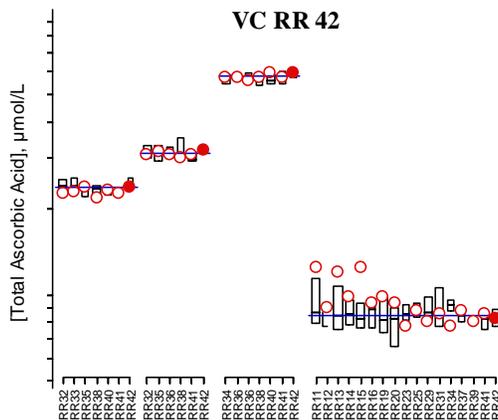
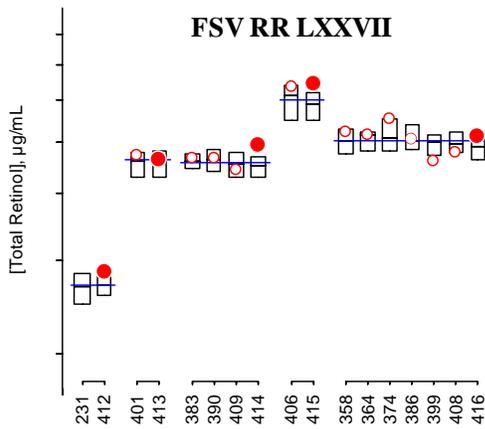


NIST Micronutrients Measurement Quality Assurance Program Winter 2015 Comparability Studies

Results for Round Robin LXXVII
Fat-Soluble Vitamins and Carotenoids in Human Serum
and Round Robin 42 Ascorbic Acid in Human Serum

David L. Duewer
Jeanice B. Thomas

This publication is available free of charge from:
<http://dx.doi.org/10.6028/NIST.IR.7880-45>



NISTIR 7880-45

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Quality Assurance Program
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David L. Duewer
Jeanice B. Thomas
*Chemical Sciences Division
Materials Measurement Laboratory*

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July 2016



U.S. Department of Commerce
Penny Pritzker, Secretary

National Institute of Standards and Technology
Willie E. May, Under Secretary of Commerce for Standards and Technology and Director

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Abstract

The National Institute of Standards and Technology coordinates the Micronutrients Measurement Quality Assurance Program (MMQAP) for laboratories that measure fat- and water-soluble vitamins and carotenoids in human serum and plasma. This report describes the design of and results for the Winter 2015 MMQAP measurement comparability improvement studies: 1) Round Robin LXXVII Fat-Soluble Vitamins and Carotenoids in Human Serum and 2) Round Robin 42 Total Ascorbic Acid in Human Serum. The materials for both studies were shipped to participants in January 2015. To help reduce overhead costs and avoid raising participation fees, the materials for Round Robin LXXVIII Fat-Soluble Vitamins and Carotenoids in Human Serum and Round Robin 43 Total Ascorbic Acid in Human Serum were also shipped in the same shipping container. Participants in Round Robins LXXVII and 42 were requested to provide measurement results by May 18, 2015.

Keywords

Human Serum

Retinol, α -Tocopherol, γ -Tocopherol, Total and *Trans*- β -Carotene
Total Ascorbic Acid

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Introduction

Beginning in 1984, the National Institute of Standards and Technology (NIST) has coordinated the Micronutrients Measurement Quality Assurance Program (MMQAP) for laboratories that measure fat- and water-soluble vitamins and carotenoids in human serum and plasma. The MMQAP provides participants with measurement comparability assessment through use of interlaboratory studies, Standard Reference Materials (SRMs) and control materials, and methods development and validation. Serum-based samples with assigned values for the target analytes (retinol, alpha-tocopherol, gamma/beta-tocopherol, *trans*- and total beta-carotene, and total ascorbic acid) and performance-evaluation standards are distributed by NIST to laboratories for analysis.

Participants use the methodology of their choice to determine analyte content in the control and study materials. Participants provide their data to NIST, where it is compiled and evaluated for trueness relative to the NIST value, within-laboratory precision, and concordance within the participant community. NIST provides the participants with a technical summary report concerning their performance for each exercise and suggestions for methods development and refinement. Participants who have concerns regarding their laboratory's performance are encouraged to consult with the MMQAP coordinators.

All MMQAP interlaboratory studies consist of individual units of batch-prepared samples that are distributed to each participant. For historical reasons these studies are referred to as "Round Robins". The MMQAP program and the nature of its studies are described elsewhere. [1,2]

Round Robin LXXVII: Fat-Soluble Vitamins and Carotenoids in Human Serum

Participants in the MMQAP Fat-Soluble Vitamins and Carotenoids in Human Serum Round Robin LXXVII comparability study (hereafter referred to as RR77) received one lyophilized and four liquid-frozen human serum test samples for analysis. Unless multiple vials were previously requested, participants received one vial of each serum. These sera were shipped on dry ice to participants in January 2015 in the same shipping package as the Round Robin LXXVIII (RR78) samples but in a separately labeled plastic bag. Participants were requested to provide measurement results by May 18, 2015. The communication materials included in the sample shipment are provided in Appendix A.

Participants are requested to report values for all fat-soluble vitamin-related analytes that are of interest to their organizations. Not all participants report values for the target analytes, and many participants report values for non-target analytes.

The final report delivered to every participant in RR77 consists of three documents:

- A cover letter for the current study, a brief description of the other two documents, and a discussion of our analysis of the overall results that may be of broad interest. This cover letter is reproduced as Appendix B.
- The "All-Lab Report" that lists all of the reported measurement results, a number of consensus statistics for analytes reported by more than one participant, and the mean median and pooled SD from any prior distributions of the serum. This report also provides a

numerical “score card” for each participant’s measurement comparability for the more commonly reported analytes. This All-Lab Report is reproduced as Appendix C.

- An “Individualized Report” that graphically analyzes each participant’s results for all analytes reported by at least five participants. This report also provides a graphical summary of their measurement comparability. The graphical tools used in the Individualized Report are described in detail elsewhere [3]. An example Individualized Report is reproduced as Appendix D.

Round Robin 42: Vitamin C in Human Serum

Participants in the MMQAP Vitamin C in Human Serum Round Robin 42 comparability study (hereafter referred to as RR42) received four frozen serum test samples and two frozen control sera. Unless multiple vials were previously requested, participants received one vial of each material. These materials were shipped on dry ice to participants in January 2015 in the same shipping package as the Round Robin 43 (RR43) samples but in a separately labeled plastic bag. Participants were requested to provide measurement results by May 18, 2015. The communication materials included in the sample shipment are provided in Appendix E.

The test and control serum materials were prepared by adding equal volumes of 10 % metaphosphoric acid (MPA) to human serum that had been spiked with ascorbic acid. While these samples contain some dehydroascorbic acid, its content is variable. Therefore, the participants report only total ascorbic acid (TAA, ascorbic acid plus dehydroascorbic acid).

The final report delivered to every participant in RR42 consists of three documents:

- A cover letter for the current study, a brief description of the other two documents, and a discussion of our analysis of overall results that may be of broad interest. This cover letter is reproduced as Appendix F.
- The “All-Lab Report” that summarizes all of the reported measurement results and provides several consensus statistics. This All-Lab Report is reproduced as Appendix G.
- An “Individualized Report” that graphically analyzes each participant’s results for TAA, including a graphical summary of their measurement comparability. The graphical tools used in the Individualized Report are described in detail elsewhere [3]. An example Individualized Report is reproduced as Appendix H.

References

- 1 Duewer DL, Brown Thomas J, Kline MC, MacCrehan WA, Schaffer R, Sharpless KE, May WE, Crowell JA. NIST/NCI Micronutrients Measurement Quality Assurance Program: Measurement Repeatabilities and Reproducibilities for Fat-Soluble Vitamin-Related Compounds in Human Sera. *Anal Chem* 1997;69(7):1406-1413.
- 2 Margolis SA, Duewer DL. Measurement Of Ascorbic Acid in Human Plasma and Serum: Stability, Intralaboratory Repeatability, and Interlaboratory Reproducibility. *Clin Chem* 1996;42(8):1257-1262.
- 3 Duewer DL, Kline MC, Sharpless KE, Brown Thomas J, Gary KT, Sowell AL. Micronutrients Measurement Quality Assurance Program: Helping Participants Use Interlaboratory Comparison Exercise Results to Improve Their Long-Term Measurement Performance. *Anal Chem* 1999;71(9):1870-1878.

Appendix A. Shipping Package Inserts for RR77

The following three items were included in each package shipped to an RR77 participant:

- Cover letter
- Datasheet
- Packing List and Shipment Receipt Confirmation Form

The RR77 samples were packed in a sealed waterproof bag and labeled:

NIST MMQAP-FSV: RR LXXVII
Micronutrients Measurement Fat-Soluble Vitamins
Quality Assurance Program
Winter 2015 Samples
Results due on or before:
May 18, 2015

A cover letter describing both RR77 and RR78, datasheets for both studies, and packing lists for both studies were enclosed in a sealed waterproof bag placed at the top of the shipping box, between the cardboard covering and the foam insulation.



February 13, 2015

Dear Colleague:

Enclosed are samples for the fat-soluble vitamins and carotenoids in serum studies for the 2015 NIST Micronutrients Measurement Quality Assurance Program. Sample details are provided below.

<u>Comparability study/Round Robin (RR)</u>	<u>Sample description</u>	<u>Results due</u>
RR77	Sera 412 - 416	May 18, 2015
RR78	Sera 417 - 421	September 1, 2015

RR77 consists of one vial of lyophilized serum and one vial each of four liquid-frozen serum samples for analysis; RR78 consists of four liquid-frozen serum samples. Samples should be stored in the dark at or below -20°C upon receipt. A form for each study is also included for reporting your results. When reporting your results, please submit one value for each analyte for each serum sample. If a value obtained is below your limit of quantification, please indicate this result on the form as "nq" (*Not Quantified*) or " $<x$ " where x is your established limit of quantification. Results are due to NIST for each study as indicated above. Results received more than two weeks after the due date may not be included in the summary report for this round robin study. The feedback report concerning each study will be distributed in June and October 2015, respectively. Please contact us immediately if this schedule is problematic for your laboratory.

Samples should be allowed to stand at room temperature under subdued light until thawed. We recommend that sample mixing be facilitated with 3 to 5 min agitation in an ultrasonic bath or at least 15 min at room temperature with intermittent swirling. (CAUTION: Vigorous shaking will cause foaming and possibly interfere with accurate measurement. The rubber stopper contains phthalate esters that may leach into the sample upon intermittent contact of the liquid sample with the stopper. These esters absorb strongly in the UV region and elute near retinol in most LC systems creating analytical problems.) **Water should not be added to the liquid-frozen samples.**

For consistency, we request that laboratories use the following absorptivities ($\text{dL/g} \cdot \text{cm}$): retinol, 1843 at 325 nm (ethanol); retinyl palmitate, 975 at 325 nm (ethanol); α -tocopherol, 75.8 at 292 nm (ethanol); γ -tocopherol, 91.4 at 298 nm (ethanol); α -carotene, 2800 at 444 nm (hexane); β -carotene, 2560 at 450 nm (ethanol), 2592 at 452 nm (hexane); and lycopene, 3450 at 472 nm (hexane).

Please report your results by e-mail to david.duewer@nist.gov or fax to 301-977-0685. If you have questions or comments regarding the studies, please contact us at 301-975-3120 (Jeanice); jbthomas@nist.gov or 301-975-3935 (Dave); david.duewer@nist.gov.

Sincerely,

Jeanice B. Thomas, M.B.A.
Research Chemist
Chemical Sciences Division
Material Measurement Laboratory

David L. Duewer, Ph.D.
Research Chemometrician
Chemical Sciences Division
Material Measurement Laboratory

Enclosure

Participant #: _____

Date: _____

Round Robin LXXVII: Human Sera
NIST Micronutrients Measurement Quality Assurance Program

Analyte	412	413	414	415	416	Units*
total retinol						
trans-retinol						
retinyl palmitate						
α-tocopherol						
γ/β-tocopherol						
δ-tocopherol						
total β-carotene						
trans-β-carotene						
total cis-β-carotene						
total α-carotene						
total lycopene						
trans-lycopene						
total β-cryptoxanthin						
total α-cryptoxanthin						
total lutein						
total zeaxanthin						
total lutein&zeaxanthin						
total coenzyme Q10						
ubiquinol (QH ₂)						
ubiquinone (Qox)						
phylloquinone (K ₁)						
25-hydroxyvitamin D						
Phytoene						
Phytofluene						

* We prefer µg/mL

Were the samples frozen when received? Yes | No

Comments:

Mail: M²QAP
 NIST, Stop 8392
 Gaithersburg, MD 20899-8392

Please return results by
18-May-2015

Fax: 301-977-0685
 Email: David.Duewer@NIST.gov

This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.IR.7880-45>

Participant #: _____

Date: _____

Fat-Soluble Vitamins Round Robin LXXVII
NIST Micronutrients Measurement Quality Assurance Program

Packing List and Shipment Receipt Confirmation Form

This box contains: one vial each of the following five FSV M²QAP sera

Serum	Form	Reconstitute?	Vial/Cap
#412	Lyophilized	Yes	2 mL amber / red
#413	Liquid frozen	No	5 mL clear / silver
#414	Liquid frozen	No	2 mL amber / gold
#415	Liquid frozen	No	2 mL amber / green
#416	Liquid frozen	No	3 mL amber / blue

- Please**
- 1) Open the pack immediately
 - 2) Check that it contains all of the above samples
 - 3) Check if the vials are intact
 - 4) Store the sera at -20 °C or below until analysis
 - 5) Email (david.duewer@nist.gov) or fax (301-977-0685) us the following information:

1) Date this shipment arrived: _____

2) Are all five sera vials intact? Yes | No
If "No", which one(s) were damaged?

3) Was there any dry-ice left in cooler? Yes | No

4) Did the samples arrive frozen? Yes | No

5) At what temperature are you storing the serum samples? _____ °C

6) When do you anticipate analyzing these samples? _____

Your prompt return of this information is appreciated.

The M²QAP Gang

Mail: M²QAP
NIST, Stop 8392
Gaithersburg, MD 20899-8392

Please return results by
1-Sep-2015

Fax: 301-977-0685
Email: David.Duewer@NIST.gov

Appendix B. Final Report for RR77

The following four pages are the final report for RR77 as provided to all participants:

- Cover letter.
- An information sheet that:
 - describes the contents of the “All-Lab” report,
 - describes the content of the “Individualized” report,
 - describes the nature of the test samples and details their previous distributions, if any, and
 - summarizes aspects of the study that we believe may be of interest to the participants.

June 15, 2015



UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-8390

Dear Colleague:

Enclosed is the summary report of the results for “Round Robin” LXXVII (RR77) of the 2015 NIST Micronutrients Measurement Quality Assurance Program (MMQAP) for the fat-soluble vitamins and carotenoids in human serum. Included in this report are: 1) a summary of data and measurement comparability scores for all laboratories, 2) a detailed graphical analysis of your results; and 3) a graphical summary of your measurement comparability. RR77 (Sera 412 to 416) consisted of one vial of lyophilized serum and one vial each of four liquid-frozen serum samples. Details regarding the samples can be found in the enclosed report.

Your overall measurement comparability is summarized in the “Score Card” summary, page 6 of the All Lab Report. Combined results rated 1 to 3 are within 1 to 3 standard deviations of the assigned value, respectively; those rated 4 are >3 standard deviations from the assigned value. Similar information is presented graphically in the “target plots” that are the last page of your Individualized Report. If you have concerns regarding your laboratory’s performance, please contact us for consultation.

The results for fat-soluble vitamins and carotenoids in serum “Round Robin” RLXXVIII (RR78) and vitamin C in serum RR43 are due on or before **September 1, 2015**. We will send you a reminder in July. If you have questions or concerns regarding this report, please contact David Duewer at 301-975-3935; e-mail: david.duewer@nist.gov or me at 301-975-3120; e-mail: jbthomas@nist.gov; or fax: 301-977-0685.

Sincerely,

Jeanice Brown Thomas, M.B.A.
Research Chemist
Chemical Sciences Division
Material Measurement Laboratory

David L. Duewer, Ph.D.
Research Chemometrician
Chemical Sciences Division
Material Measurement Laboratory

Enclosures

Cc: Roger D. van Zee

The NIST MMQAP Round Robin LXXVII (RR77) report consists of:

Page	All-Lab Report
1-4	A listing of all results and statistics for analytes reported by more than one participant.
5	The legend for the list of results and statistics.
6	The text Comparability Summary (“Score Card”) of measurement performance.
Page	Individualized Report
1	Your values, the number of labs reporting values, and our assigned values.
2 to n	“Four Plot” summaries of your current and past measurement performance, one page for each analyte you report that is also reported by at least eight other participants.
n+1	The graphical Comparability Summary (target plot) of measurement performance.

Samples. Five samples were distributed to each participant in RR77.

Serum	Description	Prior Distributions
412	Experimental serum prepared in 1996 from a “low” single-donor pool augmented with many analytes in an attempt to approximate “low normal” concentrations. Retinyl palmitate was spiked to a quite high level.	#231:RR40-6/97
413	Liquid-frozen, multi-donor heparin-treated plasma material augmented with glycyrrhetic acid prepared in 1989	#401:RR74-9/13
414	Fresh-frozen, native, single donor, prepared in 2011	#383:RR71-3/12;#390:RR72-9/12, #409:RR76-3/14
415	Fresh-frozen, augmented, single donor, prepared in 2013. This material was prepared from a (reasonably) normal serum augmented with <i>cis</i> -retinol and γ -tocopherol.	#406:RR75-3/14
416	Fresh-frozen, native, multi-donor, prepared in 2009. This is Level II of SRM 968e.	#184:RR28-6/93, #319:RR59-3/96; #327:RR60-9/96, #407:RR76-9/14

Results

1) **Stability:** There has been no significant change in the concentration nor variability of any of the sera.

Figure 1 displays the median results for the twice-analyzed sera: A) 412, prepared in 1996 and first analyzed in 1997, and B) 413, prepared in 1989 but first analyzed for FSV analytes in 2013. Why is the absence of change in these materials interesting? Among other manipulations, the serum 412 material was lightly augmented with several carotenoids in a LDL/HDL carrier. At the time, we were concerned about the stability and the ability to reconstitute this lyophilized material. It seems to have held up rather well over the years (as have your analytical methods), displaying perhaps even fewer differences than serum 413 which is somewhat similar and more recently evaluated. This may eventually provide incentive for reviving efforts to produce more “interesting” sample materials.

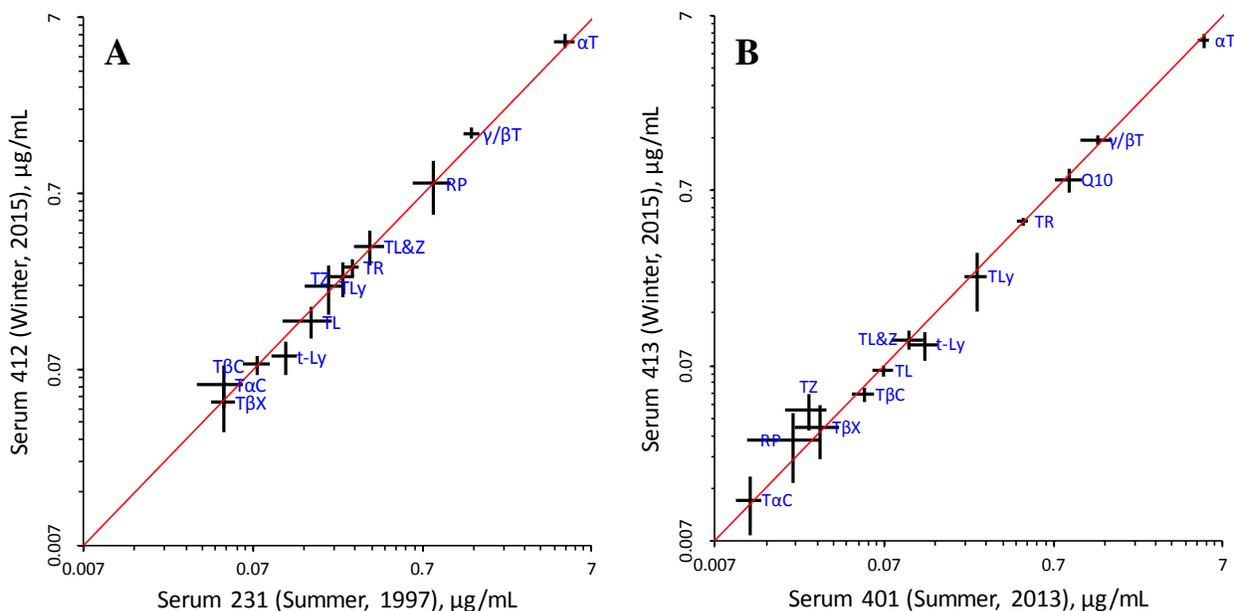


Figure 1, Comparison of Results for the Twice-Analyzed Sera 412 and 413.
 Symbols represent the median values \pm eSD

- 2) Potential interference from glycyrrhetic acid. Serum 413 was prepared as part of an investigation into the chemopreventative potential of glycyrrhetic acid (GRA). This relatively polar compound's absorbance maximum is at 248 nm and should not interfere with the analysis of the usual MMQAP analytes. There is no evidence for method-specific bias in the analysis of any of the commonly reported FSV analytes. However, based on a single observation, GRA may interfere with the fluorometric detection of δ -tocopherol. We will test this in future studies.
- 3) Total vs *trans*-Retinol: The serum pool used to prepare serum 415 contained about 0.4 $\mu\text{g}/\text{mL}$ total retinol. It was spiked with about 0.2 $\mu\text{g}/\text{mL}$ of 13-*cis*-retinol. Thus "total retinol" for this material should be about 0.6 $\mu\text{g}/\text{mL}$ while "*trans*-retinol" should be about 0.4 $\mu\text{g}/\text{mL}$.

If your retinol results for the other sera in RR77 agree reasonably well with the interlab medians but your result for serum 415 does not, we strongly encourage you to examine the retinol sections of your chromatogram for 415. If you are resolving the 13-*cis* but not including it in the total integration, in the future you may want to consider either reporting *trans*-retinol or modifying your method to include the 13-*cis* area. If you are not resolving the 13-*cis* peak but report *trans*-retinol, you may want to consider either reporting total retinol or improving the resolution of your chromatographic method.

Appendix C. “All-Lab Report” for RR77

The following six pages are the “All-Lab Report” for RR77 as provided to all participants, with two exceptions:

- the participant identifiers (Lab) have been altered.
- the order in which the participant results are listed has been altered.

The data summary in the “All-Lab Report” has been altered to ensure confidentiality of identification codes assigned to laboratories.

Round Robin LXXVII Laboratory Results

3

Lab	Total Retinol, µg/mL					trans-Retinol, µg/mL					Retinyl Palmitate, µg/mL					α-Tocopherol, µg/mL					γ/β-Tocopherol, µg/mL					δ-Tocopherol, µg/mL				
	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416
FSV-BB	0.286	0.464	0.494	0.645	0.512											5.15	5.03	6.92	8.26	10.15	1.41	1.35	1.75	4.49	1.41	1.063	0.064	0.047	0.119	0.053
FSV-BC	0.267	0.474	0.478	0.504	0.506											5.40	5.10	7.00	8.20	10.90	1.54	1.42	1.85	4.70	1.32					
FSV-BD	0.289	0.483	0.502	0.619	0.519											5.45	5.36	7.52	9.32	10.93	1.47	1.34	1.78	4.57	1.40					
FSV-BE	0.296	0.528	0.476	0.643	0.476											4.60	4.60	6.50	7.60	10.00	1.48	1.37	1.84	4.82	1.51					
FSV-BFa	0.240	0.470	0.480	0.570	0.490											4.93	5.27	6.92	8.67	10.34	1.55	1.17	1.67	4.35	1.36					
FSV-BG	0.284	0.494	0.456	0.622	0.508											5.67	5.62	7.56	9.22	11.60	1.40	1.37	1.84	4.82	1.51					
FSV-BH	0.172	0.377	0.413	0.459	0.419											4.78	4.68	6.53	8.00	10.40	1.40	1.37	1.84	4.82	1.51					
FSV-BJ	0.277	0.474	0.453	0.609	0.484											5.03	5.06	6.68	8.09	9.93	1.40	1.37	1.84	4.82	1.51					
FSV-BK	0.272	0.463	0.452	0.579	0.485											5.20	5.60	7.30	9.00	10.80	1.40	1.37	1.84	4.82	1.51					
FSV-BL	0.260	0.460	0.460	0.600	0.490											5.20	5.20	6.80	7.90	9.90	1.40	1.37	1.84	4.82	1.51					
FSV-BM	0.260	0.430	0.420	0.550	0.450											4.83	5.03	6.61	7.90	9.46	1.40	1.37	1.84	4.82	1.51					
FSV-BN	0.282	0.520	0.464	0.636	0.505											6.05	6.05	8.92	10.32	12.54	1.40	1.37	1.84	4.82	1.51					
FSV-BR	≥0.329	≥0.478	≥0.517	≥0.637	≥0.524	0.329	0.478	0.517	0.637	0.524						6.75	6.60	8.84	11.04	13.57	1.40	1.37	1.84	4.82	1.51					
FSV-BS	≥0.269	≥0.526	≥0.483	≥0.769	≥0.520	0.269	0.526	0.483	0.769	0.520						4.78	4.96	7.13	8.74	9.98	1.40	1.37	1.84	4.82	1.51					
FSV-BT	0.289	0.403	0.430	0.460	0.419											5.65	5.72	7.36	9.05	10.56	1.32	1.34	1.80	4.12	1.48					
FSV-BU	0.257	0.308	0.417	0.576	0.600											1.80	1.63	2.14	5.99	1.65	1.082	0.182	0.038	0.038	0.038					
FSV-BV	0.195	0.413	0.543	0.523	0.471											5.47	5.31	8.09	8.49	10.79	1.40	1.37	1.84	4.82	1.51					
FSV-BW	0.260	0.460	0.440	0.610	0.490						0.97	0.019	0.008	0.023	0.015	5.19	4.94	7.02	8.02	10.51	1.40	1.37	1.84	4.82	1.51					
FSV-CD	0.304	0.476	0.421	0.561	0.467						0.81	nd	nd	nd	nd	6.43	5.57	8.61	9.61	11.31	1.78	1.28	1.92	4.57	1.45					
FSV-CE	0.290	0.470	0.460	0.690	0.490											5.21	4.83	6.95	8.95	10.67	1.40	1.37	1.84	4.82	1.51					
FSV-CF	0.262	0.458	0.450	0.496	0.504											4.70	4.70	6.60	7.80	10.10	1.45	1.40	1.97	4.63	4.41					
FSV-CG	0.239	0.415	0.376	0.510	0.399											3.84	4.04	5.19	6.23	7.74	1.58	1.41	1.82	4.75	1.34					
FSV-CI	0.229	0.389	0.435	0.611	0.490						0.75	0.018	0.011	0.022	0.028	5.09	5.51	7.06	8.28	10.23	1.55	1.39	2.15	5.11	1.59					
FSV-CO	0.320	0.482	0.511	0.594	0.490											5.01	4.98	7.62	8.48	10.50	1.54	1.32	1.63	4.63	1.38					
FSV-CZ	0.319	0.515	0.470	0.656	0.536											4.15	5.74	6.09	8.86	8.60	1.40	1.37	1.84	4.82	1.51					
FSV-DD	0.300	0.490	0.470	0.650	0.450											4.20	4.50	5.60	7.50	8.50	1.40	1.37	1.84	4.82	1.51					
FSV-DV	0.259	0.483	0.467	0.660	0.539											6.09	5.44	7.01	8.19	10.20	1.66	1.40	1.80	4.33	1.41					
FSV-EE	0.342	0.469	0.446	0.563	0.449						1.00	0.034	0.028	0.034	0.032	5.10	4.50	6.20	7.30	9.20	1.48	1.26	1.70	4.43	1.35					
FSV-EZ	0.247	0.469	0.375	0.526	0.393						0.50	0.024	0.015	0.023	0.039	5.28	4.84	6.41	7.84	9.89	1.33	1.23	1.71	4.35	1.38					
FSV-FK	0.270	0.450	0.450	0.590	0.480											4.81	5.01	7.17	8.10	10.09	1.40	1.37	1.84	4.82	1.51					
FSV-FZ	0.240	0.431	0.316	0.560	0.465																									
FSV-GD	0.240	0.431	0.316	0.560	0.465																									
FSV-GF	0.240	0.431	0.316	0.560	0.465																									
FSV-GG	0.240	0.431	0.316	0.560	0.465																									
n	29	29	29	29	29	2	2	2	2	2	8	7	7	7	7	29	29	29	29	29	17	17	17	17	17	3	3	3	3	3
Min	0.172	0.308	0.316	0.459	0.393	0.269	0.478	0.483	0.637	0.520	0.47	0.018	0.008	0.022	0.015	3.84	4.04	5.19	6.23	7.74	1.32	1.17	1.63	4.12	1.32	0.910	0.064	0.038	0.038	0.038
Median	0.270	0.469	0.453	0.590	0.490	0.299	0.502	0.500	0.703	0.522	0.85	0.024	0.015	0.023	0.032	5.15	5.06	7.00	8.26	10.23	1.54	1.35	1.80	4.57	1.41	1.063	0.182	0.047	0.093	0.046
Max	0.342	0.528	0.543	0.690	0.600	0.329	0.526	0.517	0.769	0.524	1.81	0.050	0.070	0.120	0.250	6.75	6.60	8.92	11.04	13.57	1.80	1.63	2.15	5.99	4.41	1.082	0.982	0.047	0.119	0.053
eSD	0.028	0.021	0.034	0.059	0.028						0.19	0.007	0.006	0.002	0.010	0.48	0.53	0.59	0.68	0.51	0.10	0.09	0.15	0.33	0.10					
eCV	10	4	8	10	6						23	31	40	7	32	9	10	8	8	5	7	7	8	7	7					
N _{past}	47	26	29	29	31						15	6	5	5	7	44	25	27	29	30	25	15	15	18	17	4	0	9	0	6
Median _{past}	0.268	0.461	0.459	0.613	0.505						0.82	0.020	0.016	0.026	0.027	4.90	5.36	6.99	8.19	10.32	1.36	1.27	1.74	4.45	1.40	1.056	0.063	0.063	0.073	
SD _{past}	0.026	0.036	0.032	0.070	0.039						0.15	0.009	0.007	0.006	0.012	0.68	0.39	0.65	0.68	0.80	0.14	0.27	0.17	0.38	0.13	0.043	0.043	0.043	0.024	
NAV	0.268	0.466	0.453	0.585	0.488						0.81	0.026	0.015	0.023	0.036	5.15	5.03	7.00	8.20	10.20	1.54	1.36	1.81	4.60	1.41	1.063	0.182	0.047	0.093	0.046
NAU	0.031	0.038	0.037	0.064	0.039						0.28	0.012	0.011	0.012	0.021	0.49	0.49	0.59	0.66	0.79	0.17	0.15	0.19	0.40	0.16					

Round Robin LXXVII Laboratory Results

Lab	Total β -Carotene, $\mu\text{g/mL}$					trans- β -Carotene, $\mu\text{g/mL}$					Total cis- β -Carotene, $\mu\text{g/mL}$					Total α -Carotene, $\mu\text{g/mL}$				
	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416
FSV-BB	0.057	0.037	0.037	0.316	0.211	0.053	0.034	0.034	0.300	0.199	0.004	0.003	0.003	0.016	0.011	0.046	0.010	0.009	0.041	0.030
FSV-BC																				
FSV-BD																				
FSV-BE	0.083	0.059	0.044	0.410	0.268															
FSV-BFa																				
FSV-BG	0.060	0.051	0.047	0.393	0.244											0.036	0.013	0.013	0.041	0.032
FSV-BH	0.079	0.052	0.047	0.429	0.253											0.051	<i>nq</i>	<i>nq</i>	0.037	<i>nq</i>
FSV-BJ	0.095	0.036	0.049	0.353	0.243	0.079	0.052	0.047	0.417	0.253					0.054	0.015	0.018	0.013	0.020	
FSV-BK																				
FSV-BL																				
FSV-BM																				
FSV-BN	0.081	0.051	0.042	0.398	0.243											0.060	0.013	0.012	0.063	0.039
FSV-BR																				
FSV-BS	≥ 0.082	≥ 0.058	≥ 0.051	≥ 0.317	≥ 0.224	0.082	0.058	0.051	0.317	0.224						0.072	0.032	0.033	0.059	0.066
FSV-BT	0.080	0.048	0.049	0.384	0.245	0.076	0.046	0.046	0.360	0.232						0.069	0.011	0.013	0.051	0.043
FSV-BU	0.077	0.037	0.033	0.304	0.180						0.004	0.002	0.003	0.026	0.014	0.061	0.009	0.011	0.033	0.022
FSV-BV	0.075	0.048	0.057	0.390	0.241											0.073	0.011	0.017	0.048	0.035
FSV-BW	0.070	0.048	0.030	0.365	0.222											0.058	0.014	0.012	0.057	0.075
FSV-CD	0.059	<i>nq</i>	<i>nq</i>	0.333	0.177											<i>nq</i>	<i>nq</i>	<i>nq</i>	<i>nq</i>	<i>nq</i>
FSV-CE	0.080	0.050	0.050	0.550	0.310															
FSV-CF																				
FSV-CG	0.061	0.042	0.039	0.312	0.195	0.056	0.039	0.036	0.292	0.182						0.043	0.009	0.010	0.035	0.027
FSV-CI	0.065	0.045	0.043	0.314	0.229						0.005	0.005	0.005	0.020	0.013	0.045	0.018	0.014	0.033	0.042
FSV-CO	0.040	0.050	0.054	0.392	0.249											0.029	0.007	0.010	0.033	0.024
FSV-CZ	0.074	0.047	0.040	0.311	0.204															
FSV-DD																				
FSV-DV																				
FSV-EV																				
FSV-EE																				
FSV-EZ	≥ 0.084	≤ 0.059	≤ 0.059	≥ 0.393	≥ 0.206	0.084	≤ 0.059	≤ 0.059	0.393	0.206										
FSV-FK	≥ 0.078	≥ 0.062	≥ 0.057	≥ 0.546	≥ 0.329	0.078	0.062	0.057	0.546	0.329										
FSV-FZ																				
FSV-GD	0.073	0.058	0.052	0.357	0.222	0.064	0.051	0.045	0.314	0.195						0.060	0.015	0.013	0.056	0.038
FSV-GF											0.009	0.007	0.007	0.043	0.027					
FSV-GG																				
n	17	16	16	17	17	8	7	7	8	8	4	4	4	5	4	14	13	13	14	13
Min	0.040	0.036	0.030	0.304	0.177	0.053	0.034	0.034	0.292	0.182	0.004	0.002	0.003	0.012	0.011	0.029	0.007	0.009	0.013	0.020
Median	0.074	0.048	0.046	0.365	0.241	0.077	0.051	0.046	0.339	0.215	0.005	0.004	0.004	0.020	0.014	0.056	0.013	0.013	0.041	0.035
Max	0.095	0.059	0.057	0.550	0.310	0.084	0.062	0.057	0.546	0.329	0.009	0.007	0.007	0.043	0.027	0.073	0.032	0.033	0.063	0.075
eSD	0.010	0.005	0.007	0.049	0.028	0.009	0.010	0.007	0.063	0.027	0.001	0.002	0.001	0.009	0.002	0.015	0.004	0.002	0.012	0.012
eCV	14	10	16	13	12	12	20	16	19	13	21	56	37	44	14	27	29	17	29	34
N _{past}	30	20	18	21	21	10	4	5	6	6	4	0	9	4	5	28	11	13	13	16
Median _{past}	0.075	0.053	0.047	0.374	0.240	0.068	0.048	0.041	0.371	0.217	0.008					0.047	0.011	0.013	0.043	0.032
SD _{past}	0.017	0.008	0.010	0.043	0.028	0.009	0.005	0.003	0.028	0.024						0.014	0.002	0.005	0.006	0.010
NAV	0.075	0.048	0.044	0.361	0.235	0.077	0.051	0.046	0.339	0.215	0.005	0.004	0.004	0.020	0.014	0.058	0.012	0.013	0.041	0.037
NAU	0.014	0.011	0.010	0.061	0.035	0.011	0.010	0.009	0.063	0.027	0.003	0.003	0.003	0.009	0.005	0.018	0.005	0.005	0.013	0.012

Round Robin LXXVII Laboratory Results

Lab	Total Lycopene, µg/mL					trans-Lycopene, µg/mL					Total β-Cryptoxanthin, µg/mL					Total α-Cryptoxanthin, µg/mL					Total Lutein, µg/mL				
	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416
FSV-BB	0.142	0.161	0.098	0.202	0.47	0.068	0.082	0.047	0.101	0.233	0.035	0.026	0.118	0.054	0.045	0.008	0.015	0.015	0.024	0.018	0.142	0.080	0.106	0.095	0.100
FSV-BC																									
FSV-BD																									
FSV-BE																									
FSV-BFa																									
FSV-BG	0.183	0.255	0.173	0.259	0.59	0.101	0.143	0.094	0.140	0.345	0.053	0.033	0.181	0.065	0.056						0.118	0.063	0.075	0.074	0.082
FSV-BH	0.315	0.348	0.233	0.367	0.80						0.057	0.040	0.215	0.080	0.063						0.109	0.054	0.108	0.074	0.098
FSV-BJ	0.122	0.198	0.145	0.253	0.59						0.032	0.024	0.155	0.048	0.046										
FSV-BK																									
FSV-BL																									
FSV-BM	0.230	0.287	0.156	0.260	0.60						0.051	0.035	0.193	0.063	0.056										
FSV-BN																									
FSV-BR	0.132	0.140	0.091	0.133	0.31	0.072	0.073	0.050	0.072	0.156	0.067	0.058	0.160	0.080	0.078						0.122	0.062	0.073	0.065	0.082
FSV-BT	0.112	0.120	0.093	0.136	0.31	0.096	0.103	0.081	0.116	0.269	0.033	0.026	0.097	0.042	0.043	0.008	0.012	0.013	0.017	0.018	0.155	0.068	0.092	0.062	0.087
FSV-BU	0.244	0.283	0.188	0.282	0.63						0.046	0.031	0.200	0.038	0.047										
FSV-BV	0.240	0.268	0.233	0.272	0.64						0.041	0.023	0.237	0.057	0.042										
FSV-BW	0.212	0.259	0.200	0.257	0.70																				
FSV-CD	0.252	0.285	0.215	0.344	0.68						0.055	nq	0.166	0.066	0.055	nq	nq	nq	nq	nq					
FSV-CE																									
FSV-CF																									
FSV-CG	0.179	0.212	0.157	0.220	0.46	0.094	0.105	0.076	0.114	0.244	0.045	0.044	0.147	0.071	0.067						0.154	0.068	0.083	0.071	0.091
FSV-CI																									
FSV-CO	0.100	0.225	0.187	0.250	0.56																				
FSV-CZ																									
FSV-DD																									
FSV-DV																									
FSV-EE																									
FSV-EZ																									
FSV-FK																									
FSV-FZ																									
FSV-GD	0.208	0.226	0.142	0.250	0.49																				
FSV-GF																									
FSV-GG																									
n	14	14	14	14	14	5	5	5	5	5	11	10	11	11	11	2	2	2	2	2	6	6	6	6	6
Min	0.100	0.120	0.091	0.133	0.31	0.068	0.073	0.047	0.072	0.156	0.032	0.023	0.097	0.038	0.042	0.008	0.012	0.013	0.017	0.018	0.109	0.054	0.073	0.062	0.082
Median	0.196	0.240	0.165	0.255	0.59	0.094	0.103	0.076	0.114	0.244	0.046	0.032	0.166	0.063	0.055	0.008	0.013	0.014	0.024	0.018	0.132	0.066	0.088	0.073	0.089
Max	0.315	0.348	0.233	0.367	0.80	0.101	0.143	0.094	0.140	0.345	0.067	0.058	0.237	0.080	0.078	0.008	0.015	0.015	0.033	0.018	0.155	0.080	0.108	0.095	0.100
eSD	0.076	0.063	0.043	0.032	0.14	0.010	0.031	0.027	0.019	0.037	0.013	0.010	0.040	0.013	0.013						0.027	0.004	0.020	0.007	0.010
eCV	39	26	26	13	23	11	30	36	17	15	27	32	24	20	24						20	7	23	9	12
Npast	28	12	13	15	15	7	5	5	6	7	23	10	12	13	15	0	0	8	0	6	14	5	5	8	7
Medianpast	0.194	0.245	0.171	0.257	0.60	0.108	0.120	0.086	0.143	0.295	0.047	0.029	0.168	0.063	0.053	0.025	0.026				0.153	0.069	0.088	0.073	0.091
SDpast	0.044	0.035	0.029	0.034	0.08	0.014	0.025	0.020	0.012	0.049	0.007	0.009	0.032	0.003	0.015	0.013	0.011				0.063	0.009	0.027	0.015	0.019
NAV	0.208	0.226	0.157	0.253	0.59	0.083	0.093	0.063	0.108	0.238	0.046	0.031	0.163	0.060	0.051						0.132	0.066	0.088	0.073	0.089
NAU	0.065	0.085	0.064	0.059	0.15	0.018	0.017	0.021	0.019	0.043	0.015	0.010	0.050	0.017	0.012	0.024					0.027	0.013	0.020	0.015	0.017

Round Robin LXXVII Laboratory Results

Lab	Total Zeaxanthin, µg/mL					Total Lutein&Zeaxanthin, µg/mL					Coenzyme Q10, µg/mL					Phylloquinone (K1), ng/mL					25-hydroxyvitamin D, µg/mL					
	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	412	413	414	415	416	
FSV-BB	0.234	0.040	0.056	0.041	0.051	0.407	0.131	0.177	0.148	0.148	0.193	0.57	1.09	0.795	0.82	0.205	0.456	0.098	0.508	0.340						
FSV-BC																										
FSV-BD																										
FSV-BE																										
FSV-BFa																										
FSV-BH	0.261	0.039	0.055	0.041	0.036	0.337	0.104	0.110	0.099	0.134	0.337	0.104	0.110	0.099	0.134	0.205	0.456	0.098	0.508	0.340	0.011	0.011	0.006	0.015	0.012	
FSV-BJ						0.379	0.103	0.130	0.115	0.118	0.220	0.89	0.67	0.650	0.73											
FSV-BK																										
FSV-BL																										
FSV-BM																										
FSV-BN						0.404	0.099	0.120	0.105	0.129																
FSV-BR						0.177	0.107	0.221	0.132	0.149																
FSV-BS	0.055	0.045	0.148	0.067	0.067	0.438	0.101	0.144	0.094	0.118	0.565	0.78	0.97	0.383	0.60											
FSV-BT	0.283	0.033	0.052	0.032	0.031	0.264	0.102	0.133	0.106	0.113																
FSV-BU						0.321	0.082	0.123	0.079	0.095																
FSV-BV																										
FSV-BW						0.296	0.080	0.102	0.085	0.097																
FSV-CD																										
FSV-CE																										
FSV-CF						0.254	0.091	0.110	0.093	0.108																
FSV-CG						0.352	0.096	0.126	0.102	0.117																
FSV-CI	0.198	0.028	0.043	0.031	0.026	0.379	0.091	0.144	0.105	0.115																
FSV-CO																										
FSV-CZ																										
FSV-DD																										
FSV-DV																										
FSV-EE																										
FSV-EZ																										
FSV-FK																										
FSV-FZ																										
FSV-GD																										
FSV-GF																										
FSV-GG																										
n	5	5	5	5	5	12	12	12	12	12	10	10	10	10	10	3	3	3	3	3	2	2	2	2	2	2
Min	0.055	0.028	0.043	0.031	0.026	0.177	0.080	0.102	0.079	0.095	0.193	0.57	0.67	0.383	0.60	0.205	0.456	0.098	0.508	0.340	0.011	0.011	0.006	0.015	0.012	
Median	0.234	0.039	0.055	0.041	0.036	0.344	0.100	0.128	0.104	0.118	0.218	0.81	1.04	0.798	0.90	0.240	0.550	0.130	0.520	0.350	0.012	0.012	0.006	0.017	0.013	
Max	0.283	0.045	0.148	0.067	0.067	0.438	0.131	0.221	0.148	0.149	0.565	0.95	1.14	1.019	1.11	0.324	0.678	0.140	0.576	0.388	0.013	0.013	0.006	0.019	0.013	
eSD	0.053	0.009	0.004	0.013	0.015	0.080	0.008	0.024	0.015	0.016	0.027	0.13	0.08	0.091	0.16											
eCV	23	23	8	33	41	12	8	19	14	13	12	16	8	11	18											
N _{past}	11	4	7	6	7	22	11	12	13	15	0	8	9	10	9	0	0	0	0	0	0	0	0	0	0	11
Median _{past}	0.236	0.025	0.042	0.030	0.029	0.346	0.098	0.123	0.102	0.126	0.87	1.07	0.825	0.96												
SD _{past}	0.030	0.007	0.020	0.008	0.014	0.068	0.021	0.026	0.013	0.030	0.16	0.13	0.093	0.12												0.004
NAV	0.234	0.039	0.055	0.041	0.036	0.352	0.099	0.130	0.105	0.117	0.218	0.81	1.04	0.798	0.90	0.240	0.550	0.130	0.520	0.350						
NAU	0.062	0.011	0.015	0.013	0.015	0.082	0.021	0.027	0.022	0.024	0.027	0.13	0.10	0.091	0.16											

Round Robin LXXVII Laboratory Results

Analytes Reported By One Laboratory

Values in µg/mL

Analyte	Code	412	413	414	415	416
Phytofluene	FSV-BS	0.083	0.094	0.075	0.073	0.152
β-Tocopherol	FSV-BU	0.093	0.069	0.158	0.141	0.109

Table Legend

Term	Definition
N	Number of (non-NIST) quantitative values reported for this analyte
Min	Minimum (non-NIST) quantitative value reported
Median	Median (non-NIST) quantitative value reported
Max	Maximum (non-NIST) quantitative value reported
SD	Adjusted median absolute deviation from the median of the non-NIST results
CV	Coefficient of Variation for (non-NIST) results: 100*SD/Median
N_{past}	Mean of N(s) from past RR(s)
$\text{Median}_{\text{past}}$	Mean of Median(s) from past RR(s)
SD_{past}	Pooled SD from past RR(s)
NAV	NIST Assigned Value, the median for analytes reported by ≥ 5 labs
NAU	NIST Assigned Uncertainty, the maximum of (0.05*NAV, SD, SD_{past} , eSD) The expected long-term SD, eSD, is defined: Duewer et al., Anal Chem 1997;69(7):1406-1413.
<i>nd</i>	Not detected (i.e., no detectable peak for analyte)
<i>nq</i>	Detected but not quantitatively determined
$\leq x$	Concentration at or below the limit of quantification, x
$\geq x$	Concentration greater than or equal to x
<i>italics</i>	Not explicitly reported but calculated by NIST from reported values

Round Robin LXXVII Laboratory Results

Comparability Summary

Lab	TR	aT	g/bT	bC	tbC	aC	TLy	TbX	TLu	TZ	L&Z
FSV-BB	1	1	1	1	2	1	1	1	2	1	2
FSV-BC	1										
FSV-BD	1	1									
FSV-BE	1	2	1	1							
FSV-BFa	1	1									
FSV-BG	1	1	1	1		1	1	1			1
FSV-BH	3	2	1	1	1	1	2	1	1	1	1
FSV-BJ	1	1	1	1		2	1	1	1		
FSV-BK	1	1									
FSV-BL	1	1									
FSV-BM	1	1									
FSV-BN	1	1		1		1	1	1			1
FSV-BR	2	3									
FSV-BS	2	4		1	1	3	2	2	1	4	3
FSV-BT	2	1	1	1	1	1	2	2	1	1	1
FSV-BU	3	2	3	2		1	1	1			1
FSV-BV	2	2	2	1		1	1	2			1
FSV-BW	1	1	1	1		2	1				
FSV-CD	1	3	1	2			1	1			1
FSV-CE	1	1		2							
FSV-CF	1	1									
FSV-CG	2	3	4	1	2	1	1	1			1
FSV-CI	2	1	1	1		1			1	1	1
FSV-CO	2	1	2	2		2	1				1
FSV-CZ	2	2	1	1							
FSV-DD	1										
FSV-DV	1	2									
FSV-EZ	2	2	1	2	1						
FSV-FK	2	2		2	3						
FSV-FZ	1	1	1								
FSV-GD	2	1	1	1	1	1	1				
n	31	29	17	20	8	14	14	11	6	5	12

	TR	aT	g/bT	bC	tbC	aC	TLy	TbX	TLu	TZ	L&Z
% 1	55	59	76	70	63	71	64	73	83	80	83
% 2	35	28	12	25	25	21	36	27	17	0	8
% 3	10	10	6	5	13	7	0	0	0	0	8
% 4	0	3	6	0	0	0	0	0	0	20	0

Label	Definition
Lab	Participant code
TR	Total Retinol
aT	α -Tocopherol
g/bT	γ/β -Tocopherol
bC	Total β -Carotene
tbC	trans- β -Carotene
aC	Total α -Carotene
TLy	Total Lycopene
TbX	Total β -Cryptoxanthin
TLu	Total Lutein
TZ	Total Zeaxanthin
L&Z	Total Lutein & Zeaxanthin

- n | number of participants providing quantitative data
- % 1 | Percent of CS = 1 (within 1 SD of medians)
- % 2 | Percent of CS = 2 (within 2 SD of medians)
- % 3 | Percent of CS = 3 (within 3 SD of medians)
- % 4 | Percent of CS = 4 (3 or more SD from medians)

“Comparability Score”

The Comparability Score (CS) summarizes your measurement performance for a given analyte relative to the consensus medians in this study. CS is the average distance (in units of standard deviation) of your measurement performance characteristics from the consensus performance. CS is calculated when the number of quantitative values you reported, N_{you} , is at least two and at least six participants reported quantitative values for the analyte.

We define CS as follows:

$$CS = \text{MINIMUM} \left(4, \text{INTEGER} \left(1 + \sqrt{C^2 + AP^2} \right) \right)$$

$$C = \text{Concordance} = \frac{\sum_{i=1}^{N_{you}} \frac{You_i - \text{Median}_i}{NAU_i}}{N_{you}}$$

$$AP = \text{Apparent Precision} = \sqrt{\frac{\sum_{i=1}^{N_{you}} \left(\frac{You_i - \text{Median}_i}{NAU_i} \right)^2}{N_{you} - 1}}$$

NAU = NIST Assigned Uncertainty

For further details, please see

Duewer DL, Kline MC, Sharpless KE, Brown Thomas J, Gary KT. Micronutrients Measurement Quality Assurance Program: Helping participants use interlaboratory comparison exercise results to improve their long-term measurement performance. Anal Chem 1999;71(9):1870-8.

Appendix D. Representative Individualized Report for RR77

Each participant in RR77 received an “Individualized Report” reflecting their reported results. Each report included a detailed analysis for analytes that were assayed by at least five participants. The following analytes met this criterion:

- Total Retinol
- Retinyl Palmitate
- α -Tocopherol
- γ/β -Tocopherol
- Total β -Carotene
- *trans*- β -Carotene
- Total α -Carotene
- Total Lycopene
- Total β -Cryptoxanthin
- Total Lutein
- Total Zeaxanthin
- Total Lutein & Zeaxanthin
- Coenzyme Q10

The following fourteen pages are the “Individualized Report” for the analytes evaluated by participant FSV-BB.

Individualized Round Robin LXXVII Report: FSV-BB

Summary

Analyte	Serum 412			Serum 413			Serum 414			Serum 415			Serum 416		
	You	NAV	n												
Total Retinol	0.286	0.268	29	0.464	0.466	29	0.494	0.453	29	0.645	0.585	29	0.512	0.488	29
Retinyl Palmitate	0.47	0.81	8	0.0	0.0	7	0.0	0.0	7	0.02	0.02	7	0.06	0.04	7
α-Tocopherol	5.15	5.15	28	5.03	5.03	28	6.92	7.00	28	8.26	8.20	28	10.15	10.20	28
γ/β-Tocopherol	1.405	1.540	17	1.349	1.359	17	1.748	1.812	17	4.492	4.599	17	1.413	1.413	17
δ-Tocopherol	1.063	1.063	3	0.064	0.182	3	0.047	0.047	3	0.119	0.093	3	0.053	0.046	3
Total β-Carotene	0.057	0.075	17	0.037	0.048	16	0.037	0.044	16	0.316	0.361	17	0.211	0.235	17
trans-β-Carotene	0.053	0.077	8	0.034	0.051	7	0.034	0.046	7	0.300	0.339	8	0.199	0.215	8
Total cis-β-Carotene	0.004	0.005	4	0.003	0.004	4	0.003	0.004	4	0.016	0.020	5	0.011	0.014	4
Total α-Carotene	0.046	0.058	14	0.010	0.012	13	0.009	0.013	13	0.041	0.041	14	0.030	0.037	13
Total Lycopene	0.142	0.208	14	0.161	0.226	14	0.098	0.157	14	0.202	0.253	14	0.470	0.589	14
trans-Lycopene	0.068	0.083	5	0.082	0.093	5	0.047	0.063	5	0.101	0.108	5	0.233	0.238	5
Total β-Cryptoxanthin	0.035	0.046	11	0.026	0.031	10	0.118	0.163	11	0.054	0.060	11	0.045	0.051	11
Total α-Cryptoxanthin	0.008		2	0.015		2	0.015		2	0.024	0.024	3	0.018		2
Total Lutein	0.142	0.132	6	0.080	0.066	6	0.106	0.088	6	0.095	0.073	6	0.100	0.089	6
Total Zeaxanthin	0.234	0.234	5	0.040	0.039	5	0.056	0.055	5	0.041	0.041	5	0.051	0.036	5
Total Lutein&Zeaxanthin	0.407	0.352	12	0.131	0.099	12	0.177	0.130	12	0.148	0.105	12	0.148	0.117	12

You : Your reported values for the listed analytes (micrograms/milliliter)

NAV : NIST Assigned Values, here equal to this RR's median

n : Number of non-NIST laboratories reporting quantitative values for this analyte in this serum

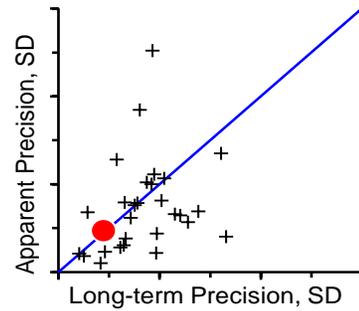
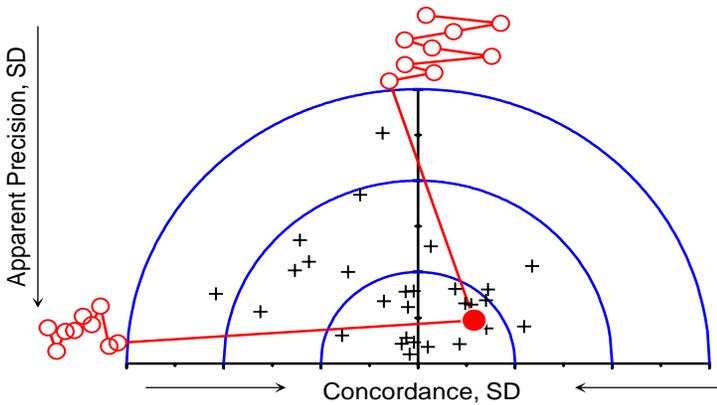
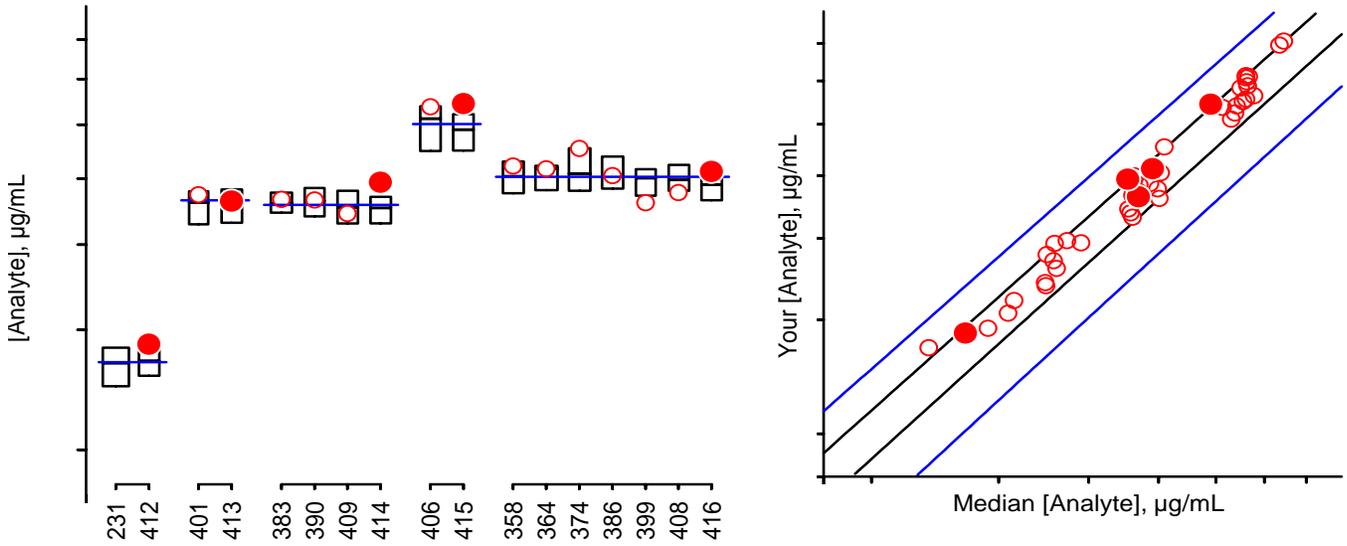
Please check our records against your records. Send corrections and/or updates to...

Micronutrients Measurement Quality Assurance Program
National Institute of Standards and Technology
100 Bureau Drive Stop 8392
Gaithersburg, MD 20899-8392 USA

Tel: (301) 975-3935
Fax: (301) 977-0685
Email: david.duewer@nist.gov

Individualized RR LXXVII Report: FSV-BB

Total Retinol, µg/mL



- 3rd Quartile (75%)
- Median (50%)
- 1st Quartile (25%)
- You, this RR
- You, past RRs
- Expectation
- You, ≥x, this RR
- You, ≥x, past RRs
- Others, this RR

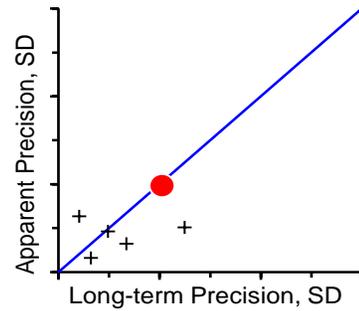
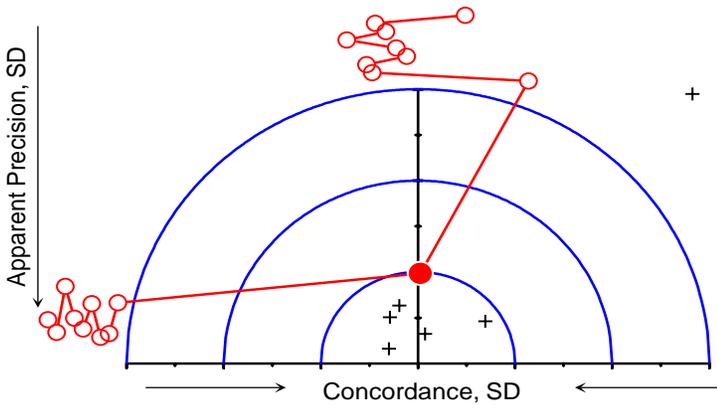
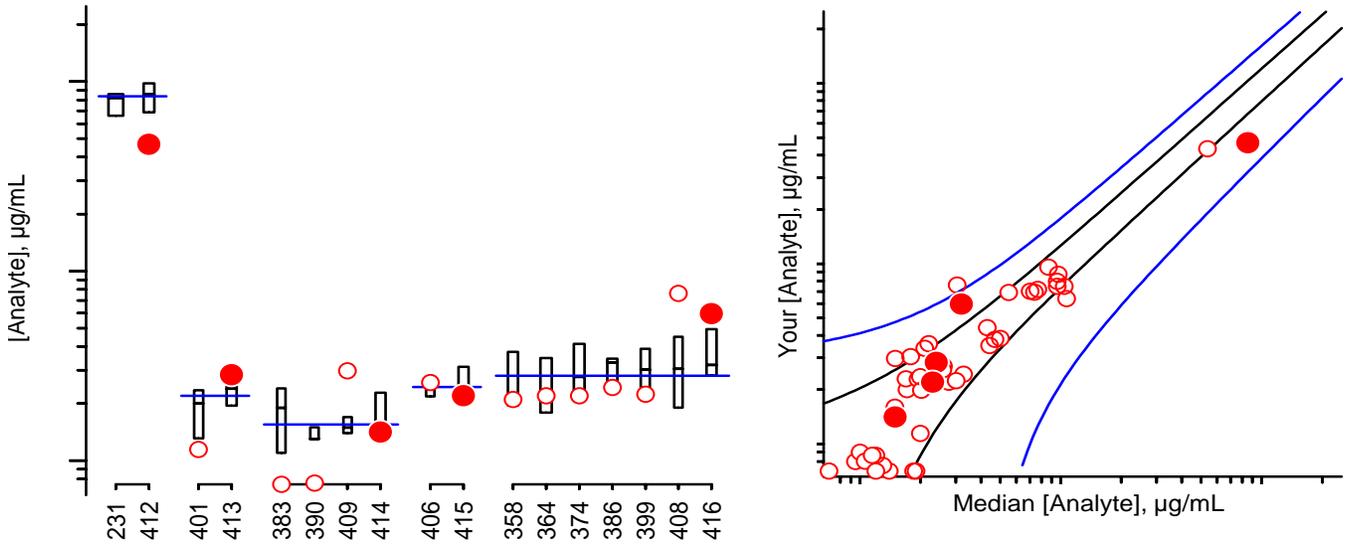
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR,γT}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

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Individualized RR LXXVII Report: FSV-BB

Retinyl Palmitate, µg/mL



- 3rd Quartile (75%)
 ● You, this RR
▲ You, ≥x, this RR
- Median (50%)
 You, past RRs
 You, ≥x, past RRs
+ Others, this RR
- 1st Quartile (25%)
 — Expectation

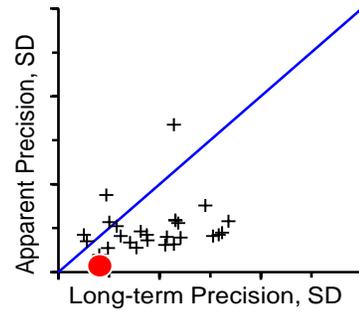
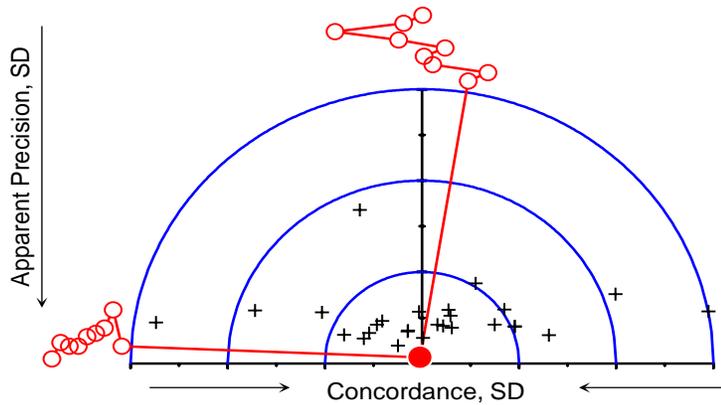
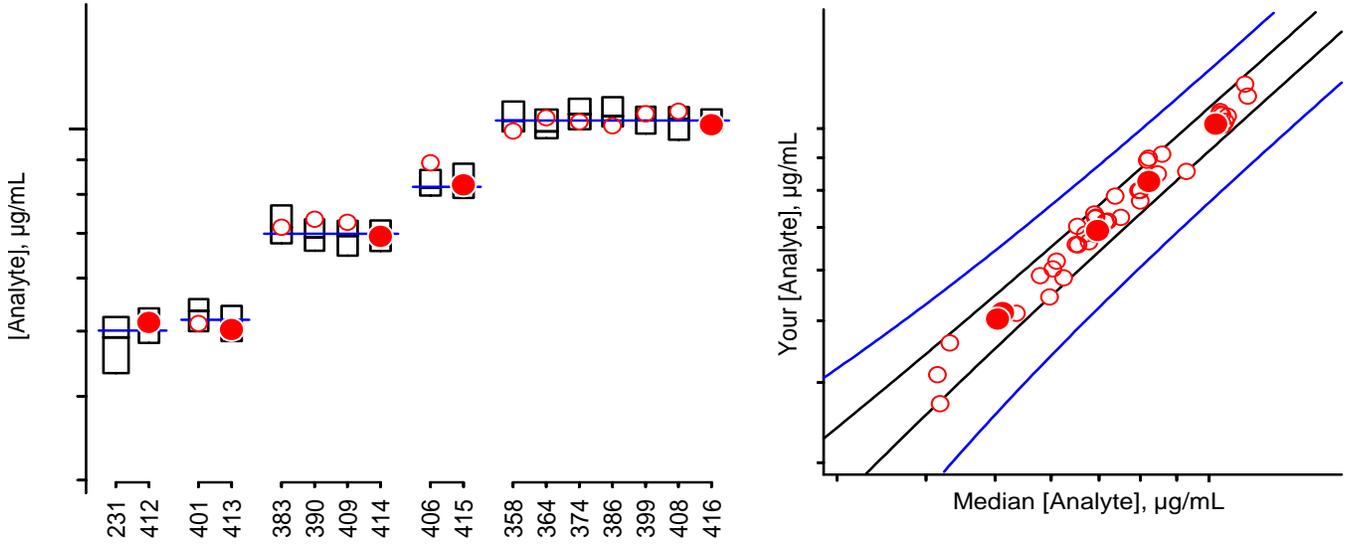
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
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#415	Fresh-frozen, augmented {cR,γT}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

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Individualized RR LXXVII Report: FSV-BB

α-Tocopherol, µg/mL



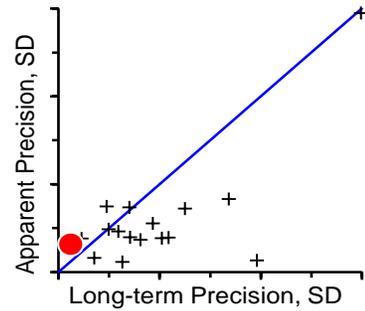
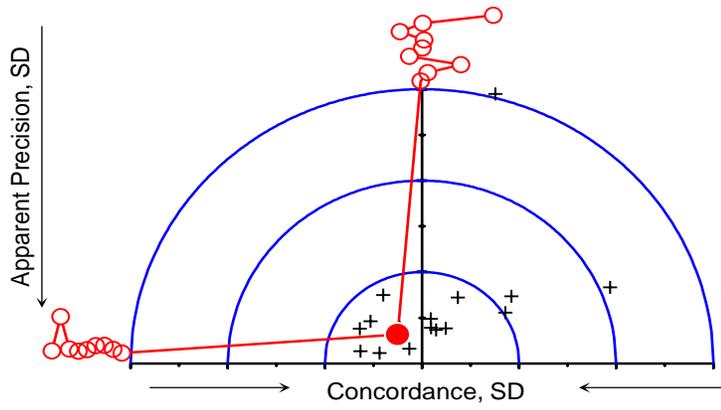
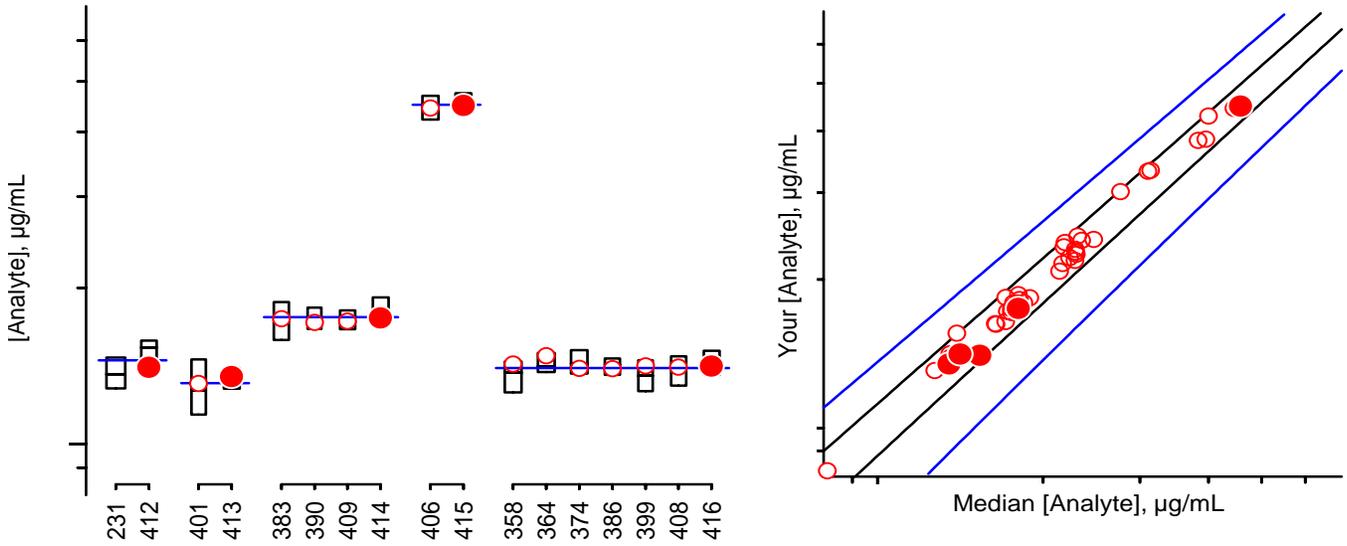
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR,γT}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

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Individualized RR LXXVII Report: FSV-BB

γ/β -Tocopherol, $\mu\text{g/mL}$



- 3rd Quartile (75%)
- Median (50%)
- 1st Quartile (25%)
- You, this RR
- You, past RRs
- Expectation
- You, $\geq x$, this RR
- You, $\geq x$, past RRs
- Others, this RR

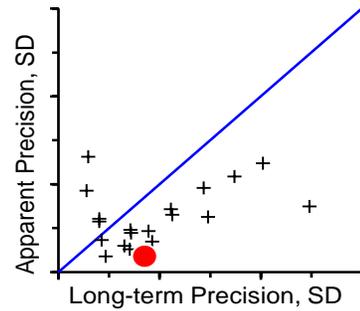
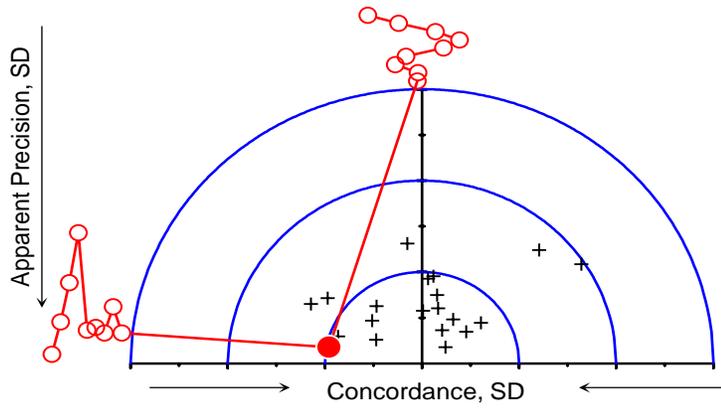
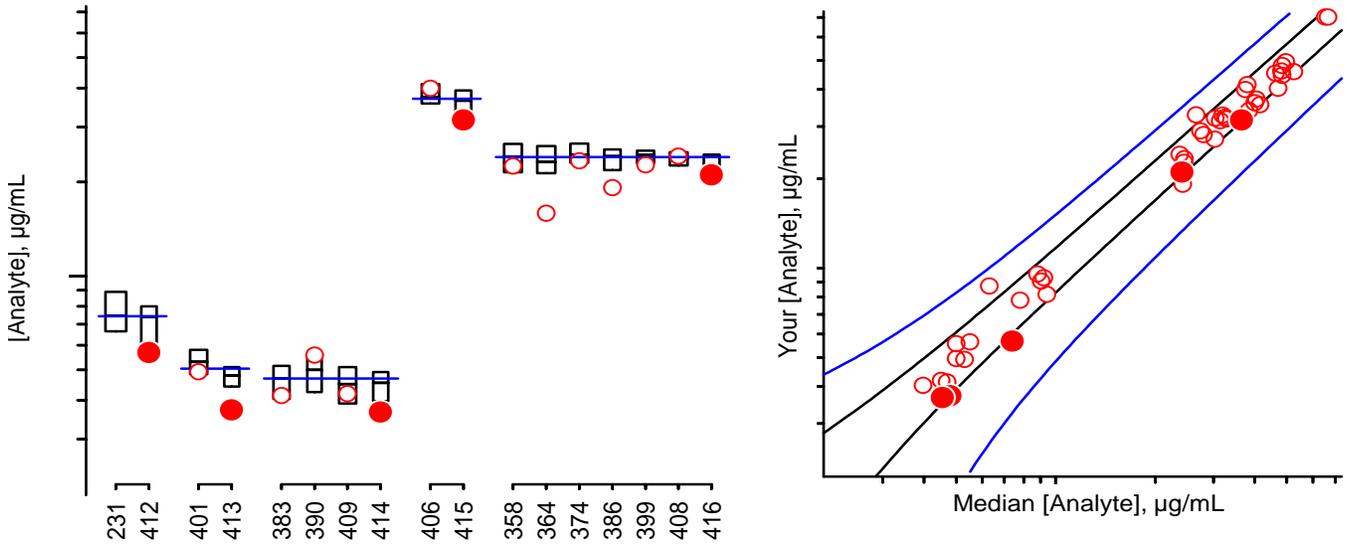
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR, γ T}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.IR.7880-45>

Individualized RR LXXVII Report: FSV-BB

Total β -Carotene, $\mu\text{g/mL}$



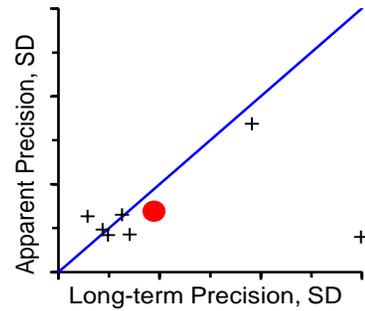
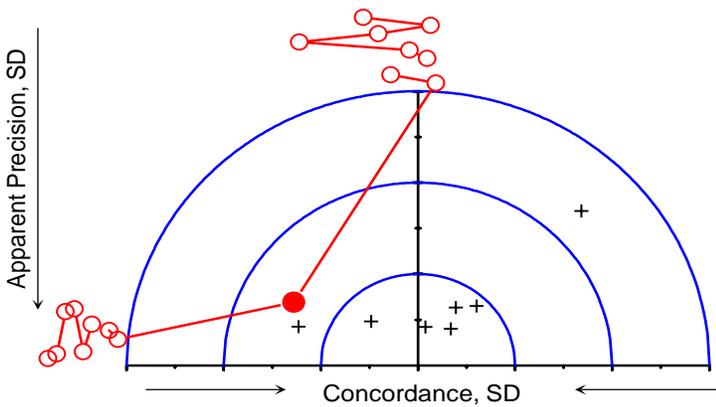
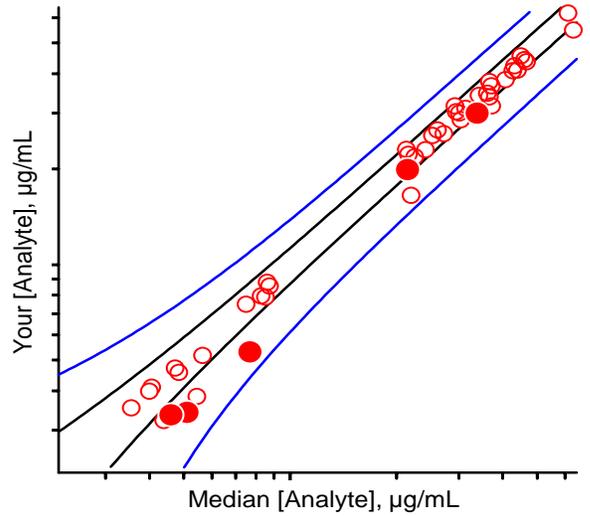
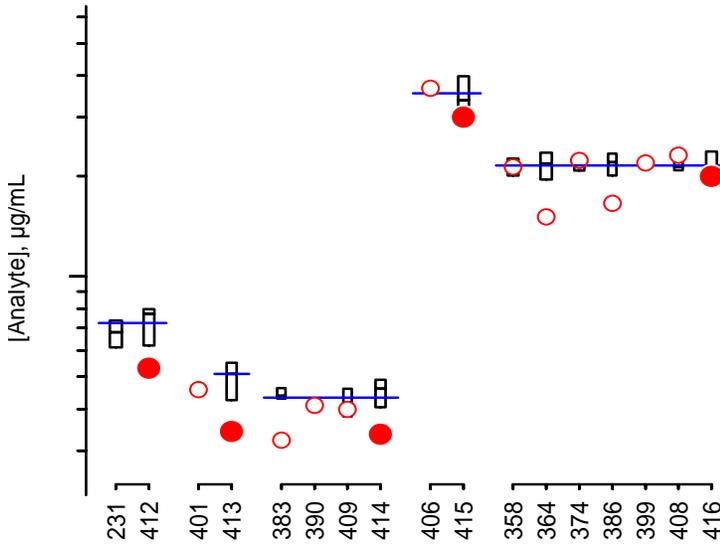
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Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
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Individualized RR LXXVII Report: FSV-BB

trans-β-Carotene, µg/mL



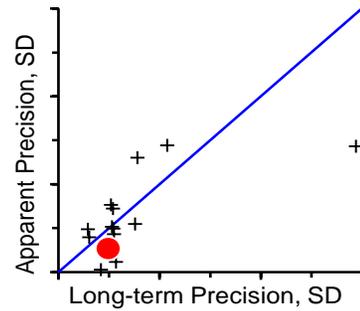
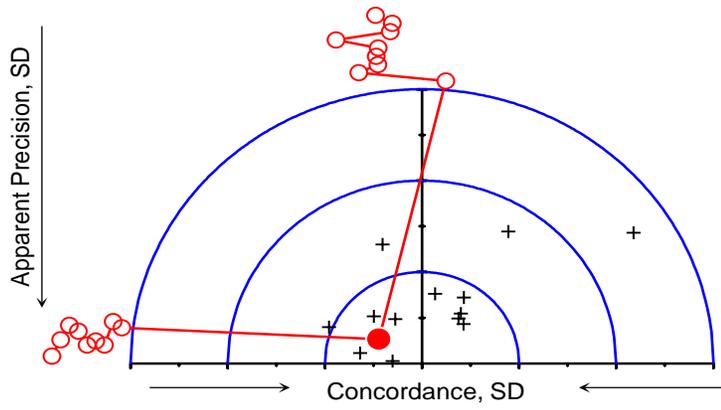
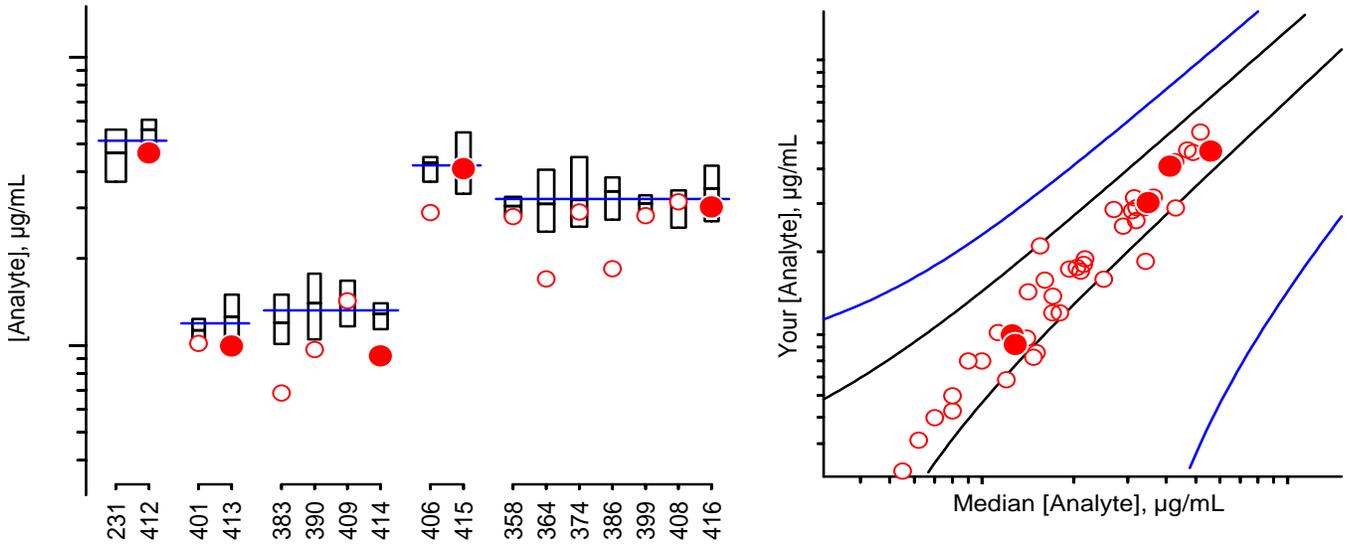
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR,γT}, single-donor	75#406
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Individualized RR LXXVII Report: FSV-BB

Total α -Carotene, $\mu\text{g/mL}$



- 3rd Quartile (75%)
 Median (50%)
 1st Quartile (25%)
- You, this RR
 ○ You, past RRs
 — Expectation
- ▲ You, $\geq x$, this RR
 △ You, $\geq x$, past RRs
 + Others, this RR

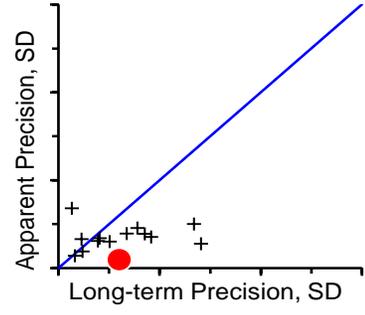
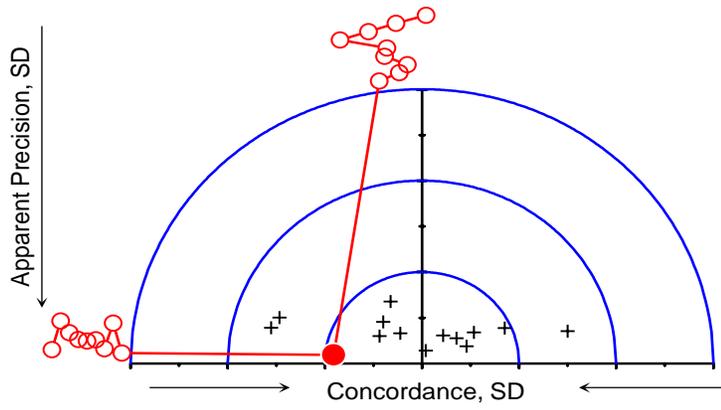
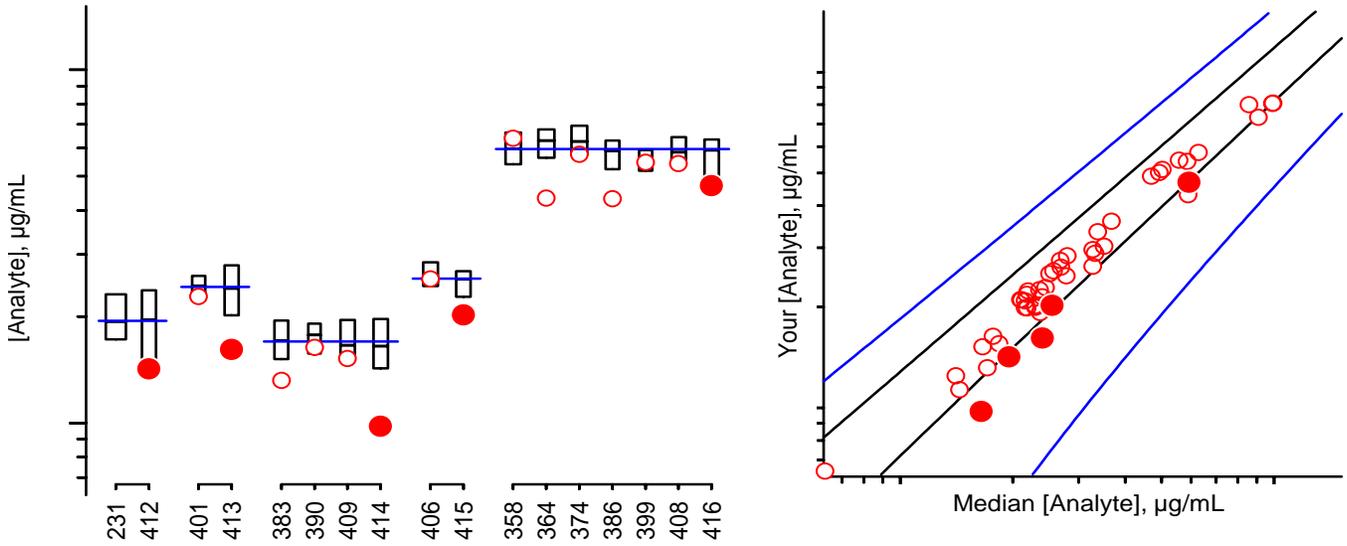
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

<u>Serum</u>	<u>Comments</u>	<u>History</u>
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
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Individualized RR LXXVII Report: FSV-BB

Total Lycopene, $\mu\text{g/mL}$



- 3rd Quartile (75%)
- Median (50%)
- 1st Quartile (25%)
- You, this RR
- You, past RRs
- Expectation
- You, $\geq x$, this RR
- You, $\geq x$, past RRs
- Others, this RR

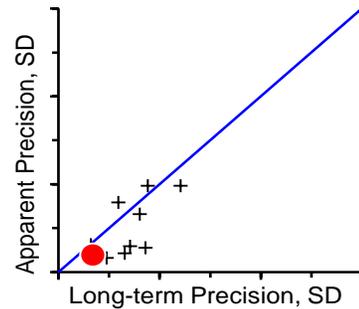
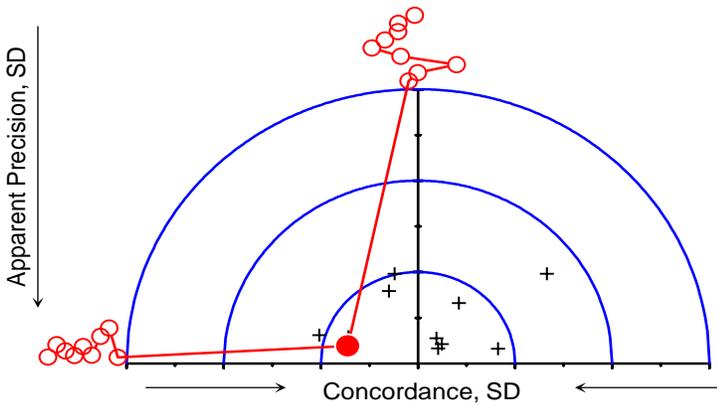
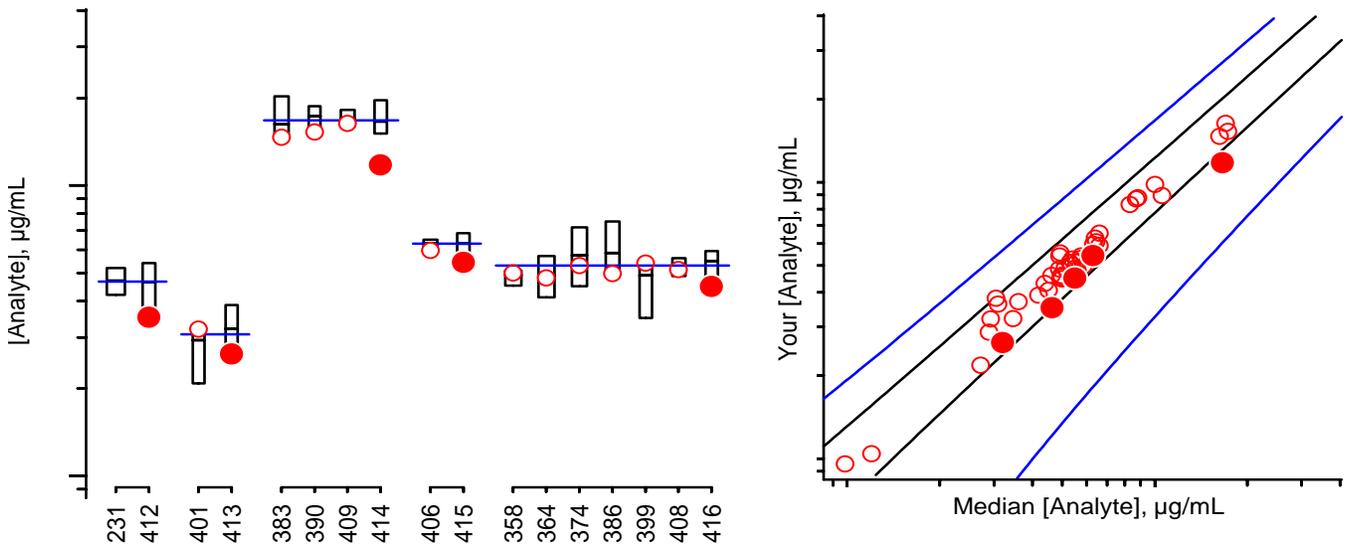
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR, γ T}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

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Individualized RR LXXVII Report: FSV-BB

Total β -Cryptoxanthin, $\mu\text{g/mL}$



- 3rd Quartile (75%)
- Median (50%)
- 1st Quartile (25%)
- You, this RR
- You, past RRs
- Expectation
- You, $\geq x$, this RR
- You, $\geq x$, past RRs
- Others, this RR

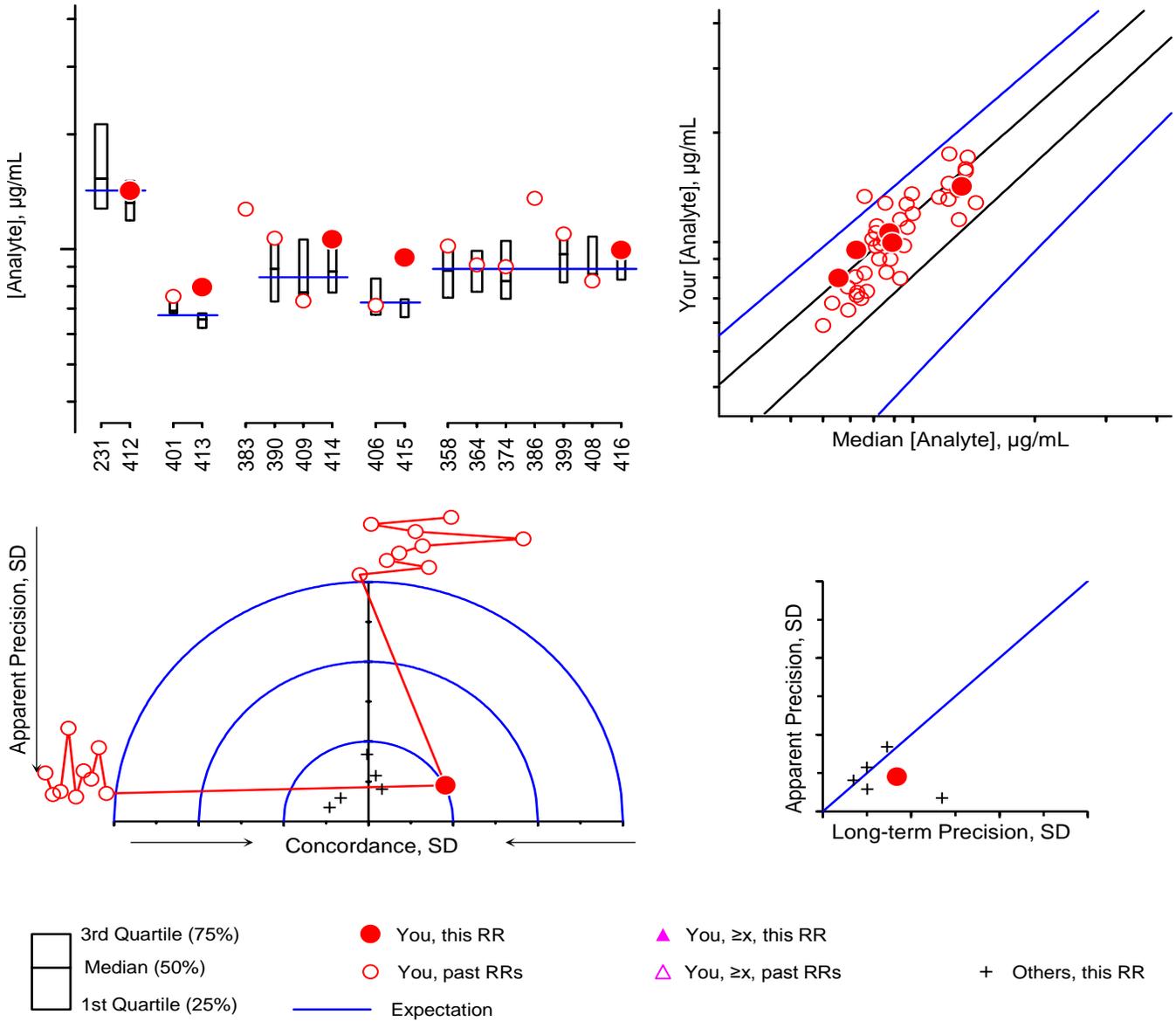
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR, γ T}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.JR.7880-45>

Individualized RR LXXVII Report: FSV-BB

Total Lutein, $\mu\text{g/mL}$



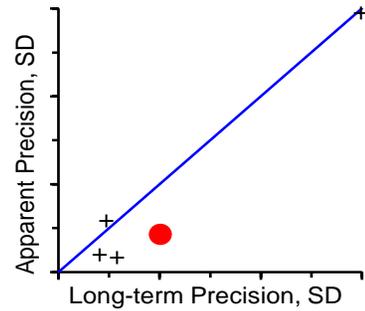
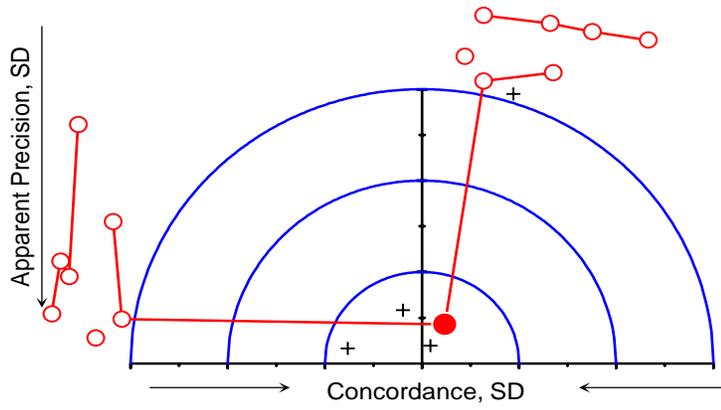
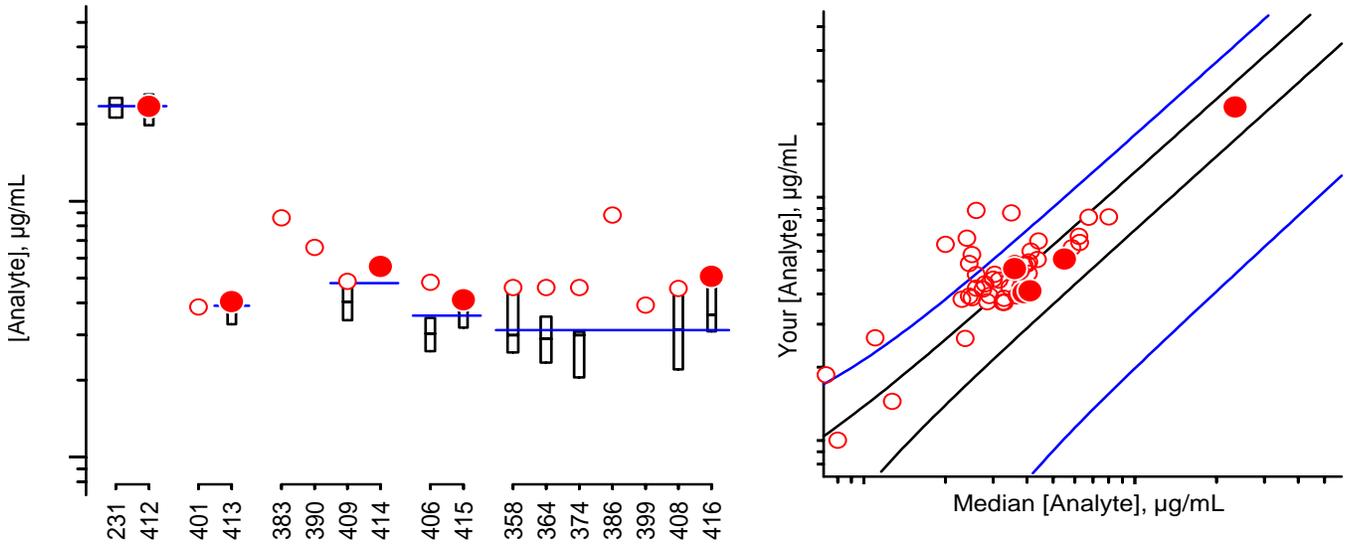
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
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This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.IR.7880-45>

Individualized RR LXXVII Report: FSV-BB

Total Zeaxanthin, $\mu\text{g/mL}$



- 3rd Quartile (75%)
- Median (50%)
- 1st Quartile (25%)
- You, this RR
- You, past RRs
- Expectation
- You, $\geq x$, this RR
- You, $\geq x$, past RRs
- Others, this RR

For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum

Comments

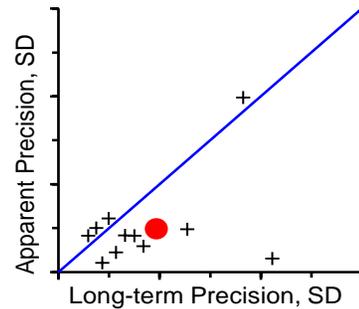
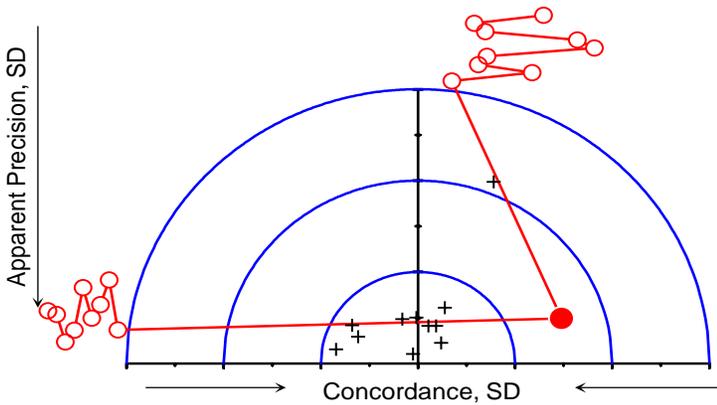
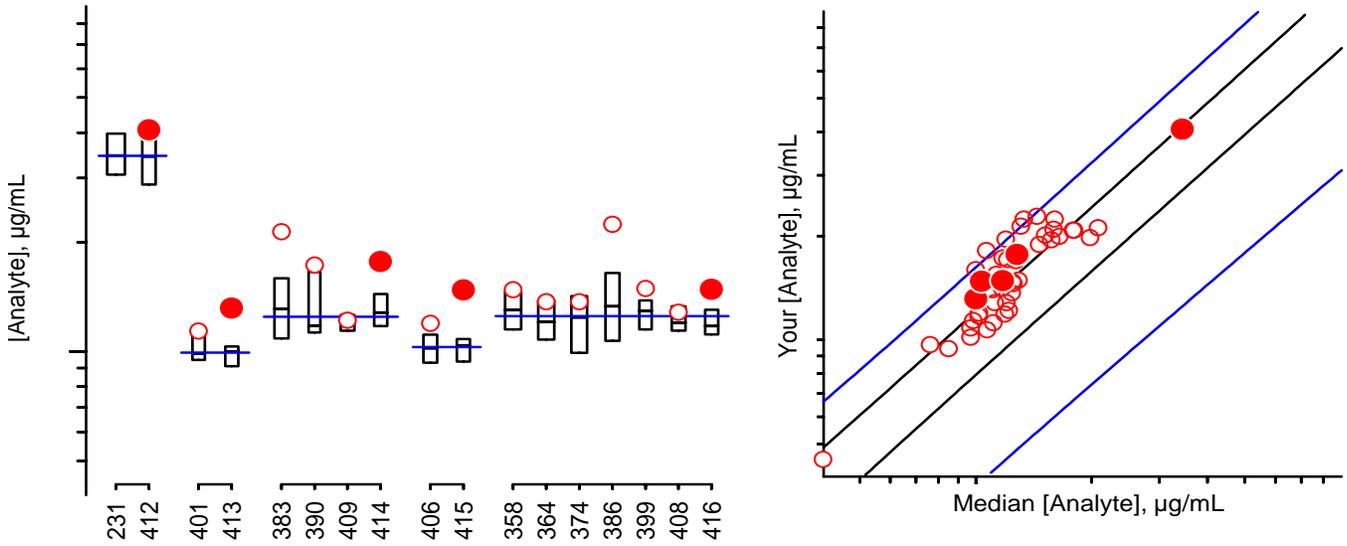
History

#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR, γ T}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.IR.7880-45>

Individualized RR LXXVII Report: FSV-BB

Total Lutein&Zeaxanthin, µg/mL



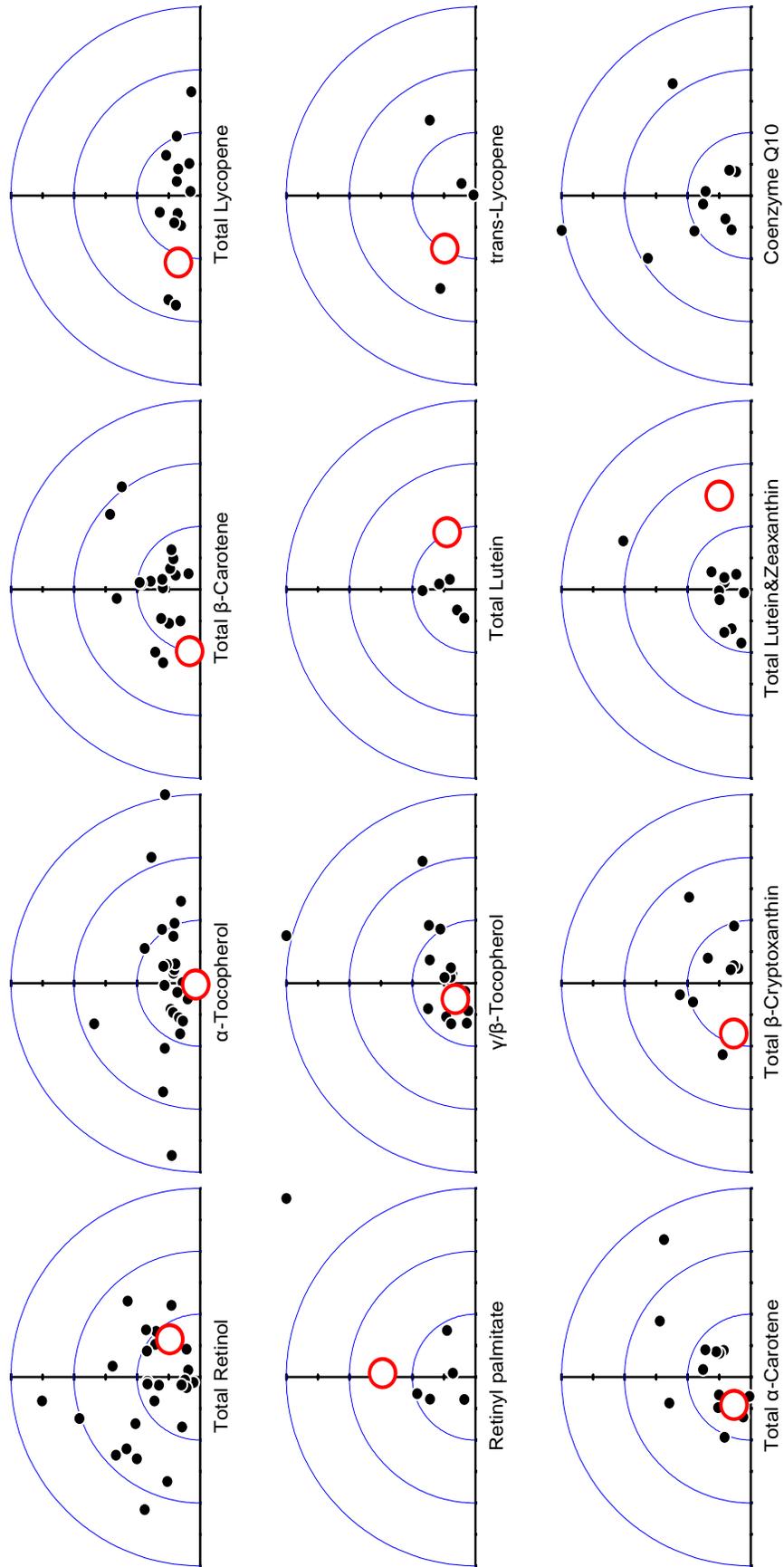
For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Serum	Comments	History
#412	Lyophilized, augmented {multi-analyte}, single-donor	40#231
#413	Fresh-frozen, native, multi-donor	74#401
#414	Fresh-frozen, native, single-donor	71#383, 72#390, 76#409
#415	Fresh-frozen, augmented {cR,γT}, single-donor	75#406
#416	Fresh-frozen, native, multi-donor: SRM 968e II	66#358, 67#364, 69#374, 71#386, 74#399, 76#401

This publication is available free of charge from: http://dx.doi.org/10.6028/NIST.IR.7880-45

Individualized Round Robin LXXVII Report: FSV-BB

Graphical Comparability Summary

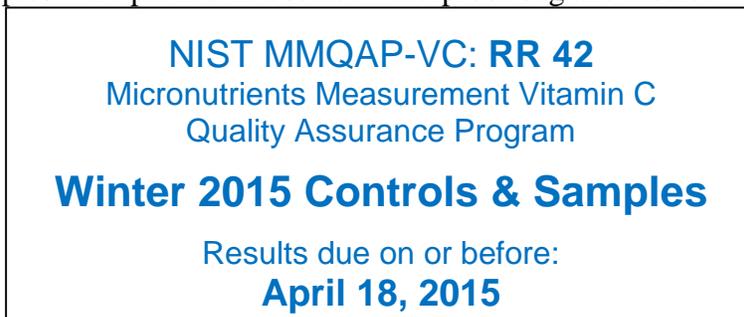


Appendix E. Shipping Package Inserts for RR42

The following three items were included in each package shipped to an RR42 participant:

- Cover letter
- Analysis of Control Materials and Test Samples Datasheet
- Packing List and Shipment Receipt Confirmation Form

The RR42 samples were packed in a sealed waterproof bag and labeled:



Cover letters describing the RR42 and RR43 studies, datasheets for both studies, and packing lists for both studies were enclosed in a sealed waterproof bag placed at the top of the shipping box, between the cardboard covering and the foam insulation.



February 10, 2015

Dear Colleague:

The samples within this package constitute Vitamin C Round Robin 42 (RR42) of the 2015 Micronutrients Measurement Quality Assurance Program. RR42 consists of one vial each of four frozen serum *test samples* (#421, #422, #423, and #424) and one vial each of two frozen *control sera* (CS#3 and CS#4). These materials are in sealed ampoules. They were prepared by adding equal volumes of 10% MPA to spiked human serum. We have checked the samples for stability and homogeneity. Only total ascorbic acid is stable. While these samples contain some dehydroascorbic acid, its content is variable. Therefore, only total ascorbic acid should be analyzed and reported.

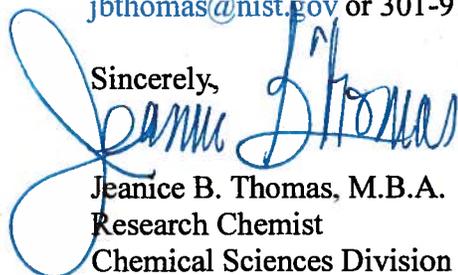
Please use the *control sera* to validate the performance of your measurement system before you analyze the *test samples*. The target value for CS#3 is $(15.5 \pm 1.6; 13.9 \text{ to } 17.1) \mu\text{mol/L}$ and the target for CS#4 is $(46.1 \pm 4.6; 41.5 \text{ to } 50.7) \mu\text{mol/L}$. We expect your results for both of these controls to be within this $\pm 10\%$ target range. If your results are significantly outside this range, your analysis system may not be suited to the analysis of MPA-preserved samples. In this case, please do **not** proceed to the analysis of the *test samples* but contact us at jbthomas@nist.gov or 301-975-3120.

The *test samples* and *control sera* should be defrosted by warming at 20 °C for not more than 10 min otherwise some irreversible degradation may occur. Please be aware that sample contact with any oxidant-contaminated surface (vials, glassware, etc.) may degrade your measurement system's performance (SA Margolis and E Park, "Stability of Ascorbic Acid in Solutions in Autosampler Vials", *Clinical Chemistry* 2001, 47(8), 1463-1464). You should suspect such degradation if you observe unusually large variation in replicate analyses.

Please measure the total ascorbic acid in each ampoule in duplicate, reporting in units of $\mu\text{mol}/(\text{L sample solution})$ rather than $\mu\text{mol}/(\text{L serum used to prepare the sample})$. Please email (david.duewer@nist.gov) or fax (301-977-0685) your results to us as soon as possible but no later than **May 18, 2015**.

Please report your results by e-mail to david.duewer@nist.gov or fax to 301-977-0685. If you have questions or comments regarding the studies, please contact us at 301-975-3120 (Jeanice); jbthomas@nist.gov or 301-975-3935 (Dave); david.duewer@nist.gov.

Sincerely,



Jeanice B. Thomas, M.B.A.
Research Chemist
Chemical Sciences Division
Material Measurement Laboratory



David L. Duewer, Ph.D.
Research Chemometrician
Chemical Sciences Division
Material Measurement Laboratory

Enclosure: RR42 Report Form for Control and Test Sample Analyses

Participant #: _____

Date: _____

Vitamin C Round Robin 42
NIST Micronutrient Measurement Quality Assurance Program

Analysis of Control Materials and Test Samples

Sample	Replicate 1	Replicate 2	Units
Control serum CS#3	_____	_____	$\mu\text{mol/L}$ of Sample <i>Target: (15.5 \pm 1.6) $\mu\text{mol/L}$</i>
Control serum CS#4	_____	_____	$\mu\text{mol/L}$ of Sample <i>Target: (46.1 \pm 4.6) $\mu\text{mol/L}$</i>
Test sample #421	_____	_____	$\mu\text{mol/L}$ of Sample
Test sample #422	_____	_____	$\mu\text{mol/L}$ of Sample
Test sample #423	_____	_____	$\mu\text{mol/L}$ of Sample
Test sample #424	_____	_____	$\mu\text{mol/L}$ of Sample

Were samples frozen upon receipt? Yes | No

Analysis method: HPLC-EC | HPLC-Fluor DAB | HPLC-OPD | HPLC-UV | AO-OPD | Other
If "Other", please describe:

Nature of samples you typically analyze: native | MPA-preserved | DTT-preserved | Other
If "Other", please describe:

COMMENTS:

Please return by **May 18, 2015**

MMQAP
100 Bureau Drive, Stop 8392
Gaithersburg, MD 20899-8392

Fax: 301-977-0685
Email: david.duewer@nist.gov

Participant #: _____

Date: _____

Vitamin C Round Robin 42
NIST Micronutrients Measurement Quality Assurance Program
Packing List and Shipment Receipt Confirmation Form

This box contains one vial each of the following **six** VitC M²QAP samples:

Label	Form
VitC #421	Liquid frozen (1:1 serum:10% MPA)
VitC #422	Liquid frozen (1:1 serum:10% MPA)
VitC #423	Liquid frozen (1:1 serum:10% MPA)
VitC #424	Liquid frozen (1:1 serum:10% MPA)
CS#3	Liquid frozen (1:1 serum:10% MPA)
CS#4	Liquid frozen (1:1 serum:10% MPA)

- Please**
- 1) Open the pack immediately
 - 2) Check that it contains one vial each of the above samples
 - 3) Check if the samples arrived frozen
 - 4) Store the samples at -20 °C or below until analysis
 - 5) Email (david.duewer@nist.gov) or fax (301-977-0685) us the following information:

1) Date this shipment arrived: _____

2) Are all of the vials intact? Yes | No
If "No", which one(s) were damaged?

3) Was there any dry-ice left in cooler? Yes | No

4) Did the samples arrive frozen? Yes | No

5) At what temperature are you storing the samples? _____ °C

Your prompt return of this information is appreciated.

The M²QAP Gang

Appendix F. Final Report for RR42

The following six pages are the final report for RR42 as provided to all participants:

- Cover letter.
- An information sheet that:
 - describes the contents of the “All-Lab” report,
 - describes the content of the “Individualized” report,
 - describes the nature of the test samples and details their previous distributions, if any, and
 - summarizes aspects of the study that we believe may be of interest to the participants.



UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-8390

June 15, 2015

Dear Colleague:

Enclosed is the summary report of the results for Round Robin 42 (RR42) for the measurement of total ascorbic acid (TAA, ascorbic acid plus dehydroascorbic acid) in human serum. Included in this report are a summary of data for all laboratories and an individualized summary of your laboratory's measurement performance. The robust median is used to estimate the consensus value for all samples, the "adjusted median absolute deviation from the median" (MADe) is used to estimate the expected standard deviation, and we estimate the coefficient of variation (CV) as $100 \times \text{MADe} / \text{median}$.

RR42 consisted of four test samples (#421, #422, #423, and #424) and one vial each of two frozen control serum control samples (CS #3 and CS #4). Details regarding the samples can be found in the enclosed report.

If you have concerns regarding your laboratory's performance, we suggest that you obtain and analyze a unit of Standard Reference Material (SRM) 970 Vitamin C in Frozen Human Serum. SRM 970 can be purchased from the NIST SRM Program at www.nist.gov/srm; phone: 301-975-6776; fax: 301-948-3730. If your measured values do not agree with the certified values, we suggest that you contact us for consultation.

The results for fat-soluble vitamins and carotenoids in serum "Round Robin" RLXXVIII (RR78) and vitamin C in serum RR43 are due on or before **September 1, 2015**. We will send you a reminder in July. If you have questions or concerns regarding this report, please contact David Duewer at 301-975-3935; e-mail: david.duewer@nist.gov or me at 301-975-3120; e-mail: jbthomas@nist.gov; or fax: 301-977-0685.

Sincerely,

Jeanice Brown Thomas, M.B.A.
Research Chemist
Chemical Sciences Division
Material Measurement Laboratory

David L. Duewer, Ph.D.
Research Chemometrician
Chemical Sciences Division
Material Measurement Laboratory

Enclosures

cc: R.D. van Zee

The NIST MMQAP Vitamin C Round Robin 42 (RR42) report consists of:

Page	“Individualized” Report
1	Summary of your reported values for the two serum control and four serum test samples.
2	Graphical summary of measurements made on the RR42 test samples.
3	Your RR42 measurements as a function of their expected values.

Page	“All-Lab” Report
1	A tabulation of results and summary statistics for total ascorbic acid [TAA] in the RR42 control and test samples. Results and summary statistics are also presented for the test samples calibrated to the results for the control samples. The consensus [TAA] content and inter-participant standard deviations are estimated using robust estimators.

Serum-Based Samples. Two serum controls and four test samples were distributed in RR42.

- CS#3 a (15.4 ±0.4) µmol/L material ampouled in 2009
- CS#4 a (46.2 ±1.2) µmol/L material ampouled in 2009
- S40:1 Ampouled in late 2009, previously distributed in RRs 32, 33, 35, 38, 40, and 41
- S40:2 Ampouled in late 2009, previously distributed in RRs 32, 35, 36, 38, and 41
- S40:3 Ampouled in late 2009, previously distributed in RRs 34, 36 (as two samples), 38, 40, and 41
- S40:4 SRM 970 level 1, ampouled in mid-1998, previously distributed as a test sample in RRs 11 to 16, 19, 20 23, 25, 29, 31, 34, 37, 39, and 41

Results.

- 1) The reported [TAA] contents of the two control sera, CS#3 and CS#4, are unchanged from the values estimated for these materials when they were distributed as test samples.
- 2) There is no evidence for any significant change in the [TAA] level or interlaboratory variability for any of the samples.
- 3) The proportional re-calibration model, $[TAA]_{\text{reportedCS}} = b \times [TAA]_{\text{referenceCS}}$, continues to perform better than the linear model, $[TAA]_{\text{reportedCS}} = a + b \times [TAA]_{\text{referenceCS}}$, at 10 µmol/L and below. They are about the same for [TAA] 20 µmol/L and above.

Appendix G. “All-Lab Report” for RR42

The following two pages are the “All-Lab Report” for RR42 as provided to all participants, with the following exceptions:

- the participant identifiers (Lab) have been altered.
- the order in which the participant results are listed has been altered.
- the Legend page has been added.

The data summary in the “All-Lab Report” has been altered to ensure confidentiality of identification codes assigned to laboratories.

Micronutrients Measurement Quality Assurance Program for Total Ascorbic Acid "Round Robin" 42 - Winter 2015

Lab	Date	Samples						Calibrated Results: [TAA] = TAA/b						Calibrated Results: [TAA]' = (TAA-a)/b										
		Total Ascorbic Acid ([TAA]), μmol/L						[TAA], μmol/L						Parameters										
		CS#3	CS#4	S42:1	S42:2	S42:3	S42:4	S42:1'	S42:2'	S42:3'	S42:4'	b	a	S42:1'	S42:2'	S42:3'	S42:4'	b	a	S42:1'	S42:2'	S42:3'	S42:4'	
VC-MB	11/03/15	15.5	48.0	23.7	32.0	59.6	8.3	1.04	22.8	30.7	57.1	7.9	1.06	-0.6	23.0	30.8	56.9	8.4	1.06	-0.6	23.0	30.8	56.9	8.4
VC-MC	14/05/15	16.1	48.0	23.9	32.2	59.7	8.0	1.05	22.9	30.7	57.0	7.6	1.04	0.3	22.8	30.7	57.1	7.4	1.04	0.3	22.8	30.7	57.1	7.4
VC-MG	01/05/15	15.2	48.9	24.0	32.0	60.6	7.7	1.06	22.6	30.2	57.2	7.3	1.10	-1.5	23.2	30.5	56.5	8.4	1.10	-1.5	23.2	30.5	56.5	8.4
VC-MI	18/05/15	16.0	49.1	26.3	32.3	61.0	7.8	1.07	24.6	30.3	57.1	7.3	1.08	-0.4	24.8	30.3	56.9	7.6	1.08	-0.4	24.8	30.3	56.9	7.6
VC-MJ	13/04/15	22.7	53.2	32.7	38.3	64.7	11.7	1.19	27.4	32.2	54.3	9.8	0.99	7.6	25.2	30.9	57.5	4.1	0.99	7.6	25.2	30.9	57.5	4.1
VC-MN	12/03/15	15.9	46.2	24.7	31.5	55.4	9.6	1.01	24.4	31.2	54.8	9.5	1.01	0.8	24.1	31.0	55.1	8.9	0.99	0.8	24.1	31.0	55.1	8.9
VC-NM	09/04/15	12.2	40.7	20.1	27.0	51.0	6.7	0.88	22.8	30.7	58.0	7.6	0.93	-2.0	23.7	31.1	56.9	9.3	0.93	-2.0	23.7	31.1	56.9	9.3
N		7	7	7	7	7	7		7	7	7	7		7	7	7	7		7	7	7	7	7	7
Average		16.2	47.7	25.0	32.2	58.8	8.5		23.9	30.8	56.5	8.2		23.8	30.8	56.7	7.7		23.8	30.8	56.7	7.7	7.7	
SD		3.2	3.7	3.8	3.3	4.4	1.6		1.7	0.7	1.4	1.1		0.9	0.3	0.8	1.7		0.9	0.3	0.8	1.7	1.7	
Min		12.2	40.7	20.1	27.0	51.0	6.7		22.6	30.2	54.3	7.3		22.8	30.3	55.1	4.1		22.8	30.3	55.1	4.1	4.1	
%25		15.3	47.1	23.8	31.8	57.5	7.8		22.8	30.5	55.9	7.4		23.1	30.6	56.7	7.5		23.1	30.6	56.7	7.5	7.5	
Median		15.9	48.0	24.0	32.0	59.7	8.0		22.9	30.7	57.1	7.6		23.7	30.8	56.9	8.4		23.7	30.8	56.9	8.4	8.4	
%75		16.0	49.0	25.5	32.2	60.8	8.9		24.5	30.9	57.2	8.7		24.4	31.0	57.0	8.7		24.4	31.0	57.0	8.7	8.7	
Max		22.7	53.2	32.7	38.3	64.7	11.7		27.4	32.2	58.0	9.8		25.2	31.1	57.5	9.3		25.2	31.1	57.5	9.3	9.3	
eSD		0.5	1.6	1.0	0.4	1.9	0.4		0.4	0.6	0.2	0.5		1.0	0.3	0.3	1.2		1.0	0.3	0.3	1.2	1.2	
eCV		3	3	4	1	3	5		2	2	0	7		4	1	1	14		4	1	1	14	14	

Appendix H. Representative “Individualized Report” for RR42

Each participant in RR42 received an “Individualized Report” reflecting their reported results. The following three pages are the “Individualized Report” for participant “VC-MB”.

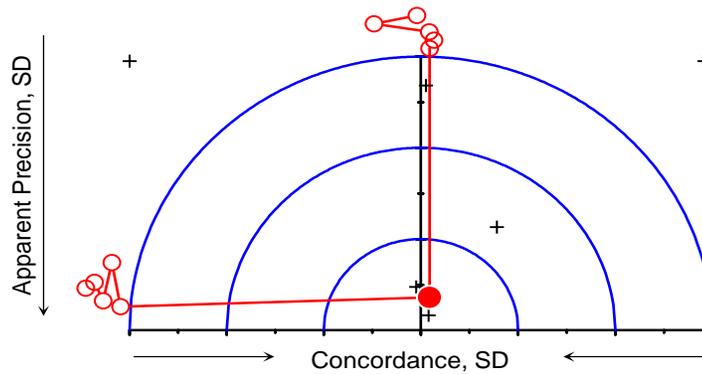
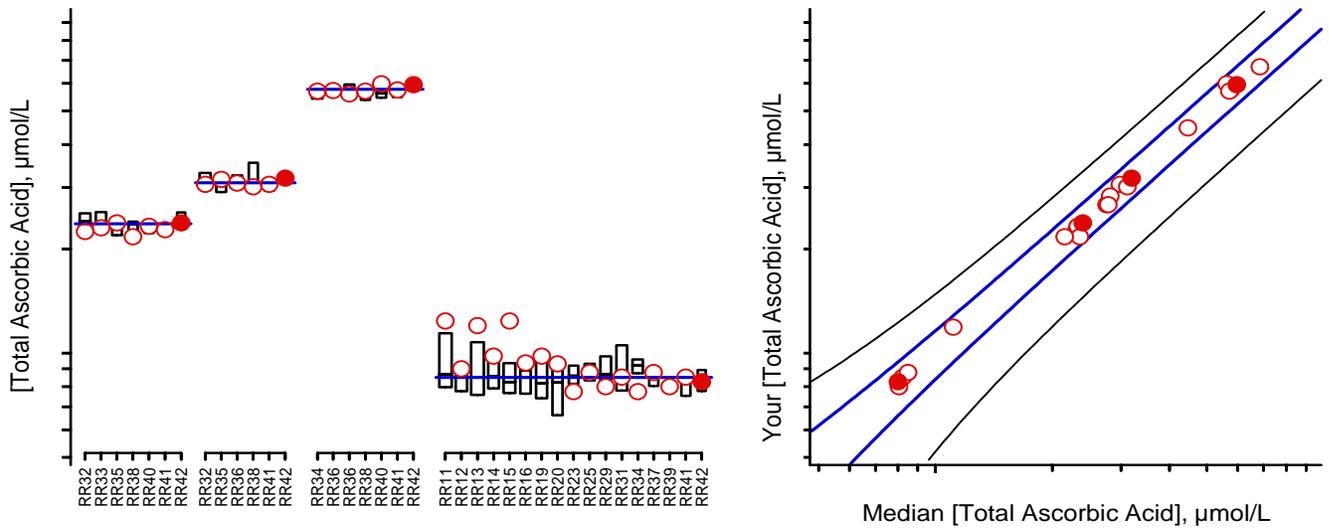
Vitamin C "Round Robin" 42 Report: Participant VC-MB

Date	RR	Sample	[TAA] mmol/Lsample					N	Mean	SD _{repeat}	SD _{reprod}
			Rep ₁	Rep ₂	F _{adj}	Mean	SD _{dup}				
01/13/10	32	S32:2	22.2	22.7	1.0	22.5	0.4	7	22.9	0.5	0.8
07/23/10	33	S33:4	23.2	22.7	1.0	23.0	0.4				
06/13/11	35	S35:2	23.7	23.7	1.0	23.7	0.0				
02/27/13	38	S38:2	21.2	22.2	1.0	21.7	0.7				
02/24/14	40	S40:3	23.7	22.7	1.0	23.2	0.7				
08/14/14	41	S41:3	22.2	23.2	1.0	22.7	0.7				
03/11/15	42	S42:1	23.7	23.7	1.0	23.7	0.0				
01/13/10	32	S32:3	30.5	31.0	1.0	30.7	0.4	6	31.1	0.4	0.7
06/13/11	35	S35:3	32.0	31.5	1.0	31.7	0.4				
03/07/12	36	S36:2	31.5	30.5	1.0	31.0	0.7				
02/27/13	38	S38:3	29.9	30.5	1.0	30.2	0.4				
08/14/14	41	S41:2	30.5	31.0	1.0	30.7	0.4				
03/11/15	42	S42:2	32.0	32.0	1.0	32.0	0.0				
01/14/11	34	S34:4	56.8	57.3	1.0	57.0	0.4	7	57.8	0.6	1.4
03/07/12	36	S36:1	57.8	56.8	1.0	57.3	0.7				
03/07/12	36	S36:4	56.8	55.2	1.0	56.0	1.1				
02/27/13	38	S38:4	57.3	56.8	1.0	57.0	0.4				
02/24/14	40	S40:4	59.9	59.9	1.0	59.9	0.0				
08/14/14	41	S41:1	57.3	57.8	1.0	57.6	0.4				
03/11/15	42	S42:3	59.4	59.9	1.0	59.6	0.4				
09/25/98	11	S11:1	25.0	25.0	0.5	12.5	0.0				
02/26/99	12	S12:1	18.0	18.0	0.5	9.0	0.0				
03/03/00	13	S13:1	24.0	24.0	0.5	12.0	0.0				
03/26/01	14	S14:3	19.6	19.6	0.5	9.8	0.0				
09/05/01	15	S15:1	25.8	23.7	0.5	12.4	0.7				
02/08/02	16	S16:1	18.7	18.7	0.5	9.4	0.0				
05/01/03	19	S19:4	19.6	19.6	0.5	9.8	0.0				
03/01/04	20	S20:3	7.8	10.9	1.0	9.3	2.2				
05/25/05	23	S23:4	7.7	7.7	1.0	7.7	0.0				
05/24/06	25	S25:1	8.8	8.8	1.0	8.8	0.0				
06/20/08	29	S29:2	8.3	7.7	1.0	8.0	0.4				
08/05/09	31	S31:3	8.8	8.3	1.0	8.5	0.4				
01/14/11	34	S34:1	7.7	7.7	1.0	7.7	0.0				
08/06/12	37	S37:1	8.8	na	1.0	8.8					
08/01/13	39	S39:1	8.3	7.7	1.0	8.0	0.4				
08/14/14	41	S41:4	8.8	8.3	1.0	8.5	0.4				
03/11/15	42	S42:4	8.3	8.3	1.0	8.3	0.0				

Please check our records against your records. Send corrections and/or updates to...

Vitamin C "Round Robin" 42 Report: Participant VC-MB

Total Ascorbic Acid, $\mu\text{mol/mL}$



3rd Quartile (75%)
 Median (50%)
 1st Quartile (25%)
 ● You, this RR
○ You, past RRs
+ Others, this RR

For details of the construction and interpretation of these plots, see:
 Duewer, Kline, Sharpless, Brown Thomas, Gary, Sowell. Anal Chem 1999;71(9):1870-8.

Sample

Comments

- S42:1 Prepared 2009; distributed RRs 32,33,35,38,40,41
- S42:2 Prepared 2009; distributed RRs 32,33,35,38,41
- S42:3 Prepared 2009; distributed RRs 34,36(dups),38,40,41
- S42:4 SRM970 Lv I; prepared 1998; distributed as unknowns RRs 11 - 16,19,20,23,25,29,31,34,37,39,41

This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.JR.7880-45>