NR		
8	0.067	0.0134	-0.44	-0.21
9	NT	NT		
10	0.07	0.028	-0.01	0.00
11	0.07	0.05	-0.01	0.00
12	0.079	0.013	1.27	0.61

Statistics

Assigned Value	0.0701	0.0064
Homogeneity Value	0.0736	0.0088
Robust Average	0.0701	0.0064
Median	0.0700	0.0042
Mean	0.0701	
N	7	
Max	0.079	
Min	0.06	
Robust SD	0.0068	
Robust CV	9.7%	


Kernel Density
Density
Result
Results: S2 - Mo
Assigned Value = 0.0701 ± 0.0064 mg/kg
Results (mg/kg)
Laboratory
6
8
2
10
11
4
12
1
3
5
7
9
Md
RA
HV


z-Scores: S2 - Mo
Standard Deviation for Proficiency Assessment 0.0070 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
-1.4
-0.4
0.0
0.0
0.0
0.7
1.3

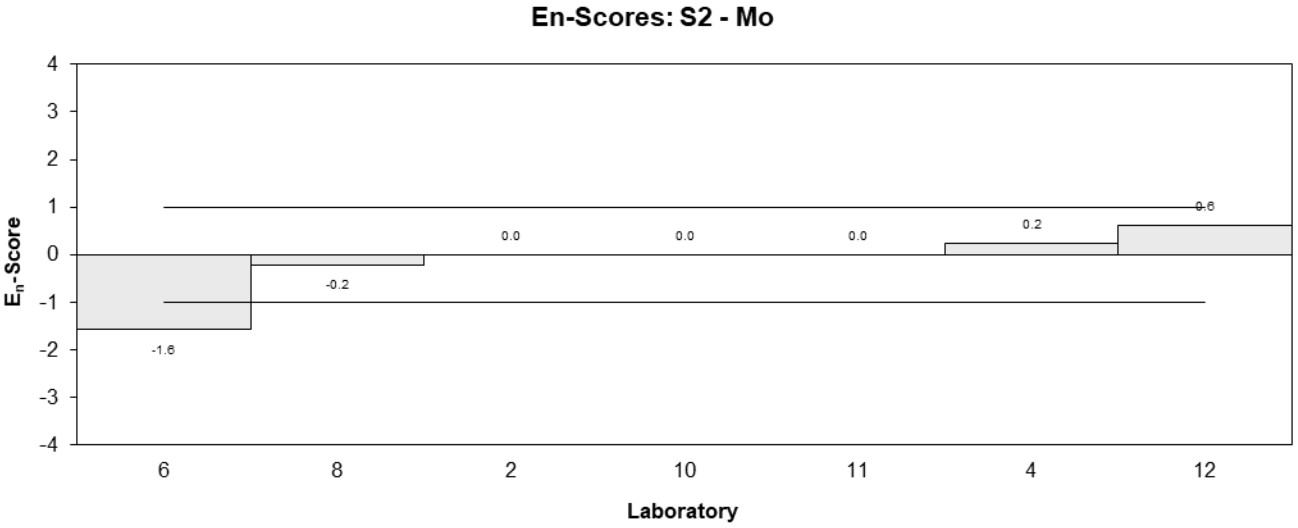

En-Scores: S2 - Mo
En-Score
Laboratory
-1.6
-0.2
0.0
0.0
0.0
0.2
0.6

Figure 49

Table 54

Sample Details

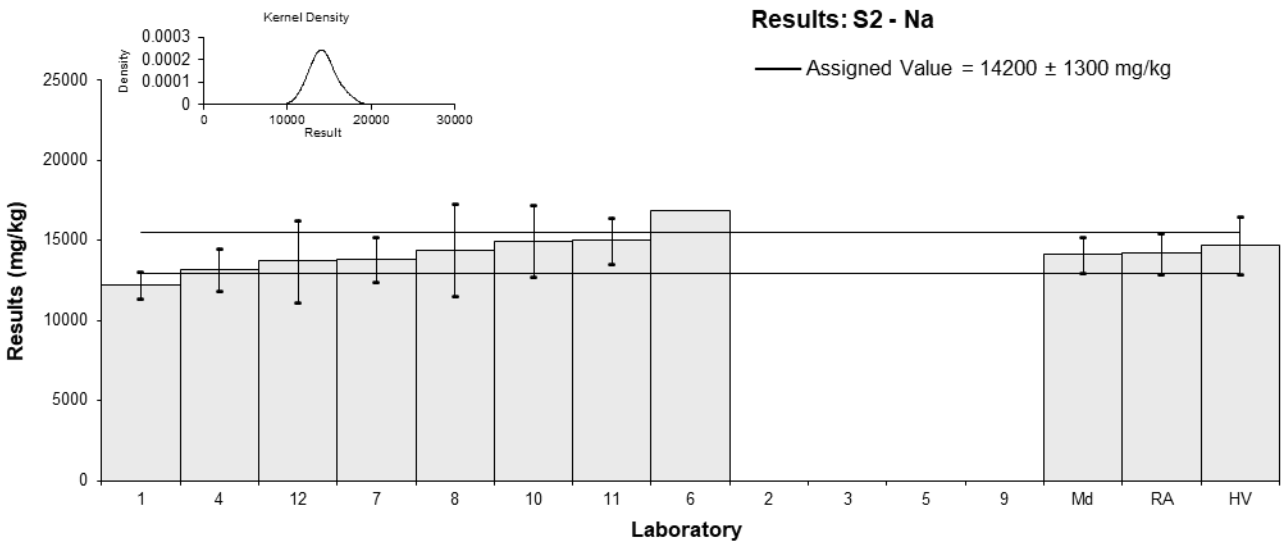
Sample No.	S2
Matrix	Seafood Biota
Analyte	Na
Unit	mg/kg

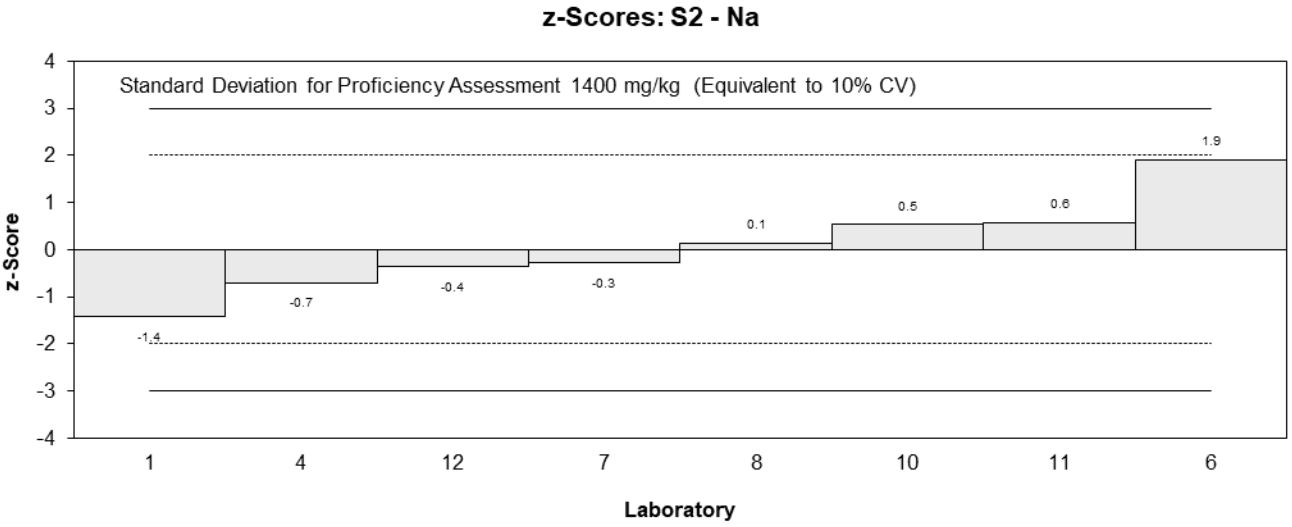
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	12200	850	-1.41	-1.29
2	NT	NT		
3	NT	NT		
4	13200	1320	-0.70	-0.54
5	NT	NT		
6	16900	NR	1.90	2.08
7	13800	1400	-0.28	-0.21
8	14400	2880	0.14	0.06
9	NT	NT		
10	14950	2242	0.53	0.29
11	15000	1424.4	0.56	0.41
12	13700.000	2600.000	-0.35	-0.17

Statistics

Assigned Value	14200	1300
Homogeneity Value	14700	1800
Robust Average	14200	1300
Median	14100	1100
Mean	14300	
N	8	
Max	16900	
Min	12200	
Robust SD	1400	
Robust CV	10%	


Results: S2 - Na
Assigned Value = 14200 ± 1300 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
1
4
12
7
8
10
11
6
2
3
5
9
Md
RA
HV


z-Scores: S2 - Na
Standard Deviation for Proficiency Assessment 1400 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
-1.4
-0.7
-0.4
-0.3
0.1
0.5
0.6
1.9

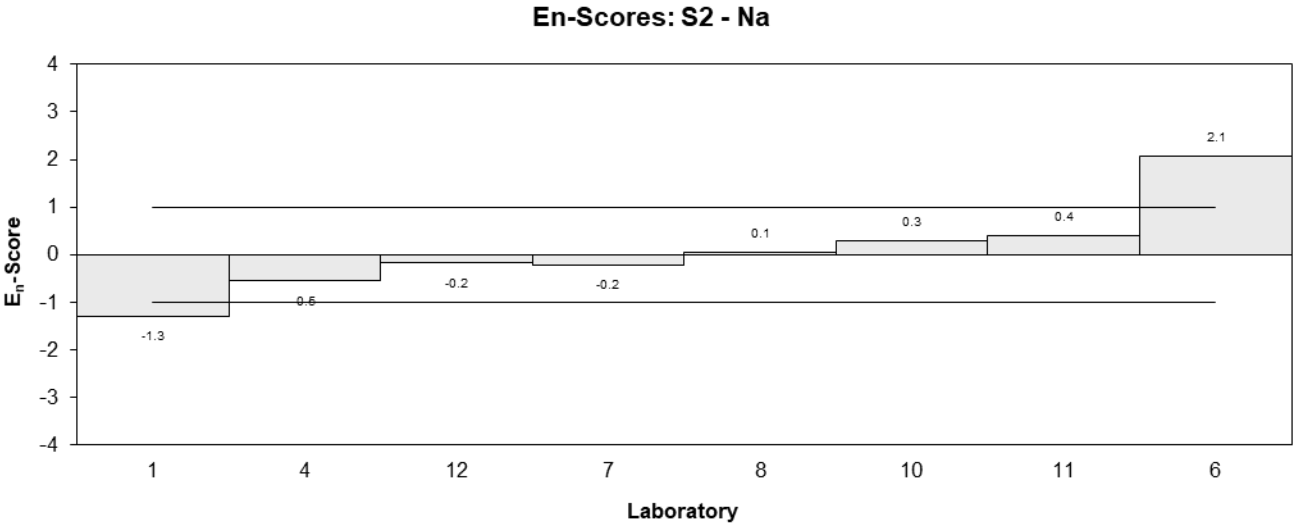

En-Scores: S2 - Na
En-Score
Laboratory
-1.3
-0.5
-0.2
-0.2
0.1
0.3
0.4
2.1

Figure 50

Table 55

Sample Details

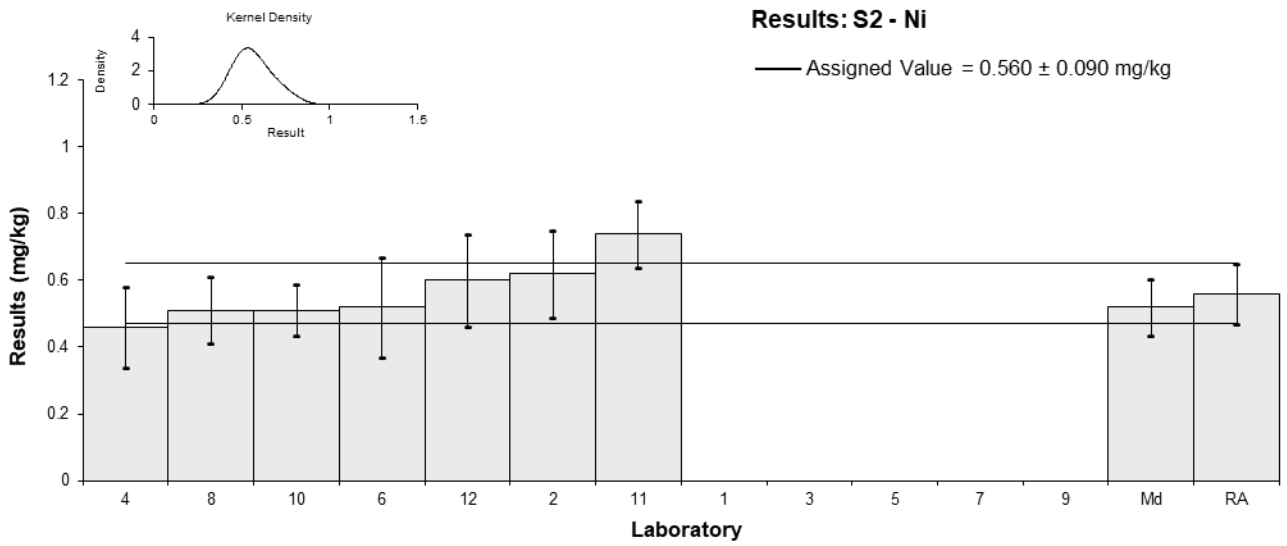
Sample No.	S2
Matrix	Seafood Biota
Analyte	Ni
Unit	mg/kg

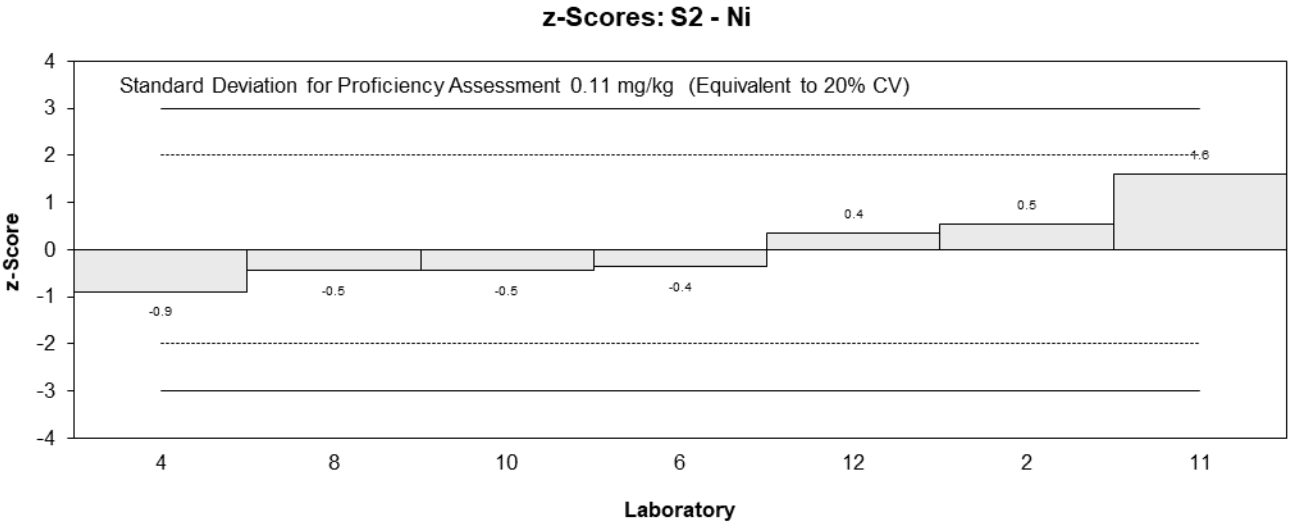
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	0.62	0.13	0.54	0.38
3	<0.7	NR		
4	0.46	0.12	-0.89	-0.67
5	<1.0	NR		
6	0.52	0.15	-0.36	-0.23
7	<1	NR		
8	0.51	0.10	-0.45	-0.37
9	NT	NT		
10	0.51	0.077	-0.45	-0.42
11	0.74	0.10	1.61	1.34
12	0.600	0.140	0.36	0.24

Statistics

Assigned Value	0.560	0.090
Robust Average	0.560	0.090
Median	0.520	0.084
Mean	0.566	
N	7	
Max	0.74	
Min	0.46	
Robust SD	0.095	
Robust CV	17%	


Kernel Density
Density
Result
Results: S2 - Ni
Assigned Value = 0.560 ± 0.090 mg/kg
Results (mg/kg)
Laboratory
4
8
10
6
12
2
11
1
3
5
7
9
Md
RA


z-Scores: S2 - Ni
Standard Deviation for Proficiency Assessment 0.11 mg/kg (Equivalent to 20% CV)
z-Score
-0.9
-0.5
-0.5
-0.4
0.4
0.5
1.6
Laboratory

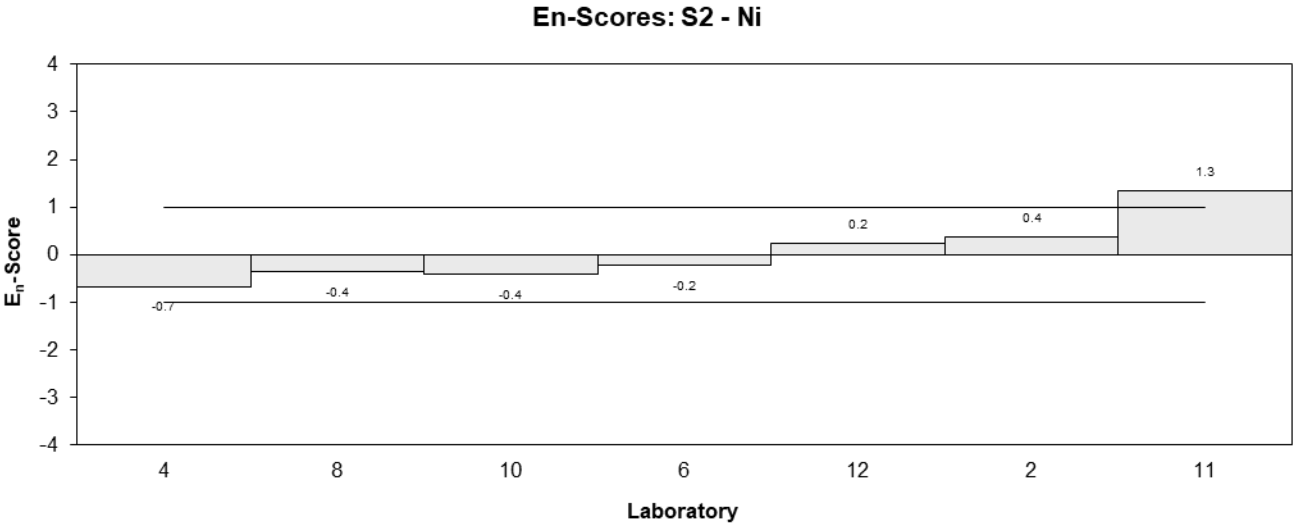

En-Scores: S2 - Ni
En-Score
-0.7
-0.4
-0.4
-0.2
0.2
0.4
1.3
Laboratory

Figure 51

Table 56

Sample Details

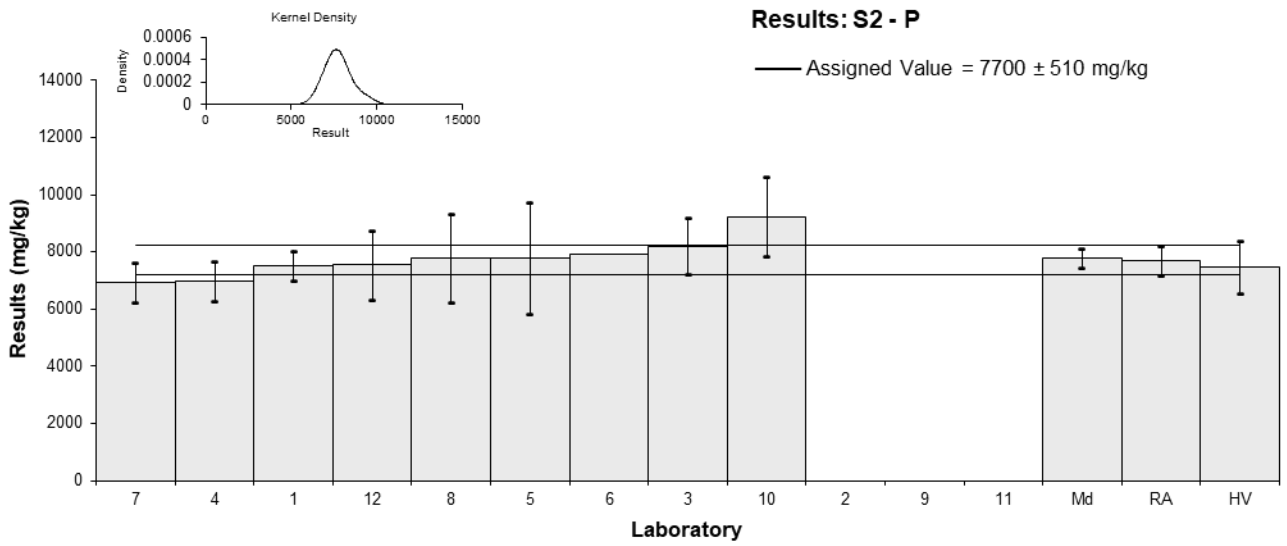
Sample No.	S2
Matrix	Seafood Biota
Analyte	P
Unit	mg/kg

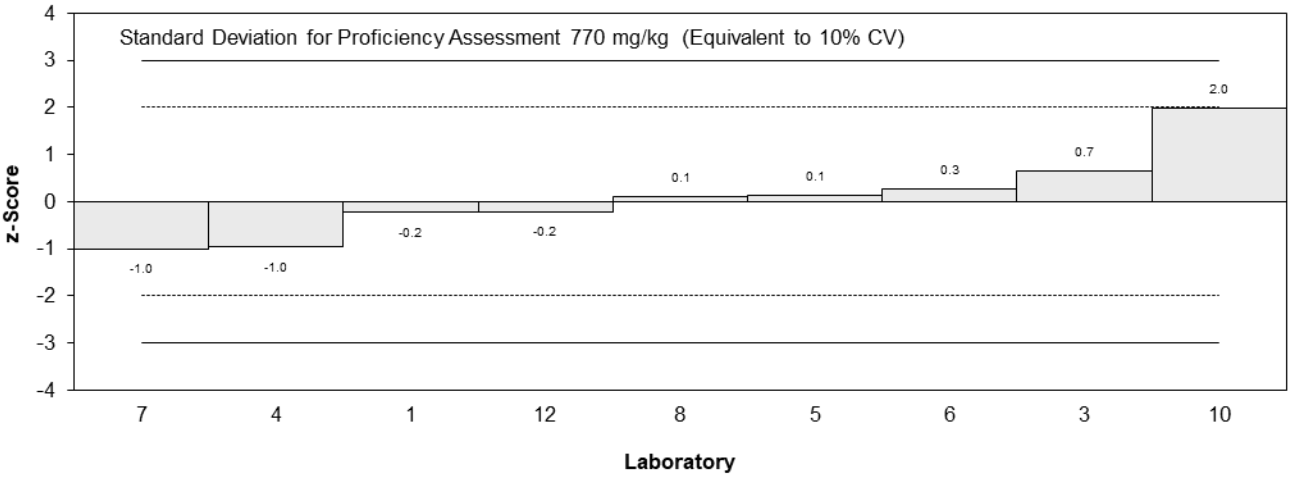
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	7520	520	-0.23	-0.25
2	NT	NT		
3	8200	980	0.65	0.45
4	6960	700	-0.96	-0.85
5	7800	1950	0.13	0.05
6	7910	NR	0.27	0.41
7	6930	690	-1.00	-0.90
8	7780	1556	0.10	0.05
9	NT	NT		
10	9230	1385	1.99	1.04
11	NR	NR		
12	7540.000	1200.000	-0.21	-0.12

Statistics

Assigned Value	7700	510
Homogeneity Value	7470	900
Robust Average	7700	510
Median	7780	320
Mean	7760	
N	9	
Max	9230	
Min	6930	
Robust SD	610	
Robust CV	8%	


Results: S2 - P
Assigned Value = 7700 ± 510 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
7 4 1 12 8 5 6 3 10 2 9 11 Md RA HV


z-Scores: S2 - P
Standard Deviation for Proficiency Assessment 770 mg/kg (Equivalent to 10% CV)
z-Score
-1.0 -1.0 -0.2 -0.2 0.1 0.1 0.3 0.7 2.0
Laboratory
7 4 1 12 8 5 6 3 10

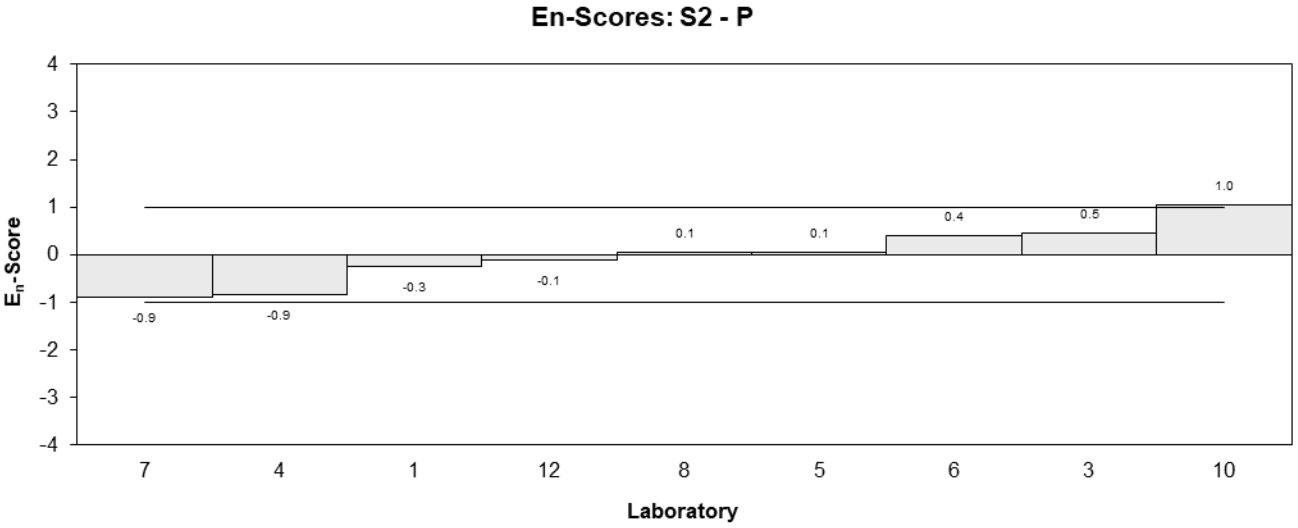

En-Scores: S2 - P
En-Score
-0.9 -0.9 -0.3 -0.1 0.1 0.1 0.4 0.5 1.0
Laboratory
7 4 1 12 8 5 6 3 10

Figure 52

Table 57

Sample Details

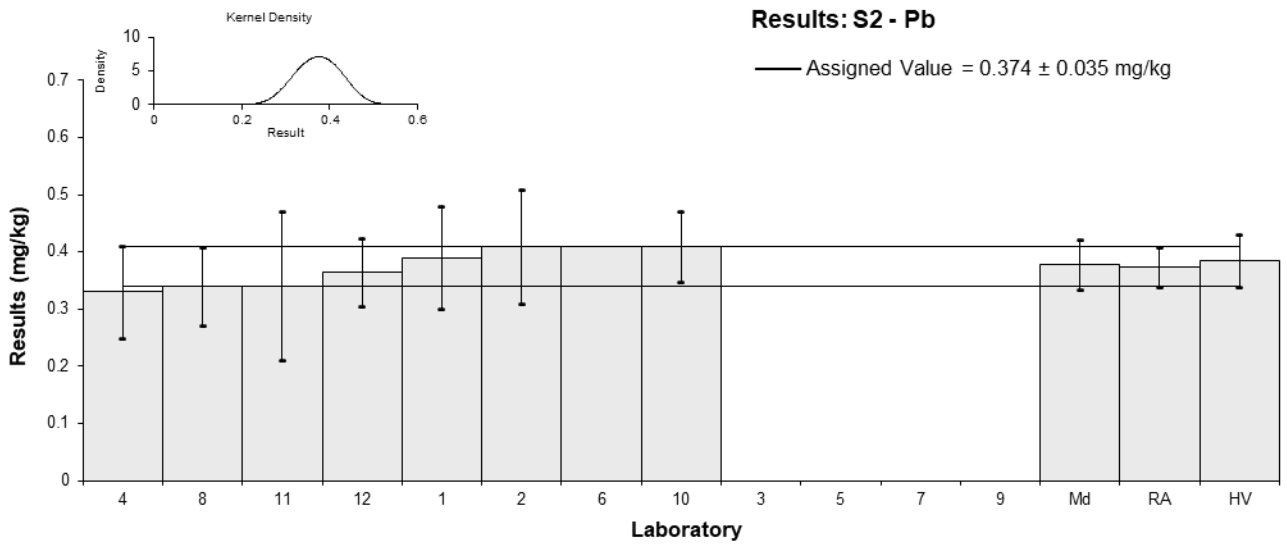
Sample No.	S2
Matrix	Seafood Biota
Analyte	Pb
Unit	mg/kg

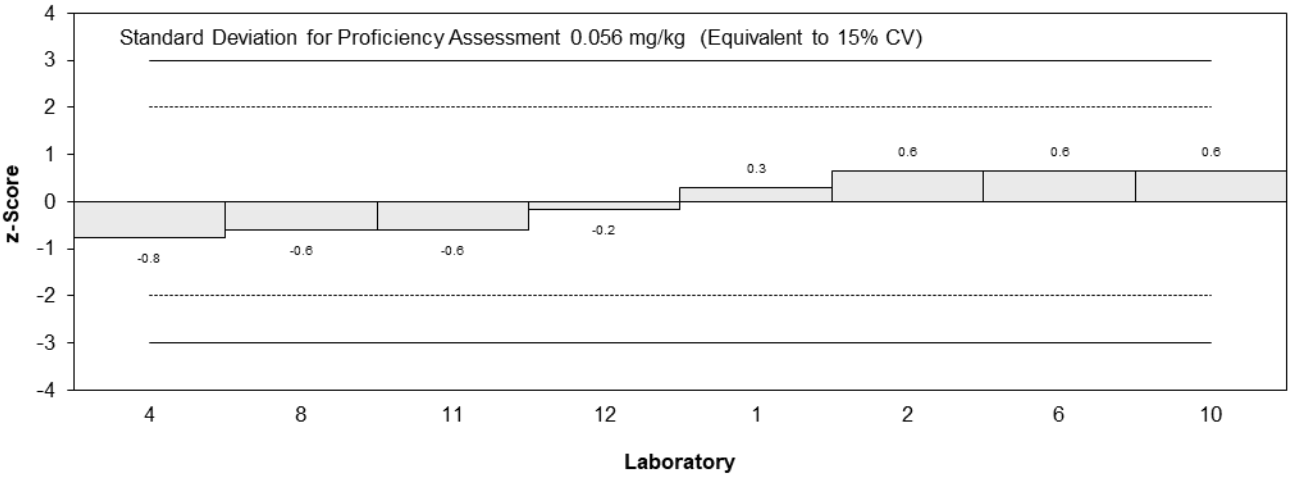
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	0.39	0.09	0.29	0.17
2	0.41	0.10	0.64	0.34
3	<1	NR		
4	0.33	0.08	-0.78	-0.50
5	<1.0	NR		
6	0.41	NR	0.64	1.03
7	<1	NR		
8	0.34	0.068	-0.61	-0.44
9	NT	NT		
10	0.41	0.062	0.64	0.51
11	0.34	0.13	-0.61	-0.25
12	0.365	0.059	-0.16	-0.13

Statistics

Assigned Value	0.374	0.035
Homogeneity Value	0.385	0.046
Robust Average	0.374	0.035
Median	0.378	0.043
Mean	0.374	
N	8	
Max	0.41	
Min	0.33	
Robust SD	0.039	
Robust CV	11%	


Kernel Density
Density
Result
Results: S2 - Pb
Assigned Value = 0.374 ± 0.035 mg/kg
Results (mg/kg)
Laboratory
4
8
11
12
1
2
6
10
3
5
7
9
Md
RA
HV


z-Scores: S2 - Pb
Standard Deviation for Proficiency Assessment 0.056 mg/kg (Equivalent to 15% CV)
z-Score
-0.8
-0.6
-0.6
-0.2
0.3
0.6
0.6
0.6
Laboratory

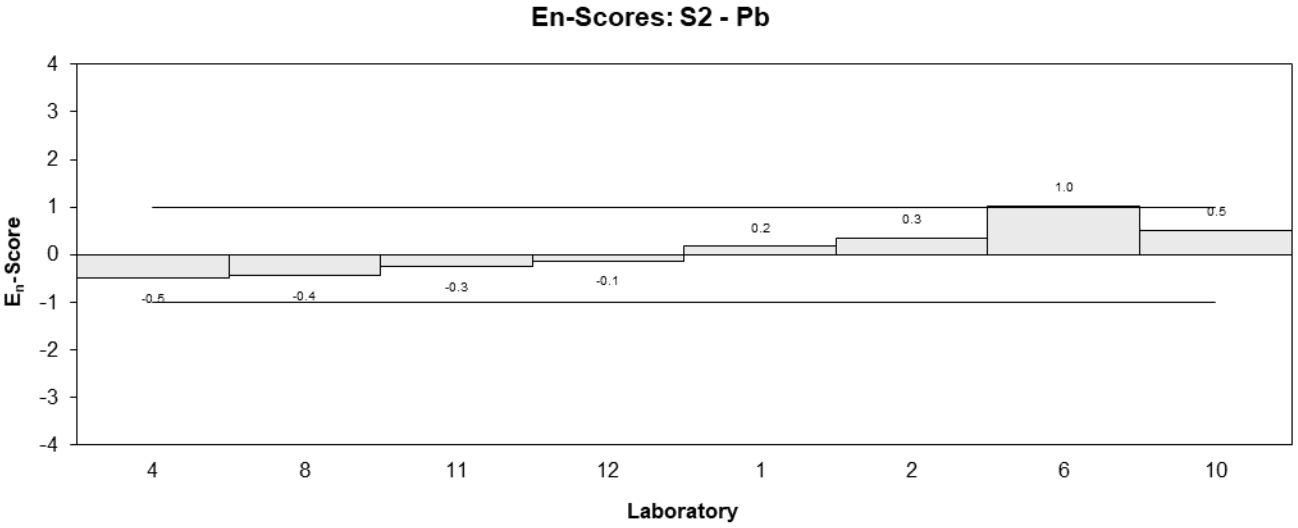

En-Scores: S2 - Pb
En-Score
-0.5
-0.4
-0.3
-0.1
0.2
0.3
1.0
0.5
Laboratory

Figure 53

Table 58

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Rb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	2.6	0.5
5	NT	NT
6	3	NR
7	NT	NT
8	2.6	0.52
9	NT	NT
10	3.23	0.485
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Homogeneity Value	2.72	0.33
Robust Average	NA (N<6)	
Median	2.80	0.37
Mean	2.86	
N	4	
Max	3.23	
Min	2.6	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

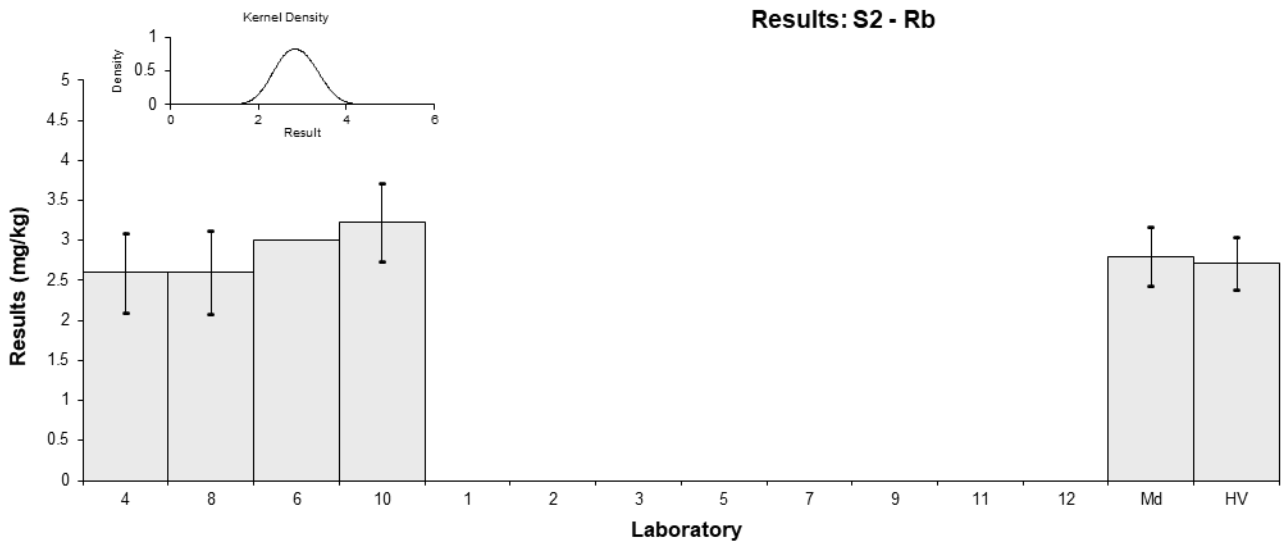

Results: S2 - Rb
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
8
6
10
1
2
3
5
7
9
11
12
Md
HV

Figure 54

Table 59

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Sb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	0.030	0.005
3	<2	NR
4	0.017	0.005
5	NT	NT
6	<0.1	NR
7	<0.1	NR
8	0.022	0.001
9	NT	NT
10	0.02	0.004
11	0.02	NR
12	0.022	0.003

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.0217	0.0026
Robust Average	0.0213	0.0038
Median	0.0210	0.0015
Mean	0.0218	
N	6	
Max	0.030	
Min	0.017	
Robust SD	0.0037	
Robust CV	18%	

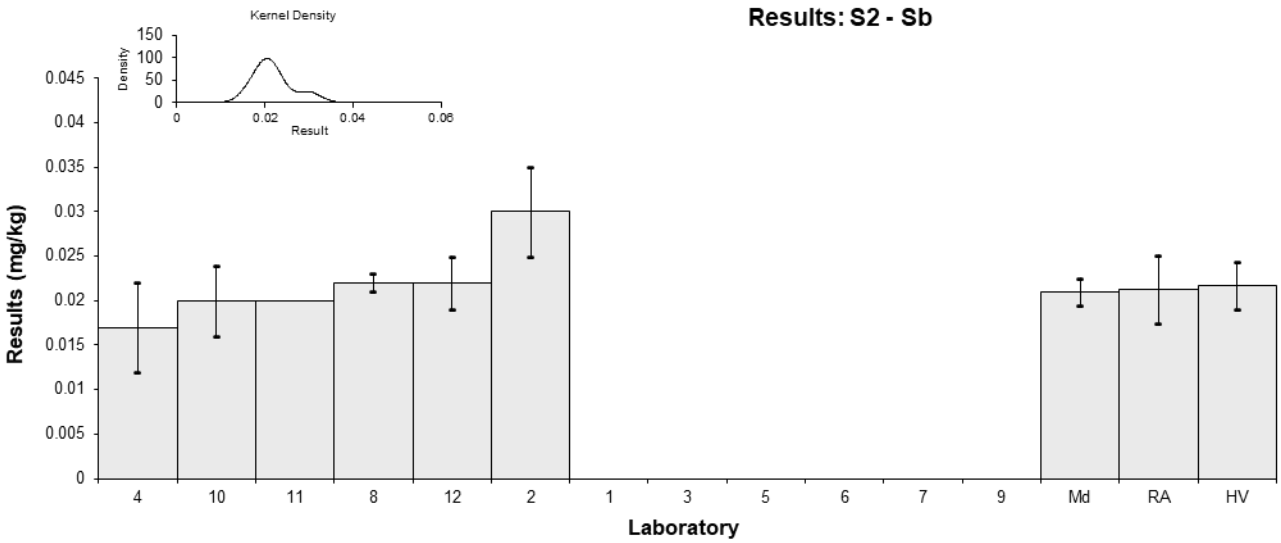

Results: S2 - Sb
Kernel Density
Density
150
100
50
0
0
0.02
0.04
0.06
Result
Results (mg/kg)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
4
10
11
8
12
2
1
3
5
6
7
9
Md
RA
HV
Laboratory

Figure 55

Table 60

Sample Details

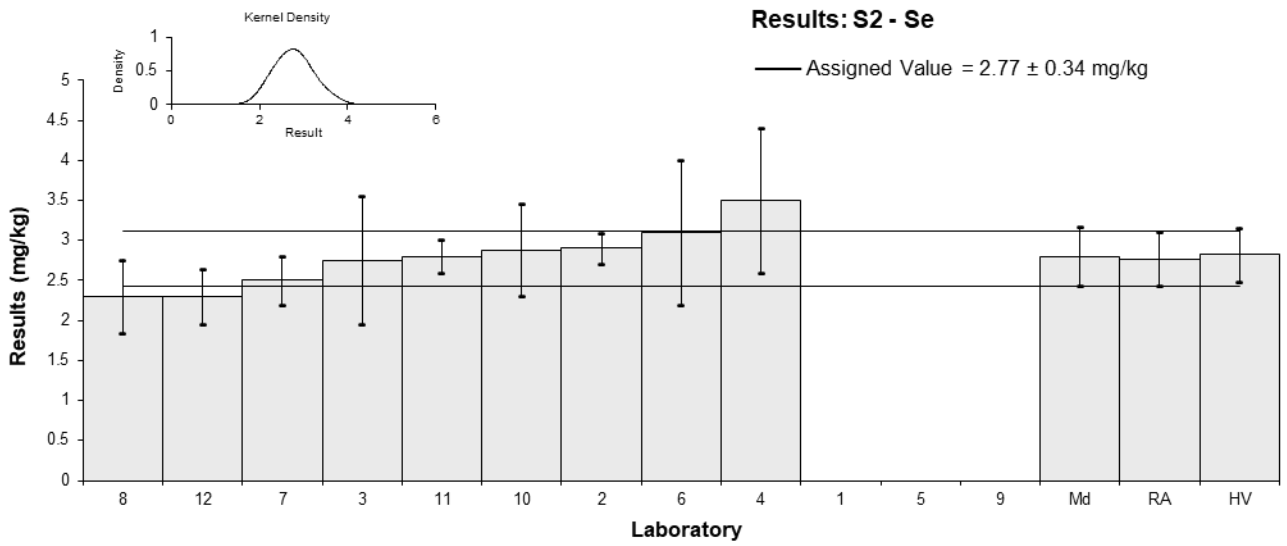
Sample No.	S2
Matrix	Seafood Biota
Analyte	Se
Unit	mg/kg

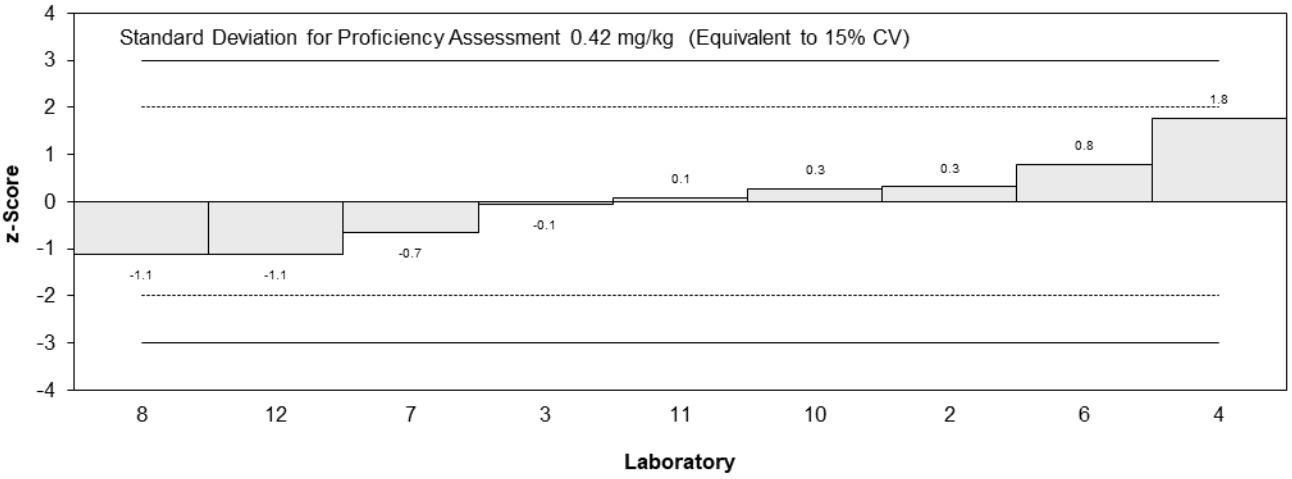
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	2.9	0.2	0.31	0.33
3	2.75	0.80	-0.05	-0.02
4	3.5	0.9	1.76	0.76
5	<5.0	NR		
6	3.1	0.9	0.79	0.34
7	2.5	0.3	-0.65	-0.60
8	2.3	0.46	-1.13	-0.82
9	NT	NT		
10	2.88	0.576	0.26	0.16
11	2.8	0.21	0.07	0.08
12	2.300	0.340	-1.13	-0.98

Statistics

Assigned Value	2.77	0.34
Homogeneity Value	2.82	0.34
Robust Average	2.77	0.34
Median	2.80	0.37
Mean	2.78	
N	9	
Max	3.5	
Min	2.3	
Robust SD	0.4	
Robust CV	15%	


Kernel Density
Density
Result
Results: S2 - Se
Assigned Value = 2.77 ± 0.34 mg/kg
Results (mg/kg)
Laboratory
8 12 7 3 11 10 2 6 4 1 5 9 Md RA HV


z-Scores: S2 - Se
Standard Deviation for Proficiency Assessment 0.42 mg/kg (Equivalent to 15% CV)
z-Score
-1.1 -1.1 -0.7 -0.1 0.1 0.3 0.3 0.8 1.8
Laboratory
8 12 7 3 11 10 2 6 4

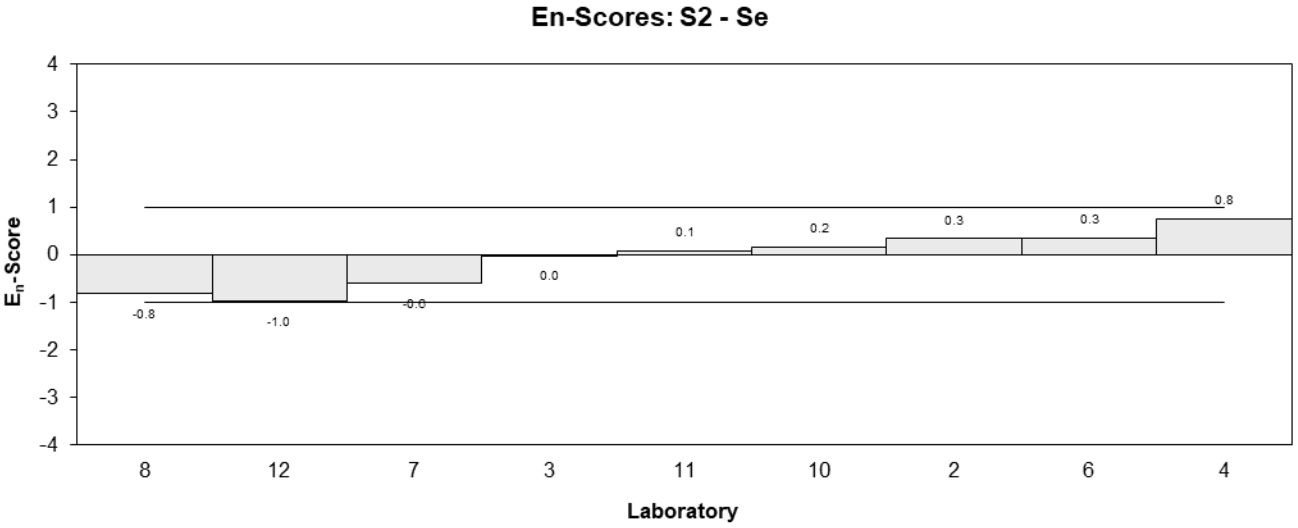

En-Scores: S2 - Se
En-Score
-0.8 -1.0 -0.6 0.0 0.1 0.2 0.3 0.3 0.8
Laboratory
8 12 7 3 11 10 2 6 4

Figure 56

Table 61

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	Sn
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	0.32	0.08
5	NT	NT
6	<0.5	NR
7	1.0	0.2
8	0.27	0.054
9	NT	NT
10	NT	NT
11	NR	NR
12	0.300	0.050

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.340	0.041
Robust Average	NA (N<6)	
Median	0.310	0.046
Mean	0.47	
N	4	
Max	1.0	
Min	0.27	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

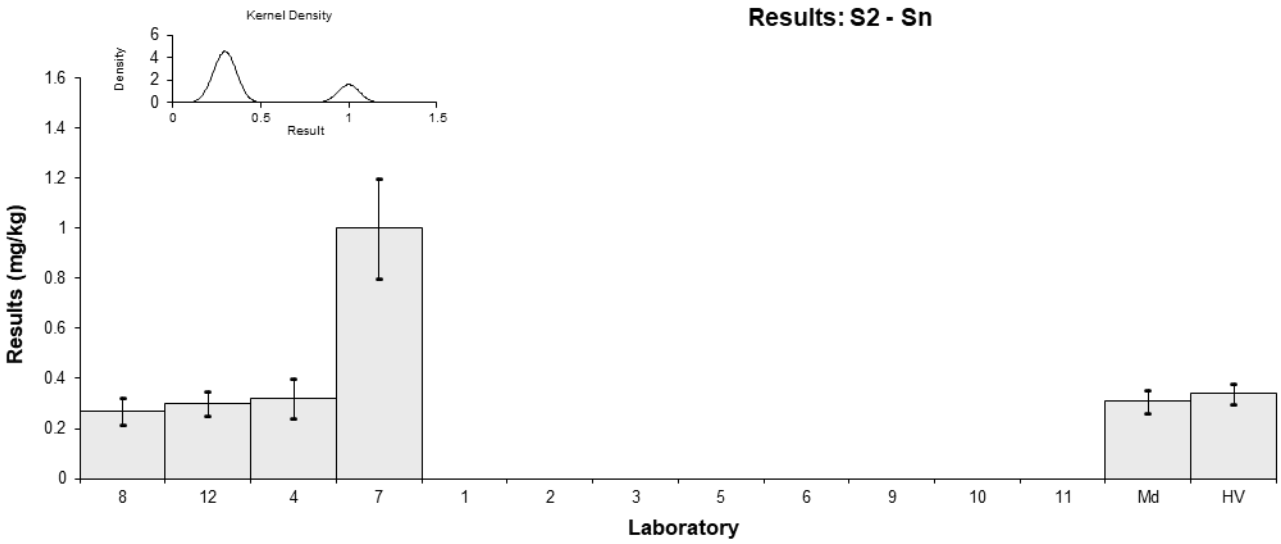

Results: S2 - Sn
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
8
12
4
7
1
2
3
5
6
9
10
11
Md
HV

Figure 57

Table 62

Sample Details

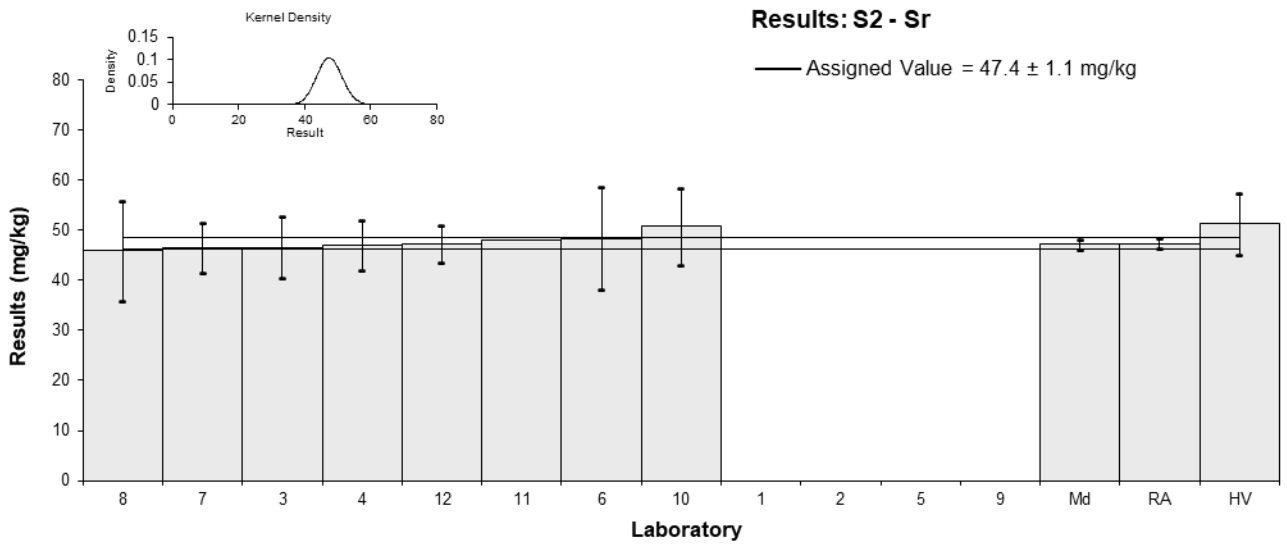
Sample No.	S2
Matrix	Seafood Biota
Analyte	Sr
Unit	mg/kg

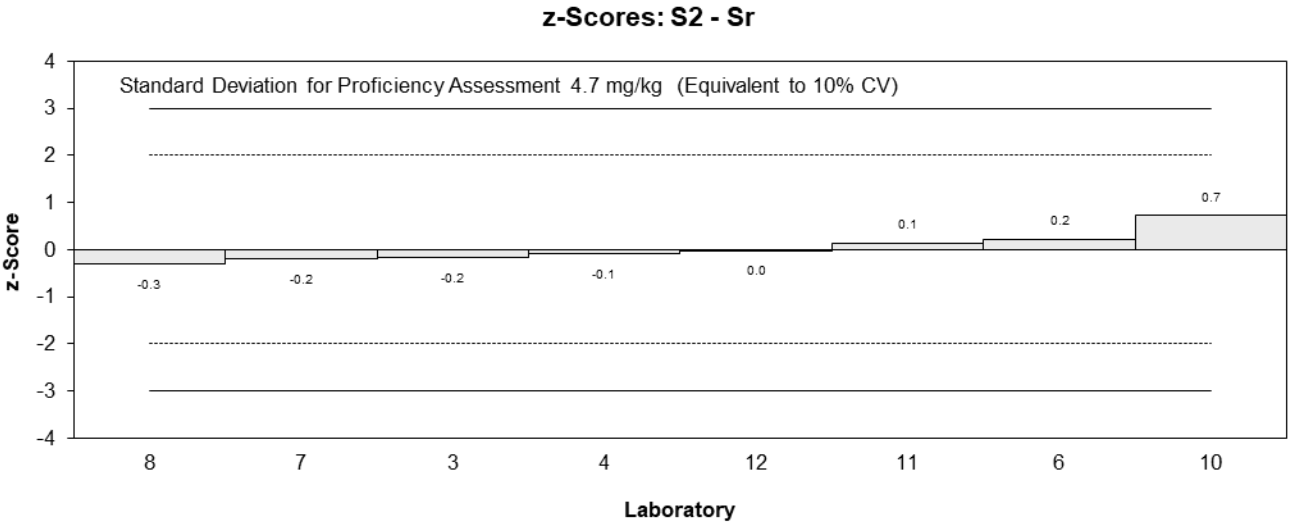
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NR	NR		
2	NT	NT		
3	46.6	6.1	-0.17	-0.13
4	47	5	-0.08	-0.08
5	NT	NT		
6	48.4	10.2	0.21	0.10
7	46.5	5.0	-0.19	-0.18
8	46	10	-0.30	-0.14
9	NT	NT		
10	50.8	7.62	0.72	0.44
11	48	NR	0.13	0.55
12	47.300	3.600	-0.02	-0.03

Statistics

Assigned Value	47.4	1.1
Homogeneity Value	51.3	6.2
Robust Average	47.4	1.1
Median	47.2	1.0
Mean	47.6	
N	8	
Max	50.8	
Min	46	
Robust SD	1.2	
Robust CV	2.6%	


Kernel Density
Density
Result
Results: S2 - Sr
Assigned Value = 47.4 ± 1.1 mg/kg
Results (mg/kg)
Laboratory
8
7
3
4
12
11
6
10
1
2
5
9
Md
RA
HV


z-Scores: S2 - Sr
Standard Deviation for Proficiency Assessment 4.7 mg/kg (Equivalent to 10% CV)
z-Score
-0.3
-0.2
-0.2
-0.1
0.0
0.1
0.2
0.7
Laboratory

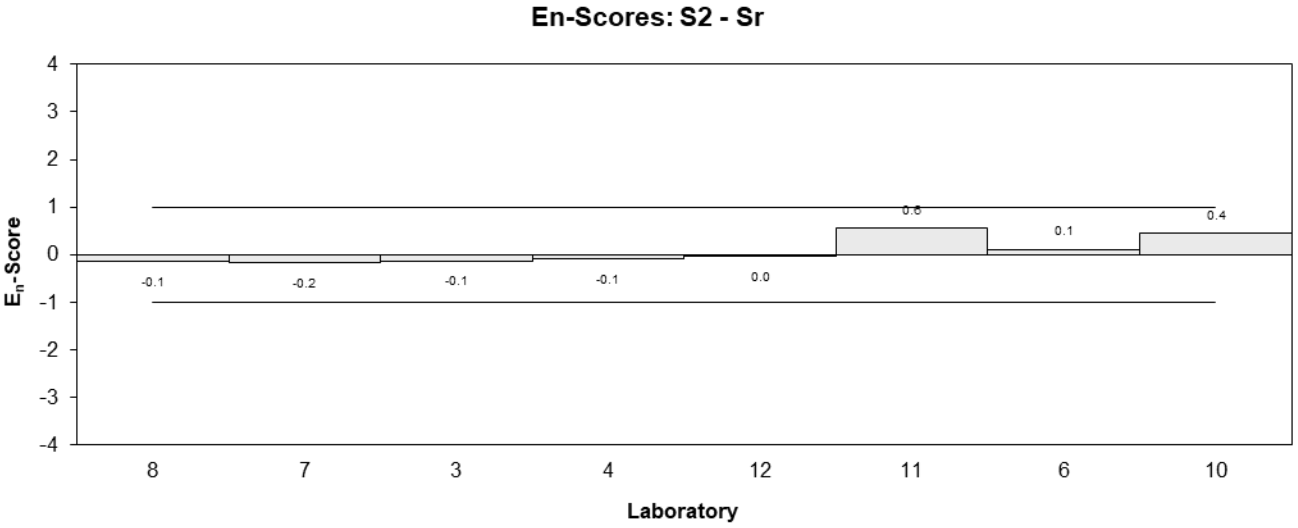

En-Scores: S2 - Sr
En-Score
-0.1
-0.2
-0.1
-0.1
0.0
0.6
0.1
0.4
Laboratory

Figure 58

Table 63

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	U
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	NT	NT
3	NT	NT
4	<0.05	0.05
5	NT	NT
6	<0.01	NR
7	<0.02	NR
8	0.017	0.0034
9	NT	NT
10	0.01	0.003
11	NR	NR
12	NT	NT

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.0130	0.0016
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	0.0135	
N	2	
Max	0.017	
Min	0.01	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

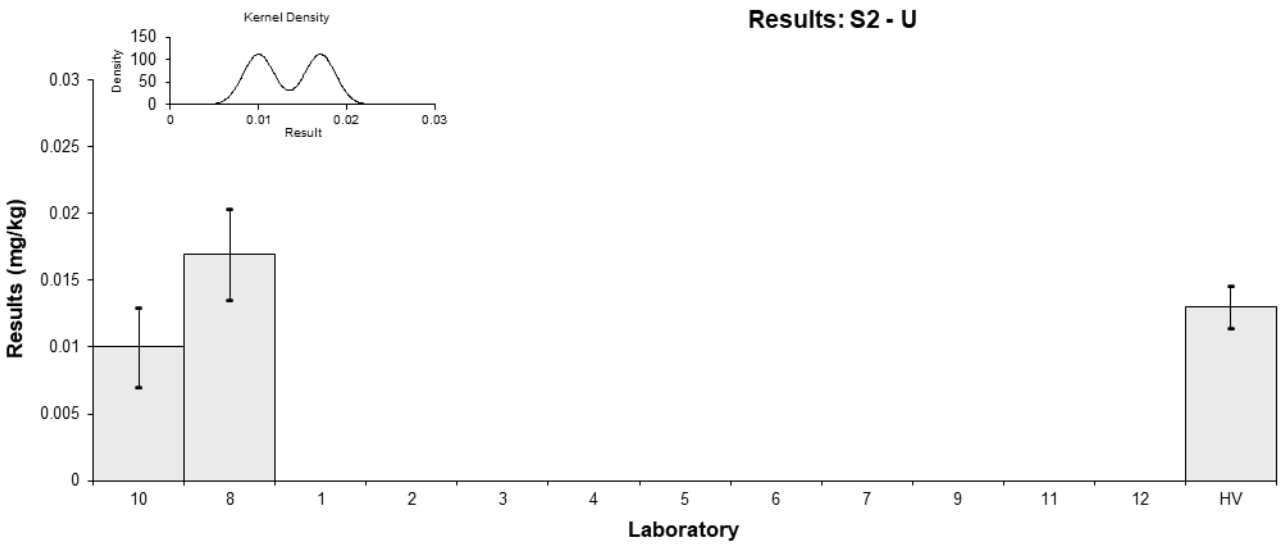

Results: S2 - U
Kernel Density
Density
150
100
50
0
0
0.01
0.02
0.03
Result
Results (mg/kg)
0.03
0.025
0.02
0.015
0.01
0.005
0
10
8
1
2
3
4
5
6
7
9
11
12
HV
Laboratory

Figure 59

Table 64

Sample Details

Sample No.	S2
Matrix	Seafood Biota
Analyte	V
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NR	NR
2	0.53	0.15
3	<0.2	NR
4	<0.1	0.1
5	<1.0	NR
6	<0.5	NR
7	<3	NR
8	<0.1	NR
9	NT	NT
10	0.11	0.022
11	0.12	NR
12	0.200	0.033

Statistics

Assigned Value	Not Set	
Homogeneity Value	0.159	0.019
Robust Average	NA (N<6)	
Median	0.160	0.083
Mean	0.24	
N	4	
Max	0.53	
Min	0.11	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

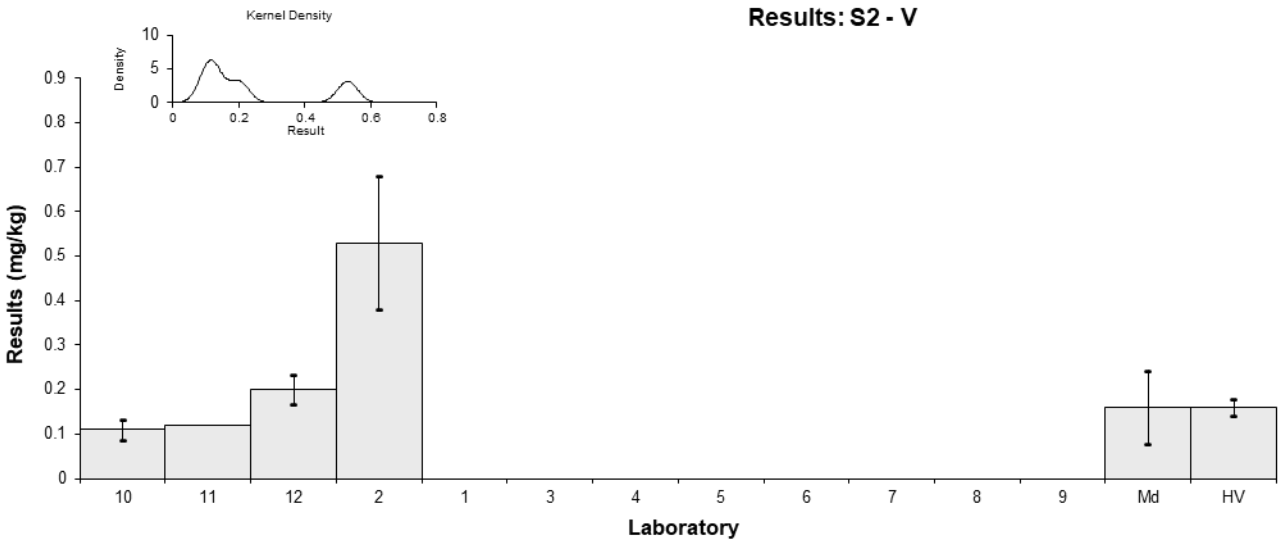

Results: S2 - V
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
10
11
12
2
1
3
4
5
6
7
8
9
Md
HV

Figure 60

Table 65

Sample Details

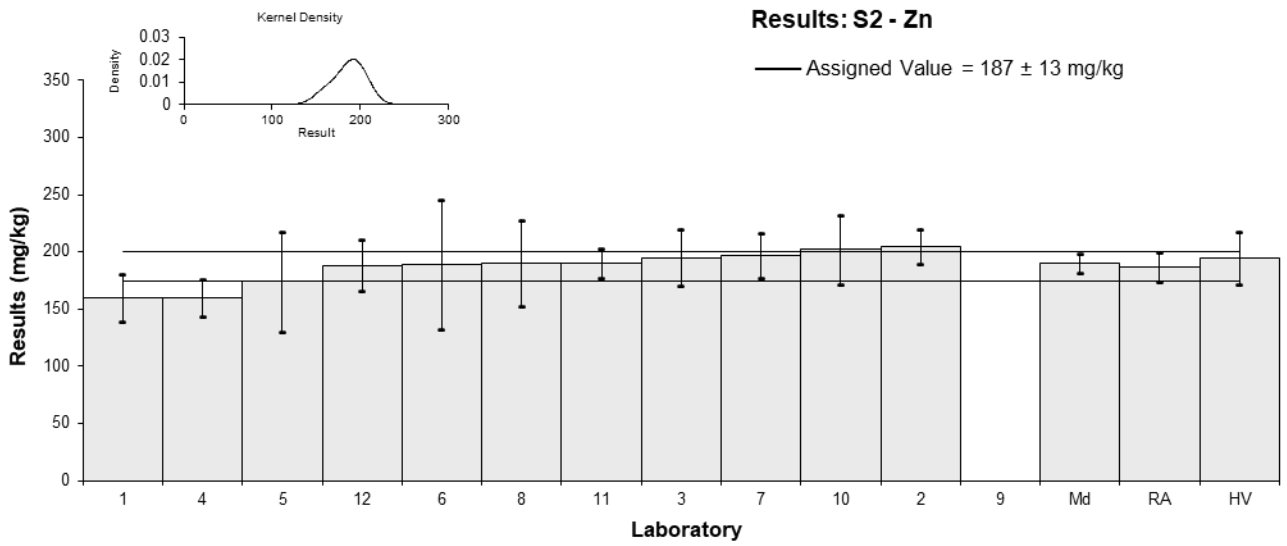
Sample No.	S2
Matrix	Seafood Biota
Analyte	Zn
Unit	mg/kg

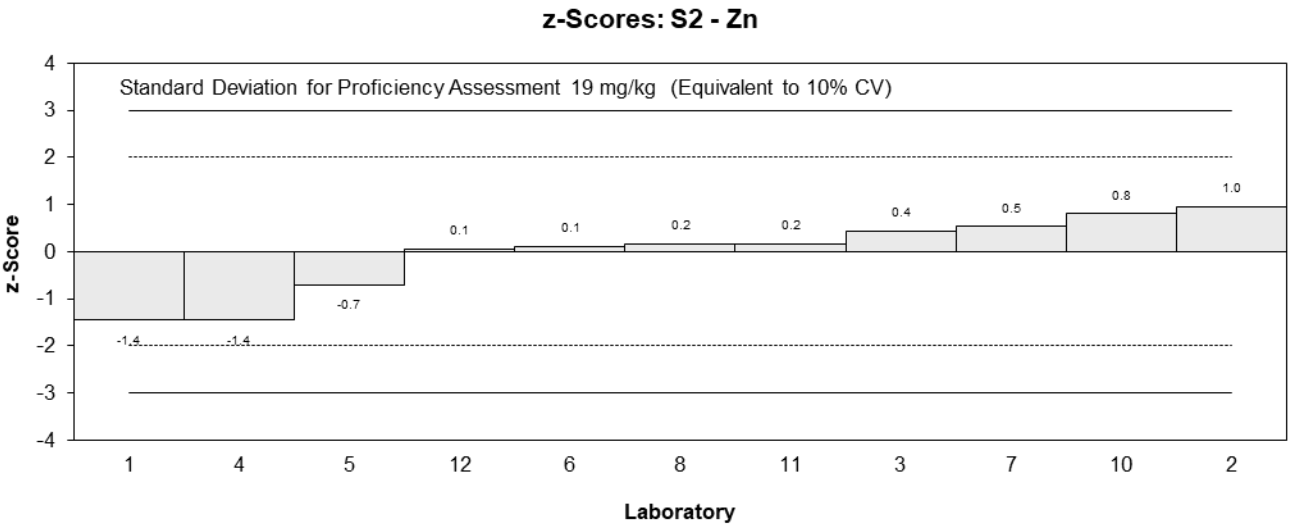
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	160	21	-1.44	-1.09
2	205	15	0.96	0.91
3	195	25	0.43	0.28
4	160	16	-1.44	-1.31
5	174	44	-0.70	-0.28
6	189	57.1	0.11	0.03
7	197	20	0.53	0.42
8	190	38	0.16	0.07
9	NT	NT		
10	202	30.3	0.80	0.45
11	190	12.7	0.16	0.17
12	188.000	22.400	0.05	0.04

Statistics

Assigned Value	187	13
Homogeneity Value	195	23
Robust Average	187	13
Median	190	8
Mean	186	
N	11	
Max	205	
Min	160	
Robust SD	17	
Robust CV	9%	


Kernel Density
Density
0.03
0.02
0.01
0
0
100
200
300
Result
Results: S2 - Zn
Assigned Value = 187 ± 13 mg/kg
Results (mg/kg)
350
300
250
200
150
100
50
0
1
4
5
12
6
8
11
3
7
10
2
9
Md
RA
HV
Laboratory


z-Scores: S2 - Zn
Standard Deviation for Proficiency Assessment 19 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-1.4
-1.4
-0.7
0.1
0.1
0.2
0.2
0.4
0.5
0.8
1.0
1
4
5
12
6
8
11
3
7
10
2
Laboratory

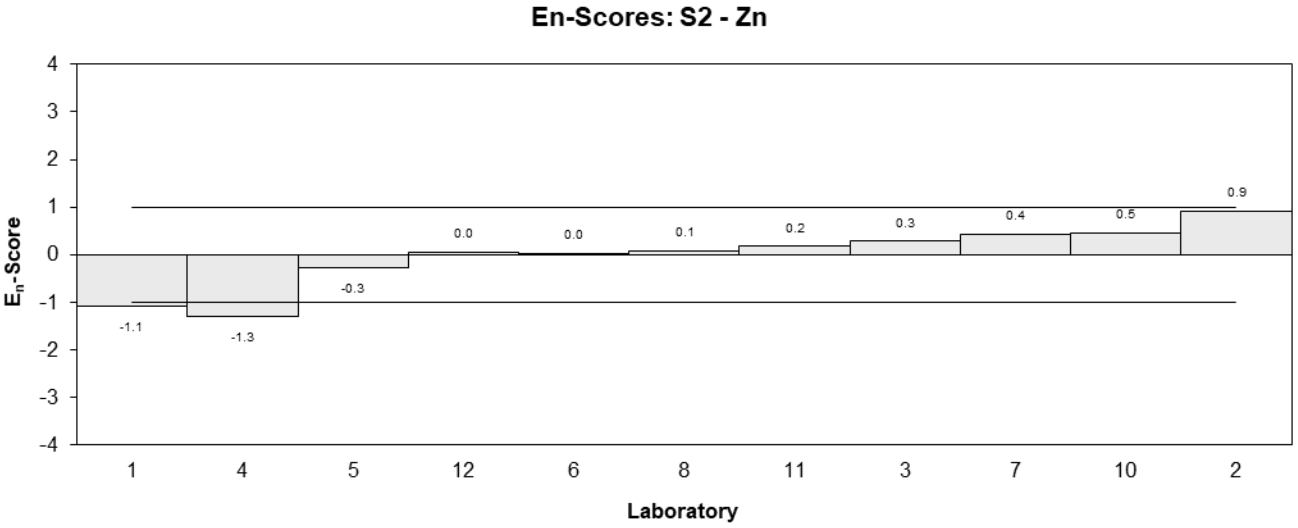

En-Scores: S2 - Zn
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.1
-1.3
-0.3
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.9
1
4
5
12
6
8
11
3
7
10
2
Laboratory

Figure 61

Table 66

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Al
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	141	39
4	120	12
5	NT	NT
6	NT	NT
7	137	15
8	150	30
9	NT	NT
10	NT	NT
11	NR	NR
12	190.000	40.000

Statistics

Assigned Value	Not Set	
Information Value	316	47
Robust Average	NA (N<6)	
Median	141	15
Mean	148	
N	5	
Max	190.000	
Min	120	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

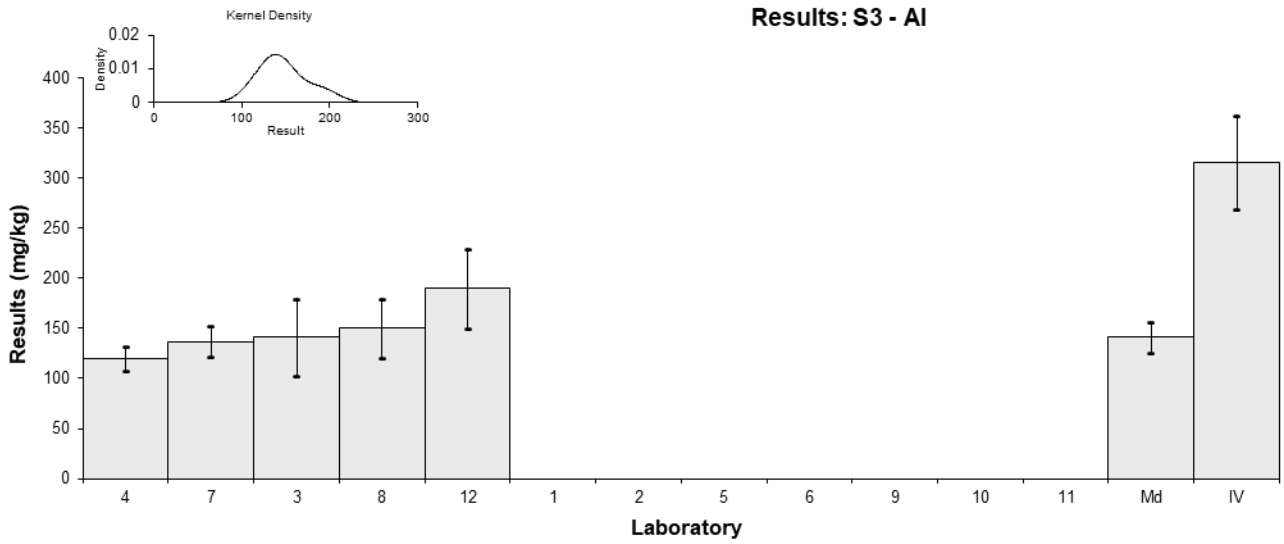

Results: S3 - Al
Kernel Density
Density
0.02
0.01
0
0
100
200
300
Result
Results (mg/kg)
400
350
300
250
200
150
100
50
0
4
7
3
8
12
1
2
5
6
9
10
11
Md
IV
Laboratory

Figure 62

Table 67

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	As
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	<2	NR
4	0.050	0.013
5	<2.0	NR
6	NT	NT
7	<2	NR
8	<0.05	NR
9	NT	NT
10	0.04	0.006
11	0.025	1.11
12	0.051	0.009

Statistics

Assigned Value	Not Set	
Information Value	0.0448	0.0067
Robust Average	NA (N<6)	
Median	0.045	0.010
Mean	0.042	
N	4	
Max	0.051	
Min	0.025	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

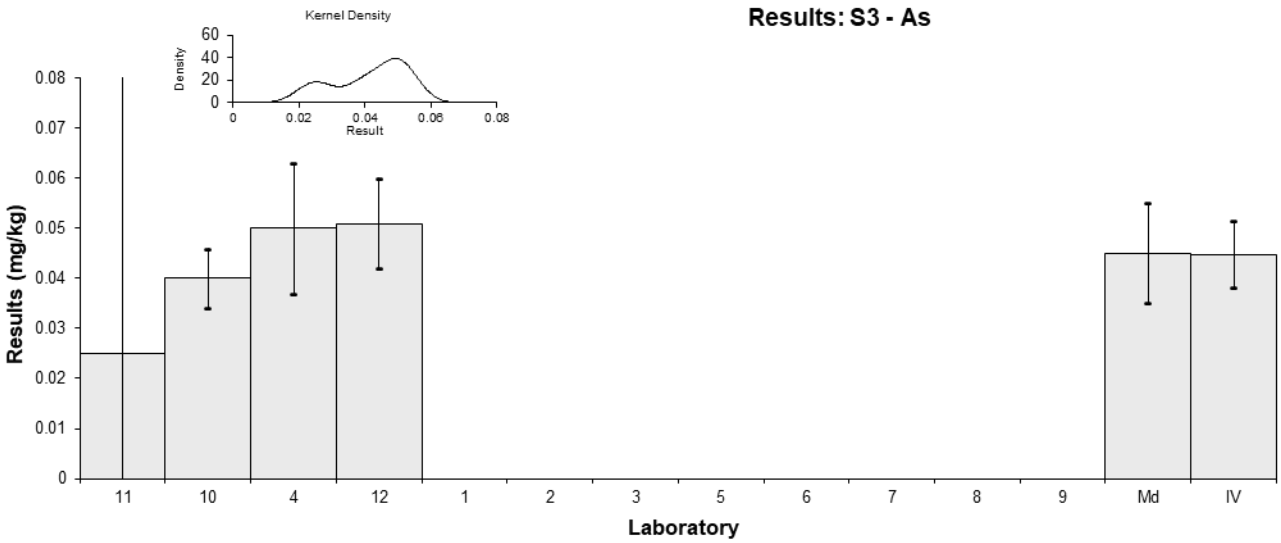

Results: S3 - As
Kernel Density
Density
60
40
20
0
0
0.02
0.04
0.06
0.08
Result
Results (mg/kg)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
11
10
4
12
1
2
3
5
6
7
8
9
Md
IV
Laboratory

Figure 63

Table 68

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	B
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	11	1.1
5	NT	NT
6	NT	NT
7	12	1.5
8	12	2.4
9	NT	NT
10	12.7	1.9
11	NR	NR
12	11.600	2.100

Statistics

Assigned Value	Not Set	
Information Value	13.3	1.6
Robust Average	NA (N<6)	
Median	12.0	0.7
Mean	11.9	
N	5	
Max	12.7	
Min	11	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

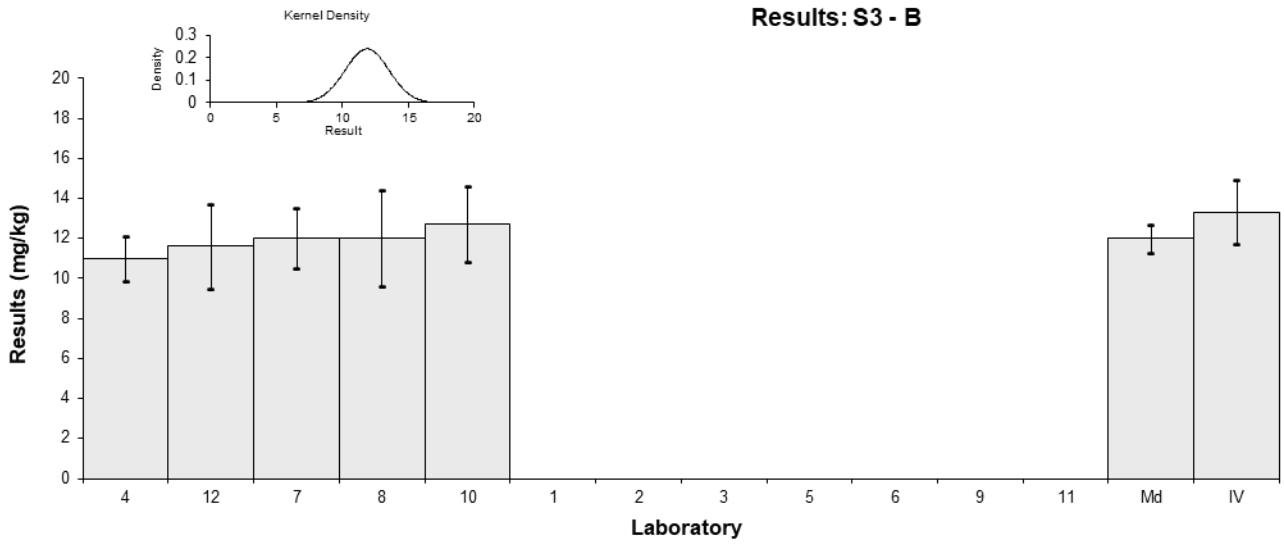

Results: S3 - B
Kernel Density
Density
0.3
0.2
0.1
0
0
5
10
15
20
Result
Results (mg/kg)
20
18
16
14
12
10
8
6
4
2
0
4
12
7
8
10
1
2
3
5
6
9
11
Md
IV
Laboratory

Figure 64

Table 69

Sample Details

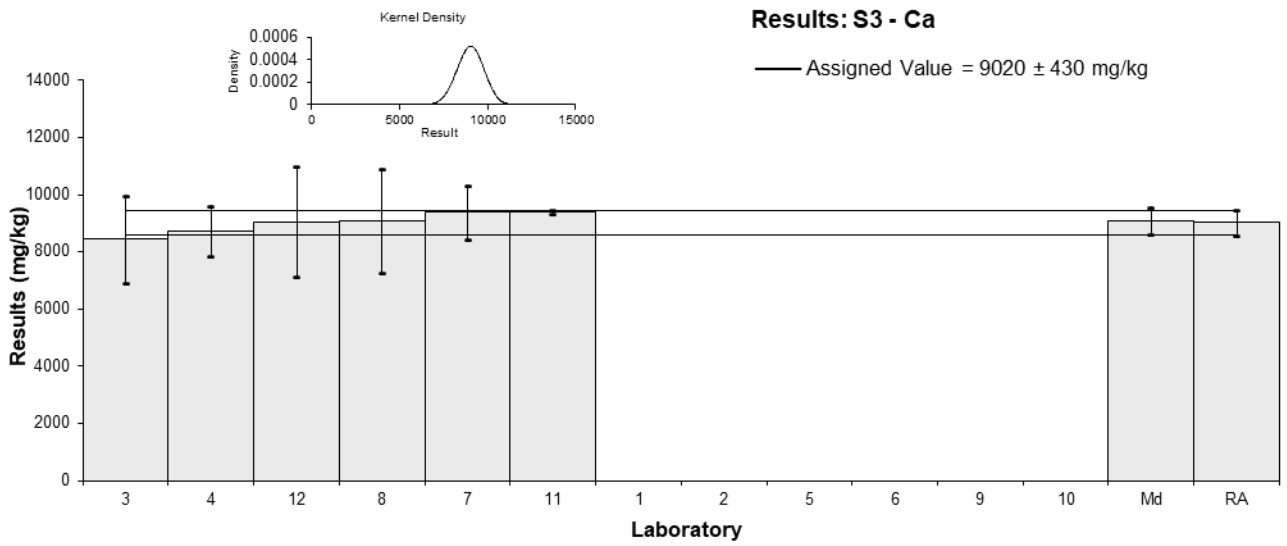
Sample No.	S3
Matrix	Cinnamon
Analyte	Ca
Unit	mg/kg

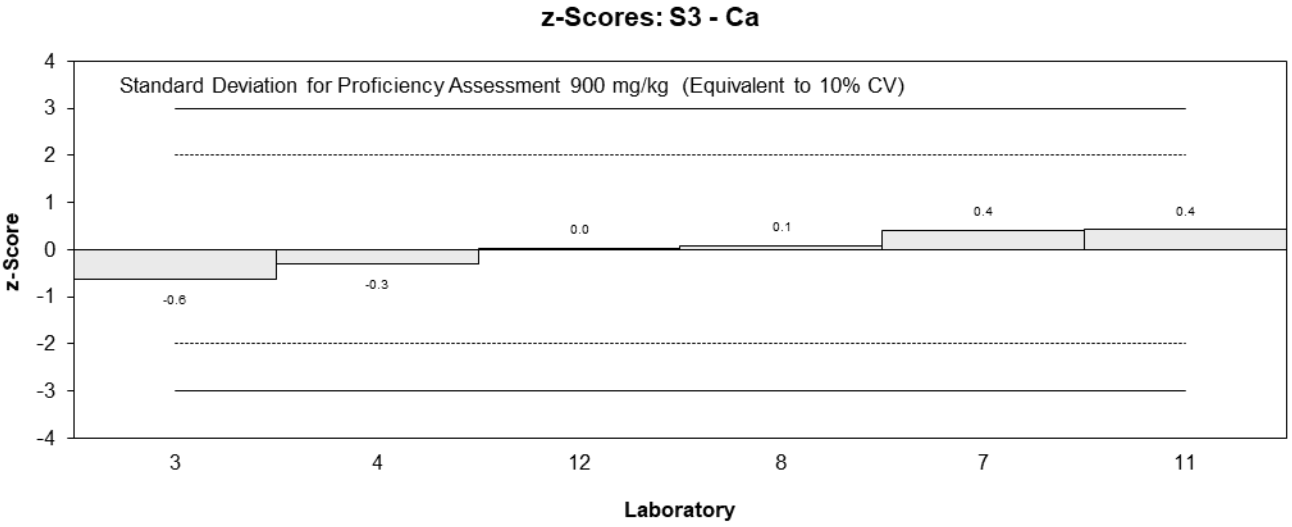
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	8440	1520	-0.64	-0.37
4	8740	874	-0.31	-0.29
5	NT	NT		
6	NT	NT		
7	9390	940	0.41	0.36
8	9100	1820	0.09	0.04
9	NT	NT		
10	NT	NT		
11	9400	58.32	0.42	0.88
12	9050.000	1930.000	0.03	0.02

Statistics

Assigned Value	9020	430
Robust Average	9020	430
Median	9080	480
Mean	9020	
N	6	
Max	9400	
Min	8440	
Robust SD	430	
Robust CV	4.7%	


Kernel Density
Density
0.0006
0.0004
0.0002
0
0
5000
10000
15000
Result
Results: S3 - Ca
Assigned Value = 9020 ± 430 mg/kg
Results (mg/kg)
14000
12000
10000
8000
6000
4000
2000
0
3
4
12
8
7
11
1
2
5
6
9
10
Md
RA
Laboratory


z-Scores: S3 - Ca
Standard Deviation for Proficiency Assessment 900 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.6
-0.3
0.0
0.1
0.4
0.4
3
4
12
8
7
11
Laboratory

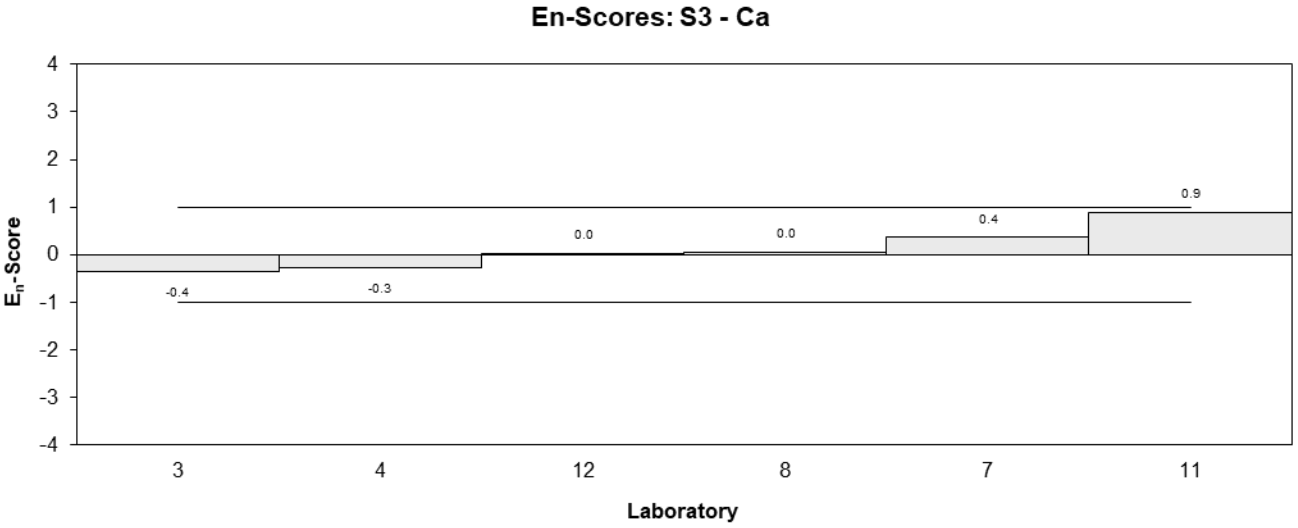

En-Scores: S3 - Ca
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.4
-0.3
0.0
0.0
0.4
0.9
3
4
12
8
7
11
Laboratory

Figure 65

Table 70

Sample Details

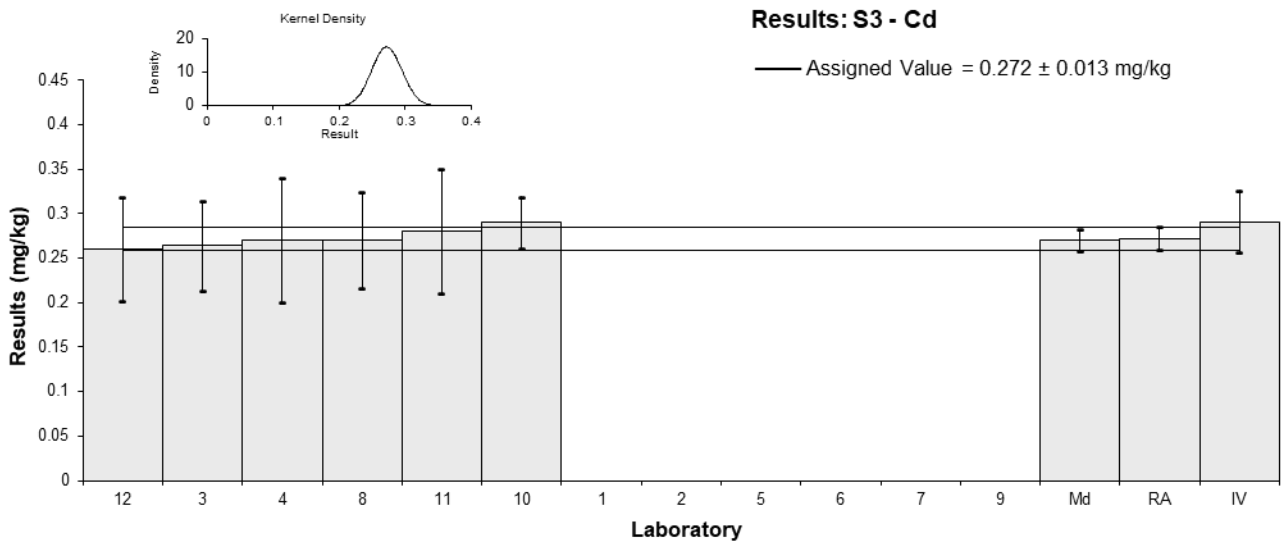
Sample No.	S3
Matrix	Cinnamon
Analyte	Cd
Unit	mg/kg

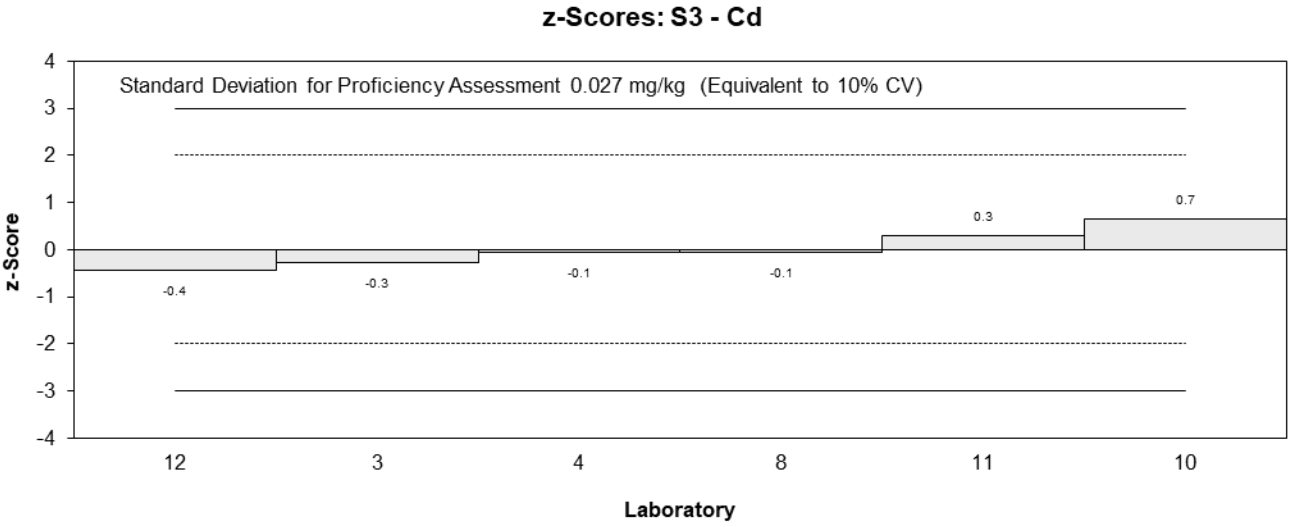
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	0.264	0.050	-0.29	-0.15
4	0.27	0.07	-0.07	-0.03
5	<1.0	NR		
6	NT	NT		
7	<0.5	NR		
8	0.27	0.054	-0.07	-0.04
9	NT	NT		
10	0.29	0.029	0.66	0.57
11	0.28	0.07	0.29	0.11
12	0.260	0.058	-0.44	-0.20

Statistics

Assigned Value	0.272	0.013
Information Value	0.291	0.035
Robust Average	0.272	0.013
Median	0.270	0.012
Mean	0.272	
N	6	
Max	0.29	
Min	0.260	
Robust SD	0.012	
Robust CV	4.6%	


Results: S3 - Cd
Assigned Value = 0.272 ± 0.013 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
12
3
4
8
11
10
1
2
5
6
7
9
Md
RA
IV


z-Scores: S3 - Cd
Standard Deviation for Proficiency Assessment 0.027 mg/kg (Equivalent to 10% CV)
z-Score
-0.4
-0.3
-0.1
-0.1
0.3
0.7
Laboratory
12
3
4
8
11
10

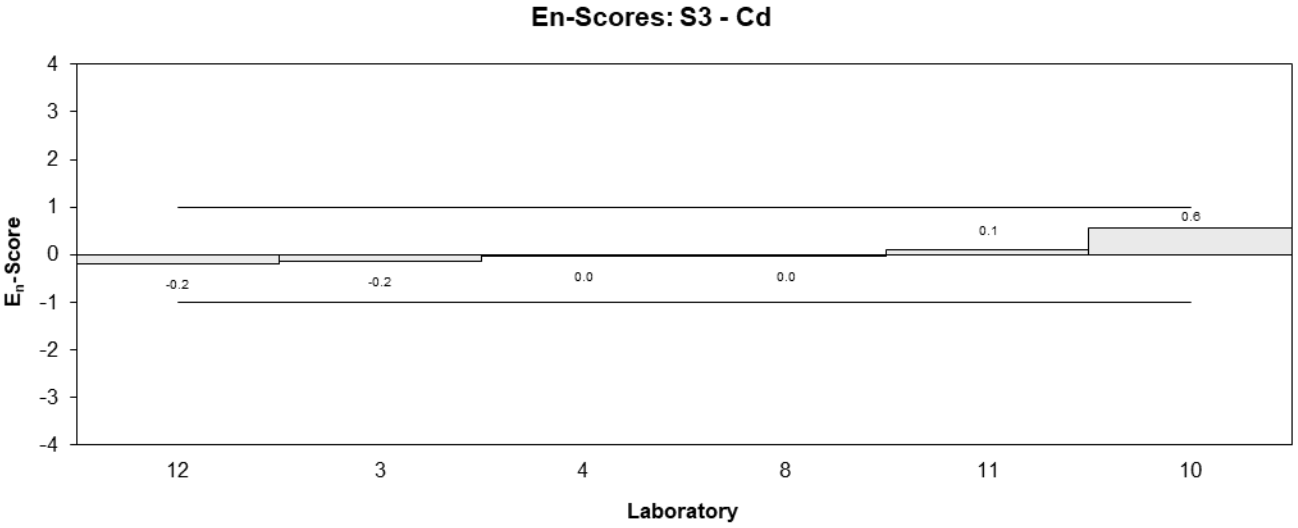

En-Scores: S3 - Cd
En-Score
-0.2
-0.2
0.0
0.0
0.1
0.6
Laboratory
12
3
4
8
11
10

Figure 66

Table 71

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Cr
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	<0.5	NR
4	0.45	0.11
5	<1.0	NR
6	NT	NT
7	<2	NR
8	0.47	0.094
9	NT	NT
10	0.35	0.07
11	0.46	0.09
12	0.630	0.140

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	0.460	0.017
Mean	0.472	
N	5	
Max	0.630	
Min	0.35	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

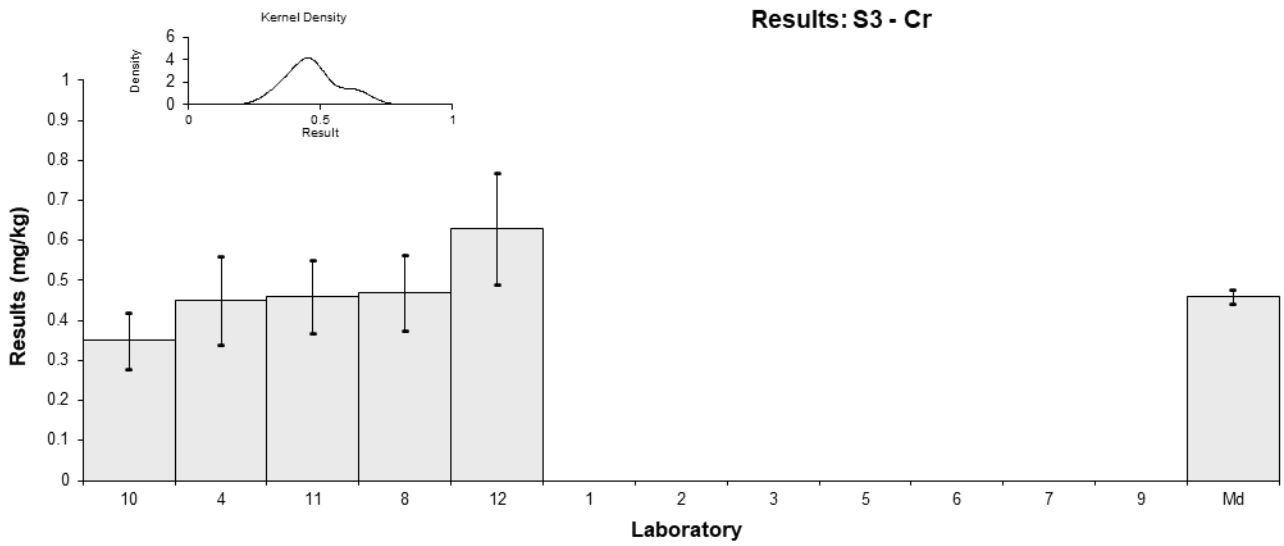

Results: S3 - Cr
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
10
4
11
8
12
1
2
3
5
6
7
9
Md

Figure 67

Table 72

Sample Details

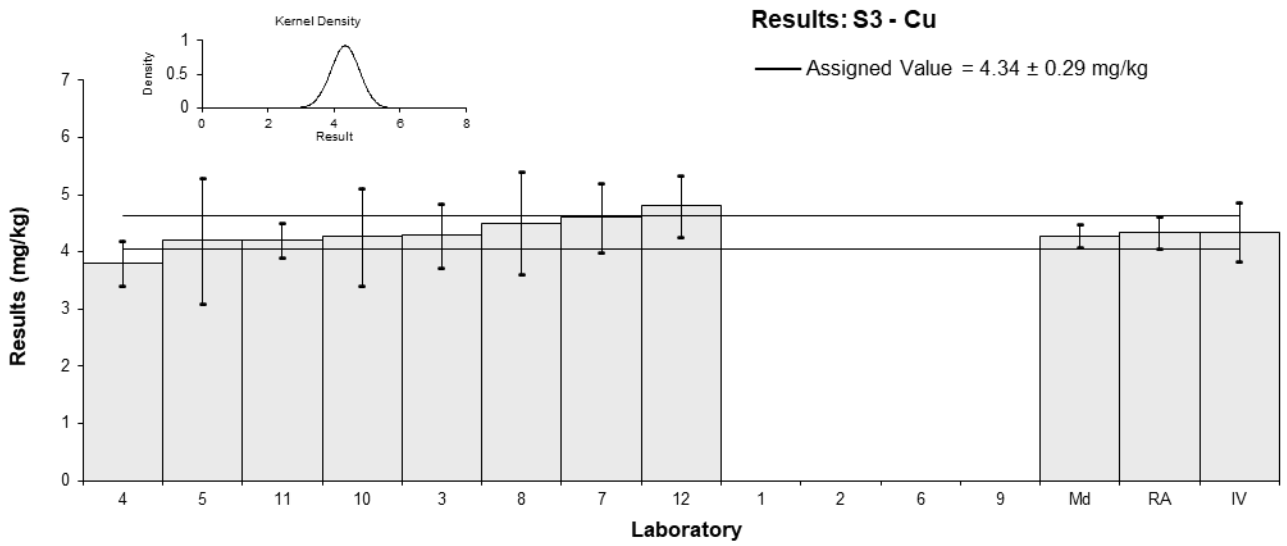
Sample No.	S3
Matrix	Cinnamon
Analyte	Cu
Unit	mg/kg

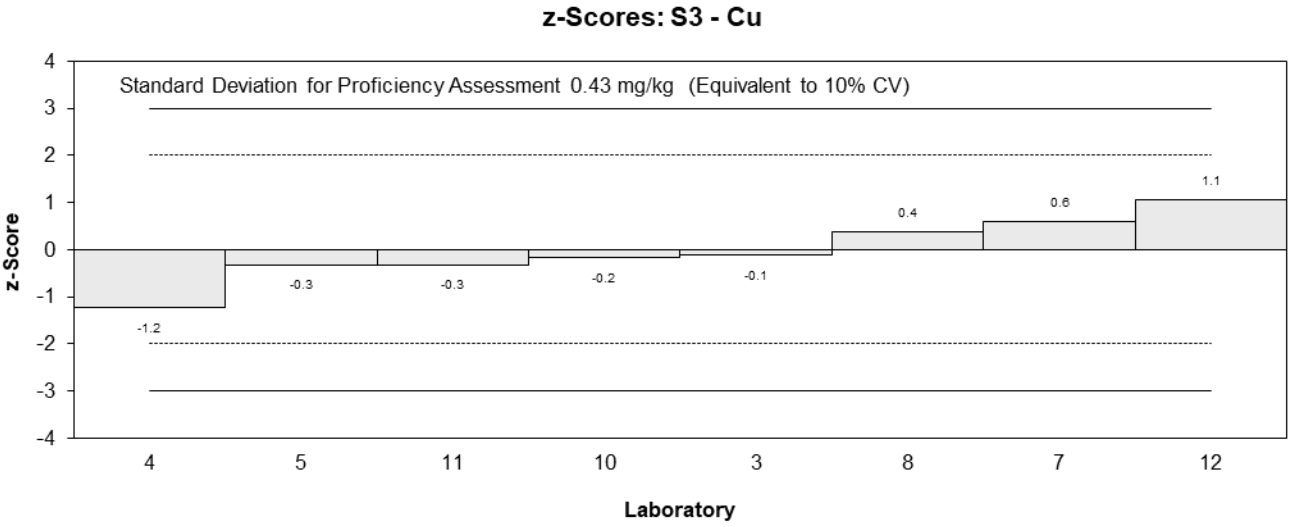
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	4.29	0.56	-0.12	-0.08
4	3.8	0.4	-1.24	-1.09
5	4.2	1.1	-0.32	-0.12
6	NT	NT		
7	4.6	0.6	0.60	0.39
8	4.5	0.9	0.37	0.17
9	NT	NT		
10	4.27	0.85	-0.16	-0.08
11	4.2	0.30	-0.32	-0.34
12	4.800	0.530	1.06	0.76

Statistics

Assigned Value	4.34	0.29
Information Value	4.35	0.52
Robust Average	4.34	0.29
Median	4.28	0.20
Mean	4.33	
N	8	
Max	4.800	
Min	3.8	
Robust SD	0.33	
Robust CV	7.7%	


Results: S3 - Cu
Assigned Value = 4.34 ± 0.29 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
5
11
10
3
8
7
12
1
2
6
9
Md
RA
IV


z-Scores: S3 - Cu
Standard Deviation for Proficiency Assessment 0.43 mg/kg (Equivalent to 10% CV)
z-Score
-1.2
-0.3
-0.3
-0.2
-0.1
0.4
0.6
1.1
Laboratory
4
5
11
10
3
8
7
12

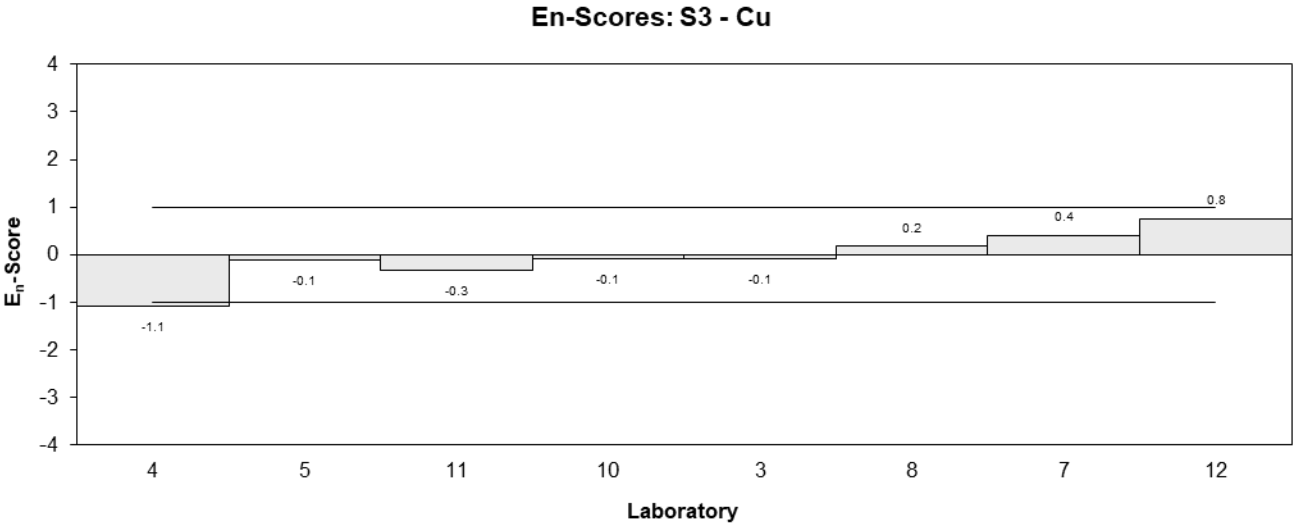

En-Scores: S3 - Cu
En-Score
-1.1
-0.1
-0.3
-0.1
-0.1
0.2
0.4
0.8
Laboratory
4
5
11
10
3
8
7
12

Figure 68

Table 73

Sample Details

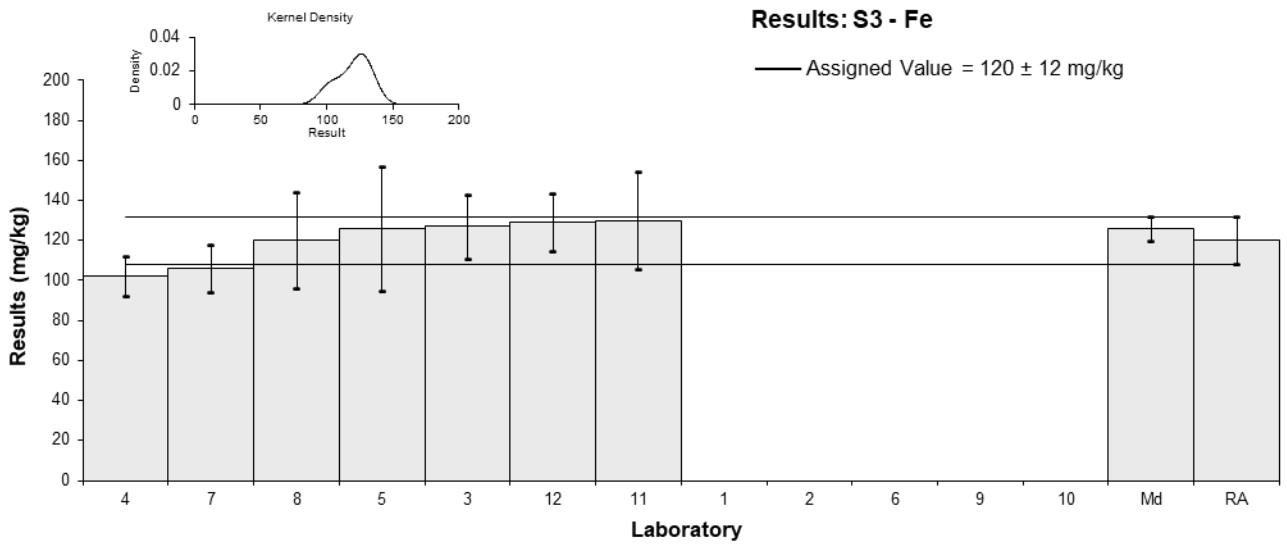
Sample No.	S3
Matrix	Cinnamon
Analyte	Fe
Unit	mg/kg

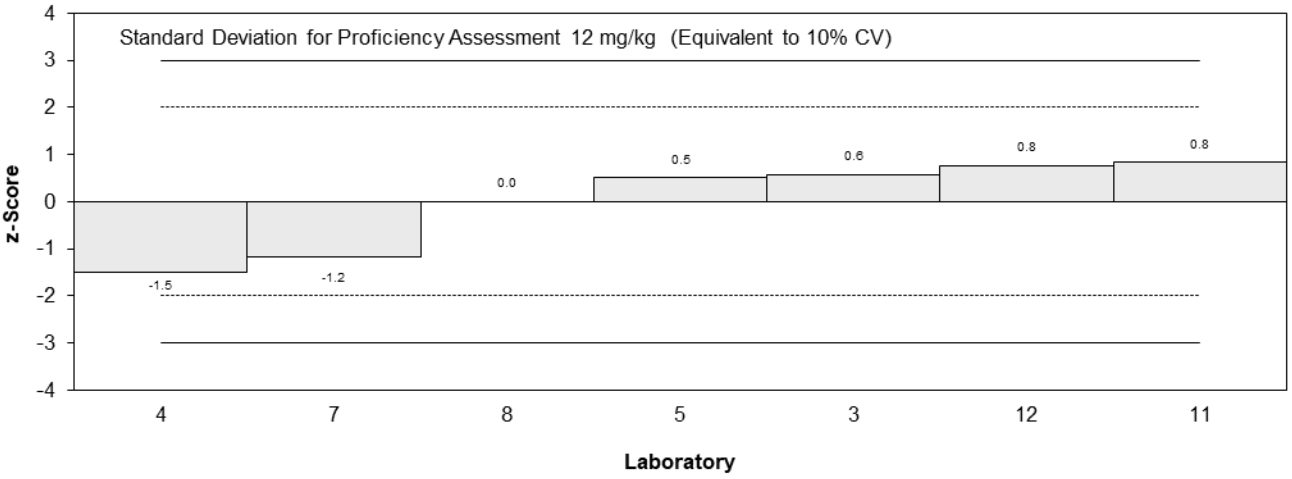
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	127	16	0.58	0.35
4	102	10	-1.50	-1.15
5	126	31	0.50	0.18
6	NT	NT		
7	106	12	-1.17	-0.82
8	120	24	0.00	0.00
9	NT	NT		
10	NT	NT		
11	130	24.3	0.83	0.37
12	129.000	14.300	0.75	0.48

Statistics

Assigned Value	120	12
Robust Average	120	12
Median	126	6
Mean	120	
N	7	
Max	130	
Min	102	
Robust SD	13	
Robust CV	11%	


Kernel Density
Density
Result
Results: S3 - Fe
Assigned Value = 120 ± 12 mg/kg
Results (mg/kg)
Laboratory
4
7
8
5
3
12
11
1
2
6
9
10
Md
RA


z-Scores: S3 - Fe
Standard Deviation for Proficiency Assessment 12 mg/kg (Equivalent to 10% CV)
z-Score
Laboratory
-1.5
-1.2
0.0
0.5
0.6
0.8
0.8

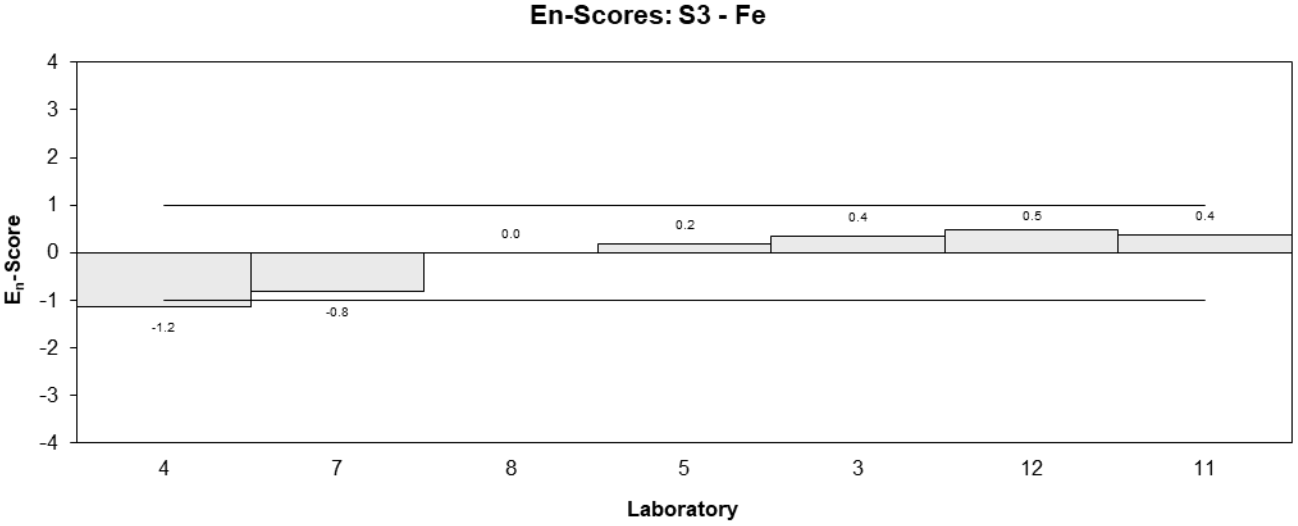

En-Scores: S3 - Fe
En-Score
Laboratory
-1.2
-0.8
0.0
0.2
0.4
0.5
0.4

Figure 69

Table 74

Sample Details

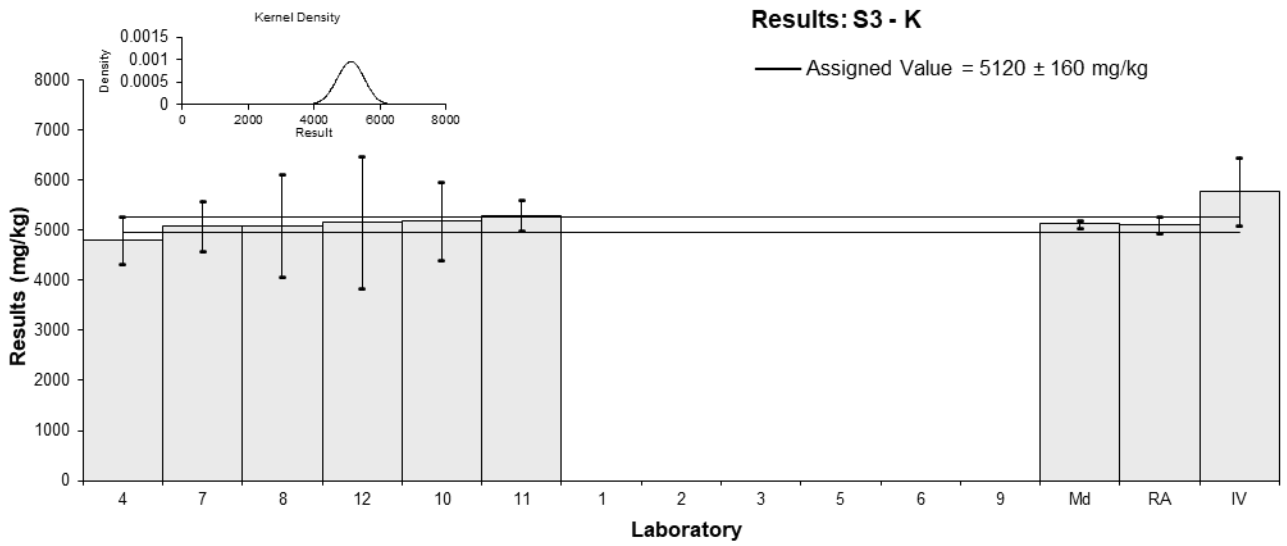
Sample No.	S3
Matrix	Cinnamon
Analyte	K
Unit	mg/kg

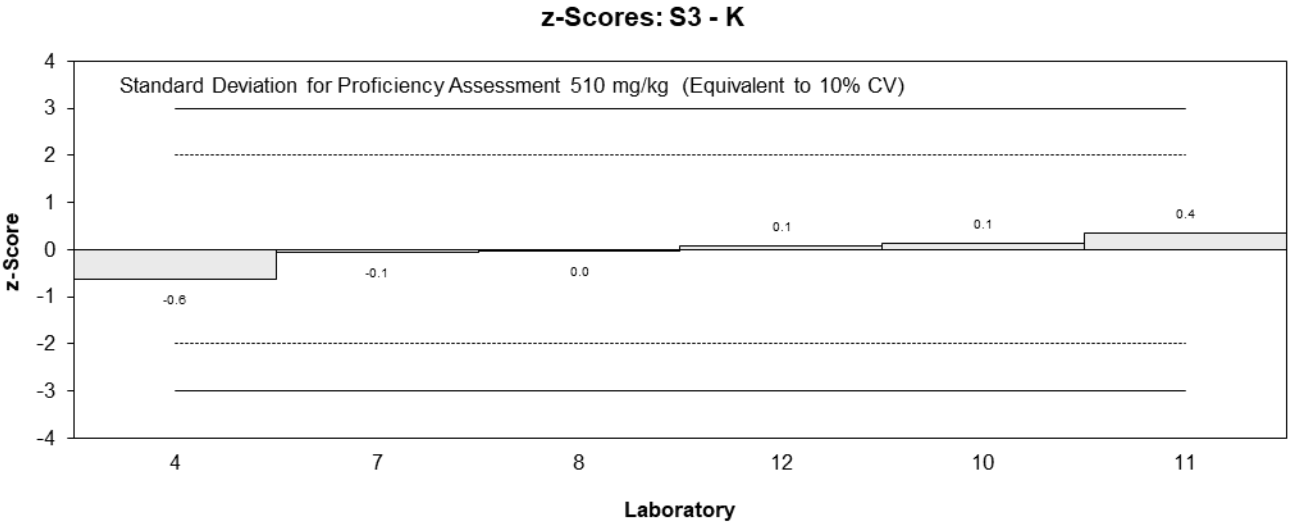
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	NT	NT		
4	4800	480	-0.62	-0.63
5	NT	NT		
6	NT	NT		
7	5090	500	-0.06	-0.06
8	5100	1020	-0.04	-0.02
9	NT	NT		
10	5185	778	0.13	0.08
11	5300	306	0.35	0.52
12	5160.000	1320.000	0.08	0.03

Statistics

Assigned Value	5120	160
Information Value	5780	690
Robust Average	5120	160
Median	5130	70
Mean	5110	
N	6	
Max	5300	
Min	4800	
Robust SD	150	
Robust CV	3%	


Results: S3 - K
Assigned Value = 5120 ± 160 mg/kg
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
7
8
12
10
11
1
2
3
5
6
9
Md
RA
IV


z-Scores: S3 - K
Standard Deviation for Proficiency Assessment 510 mg/kg (Equivalent to 10% CV)
z-Score
-0.6
-0.1
0.0
0.1
0.1
0.4
Laboratory

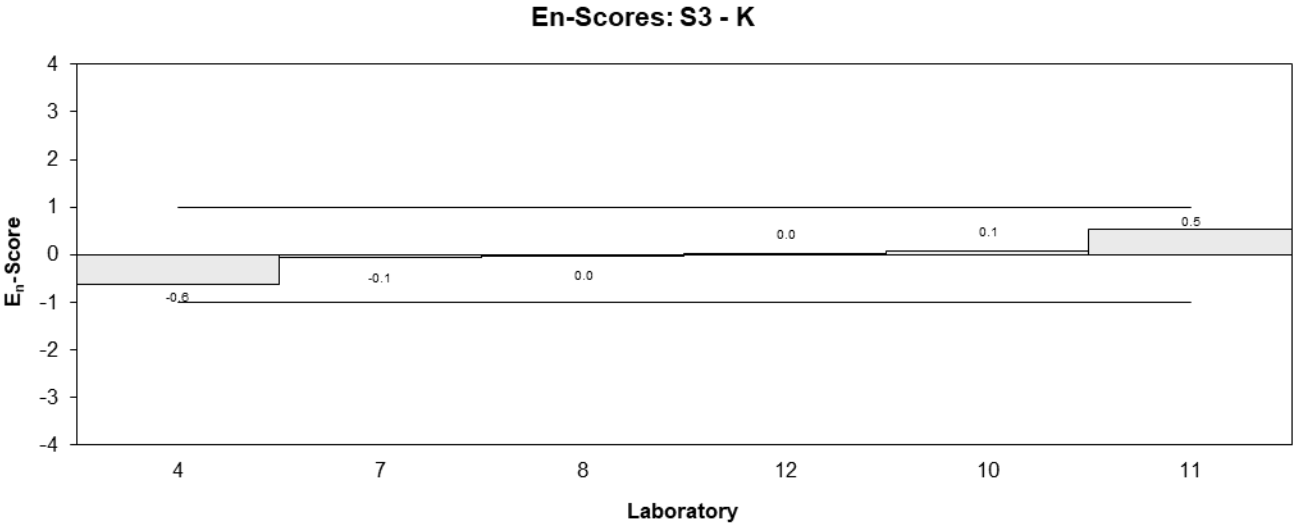

En-Scores: S3 - K
En-Score
-0.6
-0.1
0.0
0.0
0.1
0.5
Laboratory

Figure 70

Table 75

Sample Details

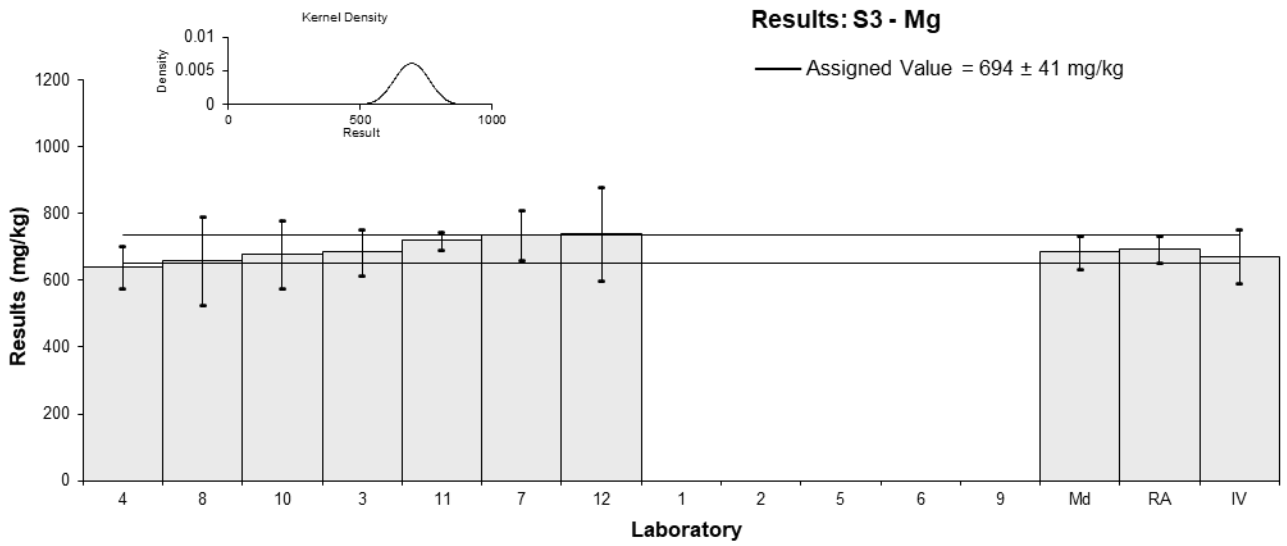
Sample No.	S3
Matrix	Cinnamon
Analyte	Mg
Unit	mg/kg

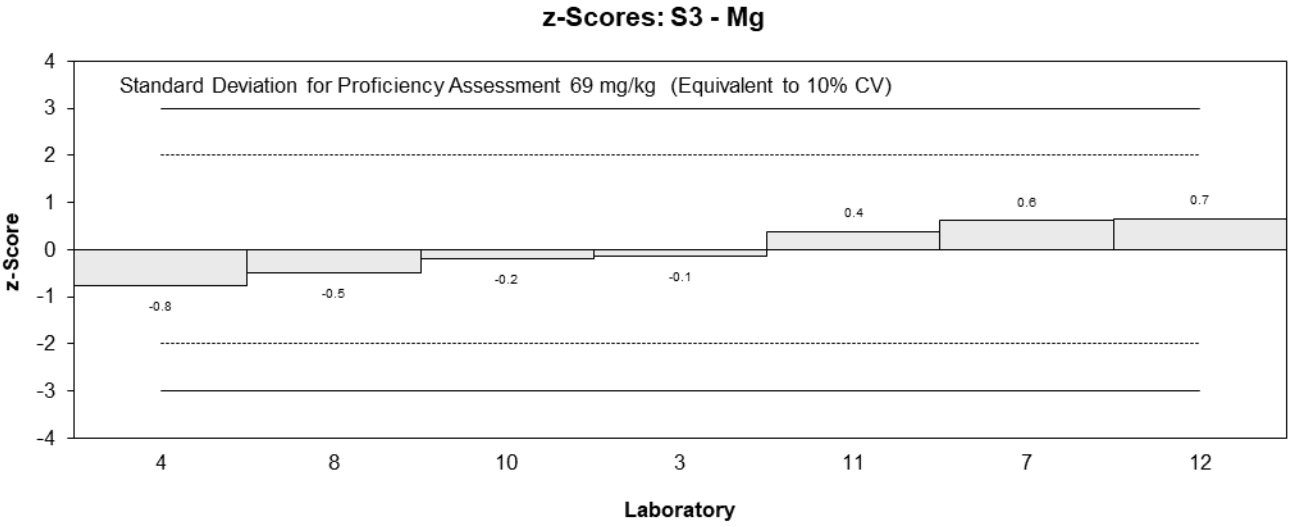
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	685	68	-0.13	-0.11
4	640	64	-0.78	-0.71
5	NT	NT		
6	NT	NT		
7	736	75	0.61	0.49
8	660	132	-0.49	-0.25
9	NT	NT		
10	680	102	-0.20	-0.13
11	720	26.4	0.37	0.53
12	740.000	141.000	0.66	0.31

Statistics

Assigned Value	694	41
Information Value	672	81
Robust Average	694	41
Median	685	49
Mean	694	
N	7	
Max	740.000	
Min	640	
Robust SD	44	
Robust CV	6.3%	


Kernel Density
Density
0.01
0.005
0
0
500
1000
Result
Results: S3 - Mg
Assigned Value = 694 ± 41 mg/kg
Results (mg/kg)
1200
1000
800
600
400
200
0
4
8
10
3
11
7
12
1
2
5
6
9
Md
RA
IV
Laboratory


z-Scores: S3 - Mg
Standard Deviation for Proficiency Assessment 69 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8
-0.5
-0.2
-0.1
0.4
0.6
0.7
4
8
10
3
11
7
12
Laboratory

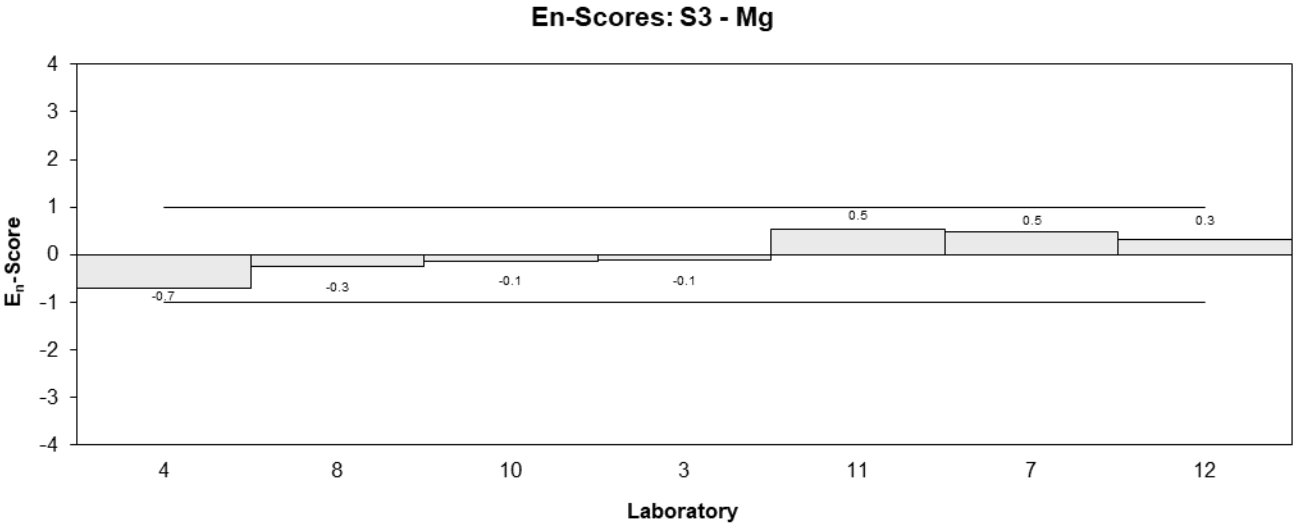

En-Scores: S3 - Mg
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.7
-0.3
-0.1
-0.1
0.5
0.5
0.3
4
8
10
3
11
7
12
Laboratory

Figure 71

Table 76

Sample Details

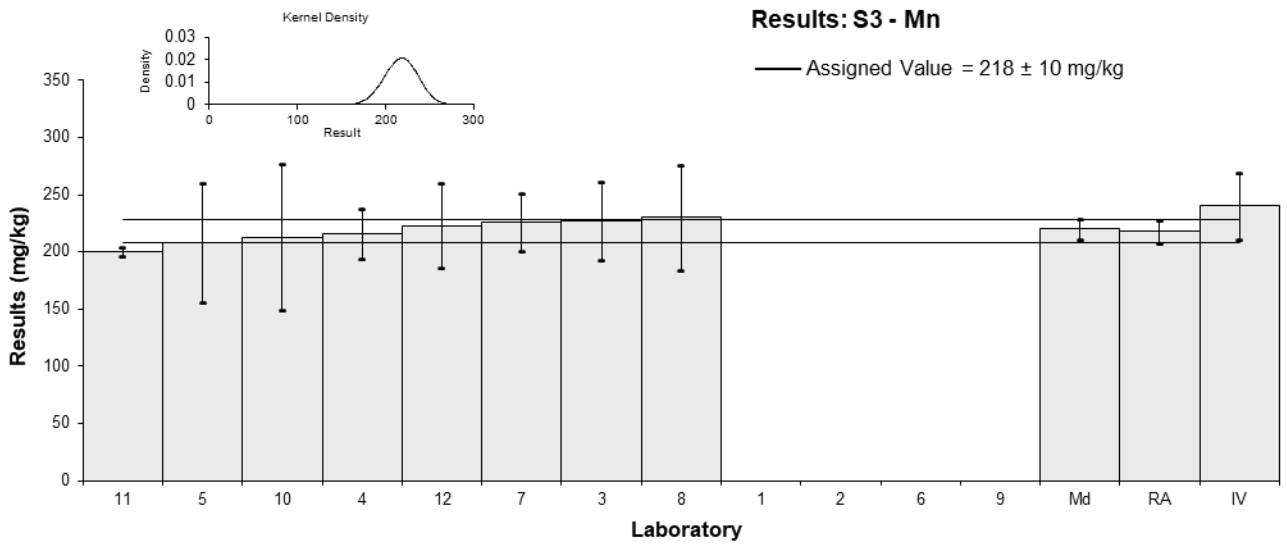
Sample No.	S3
Matrix	Cinnamon
Analyte	Mn
Unit	mg/kg

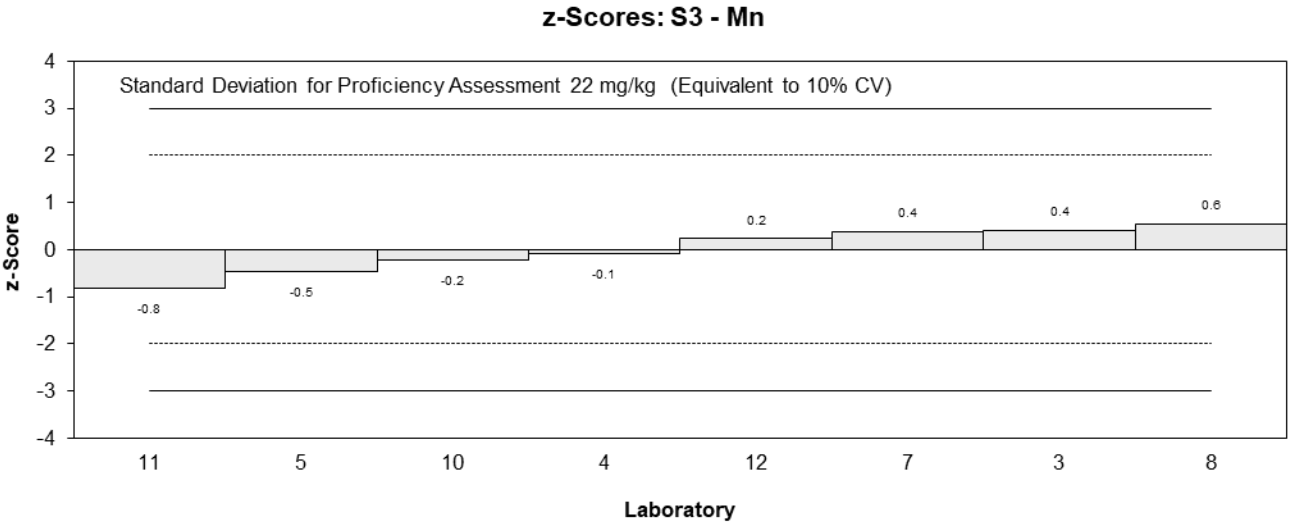
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	227	34	0.41	0.25
4	216	22	-0.09	-0.08
5	208	52	-0.46	-0.19
6	NT	NT		
7	226	25	0.37	0.30
8	230	46	0.55	0.25
9	NT	NT		
10	213	63.9	-0.23	-0.08
11	200	3.8	-0.83	-1.68
12	223.000	37.000	0.23	0.13

Statistics

Assigned Value	218	10
Information Value	240	29
Robust Average	218	10
Median	220	9
Mean	218	
N	8	
Max	230	
Min	200	
Robust SD	12	
Robust CV	5.4%	


Kernel Density
Density
0.03
0.02
0.01
0
0
100
200
300
Result
Results: S3 - Mn
Assigned Value = 218 ± 10 mg/kg
Results (mg/kg)
350
300
250
200
150
100
50
0
11
5
10
4
12
7
3
8
1
2
6
9
Md
RA
IV
Laboratory


z-Scores: S3 - Mn
Standard Deviation for Proficiency Assessment 22 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.8
-0.5
-0.2
-0.1
0.2
0.4
0.4
0.6
11
5
10
4
12
7
3
8
Laboratory

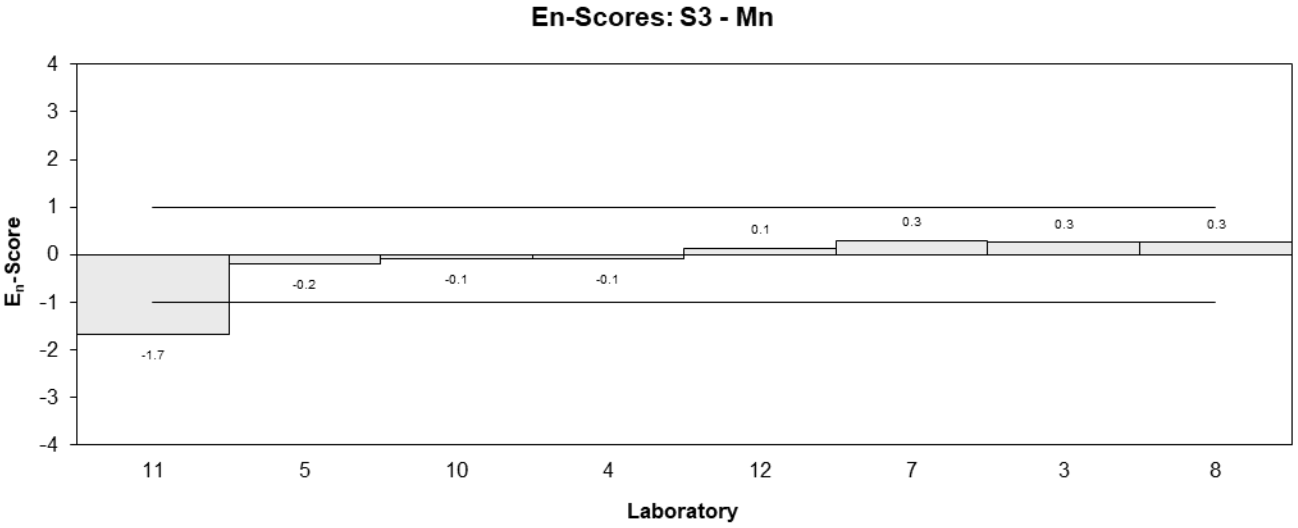

En-Scores: S3 - Mn
En-Score
4
3
2
1
0
-1
-2
-3
-4
-1.7
-0.2
-0.1
-0.1
0.1
0.3
0.3
0.3
11
5
10
4
12
7
3
8
Laboratory

Figure 72

Table 77

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Na
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	39	4
5	NT	NT
6	NT	NT
7	<50	NR
8	66	13
9	NT	NT
10	39.9	6
11	46	5.19
12	40.000	7.500

Statistics

Assigned Value	Not Set	
Information Value	44.9	5.4
Robust Average	NA (N<6)	
Median	40.0	1.7
Mean	46	
N	5	
Max	66	
Min	39	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

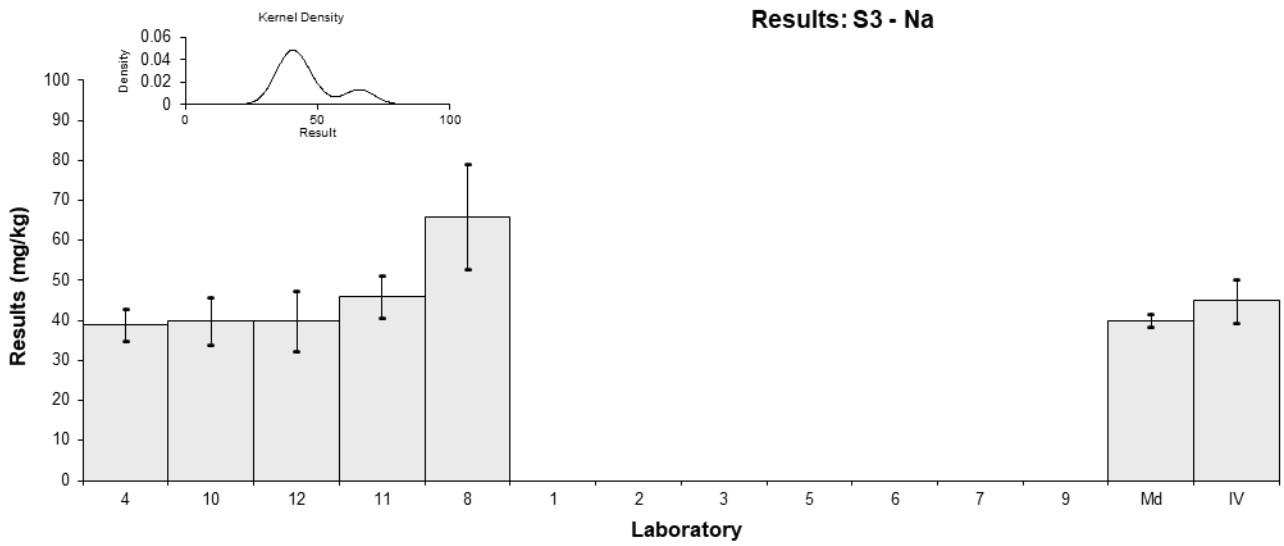

Results: S3 - Na
Kernel Density
Density
0.06
0.04
0.02
0
0
50
100
Result
Results (mg/kg)
100
90
80
70
60
50
40
30
20
10
0
4
10
12
11
8
1
2
3
5
6
7
9
Md
IV
Laboratory

Figure 73

Table 78

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Ni
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	<0.7	NR
4	0.29	0.08
5	<1.0	NR
6	NT	NT
7	<1	NR
8	0.30	0.06
9	NT	NT
10	NT	NT
11	0.31	0.10
12	0.346	0.082

Statistics

Assigned Value	Not Set	
Information Value	0.351	0.042
Robust Average	NA (N<6)	
Median	0.305	0.019
Mean	0.312	
N	4	
Max	0.346	
Min	0.29	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

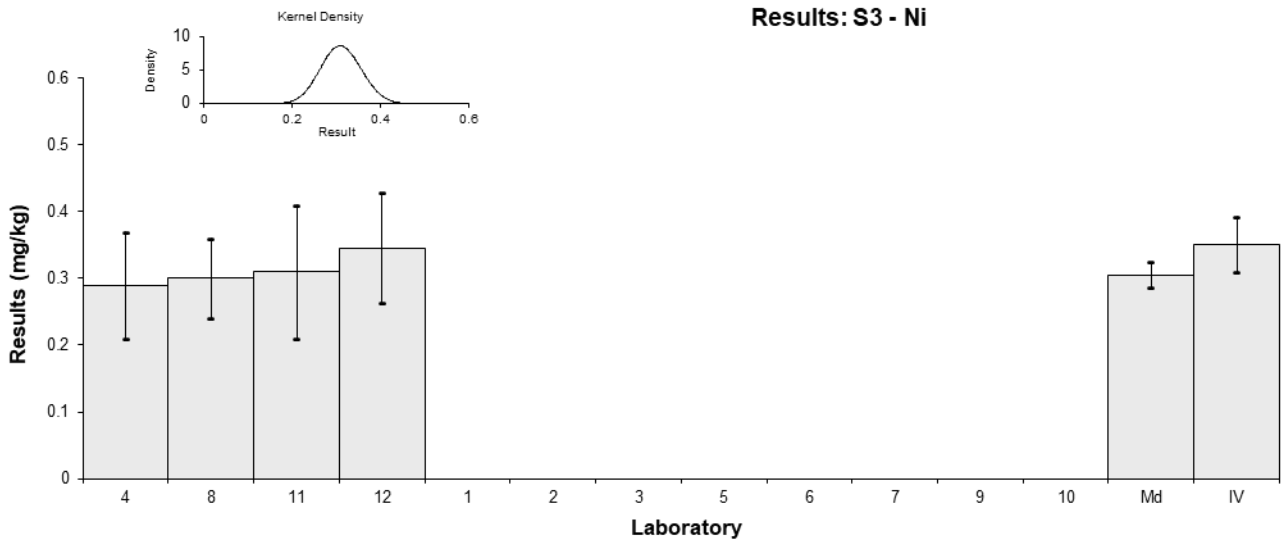

Results: S3 - Ni
Kernel Density
Density
10
5
0
0
0.2
0.4
0.6
Result
Results (mg/kg)
0.6
0.5
0.4
0.3
0.2
0.1
0
4
8
11
12
1
2
3
5
6
7
9
10
Md
IV
Laboratory

Figure 74

Table 79

Sample Details

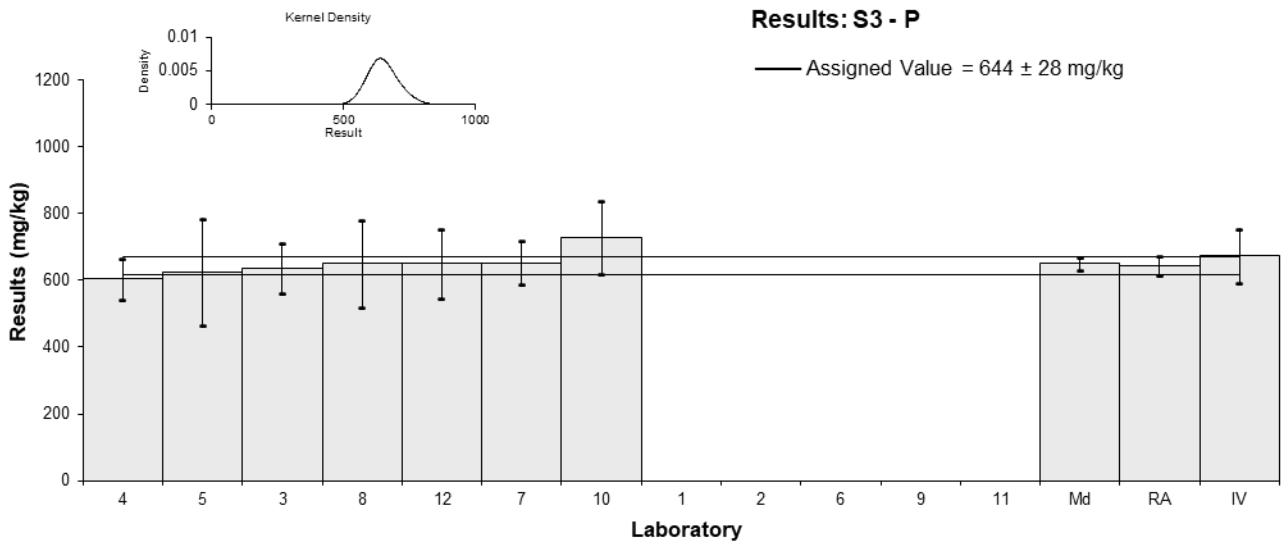
Sample No.	S3
Matrix	Cinnamon
Analyte	P
Unit	mg/kg

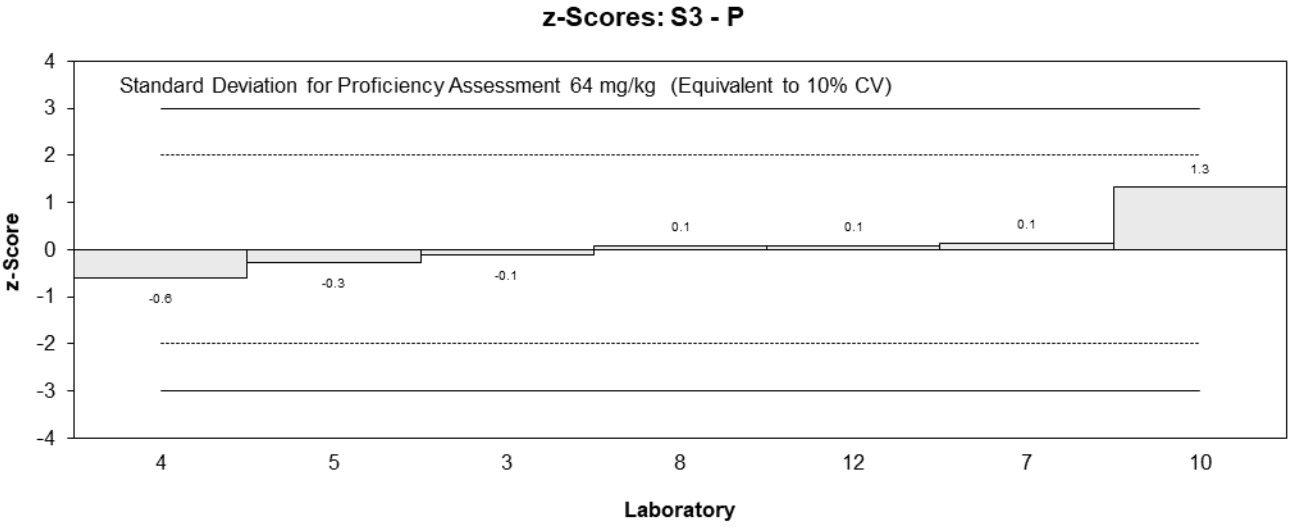
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	637	76	-0.11	-0.09
4	605	61	-0.61	-0.58
5	626	160	-0.28	-0.11
6	NT	NT		
7	653	65	0.14	0.13
8	650	130	0.09	0.05
9	NT	NT		
10	729	109	1.32	0.76
11	NR	NR		
12	650.000	103.000	0.09	0.06

Statistics

Assigned Value	644	28
Information Value	673	81
Robust Average	644	28
Median	650	18
Mean	650	
N	7	
Max	729	
Min	605	
Robust SD	29	
Robust CV	4.5%	


Kernel Density
Density
0.01
0.005
0
0
500
1000
Result
Results: S3 - P
Assigned Value = 644 ± 28 mg/kg
Results (mg/kg)
1200
1000
800
600
400
200
0
4
5
3
8
12
7
10
1
2
6
9
11
Md
RA
IV
Laboratory


z-Scores: S3 - P
Standard Deviation for Proficiency Assessment 64 mg/kg (Equivalent to 10% CV)
z-Score
4
3
2
1
0
-1
-2
-3
-4
-0.6
-0.3
-0.1
0.1
0.1
0.1
1.3
4
5
3
8
12
7
10
Laboratory

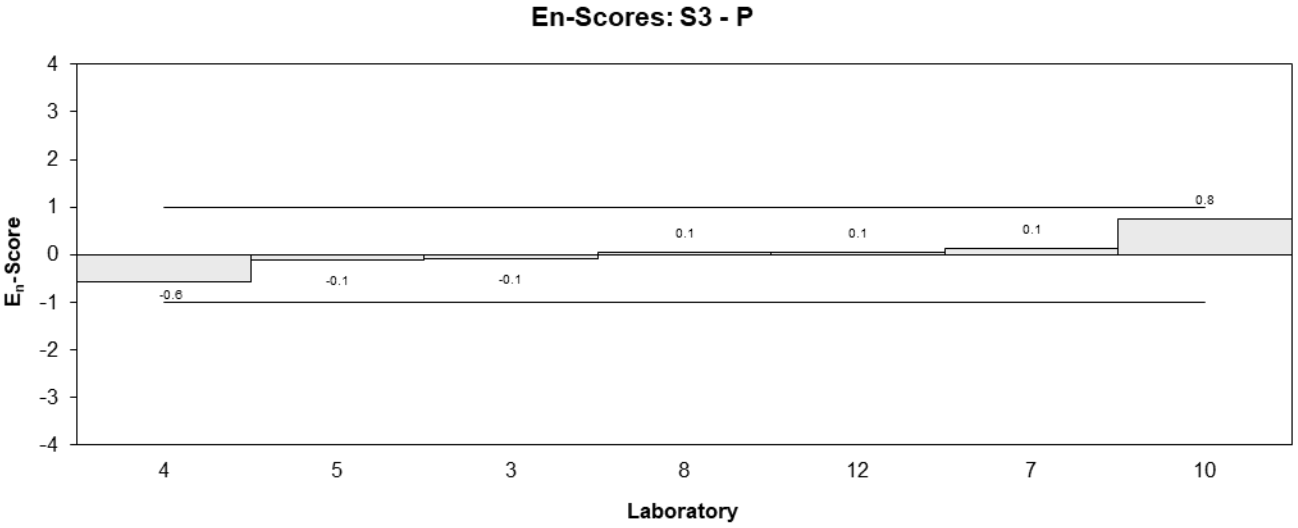

En-Scores: S3 - P
En-Score
4
3
2
1
0
-1
-2
-3
-4
-0.6
-0.1
-0.1
0.1
0.1
0.1
0.8
4
5
3
8
12
7
10
Laboratory

Figure 75

Table 80

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Pb
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	<1	NR
4	0.45	0.11
5	<1.0	NR
6	NT	NT
7	<1	NR
8	0.48	0.096
9	NT	NT
10	0.49	0.2
11	0.49	0.13
12	0.534	0.087

Statistics

Assigned Value	Not Set	
Information Value	0.503	0.060
Robust Average	NA (N<6)	
Median	0.490	0.017
Mean	0.489	
N	5	
Max	0.534	
Min	0.45	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

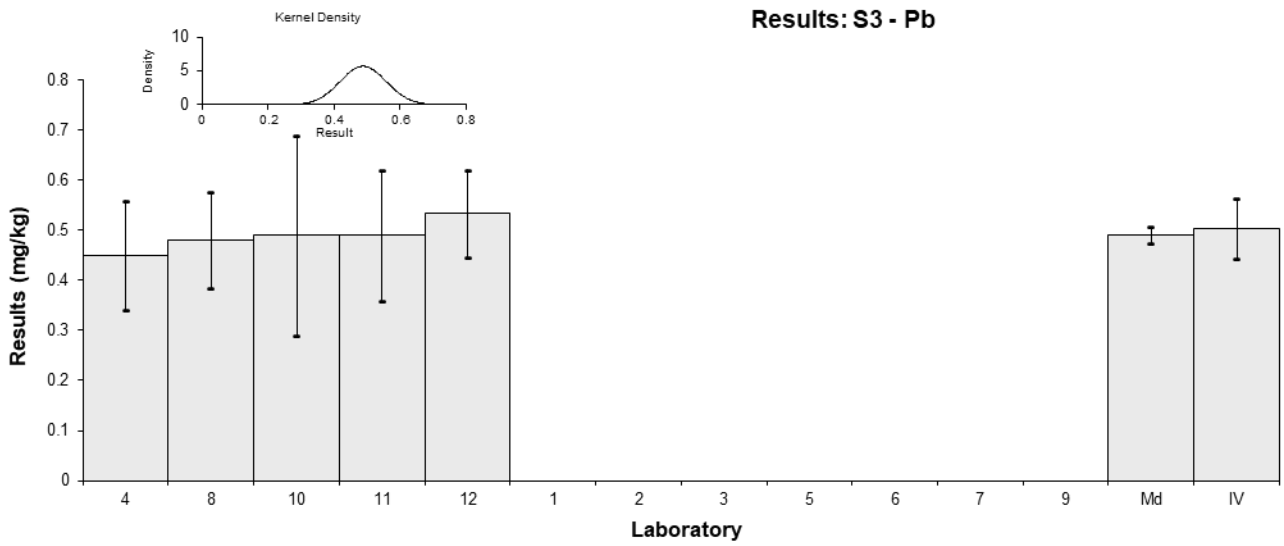

Results: S3 - Pb
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
8
10
11
12
1
2
3
5
6
7
9
Md
IV

Figure 76

Table 81

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	S
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	835	84
5	NT	NT
6	NT	NT
7	900	90
8	890	178
9	NT	NT
10	910	273
11	NR	NR
12	1080.000	145.000

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	900	17
Mean	923	
N	5	
Max	1080.000	
Min	835	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

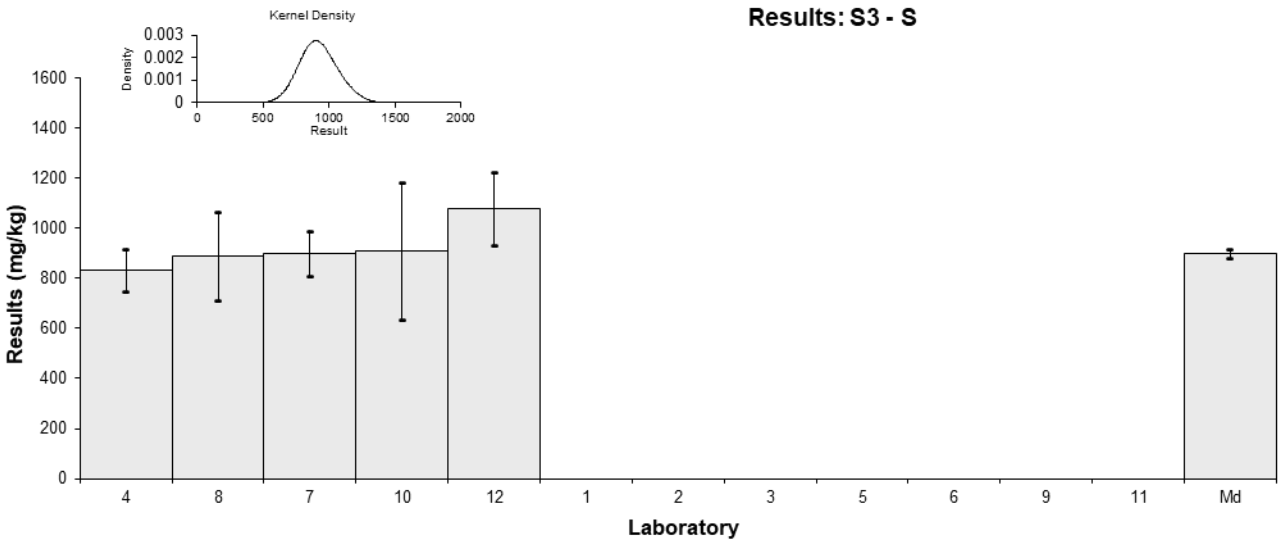

Results: S3 - S
Kernel Density
Density
0.003
0.002
0.001
0
0
500
1000
1500
2000
Result
Results (mg/kg)
1600
1400
1200
1000
800
600
400
200
0
4
8
7
10
12
1
2
3
5
6
9
11
Md
Laboratory

Figure 77

Table 82

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Se
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	<2	NR
4	0.040	0.01
5	<5.0	NR
6	NT	NT
7	<0.1	NR
8	<0.05	NR
9	NT	NT
10	NT	NT
11	0.02	0.21
12	0.034	0.005

Statistics

Assigned Value	Not Set	
Information Value	0.0241	0.0029
Robust Average	NA (N<6)	
Median	0.034	0.013
Mean	0.031	
N	3	
Max	0.040	
Min	0.02	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

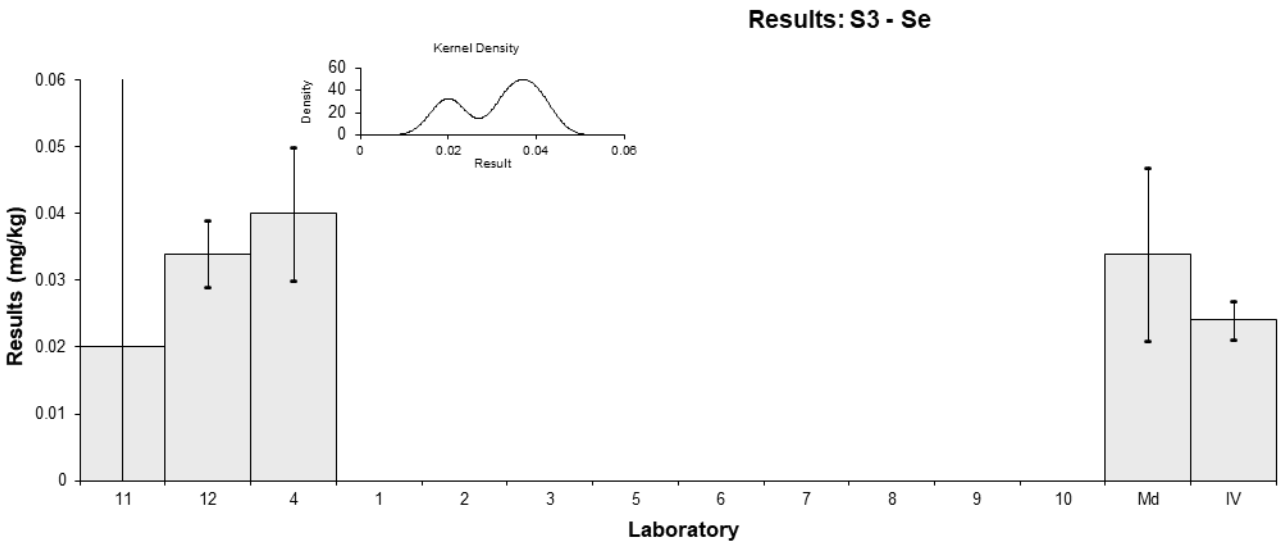

Results: S3 - Se
Kernel Density
Density
60
40
20
0
0
0.02
0.04
0.06
Result
Results (mg/kg)
0.06
0.05
0.04
0.03
0.02
0.01
0
11
12
4
1
2
3
5
6
7
8
9
10
Md
IV
Laboratory

Figure 78

Table 83

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	Sn
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	NT	NT
4	0.030	0.01
5	NT	NT
6	NT	NT
7	<0.5	NR
8	<0.02	NR
9	NT	NT
10	NT	NT
11	NR	NR
12	0.020	0.003

Statistics

Assigned Value	Not Set	
Information Value	0.0349	0.0042
Robust Average	NA (N<6)	
Median	NA (N<3)	
Mean	0.025	
N	2	
Max	0.030	
Min	0.020	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

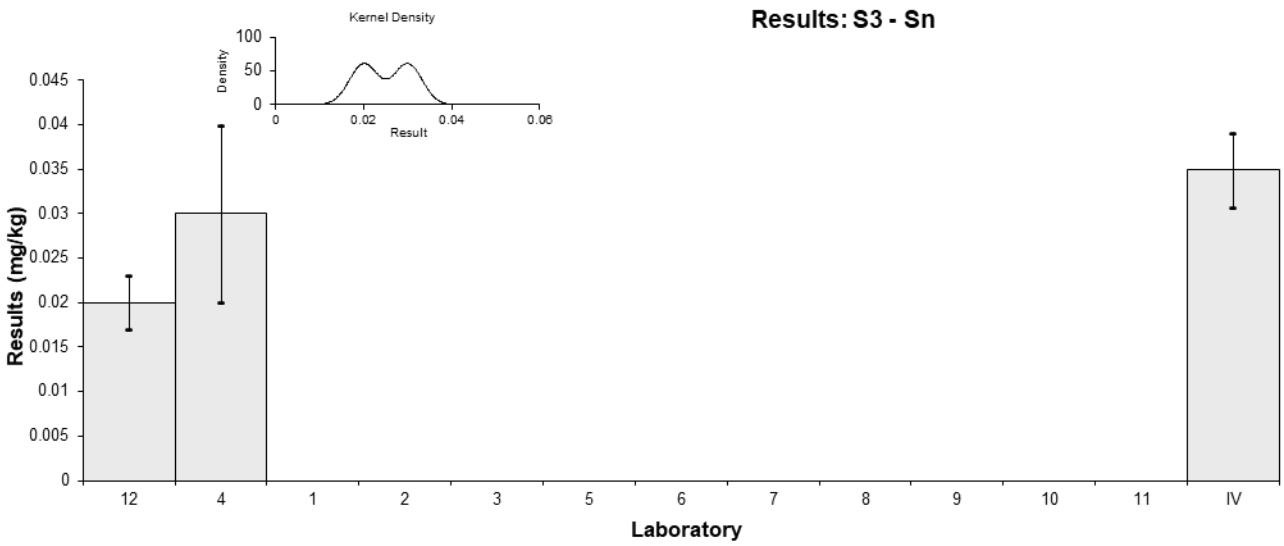

Results: S3 - Sn
Kernel Density
Density
100
50
0
0
0.02
0.04
0.06
Result
Results (mg/kg)
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
12
4
1
2
3
5
6
7
8
9
10
11
IV
Laboratory

Figure 79

Table 84

Sample Details

Sample No.	S3
Matrix	Cinnamon
Analyte	V
Unit	mg/kg

Participant Results

Lab. Code	Result	Uncertainty
1	NT	NT
2	NT	NT
3	0.280	0.087
4	0.19	0.05
5	<1.0	NR
6	NT	NT
7	<3	NR
8	0.22	0.044
9	NT	NT
10	NT	NT
11	0.25	NR
12	0.345	0.059

Statistics

Assigned Value	Not Set	
Robust Average	NA (N<6)	
Median	0.250	0.050
Mean	0.257	
N	5	
Max	0.345	
Min	0.19	
Robust SD	NA (N<6)	
Robust CV	NA (N<6)	

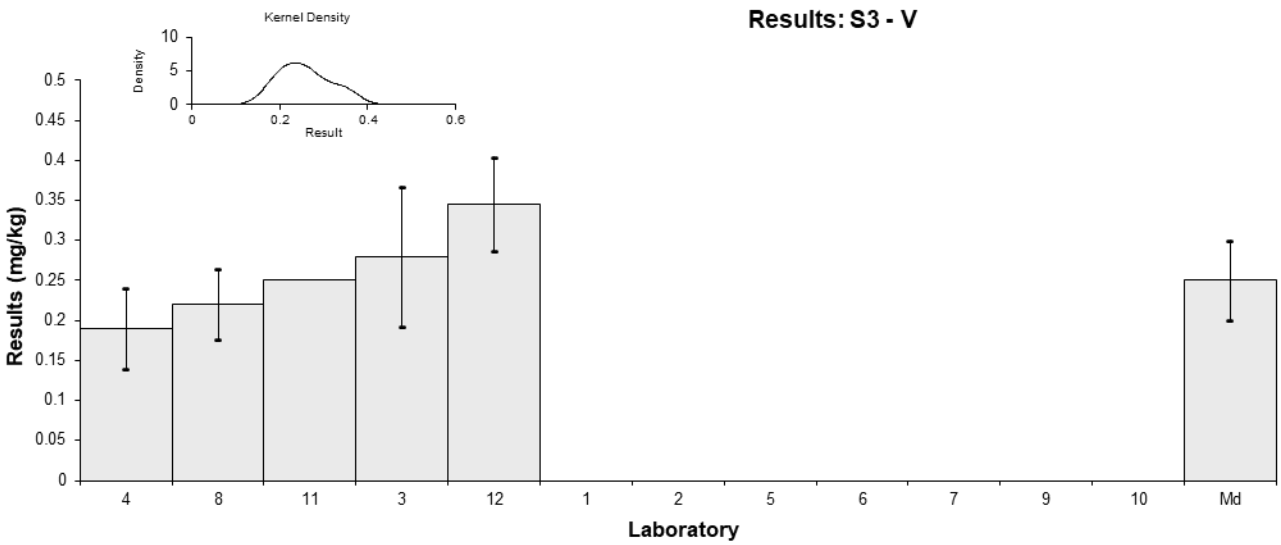

Results: S3 - V
Kernel Density
Density
Result
Results (mg/kg)
Laboratory
4
8
11
3
12
1
2
5
6
7
9
10
Md

Figure 80

Table 85

Sample Details

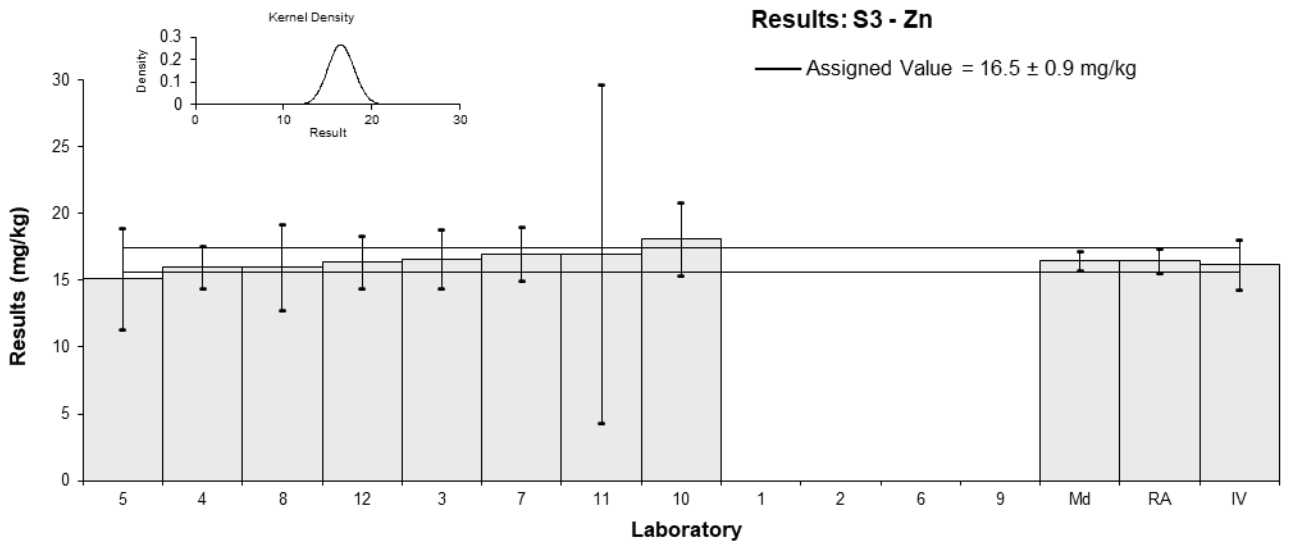
Sample No.	S3
Matrix	Cinnamon
Analyte	Zn
Unit	mg/kg

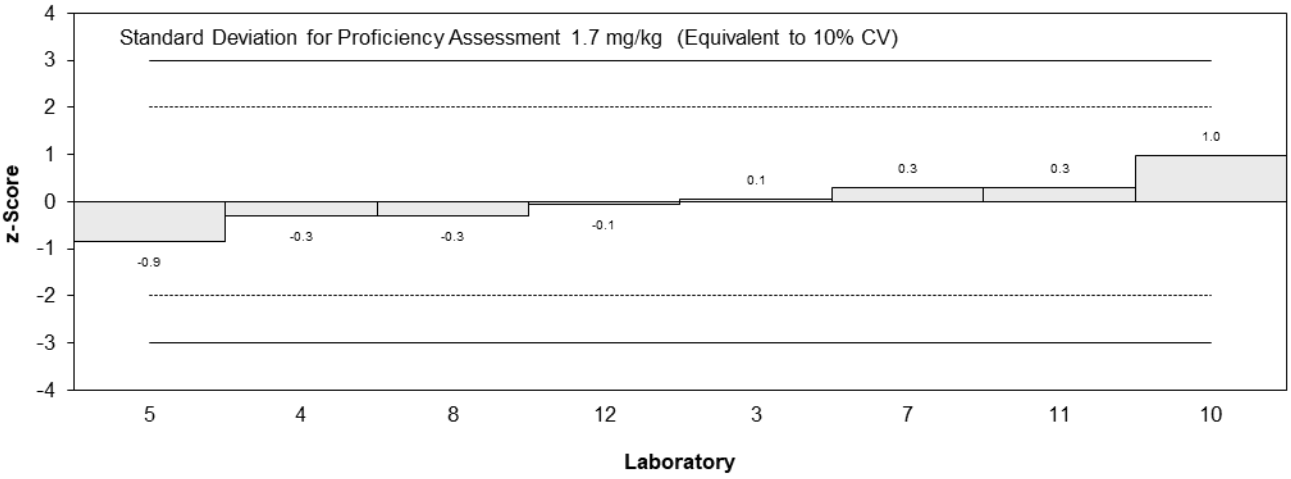
Participant Results

Lab. Code	Result	Uncertainty	z	E_n
1	NT	NT		
2	NT	NT		
3	16.6	2.2	0.06	0.04
4	16	1.6	-0.30	-0.27
5	15.1	3.8	-0.85	-0.36
6	NT	NT		
7	17	2.0	0.30	0.23
8	16	3.2	-0.30	-0.15
9	NT	NT		
10	18.1	2.72	0.97	0.56
11	17	12.7	0.30	0.04
12	16.400	1.950	-0.06	-0.05

Statistics

Assigned Value	16.5	0.9
Information Value	16.2	1.9
Robust Average	16.5	0.9
Median	16.5	0.7
Mean	16.5	
N	8	
Max	18.1	
Min	15.1	
Robust SD	0.97	
Robust CV	5.9%	


Kernel Density
Density
Result
Results: S3 - Zn
Assigned Value = 16.5 ± 0.9 mg/kg
Results (mg/kg)
Laboratory
5 4 8 12 3 7 11 10 1 2 6 9 Md RA IV


z-Scores: S3 - Zn
Standard Deviation for Proficiency Assessment 1.7 mg/kg (Equivalent to 10% CV)
z-Score
-0.9 -0.3 -0.3 -0.1 0.1 0.3 0.3 1.0
Laboratory
5 4 8 12 3 7 11 10

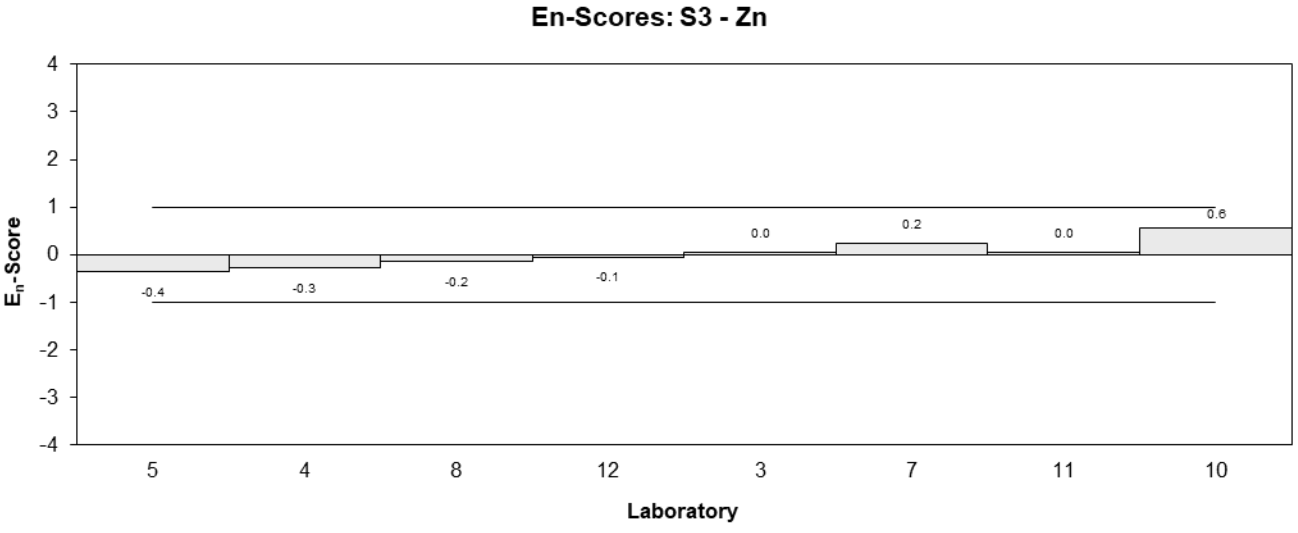

En-Scores: S3 - Zn
En-Score
-0.4 -0.3 -0.2 -0.1 0.0 0.2 0.0 0.6
Laboratory
5 4 8 12 3 7 11 10

Figure 81

6 DISCUSSION OF RESULTS

6.1 Assigned Value

The assigned values for all scored analytes were the robust averages of participants' results. Results that were less than 50% or greater than 150% of the robust average were excluded from the calculation of each assigned value.[6] The robust averages used as assigned values, and their associated expanded uncertainties were calculated using the procedure described in ISO 13528.[6] Appendix 2 sets out the calculation of the robust average of As in Sample S1 and its associated uncertainty.

Ash in Sample S1 was omitted from Tables and Figures in Section 5 because only one participant reported a numeric result for this test. Laboratory **4** reported a result of 6900 ± 690 mg/kg.

No assigned value was set for Al**,** Be**,** Bi**,** Li**,** Rb**,** Tl**,** TKN, TOC, and Ash in Sample S1, Ag, Al, As (Inorganic), Iodine (Total), La, Rb, Sb, Sn, U, and V in Sample S2, and Al, As, B, Cr, Na, Ni, Pb, S, Se, Sn, and V in Sample S3, because the results were either too variable or because too few participants reported results for these tests. However, participants may still compare their reported results with the robust average of participants' results, median value, homogeneity value, and/or information value. Descriptive statistics for these tests are presented in Section 5.

Traceability The consensus of participants' results (robust average) is not traceable to any external reference. So, although expressed in SI units, the metrological traceability of these assigned values has not been established.

6.2 Measurement Uncertainty Reported by Participants

Participants were asked to report an evaluation of the expanded measurement uncertainty associated with their results. 97% of numeric results were reported with an expanded measurement uncertainty, indicating that most laboratories have addressed this requirement of ISO/IEC 17025.[8] The magnitude of these expanded uncertainties was within the range 0.001% to 4400% of the reported value. The participants used a wide variety of procedures to evaluate the expanded measurement uncertainty. These are presented in Table 5. One participant reported using the NATA GAG Estimating and Reporting MU as their guide; this document has been officially removed from the NATA website and is considered obsolete.[9]

Approaches to evaluating measurement uncertainty include: standard deviation of replicate analysis, Horwitz formula, long term reproducibility, professional judgement, bottom up approach, top down approach using precision and evaluations of method and laboratory bias, and top down approach using only the reproducibility from inter-laboratory comparison studies.[10–15]

Participation in proficiency testing programs allows participants to check how reasonable their evaluation of uncertainty is. Results and expanded uncertainties are presented in the bar charts for each analyte (Figures 2 to 81).

As a simple rule of thumb, when the uncertainty is smaller than uncertainty of the assigned value, or larger than the uncertainty of the assigned value plus twice the SDPA, then this should be reviewed as suspect. For example, 9 laboratories' results were included in the assessment of the assigned value for Ca in S2. The uncertainty of the assigned value as determined from the robust standard deviation of the 9 laboratories' results is 220 mg/kg (7.2% of the assigned value). Laboratory **8** reported an uncertainty of 6.26 mg/kg (0.2% of their reported value) which may have been underestimated, as an uncertainty evaluated from one measurement cannot be smaller than the uncertainty evaluated from 9 measurements in different laboratories.

Alternatively, uncertainties for Ni in S1 larger than 0.22 mg/kg (the uncertainty of the assigned value, 0.063 mg/kg, plus the allowable variation from the assigned value, the SDPA

of 0.077 mg/kg, multiplied by 2, the coverage factor for a confidence interval of 95%), should also be viewed as suspect. For example, the expanded measurement uncertainty reported by Laboratory **2** for Ni in sample S1 (0.38 mg/kg) might have been over-estimated.

Laboratory **11** should assess their procedure used for evaluating measurement uncertainty, as some of their reported uncertainties were under-estimated, and others were over-estimated.

Laboratories **1** and **4** attached an evaluation of the expanded measurement uncertainty for some results that they reported as less than their limit of detection. An evaluation of uncertainty expressed as a value cannot be attached to a result expressed as a range.[1]

In some cases, the results were reported with an inappropriate number of significant figures. Including too many significant figures may inaccurately reflect the precision of measurements. The recommended format is to write uncertainty to no more than two significant figures and then to write the result with the corresponding number of decimal places. For example, instead of 38.9 ± 11.67 mg/kg, it is better to report 39 ± 12 mg/kg, or instead of 15.400 ± 2.600 mg/kg, it is better to report 15.4 ± 2.6 mg/kg.[1]

6.3 z-Score

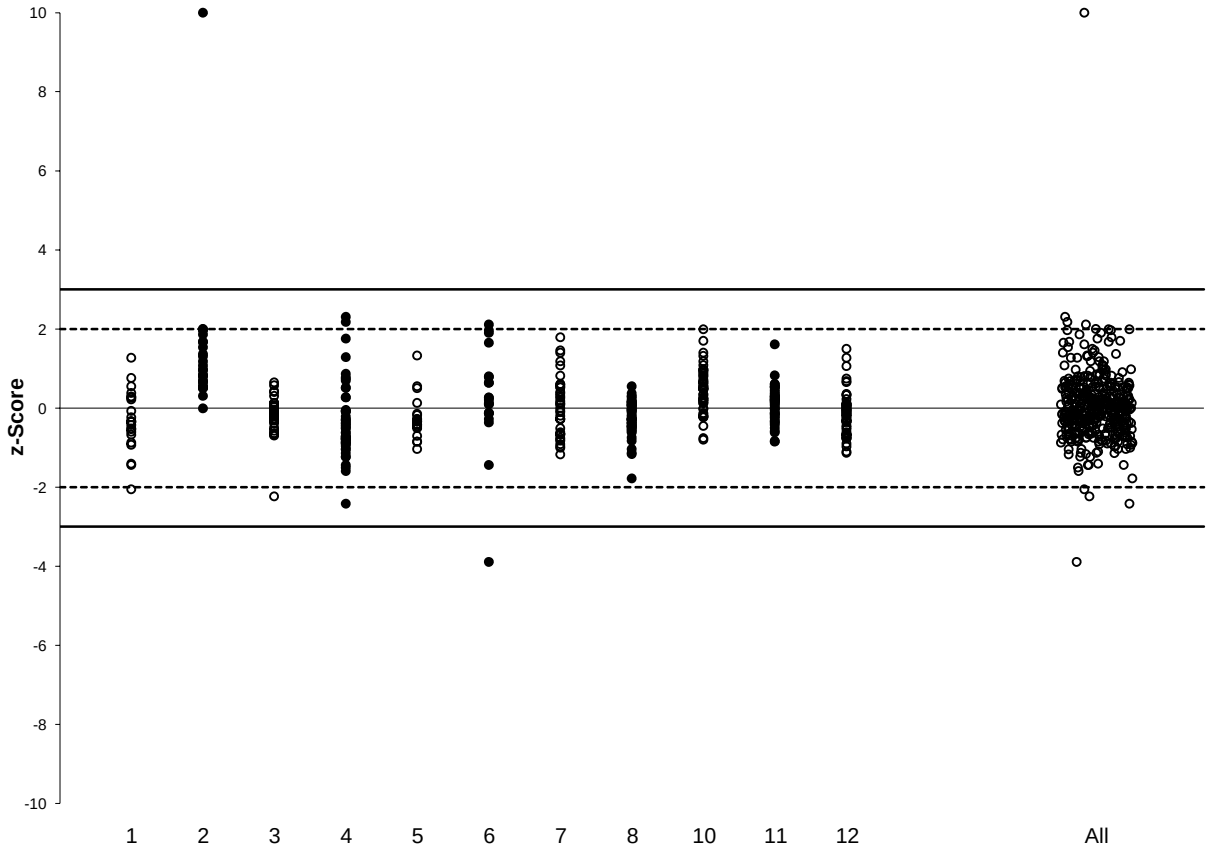
The z-score compares participants' deviation from the assigned value with the standard deviation for proficiency assessment (SDPA). The SDPA defines acceptable performance in a proficiency test. SDPAs equivalent to 10%, 15% and 20% PCV were used to calculate z-scores in this study. Unlike the standard deviation based on between-laboratory CV, setting the SDPA as a realistic set value enables z-scores to be used as reference value points for assessment of laboratory performance, independent of the group's performance.

The between-laboratory coefficient of variation predicted by the Thompson-Horwitz equation,[7] and the between-laboratory coefficient of variation from results reported in this study, are presented for comparison in Table 86 (tests with two or fewer numeric results have not been included as those statistics may be misleading).

The dispersal of participants' z-scores is presented in Figure 82 (by laboratory code) and in Figure 83 (by test). Laboratory **9** did not report any results that were scored and so has not been included in these charts.

Of 409 results for which z-scores were calculated, 401 (98%) returned an acceptable score of $|z| \leq 2.0$, and six (1%) were questionable at $2.0 < |z| < 3.0$.

Participants with multiple z-scores larger than 2.0 or smaller than -2.0 should check for laboratory bias.



Scores of >10.0 have been plotted as 10.0

Figure 82 z-Score Dispersal by Laboratory

Summary of participants' performance is presented in Figure 84.

Laboratories **8** and **12** returned the highest number of acceptable z-scores (all 51 scored tests). All results reported by Laboratories **10** (49), **11** (45), **7** (39), and **5** (19) also returned acceptable z-scores.

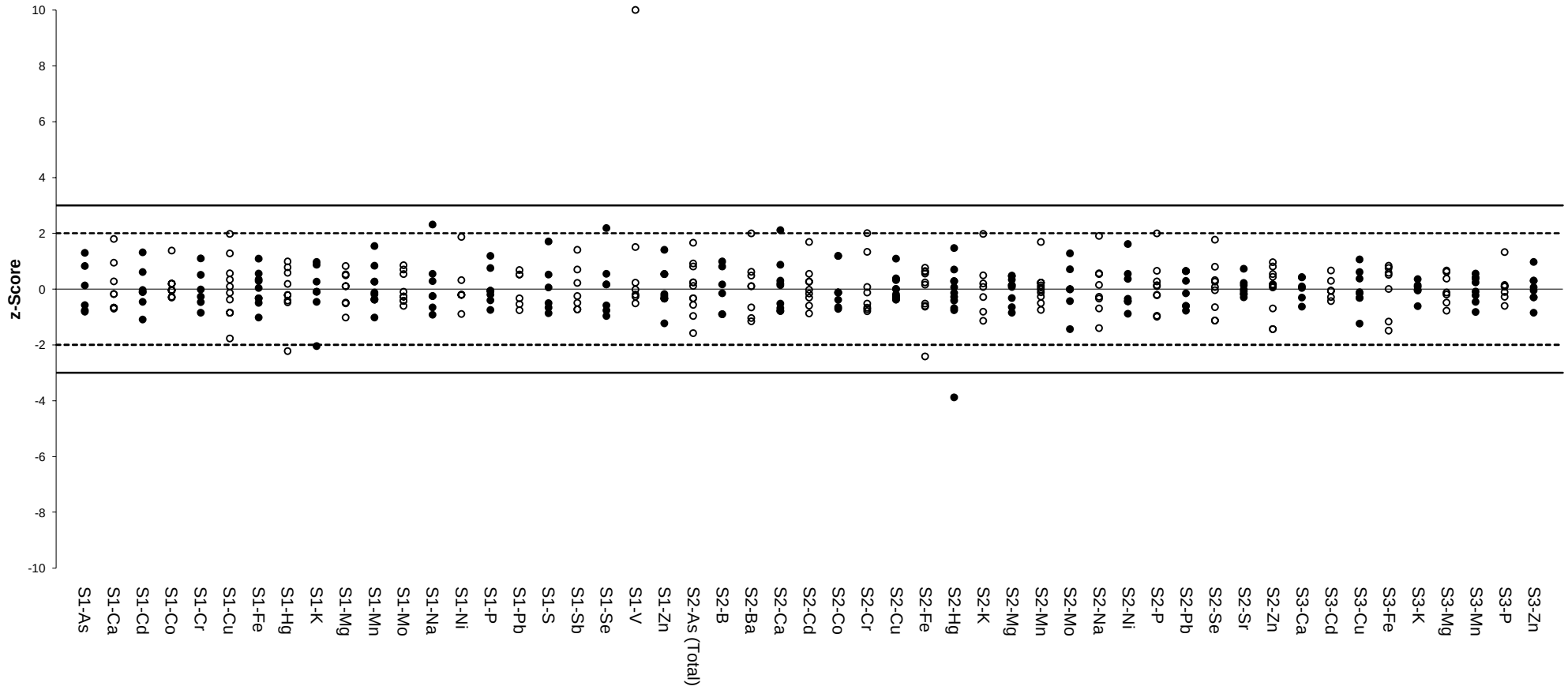
Table 86 Between-Laboratory CV of this study, Thompson-Horwitz CV and SDPA

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson-Horwitz CV* (%)	SPDA (as PCV, %)
S1	Al	5	3.82**	23	13	Not Set
S1	As	6	0.285	15	19	15
S1	Be	5	0.132**	20	22	Not Set
S1	Bi	4	0.274**	4.6	19	Not Set
S1	Ca	8	224	8.7	7.1	10
S1	Cd	7	0.283	8.7	19	10
S1	Co	8	0.282	4.3	19	15
S1	Cr	6	0.344	12	19	15
S1	Cu	10	4.26	12	13	10
S1	Fe	9	37.9	7.2	9.3	10
S1	Hg	9	0.251	16	20	20
S1	K	7	1950	9	5.1	10
S1	Li	5	0.300**	4.9	19	Not Set
S1	Mg	8	485	7.2	6.3	10

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson-Horwitz CV* (%)	SPDA (as PCV, %)
S1	Mn	10	15.6	7	11	10
S1	Mo	9	0.627	6.2	17	10
S1	Na	7	73.9	8.7	8.4	10
S1	Ni	6	0.516	12	18	15
S1	P	8	1470	6.6	5.3	10
S1	Pb	6	0.316	11	19	15
S1	Rb	3	2.40**	3.1	14	Not Set
S1	S	6	1300	16	5.4	15
S1	Sb	7	0.281	13	19	15
S1	Se	7	0.397	19	18	20
S1	Tl	5	0.270**	5.5	19	Not Set
S1	V	6	0.271	7.6	19	15
S1	Zn	10	11.4	7.2	11	10
S1	TKN	3	20100**	3	3.6	Not Set
S2	Ag	4	0.255**	17	20	Not Set
S2	Al	7	37**	44	9.3	Not Set
S2	As (Total)	11	17.6	9.7	10	10
S2	Ba	8	0.792	10	17	10
S2	B	6	6.25	14	12	15
S2	Ca	9	3040	8.5	4.8	10
S2	Cd	9	0.351	6.5	19	10
S2	Co	8	0.102	13	22	15
S2	Cr	8	1.00	16	16	15
S2	Cu	11	26.0	3.9	9.8	10
S2	Fe	10	66.0	7.6	8.5	10
S2	Hg	10	0.960	9.7	16	15
S2	K	7	9610	9.9	4	10
S2	Mg	9	1530	5.4	5.3	10
S2	Mn	11	4.11	3.9	13	10
S2	Mo	7	0.0701	9.7	22	10
S2	Na	8	14200	10	3.8	10
S2	Ni	7	0.560	17	17	20
S2	P	9	7700	8	4.2	10
S2	Pb	8	0.374	10	19	15
S2	Rb	4	2.80**	11	14	Not Set
S2	Sb	6	0.0213**	18	22	Not Set
S2	Se	9	2.77	15	14	15
S2	Sn	4	0.310**	12	19	Not Set

Sample	Analyte	Numeric Results Reported*	Assigned Value (mg/kg)	Between-Laboratory CV* (%)	Thompson-Horwitz CV* (%)	SPDA (as PCV, %)
S2	Sr	8	47.4	2.6	9	10
S2	V	4	0.160**	42	21	Not Set
S2	Zn	11	187	9	7.3	10
S3	Al	5	141**	9.5	7.6	Not Set
S3	As	4	0.045**	18	22	Not Set
S3	B	5	12.0**	4.9	11	Not Set
S3	Ca	6	9020	4.7	4.1	10
S3	Cd	6	0.272	4.6	19	10
S3	Cr	5	0.460**	3.2	18	Not Set
S3	Cu	8	4.34	7.7	13	10
S3	Fe	7	120	11	7.8	10
S3	K	6	5120	3	4.4	10
S3	Mg	7	694	6.3	6	10
S3	Mn	8	218	5.4	7.1	10
S3	Na	5	40.0**	3.7	9.2	Not Set
S3	Ni	4	0.305**	4.9	19	Not Set
S3	P	7	644	4.5	6	10
S3	Pb	5	0.490**	3	18	Not Set
S3	S	5	900**	1.6	5.7	Not Set
S3	Se	3	0.034**	37	22	Not Set
S3	V	5	0.250**	18	20	Not Set
S3	Zn	8	16.5	5.9	10	10

* Values exclude outliers if applicable. Thompson-Horwitz CV calculated from the assigned value. NA= Not Available.
**Robust Average or Median Value as applicable (assigned value not set).



Scores of >10.0 have been plotted as 10.0

Figure 83 z-Score Dispersal by Analyte

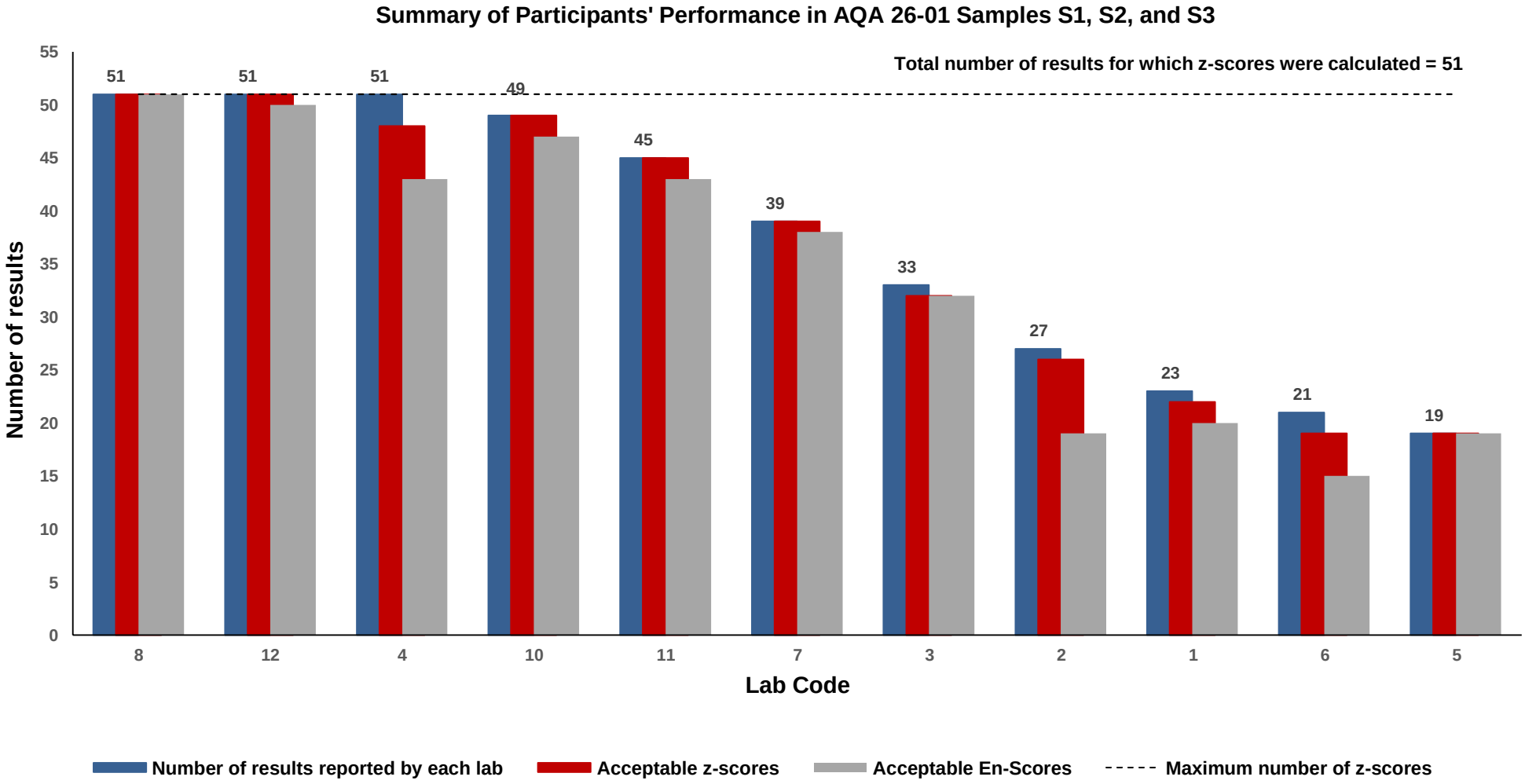


Figure 84 Summary of Participants' Performance

Table 87 Summary of Participants' Results and Performance in S1

Lab Code	Al mg/kg	As mg/kg	Be mg/kg	Bi mg/kg	Ca mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Hg mg/kg	K mg/kg	Li mg/kg	Mg mg/kg	Mn mg/kg
AV	Not Set	0.285	Not Set	Not Set	224	0.283	0.282	0.344	4.26	37.9	0.251	1950	Not Set	485	15.6
HV	5.49	0.264	0.145	0.265	NA	0.295	0.283	0.350	4.08	38.9	0.263	2080	0.318	447	16.1
1	<10	NR	NR	NR	209	NR	NR	NR	4.8	40	NR	1550	NR	460	16
2	NT	0.32	NT	NT	NT	0.32	0.34	0.37	5.1	NT	0.30	NT	NT	NT	18
3	3.82	<2	0.132	NT	209	0.282	0.269	<0.5	4.10	38.0	0.139	NT	NT	461	15.3
4	2.9	0.34	0.15	0.26	230	0.27	0.28	0.33	3.9	34	0.29	2120	0.30	510	15
5	NT	<2.0	<1.0	NT	NT	<1.0	<1.0	<1.0	3.9	36.6	0.23	NT	NT	NT	14.0
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	<25	<2	<0.5	<0.5	264	<0.5	0.29	<2	4.3	42	0.28	1930	0.31	525	16
8	2.7	0.25	0.13	0.27	220	0.28	0.27	0.32	3.5	39	0.26	1860	0.26	435	15
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	4.13	0.29	0.16	0.3	245	0.3	0.29	0.4	4.5	39.2	0.24	2140	0.31	509	16.9
11	NR	0.26	NR	NR	220	0.28	0.28	0.30	4.2	36	0.24	2000	NR	490	15
12	4.410	0.252	0.109	0.277	208.000	0.252	0.280	0.343	4.400	36.600	0.227	1930.000	0.287	490.000	15.400

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value. NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 87 Summary of Participants' Results and Performance in S1 (continued)

Lab. Code	Mo mg/kg	Na mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	Rb mg/kg	S mg/kg	Sb mg/kg	Se mg/kg	Tl mg/kg	V mg/kg	Zn mg/kg	TKN mg/kg	TOC mg/kg	Ash mg/kg
AV	0.627	73.9	0.516	1470	0.316	Not Set	1300	0.281	0.397	Not Set	0.271	11.4	Not Set	Not Set	Not Set
HV	0.618	65.5	0.528	1460	0.302	2.47	NA	0.272	0.385	0.276	0.255	11.1	NA	NA	NA
1	0.6	67	NR	1460	NR	NR	1130	NR	NR	NR	NR	11	NR	NR	NR
2	0.68	NT	0.66	NT	0.34	NT	NT	0.31	0.44	NT	0.79	12	NT	NT	NT
3	0.621	NT	<0.7	1440	<1	NT	NT	<2	<2	<2	0.263	11.1	23000	420000	NT
4	0.60	91	0.50	1580	0.28	2.4	1400	0.26	0.57	0.26	0.25	10	19700	NR	6900
5	<1.0	NT	<1.0	1410	<1.0	NT	NT	NT	<5.0	NT	<1.0	11.2	NT	NT	NT
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	0.61	69	<1	1360	<1	NT	1200	0.34	0.32	0.29	<3	12	20100	329000	NR
8	0.61	72	0.50	1460	0.29	2.2	1310	0.25	0.35	0.27	0.26	11	NR	NR	NR
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	0.24	NT	NT	NT	NT	NT
10	0.67	77.9	0.5	1644	0.34	2.4	1632	0.29	0.41	0.28	0.27	13	NT	NT	NT
11	0.66	76	0.54	NR	0.30	NR	NR	0.27	0.41	NR	0.28	12	NR	NR	NR
12	0.589	72.000	0.446	1460.000	0.348	NT	1170.000	0.250	0.336	NT	0.332	11.000	NT	NT	NT

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value. NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 88 Summary of Participants' Results and Performance in S2

Lab. Code	Ag mg/kg	Al mg/kg	As (Total) mg/kg	As (Inorganic) mg/kg	Ba mg/kg	B mg/kg	Ca mg/kg	Cd mg/kg	Co mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	Hg mg/kg	Iodine (Total) mg/kg	K mg/kg
AV	Not Set	Not Set	17.6	Not Set	0.792	6.25	3040	0.351	0.102	1.00	26.0	66.0	0.960	Not Set	9610
HV	0.265	NA	17.4	IV = 0.100	0.828	6.56	3200	0.367	0.113	NA	27.5	73.2	0.98	IV = 3.90	9800
1	0.26	69	17	NR	NR	NR	2880	0.33	NR	NR	27	71	1.0	NR	NR
2	NT	NT	19.0	NT	0.95	NT	NT	0.41	0.12	1.3	28.8	NT	1.06	NT	NT
3	NT	31.7	16.6	NT	NT	NT	2830	0.345	<0.2	1.01	26.8	61.8	0.968	NT	NT
4	0.4	18	14.8	0.065	0.71	5.4	2800	0.32	0.091	0.89	25	50	1.0	3.6	8510
5	NT	NT	17.0	NT	<1.0	NT	NT	<1.0	<1.0	1.2	25.3	69.6	0.94	NT	NT
6	0.2	25.7	20.5	NR	0.8	7	3680	0.36	0.1	0.98	25.3	70.2	0.4	NR	11500
7	<1	<25	17.8	NT	0.74	5.4	2800	<0.5	0.12	<2	26	62	1.17	4.0	8820
8	0.25	33	18	0.11	0.70	6.4	3130	0.35	0.096	0.92	25	67	0.92	NR	9680
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	38.9	19.2	NT	0.83	7.17	3303	0.36	0.1	0.88	26.9	67.5	0.85	NT	10084
11	NR	NR	18	NR	0.84	NR	3100	0.37	0.10	NR	26	70	0.90	NR	9800
12	NT	48.300	15.900	NT	0.800	6.100	3080.000	0.340	0.092	0.900	25.500	62.500	0.860	NT	9330.000

Shaded cells are results which returned a questionable or unacceptable z-score. AV = Assigned Value, HV = Homogeneity Value, IV = Information Value. NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 88 Summary of Participants' Results and Performance in S2 (continued)

Lab. Code	La mg/kg	Mg mg/kg	Mn mg/kg	Mo mg/kg	Na mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	Rb mg/kg	Sb mg/kg	Se mg/kg	Sn mg/kg	Sr mg/kg	U mg/kg	V mg/kg	Zn mg/kg
AV	Not Set	1530	4.11	0.0701	14200	0.560	7700	0.374	Not Set	Not Set	2.77	Not Set	47.4	Not Set	Not Set	187
HV	NA	1610	4.25	0.0736	14700	NA	7470	0.385	2.72	0.0217	2.82	0.340	51.3	0.0130	0.159	195
1	NR	1480	4.2	NR	12200	NR	7520	0.39	NR	NR	NR	NR	NR	NR	NR	160
2	NT	NT	4.8	0.07	NT	0.62	NT	0.41	NT	0.030	2.9	NT	NT	NT	0.53	205
3	NT	1550	4.16	<0.4	NT	<0.7	8200	<1	NT	<2	2.75	NT	46.6	NT	<0.2	195
4	<0.05	1400	3.8	0.075	13200	0.46	6960	0.33	2.6	0.017	3.5	0.32	47	<0.05	<0.1	160
5	NT	NT	3.9	<1.0	NT	<1.0	7800	<1.0	NT	NT	<5.0	NT	NT	NT	<1.0	174
6	<0.1	1550	4.06	0.06	16900	0.52	7910	0.41	3	<0.1	3.1	<0.5	48.4	<0.01	<0.5	189
7	NT	1430	4.0	<0.2	13800	<1	6930	<1	NT	<0.1	2.5	1.0	46.5	<0.02	<3	197
8	0.045	1540	4.1	0.067	14400	0.51	7780	0.34	2.6	0.022	2.3	0.27	46	0.017	<0.1	190
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	0.05	1603	4.2	0.07	14950	0.51	9230	0.41	3.23	0.02	2.88	NT	50.8	0.01	0.11	202
11	NR	1600	4.2	0.07	15000	0.74	NR	0.34	NR	0.02	2.8	NR	48	NR	0.12	190
12	NT	1580.000	4.130	0.079	13700.000	0.600	7540.000	0.365	NT	0.022	2.300	0.300	47.300	NT	0.200	188.000

AV = Assigned Value, HV = Homogeneity Value. NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 89 Summary of Participants' Results and Performance in S3

Lab. Code	Al mg/kg	As mg/kg	B mg/kg	Ca mg/kg	Cd mg/kg	Cr mg/kg	Cu mg/kg	Fe mg/kg	K mg/kg	Mg mg/kg
AV	Not Set	Not Set	Not Set	9020	0.272	Not Set	4.34	120	5120	694
IV	316	0.0448	13.3	NA	0.291	NA	4.35	NA	5780	672
1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	141	<2	NT	8440	0.264	<0.5	4.29	127	NT	685
4	120	0.050	11	8740	0.27	0.45	3.8	102	4800	640
5	NT	<2.0	NT	NT	<1.0	<1.0	4.2	126	NT	NT
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	137	<2	12	9390	<0.5	<2	4.6	106	5090	736
8	150	<0.05	12	9100	0.27	0.47	4.5	120	5100	660
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	NT	0.04	12.7	NT	0.29	0.35	4.27	NT	5185	680
11	NR	0.025	NR	9400	0.28	0.46	4.2	130	5300	720
12	190.000	0.051	11.600	9050.000	0.260	0.630	4.800	129.000	5160.000	740.000

AV = Assigned Value, IV = Information Value. NA = Not Available, NT = Not Tested, NR = Not Reported.

Table 89 Summary of Participants' Results and Performance in S3 (continued)

Lab. Code	Mn mg/kg	Na mg/kg	Ni mg/kg	P mg/kg	Pb mg/kg	S mg/kg	Se mg/kg	Sn mg/kg	V mg/kg	Zn mg/kg
AV	218	Not Set	Not Set	644	Not Set	Not Set	Not Set	Not Set	Not Set	16.5
IV	240	44.9	0.351	673	0.503	NA	0.0241	0.0349	NA	16.2
1	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
2	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
3	227	NT	<0.7	637	<1	NT	<2	NT	0.280	16.6
4	216	39	0.29	605	0.45	835	0.040	0.030	0.19	16
5	208	NT	<1.0	626	<1.0	NT	<5.0	NT	<1.0	15.1
6	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
7	226	<50	<1	653	<1	900	<0.1	<0.5	<3	17
8	230	66	0.30	650	0.48	890	<0.05	<0.02	0.22	16
9	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
10	213	39.9	NT	729	0.49	910	NT	NT	NT	18.1
11	200	46	0.31	NR	0.49	NR	0.02	NR	0.25	17
12	223.000	40.000	0.346	650.000	0.534	1080.000	0.034	0.020	0.345	16.400

AV = Assigned Value, IV = Information Value. NA = Not Available, NT = Not Tested, NR = Not Reported.

6.4 E_n-Score

The E_n-score indicates how closely a result agrees with the assigned value taking into account the respective uncertainties. E_n-scores can be interpreted in conjunction with z-scores, as an unacceptable E_n-score for an analyte can either be caused by issues with measurement, an inappropriate evaluation of measurement uncertainty, or both.

Where a participant did not report an expanded uncertainty with a result, an expanded uncertainty of zero (0) was used to calculate the E_n-score.

The dispersal of participants' E_n-scores is graphically presented in Figure 85. Laboratory **9** did not report results that were scored and so has not been included in this chart.

Of 409 results for which E_n-scores were calculated, 377 (92%) returned an acceptable score of $|E_n| < 1.0$, indicating agreement of the participants' results with the assigned values within their respective expanded measurement uncertainties.

Laboratory **8** returned the highest number of acceptable E_n-scores (all 51 scored tests). All results reported by Laboratory **5** (19) also returned acceptable E_n-scores.

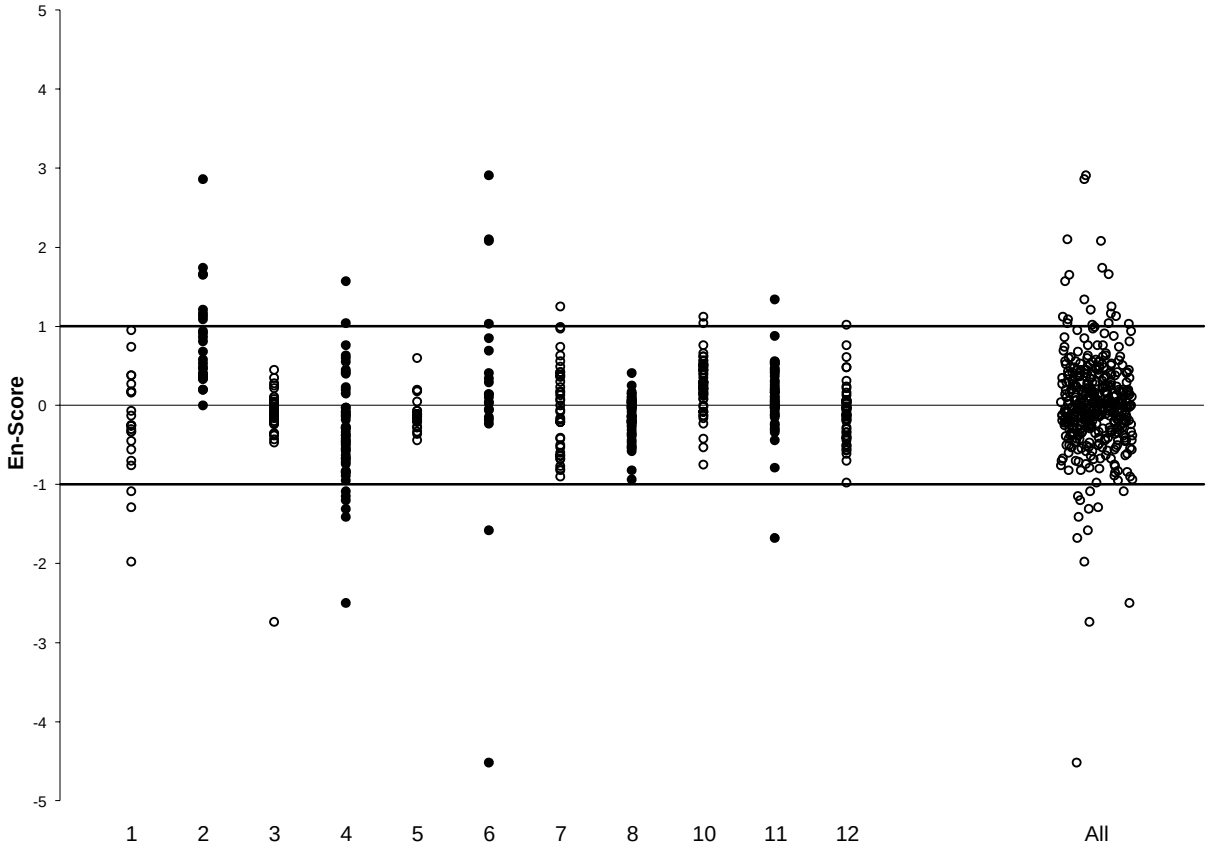


Figure 85 E_n-Score Dispersal by Laboratory

6.5 Participants' Results and Analytical Methods

A summary of participants' performance in the study samples is presented in Figures 82 to 85 and Tables 87 to 89. In general, participants were not challenged significantly by any of the three matrices, with 98% of reported results returning acceptable *z*-scores. The between-laboratory CVs were comparable across the three samples.

Measurements of Al in Sample S2 presented the most analytical difficulty to participants. No assigned value could be set for this test because the reported results were not compatible with each other (between-laboratory CV of 44%).

Measurements of low-level Se in Sample S3 and of V in Sample S2 also challenged participants analytical techniques.

The method descriptions provided by participants are presented in Tables 1 to 3; instrumental conditions are presented in Appendix 4.

Reporting results with insufficient number of significant figures may also explain some of the unacceptable performances. Analytical test results are rounded to avoid presenting a misleading impression of precision. However, most of the instrumental techniques used by participants in the present study should be capable of producing results with a reasonable degree of certainty to up to two significant figures at parts per billion level. Caution should be exercised when a rounding protocol is designed by a laboratory in order to avoid inadvertent loss of important information. According to Eurachem/CITAC Guide, 'the reported result has to provide enough information in case a decision has to be made (e.g. when the result is close to the accepted guideline)'.[1]

Laboratory **12** rounded all their results and uncertainties to 3 decimal places, regardless of the number of significant figures. This participant should also consider revising their rounding protocol.

Extraction Method

The Codex Alimentarius Commission's recommendation for the measurement of elemental impurities in food samples by ICP is 'digestion until extraction is complete'. Laboratories are expected to report total elements in food samples.[16] In previous NMIA PT studies, participants used various extraction methods and the results produced were compatible, with the exception of Al, Cr, Fe, Ni and V in some types of food.

The extraction of these elements is strongly dependent on digestion regime, especially when the food material has high silica content. An aggressive digestion regime involving nitric acid, a high digestion temperature (higher than approximately 170ºC) and/or hydrofluoric acid is usually recommended for the complete extraction of these elements.

Food laboratories are required to test for a number of total elements in a variety of food samples, and it is often challenging to find a method/extraction regime which is suitable for all of them. The use of HF is banned in many laboratories and microwave digesters allow only a limited number of samples to be digested at a time. Evidence has been found in previous studies of the importance of using (in addition to nitric acid) a high ratio of HCl (mL) to sample size (g) when the digestion temperature is high (> 170ºC) or when HF cannot be used for total Cr, Fe, Ni and V extraction.

In the present study, Sample S1 was wheat flour, Sample S2 was seafood biota, and Sample S3 was cinnamon. All participants who reported results for multiple samples used the same extraction regime for all samples analysed.

The amount of wheat flour and cinnamon sample taken for analysis by participants varied from 0.2 g to 1 g, while the amount of seafood biota sample used for analysis varied from 0.2 g to 2 g. Caution should be exercised when a small sample size is taken for analysis as this may not be representative of the whole sample. Caution should also be exercised when using too much sample mass and not enough digestion acid for the sample mass.

The majority of participants used a combination of nitric acid and hydrochloric acid. Digestion temperatures ranged from 85°C to 200°C, with some laboratories also adding hydrogen peroxide. Three laboratories used nitric acid only, but two of them also applied a high digestion temperature (200°C) and/or a high nitric acid–to–sample ratio (up to 50). Overall, despite the wide variety of digestion methods employed, the results were compatible for most analytes.

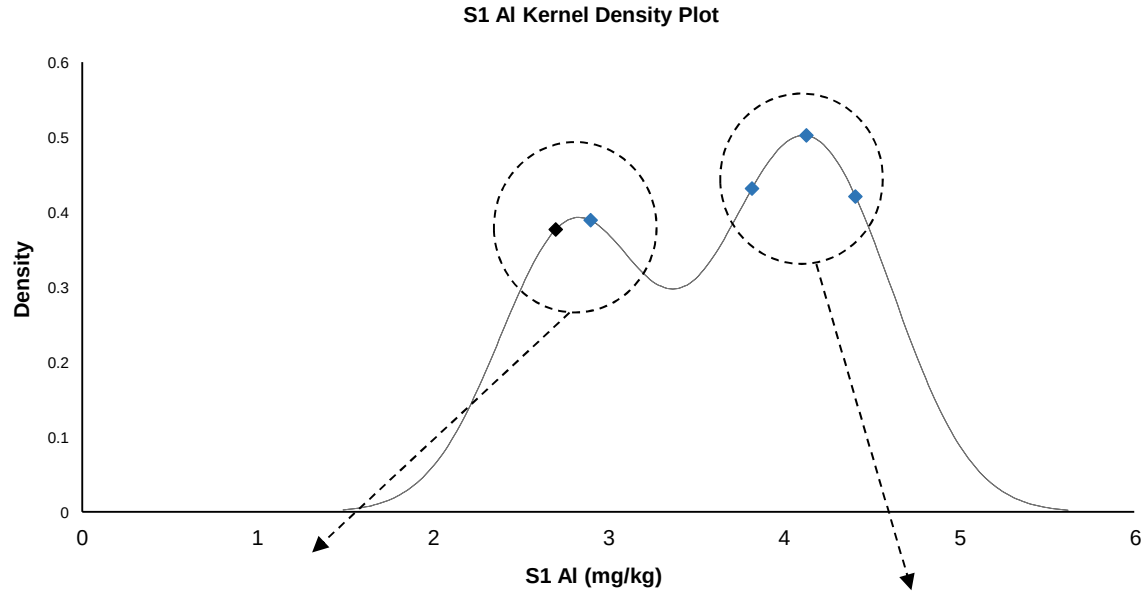
Aluminium is one of the most challenging elements to analyse in food samples. In the previous PT studies, no assigned value could be set for Al in the chicken feed, oyster tissue and biota samples due to the high variability of the reported results. Two factors were

identified as potentially affecting Al extraction efficiency: the use of high digestion temperatures (≥170ºC) and/or diluted HNO_3.

In the present study, the results reported for Al were either too variable (in Sample S2) and/or too few (Samples S1 and S3) and no value could be set for this test in any of the study samples.

For Sample S1, only 5 laboratories reported Al results. The results had a bimodal distribution, with lower values reported by participants using digestion temperatures of 85ºC and 100ºC. Of the three highest results, two were reported by laboratories employing more aggressive digestion regimes, including higher digestion temperatures, longer digestion times, and/or higher acid to sample ratios (Figure 86).

As the study required "digestion until extraction was complete", the true value for total Al in the wheat flour sample most likely lies closer to these higher reported values. Additionally, an aggressive digestion regime (microwave digestion at 260ºC for 1 hour) was used for homogeneity testing. The homogeneity value for Sample S1 Al was 5.49 mg/kg, which was higher than all participants' results, providing further support that those participants reporting the lower values may have not achieved "complete extraction".



Result (mg/kg)	Temperature (°C)	Time (min)	Sample Size (g)	Reagents
2.7	100	120	0.5	3 mL HNO_3+1 mL HCl
2.9	85	120	1	3 mL HNO_3+2 mL HCl

Result (mg/kg)	Temperature (°C)	Time (min)	Sample Size (g)	Sample size/Acid
3.82	120	**240**	**0.2**	**3 mL HNO_3+2 mL HCl**
4.13	95	120	1	2 mL HNO_3+1 mL HCl
4.41	**190**	60	**0.5**	**10 mL HNO_3+2 mL HCl**
Homogeneity Value				
5.49	**260**	60	0.5	3 mL HNO_3+1 mL HCl

Figure 86 S1 Al Kernel Density Plot of Participants' Results and Methodology

Seven laboratories reported Al results for the biota Sample S2. The results were not compatible with one other; no clear relationship between the reported values and the digestion method used was evident.

Five laboratories reported Al results for the cinnamon Sample S3, and all 5 results were in relatively good agreement with each other. However, like for Sample S1, the information value for S3 Al (316 mg/kg) produced using the same aggressive digestion regime (microwave digestion at 260ºC for 1 hour) was again higher than all participants' results. This

may be an indication that participants' methods may not achieve the complete extraction of Al from cinnamon matrix.

According to Eurachem/CITAC Guide CG 4, laboratories should consider using matrix-matched control samples to assess their extraction efficiency (the bias of their analytical methods). Bias can be expressed as recovery and should be corrected for or included in the uncertainty evaluation.[1]

Chromium and **Nickel** have also been demonstrated to be strongly dependent on digestion regime, especially when the sample has high silica content. Evidence has been found in previous studies that a high ratio of HCl to sample size is essential for complete extraction of these elements in food samples, when high digestion temperatures cannot be employed.

In the present study, participants used various extraction methods, digestion temperatures and ratios of hydrochloric acid or nitric acid to sample size for these elements. The results reported for these elements were compatible with each other regardless of method used (between-laboratory CVs ranged from 3.2% to 17%).

Individual Analyte Commentary

Aluminium, Chromium, Nickel, and **Vanadium** There was no trend between results or performance for Al, Cr, Ni, and V in Samples S1 and S2 with the instrument technique used (Figures 87 to 94).

Five laboratories reported Cr results for the cinnamon Sample S3, and all 5 results were in relatively good agreement with each other, centred around the value of 0.460 mg/kg (Figure 89).

Only four results were reported for Ni in Sample S3. All results were in excellent agreement with each other and with the information value (Figure 91).

Vanadium level in biota sample S2 was below the level of reporting of many participants. Only 4 laboratories reported results for this test. The results reported by Laboratories **10**, **11**, and **12** were in good agreement with each other and the homogeneity value. The result reported by Laboratory 2 was approximately 3 times higher than the median value; this participant may need to check their standard or dilution preparation procedure.

Five results only were also reported for V in Sample S3. However, all results were in relatively good agreement with each other centred around the value of 0.250 mg/kg (Figure 94).

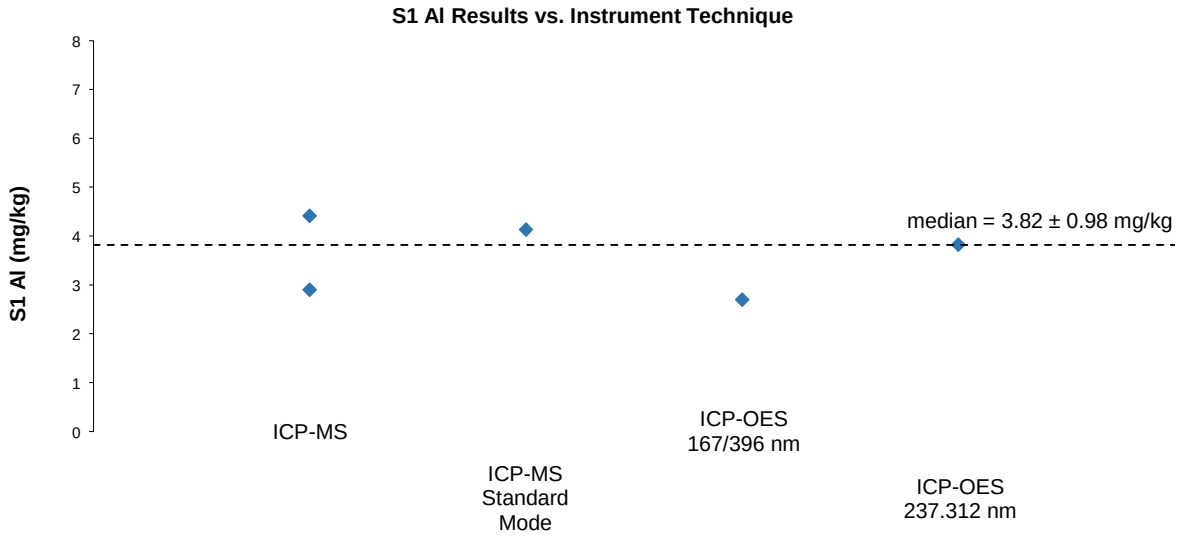


Figure 87 S1 Al Results vs Instrument Technique

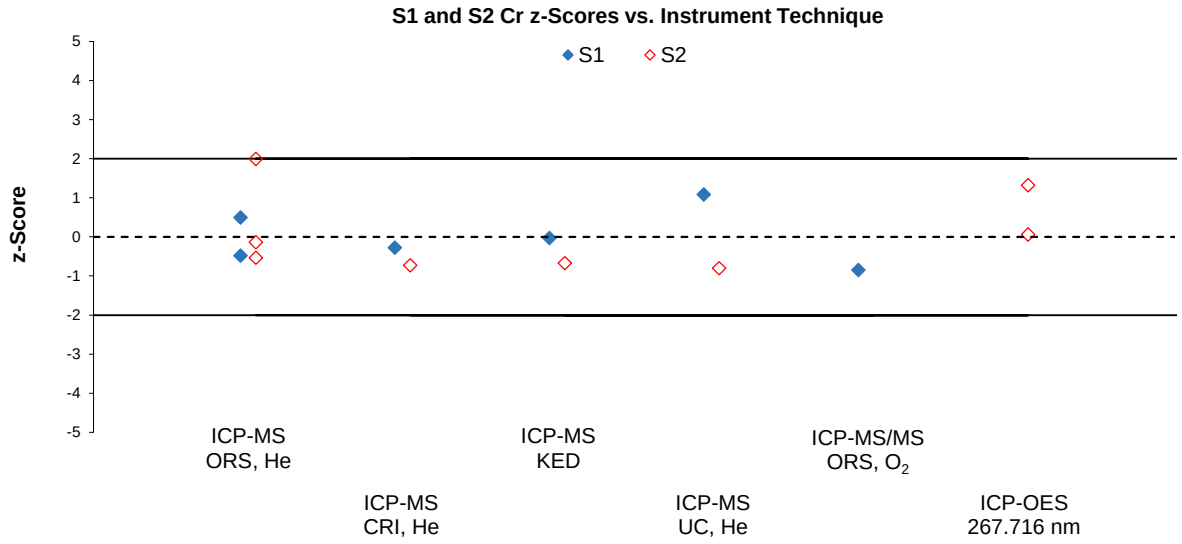


Figure 88 S1 and S2 Cr z-Scores vs Instrument Technique

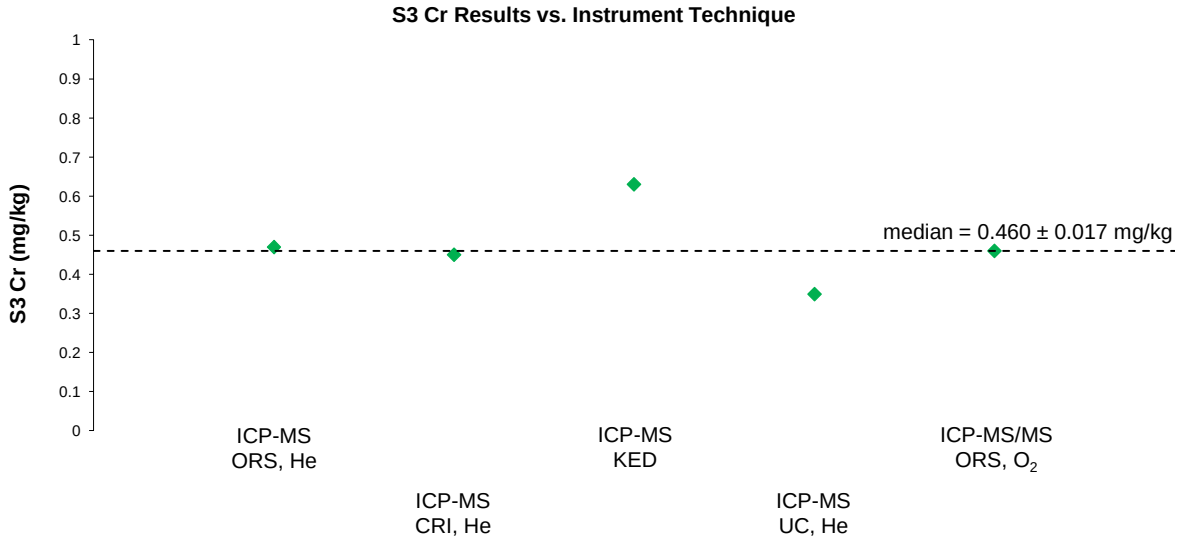


Figure 89 S3 Cr Results vs Instrument Technique

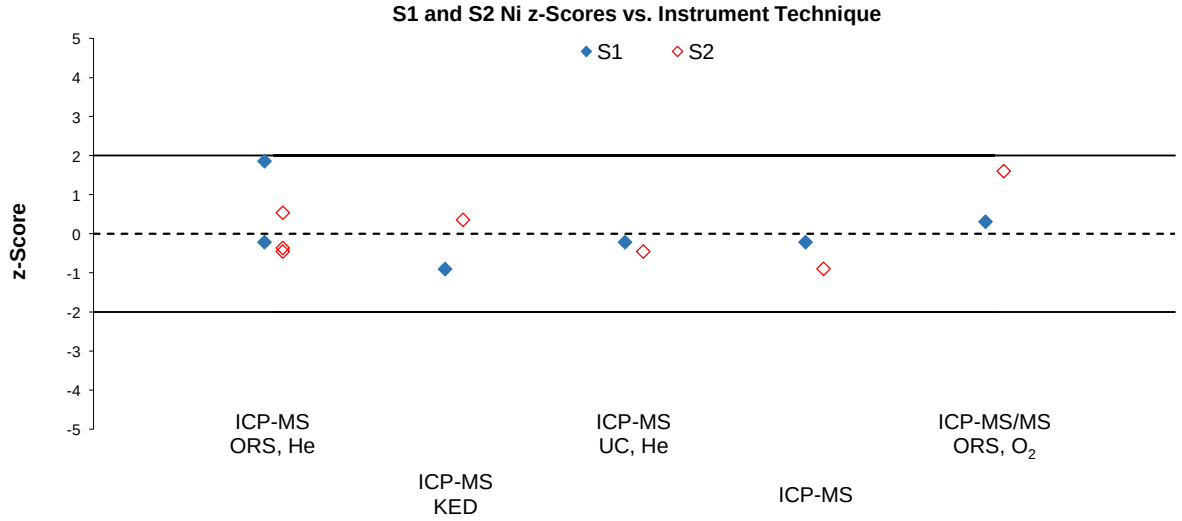


Figure 90 S1 and S2 Ni z-Scores vs Instrument Technique

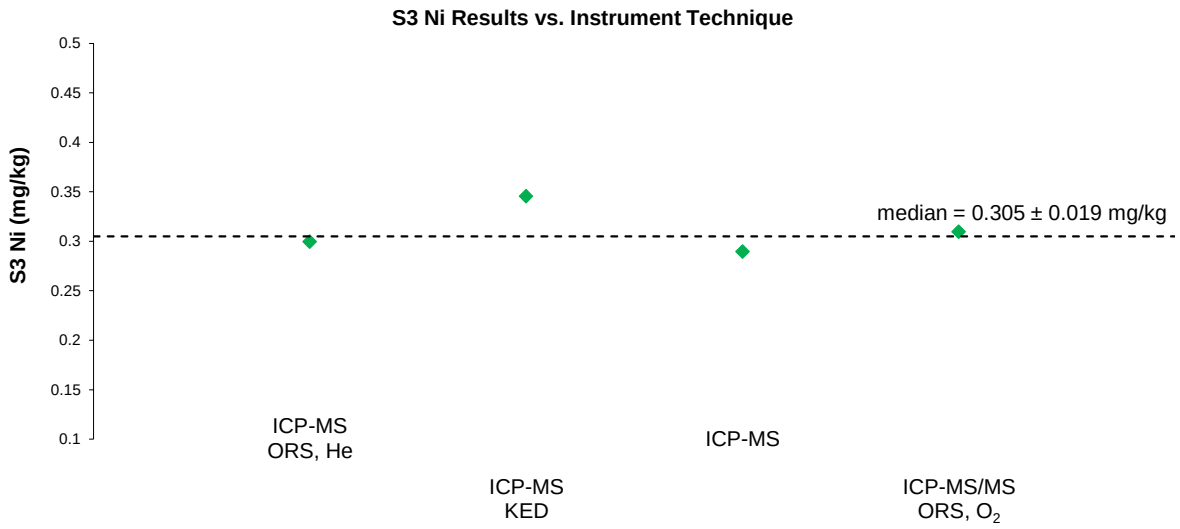


Figure 91 S3 Ni Results vs Instrument Technique

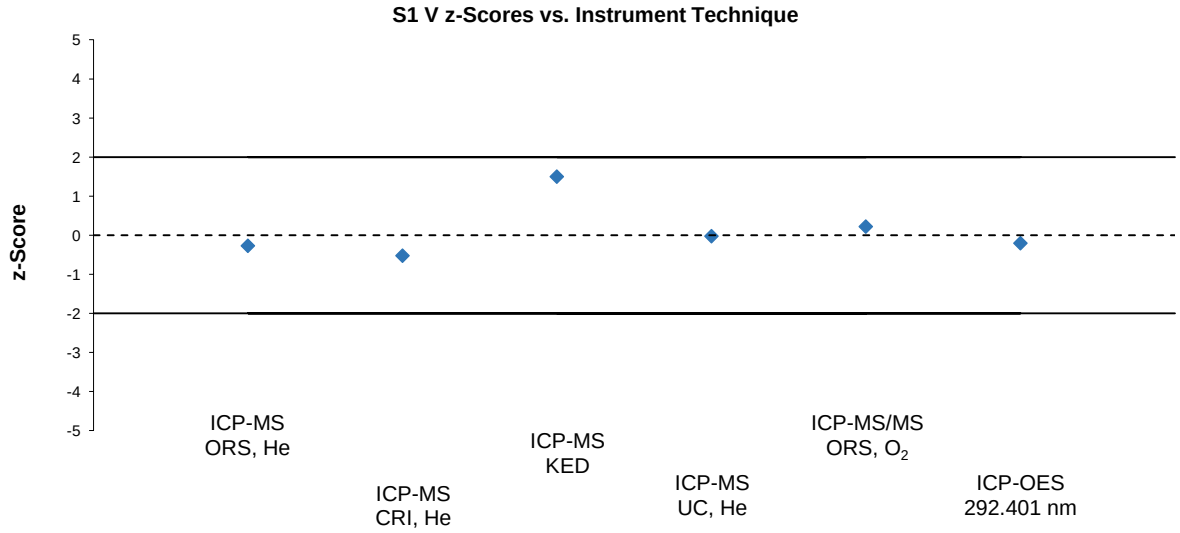


Figure 92 S1 V z-Scores vs Instrument Technique

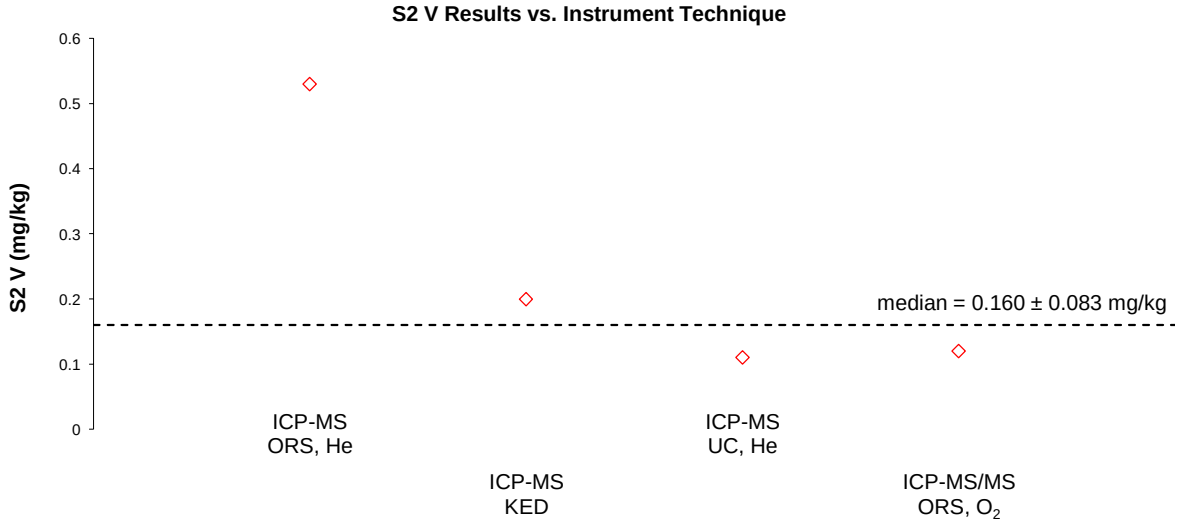


Figure 93 S2 V Results vs Instrument Technique

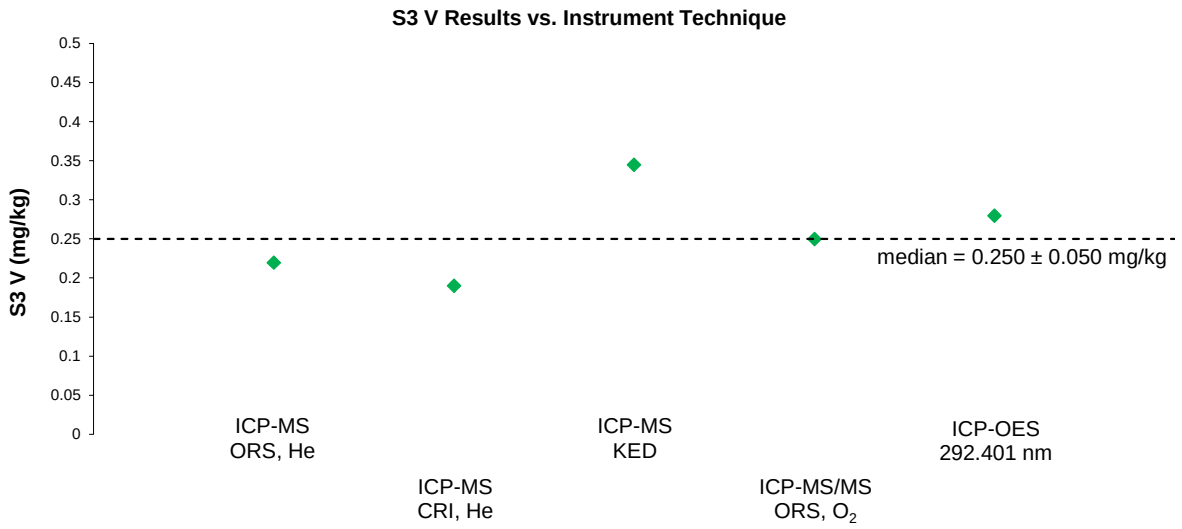


Figure 94 S3 V Results vs Instrument Technique

Arsenic results for Sample S1 and S2 were in excellent agreement with each other and with the homogeneity value.

Arsenic level in the cinnamon was below the reporting limit for 4 of the 8 laboratories that tested this sample. Three numerical results, reported by Laboratories **4**, **10**, and **12**, were in reasonable agreement with each other and the information value. Laboratory **11** reported using ICP-MS/MS in reaction mode for measurement of low level As in Sample S3. Caution should be exercised when measuring elements at very low level in MS/MS mode. The use of MS/MS mode as opposed to single-quad mode will cause a sensitivity decrease of approximately 30%. Figure 95 presents the results reported for As in Sample S3 versus instrument technique used.

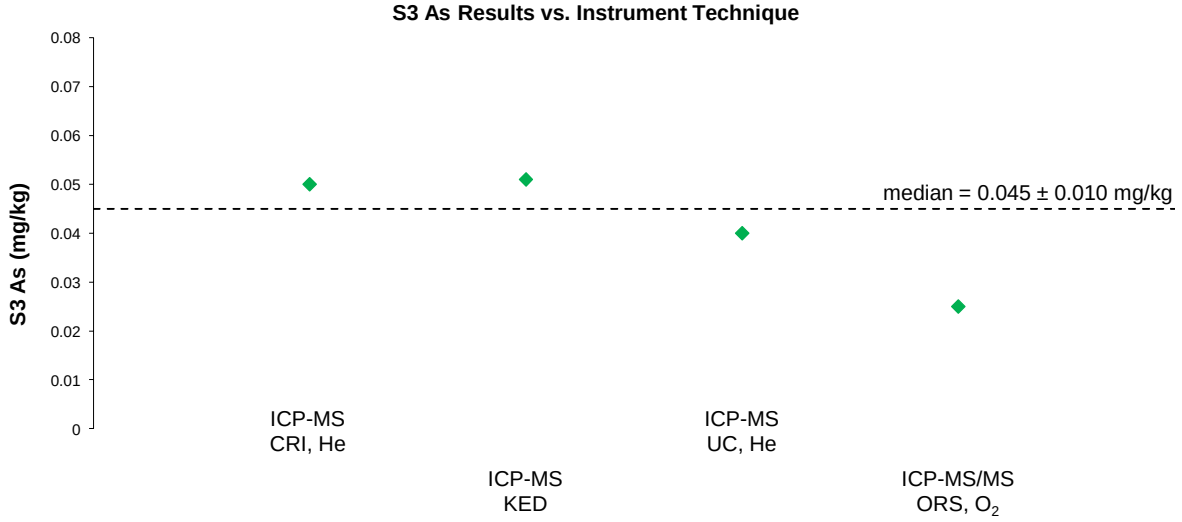


Figure 95 S3 As Results vs Instrument Technique

Inorganic Arsenic Only two participants, Laboratories 4 and 8, reported results for inorganic As in Sample S2. Figure 96 presents the plot of participants' results and the information value versus method used. The results were in reasonably good agreement with each other and the information value.

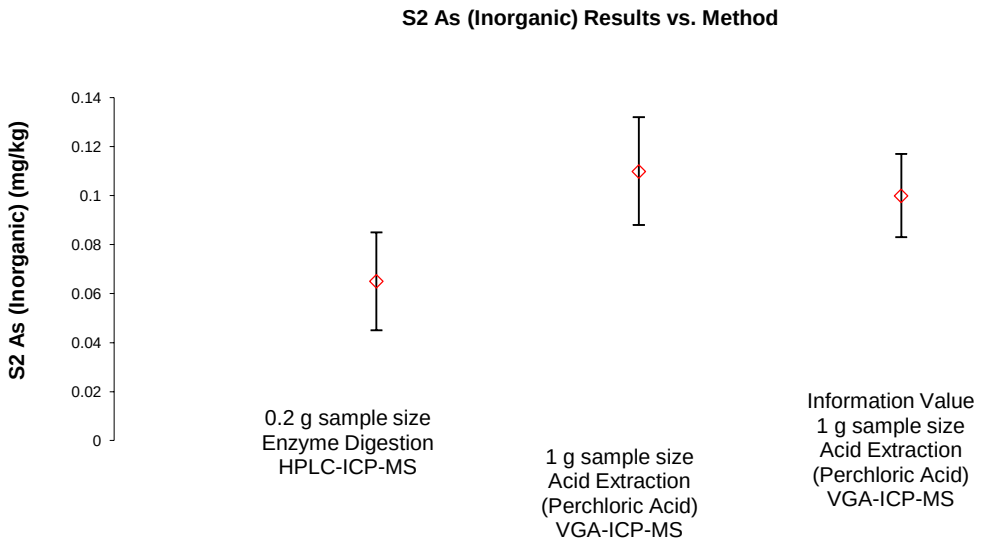


Figure 96 S2 As (Inorganic) Results vs Method

Boron and **Beryllium** Only five results were reported for B in Sample S3 and Be in Sample S1. Four participants used ICP-MS for determination of these elements, while one used ICP-OES-AV. All reported results were in excellent agreement with each other.

Bismuth Only four results were reported for Bi in Sample S1. All results were in excellent agreement with each other (centred on a value of 0.274 mg/kg), as well as the homogeneity value. All participants reported using ICP-MS.

Mercury Participants used a wide variety of techniques for Hg measurements in Samples S1 and S2, and most produced compatible results.

ICP-MS in collision mode was the most popular technique. One participant reported using ICP-OES with vapor-generating accessory (VGA). Of the two results reported using this technique one (for Sample S2) returned an acceptable z-score. The Hg concentration in Sample S1 was 0.251 mg/kg; however, in the digestion solution this concentration may have fallen outside the optimal operating range of this technique.

A plot of participants' results for Hg in S1 and S2 versus instrumental technique used is presented in Figure 97.

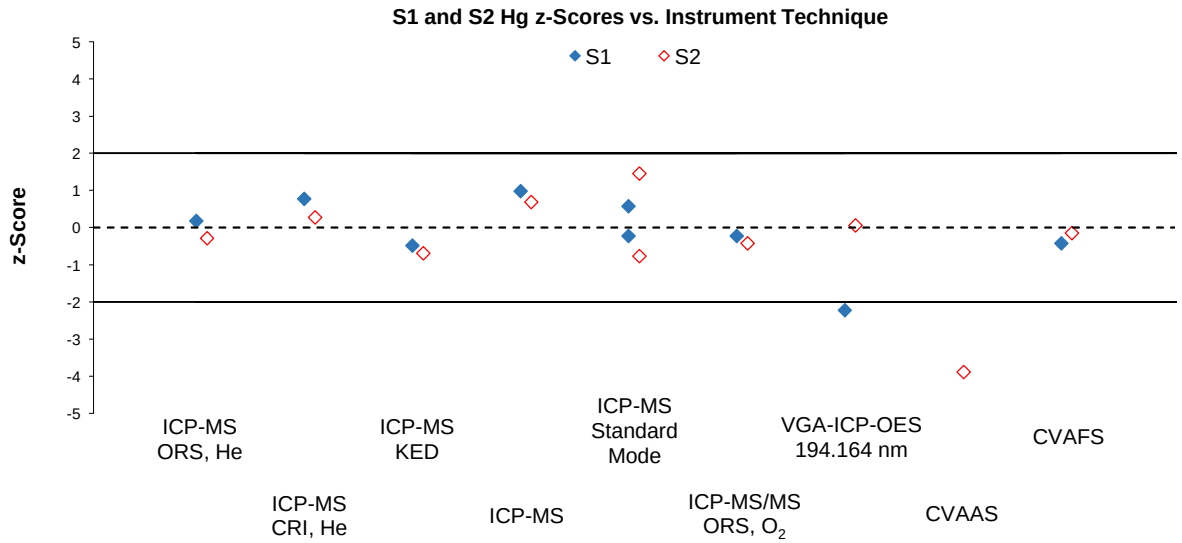


Figure 97 S1 and S2 Hg z-Scores vs Instrument Technique

Iodine (Total) Only two results were reported for total iodine in Sample S2. Both results were in excellent agreement with each other and the information value.

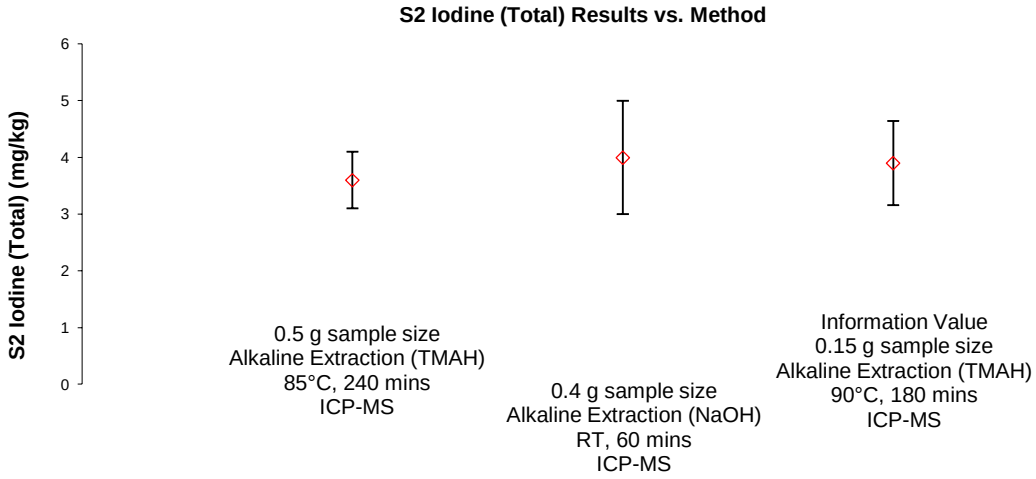


Figure 98 S2 Iodine (Total) Results vs Method

Lanthanum A limited number of laboratories measure La in food, with only 2 laboratories reporting results in Sample S2. The results were in good agreement with each other (0.045 mg/kg and 0.05 mg/kg). Both participants used ICP-MS.

Lithium Only five results were reported for Li in Sample S1. All results were in excellent agreement with each other and homogeneity value. All participants reported using ICP-MS.

Calcium, Magnesium, Potassium, and **Sodium** Measurements for Ca, Mg, K, and Na did not challenge participants' analytical techniques, with between-laboratory CVs ranging from 3% to 10%.

Plots of participants' performance for K and Na in the study samples are presented in Figures 99 and 100. ICP-OES-AV with 766 nm wavelength was the preferred analytical technique for K measurements. For the measurement of Na, most participants used ICP-OES-AV with a wavelength of 589 nm. Concentrations much higher than the true values are frequently obtained for these two tests when measurements are made by ICP-OES with axial view plasma without an ionisation buffer or correction equation. This might explain the high result reported for Na in Samples S1 and S3.

Only five results were reported for Na in Sample S3. The results reported by Laboratories **4**, **10**, **11**, and **12**, were in excellent agreement with each other (Figure 101).

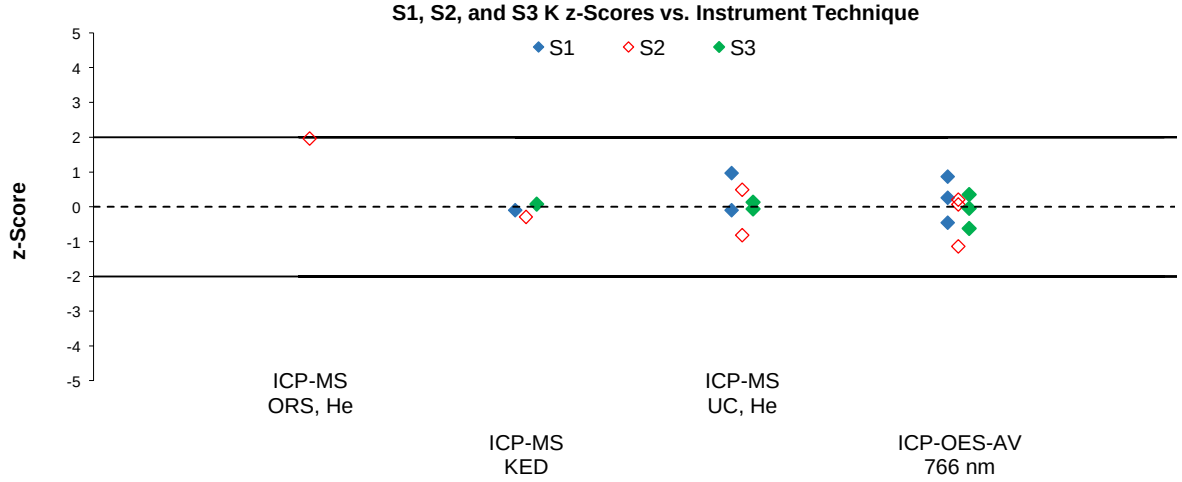


Figure 99 S1, S2 and S3 K z-Scores vs Instrument Technique

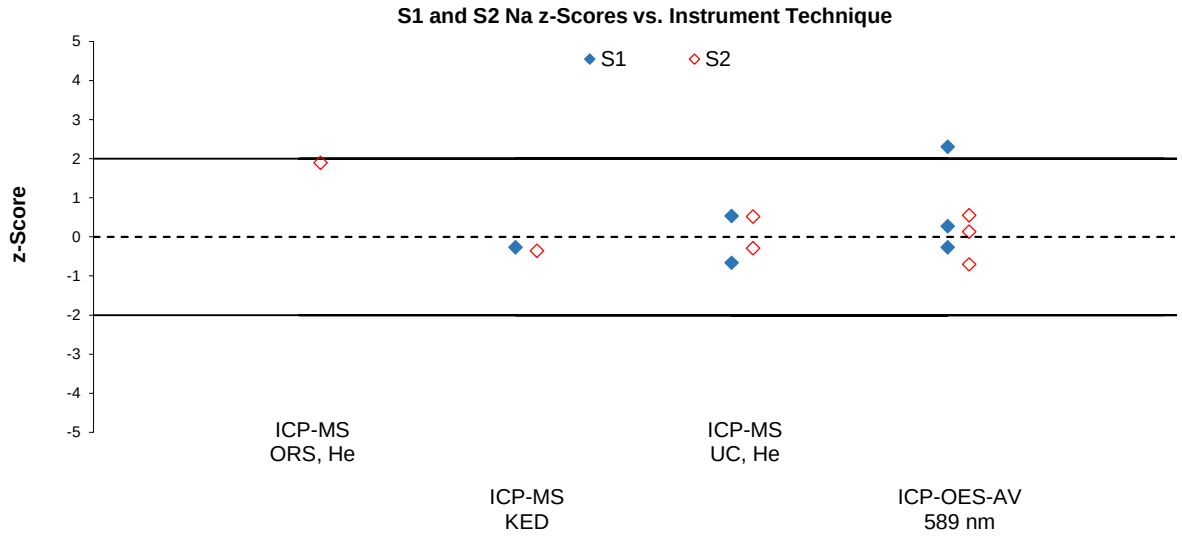


Figure 100 S1 and S2 Na z-Scores vs Instrument Technique

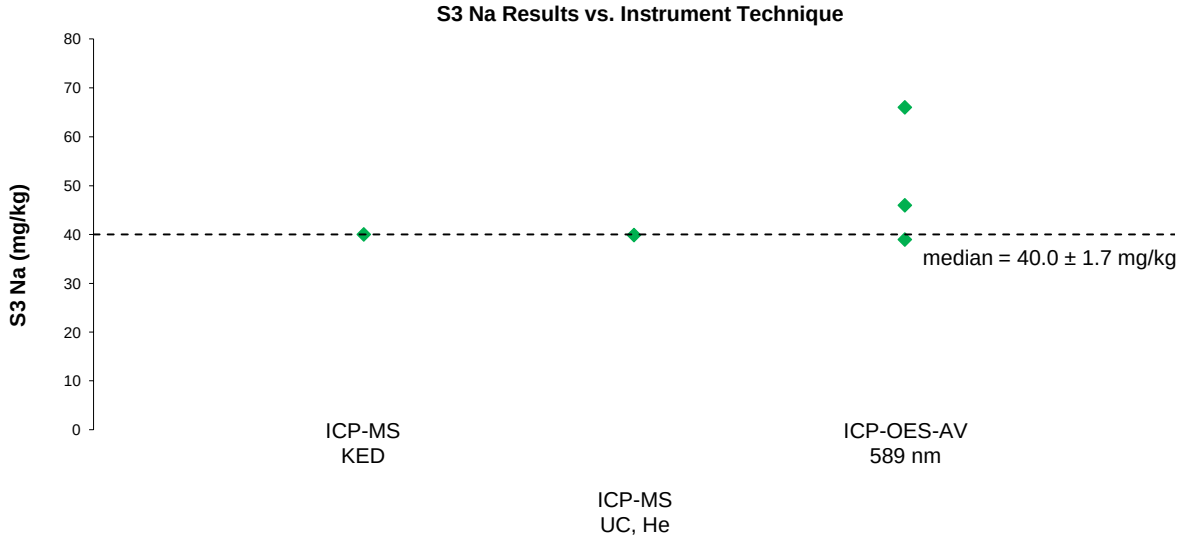


Figure 101 S3 Na Results vs Instrument Technique

Lead concentration in the seafood biota Sample S2 was 0.374 mg/kg. The FSANZ maximum level is set at 0.5 mg/kg for fish and 2 mg/kg for molluscs.[17] Laboratories **3**, **5**, and **7** all had a limit of reporting of 1 mg/kg; these participants may need to review their reporting limits, as these may not be sufficiently low to allow assessment of compliance with the relevant guideline requirements for this type of sample (particularly for fish matrix).

Only five results were reported for Pb in Sample S3. All results were in excellent agreement with each other, centred on the value of 0.490 mg/kg. Four participants reported using ICP-MS, and one participant used ICP-MS/MS instead.

Silver was present in Sample S2, with only four participants reporting results. Results reported by Laboratories **1**, **6**, and **8** were in good agreement with each other, and with the homogeneity value.

The result reported by Laboratory **4** was approximately 1.5 times greater than the consensus value and homogeneity value. This participant should consider checking the validity of their standards, as silver standards are photosensitive and can easily precipitate when expose to light, even for short periods of time. This instability increases with higher silver concentration.[18]

Rubidium Only a limited number of laboratories analysed rubidium (Rb) in the food samples. Three results were reported for Sample S1, and 4 for Sample S2. For each sample, all results were in excellent agreement with one another and with the corresponding homogeneity value. All laboratories reported the use of ICP-MS for the determination of Rb.

Sulphur Five results were reported for S in Sample S3. All results were in excellent agreement with each other (centred on a value of 900 mg/kg). Two participants reported using ICP-OES-AV, and two participants reported using ICP-MS instead.

Antimony No assigned value could be set for Sb in Sample S2 because the results were too few and too variable. The results reported by Laboratories **4**, **8**, **10**, **11**, and **12** were in excellent agreement with each other and the homogeneity value. Five participants reported using ICP-MS, and one used ICP-MS/MS.

Selenium was one of the more challenging analytes for participants' analytical techniques across all three samples.

Apart from the known spectral interreferences (Ar_2^+ and $ArCl^+$), matrix effects can also hamper accurate measurement of elements in food samples when complete digestion cannot be achieved. Matrix effects are common in food analyses using ICP-MS; they take place in the plasma and consist of signal enhancement caused by charge transfer reactions from charged carbon species to atoms like Se with a lower ionization potential.[19]

Plots of participants' performance versus instrumental technique for Se in Samples S1 and S2 are presented in Figure 102. ICP-MS in collision mode was the preferred measurement technique. One participant reported using ICP-OES with 196 nm wavelength. They returned an acceptable result.

Selenium in Sample S3 was present at a very low level, with a median value of 0.034 mg/kg. Only three participants reported numeric results. Two used ICP-MS in collision mode and one ICP-MS/MS with O_2 (Figure 103).

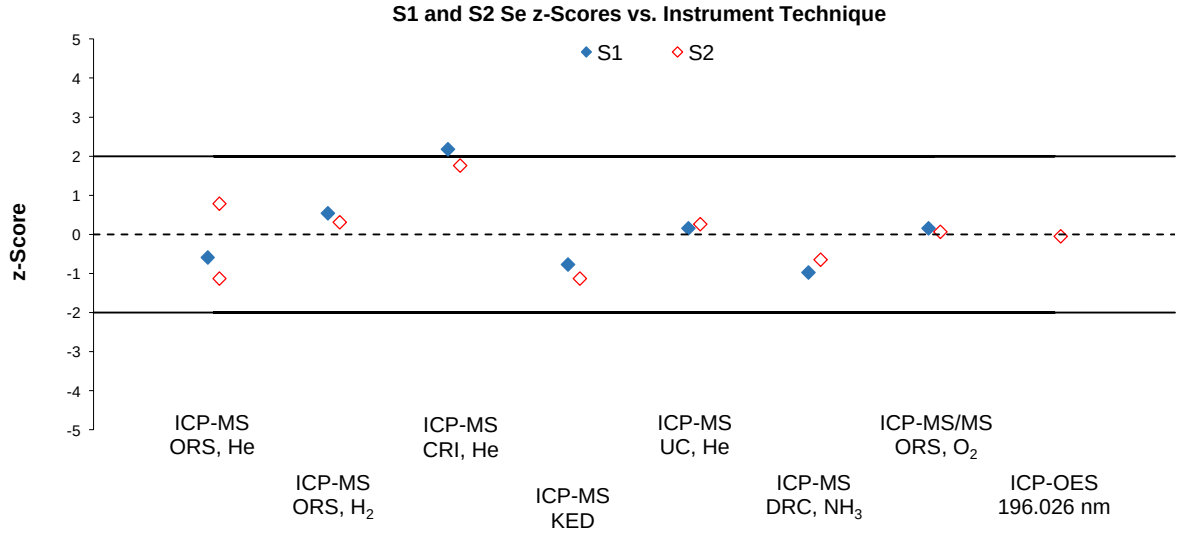


Figure 102 S1 and S2 Se z-Scores vs Instrument Technique

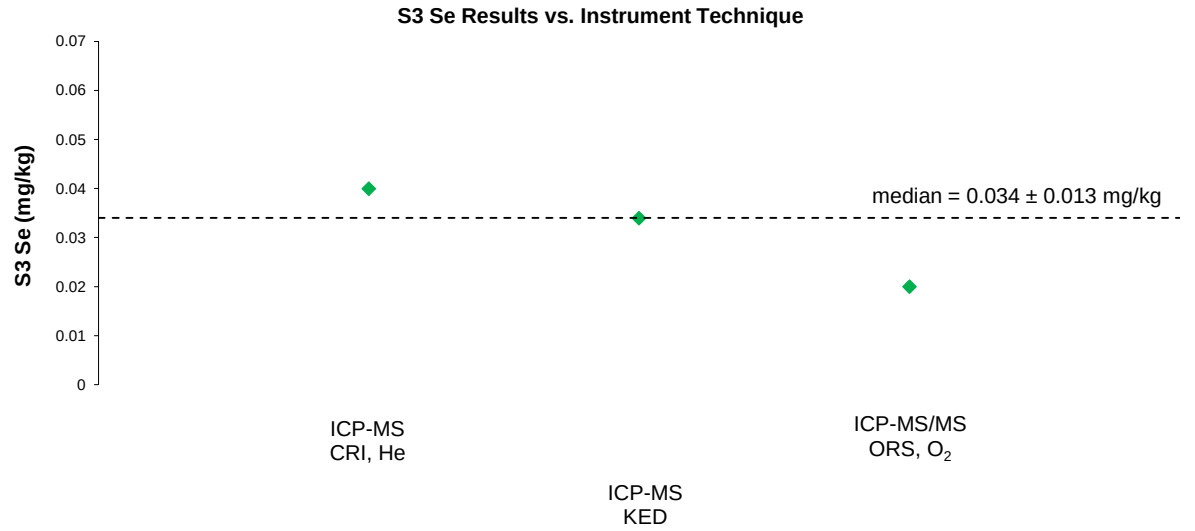


Figure 103 S3 Se Results vs Instrument Technique

Tin Only four results were reported for Sn in Sample S2. The results reported by Laboratories **4**, **8**, and **12** were in excellent agreement with each other, as well as the homogeneity value. All participants reported using ICP-MS.

Laboratories **4** and **12** were the only two participants to report results for Sn in Sample S3. These two results were in agreement with one another within their stated uncertainties.

Thallium Only five results were reported for Tl in Sample S1. All results were in excellent agreement with each other (centred on a value of 0.270 mg/kg), as well as the homogeneity value. All participants reported using ICP-MS.

Uranium level in Sample S2 was low, and only two laboratories reported results: Laboratories **8** and **10**. The results were in relatively good agreement with each other and the homogeneity value.

Total Kjeldahl Nitrogen (TKN), **Total Organic Carbon (TOC)**, and **Ash**

Three results were reported for TKN in Sample S1 and were in excellent agreement with each other (centred on a value of 20100 mg/kg). All three participants used different measurement methods (Figure 104).

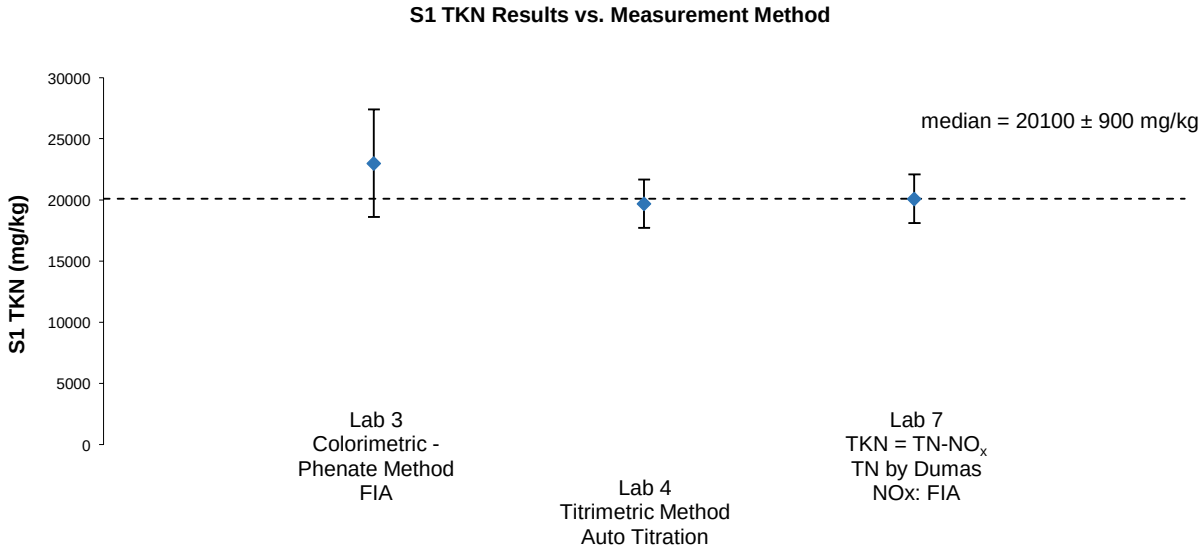


Figure 104 S1 TKN Results vs Method

Only two laboratories reported results for TOC in Sample S1. Laboratory **3** reported a result of 420,000 mg/kg and Laboratory **7** reported a result of 329,000 mg/kg. Both participants used high temperature oxidation as measurement method.

Ash Laboratory **4** was the only participant to report a result for ash (6,900 mg/kg). They followed method reference AOAC 923.03.

6.6 Effects of Sample Matrix

A higher proportion of numeric results were reported by participants for Sample S2 seafood biota tests as compared to the other matrices. However, performance across the different food samples were similar, with an excellent proportion of results returning acceptable z-scores for all matrices (Table 90).

Table 90 Performance for Each Sample

Sample	Number of Expected Results	Numeric Results Reported (% of expected number of results)	z-Scores Calculated (% of numeric results reported)	Acceptable z-Scores (% of z-Scores Calculated)
S1 Wheat Flour	330	194 (59%)	161 (83%)	156 (97%)
S2 Seafood Biota	341	222 (65%)	185 (83%)	182 (98%)
S3 Cinnamon	200	111 (56%)	63 (57%)	63 (100%)

6.7 Comparison with the Previous Proficiency Studies of Toxic and Essential Elements in Food

AQA 26-01 is the seventeenth NMIA PT study of elements in food. Laboratories' performance in the measurement of elements in food samples remain high even with challenging matrices in this study, and still reflect an improvement as compared to studies prior to 2023.

Over time laboratories should expect at least 95% of their scores to be $|z| \leq 2.0$. Scores in the range $2.0 < |z| \leq 3.0$ occasionally can occur, however these should be interpreted in conjunction with the other scores obtained by that laboratory. For example, a trend of z-scores on one side of the zero line are an indication of method or laboratory bias.

Individual performance history reports are emailed to each participant at the end of the study; the consideration of z-scores for an analyte over time provides much more useful information than a single z-score.

Participants' performance in measurements of trace elements in food over time is presented in Figure 105.

6.8 Reference Materials and Certified Reference Materials

Proficiency testing and matrix matched control samples taken through all steps of the analytical process are highly valuable quality control tools for assessing extraction efficiency. Control samples used by participants in this study are presented in Table 91.

Table 91 Control Samples Used by Participants

Lab. Code	Description of Control Samples
1	SS, CRM
2	SS, CRM: NIST2976
3	Reference Material / Ex PT Sample
4	SS
5	SS, CRM, Reference Material / Ex PT Sample

Lab. Code	Description of Control Samples
6	Reference Material / Ex PT Sample
7	CRM: BRAN 1, DORM 5 and TORT 3
8	CRM
9	SS, CRM
10	SS
11	SS
12	CRM: NIST 3233, NMIJ 7503-b

Some laboratories reported using certified reference materials. These materials may not meet the internationally recognised definition of a Certified Reference Material:

> *'a reference material, accompanied by documentation issued by an authoritative body and providing one or more specified property values with associated uncertainties and traceabilities, using valid procedures'*[20]

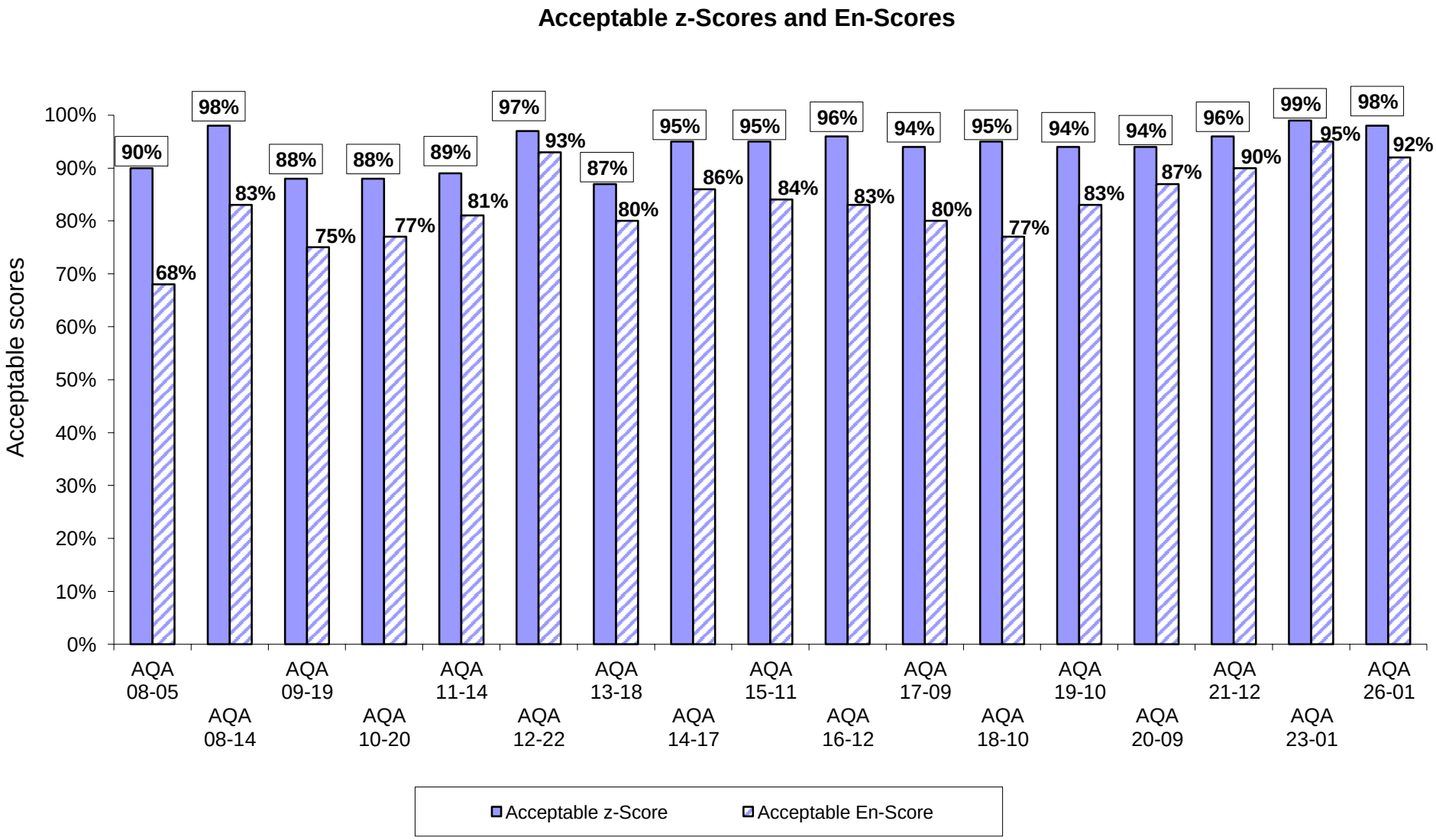


Figure 105 Participants' Performance over Time

7 REFERENCES

Note: For all undated references, the latest edition of the referenced document (including any amendments) applies.

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APPENDIX 1 - SAMPLE PREPARATION, ANALYSIS AND HOMOGENEITY TESTING

A1.1 Sample Preparation

Sample S1: Wheat flour used for Sample S1 preparation was a previously prepared reference material. The material was freeze-dried, mixed, and divided into 20 g portions.

Sample S2: Multiple types of freeze-dried seafood biota—55% prawn, 22% finfish, 5% crab meat, 2% mollusc, 7% shark, 3% seaweed, and 6% oyster—were ground, sieved using the same mesh size, and then combined. The resulting mixture was dispensed into portions of 10 g each.

Sample S3: Cinnamon bought from a local supermarket was mixed and divided into 5 g portions.

A1.2 Sample Analysis and Homogeneity Testing

The same sample procedure was followed for the preparation of Samples S1, S2, and S3 as in previous NMIA PT studies. Only a partial homogeneity test was conducted for elements of interest in Samples S1 and S2, except for Ca and S in S1, and Cr, La, and Ni in S2. Three bottles were analysed in duplicate, and the average of the results was reported as the homogeneity value. Measurements were made under repeatability conditions in random order.

Values for inorganic As and total iodine in S2, and all analytes in S3 except for Al, Ca, Cr, Fe, S, Se, and V, were also determined from duplicate analyses on one or two samples. The average of the results is presented in the current report for information purposes only as information value.

Sample Analysis for Total Elements in Samples S1, S2, and S3

Sample analyses were completed by the CRV section of NMIA. A test portion of approximately 0.5 g of each sample was digested by microwave digester at 260ºC for 1 hour with 3 mL of concentrated HNO_3 and 1 mL of concentrated HCl. After digestion, each sample was diluted to 40 mL with ultra-high purity water and further diluted as necessary for ICP-MS determination.

The measurement instrument was calibrated using external standards for targeted analytes. A set of quality control samples consisting of blanks, blank matrix spike, matrix matched reference materials, duplicates and sample matrix spikes, were carried through the same set of procedures and analysed at the same time as the samples. A summary of the instruments used, and the ions monitored for each analyte is given in Table 92.

Table 92 Instrumental Techniques Used for Total Elements in S1, S2, and S3

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/ Gas (if applicable)	Final Dilution Factor	Ion
Ag	ICP-MS	Rh	ORS	He	160	107 m/z
Al	ICP-MS	Rh	NA	NA	160	27 m/z
As	ICP-MS	Rh	ORS	He	160	75 m/z
B	ICP-MS	Rh	NA	NA	160	11 m/z
Ba	ICP-MS	Rh	ORS	He	160	134 m/z
Be	ICP-MS	Rh	NA	NA	160	9 m/z
Bi	ICP-MS	Ir	ORS	He	160	209 m/z
Ca	ICP-MS	Rh	ORS	He	160	43 m/z
Cd	ICP-MS	Rh	ORS	He	160	111 m/z

Analyte	Instrument	Internal Standard	Reaction/ Collision Cell (if applicable)	Cell Mode/ Gas (if applicable)	Final Dilution Factor	Ion
Co	ICP-MS	Rh	ORS	He	160	59 m/z
Cr	ICP-MS	Rh	ORS	He	160	52 m/z
Cu	ICP-MS	Rh	ORS	He	160	63 m/z
Fe	ICP-MS	Rh	ORS	He	160	56 m/z
Hg	ICP-MS	Ir	ORS	He	160	202 m/z
K	ICP-MS	Rh	ORS	He	160	39 m/z
Li	ICP-MS	Rh	ORS	He	160	7 m/z
Mg	ICP-MS	Rh	ORS	He	160	24 m/z
Mn	ICP-MS	Rh	ORS	He	160	55 m/z
Mo	ICP-MS	Rh	ORS	He	160	95 m/z
Na	ICP-MS	Rh	ORS	He	160	23 m/z
Ni	ICP-MS	Rh	NA	NA	160	60 m/z
P	ICP-MS	Rh	ORS	HEHe	160	31 m/z
Pb	ICP-MS	Ir	ORS	He	160	Average of 206, 207, 208 m/z
Rb	ICP-MS	Rh	ORS	He	160	85 m/z
Sb	ICP-MS	Rh	ORS	He	160	121 m/z
Se	ICP-MS	Rh	ORS	HEHe	160	78 m/z
Sn	ICP-MS	Rh	ORS	He	160	118 m/z
Sr	ICP-MS	Rh	ORS	He	160	88 m/z
Tl	ICP-MS	Rh	ORS	He	160	205 m/z
U	ICP-MS	Ir	ORS	He	160	238 m/z
V	ICP-MS	Rh	ORS	He	160	51 m/z
Zn	ICP-MS	Rh	ORS	He	160	64 m/z

Sample S2 Inorganic Arsenic

Inorganic arsenic in Sample S2 was analysed by the Inorganics Section of the NMIA Analytical Services Branch using method NT 2.56.[21] The method involves perchloric acid extraction followed by determination using ICP-MS.

Sample S2 Total Iodine

The information value for total iodine in Sample S2 was produced by the NMIA Analytical Services Branch, Food and Health Chemistry Section, using method VL 345.[22] The method involved an alkaline extraction with TMAH followed by determination using ICP-MS.

APPENDIX 2 - ASSIGNED VALUE, z-SCORE AND E_N-SCORE CALCULATION

A2.1 Assigned Value

The assigned value was calculated as the robust average using the procedure described in ISO 13528.[6] The uncertainty was evaluated as:

$$u_{rob\ av} = 1.25 * S_{rob\ av} / \sqrt{p} \qquad \text{Equation 4}$$

where:

$u_{rob\ av}$ robust average standard uncertainty

$S_{rob\ av}$ robust average standard deviation

p number of results

The expanded uncertainty ($U_{rob\ av}$) is the standard uncertainty multiplied by a coverage factor of 2 at approximately 95% confidence level.

A worked example is set out below in Table 93.

Table 93 Uncertainty of Assigned Value for As in Sample S1

No. results (p)	6
Robust Average	0.285 mg/kg
$S_{rob\ av}$	0.043 mg/kg
$u_{rob\ av}$	0.022 mg/kg
k	2
$U_{rob\ av}$	0.044 mg/kg

The assigned value for **As** in Sample S1 is **0.285 ± 0.044 mg/kg**.

A2.2 z-Score and E_n-Score

For each participant's result a z-score and E_n-score are calculated according to Equation 2 and Equation 3 respectively (see Section 4).

A worked example is set out below in Table 94.

Table 94 z-Score and E_n-score for As result reported by Laboratory 10 in S1

As Result mg/kg	Assigned Value mg/kg	Standard Deviation for Proficiency Assessment	z-Score	E_n-Score
0.26 ± 1.11	0.285 ± 0.044	15% as PCV or 0.15 x 0.285= 0.04275 mg/kg	$z = \frac{(0.26 - 0.285)}{0.04275}$ z = -0.58	$En = \frac{(0.26 - 0.285)}{\sqrt{1.11^2 + 0.044^2}}$ E_n = -0.02

APPENDIX 3 - ACRONYMS AND ABBREVIATIONS

AV	Assigned Value
CRI	Collision Reaction Interface
CRM	Certified Reference Material
CV	Coefficient of Variation
FSANZ	Food Standards Australia New Zealand
GAG	General Accreditation Guidance (NATA)
GUM	Guide to the Expression of Uncertainty in Measurement
HEHe	High energy helium
HV	Homogeneity Value
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
ICP-MS/MS	Inductively Coupled Plasma – Tandem Mass Spectrometry
ICP-OES-AV	Inductively Coupled Plasma – Optical Emission Spectrometry- axial view
ICP-OES-AV-buffer	Inductively Coupled Plasma – Optical Emission Spectrometry- axial view with buffer
ICP-OES-RV	Inductively Coupled Plasma – Optical Emission Spectrometry- radial view
ISO/IEC	International Organisation for Standardisation / International Electrotechnical Commission
IV	Information Value
KED	Kinetic Energy Discrimination
Max	Maximum value in a set of results
Md	Median
Min	Minimum value in a set of results
MU	Measurement Uncertainty
N	Number of Participants
NA	Not Available
NATA	National Association of Testing Authorities, Australia
NIST	National Institute of Standards and Technology
NMIA	National Measurement Institute (Australia)
NR	Not Reported
NT	Not Tested
ORS	Octopole Reaction System
PCV	Performance Coefficient of Variation
PT	Proficiency Testing
RA	Robust Average
RM	Reference Material
SD	Standard Deviation
SDPA	Standard Deviation for Proficiency Assessment (symbol: σ)
SI	The International System of Units
SS	Spiked Samples
TKN	Total Kjeldahl Nitrogen
TMAH	Tetramethylammonium hydroxide
TOC	Total Organic Carbon
UC	Universal Cell
VGA	Vapor-Generating Accessory

APPENDIX 4 - INSTRUMENT DETAILS

Table 95 Instrument Conditions for Al in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	237.312
4	ICP-MS	Rh/Ge/Ir				
7	ICP-MS	Sc	UC	He	312.5	27
8	ICP-OES-AV	Y			2	167/396
10	ICP-MS	Sc	Standard Mode		100	
12	ICP-MS	45Sc		He	50	

Table 96 Instrument Conditions for As in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		75
3	ICP-OES-AV-buffer	Lu			100	188.98
4	ICP-MS	Rh/Ge/Ir				
7	ICP-MS	Rh	UC	He	312.5	75
8	ICP-MS	Rh/Sc			2	75
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2		
12	ICP-MS	73Ge		He	50	

Table 97 Instrument Conditions for Be in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	313.107
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	234.861
7	ICP-MS	Sc	Standard Mode	Standard Mode	312.5	9
8	ICP-MS	Rh/Sc			2	9
10	ICP-MS	Sc	Standard Mode		100	
12	ICP-MS	45Sc		He	50	

Table 98 Instrument Conditions for Bi in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
7	ICP-MS	Ir	Standard Mode	Standard Mode	312.5	209
8	ICP-MS	Rh/Sc			2	209
10	ICP-MS	Ir	Standard Mode		100	
12	ICP-MS	193Ir		He	50	

Table 99 Instrument Conditions for Ca in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	422.673
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	44
8	ICP-OES-AV	Y			2	317/422
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-RV	Eu			80	317.933
12	ICP-MS	45Sc		He	50	

Table 100 Instrument Conditions for Cd in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		111
3	ICP-OES-AV-buffer	Lu			100	214.44
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	228.802
7	ICP-MS	Rh	Standard Mode	Standard Mode	312.5	111
8	ICP-MS	Rh/Sc			2	111
10	ICP-MS	Rh	Standard Mode		100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 101 Instrument Conditions for Co in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		59
3	ICP-OES-AV-buffer	Lu			100	228.615
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	228.615
7	ICP-MS	Ge	UC	He	312.5	59
8	ICP-MS	Rh/Sc			2	59
10	ICP-MS	Rh	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 102 Instrument Conditions for Cr in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		52
3	ICP-OES-AV-buffer	Lu			100	267.717
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	267.716
7	ICP-MS	Sc	UC	He	312.5	52
8	ICP-MS	Rh/Sc			2	52
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 103 Instrument Conditions for Cu in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		63
3	ICP-OES-AV-buffer	Lu			100	327.397
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	327.395
7	ICP-MS	Ge	UC	He	312.5	63
8	ICP-OES-AV	Rh/Sc			2	327
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	He	80	
12	ICP-MS	73Ge		He	50	

Table 104 Instrument Conditions for Fe in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	238.204
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	259.94
7	ICP-MS	Sc	UC	He	312.5	56
8	ICP-OES-AV	Y			2	238
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 105 Instrument Conditions for Hg in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS					202
3	VGA-ICP-OES				100	194.164
4	ICP-MS	Rh/Ge/Ir				
5	CVAFS	None	NA	NA	1	254
7	ICP-MS	Ir	Standard Mode	Standard Mode	312.5	201
8	ICP-MS	Rh/Sc			2	201
10	ICP-MS	Ir	Standard Mode		100	
11	ICP-MS/MS	Ir	ORS	O2	80	
12	ICP-MS	193Ir		He	50	

Table 106 Instrument Conditions for K in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Rh/Ge/Ir				
7	ICP-MS	Sc	UC	He	312.5	39
8	ICP-OES-AV	Y			2	766
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-AV	In			80	766.491
12	ICP-MS	45Sc		He	50	

Table 107 Instrument Conditions for Li in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
7	ICP-MS	Sc	Standard Mode	Standard Mode	312.5	7
8	ICP-MS	Rh/Sc			2	7
10	ICP-MS	Sc	Standard Mode		100	
12	ICP-MS	45Sc		He	50	

Table 108 Instrument Conditions for Mg in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	279.078
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	25
8	ICP-OES-AV	Y			2	279
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-RV	In			80	285.213
12	ICP-MS	45Sc		He	50	

Table 109 Instrument Conditions for Mn in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	H2		55
3	ICP-OES-AV-buffer	Lu			100	257.61
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	293.931
7	ICP-MS	Sc	UC	He	312.5	55
8	ICP-OES-AV	Y			2	293
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 110 Instrument Conditions for Mo in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		95
3	ICP-OES-AV-buffer	Lu			100	202.032
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	202.032
7	ICP-MS	Rh	Standard Mode	Standard Mode	312.5	95
8	ICP-MS	Rh/Sc			2	95
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 111 Instrument Conditions for Na in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	23
8	ICP-OES-AV	Y			2	589
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-AV	In			80	589.592
12	ICP-MS	45Sc		He	50	

Table 112 Instrument Conditions for Ni in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		60
3	ICP-OES-AV-buffer	Lu			100	227.021
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	231.604
7	ICP-MS	Ge	UC	He	312.5	60
8	ICP-MS	Rh/Sc			2	60
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 113 Instrument Conditions for P in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	213.618
4	ICP-OES-AV	Te/Y				
5	ICP-OES-AV	Y 371.029	NA	NA	1	213.618
7	ICP-MS	Sc	UC	He	312.5	31
8	ICP-OES-AV	Y			2	213
10	ICP-MS	Sc	UC	He	100	
12	ICP-MS	45Sc		He	50	

Table 114 Instrument Conditions for Pb in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS					208
3	ICP-OES-AV-buffer	Lu			100	220.353
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	220.353
7	ICP-MS	Ir	Standard Mode	Standard Mode	312.5	206+207+208
8	ICP-MS	Rh/Sc			2	208
10	ICP-MS	Ir	Standard Mode		100	
11	ICP-MS/MS	Ir	ORS	O2	80	
12	ICP-MS	193Ir		He	50	

Table 115 Instrument Conditions for Rb in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
8	ICP-MS	Rh/Sc			2	85
10	ICP-MS	Rh	Standard Mode		100	

Table 116 Instrument Conditions for S in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Te/Y				
7	LECO					
8	ICP-OES-AV	Y			2	181
10	ICP-MS	Sc	UC	He	100	
12	ICP-MS	45Sc		He	50	

Table 117 Instrument Conditions for Sb in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		121
3	ICP-OES-AV-buffer	Lu			100	206.834
4	ICP-MS	Rh/Ge/Ir				
7	ICP-MS	Rh	Standard Mode	Standard Mode	312.5	121
8	ICP-MS	Rh/Sc			2	121
10	ICP-MS	Rh	Standard Mode		100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 118 Instrument Conditions for Se in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	H2		78
3	ICP-OES-AV-buffer	Lu			100	196.026
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	196.026
7	ICP-MS	Rh	DRC	NH3	312.5	82
8	ICP-MS	Rh/Sc			2	78
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 119 Instrument Conditions for Tl in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	190.794
4	ICP-MS	Rh/Ge/Ir				
7	ICP-MS	Ir	Standard Mode	Standard Mode	312.5	205
8	ICP-MS	Rh/Sc			2	205
9	ICP-MS	Rh, Lu -VIS	ORS	He	50	205
10	ICP-MS	Ir	Standard Mode		100	

Table 120 Instrument Conditions for V in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		51
3	ICP-OES-AV-buffer	Lu			100	292.401
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	311.837
7	ICP-MS	Sc	UC	He	312.5	51
8	ICP-MS	Rh/Sc			2	51
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 121 Instrument Conditions for Zn in S1

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-OES-AV					213.857
3	ICP-OES-AV-buffer	Lu			100	206.2
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	213.857
7	ICP-MS	Ge	UC	He	312.5	66
8	ICP-OES-AV	Y			2	213
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 122 Methodology for TKN in S1

Lab. Code	Method Reference (eg USEPA No.)	Test Method: Digestion	Test Method: Distillation	Test Method: Other	Measurement Method	Instrument	Additional Information
3	Total N by Kjeldahl digestion and FIA	Yes	No		Colorimetric - Phenate Method	FIA	
4	AS 2300.1.2.1	Yes	Yes		Titrimetric Method	Kjeldahl Instrument	
7					TKN = TN-NOx (Dumas)	LECO	LECO for TN and FIA for NOX

Table 123 Methodology for TOC in S1

Lab. Code	Method Reference (eg USEPA No.)	Test Method	Measurement Technique	Additional Information
3	Inhouse	High Temperature Oxidation	Infrared Gas Analysis	
7		High Temperature Oxidation	LECO	

Table 124 Instrument Conditions for Ag in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	328.068
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Rh	ORS	He	25	107
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	109
8	ICP-MS	Rh/Sc			2	107
10	ICP-MS				100	

Table 125 Instrument Conditions for Al in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	237.312
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Sc	ORS	He	25	27
7	ICP-MS	Sc	UC	He	625	27
8	ICP-OES-AV	Y			2	167/396
10	ICP-MS	Sc			100	
12	ICP-MS	45Sc		He	50	

Table 126 Instrument Conditions for As (Total) in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		75
3	ICP-OES-AV-buffer	Lu			100	188.98
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	188.98
6	ICP-MS	Sc	ORS	He	25	75
7	ICP-MS	Rh	UC	He	625	75
8	ICP-MS	Rh/Sc			2	75
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 127 Methodology for As (Inorganic) in S2

Lab. Code	Method Reference (eg USEPA No.)	Extraction Method	Sample Size (g)	Reagents Used	Determination Technique	Wavelength or Absorbance (nm) / Ion (m/z) - if applicable	Additional Information
4		Emzyme Digestion	0.2		HPLC-ICP-MS		
12		Solvent Extraction	0.5	Water, Ethanol	HPLC-HG-AFS		

Table 128 Instrument Conditions for Ba in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-OES-AV					455.403
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	233.527
6	ICP-MS	Sc	ORS	He	25	137
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	138
8	ICP-MS	Rh/Sc			2	137
10	ICP-MS	In			100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 129 Instrument Conditions for B in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Ir	ORS	He	25	11
7	ICP-MS	Sc	Standard Mode	Standard Mode	625	10
8	ICP-OES-AV	Y			2	249
10	ICP-MS	Sc			100	
12	ICP-MS	45Sc		He	50	

Table 130 Instrument Conditions for Ca in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	422.673
4	ICP-OES-AV	Te/Y				
6	ICP-MS	Sc	ORS	He	25	44
7	ICP-MS	Sc	UC	He	625	44
8	ICP-OES-AV	Y			2	317/422
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-RV	Eu			80	317.933
12	ICP-MS	45Sc		He	50	

Table 131 Instrument Conditions for Cd in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		111
3	ICP-OES-AV-buffer	Lu			100	214.44
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	228.802
6	ICP-MS	Sc	ORS	He	25	111
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	111
8	ICP-MS	Rh/Sc			2	111
10	ICP-MS	Rh			100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 132 Instrument Conditions for Co in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		59
3	ICP-OES-AV-buffer	Lu			100	228.615
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	228.615
6	ICP-MS	Sc	ORS	He	25	59
7	ICP-MS	Ge	UC	He	625	59
8	ICP-MS	Rh/Sc			2	59
10	ICP-MS	Rg	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 133 Instrument Conditions for Cr in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		52
3	ICP-OES-AV-buffer	Lu			100	267.717
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	267.716
6	ICP-MS	Sc	ORS	He	25	52
7	ICP-MS	Sc	UC	He	625	52
8	ICP-MS	Rh/Sc			2	52
10	ICP-MS	Sc	UC	He	100	
12	ICP-MS	45Sc		He	50	

Table 134 Instrument Conditions for Cu in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		63
3	ICP-OES-AV-buffer	Lu			100	327.397
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	327.395
6	ICP-MS	Sc	ORS	He	25	63
7	ICP-MS	Ge	UC	He	625	63
8	ICP-OES-AV	Y			2	327
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	He	80	
12	ICP-MS	73Ge		He	50	

Table 135 Instrument Conditions for Fe in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	238.204
4	ICP-OES-AV	Te/Y				
5	ICP-OES-AV	Y 371.029	NA	NA	1	259.94
6	ICP-MS	Sc	ORS	He	25	56
7	ICP-MS	Sc	UC	He	625	56
8	ICP-OES-AV	Y			2	238
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 136 Instrument Conditions for Hg in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS					202
3	VGA-ICP-OES				100	194.164
4	ICP-MS	Rh/Ge/Ir				
5	CVAFS	None	NA	NA	1	254
6	CVAAS	N\A		NA	25	253.7
7	ICP-MS	Ir	Standard Mode	Standard Mode	625	201
8	ICP-MS	Rh/Sc			2	201
10	ICP-MS	Ir			100	
11	ICP-MS/MS	Ir	ORS	O2	80	
12	ICP-MS	193Ir		He	50	

Table 137 Methodology for Iodine (Total) in S2

Lab. Code	Method Reference (eg USEPA No.)	Extraction Method	Sample Size (g)	Extraction Reagents	Extraction Temperature (ºC)	Extraction Time (min)	Determination Technique	Wavelength or Absorbance (nm) / Ion (m/z) - if applicable	Additional Information
4		Alkaline extraction	0.5	TMAH	85	240	ICP-MS		
7		Alkaline extraction	0.4	NaOH	Room temperature	60	ICP-MS	127	

Table 138 Instrument Conditions for K in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Sc	ORS	He	25	39
7	ICP-MS	Sc	UC	He	625	39
8	ICP-OES-AV	Y			2	766
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-AV	In			80	766.491
12	ICP-MS	45Sc		He	50	

Table 139 Instrument Conditions for La in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Ir	ORS	He	25	139
8	ICP-MS	Rh/Sc			2	139
10	ICP-MS	Ir			100	

Table 140 Instrument Conditions for Mg in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	279.078
4	ICP-OES-AV	Te/Y				
6	ICP-MS	Sc	ORS	He	25	24
7	ICP-MS	Sc	UC	He	625	25
8	ICP-OES-AV	Y			2	279
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-RV	In			80	285.213
12	ICP-MS	45Sc		He	50	

Table 141 Instrument Conditions for Mn in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	257.61
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	293.931
6	ICP-MS	Sc	ORS	He	25	55
7	ICP-MS	Sc	UC	He	625	55
8	ICP-OES-AV	Y			2	293
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 142 Instrument Conditions for Mo in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	202.032
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	202.032
6	ICP-MS	Rh	ORS	He	25	95
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	95
8	ICP-MS	Rh/Sc			2	95
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 143 Instrument Conditions for Na in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Te/Y				
6	ICP-MS	Sc	ORS	He	25	23
7	ICP-MS	Sc	UC	He	625	23
8	ICP-OES-AV	Y			2	589
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-AV	In			80	589.592
12	ICP-MS	45Sc		He	50	

Table 144 Instrument Conditions for Ni in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		60
3	ICP-OES-AV-buffer	Lu			100	227.021
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	231.604
6	ICP-MS	Sc	ORS	He	25	65
7	ICP-MS	Ge	UC	He	625	60
8	ICP-MS	Rh/Sc			2	60
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 145 Instrument Conditions for P in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	213.618
4	ICP-OES-AV	Te/Y				
5	ICP-OES-AV	Y 371.029	NA	NA	1	213.618
6	ICP-OES-AV	Eu		NA	25	185.8
7	ICP-MS	Sc	UC	He	625	31
8	ICP-OES-AV	Y			2	213
10	ICP-MS	Sc	UC	He	100	
12	ICP-MS	45Sc		He	50	

Table 146 Instrument Conditions for Pb in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS					208
3	ICP-OES-AV-buffer	Lu			100	220.353
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	220.353
6	ICP-MS	Ir	ORS	He	25	208
7	ICP-MS	Ir	Standard Mode	Standard Mode	625	206+207+208
8	ICP-MS	Rh/Sc			2	208
10	ICP-MS	Ir			100	
11	ICP-MS/MS	Ir	DRC	O2	80	
12	ICP-MS	193Ir		He	50	

Table 147 Instrument Conditions for Rb in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Rh	ORS	He	25	85
8	ICP-MS	Rh/Sc			2	85
10	ICP-MS	Rh			100	

Table 148 Instrument Conditions for Sb in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		121
3	ICP-OES-AV-buffer	Lu			100	206.834
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Rh	ORS	He	25	121
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	121
8	ICP-MS	Rh/Sc			2	121
10	ICP-MS	Rh			100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 149 Instrument Conditions for Se in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	H2		78
3	ICP-OES-AV-buffer	Lu			100	196.026
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	196.026
6	ICP-MS	Sc	ORS	He	25	78
7	ICP-MS	Rh	DRC	NH3	625	82
8	ICP-MS	Rh/Sc			2	78
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 150 Instrument Conditions for Sn in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	189.925
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Rh	ORS	He	25	118
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	118
8	ICP-MS	Rh/Sc			2	118
10	ICP-MS	Rh			100	
12	ICP-MS	115In		He	50	

Table 151 Instrument Conditions for Sr in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	407.771
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Rh	ORS	He	25	88
7	ICP-MS	Rh	Standard Mode	Standard Mode	625	88
8	ICP-OES-AV	Rh/Sc			2	430
10	ICP-MS	Rh			100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 152 Instrument Conditions for U in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ge/Ir				
6	ICP-MS	Ir	ORS	He	25	238
7	ICP-MS	Ir	Standard Mode	Standard Mode	625	238
8	ICP-MS	Rh/Sc			2	238
10	ICP-MS	Ir			100	

Table 153 Instrument Conditions for V in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-MS		ORS	He		51
3	ICP-OES-AV-buffer	Lu			100	292.401
4	ICP-MS	Rh/Ge/Ir				
5	ICP-OES-AV	Y 371.029	NA	NA	1	311.837
6	ICP-MS	Sc	ORS	He	25	51
7	ICP-MS	Sc	UC	He	625	51
8	ICP-MS	Rh/Sc			2	51
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 154 Instrument Conditions for Zn in S2

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
2	ICP-OES-AV					213.857
3	ICP-OES-AV-buffer	Lu			100	206.2
4	ICP-OES-AV	Te/Y				
5	ICP-OES-AV	Y 371.029	NA	NA	1	213.857
6	ICP-MS	Sc	ORS	He	25	66
7	ICP-MS	Ge	UC	He	625	66
8	ICP-OES-AV	Y			2	213
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 155 Instrument Conditions for Al in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	237.312
4	ICP-MS	Rh/Ir/Ge				
7	ICP-MS	Sc	UC	He	312.5	27
8	ICP-OES-AV	Y	NA		2	167/396
10	ICP-MS	Sc			100	
12	ICP-MS	45Sc		He	50	

Table 156 Instrument Conditions for As in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	188.98
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	188.98
7	ICP-MS	Rh	UC	He	312.5	75
8	ICP-MS	Rh/Sc	ORS		2	75
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 157 Instrument Conditions for B in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-MS	Rh/Ir/Ge				
7	ICP-MS	Sc	Standard Mode	Standard Mode	312.5	10
8	ICP-OES-AV	Y	NA		2	249
10	ICP-MS	Sc			100	
12	ICP-MS	45Sc		He	50	

Table 158 Instrument Conditions for Ca in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	422.673
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	44
8	ICP-OES-AV	Y	NA		2	317/422
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-RV	Eu			80	317.933
12	ICP-MS	45Sc		He	50	

Table 159 Instrument Conditions for Cd in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	214.44
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	228.802
7	ICP-MS	Rh	Standard Mode	Standard Mode	312.5	111
8	ICP-MS	Rh/Sc	ORS		2	111
10	ICP-MS	Rh			100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	115In		He	50	

Table 160 Instrument Conditions for Cr in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	267.717
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	267.716
7	ICP-MS	Sc	UC	He	312.5	52
8	ICP-MS	Rh/Sc	ORS		2	52
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 161 Instrument Conditions for Cu in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	327.397
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	327.395
7	ICP-MS	Ge	UC	He	312.5	63
8	ICP-OES-AV	Y	NA		2	327
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	He	80	
12	ICP-MS	73Ge		He	50	

Table 162 Instrument Conditions for Fe in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	238.204
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	259.94
7	ICP-MS	Sc	UC	He	312.5	56
8	ICP-OES-AV	Y	NA		2	238
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 163 Instrument Conditions for K in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	39
8	ICP-OES-AV	Y	NA		2	766
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-AV	In			80	766.491
12	ICP-MS	45Sc		He	50	

Table 164 Instrument Conditions for Mg in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	279.078
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	25
8	ICP-OES-AV	Y	NA		2	279
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-RV	In			80	285.213
12	ICP-MS	45Sc		He	50	

Table 165 Instrument Conditions for Mn in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	257.61
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	293.931
7	ICP-MS	Sc	UC	He	312.5	55
8	ICP-OES-AV	Y	NA		2	293
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 166 Instrument Conditions for Na in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Te/Y				
7	ICP-MS	Sc	UC	He	312.5	23
8	ICP-OES-AV	Y	NA		2	589
10	ICP-MS	Sc	UC	He	100	
11	ICP-OES-AV	In			80	589.592
12	ICP-MS	45Sc		He	50	

Table 167 Instrument Conditions for Ni in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	227.021
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	231.604
7	ICP-MS	Ge	UC	He	312.5	60
8	ICP-MS	Rh/Sc	ORS		2	60
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 168 Instrument Conditions for P in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	213.618
4	ICP-OES-AV	Te/Y				
5	ICP-OES-AV	Y 371.029	NA	NA	1	213.618
7	ICP-MS	Sc	UC	He	312.5	31
8	ICP-OES-AV	Y	NA		2	213
10	ICP-MS	Sc	UC	He	100	
12	ICP-MS	45Sc		He	50	

Table 169 Instrument Conditions for Pb in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	220.353
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	220.353
7	ICP-MS	Ir	Standard Mode	Standard Mode	312.5	206+207+208
8	ICP-MS	Rh/Sc	ORS		2	208
10	ICP-MS	Ir			100	
11	ICP-MS/MS	Ir	ORS	O2	80	
12	ICP-MS	193Ir		He	50	

Table 170 Instrument Conditions for S in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
4	ICP-OES-AV	Te/Y				
7	LECO					
8	ICP-OES-AV	Y	NA		2	181
10	ICP-MS	Sc	UC	He	100	
12	ICP-MS	45Sc		He	50	

Table 171 Instrument Conditions for Se in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	196.026
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	196.026
7	ICP-MS	Rh	DRC	NH3	312.5	82
8	ICP-MS	Rh/Sc	ORS		2	78
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

Table 172 Instrument Conditions for Sn in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	189.925
4	ICP-MS	Rh/Ir/Ge				
7	ICP-MS	Rh	Standard Mode	Standard Mode	312.5	118
8	ICP-MS	Rh/Sc	ORS		2	118
10	ICP-MS	Rh			100	
12	ICP-MS	115In		He	50	

Table 173 Instrument Conditions for V in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	292.401
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	311.837
7	ICP-MS	Sc	UC	He	312.5	51
8	ICP-MS	Rh/Sc	ORS		2	51
10	ICP-MS	Sc	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	45Sc		He	50	

Table 174 Instrument Conditions for Zn in S3

Lab. Code	Instrument	Internal standard	Reaction Collision Cell	Cell Gas	Final Dilution Factor	Wavelength (nm)/ Ion(m/z)/ Absorbance (nm)
3	ICP-OES-AV-buffer	Lu			100	206.2
4	ICP-MS	Rh/Ir/Ge				
5	ICP-OES-AV	Y 371.029	NA	NA	1	213.857
7	ICP-MS	Ge	UC	He	312.5	66
8	ICP-OES-AV	Y	NA		2	213
10	ICP-MS	Ga	UC	He	100	
11	ICP-MS/MS	Rh	ORS	O2	80	
12	ICP-MS	73Ge		He	50	

END OF REPORT