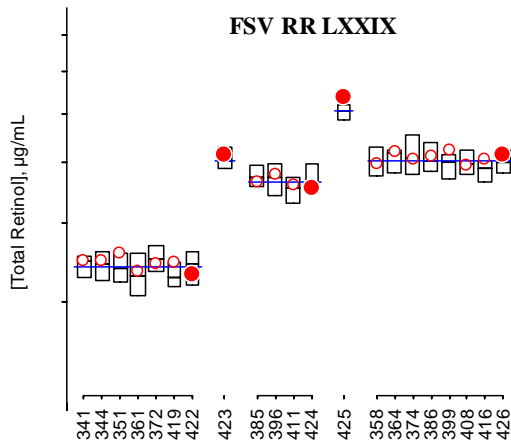


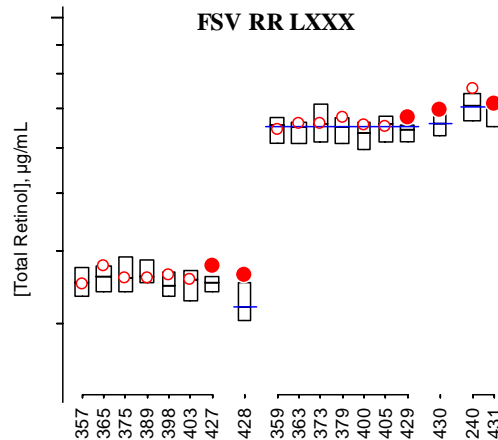
NIST Micronutrients Measurement Quality Assurance Program Winter and Summer 2016 Comparability Studies

Results for Round Robins LXXIX and LXXX
Fat-Soluble Vitamins and Carotenoids in Human Serum



David L. Duewer
Jeanice B. Thomas

This publication is available free of charge from:
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NISTIR 7880-47

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**Results for Round Robin LXXIX and LXXX
Fat-Soluble Vitamins and Carotenoids in Human Serum**

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Jeanice B. Thomas
*Chemical Sciences Division
Material Measurement Laboratory*

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March 2017



U.S. Department of Commerce
Wilbur L. Ross, Jr., Secretary

National Institute of Standards and Technology
Kent Rochford, Acting NIST Director and Under Secretary of Commerce for Standards and Technology

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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-soluble vitamins and carotenoids in human serum and plasma. This report describes the design of and results for the Winter and Summer 2016 MMQAP measurement comparability improvement studies: 1) Round Robin LXXIX Fat-Soluble Vitamins and Carotenoids in Human Serum (RR79) and 2) Round Robin LXXX Fat-Soluble Vitamins and Carotenoids in Human Serum (RR80). The RR79 samples were shipped in early March 2016, with results due May 16, 2016. The RR80 samples were shipped in late June 2016, with results due September 12, 2016.

Keywords

Human Serum

Retinol, α -Tocopherol, γ -Tocopherol, Total β -Carotene

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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 coenzyme Q10) 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]

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

Participants in the MMQAP Fat-Soluble Vitamins and Carotenoids in Human Serum Round Robin LXXIX comparability study (hereafter referred to as RR79) received five 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 March 2016. Participants were requested to provide their measurement results by May 16, 2016. 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 RR79 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 [2]. An example Individualized Report is reproduced as Appendix D.

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

Participants in the MMQAP Fat-Soluble Vitamins and Carotenoids in Human Serum Round Robin LXXX comparability study (hereafter referred to as RR80) received one lyophilized human serum 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 June 2016. Participants were requested to provide their measurement results by September 12, 2016. The communication materials included in the sample shipment are provided in Appendix E.

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 RR80 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 F.
- 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 G.
- 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 [2]. 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 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 RR79

The following items were included in each package shipped to an RR79 participant:

- Cover letter for Round Robin LXXIX (RR79), enclosed in a sealed waterproof bag.
- Datasheet for RR79. This was enclosed in the same sealed waterproof bag that contained the cover letter.
- Packing List and Shipment Receipt Confirmation Form for RR79.

This RR79 samples were enclosed in a bubble-wrapped sealed plastic bag

The packing list was placed at the top of the shipping box, between the cardboard covering and the foam insulation.



March 9, 2016

Dear Colleague:

Our sample distribution schedule for the 2016 NIST Micronutrients Measurement Quality Assurance Program (MMQAP) has been changed from that of last year in which we combined samples for the entire year into one shipment. Enclosed are samples for the first fat-soluble vitamins and carotenoids in serum study (RR79). Because we are in the process of preparing new sera pools for future studies, you will receive samples for the second comparability study (RR80) in a separate shipment during the latter part of June.

RR79 consists of one vial each of five liquid-frozen serum samples for analysis. Samples should be stored in the dark at or below $-20\text{ }^{\circ}\text{C}$ upon receipt. When reporting your results, please use the enclosed form and 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 RR79 by **May 16, 2016**. 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 for RR79 will be distributed early June. 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 LXXIX: Human Sera
NIST Micronutrients Measurement Quality Assurance Program

| Analyte | 422 | 423 | 424 | 425 | 426 | 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:

This publication is available free of charge from: <https://doi.org/10.6028/NIST.JR.7880-47>

Please return results by
16-May-2016

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

A3

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

Participant #: _____

Date: _____

Fat-Soluble Vitamins Round Robin LXXIX
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 |
|-------|---------------|---------------|---------------------|
| #422 | Liquid frozen | No | 10 mL amber, silver |
| #423 | Liquid frozen | No | 2 mL amber / gold |
| #424 | Liquid frozen | No | 2 mL amber / black |
| #425 | Liquid frozen | No | 2 mL amber / silver |
| #426 | Liquid frozen | No | 2 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

Please return results by
16-May-2016

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

A4

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

Appendix B. Final Report for RR79

The following two pages are the final report for RR79 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 20, 2016

Dear Colleague:

Enclosed is the summary report of the results for “Round Robin” LXXIX (RR79) of the 2016 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. RR79 (Sera 422 to 426) consisted of one vial each of five 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.

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: 301-979-0685.

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

The NIST MMQAP Round Robin LXXIX (RR79) 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 RR79.

| Serum | Description | Prior Distributions |
|-------|--|---|
| 422 | Fresh-frozen, native, multi-donor serum prepared in Fall, 2007. This was SRM 968d. | #341 & #344:RR63-3/08, #351:RR64-9/08, #361:RR66-9/09 #372:RR69-3/11, #419:RR78 |
| 423 | Fresh-frozen, native, multi donor serum, prepared in 2011. This is SRM 972a Level 2, a vitamin D metabolite validation material. | Initial FSV distribution |
| 424 | Fresh-frozen, two donor, prepared in 2011. | #385:RR71-3/12;#396:RR73-3/13 #411:RR76-9/14 |
| 425 | Fresh-frozen, native, multi donor serum, prepared in 2012. This is the VitDQAP material “VitDQAP-1.” | Initial FSV distribution |
| 426 | Fresh-frozen, native, multi-donor, prepared in 2009. This is Level II of SRM 968e. | #358:RR66-9/09, #364:RR67-3/10, #374:RR69-3/11, #386:RR71-3/12 #399:RR74-9/13 |

Results

- 1) **Stability:** There has been no significant change in the concentration nor variability of any of the sera, with the possible exception of “Total Lutein & Zeaxanthin” in the serum #422 (SRM 968d). Since “Total Lutein” for this material appears to stable, any decline would come from loss of “Total Zeaxanthin.” Zeaxanthin is the analyte most likely to decrease over time; however, there are too few data to directly evaluate the zeaxanthin level.
- 2) **Sera 423 and 425:** These materials previously have been characterized only for vitamin D metabolites: 25(OH)D₂, 25(OH)D₃, and 3-*epi*-25(OH)D₃. With the consolidation of the ClinQAP programs, we are repurposing a number of our serum materials.

Appendix C. “All-Lab Report” for RR79

The following six pages are the “All-Lab Report” for RR79 as provided to all participants, with two exceptions:

- the participant identifiers (Lab) have been altered and
- 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 LXXIX Laboratory Results

| Lab | Total Retinol, µg/mL | | | | | Retinyl Palmitate, µg/mL | | | | | α-Tocopherol, µg/mL | | | | | γ/β-Tocopherol, µg/mL | | | | | Total β-Carotene, µg/mL | | | | |
|------------------------|----------------------|--------|--------|--------|--------|--------------------------|-------|-------|-------|-------|---------------------|-------|------|-------|-------|-----------------------|------|------|------|------|-------------------------|-------|-------|-------|-------|
| | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 |
| FSV-BC | 0.310 | 0.490 | 0.440 | 0.580 | 0.490 | 0.022 | 0.020 | 0.023 | 0.058 | 0.053 | 6.80 | 12.50 | 7.80 | 11.90 | 10.80 | 1.53 | 1.94 | 1.89 | 1.49 | 1.50 | 0.070 | 0.240 | 0.060 | 0.230 | 0.280 |
| FSV-BD | 0.359 | 0.561 | 0.504 | 0.664 | 0.525 | | | | | | 6.53 | 12.58 | 7.92 | 12.20 | 11.64 | | | | | | | | | | |
| FSV-BE | 0.360 | 0.540 | 0.500 | 0.700 | 0.560 | | | | | | 5.46 | 11.21 | ! | 10.49 | 10.14 | | | | | | | | | | |
| FSV-BFa | 0.279 | 0.429 | ! | 0.501 | 0.506 | | | | | | 5.47 | 10.44 | 6.67 | 10.19 | 9.57 | | | | | | | | | | |
| FSV-BG | 0.331 | 0.515 | 0.457 | 0.637 | 0.516 | | | | | | 5.71 | 9.04 | 8.37 | 8.00 | 9.69 | | | | | | | | | | |
| FSV-BH | 0.338 | 0.505 | 0.463 | 0.605 | 0.522 | | | | | | 6.03 | 12.76 | 7.81 | 11.62 | 11.00 | | | | | | | | | | |
| FSV-BJ | 0.333 | 0.519 | 0.470 | 0.617 | 0.502 | | | | | | 6.06 | 10.84 | 6.95 | 10.43 | 9.93 | | | | | | | | | | |
| FSV-BK | 0.381 | 0.500 | 0.446 | 0.604 | 0.488 | | | | | | 6.50 | 10.80 | 7.30 | 10.30 | 9.90 | | | | | | | | | | |
| FSV-BL | 0.370 | 0.520 | 0.460 | 0.600 | 0.490 | | | | | | 5.50 | 10.80 | 7.40 | 9.80 | 10.30 | | | | | | | | | | |
| FSV-BM | 0.355 | 0.461 | 0.479 | 0.547 | 0.530 | | | | | | 5.74 | 11.99 | 7.69 | 10.53 | 10.34 | | | | | | | | | | |
| FSV-BN | 0.350 | 0.554 | 0.511 | 0.618 | 0.525 | | | | | | 6.56 | 11.95 | 7.53 | 10.63 | 10.13 | | | | | | | | | | |
| FSV-BR | 0.367 | 0.539 | 0.496 | 0.640 | 0.544 | | | | | | 6.57 | 13.30 | 8.48 | 11.75 | 11.76 | | | | | | | | | | |
| FSV-BS | ≥0.330 | ≥0.471 | ≥0.425 | ≥0.503 | ≥0.428 | | | | | | 5.04 | 11.72 | 6.75 | 10.65 | 10.42 | | | | | | | | | | |
| FSV-BT | 0.475 | 0.470 | 0.538 | 0.564 | 0.465 | | | | | | 5.25 | 10.65 | 6.99 | 10.09 | 9.93 | | | | | | | | | | |
| FSV-BU | 0.398 | 0.605 | 0.550 | 0.730 | 0.600 | | | | | | 6.00 | 11.48 | 7.22 | 10.58 | 10.49 | | | | | | | | | | |
| FSV-BV | 0.396 | 0.599 | 0.533 | 0.705 | 0.563 | | | | | | 5.69 | 11.04 | 7.07 | 10.71 | 10.54 | | | | | | | | | | |
| FSV-BW | 0.330 | 0.500 | 0.470 | 0.620 | 0.500 | 0.003 | 0.020 | 0.006 | 0.016 | 0.018 | 6.03 | 11.40 | 7.09 | 10.74 | 9.20 | | | | | | | | | | |
| FSV-CD | 0.360 | 0.510 | 0.450 | 0.620 | 0.440 | | | | | | 5.42 | 11.77 | 7.13 | 10.81 | 10.46 | | | | | | | | | | |
| FSV-CE | 0.350 | 0.520 | 0.460 | 0.590 | 0.510 | | | | | | 6.00 | 11.80 | 7.60 | 10.70 | 10.10 | | | | | | | | | | |
| FSV-CF | 0.320 | 0.496 | 0.445 | 0.560 | 0.455 | | | | | | 3.83 | 8.27 | 4.85 | 7.77 | 7.17 | | | | | | | | | | |
| FSV-CG | 0.280 | 0.412 | 0.350 | 0.479 | 0.413 | | | | | | 4.63 | 10.65 | 7.02 | 9.15 | 10.07 | | | | | | | | | | |
| FSV-CI | 0.316 | 0.486 | 0.439 | 0.596 | 0.485 | 0.013 | 0.007 | 0.014 | 0.024 | 0.036 | 5.36 | 11.55 | 7.49 | 10.91 | 10.60 | | | | | | | | | | |
| FSV-CO | 0.310 | 0.502 | 0.455 | 0.607 | 0.495 | | | | | | 4.87 | 11.81 | 6.90 | 11.18 | 9.91 | | | | | | | | | | |
| FSV-CZ | 0.345 | 0.505 | 0.455 | 0.606 | 0.509 | | | | | | 4.80 | 9.50 | 6.50 | 8.90 | 9.00 | | | | | | | | | | |
| FSV-DV | 0.358 | 0.545 | 0.502 | 0.606 | 0.541 | | | | | | 5.60 | 11.00 | 7.20 | 9.30 | 10.20 | | | | | | | | | | |
| FSV-EE | | | | | | | | | | | 6.09 | 11.60 | 7.40 | 11.00 | 10.49 | | | | | | | | | | |
| FSV-FK | 0.319 | 0.488 | 0.439 | 0.602 | 0.468 | 0.023 | 0.024 | 0.020 | 0.039 | 0.043 | 5.86 | 11.76 | 7.30 | 10.58 | 10.28 | | | | | | | | | | |
| FSV-FZ | 0.340 | 0.477 | 0.470 | 0.613 | 0.456 | | | | | | 6.20 | 12.00 | 8.20 | 11.00 | 11.20 | | | | | | | | | | |
| FSV-GD | 0.312 | 0.490 | 0.445 | 0.582 | 0.478 | | | | | | | | | | | | | | | | | | | | |
| FSV-GF | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-GG | | | | | | | | | | | | | | | | | | | | | | | | | |
| N | 27 | 27 | 26 | 27 | 27 | 4 | 4 | 4 | 4 | 4 | 28 | 28 | 27 | 28 | 28 | 15 | 15 | 15 | 15 | 15 | 17 | 17 | 17 | 17 | 17 |
| Min | 0.279 | 0.412 | 0.350 | 0.479 | 0.413 | 0.003 | 0.007 | 0.006 | 0.016 | 0.018 | 3.83 | 8.27 | 4.85 | 7.77 | 7.17 | 1.06 | 1.44 | 1.25 | 1.06 | 1.08 | 0.044 | 0.150 | 0.029 | 0.151 | 0.168 |
| Median | 0.345 | 0.505 | 0.462 | 0.606 | 0.502 | 0.017 | 0.020 | 0.017 | 0.032 | 0.040 | 5.73 | 11.51 | 7.30 | 10.61 | 10.24 | 1.36 | 1.90 | 1.77 | 1.38 | 1.42 | 0.079 | 0.218 | 0.054 | 0.210 | 0.246 |
| Max | 0.475 | 0.605 | 0.550 | 0.730 | 0.600 | 0.023 | 0.024 | 0.023 | 0.058 | 0.053 | 6.80 | 13.30 | 8.48 | 12.20 | 11.76 | 1.59 | 2.29 | 2.09 | 1.53 | 1.61 | 0.096 | 0.250 | 0.065 | 0.270 | 0.280 |
| eSD | 0.033 | 0.025 | 0.025 | 0.024 | 0.034 | 0.007 | 0.003 | 0.006 | 0.017 | 0.013 | 0.52 | 0.74 | 0.46 | 0.58 | 0.46 | 0.15 | 0.18 | 0.15 | 0.09 | 0.14 | 0.016 | 0.025 | 0.009 | 0.019 | 0.021 |
| eCV | 9 | 5 | 5 | 4 | 7 | 42 | 15 | 38 | 54 | 32 | 9 | 6 | 6 | 6 | 5 | 11 | 9 | 8 | 7 | 10 | 21 | 12 | 18 | 9 | 8 |
| N _{past} | 30 | 0 | 30 | 0 | 30 | 7 | 0 | 5 | 0 | 7 | 31 | 0 | 29 | 0 | 30 | 20 | 0 | 17 | 0 | 17 | 21 | 0 | 20 | 0 | 21 |
| Median _{past} | 0.340 | 0.468 | 0.468 | 0.503 | 0.503 | 0.010 | 0.016 | 0.016 | 0.028 | 0.028 | 5.72 | 7.40 | 7.40 | 10.31 | 10.49 | 1.41 | 1.78 | 1.41 | 1.40 | 1.40 | 0.077 | 0.063 | 0.053 | 0.240 | 0.240 |
| SD _{past} | 0.027 | 0.035 | 0.035 | 0.036 | 0.036 | 0.006 | 0.035 | 0.012 | 0.011 | 0.011 | 0.68 | 0.67 | 0.67 | 0.73 | 0.73 | 0.14 | 0.09 | 0.11 | 0.11 | 0.11 | 0.015 | 0.009 | 0.009 | 0.025 | 0.025 |
| NAV | 0.345 | 0.505 | 0.462 | 0.606 | 0.502 | 0.017 | 0.020 | 0.017 | 0.032 | 0.040 | 5.73 | 11.51 | 7.30 | 10.61 | 10.24 | 1.36 | 1.90 | 1.77 | 1.38 | 1.42 | 0.079 | 0.218 | 0.054 | 0.210 | 0.246 |
| NAU | 0.033 | 0.041 | 0.037 | 0.048 | 0.040 | 0.017 | 0.020 | 0.017 | 0.032 | 0.040 | 0.52 | 0.89 | 0.60 | 0.82 | 0.80 | 0.15 | 0.20 | 0.19 | 0.16 | 0.16 | 0.016 | 0.033 | 0.011 | 0.032 | 0.037 |

Round Robin LXXIX Laboratory Results

| Lab | trans-β-Carotene, µg/mL | | | | Total cis-β-Carotene, µg/mL | | | | Total α-Carotene, µg/mL | | | | Total Lycopene, µg/mL | | | | trans-Lycopene, µg/mL | | | |
|------------------------|-------------------------|-------|-------|-------|-----------------------------|-------|-------|-------|-------------------------|-------|-------|-------|-----------------------|-------|-------|-------|-----------------------|-------|-------|-------|
| | 422 | 423 | 424 | 425 | 422 | 423 | 424 | 425 | 0 | 0 | 0 | 0 | 422 | 423 | 424 | 425 | 422 | 423 | 424 | 425 |
| FSV-BC | | | | | | | | | | | | | | | | | | | | |
| FSV-BD | | | | | | | | | | | | | | | | | | | | |
| FSV-BE | | | | | | | | | | | | | | | | | | | | |
| FSV-BFa | | | | | | | | | | | | | | | | | | | | |
| FSV-BG | | | | | | | | | 0.010 | 0.070 | 0.021 | 0.060 | 0.279 | 0.404 | 0.238 | 0.456 | 0.128 | 0.205 | 0.120 | 0.238 |
| FSV-BH | | | | | | | | | nq | 0.067 | nq | 0.058 | 0.252 | 0.395 | 0.248 | 0.490 | 0.156 | 0.224 | 0.133 | 0.239 |
| FSV-BJ | | | | | | | | | 0.013 | 0.077 | 0.025 | 0.051 | 0.318 | 0.423 | 0.276 | 0.435 | 0.055 | 0.085 | 0.055 | 0.096 |
| FSV-BK | | | | | | | | | | | | | | | | | | | | |
| FSV-BL | | | | | | | | | | | | | | | | | | | | |
| FSV-BM | | | | | | | | | | | | | | | | | | | | |
| FSV-BN | | | | | | | | | 0.015 | 0.114 | 0.031 | 0.091 | 0.223 | 0.428 | 0.233 | 0.430 | 0.156 | 0.224 | 0.133 | 0.239 |
| FSV-BR | | | | | | | | | | | | | | | | | | | | |
| FSV-BS | 0.092 | 0.213 | 0.064 | 0.208 | 0.007 | 0.016 | 0.008 | 0.016 | 0.041 | 0.107 | 0.054 | 0.098 | 0.188 | 0.252 | 0.163 | 0.283 | 0.055 | 0.085 | 0.055 | 0.096 |
| FSV-BT | 0.086 | 0.219 | 0.057 | 0.213 | 0.007 | 0.016 | 0.008 | 0.016 | 0.010 | 0.084 | 0.028 | 0.069 | 0.181 | 0.254 | 0.151 | 0.280 | 0.156 | 0.224 | 0.133 | 0.239 |
| FSV-BU | | | | | | | | | nd | 0.132 | 0.038 | 0.090 | 0.263 | 0.421 | 0.237 | 0.442 | | | | |
| FSV-BV | | | | | | | | | 0.006 | 0.072 | 0.020 | 0.057 | 0.266 | 0.408 | 0.229 | 0.456 | | | | |
| FSV-BW | | | | | | | | | 0.006 | 0.108 | 0.026 | 0.077 | 0.213 | 0.329 | 0.199 | 0.396 | | | | |
| FSV-CD | | | | | | | | | nq | 0.080 | nq | 0.060 | 0.380 | 0.540 | 0.310 | 0.650 | | | | |
| FSV-CE | | | | | | | | | | | | | | | | | | | | |
| FSV-CF | | | | | | | | | | | | | | | | | | | | |
| FSV-CG | 0.048 | 0.141 | 0.028 | 0.142 | 0.005 | 0.005 | 0.005 | 0.005 | 0.004 | 0.063 | 0.014 | 0.051 | 0.177 | 0.323 | 0.166 | 0.360 | 0.083 | 0.163 | 0.079 | 0.186 |
| FSV-CI | | | | | | | | | 0.013 | 0.090 | 0.028 | 0.074 | 0.246 | 0.377 | 0.239 | 0.433 | | | | |
| FSV-CO | | | | | | | | | 0.010 | 0.081 | 0.023 | 0.066 | | | | | | | | |
| FSV-CZ | | | | | | | | | | | | | | | | | | | | |
| FSV-DV | | | | | | | | | | | | | | | | | | | | |
| FSV-EE | | | | | | | | | | | | | | | | | | | | |
| FSV-FK | | | | | | | | | | | | | | | | | | | | |
| FSV-FZ | | | | | | | | | | | | | | | | | | | | |
| FSV-GD | 0.073 | 0.188 | 0.047 | 0.193 | 0.011 | 0.026 | 0.007 | 0.027 | 0.012 | 0.090 | 0.025 | 0.072 | 0.248 | 0.367 | 0.227 | 0.418 | | | | |
| FSV-GF | | | | | | | | | | | | | | | | | | | | |
| FSV-GG | | | | | | | | | | | | | | | | | | | | |
| N | 4 | 4 | 4 | 4 | 3 | 3 | 3 | 3 | 11 | 14 | 12 | 14 | 13 | 13 | 13 | 13 | 4 | 4 | 4 | 4 |
| Min | 0.048 | 0.141 | 0.028 | 0.142 | 0.005 | 0.005 | 0.005 | 0.005 | 0.004 | 0.063 | 0.014 | 0.051 | 0.177 | 0.252 | 0.151 | 0.280 | 0.055 | 0.085 | 0.055 | 0.096 |
| Median | 0.080 | 0.201 | 0.052 | 0.201 | 0.007 | 0.016 | 0.007 | 0.016 | 0.010 | 0.083 | 0.026 | 0.068 | 0.248 | 0.395 | 0.233 | 0.433 | 0.105 | 0.184 | 0.100 | 0.212 |
| Max | 0.092 | 0.219 | 0.064 | 0.213 | 0.011 | 0.026 | 0.008 | 0.027 | 0.041 | 0.132 | 0.054 | 0.098 | 0.380 | 0.540 | 0.310 | 0.650 | 0.156 | 0.224 | 0.133 | 0.239 |
| eSD | 0.014 | 0.023 | 0.013 | 0.015 | | | | | 0.004 | 0.017 | 0.005 | 0.014 | 0.046 | 0.042 | 0.022 | 0.034 | 0.054 | 0.045 | 0.040 | 0.039 |
| eCV | 18 | 11 | 24 | 7 | | | | | 36 | 20 | 20 | 20 | 18 | 11 | 10 | 8 | 51 | 24 | 40 | 19 |
| N _{past} | 8 | 0 | 5 | 0 | 6 | 0 | 6 | 0 | 15 | 0 | 15 | 0 | 16 | 0 | 15 | 0 | 7 | 0 | 6 | 0 |
| Median _{past} | 0.073 | 0.050 | 0.006 | 0.021 | 0.005 | 0.005 | 0.005 | 0.005 | 0.009 | 0.025 | 0.025 | 0.032 | 0.265 | 0.239 | 0.239 | 0.597 | 0.116 | 0.123 | 0.029 | 0.288 |
| SD _{past} | 0.009 | 0.006 | 0.006 | 0.021 | 0.002 | 0.004 | 0.004 | 0.003 | 0.003 | 0.005 | 0.005 | 0.009 | 0.059 | 0.045 | 0.045 | 0.085 | 0.024 | 0.029 | 0.029 | 0.040 |
| NAV | 0.080 | 0.201 | 0.052 | 0.201 | 0.007 | 0.016 | 0.007 | 0.016 | 0.010 | 0.083 | 0.026 | 0.068 | 0.248 | 0.395 | 0.233 | 0.433 | 0.105 | 0.184 | 0.100 | 0.212 |
| NAU | | | | | 0.007 | 0.016 | 0.007 | 0.016 | 0.004 | 0.024 | 0.009 | 0.020 | 0.058 | 0.085 | 0.056 | 0.092 | 0.024 | 0.029 | 0.029 | 0.040 |

Round Robin LXXIX Laboratory Results

| Lab | Total β-Cryptoxanthin, µg/mL | | | | | Total α-Cryptoxanthin, µg/mL | | | | | Total Lutein, µg/mL | | | | | Total Zeaxanthin, µg/mL | | | | | Total Lutein&Zeaxanthin, µg/mL | | | | |
|------------------------|------------------------------|-------|-------|-------|-------|------------------------------|-----------|-----------|-------|-----------|---------------------|-------|-------|-------|-------|-------------------------|-------|-------|-------|-------|--------------------------------|-------|-------|-------|-------|
| | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 |
| FSV-BC | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BD | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BE | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BFa | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BG | 0.042 | 0.065 | 0.099 | 0.096 | 0.061 | | | | | | | | | | | | | | | | | | | | |
| FSV-BH | 0.042 | 0.069 | 0.113 | 0.092 | 0.059 | | | | | | | | | | | | | | | | | | | | |
| FSV-BJ | 0.030 | 0.047 | 0.100 | 0.082 | 0.046 | | | | | | | | | | | | | | | | | | | | |
| FSV-BK | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BL | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BM | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BN | 0.041 | 0.073 | 0.111 | 0.085 | 0.061 | | | | | | | | | | | | | | | | | | | | |
| FSV-BR | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-BS | 0.049 | 0.072 | 0.111 | 0.090 | 0.075 | | | | | | | | | | | | | | | | | | | | |
| FSV-BT | 0.045 | 0.056 | 0.076 | 0.074 | 0.048 | 0.016 | 0.015 | 0.012 | 0.024 | 0.017 | | | | | | | | | | | | | | | |
| FSV-BU | 0.055 | 0.069 | 0.126 | 0.100 | 0.065 | | | | | | | | | | | | | | | | | | | | |
| FSV-BV | 0.037 | 0.062 | 0.105 | 0.080 | 0.046 | | | | | | | | | | | | | | | | | | | | |
| FSV-BW | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-CD | <i>nq</i> | 0.070 | 0.100 | 0.090 | 0.060 | <i>nq</i> | <i>nq</i> | <i>nq</i> | 0.030 | <i>nq</i> | | | | | | | | | | | | | | | |
| FSV-CE | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-CF | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-CG | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-CI | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-CO | 0.043 | 0.055 | 0.084 | 0.072 | 0.048 | | | | | | | | | | | | | | | | | | | | |
| FSV-CZ | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-DV | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-EE | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-FK | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-FZ | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-GD | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-GF | | | | | | | | | | | | | | | | | | | | | | | | | |
| FSV-GG | | | | | | | | | | | | | | | | | | | | | | | | | |
| N | 9 | 10 | 10 | 10 | 10 | 1 | 1 | 1 | 2 | 1 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 10 | 10 | 10 | 10 | 10 |
| Min | 0.030 | 0.047 | 0.076 | 0.072 | 0.046 | 0.024 | | | | | 0.043 | 0.087 | 0.068 | 0.137 | 0.079 | 0.011 | 0.013 | 0.016 | 0.026 | 0.015 | 0.054 | 0.100 | 0.084 | 0.163 | 0.096 |
| Median | 0.042 | 0.067 | 0.103 | 0.088 | 0.060 | 0.027 | 0.017 | | | | 0.058 | 0.105 | 0.089 | 0.145 | 0.084 | 0.024 | 0.023 | 0.031 | 0.033 | 0.024 | 0.075 | 0.127 | 0.118 | 0.193 | 0.123 |
| Max | 0.055 | 0.073 | 0.126 | 0.100 | 0.075 | 0.030 | | | | | 0.075 | 0.120 | 0.104 | 0.177 | 0.115 | 0.036 | 0.044 | 0.041 | 0.053 | 0.033 | 0.110 | 0.156 | 0.136 | 0.212 | 0.137 |
| eSD | 0.005 | 0.007 | 0.013 | 0.010 | 0.012 | | | | | | 0.018 | 0.016 | 0.021 | 0.009 | 0.005 | 0.015 | 0.011 | 0.012 | 0.009 | 0.009 | 0.006 | 0.007 | 0.011 | 0.016 | 0.016 |
| eCV | 12 | 11 | 12 | 11 | 21 | | | | | | 31 | 16 | 23 | 6 | 6 | 63 | 49 | 41 | 27 | 37 | 8 | 5 | 9 | 8 | 13 |
| N _{past} | 16 | 0 | 14 | 0 | 14 | 7 | 0 | 5 | 0 | 6 | 10 | 0 | 6 | 0 | 7 | 8 | 0 | 8 | 0 | 7 | 17 | 0 | 14 | 0 | 15 |
| Median _{past} | 0.040 | 0.100 | 0.053 | 0.053 | 0.014 | 0.026 | 0.019 | 0.007 | | 0.026 | 0.056 | 0.089 | 0.090 | 0.090 | 0.090 | 0.023 | 0.035 | 0.035 | 0.030 | 0.030 | 0.083 | 0.119 | 0.119 | 0.125 | 0.125 |
| SD _{past} | 0.009 | 0.023 | 0.014 | 0.014 | 0.014 | 0.011 | 0.004 | 0.004 | | 0.011 | 0.014 | 0.023 | 0.023 | 0.017 | 0.017 | 0.010 | 0.020 | 0.020 | 0.013 | 0.013 | 0.017 | 0.029 | 0.029 | 0.027 | 0.027 |
| NAV | 0.042 | 0.067 | 0.103 | 0.088 | 0.060 | | | | | | 0.058 | 0.105 | 0.089 | 0.145 | 0.084 | 0.024 | 0.023 | 0.031 | 0.033 | 0.024 | 0.075 | 0.127 | 0.118 | 0.193 | 0.123 |
| NAU | 0.010 | 0.016 | 0.023 | 0.020 | 0.014 | | | | | | 0.018 | 0.020 | 0.021 | 0.027 | 0.016 | | | | | | 0.016 | 0.026 | 0.024 | 0.040 | 0.025 |

Round Robin LXXIX Laboratory Results

| Lab | Coenzyme Q10, µg/mL | | | | | Phylloquinone (K1), ng/mL | | | | | 25-hydroxyvitamin D, µg/mL | | | | |
|------------------------|---------------------|------|-------|------|-------|---------------------------|-------|-------|-------|-------|----------------------------|-------|-------|-------|-------|
| | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 | 422 | 423 | 424 | 425 | 426 |
| FSV-BC | | | | | | | | | | | | | | | |
| FSV-BD | | | | | | | | | | | | | | | |
| FSV-BE | 0.850 | 1.08 | 0.880 | 0.95 | 0.990 | 0.175 | 0.622 | 0.140 | 0.537 | 0.369 | 0.013 | 0.021 | 0.006 | 0.035 | 0.014 |
| FSV-BFa | | | | | | | | | | | | | | | |
| FSV-BG | | | | | | | | | | | | | | | |
| FSV-BH | | | | | | | | | | | | | | | |
| FSV-BJ | 0.695 | 0.78 | 0.736 | 0.51 | 0.696 | | | | | | 0.013 | 0.020 | 0.006 | 0.033 | 0.014 |
| FSV-BK | | | | | | | | | | | | | | | |
| FSV-BL | | | | | | | | | | | | | | | |
| FSV-BM | | | | | | | | | | | | | | | |
| FSV-BN | | | | | | | | | | | | | | | |
| FSV-BR | | | | | | | | | | | | | | | |
| FSV-BS | | | | | | | | | | | | | | | |
| FSV-BT | 0.591 | 1.10 | 0.924 | 0.82 | 1.023 | | | | | | | | | | |
| FSV-BU | | | | | | | | | | | | | | | |
| FSV-BV | | | | | | | | | | | | | | | |
| FSV-BW | | | | | | | | | | | | | | | |
| FSV-CD | | | | | | | | | | | | | | | |
| FSV-CE | | | | | | | | | | | | | | | |
| FSV-CF | | | | | | | | | | | | | | | |
| FSV-CG | | | | | | | | | | | | | | | |
| FSV-CI | 0.710 | 0.98 | 1.030 | 0.70 | 0.980 | 0.200 | 0.718 | 0.170 | 0.634 | 0.409 | | | | | |
| FSV-CO | | | | | | | | | | | | | | | |
| FSV-CZ | 0.728 | 1.13 | 1.027 | 0.88 | 1.059 | | | | | | | | | | |
| FSV-DV | | | | | | | | | | | | | | | |
| FSV-EE | 0.699 | 0.97 | 0.976 | 0.70 | 0.949 | 0.140 | 0.560 | 0.120 | 0.580 | 0.330 | | | | | |
| FSV-FK | | | | | | | | | | | | | | | |
| FSV-FZ | | | | | | | | | | | | | | | |
| FSV-GD | 0.699 | 0.95 | 0.928 | 0.77 | 0.948 | | | | | | | | | | |
| FSV-GF | 0.710 | 0.89 | 1.060 | 0.66 | 0.960 | | | | | | | | | | |
| FSV-GG | 0.800 | 1.00 | 1.100 | 0.70 | 1.000 | | | | | | | | | | |
| N | 9 | 9 | 9 | 9 | 9 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 |
| Min | 0.591 | 0.78 | 0.736 | 0.51 | 0.696 | 0.140 | 0.560 | 0.120 | 0.537 | 0.330 | 0.013 | 0.020 | 0.006 | 0.033 | 0.014 |
| Median | 0.710 | 0.98 | 0.976 | 0.70 | 0.980 | 0.175 | 0.622 | 0.140 | 0.580 | 0.369 | 0.013 | 0.021 | 0.006 | 0.034 | 0.014 |
| Max | 0.850 | 1.13 | 1.100 | 0.95 | 1.059 | 0.200 | 0.718 | 0.170 | 0.634 | 0.409 | 0.013 | 0.021 | 0.006 | 0.035 | 0.014 |
| eSD | 0.022 | 0.13 | 0.080 | 0.10 | 0.046 | | | | | | | | | | |
| eCV | 3 | 14 | 8 | 14 | 5 | | | | | | | | | | |
| N _{past} | 8 | 0 | 8 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 |
| Median _{past} | 0.656 | | 1.002 | | 0.950 | | | | | | | | | | 0.016 |
| SD _{past} | 0.115 | | 0.093 | | 0.119 | | | | | | | | | | 0.000 |
| NAV | 0.710 | 0.98 | 0.976 | 0.70 | 0.980 | 0.175 | 0.622 | 0.140 | 0.580 | 0.369 | | | | | |
| NAU | 0.071 | 0.13 | 0.098 | 0.10 | 0.098 | | | | | | | | | | |

Round Robin LXXIX Laboratory Results

Analytes Reported By One Laboratory

Values in µg/mL

| Analyte | Code | 422 | 423 | 424 | 425 | 426 |
|---------------|--------|-------|-------|-------|-------|-------|
| Phytofluene | FSV-BS | 0.058 | 0.059 | 0.060 | 0.100 | 0.128 |
| trans-Retinol | FSV-BS | 0.330 | 0.471 | 0.425 | 0.503 | 0.428 |
| δ-Tocopherol | FSV-CG | 0.197 | 0.039 | 0.039 | 0.039 | 0.039 |

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 |
| eSD | Adjusted median absolute deviation from the median of the non-NIST results |
| eCV | Coefficient of Variation for (non-NIST) results: $100 \cdot eSD / \text{Median}$ |
| 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 = Median for analytes reported by ≥ 5 labs |
| NAU | NIST Assigned Uncertainty: maximum of ($0.05 \cdot \text{NAV}$, eSD, SD_{past} , expSD) The expected long-term SD, expSD, is defined in: 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 |
| $\geq x$ | Concentration greater than or equal to x |
| ! | Discrepant value: Miss-labelled sample, damaged sample, malfunction, etc. |
| <i>italics</i> | Not explicitly reported but calculated by NIST from reported values |

Round Robin LXXIX Laboratory Results

Comparability Summary

This publication is available free of charge from: <https://doi.org/10.6028/NIST.JR.7880-47>

| Lab | TR | aT | g/bT | bC | aC | TLy | TbX | TLu | L&Z |
|---------|----|----|------|----|----|-----|-----|-----|-----|
| FSV-BC | 1 | | | | | | | | |
| FSV-BD | 2 | 2 | | | | | | | |
| FSV-BE | 2 | 2 | 1 | 1 | | | | | |
| FSV-BFa | 2 | 1 | | | | | | | |
| FSV-BG | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| FSV-BH | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| FSV-BJ | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | |
| FSV-BK | 1 | 1 | | | | | | | |
| FSV-BL | 1 | 1 | | | | | | | |
| FSV-BM | 1 | 1 | | | | | | | |
| FSV-BN | 1 | 1 | | 1 | 2 | 1 | 1 | | 1 |
| FSV-BR | 1 | 1 | | | | | | | |
| FSV-BS | 2 | 2 | | 1 | 4 | 2 | 1 | 1 | 2 |
| FSV-BT | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 |
| FSV-BU | 3 | 1 | 1 | 1 | 2 | 1 | 1 | | 1 |
| FSV-BV | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| FSV-BW | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| FSV-CD | 1 | 1 | 1 | 2 | 1 | 2 | 1 | | 1 |
| FSV-CE | 1 | 1 | | 1 | | | | | |
| FSV-CF | 1 | 1 | | | | | | | |
| FSV-CG | 3 | 4 | 3 | 3 | 2 | 2 | | | 1 |
| FSV-CI | 1 | 2 | 1 | 1 | 1 | | | 1 | 1 |
| FSV-CO | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | |
| FSV-CZ | 1 | 1 | 1 | 1 | | | | | |
| FSV-DV | 1 | 2 | | | | | | | |
| FSV-FK | 1 | 1 | | 1 | | | | | |
| FSV-FZ | 1 | 1 | 1 | | | | | | |
| FSV-GD | 1 | 1 | 1 | 1 | 1 | 1 | | | |
| FSV-GF | | 2 | | | | | | | |
| n | 28 | 28 | 15 | 18 | 14 | 13 | 10 | 6 | 10 |
| | TR | aT | g/bT | bC | aC | TLy | TbX | TLu | L&Z |
| % 1 | 71 | 68 | 87 | 89 | 71 | 69 | 100 | 83 | 80 |
| % 2 | 18 | 25 | 7 | 6 | 21 | 31 | 0 | 17 | 20 |
| % 3 | 11 | 4 | 7 | 6 | 0 | 0 | 0 | 0 | 0 |
| % 4 | 0 | 4 | 0 | 0 | 7 | 0 | 0 | 0 | 0 |

| Label | Definition |
|-------|--|
| Lab | Participant code |
| TR | Total Retinol |
| aT | α-Tocopherol |
| g/bT | γ/β-Tocopherol |
| bC | Total β-Carotene |
| aC | Total α-Carotene |
| TLy | Total Lycopene |
| TbX | Total β-Cryptoxanthin |
| TLu | Total Lutein |
| 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 RR79

Each participant in RR79 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
- α -Tocopherol
- γ/β -Tocopherol
- Total β -Carotene
- Total α -Carotene
- Total Lycopene
- Total β -Cryptoxanthin
- Total Lutein
- Total Lutein & Zeaxanthin
- Coenzyme Q10

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

Individualized Round Robin LXXIX Report: FSV-BG

Summary

| Analyte | Serum 422 | | | Serum 423 | | | Serum 424 | | | Serum 425 | | | Serum 426 | | |
|-------------------------|-----------|-------|----|-----------|-------|----|-----------|-------|----|-----------|-------|----|-----------|-------|----|
| | You | NAV | n | You | NAV | n | You | NAV | n | You | NAV | n | You | NAV | n |
| Total Retinol | 0.331 | 0.348 | 26 | 0.515 | 0.504 | 26 | 0.457 | 0.460 | 25 | 0.637 | 0.606 | 26 | 0.516 | 0.501 | 26 |
| Retinyl Palmitate | 0.02 | 0.02 | 4 | 0.0 | 0.0 | 4 | 0.0 | 0.0 | 4 | 0.06 | 0.03 | 4 | 0.05 | 0.04 | 4 |
| α-Tocopherol | 5.47 | 5.74 | 27 | 10.44 | 11.55 | 27 | 6.67 | 7.30 | 26 | 10.19 | 10.63 | 27 | 9.57 | 10.28 | 27 |
| γ/β-Tocopherol | 1.348 | 1.371 | 14 | 1.796 | 1.920 | 14 | 1.781 | 1.781 | 14 | 1.317 | 1.400 | 14 | 1.392 | 1.425 | 14 |
| Total β-Carotene | 0.078 | 0.080 | 16 | 0.211 | 0.221 | 16 | 0.054 | 0.054 | 16 | 0.210 | 0.210 | 16 | 0.242 | 0.248 | 16 |
| Total α-Carotene | 0.010 | 0.010 | 11 | 0.070 | 0.084 | 13 | 0.021 | 0.026 | 12 | 0.060 | 0.069 | 13 | 0.031 | 0.030 | 12 |
| Total Lycopene | 0.279 | 0.247 | 12 | 0.404 | 0.390 | 12 | 0.238 | 0.233 | 12 | 0.456 | 0.432 | 12 | 0.599 | 0.578 | 12 |
| trans-Lycopene | 0.128 | 0.105 | 4 | 0.205 | 0.184 | 4 | 0.120 | 0.120 | 4 | 0.238 | 0.212 | 4 | 0.313 | 0.262 | 4 |
| Total β-Cryptoxanthin | 0.042 | 0.042 | 8 | 0.065 | 0.065 | 9 | 0.099 | 0.100 | 9 | 0.096 | 0.085 | 9 | 0.061 | 0.060 | 9 |
| Total Lutein&Zeaxanthin | 0.074 | 0.074 | 9 | 0.132 | 0.126 | 9 | 0.116 | 0.118 | 9 | 0.212 | 0.192 | 9 | 0.137 | 0.126 | 9 |

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

D2

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

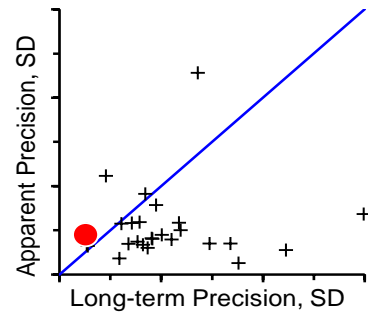
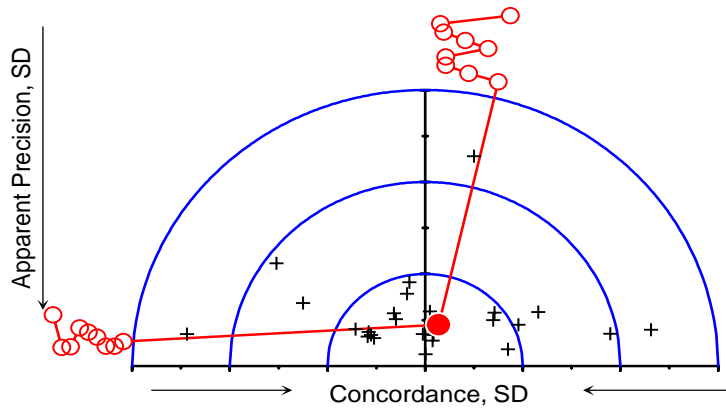
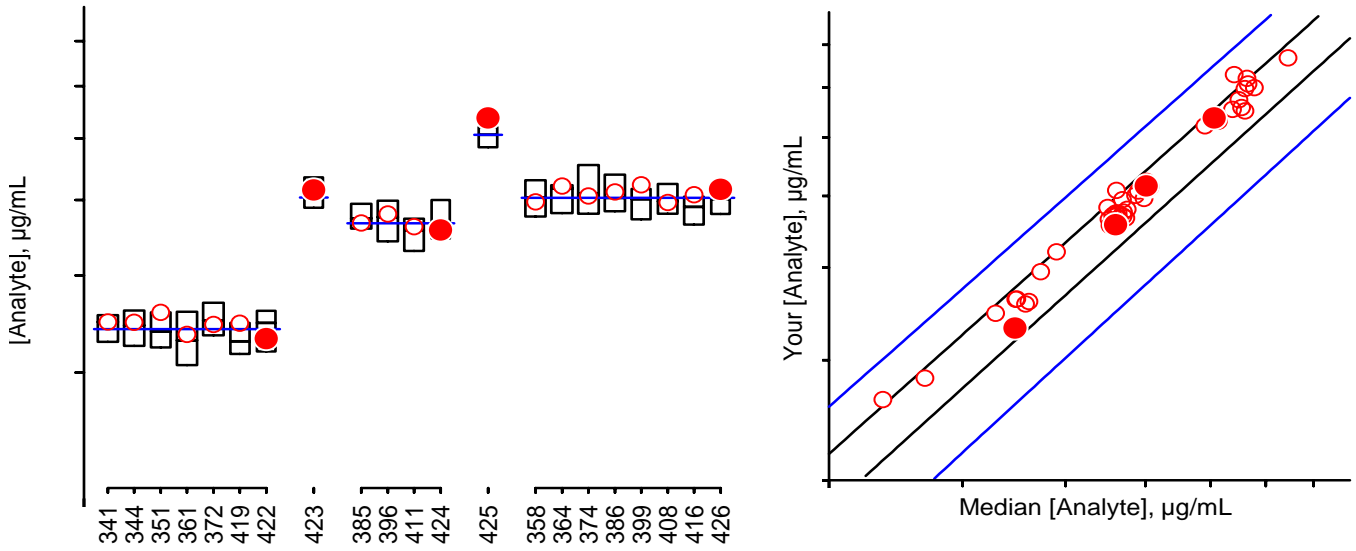
Micronutrients Measurement Quality Assurance Program
 National Institute of Standards and Technology
 100 Bureau Drive Stop 8392
 Gaithersburg, MD 20899-8392 USA

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

Individualized RR LXXIX Report: FSV-BG

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



- 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

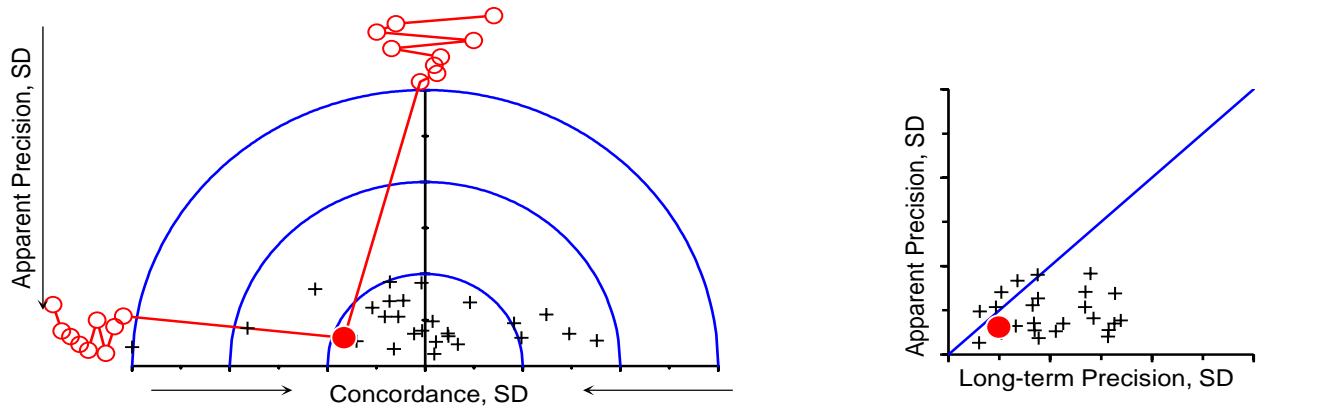
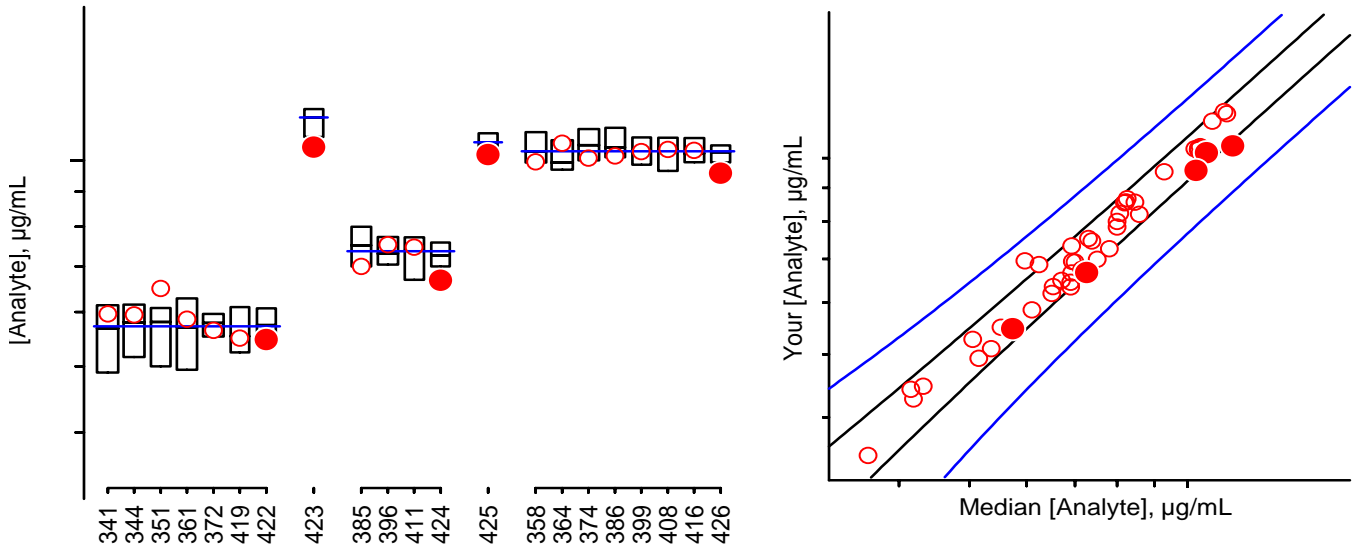
Comments

History

| | |
|---|--|
| <p>#422 Fresh-frozen, native, multi-donor: SRM968d</p> <p>#423 Fresh-frozen, native, multi-donor: SRM 972a II</p> <p>#424 Fresh-frozen, native, two-donor</p> <p>#425 Fresh-frozen, native, multi-donor: VitDQAP-1</p> <p>#426 Fresh-frozen, native, multi-donor: SRM 968e II</p> | <p>RR63#341 & 344, RR64#351, RR66#361, RR69#372, RR78#419</p> <p>First FSV distribution 71#385, 73#396, 76#411</p> <p>First FSV distribution 66#358, 67#364, 69#374, 71#386, 74#399,</p> |
|---|--|

Individualized RR LXXIX Report: FSV-BG

α-Tocopherol, 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

- #422 Fresh-frozen, native, multi-donor: SRM968d
- #423 Fresh-frozen, native, multi-donor: SRM 972a II
- #424 Fresh-frozen, native, two-donor
- #425 Fresh-frozen, native, multi-donor: VitDQAP-1
- #426 Fresh-frozen, native, multi-donor: SRM 968e II

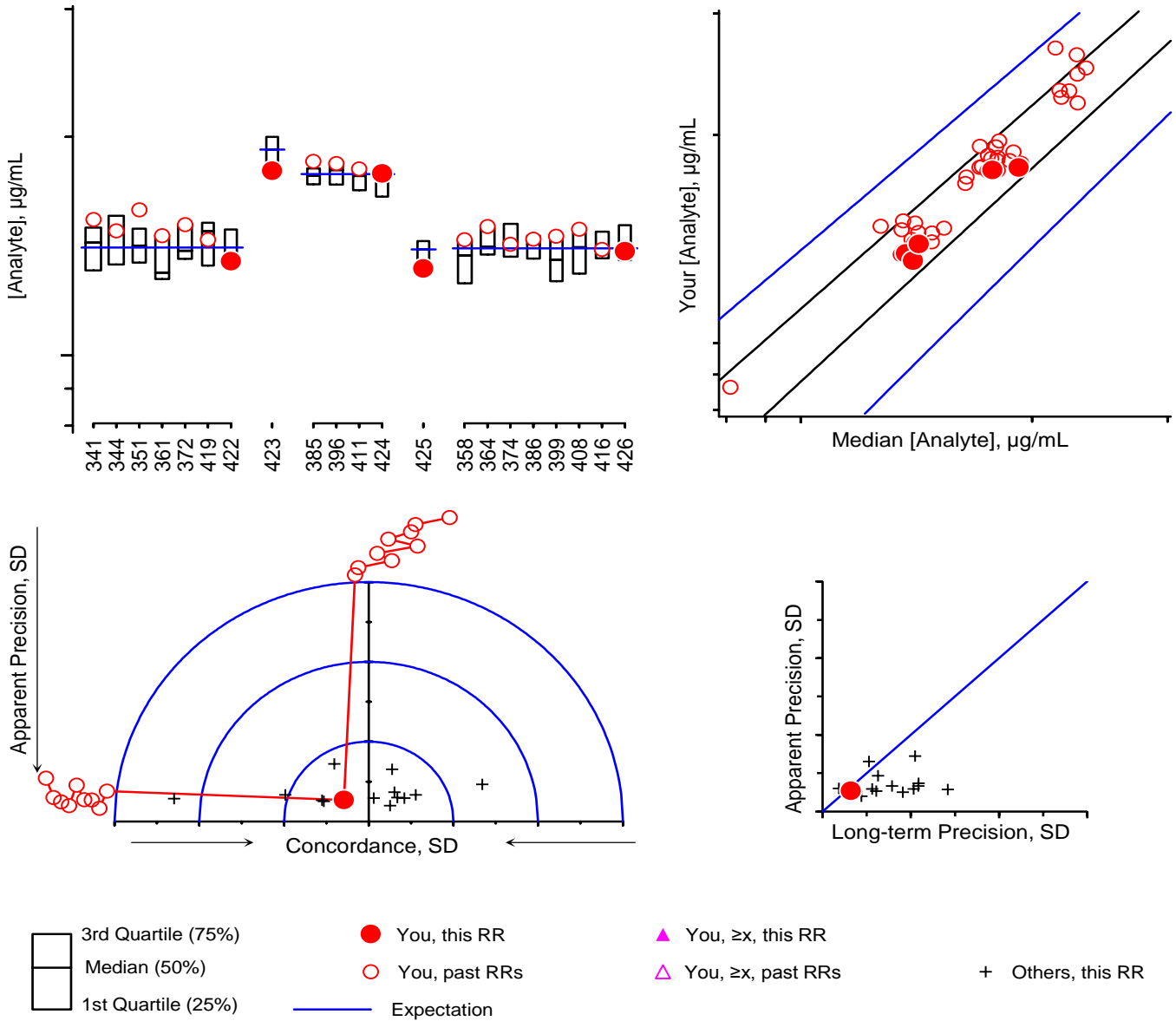
- RR63#341 & 344, RR64#351, RR66#361, RR69#372, RR78#419
- First FSV distribution 71#385, 73#396, 76#411
- First FSV distribution 66#358, 67#364, 69#374, 71#386, 74#399,

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Individualized RR LXXIX Report: FSV-BG

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γ/β -Tocopherol, $\mu\text{g/mL}$



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

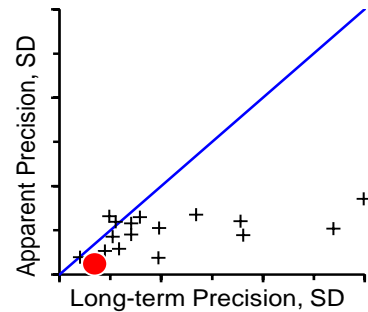
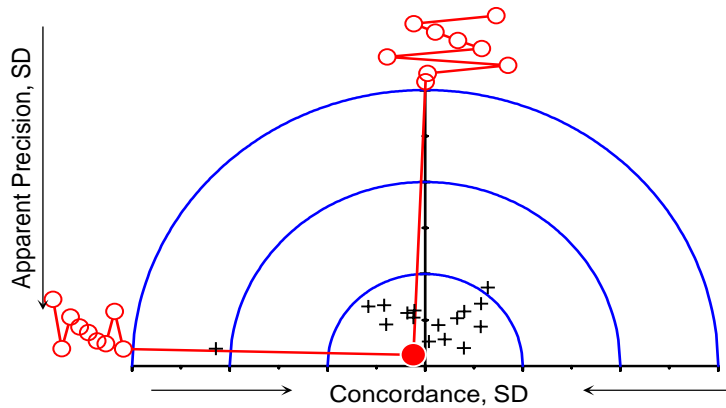
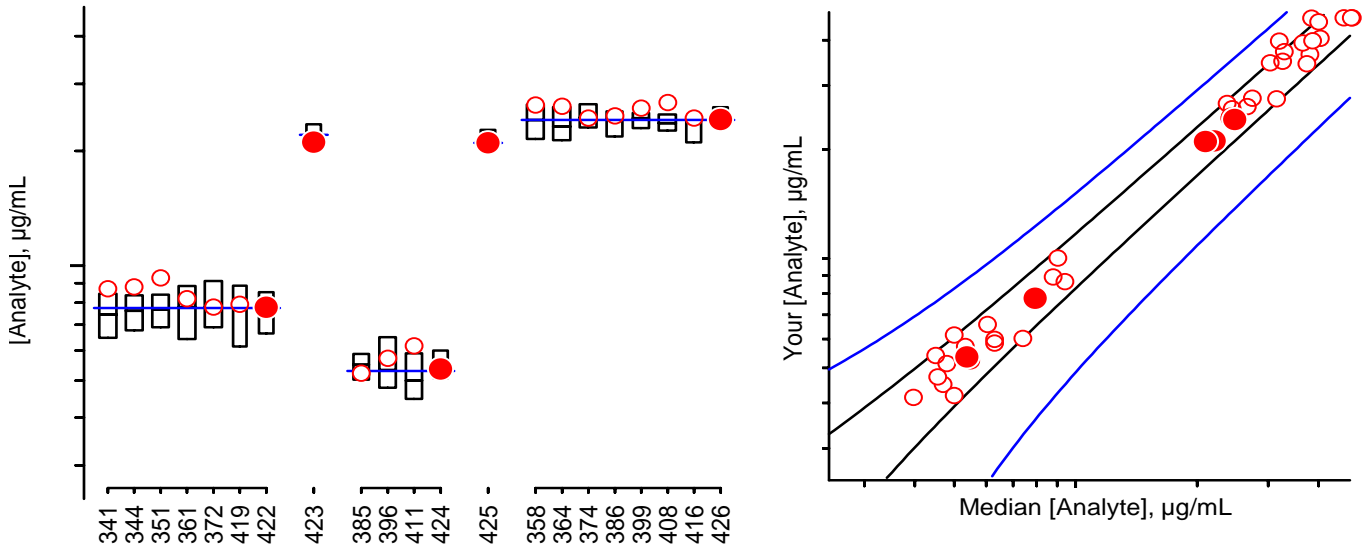
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 #424 Fresh-frozen, native, two-donor
 #425 Fresh-frozen, native, multi-donor: VitDQAP-1
 #426 Fresh-frozen, native, multi-donor: SRM 968e II

RR63#341 & 344, RR64#351, RR66#361,
 RR69#372, RR78#419
 First FSV distribution
 71#385, 73#396, 76#411
 First FSV distribution
 66#358, 67#364, 69#374, 71#386, 74#399,

Individualized RR LXXIX Report: FSV-BG

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Total β -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.

Serum

Comments

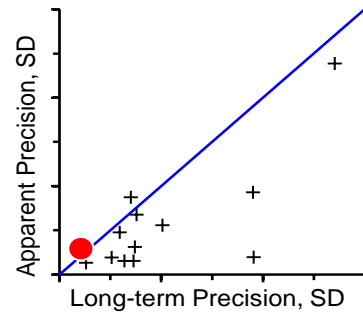
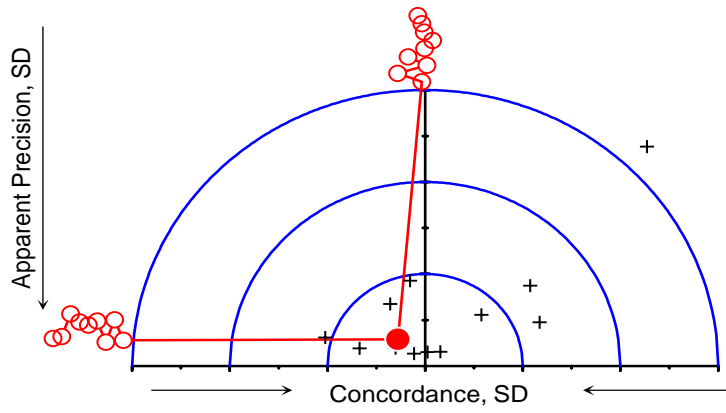
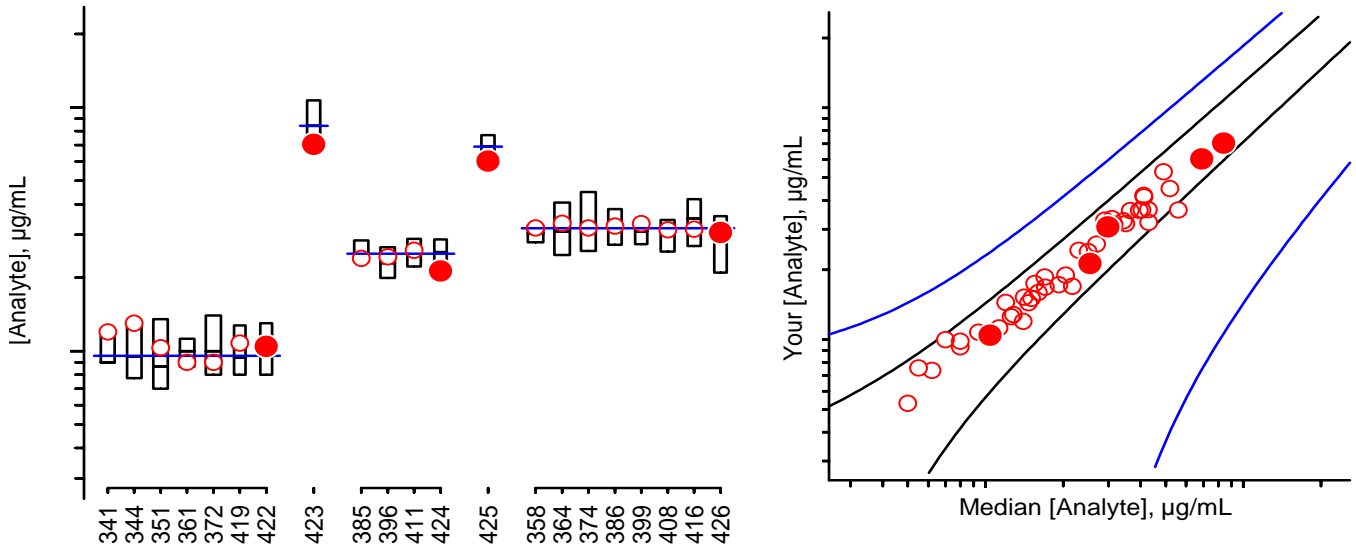
History

| | |
|---|--|
| <p>#422 Fresh-frozen, native, multi-donor: SRM968d</p> <p>#423 Fresh-frozen, native, multi-donor: SRM 972a II</p> <p>#424 Fresh-frozen, native, two-donor</p> <p>#425 Fresh-frozen, native, multi-donor: VitDQAP-1</p> <p>#426 Fresh-frozen, native, multi-donor: SRM 968e II</p> | <p>RR63#341 & 344, RR64#351, RR66#361, RR69#372, RR78#419</p> <p>First FSV distribution</p> <p>71#385, 73#396, 76#411</p> <p>First FSV distribution</p> <p>66#358, 67#364, 69#374, 71#386, 74#399,</p> |
|---|--|

Individualized RR LXXIX Report: FSV-BG

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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.

Serum

Comments

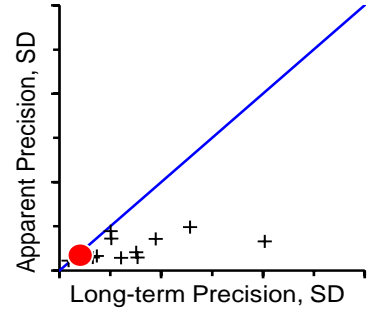
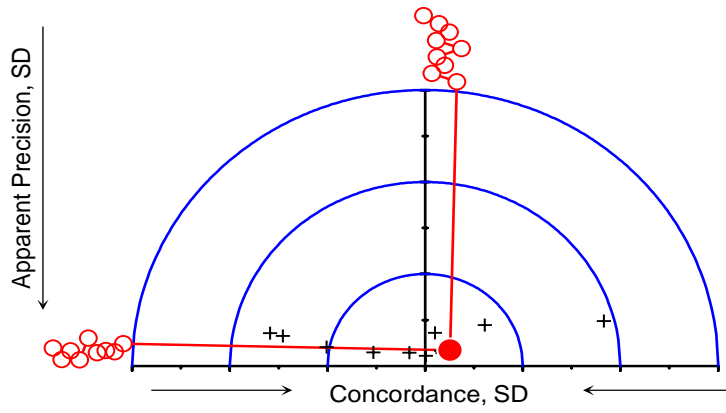
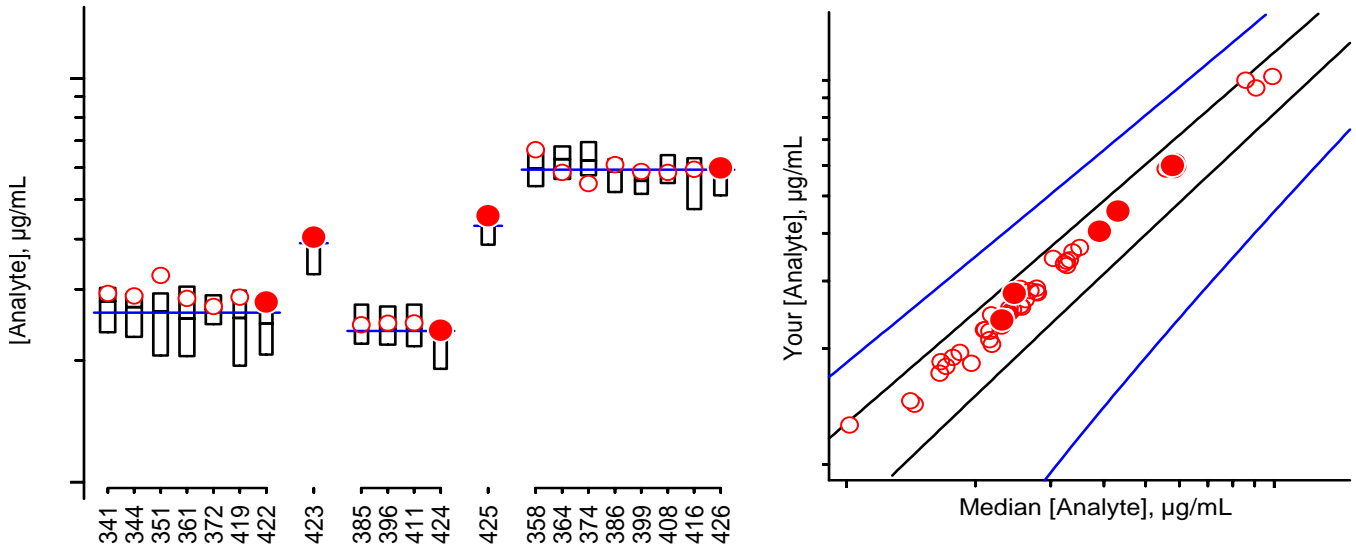
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| | |
|---|--|
| <p>#422 Fresh-frozen, native, multi-donor: SRM968d</p> <p>#423 Fresh-frozen, native, multi-donor: SRM 972a II</p> <p>#424 Fresh-frozen, native, two-donor</p> <p>#425 Fresh-frozen, native, multi-donor: VitDQAP-1</p> <p>#426 Fresh-frozen, native, multi-donor: SRM 968e II</p> | <p>RR63#341 & 344, RR64#351, RR66#361, RR69#372, RR78#419</p> <p>First FSV distribution 71#385, 73#396, 76#411</p> <p>First FSV distribution 66#358, 67#364, 69#374, 71#386, 74#399,</p> |
|---|--|

Individualized RR LXXIX Report: FSV-BG

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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

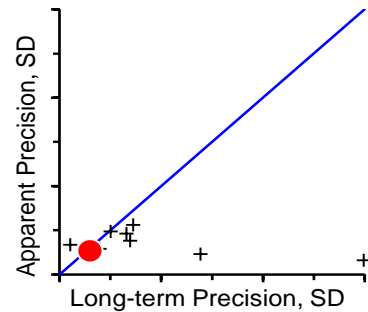
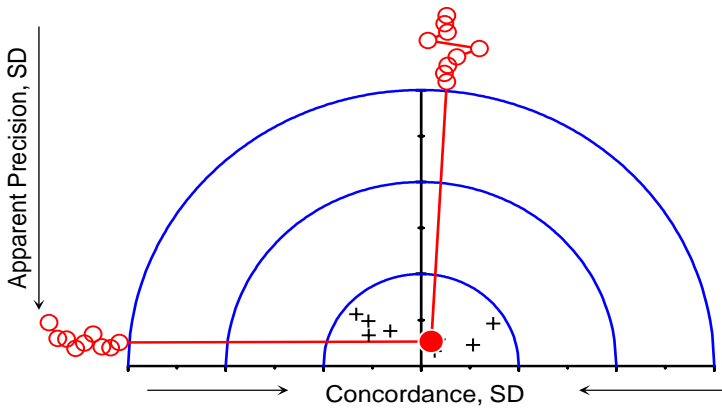
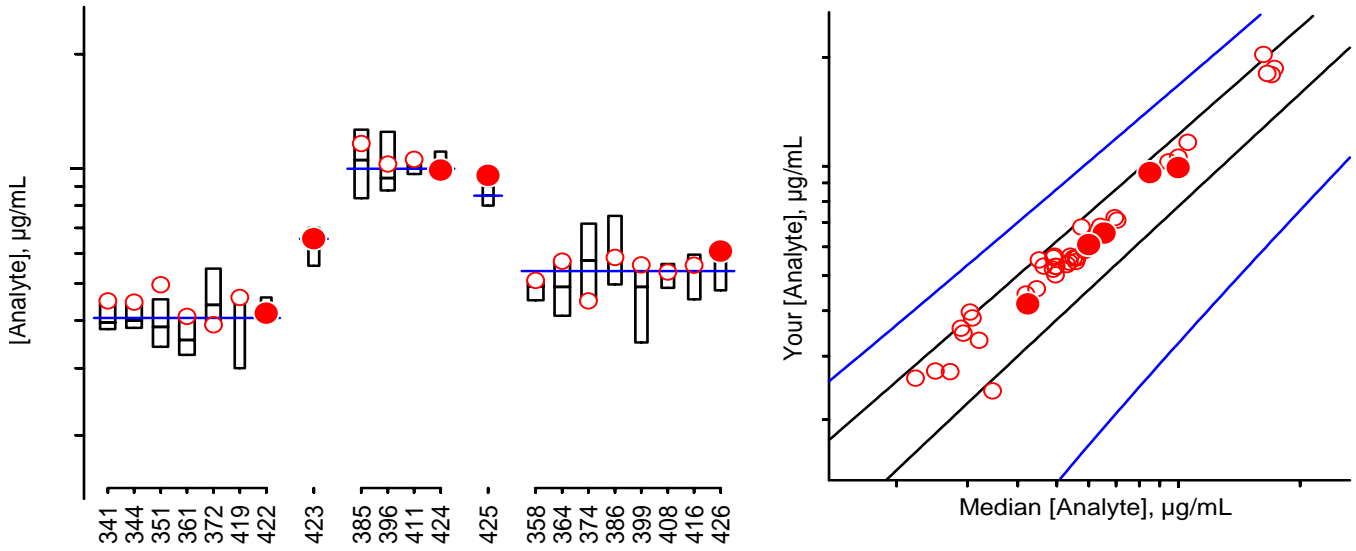
Comments

History

| | |
|---|--|
| <p>#422 Fresh-frozen, native, multi-donor: SRM968d</p> <p>#423 Fresh-frozen, native, multi-donor: SRM 972a II</p> <p>#424 Fresh-frozen, native, two-donor</p> <p>#425 Fresh-frozen, native, multi-donor: VitDQAP-1</p> <p>#426 Fresh-frozen, native, multi-donor: SRM 968e II</p> | <p>RR63#341 & 344, RR64#351, RR66#361, RR69#372, RR78#419</p> <p>First FSV distribution 71#385, 73#396, 76#411</p> <p>First FSV distribution 66#358, 67#364, 69#374, 71#386, 74#399,</p> |
|---|--|

Individualized RR LXXIX Report: FSV-BG

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

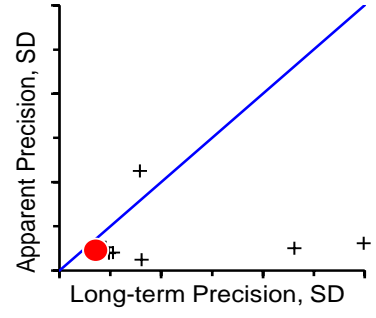
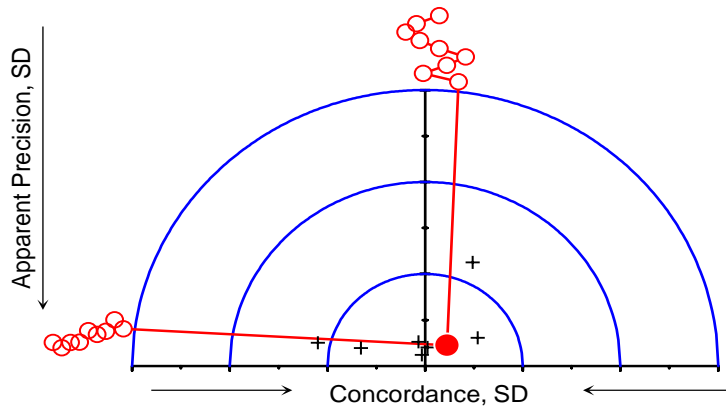
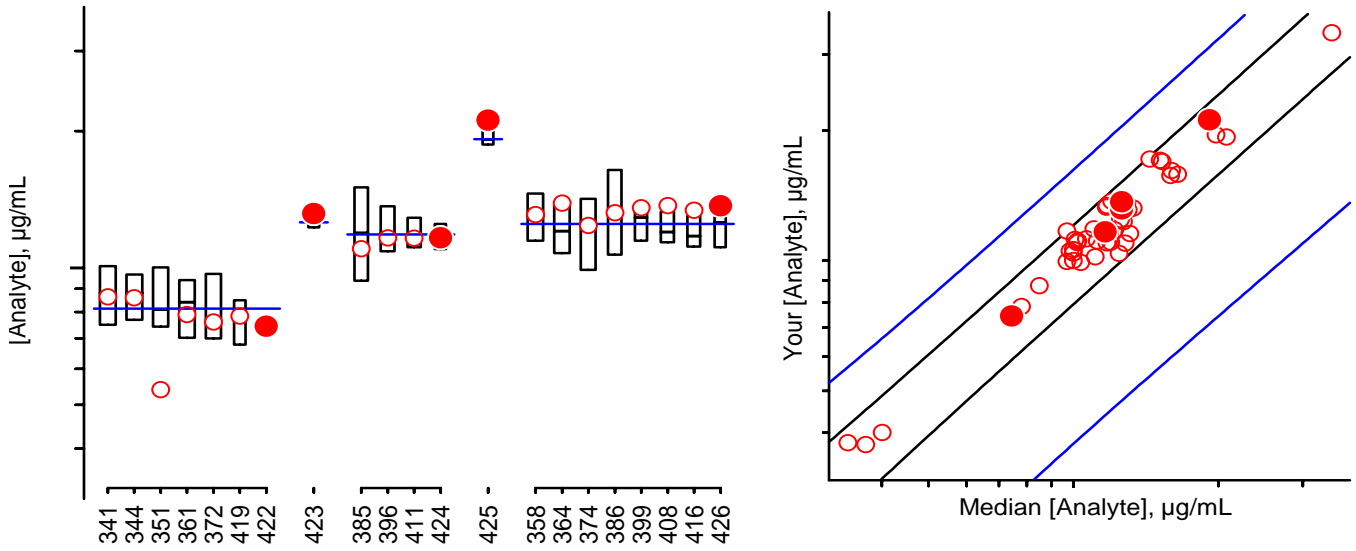
History

| | |
|---|--|
| <p>#422 Fresh-frozen, native, multi-donor: SRM968d</p> <p>#423 Fresh-frozen, native, multi-donor: SRM 972a II</p> <p>#424 Fresh-frozen, native, two-donor</p> <p>#425 Fresh-frozen, native, multi-donor: VitDQAP-1</p> <p>#426 Fresh-frozen, native, multi-donor: SRM 968e II</p> | <p>RR63#341 & 344, RR64#351, RR66#361, RR69#372, RR78#419</p> <p>First FSV distribution</p> <p>71#385, 73#396, 76#411</p> <p>First FSV distribution</p> <p>66#358, 67#364, 69#374, 71#386, 74#399,</p> |
|---|--|

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Individualized RR LXXIX Report: FSV-BG

Total Lutein&Zeaxanthin, 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

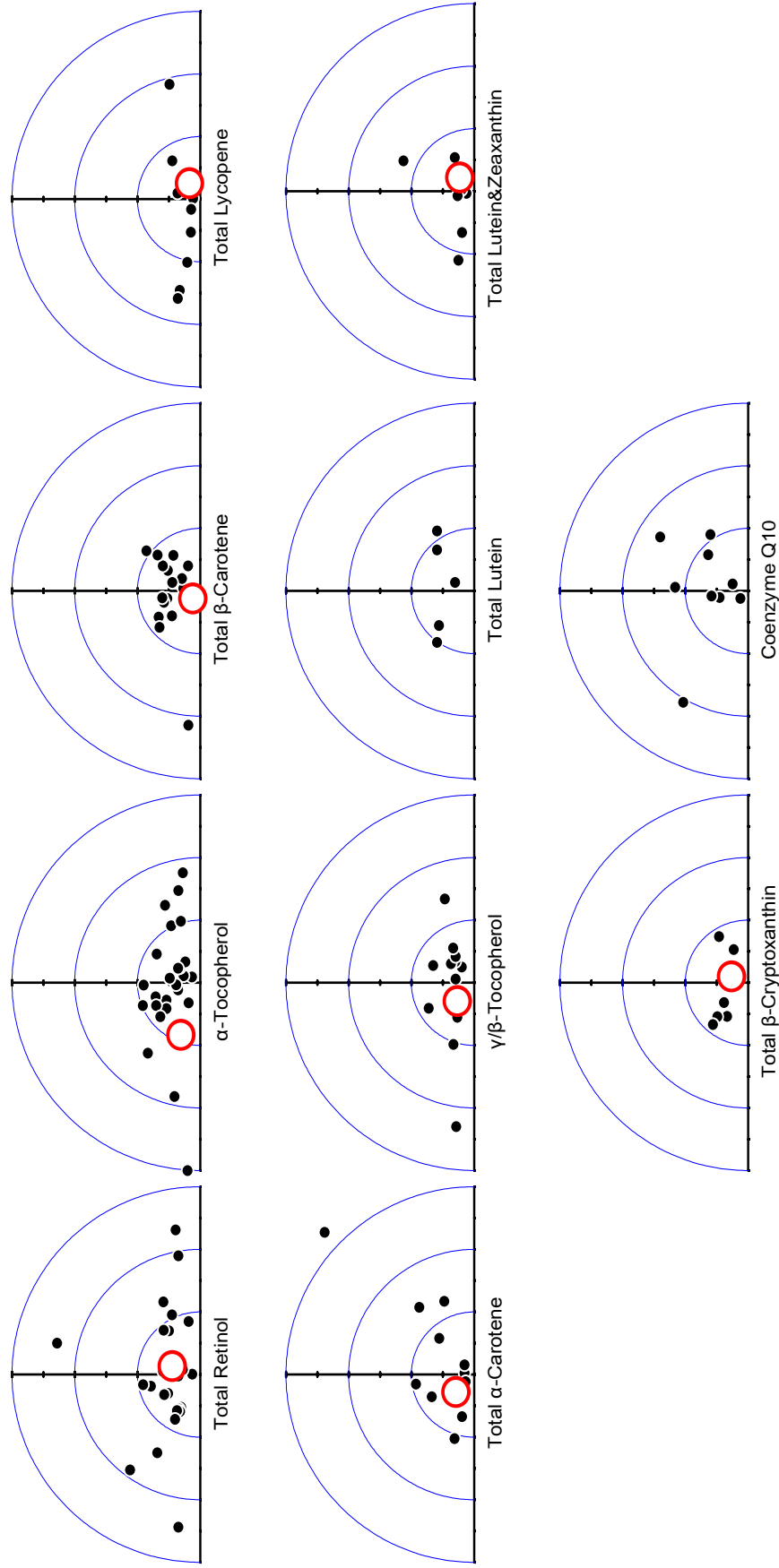
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 #424 Fresh-frozen, native, two-donor
 #425 Fresh-frozen, native, multi-donor: VitDQAP-1
 #426 Fresh-frozen, native, multi-donor: SRM 968e II

RR63#341 & 344, RR64#351, RR66#361,
 RR69#372, RR78#419
 First FSV distribution
 71#385, 73#396, 76#411
 First FSV distribution
 66#358, 67#364, 69#374, 71#386, 74#399,

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Individualized Round Robin LXXIX Report: FSV-BG

Graphical Comparability Summary



D11

Appendix E. Shipping Package Inserts for RR80

The following items were included in each package shipped to an RR80 participant:

- Cover letter for Round Robin LXXX (RR80), enclosed in a sealed waterproof bag.
- Datasheet for RR80. This was enclosed in the same sealed waterproof bag that contained the cover letter.
- Packing List and Shipment Receipt Confirmation Form for RR80.

This RR80 samples were enclosed in a bubble-wrapped sealed plastic bag

The packing list was placed at the top of the shipping box, between the cardboard covering and the foam insulation.



June 24, 2016

Dear Colleague:

Enclosed are samples for the second fat-soluble vitamins and carotenoids in serum study (RR80) for the 2016 NIST Micronutrients Measurement Quality Assurance Program (MMQAP). RR80 consists of one vial each of four liquid-frozen serum samples and one lyophilized sample for analysis. Samples should be stored in the dark at or below -20°C upon receipt. When reporting your results, please use the enclosed form and 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 RR80 by **September 12, 2016**. 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 for RR80 will be distributed in mid-October. 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 LXXX: Human Sera
NIST Micronutrients Measurement Quality Assurance Program

| Analyte | 427 | 428 | 429 | 430 | 431 | 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:

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Please return results by
12-Sep-2016

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

E3

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

Participant #: _____

Date: _____

Fat-Soluble Vitamins Round Robin LXXX
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 |
|-------|---------------|---------------|--------------------|
| #427 | Liquid frozen | No | 2 mL amber / red |
| #428 | Liquid frozen | No | 3 mL amber / black |
| #429 | Liquid frozen | No | 2 mL amber / green |
| #430 | Liquid frozen | No | 3 mL amber / gold |
| #431 | Lyophilized | Yes | 5 mL clear / green |

- 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

Please return results by
12-Sep-2016

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

E4

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

Appendix F. Final Report for RR80

The following two pages are the final report for RR80 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

October 27, 2016

Dear Colleague:

Enclosed is the summary report of the results for “Round Robin” LXXX (RR80) of the 2016 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. RR80 (Sera 427 to 431) consisted of one vial each of one lyophilized and 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.

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: 301-978-0685.

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

The NIST MMQAP Round Robin LXXVIII (RR80) 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 RR80.

| Serum | Description | Prior Distributions |
|-------|--|---|
| 427 | Fresh-frozen, native, multi-donor, prepared in 2009. This is Level 1 of SRM 968e. | #357: RR66-9/09, #365: RR67-3/10, #376: RR69-3/11, #389: RR72-9/12, #402: RR75-3/14 |
| 428 | Fresh-frozen, native, multi-donor, prepared in 2015. This is the candidate SRM 968f-Level 1. | First MMQAP FSV distribution |
| 429 | Fresh-frozen, native, multi-donor, prepared in 2009. This is Level 3 of SRM 968e. | #359: RR66-9/09, #363: RR67-3/10, #373: RR69-3/11, #379: RR70-9/11 |
| 430 | Fresh-frozen, native, multi-donor, prepared in 2015. This is the candidate SRM 968f-Level 2. | First MMQAP FSV distribution |
| 431 | Lyophilized, multi-donor, prepared in 1997. This material was augmented with retinol, retinyl palmitate, α -tocopherol, γ -tocopherol, δ -tocopherol, <i>trans</i> - β -carotene, <i>trans</i> - α -carotene, <i>trans</i> - β -cryptoxanthin, lutein, and zeaxanthin. | #240: RR42-3/98 |

Results

- 1) SRM 968e Stability: There has been no significant change in the concentration nor variability of any analyte in the SRM 968e-Level 1 and Level 3 materials.
- 2) Serum 431: There likewise has been no significant change in the concentration nor variability of any analyte in the extensively manipulated serum #431 material - other than total β -carotene and possibly retinyl palmitate. There are too few data for retinyl palmitate to have any confidence in its observed decline, but the observed β -carotene decline is “statistically significant.” This is curious, because the concentrations of the other carotenoids appear unchanged over the past 18 years. Unfortunately, this material was produced in too limited a quantity to support further investigations.

Appendix G. “All-Lab Report” for RR80

The following six pages are the “All-Lab Report” for RR80 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.

Round Robin LXXX Laboratory Results

| Lab | Total Lycopene, µg/mL | | | | trans-Lycopene, µg/mL | | | | Total β-Cryptoxanthin, µg/mL | | | | Total α-Cryptoxanthin, µg/mL | | | |
|------------------------|-----------------------|-------|------|-------|-----------------------|-------|-------|-------|------------------------------|-------|-------|-------|------------------------------|-------|-------|-------|
| | 427 | 428 | 429 | 430 | 427 | 428 | 429 | 430 | 427 | 428 | 429 | 430 | 427 | 428 | 429 | 430 |
| FSV-BC | 13 | 13 | 13 | 13 | 4 | 4 | 4 | 4 | 11 | 10 | 10 | 11 | 1 | 1 | 1 | 1 |
| FSV-BD | 0.081 | 0.065 | 0.57 | 0.37 | 0.063 | 0.051 | 0.360 | 0.221 | 0.029 | 0.013 | 0.015 | 0.019 | 0.012 | 0.009 | 0.020 | 0.015 |
| FSV-BE | 0.200 | 0.142 | 0.90 | 0.57 | 0.093 | 0.076 | 0.465 | 0.311 | 0.050 | 0.027 | 0.035 | 0.039 | 0.012 | 0.009 | 0.020 | 0.015 |
| FSV-BFa | 0.260 | 0.182 | 1.18 | 0.71 | 0.121 | 0.099 | 0.513 | 0.337 | 0.059 | 0.033 | 0.089 | 0.096 | 0.040 | 0.030 | 0.040 | 0.045 |
| FSV-BG | 0.044 | 0.033 | 0.09 | 0.09 | 0.031 | 0.023 | 0.062 | 0.035 | 0.009 | 0.007 | 0.011 | 0.009 | 0.056 | 0.030 | 0.040 | 0.045 |
| FSV-BH | 22 | 23 | 10 | 17 | 33 | 30 | 13 | 11 | 17 | 28 | 33 | 26 | 0.059 | 0.031 | 0.034 | 0.039 |
| FSV-BI | 15 | 0 | 16 | 0 | 7 | 0 | 7 | 0 | 14 | 0 | 15 | 0 | 0.055 | 0.020 | 0.030 | 0.033 |
| FSV-BJ | 0.219 | 0.160 | 0.84 | 0.53 | 0.093 | 0.076 | 0.465 | 0.311 | 0.050 | 0.027 | 0.035 | 0.039 | 0.046 | 0.020 | 0.067 | 0.062 |
| FSV-BK | 0.049 | 0.037 | 0.17 | 0.12 | 0.015 | 0.015 | 0.077 | 0.131 | 0.010 | 0.012 | 0.012 | 0.019 | 0.050 | 0.028 | 0.089 | 0.096 |
| FSV-BL | 0.200 | 0.142 | 0.90 | 0.57 | 0.121 | 0.099 | 0.500 | 0.332 | 0.044 | 0.027 | 0.044 | 0.042 | 0.044 | 0.027 | 0.044 | 0.042 |
| FSV-BM | 0.200 | 0.152 | 0.90 | 0.57 | 0.200 | 0.152 | 0.90 | 0.57 | 0.043 | 0.020 | 0.015 | 0.022 | 0.043 | 0.020 | 0.015 | 0.022 |
| FSV-BN | 0.157 | 0.075 | 0.90 | 0.52 | 0.063 | 0.051 | 0.513 | 0.337 | 0.029 | 0.013 | 0.016 | 0.019 | 0.029 | 0.013 | 0.016 | 0.019 |
| FSV-BR | 0.081 | 0.065 | 0.67 | 0.43 | 0.121 | 0.099 | 0.500 | 0.332 | 0.050 | 0.028 | 0.089 | 0.096 | 0.050 | 0.028 | 0.089 | 0.096 |
| FSV-BS | 0.136 | 0.112 | 0.57 | 0.38 | 0.121 | 0.099 | 0.500 | 0.332 | 0.044 | 0.027 | 0.044 | 0.042 | 0.044 | 0.027 | 0.044 | 0.042 |
| FSV-BT | 0.200 | 0.152 | 0.90 | 0.57 | 0.200 | 0.152 | 0.90 | 0.57 | 0.043 | 0.020 | 0.015 | 0.022 | 0.043 | 0.020 | 0.015 | 0.022 |
| FSV-BU | 0.151 | 0.108 | 0.57 | 0.37 | 0.063 | 0.051 | 0.513 | 0.337 | 0.029 | 0.013 | 0.016 | 0.019 | 0.029 | 0.013 | 0.016 | 0.019 |
| FSV-BUa | 0.173 | 0.135 | 1.16 | 0.66 | 0.121 | 0.099 | 0.500 | 0.332 | 0.050 | 0.028 | 0.089 | 0.096 | 0.050 | 0.028 | 0.089 | 0.096 |
| FSV-BV | 0.260 | 0.180 | 1.18 | 0.71 | 0.121 | 0.099 | 0.500 | 0.332 | 0.044 | 0.027 | 0.044 | 0.042 | 0.044 | 0.027 | 0.044 | 0.042 |
| FSV-BW | 0.165 | 0.136 | 0.83 | 0.48 | 0.079 | 0.068 | 0.360 | 0.221 | 0.037 | 0.026 | 0.033 | 0.033 | 0.037 | 0.026 | 0.033 | 0.033 |
| FSV-BX | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-CY | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-CZ | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-DV | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-EE | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-EZ | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-FK | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-FZ | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-GD | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-GF | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| FSV-GG | 0.213 | 0.164 | 0.90 | 0.59 | 0.079 | 0.068 | 0.360 | 0.221 | 0.052 | 0.033 | 0.035 | 0.039 | 0.052 | 0.033 | 0.035 | 0.039 |
| n | 13 | 13 | 13 | 13 | 4 | 4 | 4 | 4 | 11 | 10 | 10 | 11 | 1 | 1 | 1 | 1 |
| Min | 0.081 | 0.065 | 0.57 | 0.37 | 0.063 | 0.051 | 0.360 | 0.221 | 0.029 | 0.013 | 0.015 | 0.019 | 0.012 | 0.009 | 0.020 | 0.015 |
| Median | 0.200 | 0.142 | 0.90 | 0.57 | 0.093 | 0.076 | 0.465 | 0.311 | 0.050 | 0.027 | 0.035 | 0.039 | 0.012 | 0.009 | 0.020 | 0.015 |
| Max | 0.260 | 0.182 | 1.18 | 0.71 | 0.121 | 0.099 | 0.513 | 0.337 | 0.059 | 0.033 | 0.089 | 0.096 | 0.040 | 0.030 | 0.040 | 0.045 |
| eSD | 0.044 | 0.033 | 0.09 | 0.09 | 0.031 | 0.023 | 0.062 | 0.035 | 0.009 | 0.007 | 0.011 | 0.009 | 0.056 | 0.030 | 0.040 | 0.045 |
| eCV | 22 | 23 | 10 | 17 | 33 | 30 | 13 | 11 | 17 | 28 | 33 | 26 | 0.059 | 0.031 | 0.034 | 0.039 |
| N _{past} | 15 | 0 | 16 | 0 | 7 | 0 | 7 | 0 | 14 | 0 | 15 | 0 | 7 | 0 | 6 | 0 |
| Median _{past} | 0.219 | 0.94 | 0.94 | 0.488 | 0.116 | 0.421 | 0.421 | 0.365 | 0.051 | 0.032 | 0.032 | 0.111 | 0.018 | 0.023 | 0.023 | 0.037 |
| SD _{past} | 0.025 | 0.16 | 0.16 | 0.096 | 0.015 | 0.077 | 0.077 | 0.131 | 0.010 | 0.012 | 0.012 | 0.019 | 0.003 | 0.008 | 0.008 | 0.037 |
| NAV | 0.200 | 0.142 | 0.90 | 0.57 | 0.093 | 0.076 | 0.465 | 0.311 | 0.050 | 0.027 | 0.035 | 0.039 | 0.012 | 0.009 | 0.020 | 0.015 |
| NAU | 0.049 | 0.037 | 0.17 | 0.12 | 0.015 | 0.015 | 0.077 | 0.131 | 0.010 | 0.012 | 0.012 | 0.019 | 0.003 | 0.008 | 0.008 | 0.037 |

Round Robin LXXX Laboratory Results

Analytes Reported By One Laboratory

Values in µg/mL

| Analyte | Code | 427 | 428 | 429 | 430 | 431 |
|---------------------|---------|-------|-------|-------|-------|-----------|
| 25-hydroxyvitamin D | FSV-BH | 0.008 | 0.013 | 0.020 | 0.017 | 0.020 |
| Phytofluene | FSV-BS | 0.038 | 0.034 | 0.265 | 0.174 | 0.059 |
| trans-Retinol | FSV-BS | 0.396 | 0.366 | 0.718 | 0.783 | 0.652 |
| Ubiquinol (QH2) | FSV-BW | 0.390 | 0.170 | 0.430 | 0.520 | <i>nd</i> |
| Ubiquinone (Qox) | FSV-BW | 0.250 | 0.200 | 0.570 | 0.420 | 0.420 |
| β-Tocopherol | FSV-BUa | 0.147 | 0.084 | 0.225 | 0.192 | 0.132 |
| γ-Tocopherol | FSV-BUa | 2.370 | 1.360 | 2.940 | 3.350 | 3.650 |

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: $100 \cdot SD / \text{Median}$ |
| 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: ' Median for analytes reported by ≥ 5 labs |
| NAU | NIST Assigned Uncertainty: the maximum of ($0.05 \cdot \text{NAV}$, SD, SD_{past} , eSD) The expected long-term SD, eSD, is defined in: 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 |
| <x | Concentration at or below the limit of quantification, x |
| $\geq x$ | Concentration greater than or equal to x |
| ! | Discrepant value: interference, damaged sample, malfunction, etc. |
| <i>italics</i> | Not explicitly reported but calculated by NIST from reported values |

Round Robin LXXX Laboratory Results

Comparability Summary

This publication is available free of charge from: <https://doi.org/10.6028/NIST.JR.7880-47>

| Lab | TR | aT | g/bT | bC | aC | TLy | TbX | L&Z | Q10 |
|---------|----|----|------|----|----|-----|-----|-----|-----|
| FSV-BC | 1 | | | | | | | | |
| FSV-BD | 1 | 1 | | | | | | | |
| FSV-BE | 2 | 1 | 1 | 1 | | | | | 2 |
| FSV-BFa | 2 | 2 | | | | | | | |
| FSV-BG | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | |
| FSV-BH | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | |
| FSV-BJ | 1 | 1 | 1 | 1 | 2 | 1 | 1 | | 2 |
| FSV-BK | 1 | 1 | | | | | | | |
| FSV-BL | 1 | 1 | | | | | | | |
| FSV-BM | 2 | 1 | | | | | | | |
| FSV-BN | 1 | 2 | | 2 | 1 | 2 | 2 | 1 | |
| FSV-BR | 2 | 2 | | | | | | | |
| FSV-BS | 2 | 2 | | 2 | 4 | 2 | 4 | 1 | |
| FSV-BT | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 |
| FSV-BU | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | |
| FSV-BUa | | 2 | 4 | | | | | | |
| FSV-BV | 1 | 4 | 2 | 1 | 1 | 2 | 2 | 1 | |
| FSV-BW | 1 | 1 | | 2 | 4 | 1 | | | 2 |
| FSV-CD | 2 | 1 | 1 | 2 | 4 | 2 | 2 | 1 | |
| FSV-CE | 1 | 2 | | 2 | | | | | |
| FSV-CF | 1 | 3 | | | | | | | |
| FSV-CG | 2 | 2 | 2 | 1 | 2 | 1 | 1 | 1 | |
| FSV-CI | 1 | 1 | 1 | | | | | | 1 |
| FSV-CO | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | |
| FSV-CZ | 1 | 2 | 2 | 2 | | | | | 2 |
| FSV-DV | 1 | 2 | | | | | | | |
| FSV-EE | | | | | | | | | 1 |
| FSV-EZ | 1 | 1 | 1 | 1 | | | | | |
| FSV-FK | 2 | 1 | | 3 | | | | | |
| FSV-FZ | 1 | 1 | 1 | | | | | | |
| FSV-GD | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 |
| FSV-GF | | 2 | | | | | | | 1 |
| FSV-GG | | | | | | | | | 1 |
| n | 29 | 30 | 16 | 18 | 13 | 13 | 11 | 10 | 10 |

| | TR | aT | g/bT | bC | aC | TLy | TbX | L&Z | Q10 |
|-----|----|----|------|----|----|-----|-----|-----|-----|
| % 1 | 72 | 60 | 63 | 56 | 54 | 62 | 55 | 80 | 60 |
| % 2 | 28 | 33 | 31 | 39 | 23 | 38 | 36 | 20 | 40 |
| % 3 | 0 | 3 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| % 4 | 0 | 3 | 6 | 0 | 23 | 0 | 9 | 0 | 0 |

| Label | Definition |
|-------|---------------------------|
| Lab | Participant code |
| TR | Total Retinol |
| aT | α-Tocopherol |
| g/bT | γ/β-Tocopherol |
| bC | Total β-Carotene |
| aC | Total α-Carotene |
| TLy | Total Lycopene |
| TbX | Total β-Cryptoxanthin |
| L&Z | Total Lutein & Zeaxanthin |
| Q10 | Coenzyme Q10 |

- 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 H. Representative “Individualized Report” for RR80

Each participant in RR80 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
- Total α -Carotene
- Total Lycopene
- Total β -Cryptoxanthin
- Total Lutein & Zeaxanthin
- Coenzyme Q10

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

Individualized Round Robin LXXX Report: FSV-BG

Summary

| Analyte | Serum 427 | | | Serum 428 | | | Serum 429 | | | Serum 430 | | | Serum 431 | | |
|-------------------------|-----------|-------|----|-----------|-------|----|-----------|-------|----|-----------|-------|----|-----------|-------|----|
| | You | NAV | n | You | NAV | n | You | NAV | n | You | NAV | n | You | NAV | n |
| Total Retinol | 0.377 | 0.352 | 28 | 0.363 | 0.320 | 28 | 0.676 | 0.643 | 28 | 0.695 | 0.661 | 28 | 0.713 | 0.701 | 28 |
| Retinyl Palmitate | 0.01 | 0.01 | 3 | 0.0 | 0.0 | 3 | 0.2 | 0.1 | 5 | 0.08 | 0.04 | 4 | 0.03 | 0.03 | 4 |
| α-Tocopherol | 6.77 | 6.80 | 30 | 4.68 | 5.00 | 30 | 18.88 | 19.08 | 30 | 11.86 | 12.35 | 30 | 14.16 | 14.23 | 30 |
| γ/β-Tocopherol | 1.954 | 1.797 | 16 | 1.128 | 1.075 | 16 | 2.351 | 2.248 | 16 | 2.707 | 2.585 | 16 | 3.157 | 2.917 | 16 |
| Total β-Carotene | 0.092 | 0.091 | 15 | 0.120 | 0.111 | 15 | 0.474 | 0.430 | 15 | 0.218 | 0.177 | 15 | 0.351 | 0.330 | 15 |
| Total α-Carotene | 0.008 | 0.008 | 10 | 0.023 | 0.023 | 12 | 0.021 | 0.014 | 11 | 0.014 | 0.011 | 11 | 0.196 | 0.212 | 13 |
| Total Lycopene | 0.206 | 0.200 | 13 | 0.156 | 0.142 | 13 | 0.956 | 0.901 | 13 | 0.602 | 0.574 | 13 | 0.403 | 0.449 | 13 |
| trans-Lycopene | 0.107 | 0.093 | 4 | 0.084 | 0.076 | 4 | 0.430 | 0.465 | 4 | 0.290 | 0.311 | 4 | 0.241 | 0.278 | 4 |
| Total β-Cryptoxanthin | 0.056 | 0.050 | 11 | 0.030 | 0.027 | 10 | 0.040 | 0.035 | 10 | 0.045 | 0.039 | 10 | 0.115 | 0.102 | 11 |
| Total Lutein&Zeaxanthin | 0.129 | 0.110 | 10 | 0.050 | 0.050 | 10 | 0.138 | 0.138 | 10 | 0.108 | 0.119 | 10 | 0.570 | 0.381 | 10 |

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

H2

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

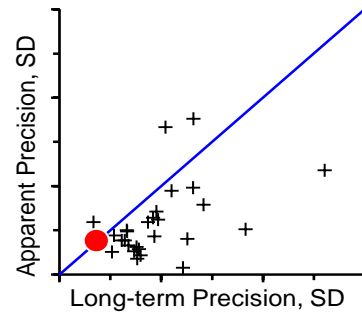
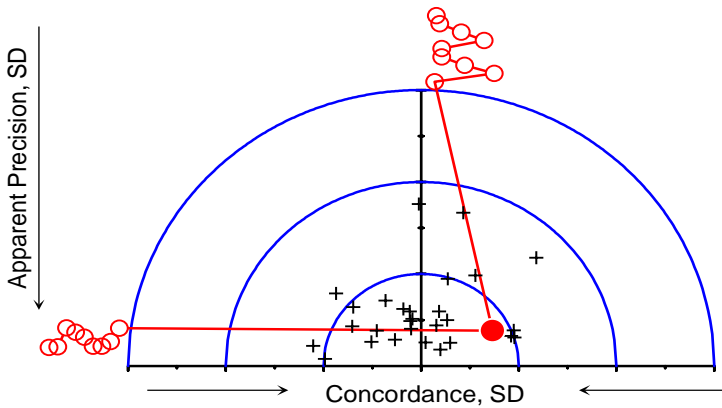
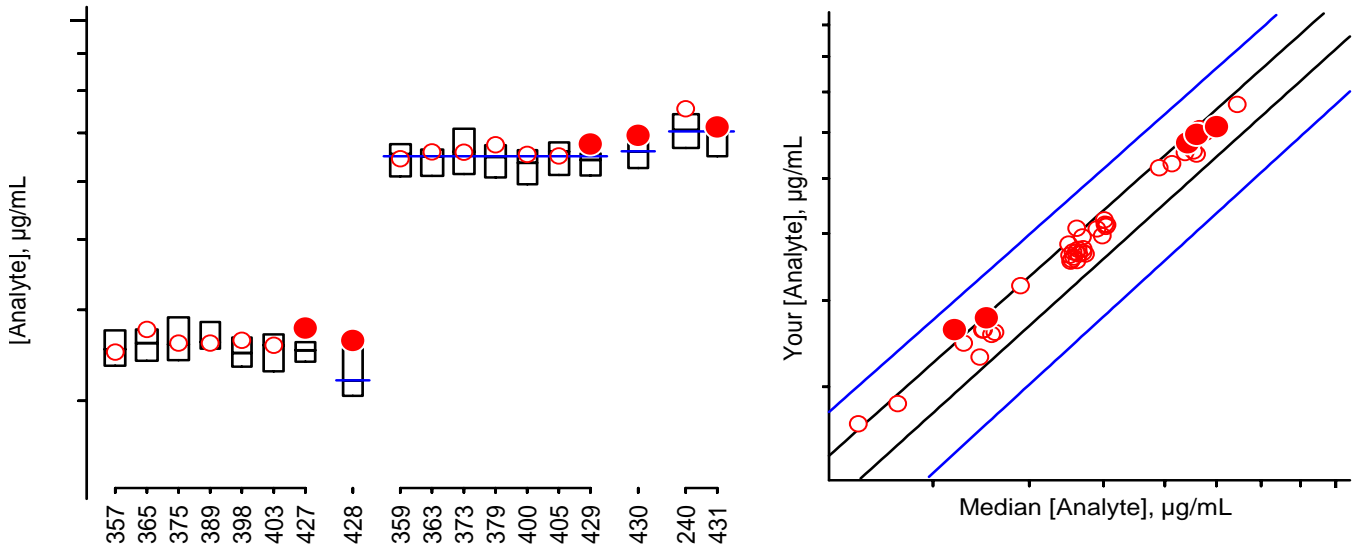
Micronutrients Measurement Quality Assurance Program
 National Institute of Standards and Technology
 100 Bureau Drive Stop 8392
 Gaithersburg, MD 20899-8392 USA

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

Individualized RR LXXX Report: FSV-BG

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



- 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

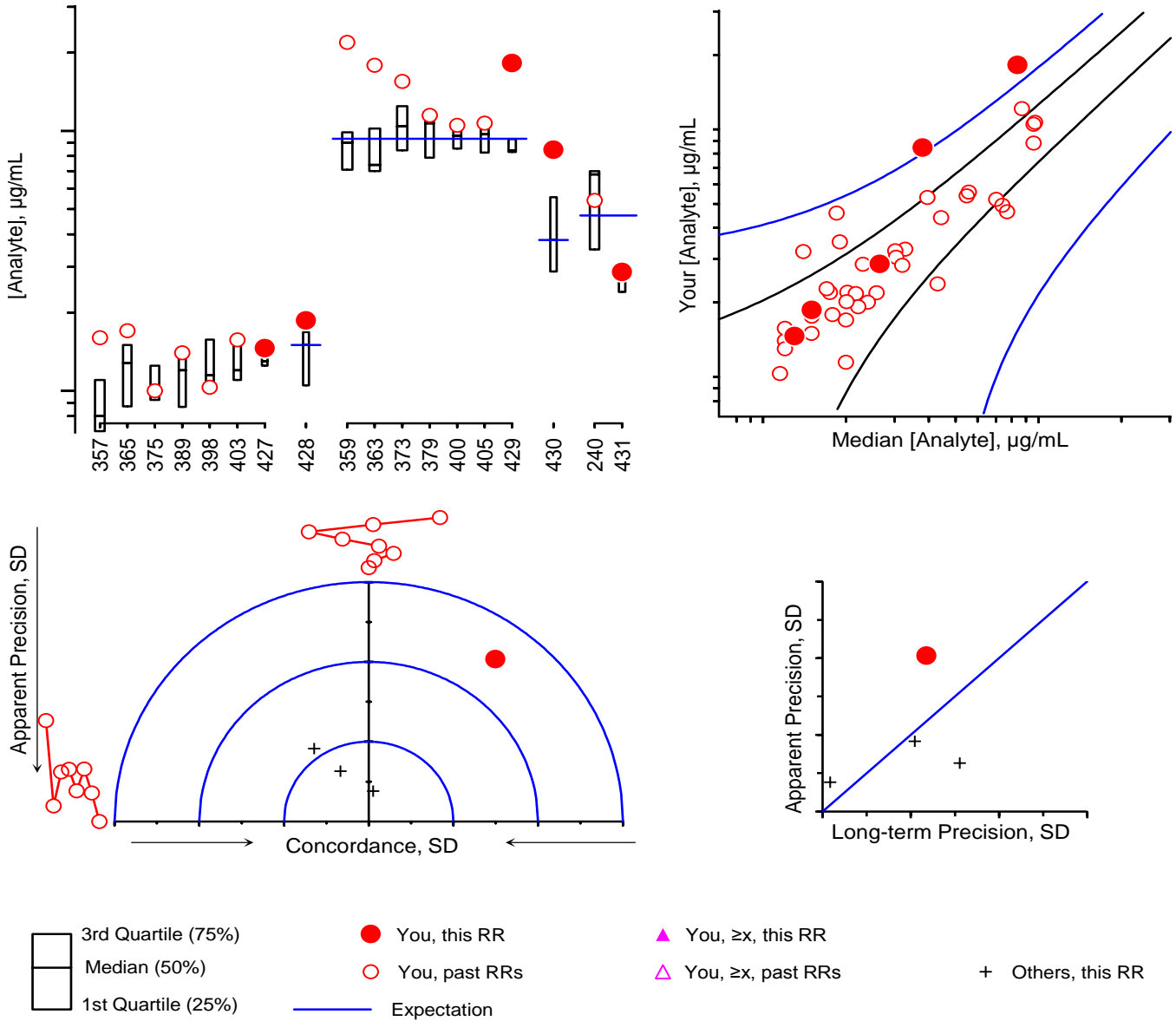
- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

Individualized RR LXXX Report: FSV-BG

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Retinyl Palmitate, $\mu\text{g/mL}$



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

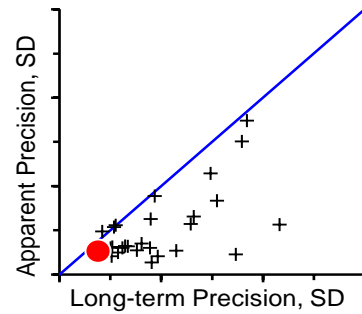
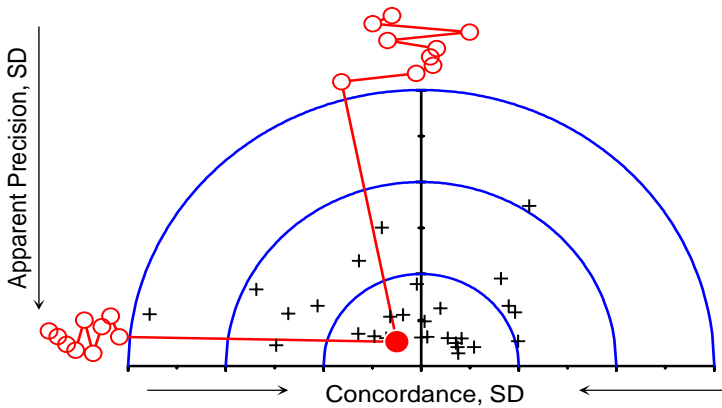
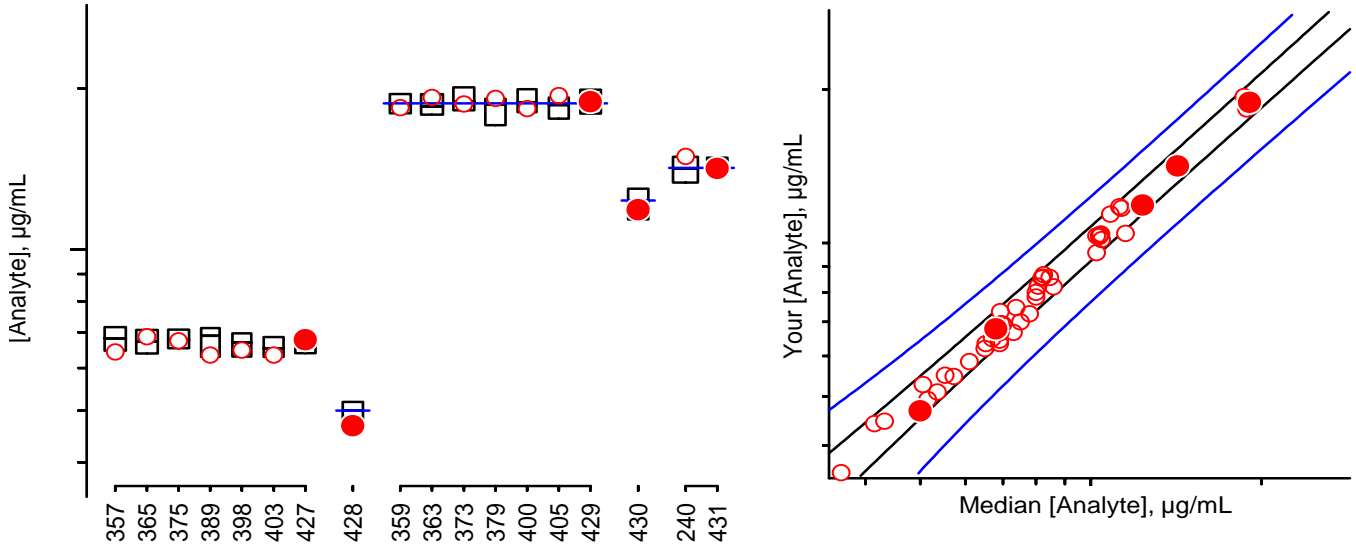
History

- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

Individualized RR LXXX Report: FSV-BG

α-Tocopherol, 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

- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

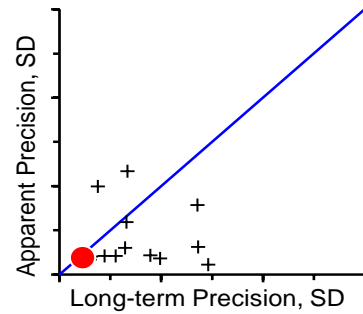
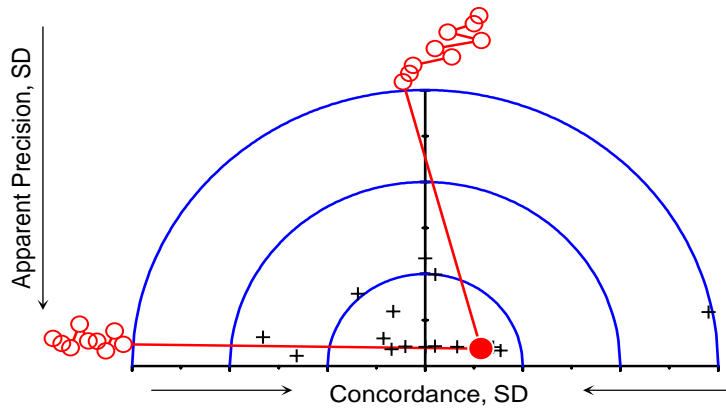
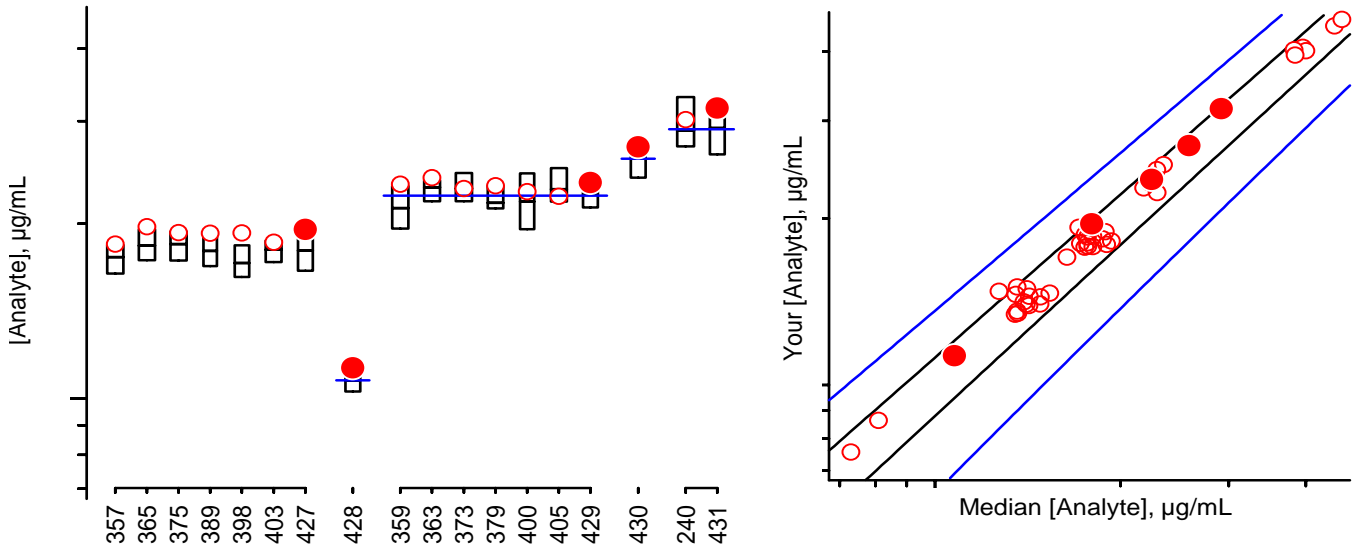
- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

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Individualized RR LXXX Report: FSV-BG

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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

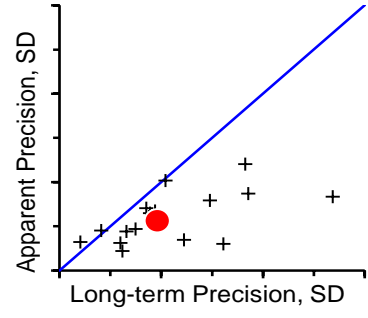
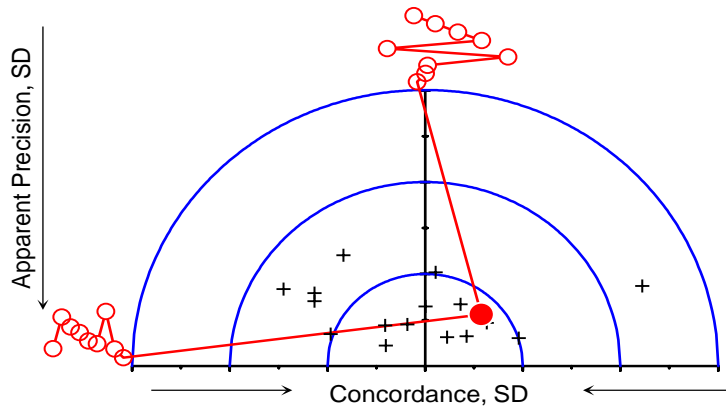
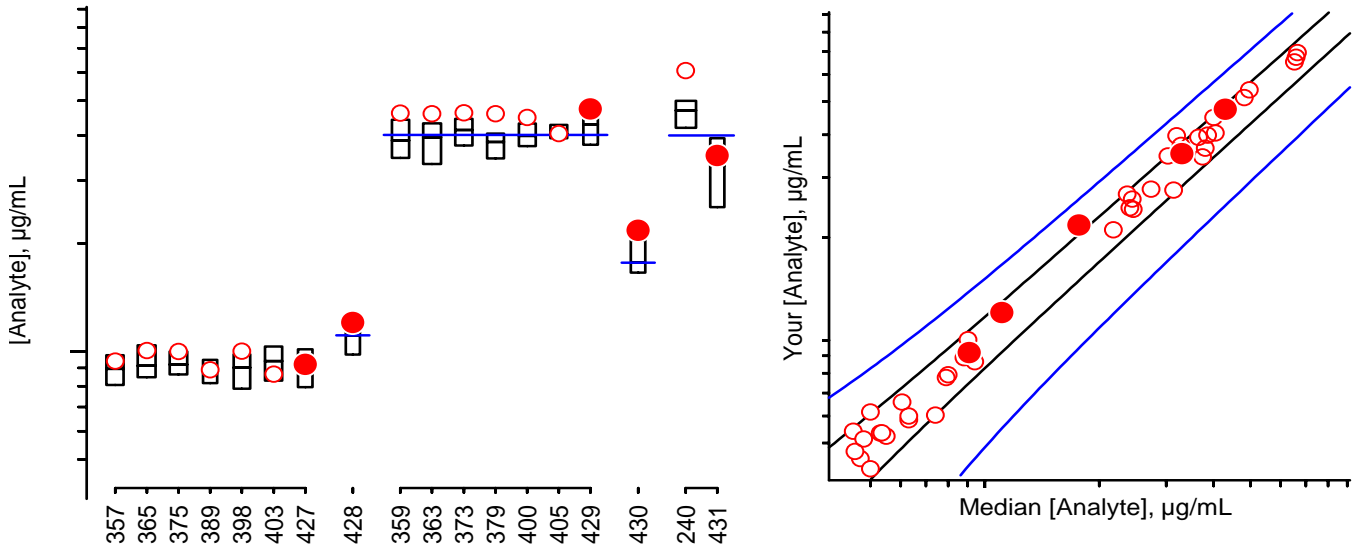
- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

Individualized RR LXXX Report: FSV-BG

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Total β -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.

Serum

Comments

History

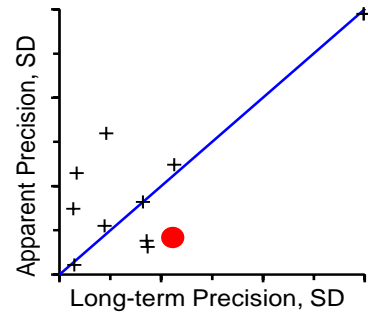
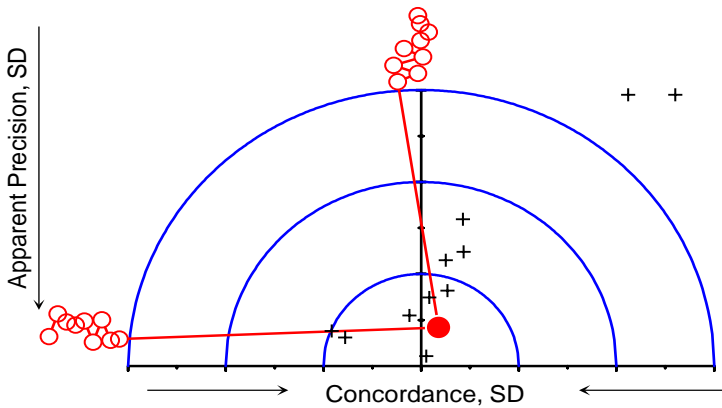
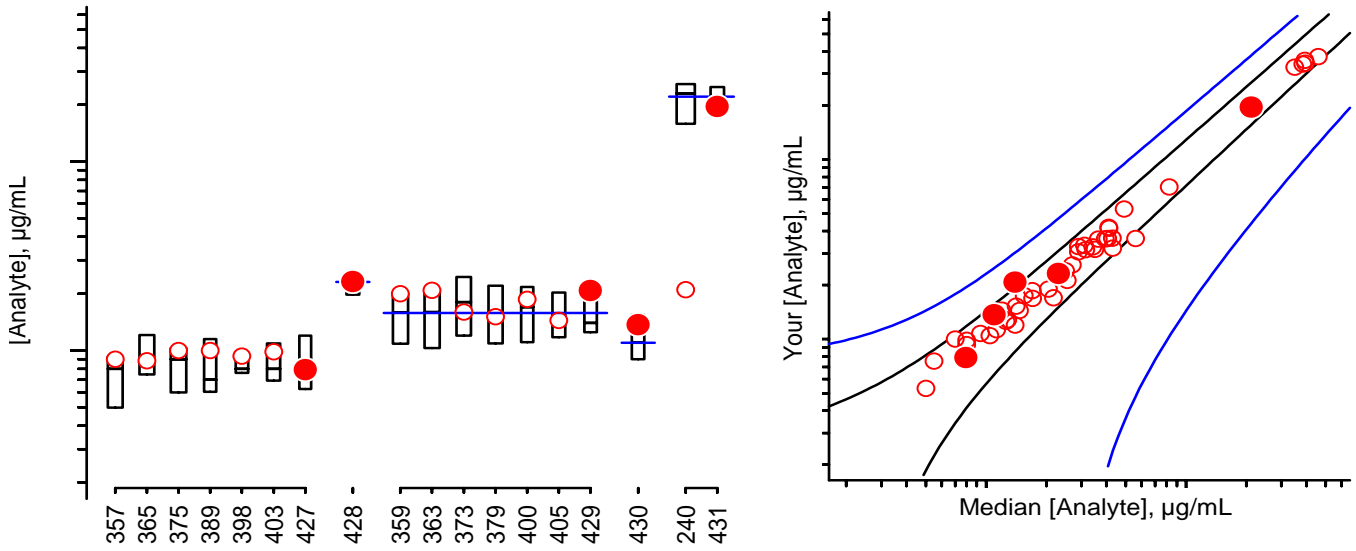
- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

Individualized RR LXXX Report: FSV-BG

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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.

Serum

Comments

History

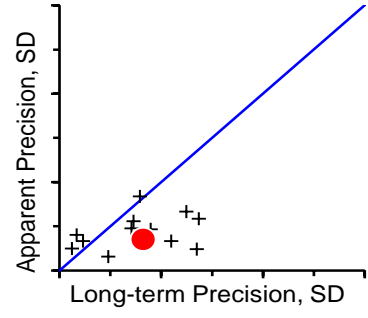
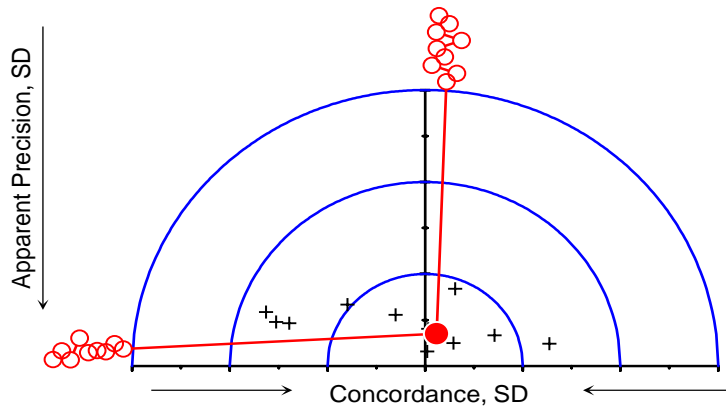
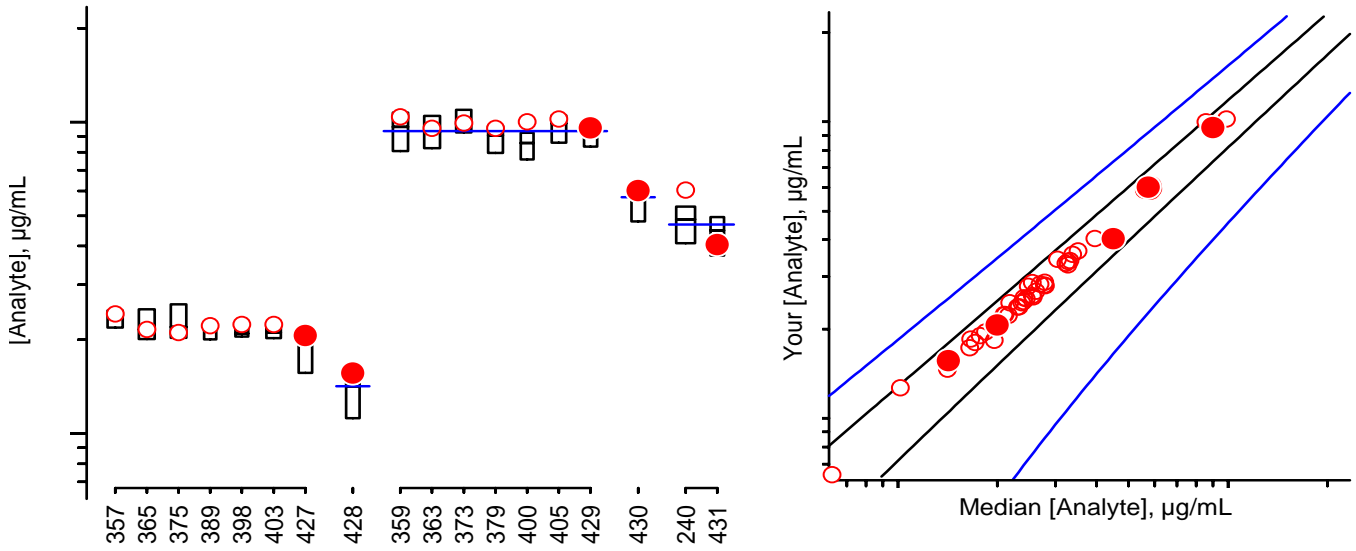
- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

Individualized RR LXXX Report: FSV-BG

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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

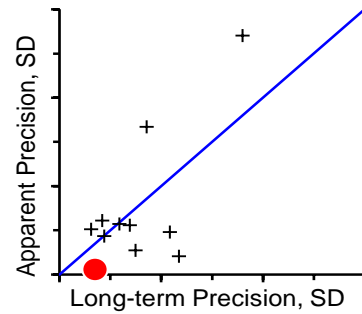
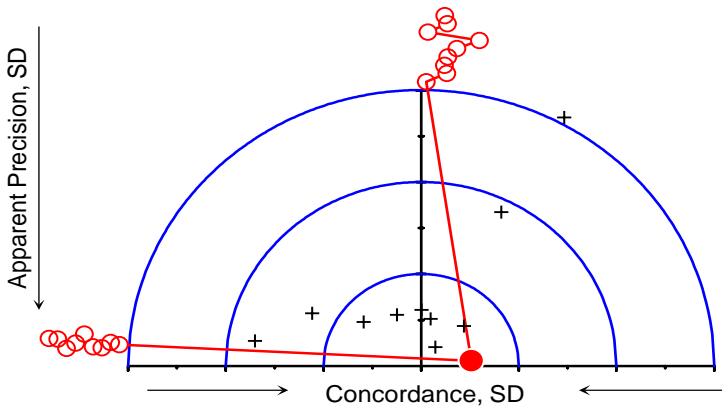
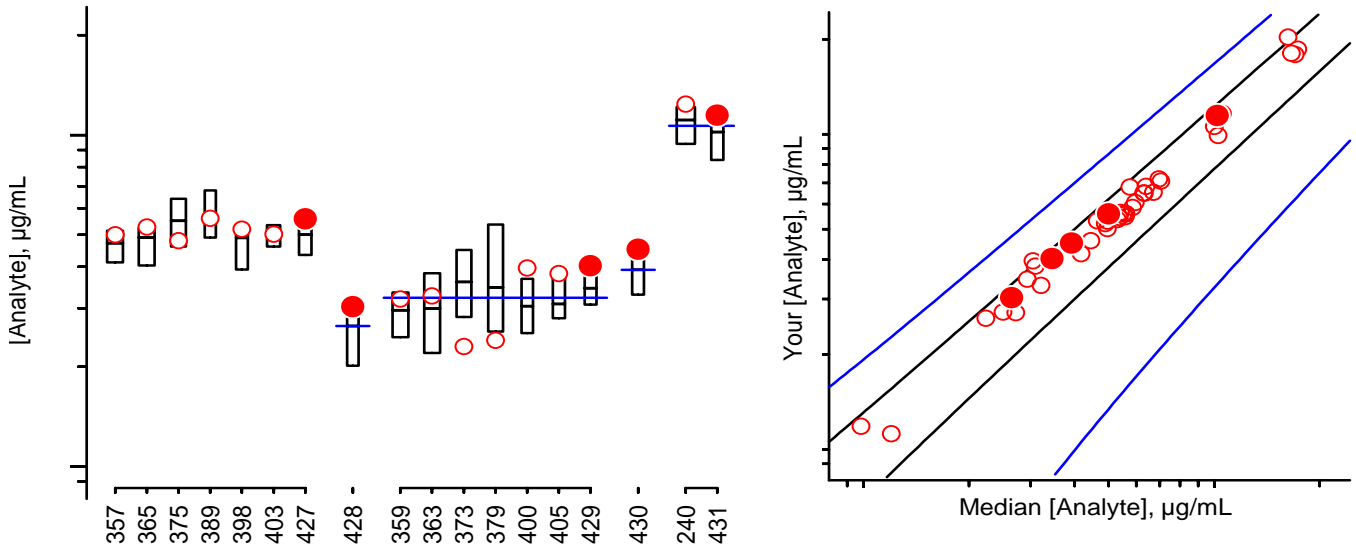
History

- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

Individualized RR LXXX Report: FSV-BG

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

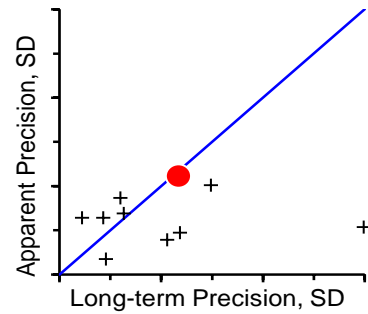
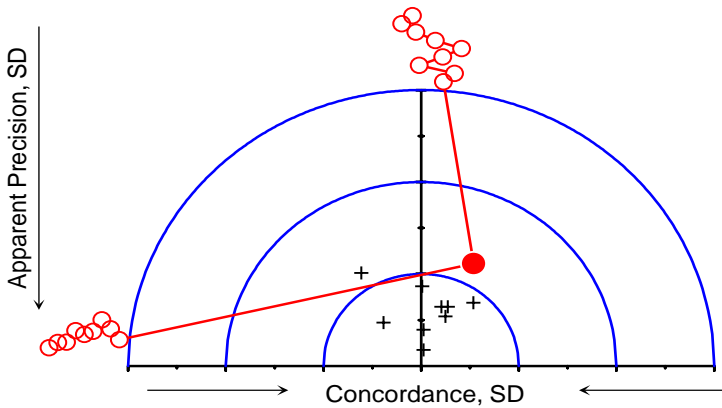
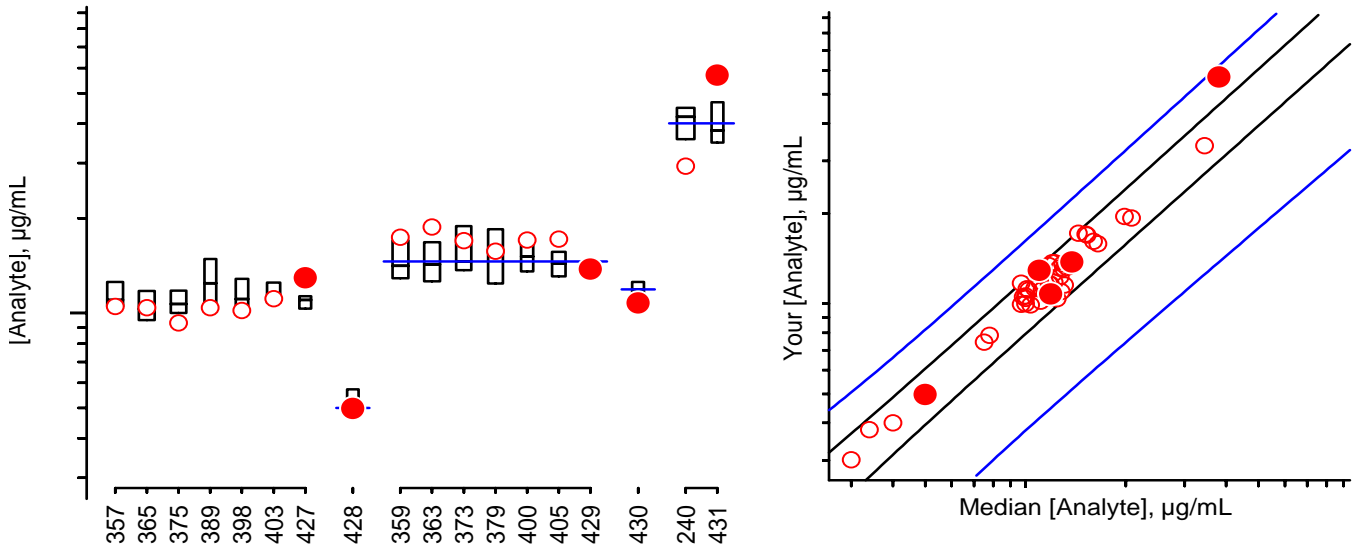
- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

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Individualized RR LXXX Report: FSV-BG

Total Lutein&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

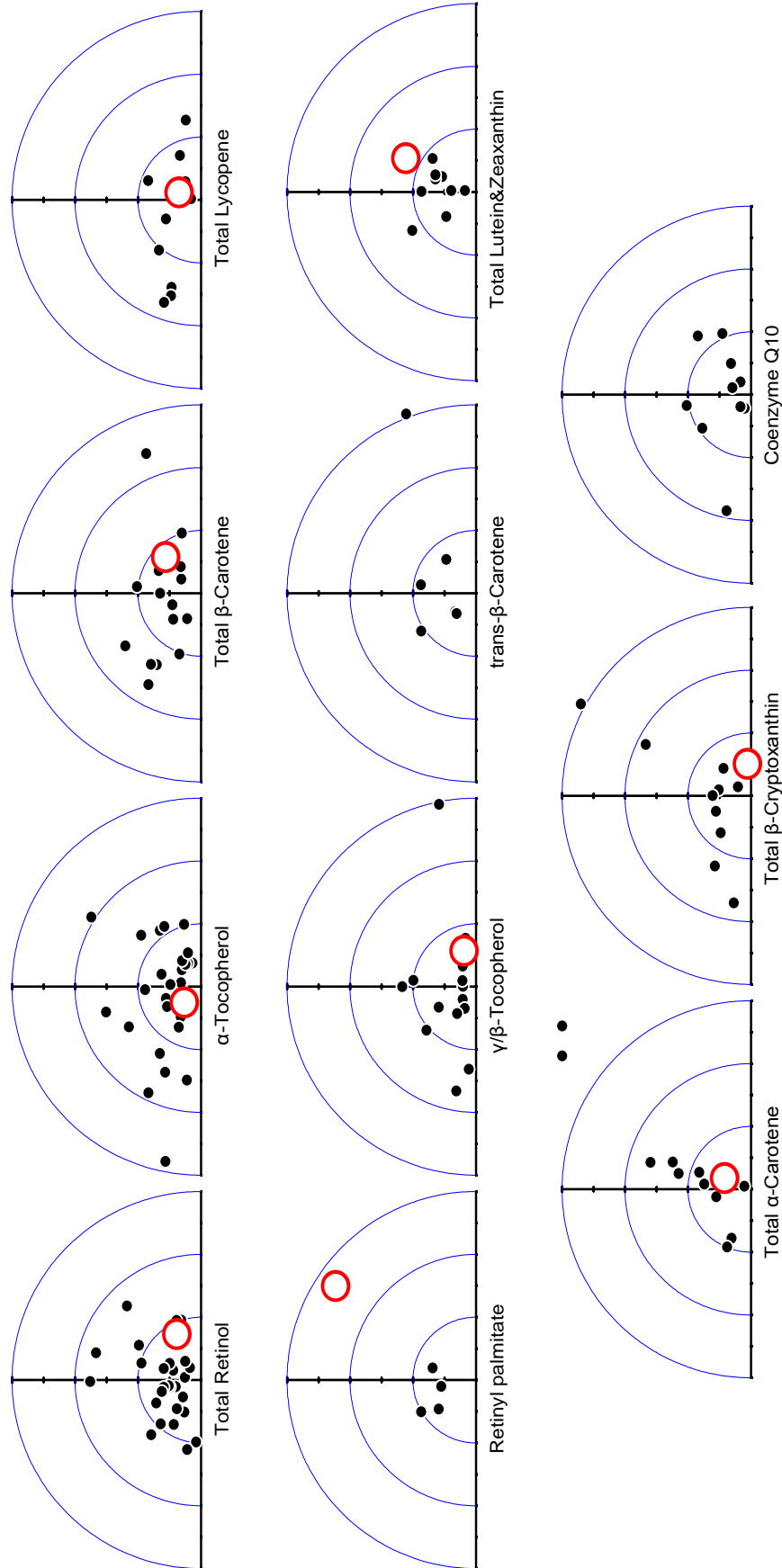
History

- #427 Fresh-frozen, native, multi-donor, SRM 968e-I
- #428 Fresh-frozen, native, multi-donor
- #429 Fresh-frozen, native, multi-donor: SRM968e-III
- #430 Fresh-frozen, native, multi-donor
- #431 Lyophilized, highly augmented, multi-donor

- RR66#357, RR67#365, RR69#375, RR72#389, RR74#398, RR75#403
- First distribution
- RR66#359, RR67#363, RR69#373, RR70#379, RR74#400, RR75#405
- First distribution
- RR42#240

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Individualized Round Robin LXXX Report: FSV-BG Graphical Comparability Summary



H12