NISTIR 7880-31

NIST Micronutrients Measurement Quality Assurance Program Winter, Spring, and Fall 1993 Comparability Studies

Results for Round Robins XXVII, XXVIII, and XXIX Fat-Soluble Vitamins and Carotenoids in Human Serum and Round Robin 4 Ascorbic Acid in Human Serum

David L. Duewer
Margaret C. Kline
Sam A. Margolis (Retired)
Willie E. May
Katherine E. Sharpless
Jeanice B. Thomas

This publication is available free of charge from
http://dx.doi.org/10.6028/NIST.IR.7880-31

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

AUTHENTICATED
U.S. GOVERNMENT
INFORMATION
GPO

NISTIR 7880-31

NIST Micronutrients Measurement Quality Assurance Program Winter, Spring, and Fall 1993 Comparability Studies

Results for Round Robins XXVII, XXVIII, and XXIX Fat-Soluble Vitamins and Carotenoids in Human Serum and Round Robin 4 Ascorbic Acid in Human Serum

David L. Duewer
Sam A. Margolis (Retired)
Jeanice B. Thomas
Chemical Sciences Division, Materials Measurement Laboratory

Margaret C. Kline
Biomolecular Measurement Division, Materials Measurement Laboratory

Katherine E. Sharpless
Office of Special Programs

Willie E. May
Associate Directory for Laboratory Programs

This publication is available free of charge from
http://dx.doi.org/10.6028/NIST.IR.7880-31

December, 2014

U.S. Department of Commerce
Penny Pritzker, Secretary

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

(This page intentionally blank)

Abstract

The National Institute of Standards and Technology coordinates the Micronutrients Measurement Quality Assurance Program (MMQAP) for laboratories that measure fat- and water-soluble vitamins and carotenoids in human serum and plasma. This report describes the design of and results for the Winter, Spring and Fall 1993 MMQAP measurement comparability improvement studies: 1) Round Robin XXVII Fat-Soluble Vitamins and Carotenoids in Human Serum, 2) Round Robin XXVIII Fat-Soluble Vitamins and Carotenoids in Human Serum, 3) Round Robin XXIX Fat-Soluble Vitamins and Carotenoids in Human Serum, and 4) Round Robin 4 Ascorbic Acid in Human Serum. The materials for Round Robin XXVII were shipped to participants in January 1993; participants were requested to provide their measurement results by March 19, 1993. The materials for Round Robin XXVIII were shipped to participants in April 1993; participants were requested to provide their measurement results by June 14, 1993. The materials for Round Robin XXIX were shipped to participants in July 1993; participants were requested to provide their measurement results by August 30, 1993. The sample materials for Round Robin 4 were distributed in August 1993 with results due by September 15, 1993.

Keywords

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

Table of Contents

Abstract iii
Keywords iii
Table of Contents iv
Introduction 1
Round Robin XXVII: Fat-Soluble Vitamins and Carotenoids in Human Serum 1
Round Robin XXVIII: Fat-Soluble Vitamins and Carotenoids in Human Serum 2
Round Robin XXIX: Fat-Soluble Vitamins and Carotenoids in Human Serum 2
Round Robin 4: Vitamin C in Human Serum 3
References 3

Appendix A. Shipping Package Inserts for RR27 ..... A1
Appendix B. Final Report for RR27 ..... B1
Appendix C. "Individualized Report" for RR27 ..... C1
Appendix D. Revised "All-Lab Report" for RR27 ..... D1
Appendix E. Shipping Package Inserts for RR28 ..... E1
Appendix F. Final Report for RR28 ..... F1
Appendix G. "Individualized Report" for RR28 ..... G1
Appendix H. Revised "All-Lab Report" for RR28 ..... H1
Appendix I. Shipping Package Inserts for RR29 ..... I1
Appendix J. Final Report for RR29 ..... J1
Appendix K. "Individualized Report" for RR29 ..... K1
Appendix L. Revised "All-Lab Report" for RR29 ..... L1
Appendix M. Shipping Package Inserts for RR04 ..... M1
Appendix N. Final Report for RR04 ..... N1
Appendix O. Revised "All-Lab Report" for RR04 ..... O1

Introduction

Beginning in 1988, 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 ascorbic acid) and performance-evaluation standards are distributed by NIST to laboratories for analysis.

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

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

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

Participants in the MMQAP Fat-Soluble Vitamins and Carotenoids in Human Serum Round Robin XXVII comparability study (hereafter referred to as RR27) received five lyophilized human serum test samples for analysis. Unless multiple vials were previously requested, participants received one vial of each serum. These sera were shipped on dry ice to participants in January 1993. The communication materials included in the sample shipment are described 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 some participants report values for non-target analytes.

The final report delivered to every participant in RR27 is reproduced as Appendix B. This report included:

- Our analysis of the participants' results.
- Tabular presentations of all participant results
- Graphical presentations of "Interlaboratory Precision vs Time"

Each participant also received an "Individualized Report" that graphs their results for selected analytes. An example "Individualized Report" is reproduced as Appendix C.

Appendix D lists all of the measurement results reported for RR27 in a more accessible format.

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

Participants in the MMQAP Fat-Soluble Vitamins and Carotenoids in Human Serum Round Robin XXVIII comparability study (hereafter referred to as RR28) received five lyophilized human serum test samples for analysis. Unless multiple vials were previously requested, participants received one vial of each material. These sample materials were shipped on dry ice to participants in April 1993. The communication materials included in the sample shipment are described 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 some participants report values for non-target analytes.

The final report delivered to every participant in RR28 is reproduced as Appendix F. This report included:

- Our analysis of the participants' results.
- Tabular presentations of all participant results
- Graphical presentations of "Interlaboratory Precision vs Time"

Each participant also received an "Individualized Report" that graphs their results for selected analytes. An example "Individualized Report" is reproduced as Appendix G.

Appendix H lists all of the measurement results reported for RR28 in a more accessible format.

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

Participants in the MMQAP Fat-Soluble Vitamins and Carotenoids in Human Serum Round Robin XXIX comparability study (hereafter referred to as RR29) received three lyophilized and two liquid-frozen human serum test samples for analysis. Unless multiple vials were previously requested, participants received one vial of each material. These sample materials were shipped on dry ice to participants in July 1993. The communication materials included in the sample shipment are described in Appendix I.

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 some participants report values for non-target analytes.

A preliminary report for RR29 was mailed to all participants shortly before the Micronutrients QA Workshop held on October 1993. The "Summary of 1993 Round Robin Activities" was mailed to every participant in the 1993 program in November 1993. This Summary included lists of all the Fat-Soluble Vitamin MMQAP results for RR27 and RR28 as well as RR29. The cover letter of the preliminary report and the RR29-related components of the Summary are reproduced as Appendix J.

Each participant also received an "Individualized Report" that graphs their RR29 results for selected analytes. An example "Individualized Report" is reproduced as Appendix K.

Appendix L lists all of the measurement results reported for RR29 in a more accessible format.

Round Robin 4: Vitamin C in Human Serum

Participants in the MMQAP Vitamin C in Human Serum Round Robin 4 comparability study (hereafter referred to as RR04) received six frozen serum test samples, two ampoules of each of three different materials. These samples were shipped on dry ice to participants in August 1993. The available communication materials included in the sample shipment are described in Appendix M.

The test materials were prepared by adding equal volumes of 10 % metaphosphoric acid (MPA) to human serum that had been spiked with ascorbic acid. Participants were asked to provide two results for each vial.

The final report delivered to all participants in RR04 consists of a cover letter and a series of Tables and Figures that summarize the results of the study. This report is reproduced as Appendix N.

While not distributed to the participants in RR04, Appendix O is a revised "All-Lab Report" that lists the results for the test materials transformed into units of µmol/mL sample.

No "Individualized Report" was provided to the participants in RR04.

References

1 Duewer DL, Brown Thomas J, Kline MC, MacCrehan WA, Schaffer R, Sharpless KE, May WE, Crowell JA. NIST/NCI Micronutrients Measurement Quality Assurance Program: Measurement Repeatabilities and Reproducibilities for Fat-Soluble Vitamin-Related Compounds in Human Sera. Anal Chem 1997;69(7):1406-1413.

2 Margolis SA, Duewer DL. Measurement Of Ascorbic Acid in Human Plasma and Serum: Stability, Intralaboratory Repeatability, and Interlaboratory Reproducibility. Clin Chem 1996;42(8):1257-1262.

Appendix A. Shipping Package Inserts for RR27

Two slightly different sets of samples were distributed in RR27. All participants received two vials each of Sera 173 to 174. In addition, "Core labs" – those who had participated in at least the 1991 and 1992 Round Robin studies – received one vial of Serum 177. The Core and non-Core participants received different letters and datasheets.

The following two items were included in each package shipped to an RR27 participant:

- **Cover letter**. The original letters have been lost. The attached version has been reconstructed from a letter sent to a participant who enrolled in the 1993 program after RR27 had been shipped. This version represents what was sent to the Core labs; the version sent to non-Core labs would excluded the information on Serum 177.
- **Datasheet**. As with the cover letter, the attached version is what was sent to the Core labs. The version sent to the non-Core labs deleted the spaces provided for Serum 177 results and the comment that only one vial of Serum 177 was available per participant.

These items were attached to the shipping box.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

January 11, 1993

Dear Colleague:

The 1993 NIST/NCI Fat-Soluble Vitamins Quality Assurance Program will consist of three Round Robin exercises. The core analytes in the program will be: retinol, retinyl palmitate, α-tocopherol, γ-tocopherol, and total β-carotene. Data will also be collected and analyzed for α-carotene, trans-β-carotene, β-cryptoxanthin, lutein, total lycopene, trans-lycopene, and zeaxanthin. One of the three studies is designed to focus primarily on problems associated with selected carotenoid compounds.

Enclosed is the set of samples for the first 1993 Round Robin exercise (Round Robin XXVII). You will find duplicate vials of four lyophilized sera samples (Sera 173 to 176) and one vial of Serum 177 for analysis along with a form for reporting your results. When reporting your results, please submit one value for each analyte for a given serum sample.

Samples should be reconstituted with 1.00 mL of HPLC Grade water or equivalent. We recommend that dissolution be facilitated with 3 to 5 minutes agitation in an ultrasonic bath or at least 30 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 which will leach into the sample upon intermittent contact of the liquid sample with the stopper. These esters absorb strongly in the UV region and elute very near retinol in most HPLC systems creating analytical problems.) Pipette a known volume of serum from the vial for analysis since the final volume of the reconstituted sample is greater than 1.0 mL. For consistency, we have requested that laboratories use the following absorptivities ($E^{1\%}_{cm}$) in ethanol: retinol, 1850 at 325 nm; retinyl palmitate, 975 at 325 nm; α-tocopherol, 75.8 at 292 nm; γ-tocopherol, 91.4 at 298 run; α-carotene, 2800 at 444 nm; β-carotene, 2560 at 450 nm; lycopene, 3450 at 472 nm. We understand that there is some discrepancy in the reported absorptivities and studies are currently underway to identify certified values in ethanol and hexane.

Results for Round Robin XXVII are due to NIST by March 19, 1993. Results may be mailed or FAXed to:

Ms. Nancy T. Miles
NIST
Bldg. 222, Rm. B158
Ga1tnersburg, MD 20899 USA
FAX: (301) 926-8671

Analytical and technical queries should be directed to me at the same address or via telephone at (301) 975-3208.

This year's workshop is being planned for late September. You will be informed of the actual date and meeting place.

Sincerely,

Willie E. May, Ph.D.
Chief
Organic Analytical Research Division
Chemical Science and Technology Laboratory

ROUND ROBIN XXVII RESULTS FROM LABORATORY # _____
DATE OF ANALYSIS _____
RESULTS IN ug/mL

SAMPLE NUMBER	ANALYTE	RESULT
SERUM 173	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 174	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 175	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 176	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 177	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____

OPTIONAL ANALYTES: SUPPLY ONE RESULT IF AVAILABLE

SERUM #	173	174	175	176	177
TRANS-BETA CAROTENE					
ALPHA-CAROTENE					
RETINYL PALMITATE					
GAMMA-TOCOPHEROL					
LYCOPENE (TOTAL)					
9-CIS-BETA CAROTENE					
13-CIS-BETA-CAROTENE					
LUTEIN					
ZEAXANTHIN					
BETA-CRYPTOXANTHIN					

DIRECTIONS: Reconstitute with 1.0 mL distilled water.

COMMENT: Only 1 vial of Serum 177 is available per lab.

FAX RESULTS TO 301/926-8671

Appendix B. Final Report for RR27

The following eleven pages are the final report for RR27 as provided to all participants. This report consists of:

- A cover letter and discussion.
- Tables 1 to 4 that list the results and various summary values for total retinol, α-tocopherol, total β-carotene, and γ/β-tocopherol.
- Tables 5 to 16 that list the results and simple summary statistics for *trans*-β-carotene, total α-carotene, retinyl palmitate, total lutein, total lycopene, total zeaxanthin, total lutein & zeaxanthin, total β-cryptoxanthin, *trans*-lycopene, total *cis*-β-carotene, *trans*-α-carotene, and δ-tocopherol.
- three graphical presentations of "Interlaboratory Precision vs Time" for total retinol, α-tocopherol, and total β-carotene.

Due to the complex formatting used in the Tables, the originally listed laboratory codes have been deleted without replacement. However, Appendix D provides a complete listing of the RR27 results where the original codes have been altered to ensure confidentiality. Appendix D also provides more relevant summary statistics.

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

April 28, 1993

Dear Colleague:

This report describes both overall-group and your laboratory's performance in Round Robin XXVII. Specifically, your package contains for retinol, α-tocopherol, and β-carotene, respectively: tabular presentations of all data submitted for Round Robin XXVII; a Blind Control Chart representing a summary of your laboratory's data vs the assigned values for the past six years; and a graphical presentation of data from your laboratory's analysis of blind duplicate samples. Tabular data only is provided for γ-tocopherol, δ-tocopherol, all-*trans* β-carotene, *trans* α-carotene, α-carotene, retinyl palmitate, total and *trans*-lycopene, lutein, zeaxanthin, β-cryptoxanthin, and total *cis*-β-carotene.

As indicated in the tables, each of the samples in Round Robin XXVII (Serum 173-177) had been distributed as part of previous round robins. For example, Serum 173, the mid-level of SRM 968a, was previously distributed as Sera 149 and 159. Serum 177, the high-level of SRM 968a, was previously distributed as Sera 150 and 161. As part of a study to monitor the stability of the fat-soluble vitamins in SRM 968a, Serum 177 was distributed to only the Core labs (program participants for more than two years) in this round robin exercise.

Table 1 provides a summary of the data submitted for retinol in Round Robin XXVII. Thirty-eight labs submitted data: 27 Core labs and 11 New labs, 8 with one- to two-year participation and 3 participating in our round-robin study for the first time. As shown in Table 1, the mean relative standard deviation (RSD) for All and Core laboratory retinol measurements approached 13%. The mean RSD for the trimmed Core labs, however, was about 6% for retinol. The Core labs mean RSD for retinol over the past two years has ranged from 8.7 - 12.7%. The mean RSD for the New labs with one- to two-year participation ranged from 9.9 - 18%. The mean RSD for those labs participating for the first time was about 3%. The overall values obtained for retinol in this round robin were comparable to those obtained in the previous round robin studies.

Table 2 provides a summary of data submitted for the determination of α-tocopherol in Round Robin XXVII. Thirty-four laboratories submitted data: 25 Core labs; 8 one- to two-year participants; and 1 first-time participant. The mean RSD for Core labs was about 9%, while the mean RSD for New labs with one- to two-year participation ranged from about 12.5 - 18%. The overall RSD for the Core labs has remained in the 9 - 11% range over the past two years. Again, there was no significant change in values for α-tocopherol in this study and the previous round robin studies.

Table 3 provides a summary of data for total β-carotene. Thirty-three laboratories submitted data: 24 Core labs; 7 one- to two-year participants; and 2 first-time participants. As in recent studies, the overall quality of the β-carotene data is slightly poorer than for retinol and α-tocopherol. The mean RSD for All labs was about 34%, while the mean RSD for the Core labs

was about 26%. In the last round-robin exercise, the mean RSD for the Core labs was 16% and was >20% over the past two years. The mean RSD for the trimmed Core labs in this study was about 14%. There is no obvious correlation between RSD and concentration.

Tables 4-16 provide summaries of RRXXVII data submitted for other fat-soluble vitamins and carotenoid compounds. Data submitted for γ-tocopherol again appears to show improvement with the RSD for the trimmed lab average being around 7.7%. Except for *trans* β-carotene and lycopene, the concentrations of the remaining analytes appear to be too low for a fair assessment of either individual or interlaboratory measurement capabilities.

Data for your use in evaluating your laboratory's individual performance in RRXXVII is provided on the right side of Tables 1-4. The Core labs **trimmed values** were used as the assigned values. By convention, 0-5% bias from the assigned value represents **EXCEPTIONAL** performance, 6-10% **ACCEPTABLE** performance, 11-20% **MARGINAL** performance and >20% **POOR** performance relative to the current state of the art for these measurements. If you have concerns regarding your performance or are a lab whose performance would be rated "U" based on the convention stated above, we suggest that you obtain a unit of SRM 968a and analyze all three levels. If, with minor method modifications, your measured values do not agree with the certified values, feel free to contact us for consultation. SRM 968a can be obtained through the NIST Standard Reference Materials Program (301/975-6776).

Round Robin XXVIII samples were shipped during the week of April 26. If you have not received them, please call Nancy Miles at 301/975-3108. Results will be due by June 14 and we expect to provide you feedback concerning your performance by July 26. Results from all three 1993 Interlaboratory Studies will be discussed at our Annual QA Workshop in the fall.

As some of you are perhaps aware, Dr. Neal Craft has resigned his position at NIST. Calls concerning various aspects of the round robin studies should be directed to me at 301/975-3108 or Ms. Jeanice Brown Thomas at 301/975-3120.

Sincerely,

Willie E. May, Ph.D.
Chief
Organic Analytical Research Division
Chemical Science and Technology Laboratory

Enclosures

Table 1. Round Robin XXVII

Retinol Results

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	0.493	0.527	0.405	0.536	0.644
	0.449	*0.450	0.366	0.503	*0.538
	0.552	0.538	0.377	*0.691	0.673
	*0.583	*0.644	0.390	0.613	0.750
	0.499	0.585	0.368	0.513	0.624
	0.465	0.508	0.367	0.517	0.609
	0.525	0.570	0.431	0.597	0.704
	0.491	0.556	0.418	0.542	0.653
	*0.381	0.480	0.355	0.476	*0.496
	0.498	0.554	0.405	0.536	0.712
	0.524	0.572	0.414	0.561	0.694
	0.506	0.545	0.397	0.528	0.621
	0.505	0.527	0.422	0.576	0.675
	0.452	0.589	0.386	0.531	0.630
	0.500	*0.320	0.380	0.540	0.640
	0.521	0.530	0.414	0.580	0.718
	0.540	0.597	*0.562	0.588	0.695
	0.495	0.528	0.386	0.538	0.661
	0.533	0.576	0.419	0.547	0.652
	0.491	0.500	0.383	0.501	
	0.482	0.509	0.375	0.506	0.611
	0.508	0.538	0.440	0.552	0.692
	0.514	0.538	0.396	0.541	0.720
	*0.352	*0.383	*0.322	*.0398	*1.119
	*0.596	*0.673	*0.473	*0.676	0.745
	0.497	0.523	0.407	0.519	0.643
	*0.432	*0.454	0.346	*0.456	*0.570
	0.468	0.513	0.382	0.537	
	0.671	0.756	0.508	0.737	
	0.557	0.585	0.449	0.581	
	0.463	0.467	0.347	0.481	
	0.285	0.298	0.245	0.345	
	0.504	0.577	0.429	0.513	
	0.529	0.624	0.467	0.572	
	0.480	0.550	0.410	0.490	
	0.580	0.561	0.401	0.534	
	0.448	0.491	0.366	0.478	
	0.503	0.532	0.403	0.541	
	0.480	0.500	0.390	0.530	
	0.505	0.530	0.401	0.584	
	0.880	0.920	0.710	0.860	
	0.502	0.554	0.394	0.537	
	0.500	0.540	0.420	0.610	
NIST 1	0.517	0.542	0.407	0.562	0.632
NIST 3	0.482	0.502	0.372	0.547	0.643
All Labs					
AVG (38)	0.503	0.539	0.405	0.545	0.673
SD	0.056	0.074	0.045	0.063	0.109
RSD	11.1	13.8	11.1	11.5	16.2
Core Labs					
AVG	0.496	0.530	0.400	0.543	0.673
SD	0.052	0.072	0.045	0.060	0.109
RSD	10.5	13.5	11.2	11.0	16.2
(a) New Labs			2 yr participation.		
AVG	0.549	0.596	0.433	0.578	
SD	0.090	0.119	0.067	0.114	
RSD	16.4	20.0	15.4	19.7	
(b) New Labs			1-2 yr participation.		
AVG	0.509	0.557	0.411	0.519	
SD	0.058	0.054	0.042	0.043	
RSD	11.3	9.8	10.2	8.3	
(c) New Labs			First time participation.		
AVG	0.496	0.521	0.398	0.552	
SD	0.014	0.018	0.007	0.029	
RSD	2.8	3.4	1.8	5.2	

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	-1.7	-2.8	2.9	-0.9	-4.0
	-10.5	-17.0	-7.0	-7.0	-19.8
	10.0	-0.8	-4.2	27.7	0.3
	16.2	18.7	-0.9	13.3	11.7
	-0.5	7.9	-6.5	-5.2	-7.0
	-7.4	-6.4	-6.8	-4.4	-9.3
	4.6	5.1	9.5	10.4	4.9
	-2.1	2.5	6.2	0.2	-2.7
	-24.1	-11.5	-9.8	-12.0	-26.1
	-0.7	2.1	2.9	-0.9	6.1
	4.4	5.5	5.2	3.7	3.4
	0.8	0.5	0.9	-2.4	-7.5
	0.6	-2.8	7.2	6.5	0.6
	-9.9	8.6	-1.9	-1.8	-6.1
	-0.3	-41.0	-3.5	-0.2	-4.6
	3.8	-2.3	5.3	7.3	7.0
	7.6	10.1	42.8	8.7	3.6
	-1.3	-2.6	-1.9	-0.5	-1.5
	6.1	6.2	6.4	1.1	-2.9
	-2.1	-7.8	-2.7	-7.4	
	-3.9	-6.1	-4.7	-6.5	-9.0
	1.2	-0.8	11.7	2.0	3.1
	2.4	-0.8	0.6	0.0	7.3
	-29.8	-29.4	-18.2	-26.4	66.7
	18.8	24.1	20.2	25.0	11.0
	-0.9	-3.6	3.4	-4.1	-4.2
	-13.9	-16.3	-12.1	-15.7	-15.1
	-6.7	-5.4	-3.0	-0.7	
	33.7	39.4	29.1	36.3	
	11.0	7.9	14.1	7.4	
	-7.7	-13.9	-11.8	-11.1	
	-43.2	-45.1	-37.8	-36.2	
	0.4	6.4	9.0	-5.2	
	5.4	15.1	18.6	5.7	
	-4.3	1.4	4.2	-9.4	
	15.6	3.4	1.9	-1.3	
	-10.6	-9.4	-6.9	-11.6	
	0.2	-1.9	2.4	0.0	
	-4.3	-7.8	-0.9	-2.0	
	0.6	-2.3	1.9	8.0	
	75.4	69.6	80.4	59.0	
	0.0	2.1	0.1	-0.7	
	-0.3	-0.4	6.7	12.8	
Core Labs Trimmed					
AVG	0.502	0.542	0.394	0.541	0.671
SD	0.026	0.031	0.025	0.033	0.042
RSD	5.1	5.7	6.2	6.2	6.3

PREVIOUS	5/91 149				5/91 150
VALUE	0.489	8/91 155	8/91 156	8/92 171	0.659
	8/91 159	0.536	0.405	0.538	1/92 161
	0.506				0.673

* = Value removed for Core Lab Trimmed Average.

L = Late results not included in statistical analysis.

Table 2. Round Robin XXVII

Alpha-Tocopherol

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	10.40	7.35	10.08	4.93	16.01
	9.71	*6.52	9.31	4.61	*13.16
	10.65	7.24	9.50	5.70	15.73
	10.14	7.00	9.13	4.73	15.67
	*9.12	7.38	*8.69	3.95	14.36
	10.26	7.10	9.57	4.53	15.20
	11.70	7.98	10.40	*6.10	17.00
	11.12	7.84	10.71	5.13	15.53
	10.67	7.61	9.50	4.84	15.11
	11.42	7.90	11.00	5.20	17.20
	10.34	7.45	10.01	5.13	16.21
	11.04	7.63	10.24	5.15	17.15
	10.10	*8.99	11.00	5.55	17.00
	9.58	*6.30	10.80	3.69	*19.16
	10.50	*4.53	10.57	4.93	15.60
	11.40	7.30	10.30	5.00	16.30
	11.35	7.61	10.54	5.14	16.57
	11.15	7.71	10.76	4.94	16.19
	10.05	7.04	9.00	4.49	13.87
	10.90	7.92	9.77	5.28	
	10.11	7.33	9.56	5.02	15.82
	11.10	7.67	10.15	4.91	14.43
	11.30	8.14	10.10	3.64	14.50
	10.95	7.76	10.73	4.36	16.23
	*8.70	*6.46	*8.12	3.64	13.72
	7.84	4.70	8.40	3.58	
	8.41	5.83	7.02	4.74	
	11.96	7.97	11.42	5.62	
	11.18	8.09	10.03	6.17	
	8.73	6.15	8.58	4.25	
	8.24	6.05	8.95	4.31	
	13.01	9.66	11.30	5.00	
	10.32	7.65	9.06	4.78	
	11.63	8.39	11.25	5.43	
	9.54	6.70	8.93	4.50	
	10.00	6.50	10.20	4.50	
	15.90	10.70	16.70	7.20	7.20
	10.85	7.80	10.50	5.20	
	10.80	7.60	10.40	4.80	
NIST 1	10.76	7.48	9.77	4.72	15.78
NIST 3	10.53	7.96	10.28	5.03	15.80
All Labs					
AVG (34)	10.53	7.37	9.93	4.87	15.74
SD	1.02	0.93	0.97	0.61	1.33
RSD	9.7	12.6	9.7	12.6	8.5
Core Labs					
AVG	10.55	7.35	9.98	4.82	15.74
SD	0.75	0.82	0.75	0.62	1.33
RSD	7.1	11.1	7.6	12.8	8.5
(a) New Labs		2 yr participation.			
AVG	9.95	6.98	9.36	5.21	
SD	1.90	1.21	1.86	0.84	
RSD	19.1	17.3	19.8	16.2	
(b) New Labs		1-2 yr participation.			
AVG	11.13	8.10	10.13	4.93	
SD	1.52	1.25	1.32	0.39	
RSD	13.7	15.4	13.0	7.9	
(c) New Labs		First time participation.			
Value	10.00	6.50	10.20	4.50	

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	-2.7	-2.6	-0.4	3.3	2.0
	-9.2	-13.6	-8.0	-3.3	-16.2
	-0.4	-4.1	-6.1	19.5	0.2
	-5.2	-7.3	-9.8	-0.8	-0.2
	-14.7	-2.2	-14.1	-17.2	-8.5
	-4.1	-5.9	-5.4	-5.0	-3.2
	9.4	5.7	2.8	27.9	8.3
	4.0	3.9	5.8	7.6	-1.1
	-0.2	0.8	-6.1	1.5	-3.8
	6.8	4.7	8.7	9.0	9.6
	-3.3	-1.3	-1.0	7.5	3.2
	3.2	1.1	1.2	8.0	9.2
	-5.5	19.1	8.7	16.4	8.3
	-10.4	-16.5	6.7	-22.6	22.0
	-1.8	-40.0	4.5	3.4	-0.6
	6.6	-3.3	1.8	4.8	3.8
	6.1	0.8	4.2	7.8	5.5
	4.2	2.1	6.4	3.6	3.1
	-6.0	-6.8	-11.1	-5.9	-11.7
	1.9	4.9	-3.5	10.7	
	-5.5	-2.9	-5.6	5.1	0.7
	3.8	1.7	0.3	2.9	-8.1
	5.7	7.8	-0.2	-23.7	-7.6
	2.4	2.8	6.0	-8.6	3.4
	-18.6	-14.4	-19.8	-23.8	-12.6
	-26.7	-37.7	-17.0	-24.9	
	-21.4	-22.8	-30.6	-0.6	
	11.8	5.6	12.9	17.8	
	4.5	7.1	-0.9	29.4	
	-18.4	-18.5	-15.2	-10.9	
	-23.0	-19.8	-11.5	-9.7	
	21.7	28.0	11.7	4.8	
	-3.5	1.4	-10.5	0.2	
	8.8	11.1	11.2	13.7	
	-10.8	-11.2	-11.8	-5.7	
	-6.5	-13.9	0.8	-5.7	
	48.7	41.8	65.0	51.0	
	1.5	3.3	3.8	9.0	
	1.0	0.7	2.8	0.6	
Core Labs Trimmed					
AVG	10.69	7.55	10.12	4.77	15.70
SD	0.59	0.33	0.61	0.57	1.03
RSD	5.5	4.3	6.0	11.9	6.6
PREVIOUS	5/91 149				5/91 150
VALUE	10.50	8/91 155	8/91 156	8/92 171	16.59
	8/91 159	7.55	10.16	5.03	1/92 161
	10.42				15.95

* = Value removed for Core Lab Trimmed Average.

Table 3. Round Robin XXVII

Total Beta-Carotene

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	0.957	0.387	0.968	0.442	2.583
	0.853	0.332	0.774	0.361	1.823
	0.830	0.300	0.728	0.324	2.034
	*1.377	0.481	*1.276	0.528	2.950
	0.965	0.410	0.858	0.412	2.364
	0.921	0.355	0.972	0.412	2.390
	0.836	0.275	0.722	*0.204	1.830
	*1.130	0.490	1.040	0.480	3.070
	0.980	0.369	0.874	0.406	2.418
	0.964	0.377	0.866	0.410	2.259
	1.020	0.421	0.923	0.435	2.500
	0.927	0.428	1.020	0.504	2.860
	0.930	0.386	0.820	0.386	2.286
	0.946	0.377	0.977	0.416	
	0.930	0.300	0.900	0.470	2.880
	0.874	0.361	0.811	0.412	2.347
	0.933	0.348	0.850	0.429	2.461
	*1.129	0.464	0.980	0.477	
	0.786	0.325	0.644	0.350	1.963
	*0.695	0.296	0.640	0.294	1.635
	0.932	0.372	0.932	0.434	2.530
	0.862	0.344	0.634	0.463	2.205
	0.853	0.341	0.734	0.335	1.900
		*1.120	*0.395	*0.996	3.190
	*0.719	0.309	0.721	0.316	2.037
	0.325	0.089	0.346	0.171	
	1.067	0.231	0.999	0.401	
	0.890	0.570	0.794	0.485	
	0.902	0.371	0.791	0.340	
	0.993	0.383	0.926	0.382	
	0.367	0.145	0.429	0.196	
	0.840	0.423	0.823	0.376	
	0.990	0.379	0.889	0.424	
	0.705	0.300	0.627	0.305	
	1.760	1.330	2.310	1.040	
	0.907	0.389	0.832	0.422	
NIST 1	0.892	0.315	0.693	0.322	1.950
NIST 3	0.868	0.343	0.782	0.413	2.220
All Labs					
AVG (33)	0.936	0.416	0.875	0.435	2.374
SD	0.223	0.224	0.311	0.169	0.430
RSD	23.9	53.9	35.6	38.8	18.1
Core Labs					
AVG	0.931	0.399	0.843	0.430	2.374
SD	0.143	0.164	0.178	0.141	0.430
RSD	15.4	41.1	21.2	32.9	18.1
(a) New Labs		2 yr participation.			
AVG	0.983	0.395	0.906	0.423	
SD	0.089	0.170	0.104	0.055	
RSD	9.0	43.0	11.5	13.0	
(b) New Labs					
AVG	0.726	0.312	0.692	0.325	
SD	0.266	0.122	0.208	0.099	
RSD	36.6	39.2	30.0	30.5	
(c) New Labs					
AVG	1.334	0.860	1.571	0.731	
SD	0.603	0.665	1.045	0.437	
RSD	45.2	77.4	66.5	59.8	

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	5.2	5.2	14.7	6.8	8.8
	-6.2	-9.8	-8.3	-12.8	-23.2
	-8.7	-18.5	-13.7	-21.7	-14.3
	51.4	30.7	51.2	27.5	24.3
	6.1	11.4	1.6	-0.6	-0.4
	1.3	-3.5	15.2	-0.5	0.7
	-8.1	-25.3	-14.5	-50.7	-22.9
	24.3	33.2	23.2	15.9	29.3
	7.8	0.3	3.6	-1.9	1.9
	6.0	2.5	2.6	-1.0	-4.8
	12.2	14.4	9.4	5.1	5.3
	1.9	16.3	20.9	21.7	20.5
	2.3	4.9	-2.8	-6.8	-3.7
	4.0	2.5	15.8	0.5	
	2.3	-18.5	6.6	13.5	21.3
	-3.9	-1.9	-4.0	-0.6	-1.1
	2.6	-5.4	0.7	3.6	3.7
	24.2	26.1	16.1	15.2	
	-13.6	-11.7	-23.7	-15.5	-17.3
	-23.6	-19.5	-24.2	-29.1	-31.2
	2.5	1.1	10.4	4.8	6.6
	-5.2	-6.5	-24.9	11.8	-7.1
	-6.2	-7.3	-13.0	-19.1	-20.0
		204.4	-53.2	140.6	34.4
	-20.9	-16.0	-14.6	-23.7	-14.2
	-64.3	-75.8	-59.0	-58.7	
	17.3	-37.2	18.4	-3.1	
	-2.1	54.9	-5.9	17.1	
	-0.8	0.8	-6.3	-17.9	
	9.2	4.1	9.7	-7.7	
	-59.6	-60.6	-49.2	-52.7	
	-7.6	15.0	-2.5	-9.2	
	8.9	3.0	5.3	2.4	
	-22.5	-18.5	-25.7	-26.3	
	93.5	261.5	173.7	151.2	
	-0.3	5.7	-1.4	1.9	

Core Labs Trimmed

AVG	0.909	0.368	0.844	0.414	2.374
SD	0.062	0.059	0.128	0.063	0.430
RSD	6.8	16.1	15.2	15.1	18.1

PREVIOUS	5/91 149				5/91 150
VALUE	0.890	8/91 155	8/91 156	8/92 171	2.338
	8/91 159	0.371	0.822	0.416	1/92 161
	0.879				2.212

* = Value removed for Core Lab Trimmed Average.

L = Late results not included in statistical analysis.

Table 4. Round Robin XXVII

Gamma Tocopherol

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	2.83	2.24	1.97	2.14	3.90
	2.55	2.00	1.78	1.97	*3.12
	2.70	2.32	1.94	2.12	3.85
	2.90	2.40	2.10	2.10	4.00
	2.64	2.15	1.88	2.01	3.65
	3.20	2.58	2.23	2.48	*4.55
	2.82	2.85	2.11	2.40	4.13
	2.95	2.22	2.03	2.05	3.79
	3.09	2.70	2.18	2.32	
	2.94	2.35	2.06	*3.47	3.96
	2.77	2.28	1.90	1.93	3.75
	2.27	1.76	1.69	1.79	
	*2.18	1.76	*1.53	1.84	
	2.19	1.77	1.33	1.75	
	3.02	2.50	2.13	2.27	
NIST 1	2.96	2.42	1.94	2.13	3.85
NIST 3	2.77	2.23	1.98	2.27	3.87
AVG	2.81	2.33	1.99	2.24	3.87
SD	0.26	0.29	0.19	0.41	0.36
RSD	9.3	12.3	9.5	18.5	9.4

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	-1.3	-4.0	-2.8	0.1	0.4
	-11.1	-14.3	-12.1	-7.8	-19.6
	-5.8	-0.6	-4.2	-0.8	-0.7
	1.2	2.8	3.7	-1.7	3.1
	-7.9	-8.1	-7.4	-5.8	-5.8
	11.6	10.5	10.1	16.1	17.3
	-1.6	22.1	4.2	12.3	6.5
	2.8	-4.9	0.4	-4.0	-2.3
	7.8	15.7	7.6	8.6	
	2.5	0.7	1.7	62.4	2.1
	-3.4	-2.3	-6.2	-9.7	-3.3
	-20.8	-24.6	-16.6	-16.2	
	-24.0	-24.4	-24.5	-13.8	
	-23.6	-24.2	-34.3	-18.1	
	5.2	7.0	5.1	6.4	

Trimmed Lab Average

AVG	2.87	2.33	2.03	2.14	3.88
SD	0.19	0.29	0.13	0.20	0.15
RSD	6.6	12.3	6.7	9.2	3.9

Table 5. Round Robin XXVII

Trans-Beta-Carotene

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	0.895	0.345	0.814	0.376	2.055
	0.957	0.396	0.877	0.403	2.362
	0.726	0.293	0.599	0.313	1.836
	0.942	0.362	0.856	0.404	
NIST 1	0.862	0.312	0.659	0.288	1.760
NIST 3	0.786	0.311	0.731	0.374	2.000
AVG	0.880	0.349	0.787	0.374	2.084
SD	0.106	0.043	0.128	0.043	0.264
RSD	12.0	12.3	16.2	11.4	12.7

Table 6. Round Robin XXVII

Alpha-Carotene

Lab#	Serum# 173	Serum# 174	Serum# 175	Serum# 176	Serum# 177
	0.047	0.026	0.033	0.016	0.125
	0.048	0.021	0.030	0.015	0.083
	0.049	0.035	0.021	0.011	0.066
	0.065	0.022	0.057	0.020	0.089
	0.050	0.020	0.030	0.010	0.100
	0.054	0.022	0.038	0.013	0.097
	0.050	0.017	0.034	0.016	0.104
	0.062	0.031	0.048	0.019	0.127
	0.042	0.022	0.030	0.012	0.080
	0.079	0.028	0.045	0.019	0.155
	0.036	0.016	0.027	0.014	0.067
	0.053	0.019	0.031	0.018	
	0.040	0.016	0.027	0.011	0.075
	0.038	0.017	0.029	0.017	0.095
	0.089	0.000	0.067	0.000	0.163
	0.059	0.025	0.041	0.021	0.126
	0.055	0.018	0.038	0.017	
	0.049	0.029	0.033	0.024	
	0.023	0.006	0.017	0.006	
	0.048	0.025	0.031	0.013	
NIST 3	0.068	0.030	0.043	0.026	0.125
AVG	0.052	0.021	0.035	0.015	0.103
SD	0.015	0.008	0.012	0.005	0.030
RSD	28.2	38.7	33.3	37.5	29.0

Table 7. Round Robin XXVII
Retinyl Palmitate

Lab#	173	174	175	176	177
	0.027	0.016	0.008	0.204	0.024
				0.228	
	0.014			0.146	0.028
	0.055	0.058	0.041	0.162	0.075
				0.151	
				0.186	0.071
	0.059	0.065	0.062	0.187	0.168
	0.015			0.198	
	0.015	0.014	0.009	0.246	
NIST 3				0.154	0.025
AVG	0.031	0.038	0.030	0.190	0.073
SD	0.021	0.027	0.026	0.034	0.058
RSD	67.7	70.6	87.6	17.8	79.2

Table 8. Round Robin XXVII
Lutein

Lab#	173	174	175	176	177
	0.093	0.077	0.097	0.046	0.079
	0.109	0.080	0.100	0.043	0.073
	0.107	0.100	0.109	0.053	0.097
	0.113	0.086	0.110	0.052	0.090
	0.122	0.105	0.123	0.066	
	0.093	0.074	0.104	0.037	
	0.200	0.156	0.178	0.085	
	0.138	0.104	0.162	0.064	
NIST 3	0.104	0.085	0.103	0.047	0.082
AVG	0.122	0.098	0.123	0.056	0.085
SD	0.035	0.027	0.030	0.015	0.011
RSD	28.6	27.2	24.8	27.6	12.7

Table 9. Round Robin XXVII
Lycopene (Total)

Lab#	173	174	175	176	177
	0.425	0.593	0.477	0.186	0.354
	0.330	0.432	0.344	0.154	0.248
	0.239	0.278	0.225	0.087	0.167
	0.356	0.497	0.368	0.159	0.312
	0.691	0.896	0.789	0.326	0.542
	0.750	1.120	0.810	0.300	0.610
	0.417	0.564	0.446	0.170	0.376
	0.386	0.562	0.471	0.210	0.392
	0.426	0.578	0.410	0.176	0.309
	0.411	0.557	0.418	0.186	0.342
	0.226	0.303	0.232	0.118	0.186
	0.499	0.702	0.507	0.219	
	0.408	0.572	0.409	0.158	0.295
	0.276	0.342	0.333	0.149	0.276
	0.421	0.571	0.428	0.171	0.364
	0.449	0.543	0.456	0.242	0.438
	0.431	0.378	0.424	0.251	
	0.403	0.633	0.446	0.165	
	0.241	0.230	0.270	0.114	
	0.387	0.529	0.414	0.176	
NIST 3	0.512	0.645	0.525	0.233	0.451
AVG	0.409	0.544	0.434	0.186	0.347
SD	0.131	0.206	0.147	0.059	0.119
RSD	32.0	37.8	34.0	31.8	34.2

Table 10.Round Robin XXVII
Zeaxanthin

Lab#	173	174	175	176	177
	0.042	0.030	0.042	0.022	0.029
	0.040	0.022	0.038	0.028	0.030
	0.036	0.022	0.032	0.022	0.026
	0.142	0.111	0.146	0.066	0.113
	0.073	0.064	0.065	0.048	
	0.048	0.032	0.045	0.035	
	0.046	0.032	0.043	0.021	
NIST 3	0.046	0.036	0.046	0.028	0.036
AVG	0.061	0.045	0.059	0.035	0.049
SD	0.038	0.032	0.040	0.017	0.042
RSD	61.6	72.6	67.9	49.0	85.4

Table 11.Round Robin XXVII
Lutein + Zeaxanthin

Lab#	173	174	175	176	177
	0.150	0.109	0.153	0.074	0.111
	0.185	0.153	0.199	0.075	0.167
	0.195	0.147	0.195	0.085	0.148
	0.203	0.201	0.235	0.112	0.201
	0.141	0.108	0.175	0.070	0.148
	0.151	0.116	0.157	0.072	
AVG	0.171	0.139	0.186	0.081	0.155
SD	0.027	0.036	0.031	0.016	0.033
RSD	15.6	25.9	16.5	19.5	21.1

Table 12.Round Robin XXVII
Beta-Cryptoxanthin

Lab#	173	174	175	176	177
	0.102	0.063	0.065	0.049	0.064
	0.097	0.066	0.068	0.044	0.063
	0.115	0.084	0.083	0.054	0.083
	0.148	0.123	0.122	0.077	0.136
	0.126	0.103	0.095	0.072	0.080
	0.059	0.040	0.036	0.029	0.036
	0.113	0.092	0.094	0.057	0.099
	0.064	0.045	0.040	0.025	
	0.229	0.209	0.186	0.157	
	0.040	0.021	0.240	0.025	
	0.093	0.061	0.064	0.043	
NIST 3	0.058	0.041	0.042	0.032	0.040
AVG	0.108	0.082	0.099	0.057	0.080
SD	0.051	0.051	0.062	0.037	0.032
RSD	47.3	62.2	62.9	65.0	39.4

Table 13.Round Robin XXVII
Lycopene (Trans)

Lab#	173	174	175	176	177
	0.223	0.294	0.235	0.111	0.174
	0.354	0.498	0.457	0.238	
NIST 3	0.192	0.249	0.205	0.109	0.162
AVG	0.289	0.396	0.346	0.175	0.174
SD	0.093	0.144	0.157	0.090	
RSD	32.1	36.4	45.4	51.5	

Table 14.Round Robin XXVII
Total Cis-Beta-Carotene

Lab#	173	174	175	176	177
	0.047	0.017	0.033	0.020	

Table 15.Round Robin XXVII
Trans-Alpha-Carotene

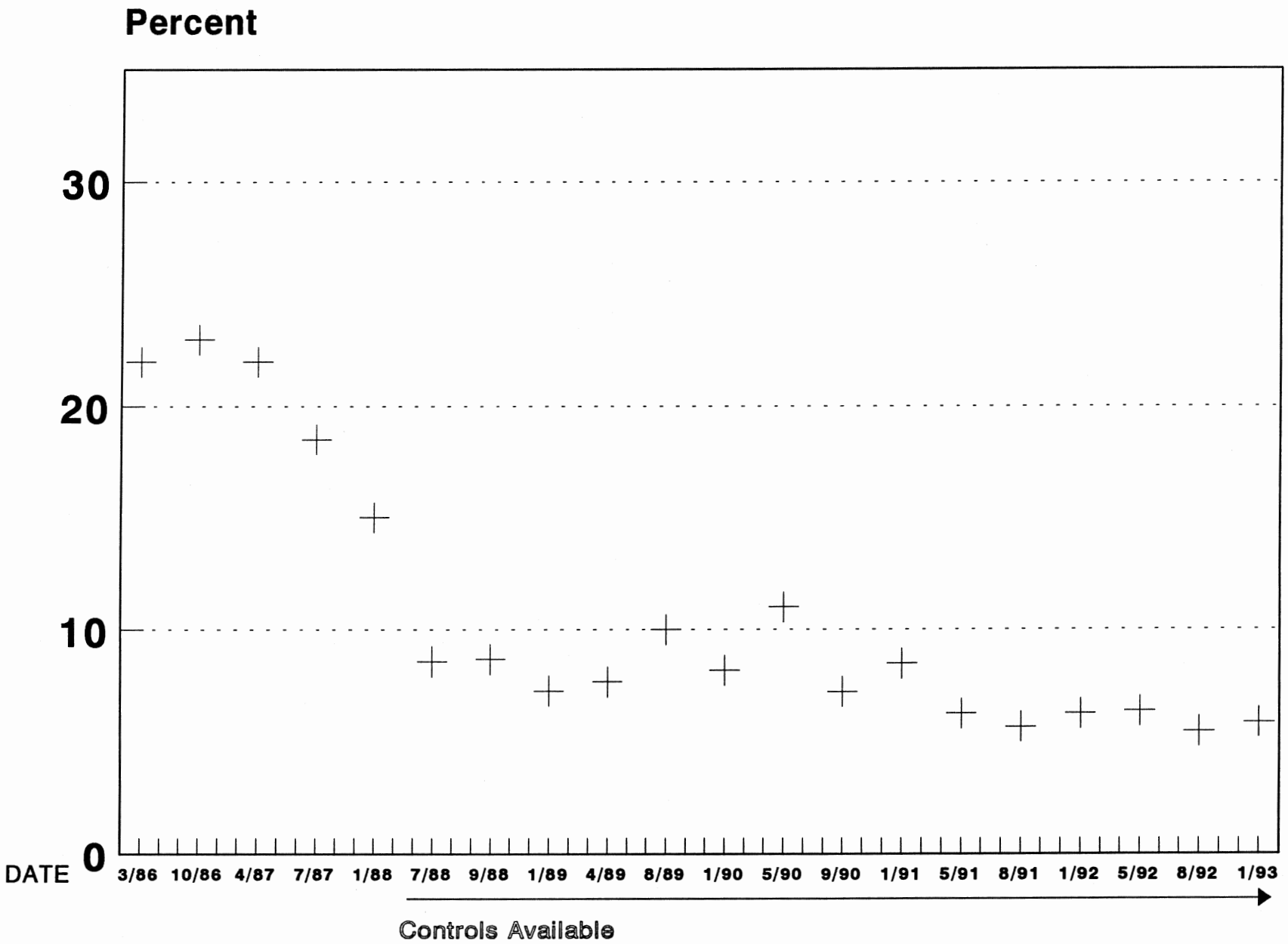
Lab#	173	174	175	176	177
NIST 3	0.041	0.018	0.027	0.016	0.080

Table 16.Round Robin XXVII
Delta-Tocopherol

Lab#	173	174	175	176	177
NIST 3	0.212	0.117	0.057	0.136	0.156

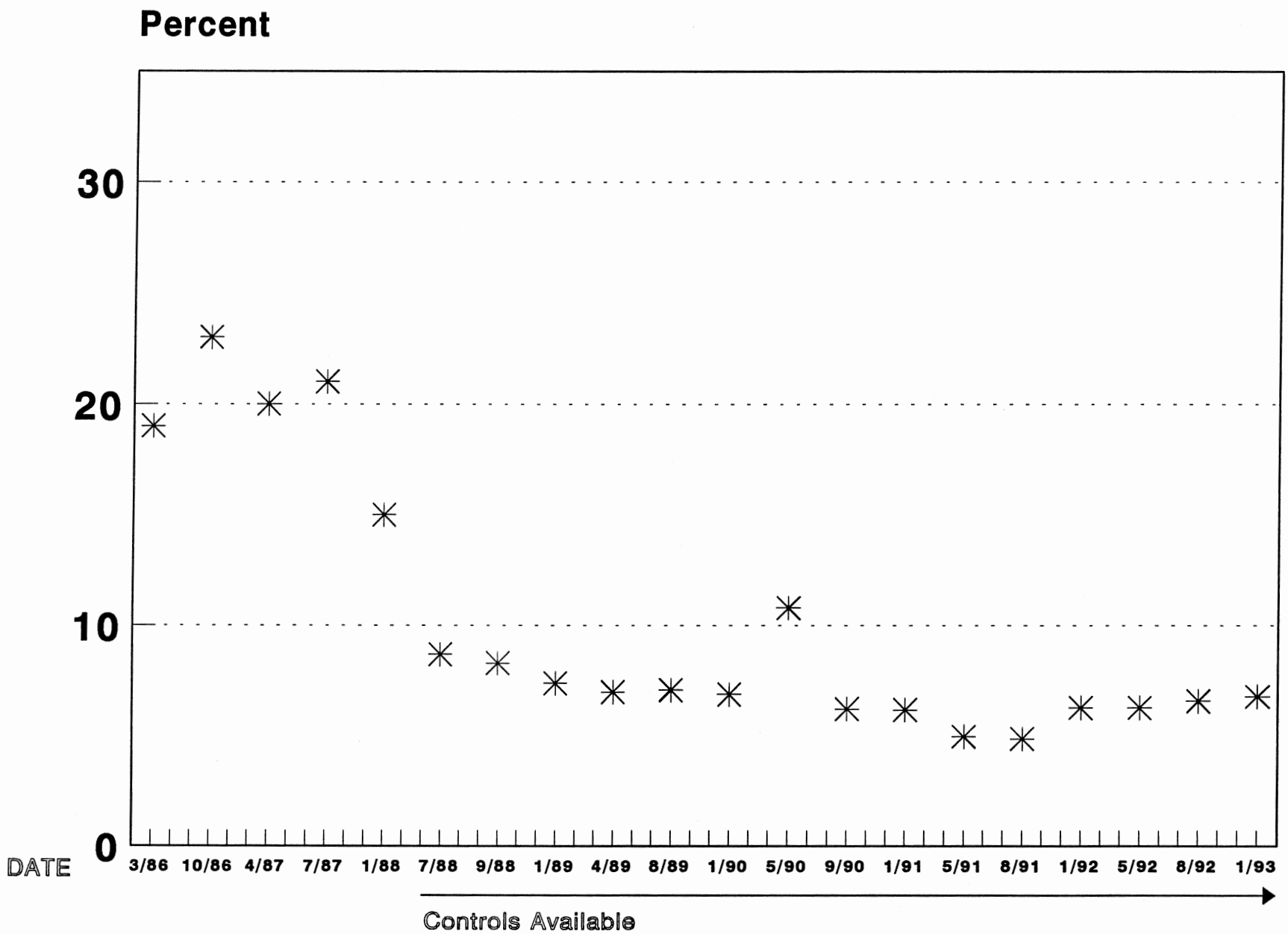
Interlaboratory Precision vs Time

Retinol



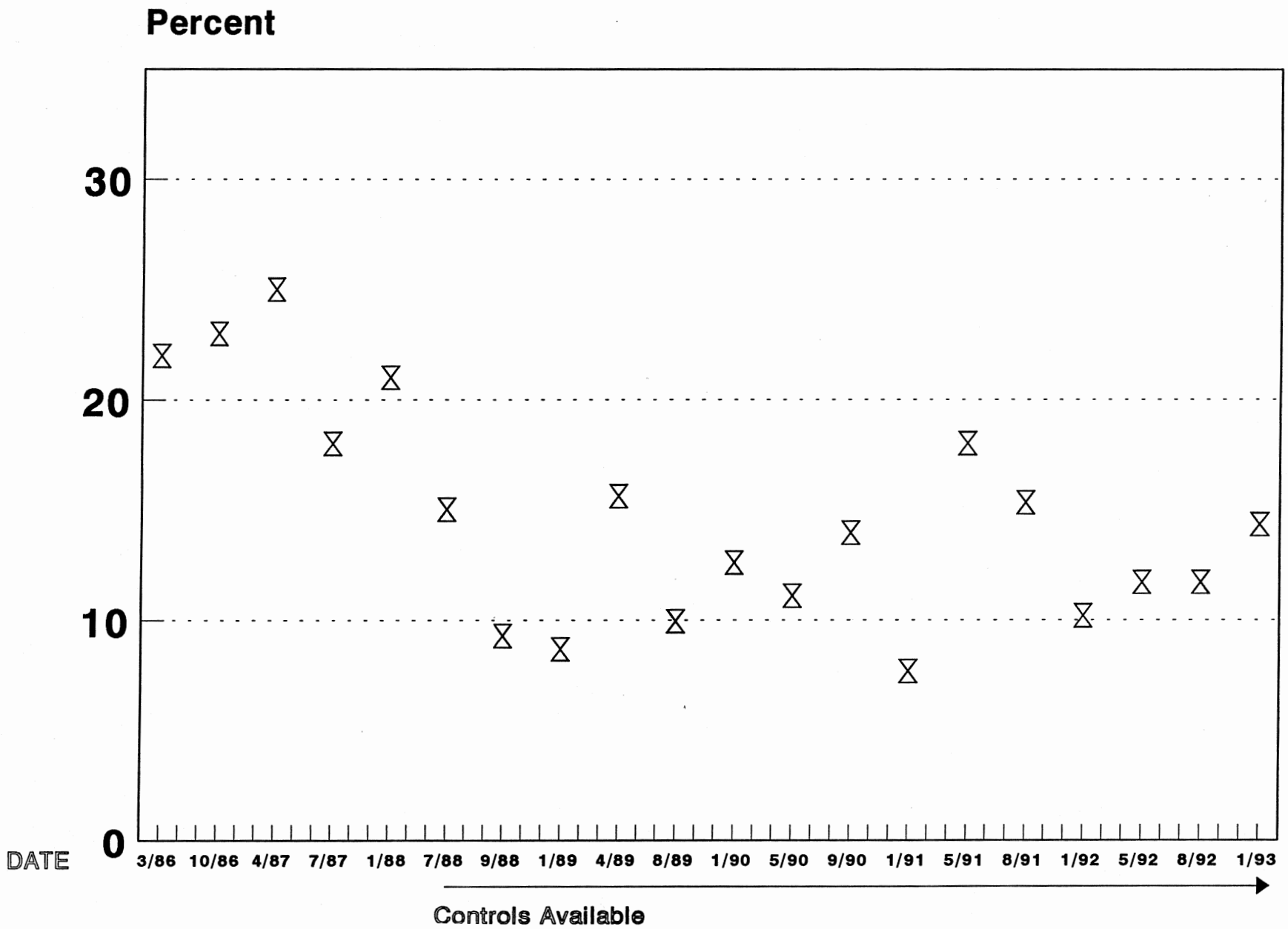
Interlaboratory Precision vs Time

Alpha-Tocopherol



Interlaboratory Precision vs Time

Beta-Carotene



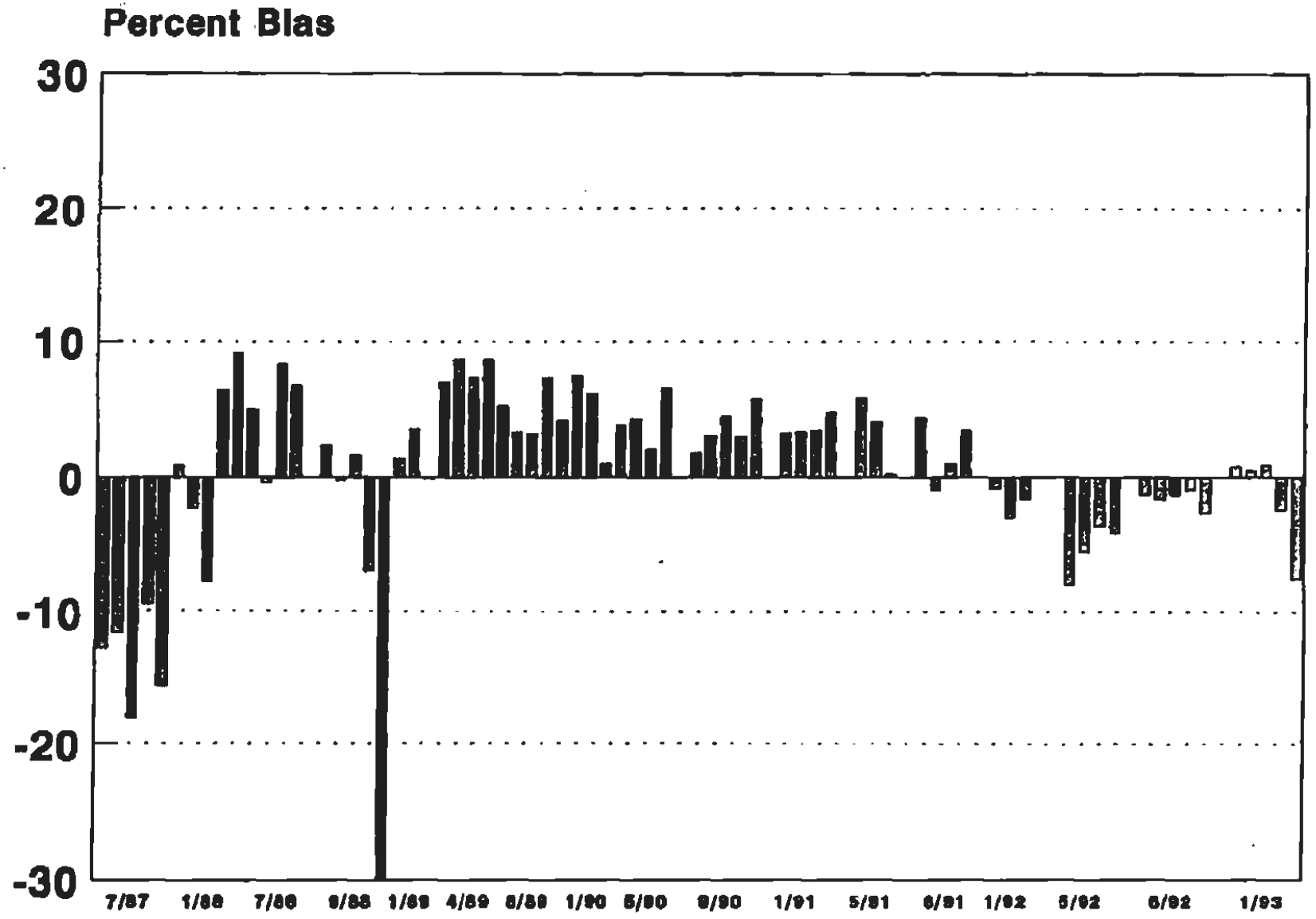
Appendix C. Representative "Individualized Report" for RR27

Each participant in RR27 received graphical summaries of their own measurement performance for total retinol, α-tocopherol, and/or total β-carotene. In RR27, two sets of graphs were prepared:

- "Percent Bias" relative to the "Trimmed Core Lab Average" for of the serum-based samples distributed from 7/1987 through 1/93.
- "Blind Duplicate Performance", documenting the history of the % Bias values for just the sera distributed in RR27.

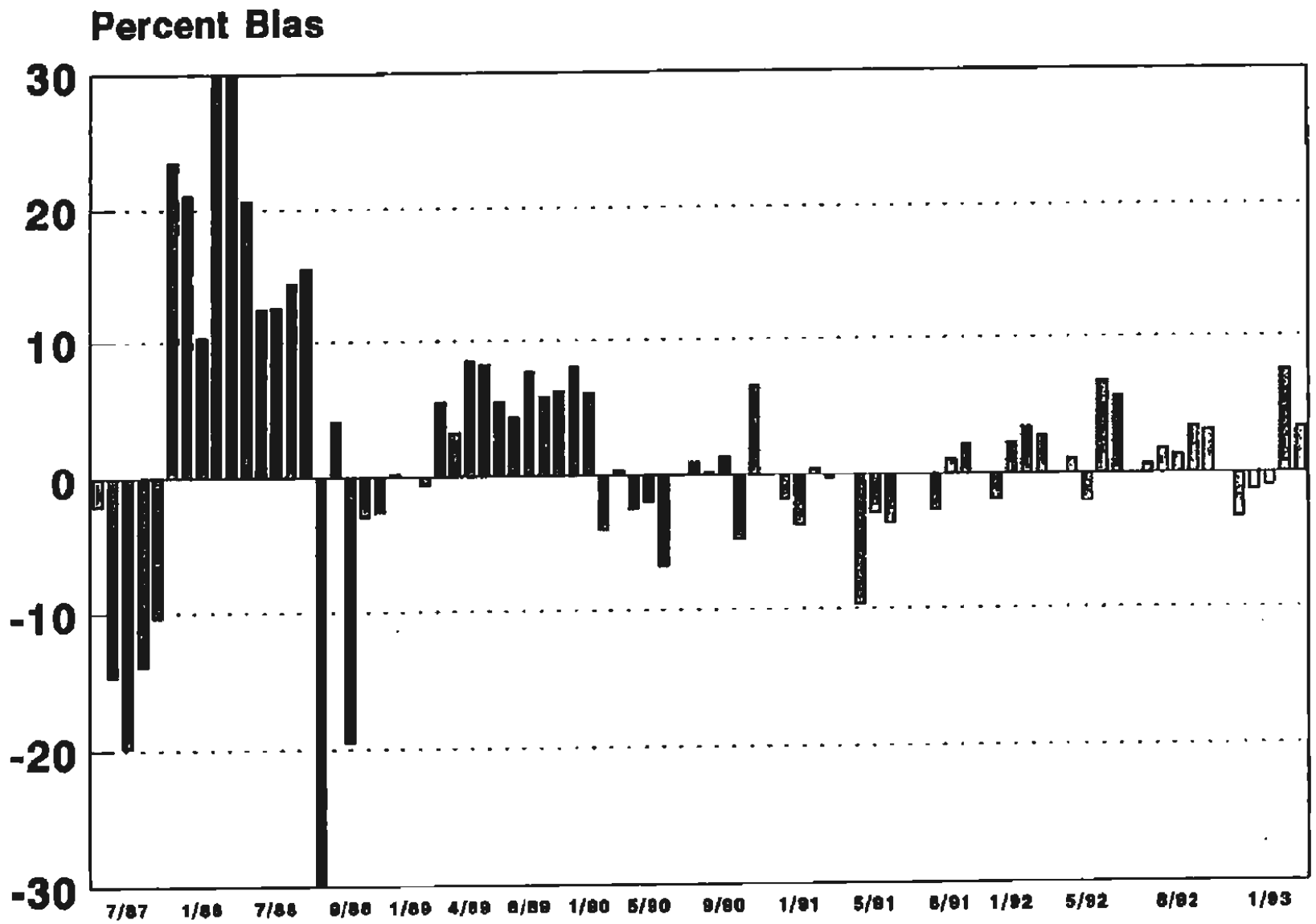
The following six pages constitute the individualized report for participant FSV-BA.

Laboratory FSV-BA
Retinol



% Bias from Assigned Values

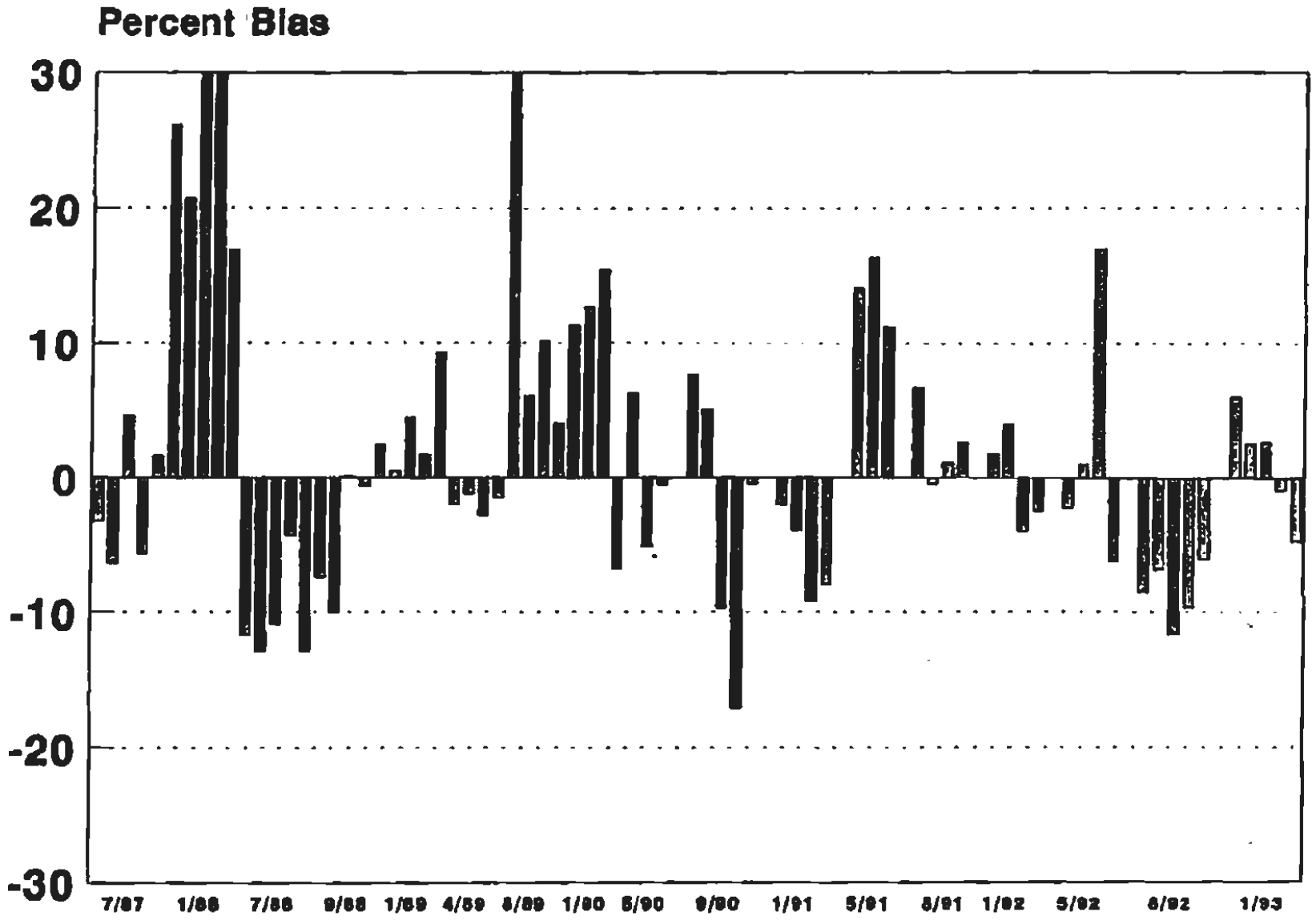
Laboratory FSV-BA
Alpha-Tocopherol



% Bias from Assigned Values

Laboratory FSV-BA

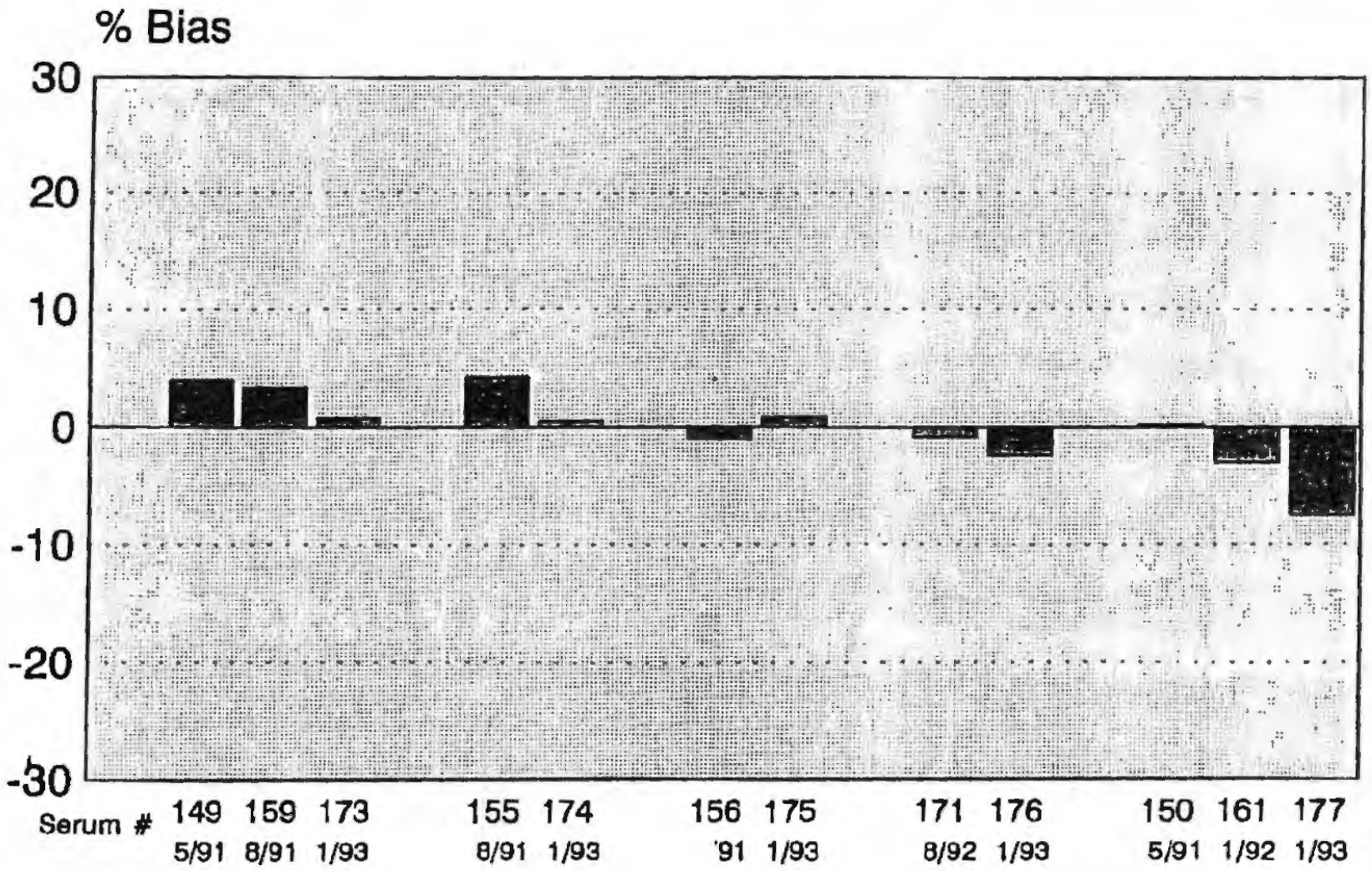
Total Beta-Carotene



% Bias from Assigned Values

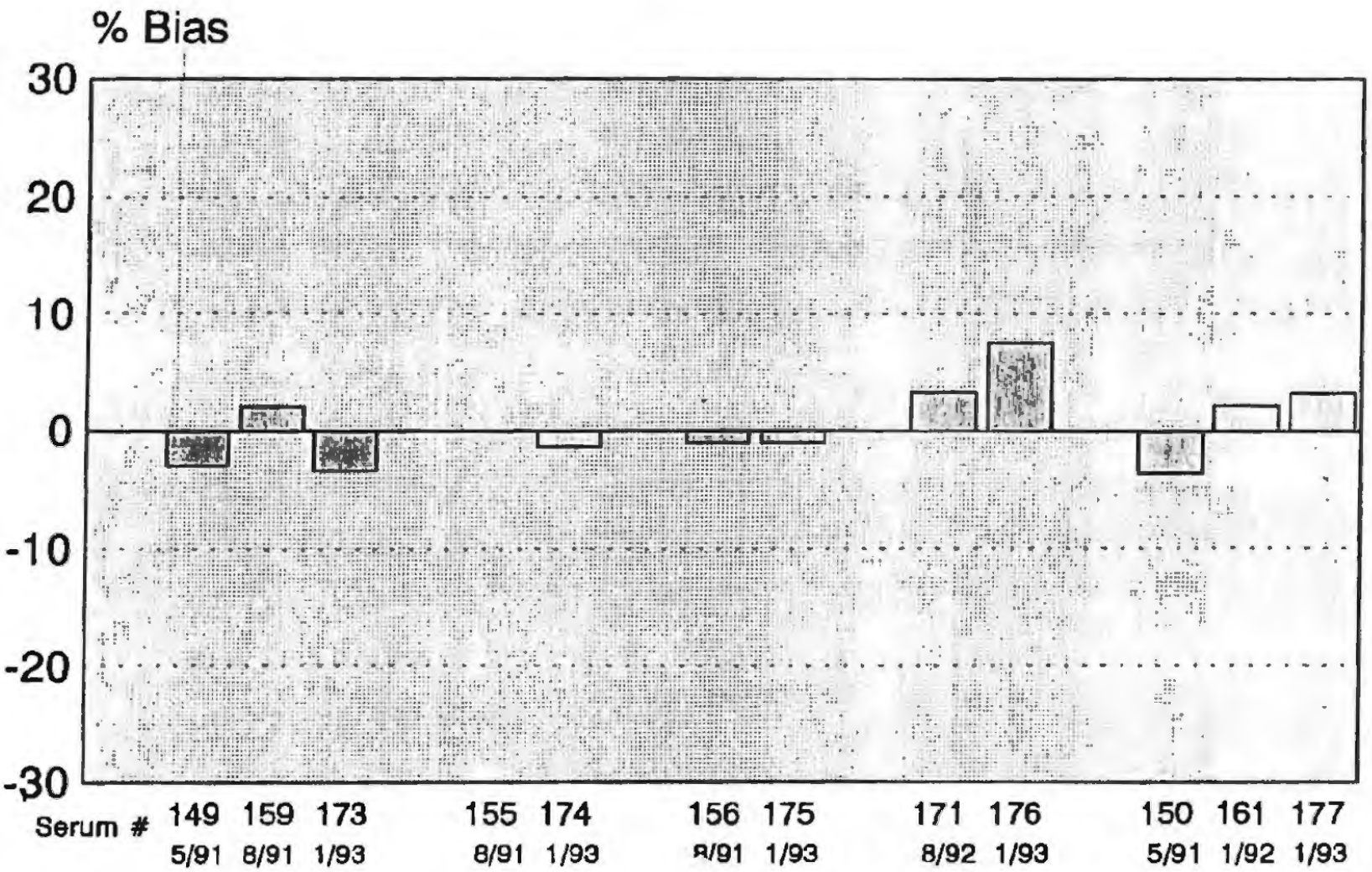
Laboratory **FSV-BA**

Blind Duplicate Performance
Retinol



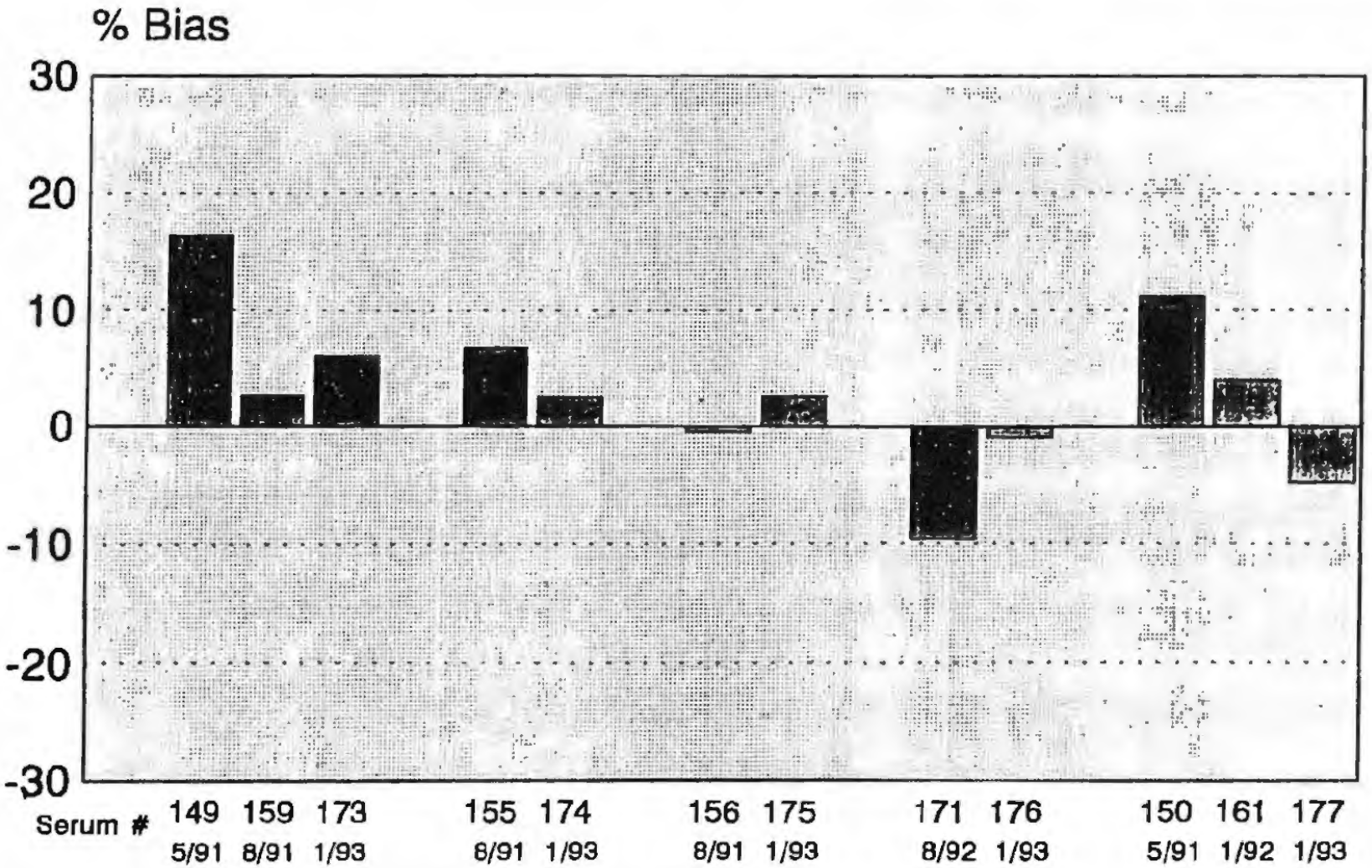
Laboratory **FSV-BA**

Blind Duplicate Performance
Alpha-Tocopherol



Laboratory **FSV-BA**

Blind Duplicate Performance
Total Beta-Carotene



Appendix D. Updated "All-Lab Report" for RR27

The following six pages are a modified version of an "All-Lab" report for RR27. This report has three parts:

- pages 1 thru 4 list results for all analytes reported by at least twice, counting both participants and NIST analysts.
- page 5 lists values for all analytes reported by only once. This page also provides a legend for pages 1 thru 4.
- page 6 summarizes each participants' performance for total retinol, α- and γ/β-tocopherol, and total β-carotene. These summaries are compatible with the percent bias evaluation advice given in the RR27 Report. However, the current bias summaries are estimated relative to the median of all reported values for each analyte in each serum rather than to the "Trimmed Core Lab Average" used in the original and detailed in Appendix B. These original reference values were estimated from on-time results of the more experienced participants, with subjective exclusion of results deemed non-representative.

To ensure confidentiality, the laboratory identifiers used in this "All-Lab Report" have been altered from those used in RR27. The only attributed results are those reported by NIST. The NIST results are not used in the assessment of the consensus summary results of the study.

Note: The analysts designated NISTa and NISTb in this modified All-Lab report are designated "NIST 1" and "NIST 3" in the Tables described in Appendix B.

Round Robin XXVII Laboratory Results

	Total Retinol, µg/mL					Retinyl Palmitate, µg/mL					α-Tocopherol, µg/mL					γ/β-Tocopherol, µg/mL				
Lab	173	174	175	176	177	173	174	175	176	177	173	174	175	176	177	173	174	175	176	177
FSV-BA	0.506	0.545	0.397	0.528	0.621	0.055	0.058	0.041	0.162	0.075	10.34	7.45	10.01	5.13	16.2	2.64	2.15	1.88	2.01	3.65
FSV-BD	0.525	0.570	0.431	0.597	0.704						11.70	7.98	10.40	6.10	17.0					
FSV-BE	0.498	0.554	0.405	0.536	0.712						11.42	7.90	11.00	5.20	17.2	2.90	2.40	2.10	2.10	4.00
FSV-BF	0.491	0.556	0.418	0.542	0.653						11.12	7.84	10.71	5.13	15.5	2.70	2.32	1.94	2.12	3.85
FSV-BG	0.552	0.538	0.377	0.691	0.673	0.014	*nd*	*nd*	0.146	0.028	10.65	7.24	9.50	5.70	15.7					
FSV-BH	0.505	0.527	0.422	0.576	0.675	*nd*	*nd*	*nd*	0.151	*nd*	11.04	7.63	10.24	5.15	17.2	3.20	2.58	2.23	2.48	4.55
FSV-BI	0.449	0.450	0.366	0.503	0.538	*nd*	*nd*	*nd*	0.228	*nd*	9.71	6.52	9.31	4.61	13.2	2.55	2.00	1.78	1.97	3.12
FSV-BJ	0.495	0.528	0.386	0.538	0.661	*nd*	*nd*	*nd*	0.186	0.071	11.15	7.71	10.76	4.94	16.2	2.95	2.22	2.03	2.05	3.79
FSV-BK	0.533	0.576	0.419	0.547	0.652						10.05	7.04	9.00	4.49	13.9					
FSV-BL	0.540	0.597	0.562	0.588	0.695						11.35	7.61	10.54	5.14	16.6					
FSV-BM	0.502	0.554	0.394	0.537							10.85	7.80	10.50	5.20						
FSV-BN	0.463	0.467	0.347	0.481		0.015	*nq*	*nq*	0.198		11.18	8.09	10.03	6.17		2.18	1.76	1.53	1.84	
FSV-BO	0.529	0.624	0.467	0.572							13.01	9.66	11.30	5.00						
FSV-BP	0.557	0.585	0.449	0.581							11.96	7.97	11.42	5.62						
FSV-BQ	0.480	0.500	0.390	0.530							10.00	6.50	10.20	4.50						
FSV-BR	0.503	0.532	0.403	0.541																
FSV-BT	0.580	0.561	0.401	0.534		0.015	0.014	0.009	0.246		11.63	8.39	11.25	5.43		3.02	2.50	2.13	2.27	
FSV-BX																				
FSV-BY	0.493	0.527	0.405	0.536	0.644	0.027	0.016	0.008	0.204	0.024	10.40	7.35	10.08	4.93	16.0	2.83	2.24	1.97	2.14	3.90
FSV-BZ											9.58	6.30	10.80	3.69	19.2					
FSV-CA	0.499	0.585	0.368	0.513	0.624						9.12	7.38	8.69	3.95	14.4					
FSV-CB	0.671	0.756	0.508	0.737							8.41	5.83	7.02	4.74						
FSV-CH	0.596	0.673	0.473	0.676	0.745						11.30	8.14	10.10	3.64	14.5	2.94	2.35	2.06	3.47	3.96
FSV-CJ	0.583	0.644	0.390	0.613	0.750						10.14	7.00	9.13	4.73	15.7					
FSV-CK	0.452	0.589	0.386	0.531	0.630						10.10	8.99	11.00	5.55	17.0	2.82	2.85	2.11	2.40	4.13
FSV-CM											11.40	7.30	10.30	5.00	16.3					
FSV-CO	0.465	0.508	0.367	0.517	0.609						10.26	7.10	9.57	4.53	15.0					
FSV-CP	0.508	0.538	0.440	0.552	0.692						7.66	5.45	7.08	3.40	11.6					
FSV-CQ	0.381	0.480	0.355	0.476	0.496						10.67	7.61	9.50	4.84	15.1					
FSV-CR	0.500	0.540	0.420	0.610							10.80	7.60	10.40	4.80						
FSV-CT	0.504	0.577	0.429	0.513							8.24	6.05	8.95	4.31						
FSV-CU	0.482	0.509	0.375	0.506	0.611	0.059	0.065	0.062	0.187	0.168	10.11	7.33	9.56	5.02	15.8					
FSV-CV	0.491	0.500	0.383	0.501							10.90	7.92	9.77	5.28		3.09	2.70	2.18	2.32	
FSV-CY	0.500	0.320	0.380	0.540	0.640						10.50	4.53	10.57	4.93	15.6					
FSV-DC	0.524	0.572	0.414	0.561	0.694															
FSV-DJ	0.880	0.920	0.710	0.860							15.90	10.70	16.70	7.20						
FSV-DL	0.352	0.383	0.322	0.398	1.119															
FSV-DM	0.432	0.454	0.346	0.456	0.570						8.70	6.46	8.12	3.64	13.7					
FSV-DS	0.480	0.550	0.410	0.490							10.32	7.65	9.06	4.78						
FSV-DX	0.456	0.489	0.366	0.486							10.30	9.00	11.00	6.30						
FSV-DY	0.521	0.530	0.414	0.580	0.718															
FSV-EA	0.468	0.513	0.382	0.537							7.84	4.70	8.40	3.58		2.27	1.76	1.69	1.79	
FSV-EB	0.514	0.538	0.396	0.541	0.720						11.10	7.67	10.15	4.91	14.4					
FSV-EC	0.448	0.491	0.366	0.478							9.54	6.70	8.93	4.50						
FSV-EI	0.285	0.298	0.245	0.345							8.73	6.15	8.58	4.25		2.19	1.77	1.33	1.75	
FSV-EJ	0.497	0.523	0.407	0.519	0.643						10.95	7.76	10.73	4.36	16.2	2.77	2.28	1.90	1.93	3.75
FSV-EK	0.571	0.613	0.415	0.595		*nd*	*nd*	*nd*	0.203		10.33	7.27	10.02	4.88		3.17	2.61	2.16	2.49	
FSV-EX	0.430	0.460	0.350	0.460							10.54	7.57	10.02	4.78						
FSV-FF	0.505	0.530	0.401	0.584																
n	46	46	46	46	26	6	4	4	10	5	43	43	43	43	25	16	16	16	16	10
Min	0.285	0.298	0.245	0.345	0.496	0.014	0.014	0.008	0.146	0.024	7.66	4.53	7.02	3.40	11.6	2.18	1.76	1.33	1.75	3.12
Mean	0.504	0.541	0.406	0.546	0.673	0.031	0.038	0.030	0.191	0.073	10.49	7.37	10.01	4.88	15.6	2.76	2.28	1.94	2.20	3.87
Max	0.880	0.920	0.710	0.860	1.119	0.059	0.065	0.062	0.246	0.168	15.90	10.70	16.70	7.20	19.2	3.20	2.85	2.23	3.47	4.55
SD	0.084	0.097	0.067	0.082	0.109	0.021	0.027	0.026	0.032	0.058	1.40	1.14	1.47	0.76	1.5	0.33	0.33	0.25	0.41	0.36
CV	17	18	16	15	16	68	71	88	17	79	13	16	15	16	10	12	15	13	19	9
NISTa	0.517	0.542	0.407	0.562	0.632						10.76	7.48	9.77	4.72	15.8	2.96	2.42	1.94	2.13	3.85
NISTb	0.482	0.502	0.372	0.547	0.643	*nd*	*nd*	*nd*	0.154	0.025	10.53	7.96	10.28	5.03	15.8	2.77	2.23	1.98	2.27	3.87
Median	0.500	0.538	0.399	0.537	0.657	0.021			0.193	0.071	10.50	7.57	10.08	4.91	15.7	2.83	2.30	2.00	2.11	3.87
eSD	0.040	0.056	0.032	0.053	0.056	0.010			0.031	0.064	0.92	0.61	0.96	0.55	1.2	0.28	0.35	0.19	0.29	0.19
eCV	8	10	8	10	8	46			16	90	9	8	10	11	8	10	15	9	14	5

Round Robin XXVII Laboratory Results

	Total β-Carotene, µg/mL					trans-β-Carotene, µg/mL					Total cis-β-Carotene, µg/mL					Total α-Carotene, µg/mL				
Lab	173	174	175	176	177	173	174	175	176	177	173	174	175	176	177	173	174	175	176	177
FSV-BA	0.96	0.377	0.87	0.410	2.26	0.895	0.345	0.814	0.376	2.055	*0.069*	*0.032*	*0.052*	*0.034*	*0.204*	0.054	0.022	0.038	0.013	0.097
FSV-BD																				
FSV-BE	1.13	0.490	1.04	0.480	3.07											0.050	0.020	0.030	0.010	0.100
FSV-BF	0.92	0.355	0.97	0.412	2.39											0.065	0.022	0.057	0.020	0.089
FSV-BG	0.83	0.300	0.73	0.324	2.03															
FSV-BH	1.02	0.421	0.92	0.435	2.50	0.957	0.396	0.877	0.403	2.362	*0.063*	*0.025*	*0.046*	*0.032*	*0.138*	0.050	0.017	0.034	0.016	0.104
FSV-BI	0.85	0.332	0.77	0.361	1.82											0.048	0.021	0.030	0.015	0.083
FSV-BJ	0.93	0.348	0.85	0.429	2.46											0.036	0.016	0.027	0.014	0.067
FSV-BK																				
FSV-BL																				
FSV-BM																				
FSV-BN	0.89	0.570	0.79	0.485												0.049	0.029	0.033	0.024	
FSV-BO	0.37	0.145	0.43	0.196												0.023	0.006	0.017	0.006	
FSV-BP	1.07	0.231	1.00	0.401												0.055	0.018	0.038	0.017	
FSV-BQ	1.76	1.330	2.31	1.040																
FSV-BR																				
FSV-BT	0.99	0.379	0.89	0.424		0.942	0.362	0.856	0.404		0.047	0.017	0.033	0.020		0.048	0.025	0.031	0.013	
FSV-BX	0.93	0.386	0.82	0.386	2.29											0.042	0.022	0.030	0.012	0.080
FSV-BY	0.96	0.387	0.97	0.442	2.58											0.047	0.026	0.033	0.016	0.125
FSV-BZ	0.95	0.377	0.98	0.416																
FSV-CA																				
FSV-CB																				
FSV-CH	0.85	0.341	0.73	0.335	1.90											0.089	*nd*	0.067	*nd*	0.163
FSV-CJ	1.38	0.481	1.28	0.528	2.95											0.049	0.035	0.021	0.011	0.066
FSV-CK	0.93	0.428	1.02	0.504	2.86											0.062	0.031	0.048	0.019	0.127
FSV-CM																				
FSV-CO	0.96	0.410	0.86	0.412	2.36															
FSV-CP	0.70	0.296	0.64	0.294	1.63											0.040	0.016	0.027	0.011	0.075
FSV-CQ	0.84	0.275	0.72	0.204	1.83															
FSV-CR																				
FSV-CT	0.99	0.383	0.93	0.382																
FSV-CU	0.79	0.325	0.64	0.350	1.96	0.726	0.293	0.599	0.313	1.836	*0.060*	*0.032*	*0.045*	*0.037*	*0.127*					
FSV-CV	1.13	0.464	0.98	0.477												0.053	0.019	0.031	0.018	
FSV-CY	0.93	0.300	0.90	0.470	2.88															
FSV-DC	0.98	0.369	0.87	0.406	2.42															
FSV-DJ																				
FSV-DL	0.86	0.344	0.63	0.463	2.21											0.038	0.017	0.029	0.017	0.095
FSV-DM	0.72	0.309	0.72	0.316	2.04															
FSV-DS	0.84	0.423	0.82	0.376																
FSV-DX	0.71	0.300	0.72	0.330												*nd*	*nd*	0.030	*nd*	*nd*
FSV-DY	0.87	0.361	0.81	0.412	2.35											0.079	0.028	0.045	0.019	0.155
FSV-EA	0.33	0.089	0.35	0.171																
FSV-EB	0.93	0.372	0.93	0.434	2.53															
FSV-EC	0.71	0.300	0.63	0.305																
FSV-EI	0.90	0.371	0.79	0.340																
FSV-EJ	1.12	0.395	1.00		3.19											0.059	0.025	0.041	0.021	0.126
FSV-EK	0.80	0.478	0.79	0.332																
FSV-EX	0.87	0.330	0.89	0.410																
FSV-FF	0.91	0.389	0.83	0.422																
n	39	39	39	38	23	4	4	4	4	3	4	4	4	4	3	20	19	21	19	15
Min	0.33	0.089	0.35	0.171	1.63	0.726	0.293	0.599	0.313	1.836	0.047	0.017	0.033	0.020	0.127	0.023	0.006	0.017	0.006	0.066
Mean	0.91	0.384	0.87	0.403	2.37	0.880	0.349	0.787	0.374	2.084	0.060	0.027	0.044	0.031	0.156	0.052	0.022	0.035	0.015	0.103
Max	1.76	1.330	2.31	1.040	3.19	0.957	0.396	0.877	0.404	2.362	0.069	0.032	0.052	0.037	0.204	0.089	0.035	0.067	0.024	0.163
SD	0.23	0.178	0.29	0.134	0.42	0.106	0.043	0.128	0.043	0.264	0.009	0.007	0.008	0.007	0.042	0.015	0.007	0.012	0.004	0.030
CV	25	46	33	33	18	12	12	16	11	13	16	27	18	24	27	28	30	33	29	29
NISTa	0.89	0.315	0.69	0.322	1.95	0.862	0.312	0.659	0.288	1.760	*0.030*	*0.003*	*0.034*	*0.034*	*0.190*					
NISTb	0.87	0.343	0.78	0.413	2.22	0.786	0.311	0.731	0.374	2.000	*0.082*	*0.032*	*0.051*	*0.039*	*0.220*	0.068	0.030	0.043	0.026	0.125
Median	0.92	0.371	0.85	0.410	2.36											0.050	0.022	0.031	0.016	0.097
eSD	0.10	0.068	0.17	0.084	0.48											0.010	0.006	0.006	0.004	0.033
eCV	11	18	21	20	21											19	27	18	28	34

Round Robin XXVII Laboratory Results

	Total Lycopene, µg/mL					trans-Lycopene, µg/mL					Total β-Cryptoxanthin, µg/mL				
Lab	173	174	175	176	177	173	174	175	176	177	173	174	175	176	177
FSV-BA						0.223	0.294	0.235	0.111	0.174	0.097	0.066	0.068	0.044	0.063
FSV-BD															
FSV-BE	0.75	1.12	0.81	0.300	0.61										
FSV-BF	0.69	0.90	0.79	0.326	0.54										
FSV-BG	0.24	0.28	0.23	0.087	0.17										
FSV-BH	0.42	0.56	0.45	0.170	0.38						0.115	0.084	0.083	0.054	0.083
FSV-BI	0.33	0.43	0.34	0.154	0.25						0.102	0.063	0.065	0.049	0.064
FSV-BJ	0.23	0.30	0.23	0.118	0.19										
FSV-BK															
FSV-BL															
FSV-BM															
FSV-BN						0.354	0.498	0.457	0.238		0.229	0.209	0.186	0.157	
FSV-BO	0.24	0.23	0.27	0.114							0.040	0.021	0.240	0.025	
FSV-BP	0.43	0.38	0.42	0.251							0.064	0.045	0.040	0.025	
FSV-BQ															
FSV-BR															
FSV-BT	0.39	0.53	0.41	0.176							0.093	0.061	0.064	0.043	
FSV-BX	0.43	0.58	0.41	0.176	0.31						0.126	0.103	0.095	0.072	0.080
FSV-BY	0.43	0.59	0.48	0.186	0.35						0.084	0.060	0.062	0.040	0.068
FSV-BZ															
FSV-CA															
FSV-CB															
FSV-CH	0.42	0.57	0.43	0.171	0.36										
FSV-CJ	0.36	0.50	0.37	0.159	0.31						0.095	0.078	0.078	0.044	0.083
FSV-CK	0.39	0.56	0.47	0.210	0.39						0.148	0.123	0.122	0.077	0.136
FSV-CM															
FSV-CO															
FSV-CP	0.41	0.57	0.41	0.158	0.29						0.059	0.040	0.036	0.029	0.036
FSV-CQ															
FSV-CR															
FSV-CT															
FSV-CU															
FSV-CV	0.50	0.70	0.51	0.219											
FSV-CY															
FSV-DC															
FSV-DJ															
FSV-DL	0.28	0.34	0.33	0.149	0.28						0.113	0.092	0.094	0.057	0.099
FSV-DM															
FSV-DS															
FSV-DX						0.240	0.330	0.260	0.120						
FSV-DY	0.41	0.56	0.42	0.186	0.34										
FSV-EA															
FSV-EB															
FSV-EC															
FSV-EI	0.40	0.63	0.45	0.165											
FSV-EJ	0.45	0.54	0.46	0.242	0.44										
FSV-EK	0.34	0.48	0.37	0.138							0.121	0.080	0.086	*nd*	
FSV-EX															
FSV-FF															
n	21	21	21	21	15	3	3	3	3	1	14	14	14	13	9
Min	0.23	0.23	0.23	0.087	0.17	0.223	0.294	0.235	0.111		0.040	0.021	0.036	0.025	0.036
Mean	0.41	0.54	0.43	0.184	0.35	0.272	0.374	0.317	0.156	0.174	0.106	0.080	0.094	0.055	0.079
Max	0.75	1.12	0.81	0.326	0.61	0.354	0.498	0.457	0.238		0.229	0.209	0.240	0.157	0.136
SD	0.13	0.20	0.14	0.058	0.12	0.071	0.109	0.122	0.071		0.045	0.045	0.056	0.035	0.028
CV	32	37	33	32	34	26	29	38	45		43	56	59	63	35
NISTa															
NISTb	0.51	0.65	0.53	0.233	0.45	0.192	0.249	0.205	0.109	0.162	0.058	0.041	0.042	0.032	0.040
Median	0.41	0.56	0.42	0.171	0.34						0.100	0.072	0.081	0.044	0.080
eSD	0.06	0.11	0.07	0.033	0.07						0.027	0.024	0.024	0.019	0.024
eCV	15	20	18	19	22						28	33	29	44	30

Round Robin XXVII Laboratory Results

	Total Lutein, µg/mL					Total Zeaxanthin, µg/mL					Total Lutein&Zeaxanthin, µg/mL				
Lab	173	174	175	176	177	173	174	175	176	177	173	174	175	176	177
FSV-BA											0.195	0.147	0.195	0.085	0.148
FSV-BD															
FSV-BE															
FSV-BF															
FSV-BG															
FSV-BH	0.107	0.100	0.109	0.053	0.097	0.040	0.022	0.038	0.028	0.030	*0.147*	*0.122*	*0.147*	*0.081*	*0.127*
FSV-BI	0.109	0.080	0.100	0.043	0.073	0.042	0.030	0.042	0.022	0.029	0.150	0.109	0.153	0.074	0.111
FSV-BJ															
FSV-BK															
FSV-BL															
FSV-BM															
FSV-BN	0.122	0.105	0.123	0.066		0.073	0.064	0.065	0.048		0.151	0.116	0.157	0.072	
FSV-BO	0.200	0.156	0.178	0.085											
FSV-BP															
FSV-BQ															
FSV-BR															
FSV-BT	>0.138	>0.104	>0.162	>0.064		>0.046	>0.032	>0.043	>0.021		*>0.184*	*>0.136*	*>0.205*	*>0.085*	
FSV-BX	0.113	0.086	0.110	0.052	0.090	0.036	0.022	0.032	0.022	0.026	*0.149*	*0.108*	*0.142*	*0.074*	*0.116*
FSV-BY	0.093	0.077	0.097	0.046	0.079										
FSV-BZ															
FSV-CA															
FSV-CB															
FSV-CH															
FSV-CJ											0.185	0.153	0.199	0.075	0.167
FSV-CK											0.203	0.201	0.235	0.112	0.201
FSV-CM															
FSV-CO															
FSV-CP						0.142	0.111	0.146	0.066	0.113					
FSV-CQ															
FSV-CR															
FSV-CT	0.093	0.074	0.104	0.037		0.048	0.032	0.045	0.035		*0.141*	*0.106*	*0.149*	*0.072*	
FSV-CU															
FSV-CV															
FSV-CY															
FSV-DC															
FSV-DJ															
FSV-DL											0.141	0.108	0.175	0.070	0.148
FSV-DM															
FSV-DS															
FSV-DX	0.090	0.090	0.110	0.040		0.090	*nd*	*nd*	*nd*		*0.180*				
FSV-DY															
FSV-EA															
FSV-EB															
FSV-EC															
FSV-EI															
FSV-EJ															
FSV-EK	0.199	0.147	0.200	0.081											
FSV-EX															
FSV-FF															
n	9	9	9	9	4	7	6	6	6	4	10	9	9	9	7
Min	0.090	0.074	0.097	0.037	0.073	0.036	0.022	0.032	0.022	0.026	0.141	0.106	0.142	0.070	0.111
Mean	0.125	0.102	0.126	0.056	0.085	0.067	0.047	0.061	0.037	0.049	0.164	0.130	0.172	0.079	0.145
Max	0.200	0.156	0.200	0.085	0.097	0.142	0.111	0.146	0.066	0.113	0.203	0.201	0.235	0.112	0.201
SD	0.043	0.030	0.037	0.018	0.011	0.038	0.035	0.043	0.017	0.042	0.024	0.032	0.031	0.013	0.032
CV	35	30	29	31	13	57	75	70	47	85	15	24	18	16	22
NISTa															
NISTb	0.104	0.085	0.103	0.047	0.082	0.046	0.036	0.046	0.028	0.036	*0.150*	*0.121*	*0.149*	*0.075*	*0.118*
Median	0.109	0.090	0.110	0.052		0.048	0.031	0.044	0.032		0.151	0.116	0.157	0.074	0.148
eSD	0.024	0.019	0.015	0.018		0.018	0.013	0.013	0.014		0.014	0.012	0.022	0.004	0.031
eCV	22	21	13	34		37	43	29	45		9	10	14	5	21

Round Robin XXVII Laboratory Results

Analytes Reported By One Laboratory
Values in µg/mL

Analyte	Code	173	174	175	176	177
δ-Tocopherol	NISTb	0.212	0.117	0.057	0.136	0.156
trans-α-Carotene	NISTb	0.041	0.018	0.027	0.016	0.080
trans-Lutein	FSV-BT	0.138	0.104	0.162	0.064	
trans-Zeaxanthin	FSV-BT	0.046	0.032	0.043	0.021	

Legend

nd	Not detected (i.e., not reported or reported as '0', 'not determined', etc.)
nq	Not quantitatively determined (i.e., reported as 'trace')
>x	Value greater than x
italics	Value calculated from reported results
n	Number of non-NIST laboratories reporting quantitative results
Min	Minimum non-NIST reported value.
Mean	Average over all non-NIST reported values.
Max	Maximum non-NIST reported value.
SD	Standard deviation over all non-NIST values.
CV	Coefficient of Variation (% relative standard deviation): 100*SD/Mean
Median	Median over all non-NIST reported values
eSD	Robust estimate of SD based on the adjusted median absolute difference from the median (MADe)
eCV	Robust estimate of CV, 100*eSD/Median

Round Robin XXVII Laboratory Results

% Bias Summary

Lab	TR	aT	g/bT	bC
FSV-BA	-1±3	1±3	-6±1	1±3
FSV-BD	7±2	10±8		
FSV-BE	2±4	8±2	3±2	25±6
FSV-BF	1±3	4±3	-1±2	2±7
FSV-BG	7±13	1±9		-16±4
FSV-BH	3±4	4±3	14±3	9±3
FSV-BI	-12±5	-10±5	-12±5	-12±6
FSV-BJ	-1±2	4±3	-1±3	1±4
FSV-BK	4±3	-8±3		
FSV-BL	15±15	5±3		
FSV-BM	1±2	4±1		
FSV-BN	-11±3	10±11	-21±5	15±28
FSV-BO	11±6	16±12		-56±6
FSV-BP	10±2	12±4		-2±26
FSV-BQ	-4±3	-7±6		169±69
FSV-BR	0±1			
FSV-BT	5±8	11±0	7±1	4±2
FSV-BX				-2±4
FSV-BY	-1±1	0±2	0±2	8±4
FSV-BZ		-4±19		5±7
FSV-CA	-2±6	-12±6		
FSV-CB	35±6	-19±11		
FSV-CH	20±5	-4±14	15±28	-13±6
FSV-CJ	12±9	-5±4		37±12
FSV-CK	-2±7	9±8	10±9	16±9
FSV-CM		3±4		
FSV-CO	-6±2	-5±2		3±4
FSV-CP	4±4	-28±2		-26±4
FSV-CQ	-16±7	-2±3		-25±16
FSV-CR	5±6	1±2		
FSV-CT	3±6	-16±5		3±7
FSV-CU	-6±1	-2±3		-17±5
FSV-CV	-5±2	3±5	11±4	20±5
FSV-CY	-9±17	-7±19		5±16
FSV-DC	5±1			2±3
FSV-DJ	71±8	51±10		
FSV-DL	-7±43			-7±14
FSV-DM	-14±1	-18±5		-18±4
FSV-DS	-2±5	-3±5		-2±11
FSV-DX	-9±1	14±13		-19±3
FSV-DY	5±4			-3±2
FSV-EA	-4±3	-27±9	-18±4	-65±8
FSV-EB	2±4	0±5		5±4
FSV-EC	-10±1	-10±2		-24±3
FSV-EI	-40±4	-16±2	-24±7	-7±8
FSV-EJ	-1±2	1±7	-4±3	20±12
FSV-EK	11±5	-2±2	13±4	-3±22
FSV-EX	-14±1	-1±1		-3±7
FSV-FF	2±4			1±3

Label	Definition
Lab	Participant code
TR	Total Retinol
aT	a-Tocopherol
g/bT	g/b-Tocopherol
bC	Total b-Carotene
% Bias	(Mean ± SD) of individual serum biases
Mean	Average of $(x_i\text{-Median}_i)/\text{Median}_i$
SD	Standard deviation of $(x_i\text{-Median}_i)/\text{Median}_i$
x_i	Result for analyte in serum$_i$
Median$_i$	Median of non-NIST results in serum$_i$

The original analysis listed % Bias for each result for each serum calculated relative to the "Trimmed Core Lab Average" of that analyte in the serum. The summary values reported here are the (arithmetic mean ± standard deviation) of each laboratory's reported results for the analyte estimated relative to each serum's median value.

Appendix E. Shipping Package Inserts for RR28

Two items were included in each package shipped to an RR28 participant:

- **Cover letter**. The original letter has been lost. It would have been similar to the reconstructed cover letter for RR27 provided in Appendix A. That is, the cover letter for RR28 would likely have:
  - described the five samples, 181 to 185 (all lyophilized), distributed in this study;
  - provided guidance for reconstituting the samples and recommended a number of standard wavelengths and associated $E^{1\%}_{cm}$ absorptivities;
  - stated that the results were due by June 14, 1993 and should be mailed or faxed to Ms. Nancy T. Miles;
  - stated that analytical and technical queries should be directed to Willie E. May, PhD;
  - stated the date and venue for the 1993 MMQAP Workshop, and
  - was signed by Willie E. May, PhD.
- **Datasheet**.

These items were attached to the shipping box.

ROUND ROBIN XXVIII RESULTS FROM LABORATORY # _____
DATE OF ANALYSIS _____
RESULTS IN ug/mL

SAMPLE NUMBER	ANALYTE	RESULT
SERUM 181	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 182	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 183	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 184	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 185	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____

OPTIONAL ANALYTES: SUPPLY ONE RESULT IF AVAILABLE

SERUM #	181	182	183	184	185
TRANS-BETA CAROTENE					
ALPHA-CAROTENE					
RETINYL PALMITATE					
GAMMA-TOCOPHEROL					
LYCOPENE (TOTAL)					
9-CIS-BETA CAROTENE					
13-CIS-BETA-CAROTENE					
LUTEIN					
ZEAXANTHIN					
BETA-CRYPTOXANTHIN					

DIRECTIONS: Reconstitute with 1.0 mL distilled water.

RESULTS DUE BY: June 14, 1993
FAX RESULTS TO 301/926-8671

Appendix F. Final Report for RR28

The following eleven pages are the final report for RR28 as provided to all participants:

- A cover letter and discussion.
- Tables 1 thru 4 that list the results and various summary values for total retinol, α-tocopherol, total β-carotene, and γ/β-tocopherol.
- Tables 5 tthru 17 that list the results and simple summary statistics for *trans*-β-carotene, total α-carotene, retinyl palmitate, total lutein, total lycopene, total zeaxanthin, total lutein & zeaxanthin, total β-cryptoxanthin, *trans*-lycopene, *trans*-lutein & zeaxanthin, *trans*-α-carotene, δ-tocopherol, and *cis*-lutein & zeaxanthin.
- three graphical presentations of "Interlaboratory Precision vs Time" for total retinol, α-tocopherol, and total β-carotene.

Due to the complex formatting used in the Tables, the originally listed laboratory codes have been deleted without replacement. However, Appendix H provides a complete listing of the RR28 results where the original codes have been altered to ensure confidentiality. Appendix H also provides more relevant summary statistics.

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

July 22, 1993

Dear Colleague:

This report describes both overall-group and your laboratory's performance in Round Robin XXVIII. The study involved analysis of five samples (181-185); samples 182 and 185 were blind duplicates. Specifically, your package contains for retinol, α-tocopherol, and β-carotene, respectively: tabular presentations of all data submitted for Round Robin XXVIII; a Blind Control Chart representing a summary of your laboratory's data vs the assigned values for the past six years; and a graphical presentation of data from your laboratory's analysis of blind duplicate samples. Tabular data only is provided for γ-tocopherol, δ-tocopherol, all-trans β-carotene, trans α-carotene, α-carotene, retinyl palmitate, total and trans-lycopene, lutein, zeaxanthin, β-cryptoxanthin, and total cis-β-carotene.

Table 1 provides a summary of the data submitted for retinol in Round Robin XXVIII. Thirty-eight labs submitted data: 23 "Core" labs (program participants for more than two years); and 15 "New" labs, 9 with one to two-year participation and 6 participating in our round-robin studies for less that one year. As shown in Table 1, the mean relative standard deviation (RSD) was approximately 16% for all labs and approached 10% for the core laboratories. The performance for the new labs with one- to two-year participation appears to be deteriorating somewhat. Specifically, the mean RSD for the New labs with one- to two-year participation ranged from 28-31% in this study, while in the last round robin the mean RSD ranged from 10-18% and about 6% in Round-Robin XXVI. This phenomenon will be looked into and discussed at our annual workshop. The mean RSD for those labs participating for less than one year was about 10%.

Table 2 provides a summary of data submitted for the determination of α-tocopherol in Round Robin XXVIII. Thirty-eight laboratories submitted data: 25 Core labs; 9 one- to two-year participants; and 4 first-time participant. The mean RSD for Core labs was approximately 9%. The overall RSD for the Core labs has remained approximately 10% over the past two years. The RSD for New labs with one to two-year participation ranged from about 29-33%, which is nearly a factor of three higher than the mean RSD reported in the previous round robin.

Table 3 provides a summary of data for total β-carotene. Twenty-eight laboratories submitted data: 19 Core labs; 7 one- to two-year participants; and 2 first-time participants. The performance for the measurement of β-carotene remains slightly poorer than for retinol and α-tocopherol. The mean RSD for All labs was about 37%, while the mean RSD for the Core labs was $\sim$ 19%. In the last round robin exercise, the mean RSD for the Core labs was 26%. The concentrations of β-carotene ranged from about 100-400 ppb (ng/mL) in this round robin study. The RSD for the lowest level of β-carotene (Serum 181) appeared to be slightly higher than for the other levels of concentration, suggesting that 100 ppb might approach the limit for effective quantitation.

Tables 4-16 provide summaries of RRXXVIII data submitted for other fat-soluble vitamin and carotenoid compounds. Data submitted for γ-tocopherol again appears to show improvement with the RSD for the trimmed labs averaging around 6%. Except for trans β-carotene and lycopene, the concentrations of the remaining analytes appear to be too low for a fair assessment of either individual or interlaboratory measurement capabilities.

Data for use in evaluating your laboratory's individual performance in RRXXVIII is provided on the right side of Tables 1-4. The Core labs **trimmed values** were used as the assigned values. By convention, 0-5% bias from the assigned value represents **EXCEPTIONAL** performance, 6-10% **ACCEPTABLE** performance, 11-20% **MARGINAL** performance and >20% **POOR** performance relative to the current state of the art for these measurements. If you have concerns regarding your performance or are a lab whose performance would be rated "U" based on the convention stated above, we suggest that you obtain a unit of SRM 968a and analyze all three levels. If, with minor method modifications, your measured values do not agree with the certified values, feel free to contact us for consultation. SRM 968a can be obtained through the NIST Standard Reference Materials Program (301/975-6776).

Samples for Round Robin XXVIX will be shipped during the week of July 26. Results will be due by August 30 so that all three exercises can be summarized, critiqued, and discussed at the Annual QA Workshop to be held on Saturday, September 25. Detailed information regarding the Workshop will be mailed to you next week. Calls concerning various aspects of the round-robin studies should be directed to me at 301/975-3108 or Ms. Jeanice Brown Thomas at 301/975-3120.

Sincerely,

Willie E. May, Ph.D.
Chief
Organic Analytical Research Division
Chemical Science and Technology Laboratory

Enclosures

Table 1. Round Robin XXVIII

Retinol Results

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.455	0.491	0.519	0.324	0.483
	0.428	0.510	0.539	0.338	0.516
	0.434	0.473	*0.475	0.328	0.468
	*0.614	*0.620	*0.656	0.377	*0.661
	0.481	0.489	0.528	0.322	0.515
	0.438	0.484	0.500	0.309	0.481
	0.504	0.588	0.594	0.377	0.581
	0.493	0.518	0.564	0.337	0.500
	0.450	0.499	0.531	0.325	0.510
	0.484	0.579	0.569	0.361	0.571
	0.488	0.529	0.539	0.348	0.529
	0.449	0.497	0.520	0.335	0.518
	0.480	0.546	0.560	0.340	0.531
	0.480	0.560	0.540	0.330	0.520
	0.545	0.577	0.594	*0.448	*0.676
	0.500	0.555	0.559	0.364	0.561
	0.545	0.580	0.578	0.376	0.578
	0.405	0.538	0.533	0.360	0.530
	0.454	0.510	0.525	0.339	0.502
	0.469	0.570	0.542	0.348	0.561
	0.505	0.551	0.556	0.369	0.551
	*0.593	*0.651	*0.705	*0.450	*0.697
	0.430	0.510	0.519	0.323	0.502
	0.622	0.693	0.706	0.451	0.687
	0.470	0.550	0.560	0.360	0.550
	0.487	0.578	0.596	0.386	0.587
	0.604	0.171	0.158	0.080	0.414
	0.594	0.643	0.646	0.467	0.648
	0.570	0.573	0.581	0.378	0.556
	0.540	0.590	0.580	0.470	0.610
	0.270	0.293	0.324	0.202	0.313
	0.509	0.546	0.564	0.371	0.552
	0.583	0.667	0.672	0.437	0.658
	0.462	0.510	0.558	0.365	0.531
	0.494	0.569	0.606	0.398	0.593
	0.539	0.666	0.694	0.492	0.711
	0.460	0.590	0.640	0.410	0.610
	0.468	0.536	0.571	0.360	0.539
	0.460	0.570	0.580	0.370	0.540
	0.344	0.420	0.416	0.261	0.407
	0.420	0.490	0.490	0.320	0.490
	0.426	0.515	0.527	0.352	0.506
	0.516	0.576	0.603	0.355	0.595
NIST 1	0.412	0.509	0.504	0.369	0.501
NIST 3	0.446	0.524	0.548	0.356	0.526
All Labs					
AVG (39)	0.494	0.543	0.558	0.362	0.555
SD	0.067	0.092	0.095	0.071	0.078
RSD	13.6	16.9	17.0	19.7	14.1
Core Labs (15-101;23)					
AVG	0.484	0.540	0.554	0.353	0.545
SD	0.052	0.046	0.049	0.036	0.061
RSD	10.7	8.5	8.9	10.2	11.2
(a) New Labs (105-115;5) 2 yr participation.					
AVG	0.555	0.527	0.533	0.349	0.577
SD	0.071	0.207	0.217	0.157	0.106
RSD	12.8	39.2	40.7	44.9	18.3
(b) New Labs (116-119;4) 1-2 yr participation.					
AVG	0.472	0.500	0.512	0.355	0.508
SD	0.137	0.140	0.126	0.112	0.133
RSD	29.0	27.9	24.5	31.4	26.1
(c) New Labs (122-130;7) Less than 1 yr participation.					
AVG	0.495	0.587	0.617	0.405	0.597
SD	0.048	0.060	0.053	0.047	0.068
RSD	9.7	10.3	8.5	11.7	11.4

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	-3.7	-7.6	-4.8	-5.9	-8.1
	-9.4	-4.0	-1.2	-1.8	-1.8
	-8.1	-10.9	-12.9	-4.7	-10.9
	30.0	16.7	20.3	9.5	25.8
	1.9	-7.9	-3.2	-6.5	-2.0
	-7.3	-8.9	-8.3	-10.2	-8.4
	6.7	10.7	8.9	9.5	10.6
	4.4	-2.5	3.4	-2.1	-4.8
	-4.7	-6.1	-2.6	-5.6	-2.9
	2.5	9.0	4.3	4.9	8.7
	3.3	-0.4	-1.2	1.2	0.7
	-4.9	-6.4	-4.7	-2.7	-1.4
	1.6	2.8	2.7	-1.2	1.1
	1.6	5.4	-1.0	-4.1	-1.0
	15.4	8.6	8.9	30.1	28.7
	5.9	4.5	2.5	5.7	6.8
	15.4	9.2	5.9	9.1	9.9
	-14.2	1.3	-2.3	4.6	0.9
	-3.9	-4.0	-3.7	-1.5	-4.4
	-0.7	7.3	-0.6	1.1	6.8
	6.9	3.7	1.9	7.2	4.9
	25.6	22.6	29.3	30.7	32.7
	-8.9	-4.0	-4.8	-6.2	-4.4
	31.7	30.5	29.4	31.0	30.8
	-0.5	3.6	2.7	4.6	4.7
	3.1	8.8	9.3	12.1	11.7
	27.9	-67.8	-71.0	-76.8	-21.2
	25.8	21.1	18.4	35.6	23.3
	20.7	7.9	6.5	9.8	5.8
	14.3	11.1	6.3	36.5	16.1
	-42.8	-44.9	-40.5	-41.3	-40.5
	7.9	2.9	3.4	7.7	5.1
	23.5	25.6	23.2	26.9	25.2
	-2.2	-4.0	2.3	6.0	1.1
	4.6	7.1	11.1	15.6	12.9
	14.1	25.4	27.2	42.9	35.3
	-2.6	11.1	17.3	19.1	16.1
	-0.9	0.9	4.7	4.6	2.6
	-2.6	7.3	6.3	7.5	2.8
	-27.2	-20.9	-23.8	-24.3	-22.5
	-11.1	-7.7	-10.2	-7.1	-6.7
	-9.8	-3.0	-3.4	2.2	-3.7
	9.3	8.4	10.6	3.1	13.3

Core Labs Trimmed (15-101;23)					
AVG	0.472	0.531	0.545	0.344	0.525
SD	0.037	0.036	0.026	0.020	0.033
RSD	7.8	6.8	4.7	5.9	6.2

Sera 182 and 185 are the same material.

* = Value removed for Core Lab Trimmed Average.

Table 2. Round Robin XXVIII

Alpha-Tocopherol Results

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	6.95	5.27	10.54	4.07	5.20
	6.98	5.87	12.22	4.48	5.77
	6.66	4.84	10.11	4.11	4.94
	6.51	5.28	11.18	3.83	5.93
	6.79	5.24	11.72	4.50	5.51
	6.91	5.37	11.24	4.18	5.29
	7.70	*6.70	12.40	4.50	5.70
	7.92	5.98	12.43	4.57	5.81
	6.77	4.97	10.88	3.91	4.96
	7.00	5.26	11.30	4.38	5.33
	7.03	5.63	11.50	4.39	5.65
	7.19	5.68	11.33	4.44	5.74
	7.12	5.52	11.32	4.16	5.33
	7.13	5.30	12.10	*6.39	*6.69
	7.34	5.24	11.90	4.19	5.60
	7.33	5.61	11.35	4.58	5.63
	*5.84	5.48	10.39	4.10	5.39
	7.13	5.08	10.52	4.21	5.20
	7.19	5.50	11.09	4.41	5.46
	6.80	5.70	12.38	4.13	5.40
	6.29	5.28	10.81	4.30	5.30
	6.46	5.01	*9.48	3.72	*4.54
	7.52	5.08	11.82	*6.06	5.20
	*8.37	5.69	10.90	*5.58	*7.13
	*5.96	4.79	9.99	3.76	4.82
	7.85	6.89	10.21	5.69	6.73
	7.23	5.51	11.61	4.33	5.48
	7.85	6.50	12.81	8.48	6.54
	3.37	3.02	5.00	2.58	3.04
	9.28	7.47	15.52	5.49	6.88
	7.84	5.52	11.40	4.48	5.47
	6.52	5.49	10.39	4.23	5.37
	4.15	2.84	6.86	2.08	2.27
	7.55	5.90	11.80	4.83	5.82
	6.14	4.73	9.68	3.70	4.76
	3.50	3.62	9.00	1.89	2.57
	7.30	5.80	11.30	4.60	6.00
	7.20	5.80	10.90	4.40	5.80
	6.90	5.30	11.30	4.20	5.50
	0.26	0.20	0.51	0.15	0.23
	7.39	5.58	11.20	4.48	5.75
	7.10	6.30	13.00	6.00	7.00
	7.32	5.46	4.86	4.29	5.69
NIST 1	7.35	5.73	11.68	4.53	5.74
NIST 3	7.03	5.72	11.20	4.41	5.41
All Labs					
AVG (39)	6.86	5.38	10.99	4.41	5.38
SD	1.14	0.86	1.63	1.09	0.99
RSD	16.6	16.0	14.8	24.8	18.4
Core Labs (15-101;25)					
AVG	7.00	5.41	11.24	4.44	5.50
SD	0.56	0.41	0.79	0.65	0.54
RSD	8.0	7.5	7.0	14.7	9.8
(a) New Labs (105-115;5) 2 yr participation.					
AVG	7.11	5.88	11.03	5.31	5.73
SD	2.23	1.75	3.89	2.16	1.60
RSD	31.3	29.8	35.3	40.7	28.0
(b) New Labs (116-119;4) 1-2 yr participation.					
AVG	6.51	4.94	10.11	3.91	4.73
SD	1.68	1.41	2.25	1.24	1.65
RSD	25.7	28.6	22.2	31.8	35.0
(c) New Labs (122-130;5) Less than 1 yr participation.					
AVG	6.21	5.05	10.44	3.76	4.93
SD	1.58	0.91	1.04	1.10	1.40
RSD	25.5	18.1	10.0	29.2	28.4

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	-1.2	-1.7	-6.8	-3.7	-4.0
	-0.7	9.5	8.1	6.1	6.5
	-5.3	-9.7	-10.6	-2.7	-8.8
	-7.4	-1.5	-1.1	-9.3	9.5
	-3.4	-2.3	3.6	6.5	1.7
	-1.7	0.2	-0.6	-1.0	-2.3
	9.5	25.0	9.6	6.5	5.2
	12.6	11.5	9.9	8.2	7.3
	-3.7	-7.3	-3.8	-7.4	-8.4
	-0.5	-1.9	-0.1	3.7	-1.6
	-0.0	5.0	1.7	3.9	4.3
	2.2	5.9	0.2	5.1	6.0
	1.2	3.0	0.1	-1.5	-1.6
	1.4	-1.1	7.0	51.3	23.5
	4.4	-2.3	5.2	-0.8	3.4
	4.2	4.6	0.4	8.4	4.0
	-17.0	2.2	-8.1	-2.9	-0.5
	1.4	-5.2	-7.0	-0.3	-3.9
	2.2	2.6	-2.0	4.4	0.7
	-3.3	6.3	9.5	-2.2	-0.3
	-10.6	-1.6	-4.4	1.8	-2.2
	-8.1	-6.6	-16.1	-11.8	-16.3
	6.9	-5.2	4.5	43.4	-4.0
	19.0	6.1	-3.6	32.1	31.6
	-15.2	-10.7	-11.7	-11.1	-11.1
	11.6	28.5	-9.7	34.7	24.3
	2.8	2.8	2.7	2.5	1.2
	11.6	21.3	13.2	100.8	20.7
	-52.1	-43.6	-55.8	-39.0	-43.9
	31.9	39.4	37.2	29.9	27.1
	11.5	3.0	0.8	6.1	1.0
	-7.3	2.4	-8.1	0.2	-0.8
	-41.0	-47.0	-39.3	-50.8	-58.1
	7.3	10.1	4.4	14.4	7.4
	-12.7	-11.8	-14.4	-12.4	-12.1
	-50.2	-32.5	-20.4	-55.2	-52.5
	3.8	8.2	-0.1	8.9	10.8
	2.4	8.2	-3.6	4.2	7.1
	-1.9	-1.1	-0.1	-0.6	1.6
	-96.3	-96.3	-95.4	-96.3	-95.8
	5.1	4.1	-1.0	6.1	6.2
	1.0	17.5	14.9	42.1	29.2
	4.1	1.9	-57.0	1.5	5.0

Core Labs Trimmed (15-101;25)

AVG	7.03	5.36	11.31	4.22	5.42
SD	0.39	0.31	0.72	0.26	0.30
RSD	5.6	5.8	6.3	6.1	5.5

Sera 182 and 185 are the same material.

* = Value removed for Core Lab Trimmed Average.

Table 3. Round Robin XXVIII

Total Beta-Carotene Results

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.078	0.430	0.313	0.337	0.429
	0.077	0.433	0.389	0.348	0.438
	0.066	0.501	0.306	0.442	0.528
	0.065	0.340	0.321	0.250	0.347
	0.103	0.421	0.372	0.347	0.415
	0.072	0.436	0.338	0.365	0.428
	0.093	0.401	0.395	0.338	0.424
	*0.148	0.478	0.394	0.361	0.454
	0.092	0.416	0.428	0.351	0.408
	0.085	0.487	0.444	0.409	0.496
	0.100	*0.600	*0.500	*0.500	*0.770
	0.100	0.370	0.300	0.310	0.400
	*0.127	0.456	0.399	0.374	0.463
	0.068	0.503	0.440	0.418	0.480
	0.091	0.402	0.410	0.361	0.401
	0.060	0.329	0.277	0.259	0.327
	0.078	0.411	0.407	0.401	0.471
	0.095	0.359	0.288	0.399	0.421
	0.060	0.388	0.332	0.302	0.365
	0.242	0.408	0.367	0.342	0.360
	0.091	0.736	0.407	0.271	0.476
	0.087	0.255	0.238	0.215	0.294
	0.074	0.443	0.402	0.374	0.443
	0.634	0.314	0.228	0.261	0.344
	0.050	0.444	0.340	0.354	0.332
	0.077	0.438	0.353	0.345	0.420
	0.073	0.420	0.341	0.341	0.415
	0.397	0.633	0.577	0.392	0.565
	0.074	0.532	0.481	0.428	0.533
	0.214	1.330	1.195	0.958	1.223
	0.150	0.450	0.300	0.370	0.360
	0.630	0.360	0.340		0.360
	0.071	0.375	0.287	0.289	0.393
NIST 1	0.100	0.385	0.385	0.370	0.409
NIST 3	0.101	0.426	0.398	0.352	0.426
All Labs					
AVG (29)	0.119	0.441	0.372	0.352	0.436
SD	0.120	0.097	0.077	0.062	0.091
RSD	100.4	22.0	20.7	17.7	20.8
Core Labs (15-101;19)					
AVG	0.087	0.430	0.371	0.362	0.446
SD	0.023	0.065	0.062	0.060	0.093
RSD	26.1	15.2	16.6	16.6	20.8
(a) New Labs (108-115;4) 2 yr participation.					
AVG	0.124	0.461	0.354	0.301	0.393
SD	0.079	0.201	0.079	0.071	0.082
RSD	64.2	43.6	22.4	23.8	20.9
(b) New Labs (116-119;3) 1-2 yr participation.					
AVG	0.254	0.399	0.307	0.320	0.365
SD	0.330	0.073	0.069	0.051	0.048
RSD	129.9	18.4	22.4	16.0	13.0
(c) New Labs (122-125;3) Less than 1 yr participation.					
AVG	0.181	0.528	0.466	0.387	0.504
SD	0.187	0.107	0.119	0.044	0.079
RSD	103.0	20.2	25.4	11.3	15.7

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	-4.1	2.4	-14.0	-4.8	0.4
	-5.3	3.1	6.9	-1.7	2.5
	-18.8	19.3	-15.9	24.9	23.5
	-20.1	-19.1	-11.8	-29.4	-18.8
	26.7	0.2	2.2	-2.0	-2.9
	-11.5	3.8	-7.2	3.1	0.1
	14.4	-4.5	8.5	-4.5	-0.8
	82.0	13.8	8.2	2.0	6.2
	13.1	-1.0	17.6	-0.8	-4.6
	4.5	15.9	22.0	15.5	16.0
	23.0	42.8	37.3	41.2	80.1
	23.0	-11.9	-17.6	-12.4	-6.4
	56.2	8.6	9.6	5.6	8.3
	-17.0	19.7	20.9	18.1	12.3
	11.9	-4.3	12.6	2.0	-6.2
	-26.2	-21.7	-23.9	-26.8	-23.5
	-4.1	-2.2	11.8	13.3	10.2
	16.8	-14.5	-20.9	12.7	-1.5
	-26.2	-7.6	-8.8	-14.7	-14.6
	197.6	-2.9	0.8	-3.4	-15.8
	11.9	75.2	11.8	-23.4	11.3
	7.0	-39.3	-34.6	-39.3	-31.2
	-9.0	5.5	10.4	5.6	3.6
	679.6	-25.2	-37.4	-26.3	-19.5
	-38.5	5.7	-6.6	0.0	-22.3
	-5.2	4.2	-3.1	-2.7	-1.8
	-10.2	-0.0	-6.3	-3.7	-2.9
	388.2	50.7	58.5	10.7	32.2
	-9.0	26.6	32.1	20.9	24.7
	163.4	216.6	228.2	170.6	186.0
	84.4	7.1	-17.6	4.5	-15.8
	674.7	-14.3	-6.6		-15.8
	-12.7	-10.7	-21.2	-18.4	-8.1
Core Labs Trimmed (15-101;19)					
AVG	0.081	0.420	0.364	0.354	0.428
SD	0.015	0.052	0.055	0.051	0.051
RSD	18.0	12.4	15.0	14.5	11.9

Sera 182 and 185 are the same material.

* = Value removed for Core Lab Trimmed Average.

Table 4. Round Robin XXVIII
Gamma-Tocopherol Results

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	2.26	2.47	1.71	1.60	2.50
	2.27	2.68	1.95	1.73	2.63
	2.40	2.47	1.76	1.61	2.40
	2.40	2.50	1.86	1.65	2.51
	2.23	2.50	1.84	1.70	*3.42
	2.38	2.50	1.90	1.79	2.52
	2.45	2.69	1.89	1.76	2.73
	2.29	2.48	1.76	1.66	2.50
	*1.80	*1.61	*1.43	1.71	*1.93
	2.43	2.42	1.77	1.57	2.47
	2.05	2.23	1.58	1.45	*2.18
	2.23	2.39	1.65	1.86	2.64
	2.40	2.56	*1.20	1.44	2.68
	*0.54	*1.11	*0.24	*0.03	*1.20
	*1.24	*1.39	*1.09	*0.78	*1.05
	2.56	2.82	2.04	1.81	2.78
NIST 1	2.57	2.62	1.80	1.76	2.59
NIST 3	2.44	2.70	1.92	1.73	2.60
AVG	2.14	2.33	1.62	1.53	2.41
SD	0.52	0.49	0.44	0.46	0.57
RSD	24.3	20.9	27.1	30.0	23.7

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	-3.1	-1.8	-5.7	-3.9	-2.9
	-2.8	6.5	7.8	3.8	2.0
	2.8	-1.8	-2.7	-3.4	-6.9
	2.8	-0.6	2.9	-1.0	-2.7
	-4.5	-0.6	1.8	2.0	32.6
	1.7	-0.7	4.8	7.4	-2.2
	4.9	6.9	4.5	5.6	5.9
	-1.9	-1.4	-2.7	-0.4	-3.0
	-22.9	-36.0	-20.9	2.6	-25.2
	4.0	-3.7	-2.3	-6.0	-4.4
	-12.2	-11.4	-12.6	-13.0	-15.5
	-4.5	-5.0	-8.8	11.6	2.4
	2.8	1.7	-33.9	-13.7	3.9
	-76.8	-55.8	-86.5	-98.4	-53.6
	-47.1	-44.9	-39.5	-53.3	-59.3
	9.8	12.1	13.0	8.5	7.9

Trimmed Lab Average (17)

AVG	2.33	2.52	1.81	1.67	2.58
SD	0.13	0.15	0.13	0.13	0.12
RSD	5.6	5.9	7.2	7.5	4.7

Table 5. Round Robin XXVIII
Trans-Beta-Carotene

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.080	0.394	0.384	0.315	0.380
	0.085	0.470	0.425	0.388	0.477
	0.088	0.397	0.401	0.354	0.395
	0.087	0.255	0.238	0.215	0.294
	0.075	0.421	0.336	0.326	0.404
NIST 1	0.070	0.347	0.344	0.319	0.357
NIST 3	0.085	0.405	0.371	0.323	0.403
AVG	0.083	0.387	0.357	0.320	0.390
SD	0.006	0.080	0.074	0.065	0.065
RSD	6.7	20.7	20.7	20.3	16.8

Table 6. Round Robin XXVIII
Alpha-Carotene

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.018	0.018	0.037	0.022	0.017
	0.014	0.016	0.042	0.019	0.016
	0.016	0.018	0.034	0.020	0.013
			0.044	0.026	
	0.020	0.010	0.040	0.010	0.020
	0.013	0.014	0.052	0.015	0.013
	0.010	0.010	0.043	0.012	0.011
	0.020	0.020	0.030	0.010	0.030
	0.022	0.028	0.045	0.018	0.015
	0.006	0.008	0.043	0.010	0.005
	0.010	0.012	0.036	0.013	0.012
	0.025	0.019	0.044	0.033	0.024
	0.033	0.032	0.046	0.028	0.027
	0.020	0.027	0.053	0.015	0.022
	0.006	0.012	0.024	0.011	0.013
	0.020	0.014	0.036	0.015	0.013
NIST 3	0.043	0.030	0.062	0.034	0.028
AVG	0.017	0.017	0.041	0.017	0.017
SD	0.007	0.007	0.008	0.007	0.007
RSD	43.3	41.2	18.6	40.5	39.8

Table 7. Round Robin XXVIII
Retinyl Palmitate

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.119	0.072	0.108	0.118	0.068
	0.191	0.079	0.199	0.190	0.078
	0.122	0.068	0.139	0.141	0.059
	0.141	0.070	0.142	0.142	0.067
	0.114	0.088	0.132	0.128	0.077
	0.150	0.102	0.126	0.149	0.086
	0.115	0.041	0.137	0.098	0.050
	0.191	0.102	0.155	0.198	0.063
NIST 3	0.107	0.080	0.154	0.166	0.066
AVG	0.143	0.078	0.142	0.145	0.068
SD	0.032	0.020	0.027	0.034	0.012
RSD	22.6	25.9	18.7	23.4	16.9

Table 8. Round Robin XXVIII
Lutein

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.068	0.039	0.035	0.066	0.040
	0.069	0.043	0.044	0.085	0.047
	0.081	0.041	0.040	0.081	0.041
	0.050	0.040	0.030	0.050	0.090
	0.041	0.022	0.028	0.039	0.017
	0.060	0.036	0.036	0.066	0.036
	0.135	0.078	0.095	0.129	0.080
NIST 3	0.079	0.042	0.044	0.079	0.042
AVG	0.062	0.037	0.036	0.065	0.045
SD	0.014	0.008	0.006	0.018	0.024
RSD	23.4	20.7	16.9	27.4	53.6

Table 9. Round Robin XXVIII
Lycopene (Total)

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.518	0.240	0.240	0.182	0.236
	0.400	0.205	0.211	0.157	0.208
	0.432	0.208	0.233	0.149	0.210
	0.603	0.248	0.272	0.221	0.271
	0.610	0.280	0.340	0.230	0.290
	0.531	0.222	0.250	0.183	0.222
	0.600	0.320	0.370	0.320	0.620
	0.546	0.251	0.266	0.190	0.257
	0.493	0.280	0.305	0.235	0.275
	0.400	0.180	0.200	0.143	0.176
	0.136	0.193	0.200	0.200	0.243
	0.248	0.154	0.154	0.167	0.165
	0.521	0.470	0.313	0.183	0.303
	0.365	0.198	0.182	0.149	0.192
	0.400	0.178	0.174	0.137	0.167
	0.442	0.173	0.305	0.127	0.171
NIST 3	0.772	0.316	0.388	0.283	0.330
AVG	0.454	0.242	0.247	0.190	0.256
SD	0.134	0.077	0.064	0.048	0.110
RSD	29.6	32.1	25.7	25.1	43.0

Table 10. Round Robin XXVIII
Zeaxanthin

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.038	0.030	0.025	0.028	0.030
	0.026	0.032	0.019	0.019	0.038
	0.026	0.016	0.018	0.021	0.017
NIST 3	0.039	0.029	0.023	0.025	0.028
AVG	0.030	0.026	0.021	0.023	0.028
SD	0.007	0.009	0.004	0.005	0.011
RSD	23.1	33.5	18.3	20.8	37.4

Table 11.Round Robin XXVIII
Lutein + Zeaxanthin

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.109	0.08	0.069	0.111	0.079
	0.143	0.087	0.076	0.119	0.092
	0.164	0.091	0.095	0.125	0.088
	0.109	0.074	0.060	0.098	0.070
	0.063	0.052	0.044	0.052	0.052
	0.126	0.089	0.082	0.122	0.088
AVG	0.119	0.079	0.071	0.105	0.078
SD	0.035	0.015	0.018	0.027	0.015
RSD	29.1	18.5	25.0	26.3	19.3

Table 12.Round Robin XXVIII
Beta-Cryptoxanthin

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.066	0.040	0.043	0.057	0.039
	0.064	0.049	0.052	0.074	0.048
	0.084	0.049	0.059	0.065	0.055
	0.080	0.047	0.064	0.068	0.047
	0.095	0.057	0.065	0.086	0.060
	0.049	0.034	0.036	0.050	0.033
	0.080	0.037	0.060	0.054	0.058
	0.073	0.122	0.126	0.140	0.114
	0.026	0.026	0.019	0.014	0.026
	0.065	0.036	0.044	0.061	0.035
	0.070	0.042	0.052	0.066	0.043
NIST 3	0.045	0.028	0.033	0.042	0.028
AVG	0.068	0.049	0.056	0.067	0.051
SD	0.019	0.026	0.027	0.030	0.024
RSD	27.2	52.5	47.5	45.3	46.4

Table 13.Round Robin XXVIII
Lycopene (Trans)

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
NIST 3	0.329	0.170	0.170	0.133	0.170

Table 14.Round Robin XXVIII
Trans-Lutein/Zeaxanthin

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
	0.1235	0.0756	0.0701	0.1042	0.078

Table 15.Round Robin XXVIII
Trans-Alpha-Carotene

Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
NIST 3	0.029	0.023	0.054	0.024	0.022

Table 16.Round Robin XXVIII
Delta-Tocopherol

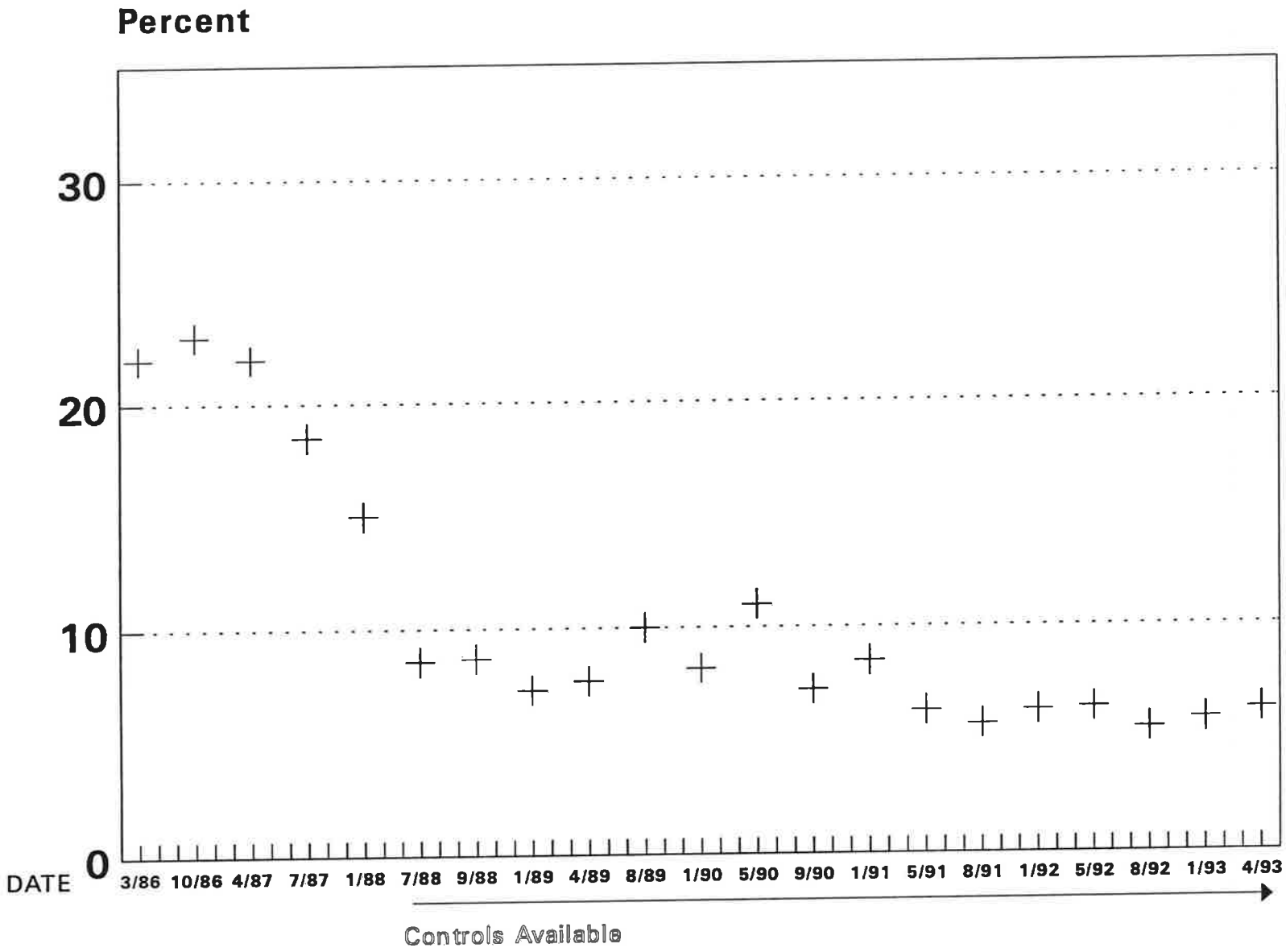
Lab#	Serum# 181	Serum# 182	Serum# 183	Serum# 184	Serum# 185
NIST 3	0.157	0.153	0.115	0.067	0.171

Table 17.Round Robin XXVIII
Lutein/Cis-Zeaxanthin

Lab#	181	182	183	184	185
	0.0956	0.0287	0.0438	0.0382	0.0305

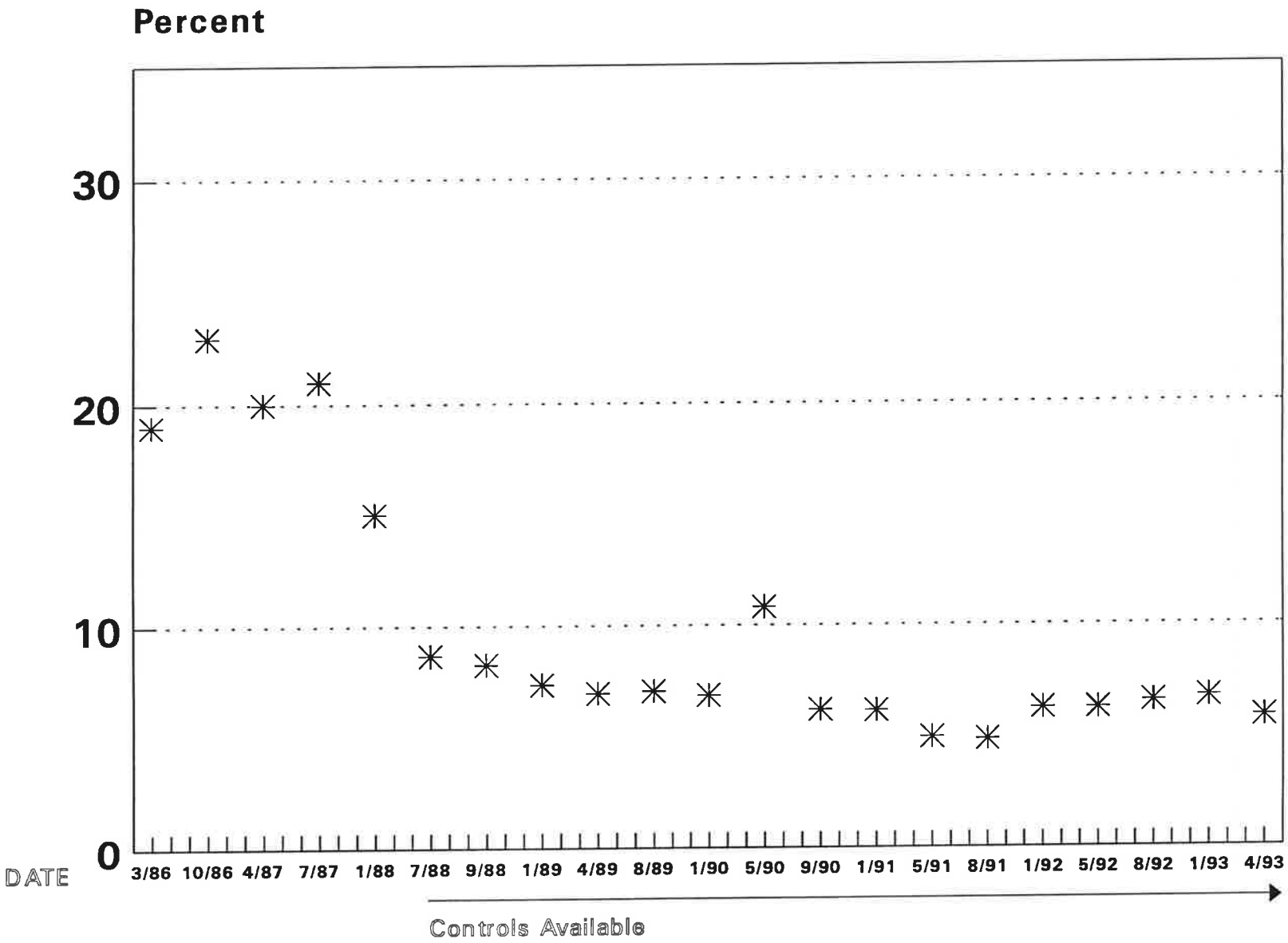
Interlaboratory Precision vs Time

Retinol



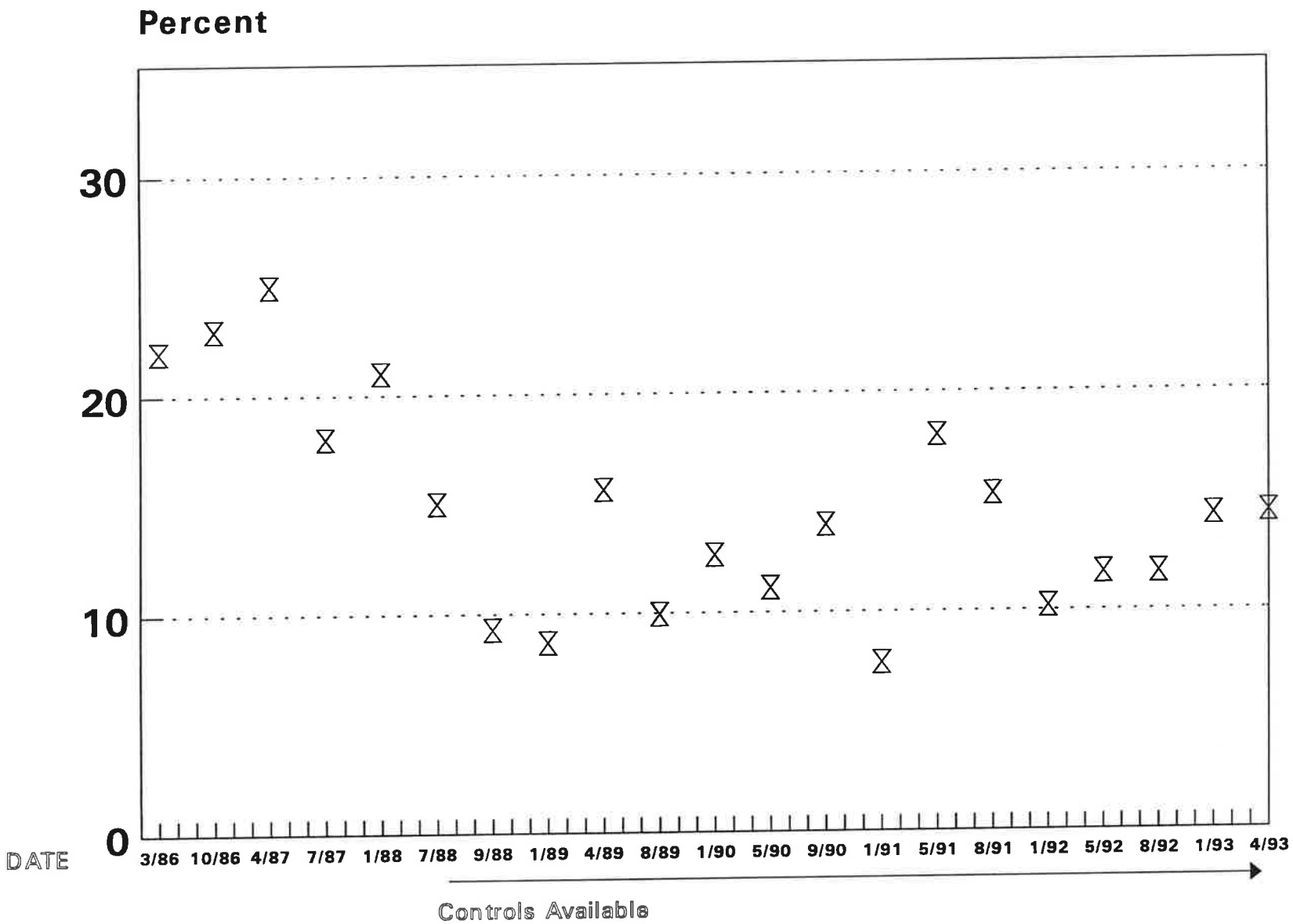
Interlaboratory Precision vs Time

Alpha-Tocopherol



Interlaboratory Precision vs Time

Beta-Carotene



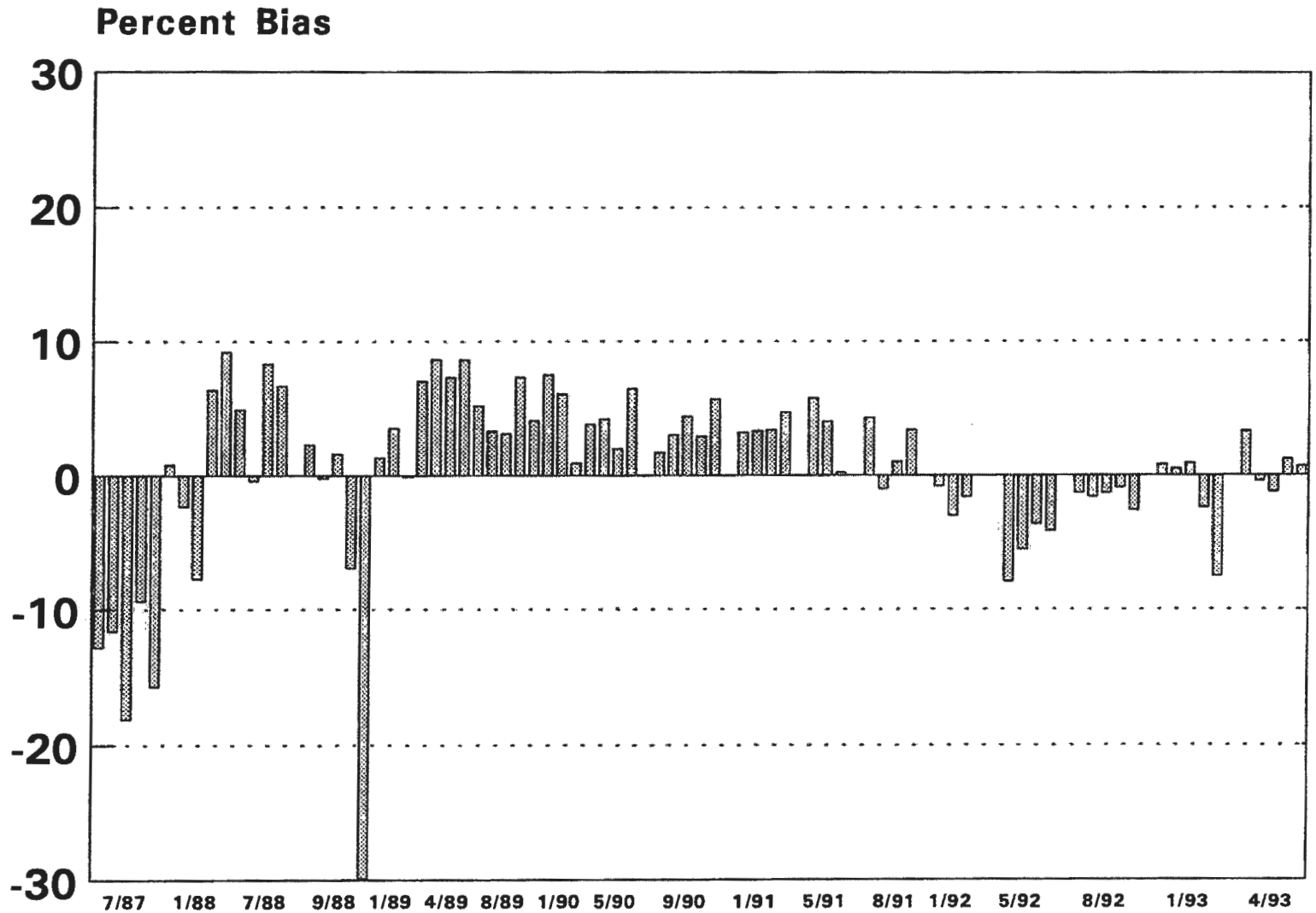
Appendix G. Representative "Individualized Report" for RR28

Each participant in RR28 received graphical summaries of their own measurement performance for total retinol, α-tocopherol, and/or total β-carotene. In RR28, two sets of graphs were prepared:

- "Percent Bias" relative to the "Trimmed Core Lab Average" for of the serum-based samples distributed from 7/1987 through 4/93.
- "Blind Duplicate Performance", documenting the history of the % Bias values for just the sera distributed in RR28.

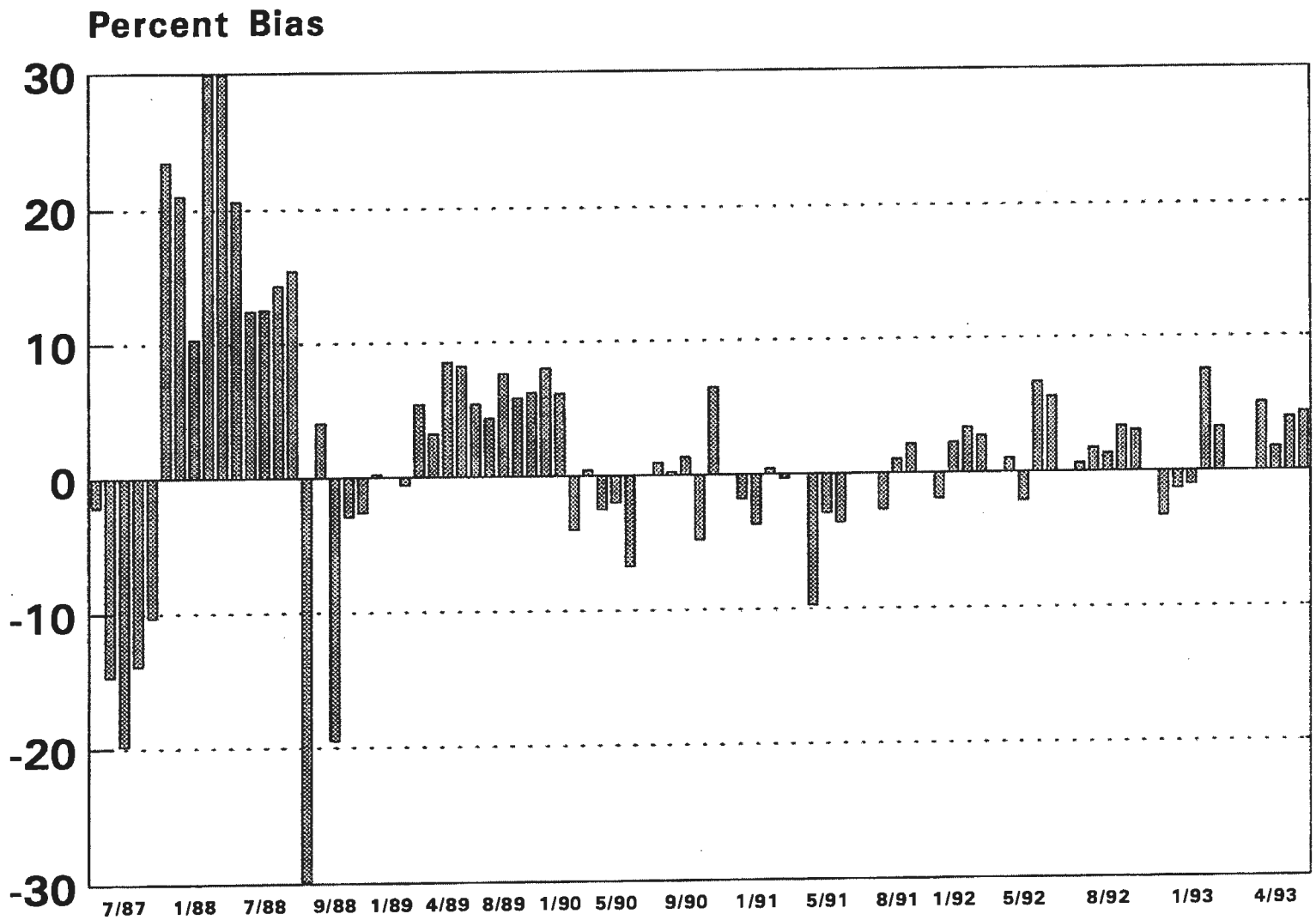
The following six pages constitute the individualized report for participant FSV-BA.

Laboratory FSV-BA
Retinol



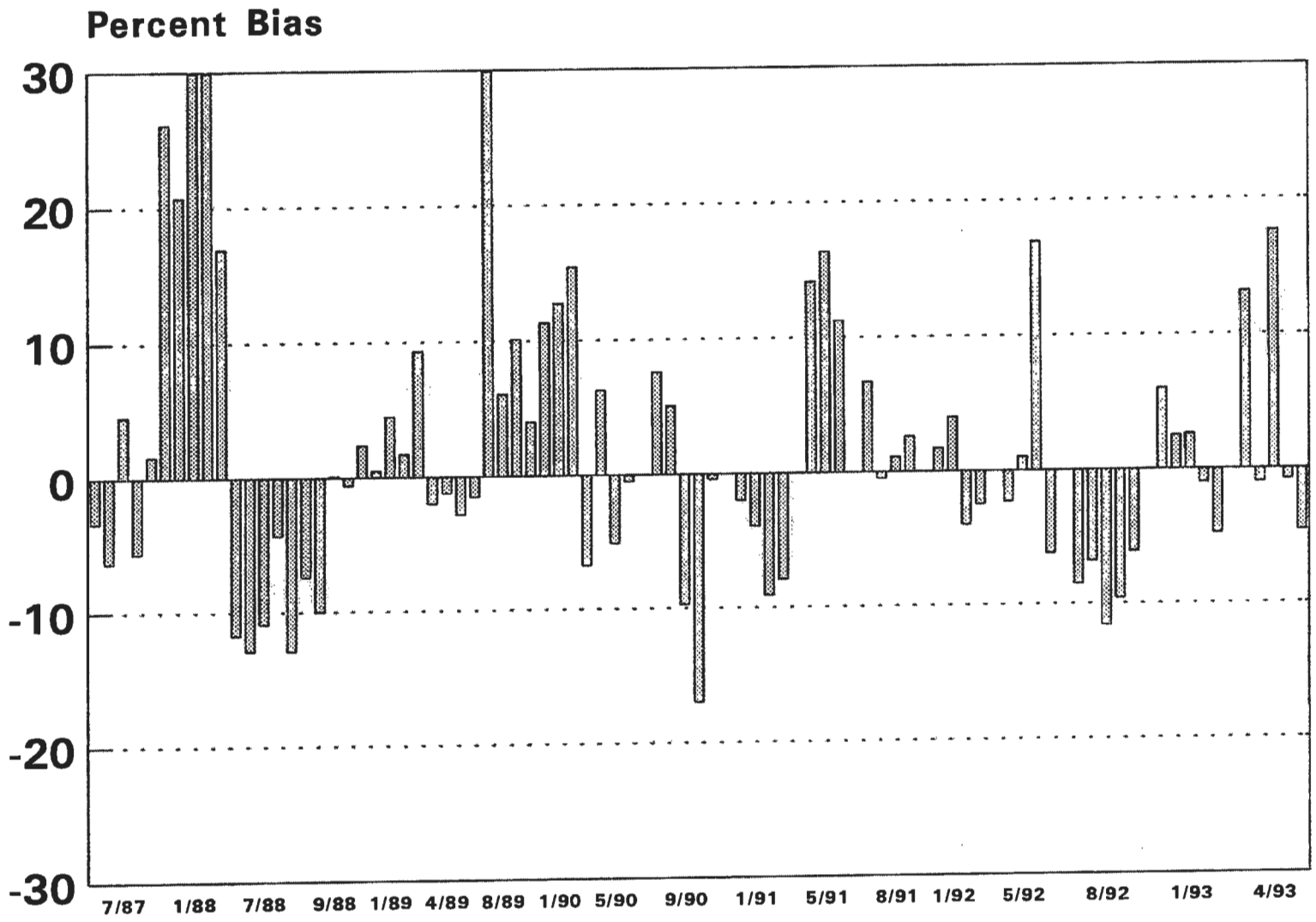
% Bias from Assigned Values

Laboratory FSV-BA
Alpha-Tocopherol



% Bias from Assigned Values

Laboratory FSV-BA
Total Beta-Carotene

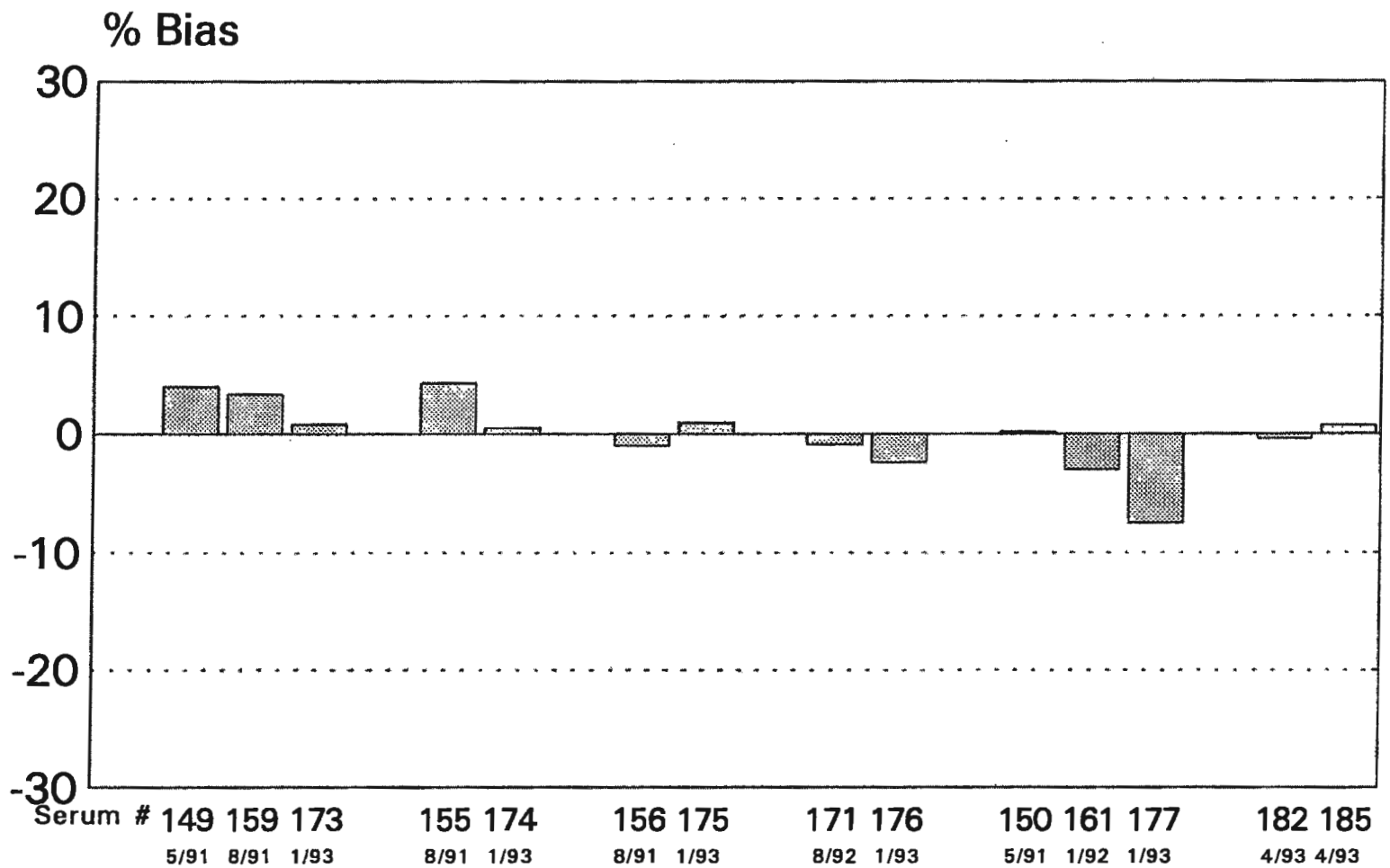


% Bias from Assigned Values

Laboratory FSV-BA

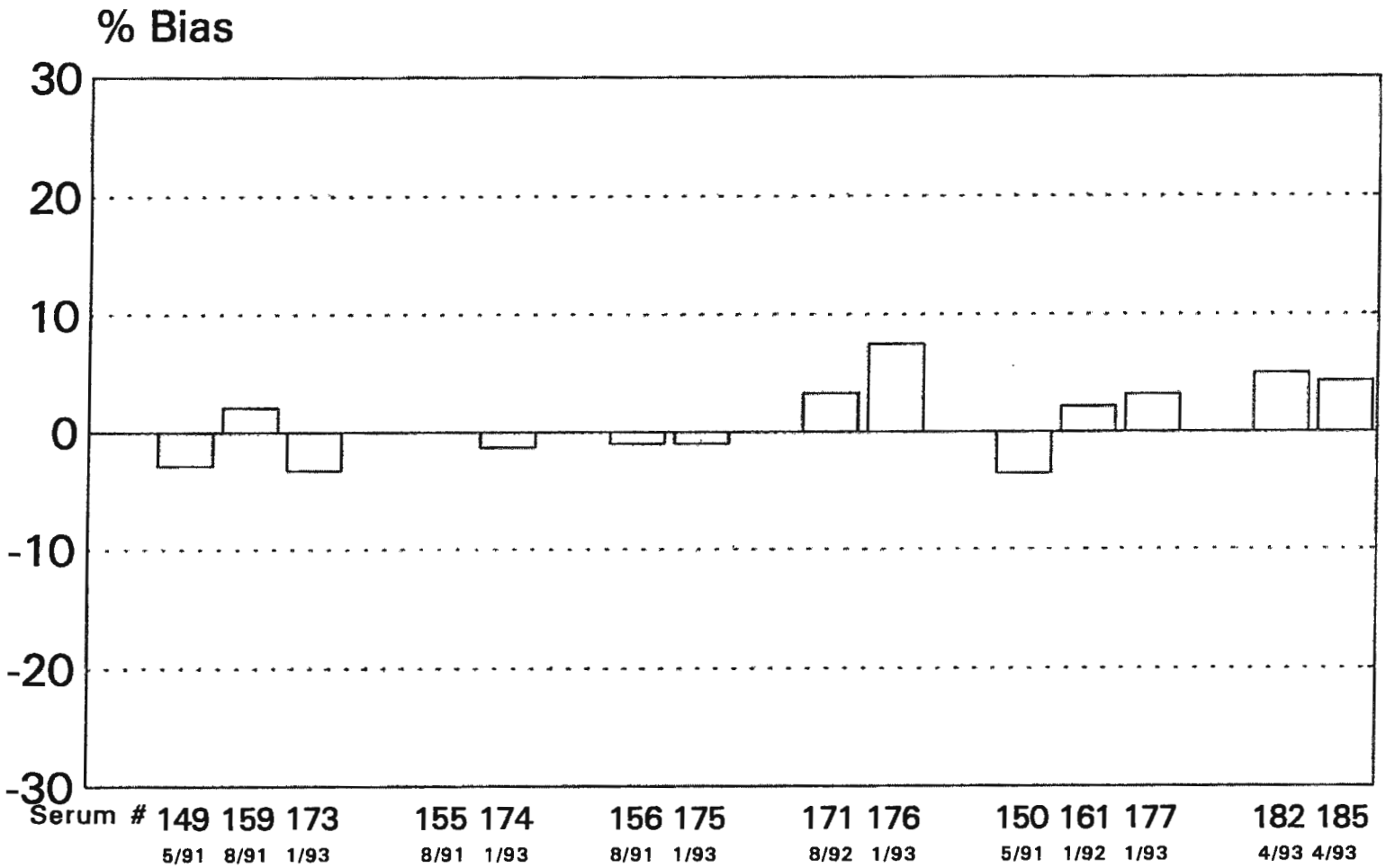
Blind Duplicate Performance

Retinol



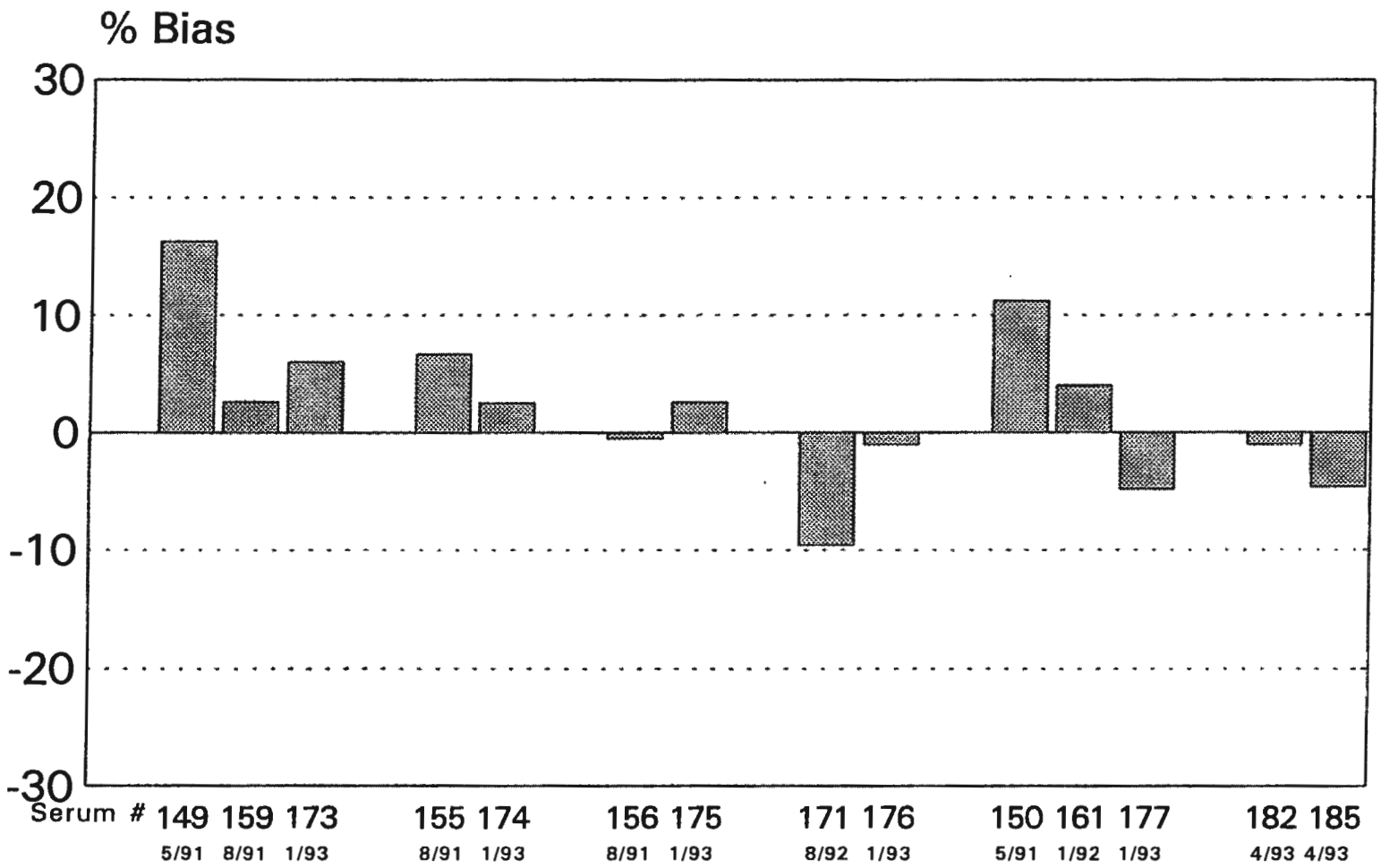
Laboratory FSV-BA

Blind Duplicate Performance
Alpha-Tocopherol



Laboratory FSV-BA

Blind Duplicate Performance
Total Beta-Carotene



Appendix H. Updated "All-Lab Report" for RR28

The following six pages are an updated version of an "All-Lab" report for RR28. This report has three parts:

- pages 1 thru 4 list results for all analytes reported by at least twice, counting both participants and NIST analysts.
- page 5 lists values for all analytes reported by only once. This page also provides a legend for pages 1 thru 4.
- page 6 summarizes each participants' performance for total retinol, α- and γ/β-tocopherol, and total β-carotene. These summaries are compatible with the percent bias evaluation advice given in the RR28 Report. However, the current bias summaries are estimated relative to the median of all reported values for each analyte in each serum rather than to the "Trimmed Core Lab Average" used in the original and detailed in Appendix F. These original reference values were estimated from on-time results of the more experienced participants, with subjective exclusion of results deemed non-representative.

To ensure confidentiality, the laboratory identifiers used in this "All-Lab Report" have been altered from those used in RR28. The only attributed results are those reported by NIST. The NIST results are not used in the assessment of the consensus summary results of the study.

Note: The analysts designated NISTa and NISTb in this updated All-Lab report are designated "NIST 1" and "NIST 3" in the Tables described in Appendix F.

Round Robin XXVIII Laboratory Results

	Total Retinol, µg/mL					Retinyl Palmitate, µg/mL					α-Tocopherol, µg/mL					γ/β-Tocopherol, µg/mL				
Lab	181	182	183	184	185	181	182	183	184	185	181	182	183	184	185	181	182	183	184	185
FSV-BA	0.488	0.529	0.539	0.348	0.529	0.141	0.070	0.142	0.142	0.067	7.03	5.63	11.50	4.39	5.65	2.38	2.50	1.90	1.79	2.52
FSV-BD	0.504	0.588	0.594	0.377	0.581						7.70	6.70	12.40	4.50	5.70					
FSV-BE	0.450	0.499	0.531	0.325	0.510						6.77	4.97	10.88	3.91	4.96	2.40	2.50	1.86	1.65	2.51
FSV-BF	0.493	0.518	0.564	0.337	0.500						7.92	5.98	12.43	4.57	5.81	2.40	2.47	1.76	1.61	2.40
FSV-BG	0.434	0.473	0.475	0.328	0.468	0.122	0.068	0.139	0.141	0.059	6.66	4.84	10.11	4.11	4.94					
FSV-BH	0.449	0.497	0.520	0.335	0.518						7.19	5.68	11.33	4.44	5.74	2.45	2.69	1.89	1.76	2.73
FSV-BI	0.428	0.510	0.539	0.338	0.516	0.191	0.079	0.199	0.190	0.078	6.98	5.87	12.22	4.48	5.77	2.27	2.68	1.95	1.73	2.63
FSV-BJ	0.500	0.555	0.559	0.364	0.561	0.114	0.088	0.132	0.128	0.077	7.13	5.08	10.52	4.21	5.20	2.43	2.42	1.77	1.57	2.47
FSV-BK	0.545	0.580	0.578	0.376	0.578						7.19	5.50	11.09	4.41	5.46					
FSV-BL	0.545	0.577	0.594	0.448	0.676						5.84	5.48	10.39	4.10	5.39					
FSV-BM	0.468	0.536	0.571	0.360	0.539						7.20	5.80	10.90	4.40	5.80					
FSV-BN	0.487	0.578	0.596	0.386	0.587	0.115	0.041	0.137	0.098	0.050	7.85	6.50	12.81	8.48	6.54	2.40	2.56	1.20	1.44	2.68
FSV-BO	0.570	0.573	0.581	0.378	0.556						7.84	5.52	11.40	4.48	5.47					
FSV-BP	0.470	0.550	0.560	0.360	0.550						7.23	5.51	11.61	4.33	5.48					
FSV-BQ	0.494	0.569	0.606	0.398	0.593						3.50	3.62	9.00	1.89	2.57					
FSV-BR	0.462	0.510	0.558	0.365	0.531															
FSV-BS	0.604	0.171	0.158	0.080	0.414						3.37	3.02	5.00	2.58	3.04	0.54	1.11	0.24	0.03	1.20
FSV-BT	0.509	0.546	0.564	0.371	0.552	0.191	0.102	0.155	0.198	0.063	7.55	5.90	11.80	4.83	5.82	2.56	2.82	2.04	1.81	2.78
FSV-BX	0.480	0.546	0.560	0.340	0.531						7.12	5.52	11.32	4.16	5.33	2.29	2.48	1.76	1.66	2.50
FSV-BY	0.455	0.491	0.519	0.324	0.483	0.119	0.072	0.108	0.118	0.068	6.95	5.27	10.54	4.07	5.20	2.26	2.47	1.71	1.60	2.50
FSV-BZ											7.13	5.30	12.10	6.39	6.69	1.80	1.61	1.43	1.71	1.93
FSV-CA	0.481	0.489	0.528	0.322	0.515						6.79	5.24	11.72	4.50	5.51					
FSV-CB	0.622	0.693	0.706	0.451	0.687						7.85	6.89	10.21	5.69	6.73					
FSV-CH	0.593	0.651	0.705	0.450	0.697						8.37	5.69	10.90	5.58	7.13	2.23	2.39	1.65	1.86	2.64
FSV-CJ	0.614	0.620	0.656	0.377	0.661						6.51	5.28	11.18	3.83	5.93					
FSV-CM											7.33	5.61	11.35	4.58	5.63					
FSV-CO	0.438	0.484	0.500	0.309	0.482						6.91	5.37	11.24	4.18	5.29					
FSV-CP	0.469	0.570	0.542	0.348	0.561						6.46	5.01	9.48	3.72	4.54					
FSV-CR	0.460	0.570	0.580	0.370	0.540						6.90	5.30	11.30	4.20	5.50					
FSV-CT	0.594	0.643	0.646	0.467	0.648						9.28	7.47	15.52	5.49	6.88					
FSV-CU	0.454	0.510	0.525	0.339	0.502	0.150	0.102	0.126	0.149	0.086	6.29	5.28	10.81	4.30	5.30					
FSV-CV	0.405	0.538	0.533	0.360	0.530						6.80	5.70	12.38	4.13	5.40	2.05	2.23	1.58	1.45	2.18
FSV-CY	0.480	0.560	0.540	0.330	0.520						7.34	5.24	11.90	4.19	5.60					
FSV-DC	0.484	0.579	0.569	0.361	0.571						7.00	5.26	11.30	4.38	5.33	2.23	2.50	1.84	1.70	3.42
FSV-DJ	0.460	0.590	0.640	0.410	0.610						7.30	5.80	11.30	4.60	6.00					
FSV-DK	1.100		1.200	0.750	1.220						7.23		10.40	4.20	2.90					
FSV-DM	0.430	0.510	0.519	0.323	0.502						5.96	4.79	9.99	3.76	4.82					
FSV-DS	0.540	0.590	0.580	0.470	0.610						6.52	5.49	10.39	4.23	5.37					
FSV-DX	0.426	0.515	0.527	0.352	0.506						7.10	6.30	13.00	6.00	7.00					
FSV-EB	0.505	0.551	0.556	0.369	0.551						7.52	5.08	11.82	6.06	5.20					
FSV-EC	0.344	0.420	0.416	0.261	0.407						0.26	0.20	0.51	0.15	0.23					
FSV-EK	0.516	0.576	0.603	0.355	0.595						7.32	5.46	4.86	4.29	5.69	2.87	2.99	1.82	2.05	3.15
FSV-EN	0.270	0.293	0.324	0.202	0.313						4.15	2.84	6.86	2.08	2.27	1.24	1.39	1.09	0.78	1.05
FSV-EX	0.420	0.490	0.490	0.320	0.490						7.39	5.58	11.20	4.48	5.75					
FSV-FC	0.583	0.667	0.672	0.437	0.658						6.14	4.73	9.68	3.70	4.76	2.53	2.74	1.91	1.79	2.75
FSV-FF	0.539	0.666	0.694	0.492	0.711															
n	44	43	44	44	44	8	8	8	8	8	44	43	44	44	44	18	18	18	18	18
Min	0.27	0.17	0.16	0.08	0.31	0.11	0.04	0.11	0.10	0.05	0.26	0.20	0.51	0.15	0.23	0.54	1.11	0.24	0.03	1.05
Mean	0.50	0.54	0.57	0.37	0.56	0.14	0.08	0.14	0.15	0.07	6.75	5.29	10.65	4.34	5.26	2.19	2.36	1.63	1.55	2.45
Max	1.10	0.69	1.20	0.75	1.22	0.19	0.10	0.20	0.20	0.09	9.28	7.47	15.52	8.48	7.13	2.87	2.99	2.04	2.05	3.42
SD	0.12	0.09	0.13	0.09	0.13	0.03	0.02	0.03	0.03	0.01	1.47	1.15	2.40	1.24	1.29	0.53	0.50	0.43	0.46	0.58
CV	23	17	24	25	23	23	26	19	23	17	22	22	23	29	25	24	21	26	30	24
NISTa	0.412	0.509	0.504	0.369	0.501						7.35	5.73	11.68	4.53	5.74	2.57	2.62	1.80	1.76	2.59
NISTb	0.446	0.524	0.548	0.356	0.526	0.107	0.080	0.154	0.166	0.066	7.03	5.72	11.20	4.41	5.41	2.44	2.70	1.92	1.73	2.60
Median	0.483	0.550	0.560	0.360	0.545	0.132	0.076	0.138	0.142	0.068	7.11	5.48	11.22	4.32	5.48	2.33	2.49	1.76	1.68	2.52
eSD	0.050	0.059	0.050	0.038	0.063	0.025	0.015	0.013	0.027	0.013	0.49	0.36	1.02	0.31	0.42	0.15	0.21	0.19	0.16	0.28
eCV	10	11	9	11	12	19	20	10	19	20	7	6	9	7	8	7	9	11	10	11

H2

Round Robin XXVIII Laboratory Results

	Total β-Carotene, µg/mL					trans-β-Carotene, µg/mL					Total cis-β-Carotene, µg/mL				
Lab	181	182	183	184	185	181	182	183	184	185	181	182	183	184	185
FSV-BA	0.092	0.416	0.428	0.351	0.408	0.080	0.394	0.384	0.315	0.380	*0.012*	*0.022*	*0.044*	*0.036*	*0.028*
FSV-BD															
FSV-BE	0.093	0.401	0.395	0.338	0.424										
FSV-BF	0.072	0.436	0.338	0.365	0.428										
FSV-BG	0.066	0.501	0.306	0.442	0.528										
FSV-BH	0.085	0.487	0.444	0.409	0.496	0.085	0.470	0.425	0.388	0.477	*nd*	*0.017*	*0.019*	*0.021*	*0.019*
FSV-BI	0.077	0.433	0.389	0.348	0.438										
FSV-BJ	0.127	0.456	0.399	0.374	0.463										
FSV-BK															
FSV-BL															
FSV-BM															
FSV-BN	0.091	0.736	0.407	0.271	0.476										
FSV-BO	0.634	0.314	0.228	0.261	0.344										
FSV-BP	0.242	0.408	0.367	0.342	0.360										
FSV-BQ	0.397	0.633	0.577	0.392	0.565										
FSV-BR															
FSV-BS	>0.087	>0.255	>0.238	>0.215	>0.294	0.087	0.255	0.238	0.215	0.294					
FSV-BT	0.077	0.438	0.353	0.345	0.420	0.075	0.421	0.336	0.326	0.404	*0.003*	*0.017*	*0.017*	*0.019*	*0.016*
FSV-BX															
FSV-BY	0.078	0.430	0.313	0.337	0.429										
FSV-BZ	0.100	0.600	0.500	0.500	0.770										
FSV-CA															
FSV-CB															
FSV-CH	0.095	0.359	0.288	0.399	0.421										
FSV-CJ	0.065	0.340	0.321	0.250	0.347										
FSV-CM															
FSV-CO	0.103	0.421	0.372	0.347	0.415										
FSV-CP	0.060	0.329	0.277	0.259	0.327										
FSV-CR															
FSV-CT	0.074	0.443	0.402	0.374	0.443										
FSV-CU	0.091	0.402	0.410	0.361	0.401	0.088	0.397	0.401	0.354	0.395	*0.003*	*0.005*	*0.009*	*0.007*	*0.006*
FSV-CV	0.068	0.503	0.440	0.418	0.480										
FSV-CY	0.100	0.370	0.300	0.310	0.400										
FSV-DC	0.148	0.478	0.394	0.361	0.454										
FSV-DJ															
FSV-DK															
FSV-DM	0.060	0.388	0.332	0.302	0.365										
FSV-DS	0.050	0.444	0.340	0.354	0.332										
FSV-DX	0.630	0.360	0.340		0.360										
FSV-EB	0.078	0.411	0.407	0.401	0.471										
FSV-EC	0.214	1.330	1.195	0.958	1.223										
FSV-EK	0.071	0.375	0.287	0.289	0.393										
FSV-EN															
FSV-EX	0.150	0.450	0.300	0.370	0.360										
FSV-FC	0.073	0.420	0.341	0.341	0.415										
FSV-FF	0.074	0.532	0.481	0.428	0.533										
n	32	32	32	31	32	5	5	5	5	5	3	4	4	4	4
Min	0.05	0.31	0.23	0.25	0.33	0.07	0.26	0.24	0.22	0.29	0.00	0.01	0.01	0.01	0.01
Mean	0.14	0.47	0.40	0.37	0.46	0.08	0.39	0.36	0.32	0.39	0.01	0.02	0.02	0.02	0.02
Max	0.63	1.33	1.20	0.96	1.22	0.09	0.47	0.43	0.39	0.48	0.01	0.02	0.04	0.04	0.03
SD	0.15	0.18	0.16	0.12	0.16	0.01	0.08	0.07	0.06	0.07	0.01	0.01	0.02	0.01	0.01
CV	105	38	41	33	36	7	21	21	20	17	92	48	69	57	53
NISTa	0.100	0.385	0.385	0.370	0.409	0.070	0.347	0.344	0.319	0.357	*0.030*	*0.038*	*0.041*	*0.051*	*0.052*
NISTb	0.101	0.426	0.398	0.352	0.426	0.085	0.405	0.371	0.323	0.403	*0.016*	*0.021*	*0.027*	*0.029*	*0.023*
Median	0.088	0.432	0.369	0.354	0.423	0.085	0.397	0.384	0.326	0.395					
eSD	0.023	0.067	0.066	0.056	0.076	0.004	0.036	0.061	0.042	0.022					
eCV	26	15	18	16	18	5	9	16	13	6					

H3

Round Robin XXVIII Laboratory Results

	Total α-Carotene, µg/mL					Total Lycopene, µg/mL					trans-Lycopene, µg/mL					Total β-Cryptoxanthin, µg/mL				
Lab	181	182	183	184	185	181	182	183	184	185	181	182	183	184	185	181	182	183	184	185
FSV-BA	0.013	0.014	0.052	0.015	0.013						0.394	0.185	0.211	0.143	0.177	0.080	0.047	0.064	0.068	0.047
FSV-BD																				
FSV-BE	0.020	0.010	0.040	0.010	0.020	0.610	0.280	0.340	0.230	0.290										
FSV-BF	*nd*	*nd*	0.044	0.026	*nd*	0.603	0.248	0.272	0.221	0.271										
FSV-BG																				
FSV-BH	0.010	0.010	0.043	0.012	0.011	0.531	0.222	0.250	0.183	0.222						0.095	0.057	0.065	0.086	0.060
FSV-BI	0.014	0.016	0.042	0.019	0.016	0.400	0.205	0.211	0.157	0.208						0.064	0.049	0.052	0.074	0.048
FSV-BJ	0.022	0.028	0.045	0.018	0.015	0.546	0.251	0.266	0.190	0.257										
FSV-BK																				
FSV-BL																				
FSV-BM																				
FSV-BN	0.020	0.027	0.053	0.015	0.022	0.521	0.470	0.313	0.183	0.303						0.073	0.122	0.126	0.140	0.114
FSV-BO	0.006	0.012	0.024	0.011	0.013	0.365	0.198	0.182	0.149	0.192						0.065	0.036	0.044	0.061	0.035
FSV-BP	0.033	0.032	0.046	0.028	0.027	0.248	0.154	0.154	0.167	0.165						0.080	0.037	0.060	0.054	0.058
FSV-BQ																				
FSV-BR																				
FSV-BS																				
FSV-BT	0.020	0.014	0.036	0.015	0.013	0.400	0.178	0.174	0.137	0.167						0.070	0.042	0.052	0.066	0.043
FSV-BX																				
FSV-BY	0.018	0.018	0.037	0.022	0.017	0.518	0.240	0.240	0.182	0.236						0.066	0.040	0.043	0.057	0.039
FSV-BZ	0.020	0.020	0.030	0.010	0.030	0.600	0.320	0.370	0.320	0.620										
FSV-CA																				
FSV-CB																				
FSV-CH	0.025	0.019	0.044	0.033	0.024	0.136	0.193	0.200	0.200	0.243										
FSV-CJ	0.016	0.018	0.034	0.020	0.013	0.432	0.208	0.233	0.149	0.210						0.084	0.049	0.059	0.065	0.055
FSV-CM																				
FSV-CO																				
FSV-CP	0.010	0.012	0.036	0.013	0.012	0.400	0.180	0.200	0.143	0.176						0.049	0.034	0.036	0.050	0.033
FSV-CR																				
FSV-CT																0.026	0.026	0.019	0.014	0.026
FSV-CU																				
FSV-CV	0.006	0.008	0.043	0.010	0.005	0.493	0.280	0.305	0.235	0.275										
FSV-CY																				
FSV-DC																				
FSV-DJ																				
FSV-DK																				
FSV-DM																				
FSV-DS																				
FSV-DX											0.310	0.150	0.170	0.130	0.150					
FSV-EB																				
FSV-EC																				
FSV-EK						0.442	0.173	0.305	0.127	0.171						0.117	*nd*	0.066	0.135	*nd*
FSV-EN																				
FSV-EX																				
FSV-FC																				
FSV-FF																				
n	15	15	16	16	15	16	16	16	16	16	2	2	2	2	2	12	11	12	12	11
Min	0.01	0.01	0.02	0.01	0.01	0.14	0.15	0.15	0.13	0.17	0.31	0.15	0.17	0.13	0.15	0.03	0.03	0.02	0.01	0.03
Mean	0.02	0.02	0.04	0.02	0.02	0.45	0.24	0.25	0.19	0.25	0.35	0.17	0.19	0.14	0.16	0.07	0.05	0.06	0.07	0.05
Max	0.03	0.03	0.05	0.03	0.03	0.61	0.47	0.37	0.32	0.62	0.39	0.19	0.21	0.14	0.18	0.12	0.12	0.13	0.14	0.11
SD	0.01	0.01	0.01	0.01	0.01	0.13	0.08	0.06	0.05	0.11	0.06	0.02	0.03	0.01	0.02	0.02	0.03	0.03	0.03	0.02
CV	43	41	19	40	40	29	32	25	26	43	17	15	15	7	12	31	52	45	48	46
NISTa																				
NISTb	0.043	0.030	0.062	0.034	0.028	0.772	0.316	0.388	0.283	0.330	0.329	0.170	0.170	0.133	0.170	0.045	0.028	0.033	0.042	0.028
Median	0.018	0.016	0.043	0.015	0.015	0.468	0.215	0.245	0.183	0.229						0.072	0.042	0.056	0.065	0.047
eSD	0.006	0.006	0.007	0.007	0.004	0.100	0.053	0.078	0.050	0.065						0.012	0.011	0.015	0.015	0.016
eCV	33	37	16	44	30	21	24	32	27	28						17	26	27	23	35

Round Robin XXVIII Laboratory Results

	Total Lutein, µg/mL					Total Zeaxanthin, µg/mL					Total Lutein&Zeaxanthin, µg/mL				
Lab	181	182	183	184	185	181	182	183	184	185	181	182	183	184	185
FSV-BA											0.164	0.091	0.095	0.125	0.088
FSV-BD															
FSV-BE															
FSV-BF															
FSV-BG															
FSV-BH	0.081	0.041	0.040	0.081	0.041	0.026	0.032	0.019	0.019	0.038	*0.107*	*0.073*	*0.059*	*0.100*	*0.079*
FSV-BI	0.069	0.043	0.044	0.085	0.047	0.038	0.030	0.025	0.028	0.030	0.109	0.080	0.069	0.111	0.079
FSV-BJ															
FSV-BK															
FSV-BL															
FSV-BM															
FSV-BN	0.041	0.022	0.028	0.039	0.017	0.026	0.016	0.018	0.021	0.017	0.063	0.052	0.044	0.052	0.052
FSV-BO											0.126	0.089	0.082	0.122	0.088
FSV-BP															
FSV-BQ															
FSV-BR															
FSV-BS															
FSV-BT											*0.219*	*0.104*	*0.114*	*0.142*	*0.109*
FSV-BX															
FSV-BY	0.068	0.039	0.035	0.066	0.040										
FSV-BZ	0.050	0.040	0.030	0.050	0.090										
FSV-CA															
FSV-CB															
FSV-CH															
FSV-CJ											0.143	0.087	0.076	0.119	0.092
FSV-CM															
FSV-CO															
FSV-CP											0.109	0.074	0.060	0.098	0.070
FSV-CR															
FSV-CT	0.060	0.036	0.036	0.066	0.036										
FSV-CU															
FSV-CV															
FSV-CY															
FSV-DC															
FSV-DJ															
FSV-DK															
FSV-DM															
FSV-DS															
FSV-DX	0.070	0.040	0.040	0.080	0.040	0.070	*nd*	*nd*	*nd*	*nd*	*0.140*				
FSV-EB															
FSV-EC															
FSV-EK	0.135	0.078	0.095	0.129	0.080										
FSV-EN															
FSV-EX															
FSV-FC															
FSV-FF															
n	8	8	8	8	8	4	3	3	3	3	9	8	8	8	8
Min	0.04	0.02	0.03	0.04	0.02	0.03	0.02	0.02	0.02	0.02	0.06	0.05	0.04	0.05	0.05
Mean	0.07	0.04	0.04	0.07	0.05	0.04	0.03	0.02	0.02	0.03	0.13	0.08	0.07	0.11	0.08
Max	0.14	0.08	0.10	0.13	0.09	0.07	0.03	0.03	0.03	0.04	0.22	0.10	0.11	0.14	0.11
SD	0.03	0.02	0.02	0.03	0.02	0.02	0.01	0.00	0.00	0.01	0.04	0.02	0.02	0.03	0.02
CV	40	37	49	36	49	52	34	18	21	37	33	19	30	25	20
NISTa															
NISTb	0.079	0.042	0.044	0.079	0.042	0.039	0.029	0.023	0.025	0.028	*0.118*	*0.071*	*0.067*	*0.104*	*0.070*
Median	0.069	0.040	0.038	0.073	0.041						0.126	0.084	0.073	0.115	0.084
eSD	0.016	0.003	0.007	0.015	0.008						0.025	0.013	0.019	0.019	0.010
eCV	23	7	18	20	20						20	15	27	16	12

H5

Round Robin XXVIII Laboratory Results

Analytes Reported By One Laboratory

Values in µg/mL

Analyte	Code	181	182	183	184	185
δ-Tocopherol	NISTb	0.157	0.153	0.115	0.067	0.171
trans-α-Carotene	NISTb	0.029	0.023	0.054	0.024	0.022
trans-Lutein&Zeaxanthin	FSV-BT	0.124	0.076	0.070	0.104	0.078
cis-Lutein&Zeaxanthin	FSV-BT	0.096	0.029	0.044	0.038	0.031

Legend

nd	Not detected (i.e., not reported or reported as '0', 'not determined', etc.)
>x	Value greater than x
italics	Value calculated from reported results
n	Number of non-NIST laboratories reporting quantitative results
Min	Minimum non-NIST reported value.
Mean	Average over all non-NIST reported values.
Max	Maximum non-NIST reported value.
SD	Standard deviation over all non-NIST values.
CV	Coefficient of Variation (% relative standard deviation): 100*SD/Mean
Median	Median over all non-NIST reported values
eSD	Robust estimate of SD based on the adjusted median absolute difference from the median (MADe)
eCV	Robust estimate of CV, 100*eSD/Median

Round Robin XXVIII Performance Summary

% Bias Summary

Lab	TR	aT	g/bT	bC
FSV-BA	-3±2	2±2	3±3	3±8
FSV-BD	6±1	10±7		
FSV-BE	-7±2	-7±3	1±3	0±6
FSV-BF	-4±5	9±3	-1±3	-4±9
FSV-BG	-12±3	-8±3		5±24
FSV-BH	-7±2	3±2	7±2	13±9
FSV-BI	-7±3	5±4	5±5	-1±7
FSV-BJ	2±2	-4±3	-1±4	15±17
FSV-BK	6±4	0±1		
FSV-BL	14±9	-6±7		
FSV-BM	-1±2	2±4		
FSV-BN	5±3	32±36	-7±16	15±34
FSV-BO	7±7	3±4		102±290
FSV-BP	0±1	1±1		30±81
FSV-BQ	7±4	-43±15		100±142
FSV-BR	-3±3			
FSV-BS	-43±44	-48±6	-74±20	-29±16
FSV-BT	2±2	7±3	11±3	-4±5
FSV-BX	-2±2	-1±2	-1±1	
FSV-BY	-9±2	-5±2	-2±2	-6±7
FSV-BZ		15±21	-20±13	42±25
FSV-CA	-7±4	0±4		
FSV-CB	26±1	16±16		
FSV-CH	24±4	16±15	0±7	-4±15
FSV-CJ	17±9	-3±8		-22±6
FSV-CM		3±2		
FSV-CO	-12±2	-2±1		2±8
FSV-CP	-1±4	-13±4		-26±4
FSV-CR	1±4	-2±2		
FSV-CT	21±6	32±6		1±10
FSV-CU	-7±1	-5±4		1±7
FSV-CV	-5±6	1±6	-12±2	9±18
FSV-CY	-3±4	1±4		-7±13
FSV-DC	2±2	-1±2	8±16	19±28
FSV-DJ	9±8	5±3		
FSV-DK	119±9	-14±22		
FSV-DM	-9±2	-13±2		-16±9
FSV-DS	13±10	-4±4		-14±19
FSV-DX	-7±3	20±15		144±315
FSV-EB	2±2	8±19		4±11
FSV-EC	-26±2	-96±0		187±31
FSV-EK	5±4	-10±26	19±9	-16±6
FSV-EN	-44±2	-48±8	-48±8	
FSV-EX	-12±1	3±2		9±36
FSV-FC	21±1	-14±0	9±1	-7±6
FSV-FF	25±9			17±19

Label	Definition
Lab	Participant code
TR	Total Retinol
aT	a-Tocopherol
g/bT	g/b-Tocopherol
bC	Total b-Carotene
% Bias	(Mean ± SD) of individual serum biases
Mean	Average of $(x_i\text{-Median}_i)/\text{Median}_i$
SD	Standard deviation of $(x_i\text{-Median}_i)/\text{Median}_i$
x_i	Result for analyte in serum_i
Median_i	Median of non-NIST results in serum_i

The original analysis listed % Bias for each result for each serum calculated relative to the "Trimmed Core Lab Average" of that analyte in the serum. The summary values reported here are the (arithmetic mean ± standard deviation) of each laboratory's reported results for the analyte estimated relative to each serum's median value.

Appendix I. Shipping Package Inserts for RR29

Two items were included in each package shipped to an RR29 participant:

- **Cover letter**. The original letter has been lost. It would have been similar to the reconstructed cover letter for RR27 provided in Appendix A. That is, the cover letter for RR29 would likely have:
  - described the five samples, 186 to 190 (186 to 188 lyophilized, 189 and 190 liquid frozen), distributed in this study;
  - provided guidance for reconstituting the lyophilized samples and recommended a number of standard wavelengths and associated $E^{1\%}_{cm}$ absorptivities;
  - stated that the results were due by August 30, 1993 and should be mailed or faxed to Ms. Nancy T. Miles;
  - stated that analytical and technical queries should be directed to Willie E. May, PhD;
  - stated the date and venue for the 1993 MMQAP Workshop, and
  - was signed by Willie E. May, PhD.
- **Datasheet**.

These items were attached to the shipping box.

ROUND ROBIN XXIX RESULTS FROM LABORATORY # _____
DATE OF ANALYSIS _____
RESULTS IN ug/mL

SAMPLE NUMBER	ANALYTE	RESULT
SERUM 186	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 187	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 188	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 189	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____
SERUM 190	RETINOL	_____
	ALPHA-TOCOPHEROL	_____
VIAL # ___	BETA-CAROTENE	_____

OPTIONAL ANALYTES: SUPPLY ONE RESULT IF AVAILABLE

SERUM #	186	187	188	189	190
TRANS-BETA CAROTENE					
ALPHA-CAROTENE					
RETINYL PALMITATE					
GAMMA-TOCOPHEROL					
LYCOPENE (TOTAL)					
9-CIS-BETA CAROTENE					
13-CIS-BETA-CAROTENE					
LUTEIN					
ZEAXANTHIN					
BETA-CRYPTOXANTHIN					

DIRECTIONS: **Serum sample 186, 187 and 188, reconstitute with 1.0 mL distilled water. Serum samples 189 and 190 are liquid.**

RESULTS DUE BACK: **August 30,, 1993**
FAX RESULTS TO 301/926-8671

Appendix J. Final Report for RR29

The following 16 pages are the final report for RR29 as provided to all participants:

- The cover letter of a preliminary report for RR29 that was sent to all participants shortly before the 1993 QA Workshop. This preliminary report included a series of Tables listing the then-current results and various summary values for total retinol, α-tocopherol, total β-carotene, γ/β-tocopherol, *trans*-β-carotene, total α-carotene, retinyl palmitate, total lutein, total lycopene, total zeaxanthin, total lutein & zeaxanthin, total β-cryptoxanthin, *trans*-lycopene, *trans*-lutein & zeaxanthin, *trans*-α-carotene, and δ-tocopherol. Since the complete results were distributed in the following "Summary of 1993 Round Robin Activities", only the cover letter is reproduced here.
- The "Summary of 1993 Round Robin Activities" that was sent to participants in November 1993.
- Tables 1a thru 1c that summarize results for total retinol, α-tocopherol, and total β-carotene for the nine Round Robin studies conducted from 1991 through 1993.
- Tables 4 thru 7 that list the results and various summary values for total retinol, α-tocopherol, total β-carotene, and γ/β-tocopherol. Note: Tables 2 and 3 reiterated the results provided in the RR27 and RR28 Final Reports and so are not included here.
- Tables 8 thru 19 that list the results and simple summary statistics for *trans*-β-carotene, total α-carotene, retinyl palmitate, total lutein, total lycopene, total zeaxanthin, total lutein & zeaxanthin, total β-cryptoxanthin, *trans*-lycopene, *trans*-lutein & zeaxanthin, *trans*-α-carotene, δ-tocopherol, and *cis*-lutein & zeaxanthin.
- three graphical presentations of "Interlaboratory Precision vs Time" for total retinol, α-tocopherol, and total β-carotene.

Due to the complex formatting used in the Tables 4 thru 19, the originally listed laboratory codes have been deleted without replacement. However, Appendix L provides a complete listing of the RR29 results where the original codes have been altered to ensure confidentiality. Appendix L also provides more relevant summary statistics.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

October 28, 1993

Dear Colleague:

Attached are the tabular results (Tables 1-16) for Round Robin XXIX. The graphical and interlaboratory data will be included in the 1993 Round Robin results review, which you will be receiving within four weeks. We apologize for the delay.

Samples for the first study will be distributed the week of January 17. Results will be due March 19. Written feedback concerning the study will be provided to you by April 25.

The second set of samples will be shipped the week of April 25 with results due by June 14 and feedback to you July 25.

The third set of samples will be shipped to you the week of July 25. Results will be due by August 30 so that all three exercises can be summarized, critiqued, and discussed at the QA Workshop.

A Round Robin study concerning the analysis of fat-soluble vitamins and carotenoid compounds in food will also be scheduled to coincide with the second serum round robin study. Please contact Dr. Kathy Sharpless (301/975-3121) to indicate your interest in participating.

Two Round Robin studies concerning the analysis of ascorbic acid in serum will be conducted. A schedule for these studies will be forthcoming. Those interested in joining these studies should contact Dr. Sam Margolis at 301/975-3137.

If you have questions, please contact me at 301/975-3120 or FAX 301/926-8671.

Sincerely,

Jeanice Brown Thomas
Research Chemist
Organic Analytical Research Division
Chemical Science and technology Laboratory

Enclosures

SUMMARY OF 1993 ROUND ROBIN ACTIVITIES

This report describes both overall-group and individual laboratory performance in the three Round-Robin exercises conducted during 1993. Specifically, this section contains for retinol, α-tocopherol, and β-carotene, respectively: graphical information concerning Interlaboratory Precision vs Time over the past 7 1/2 years; a summary table of data collected over the past three years; tabular presentations of both individual laboratory and summary statistical data for Round Robins XXVII, XXVIII, and XXIX; a Blind Control Chart representing a summary of each laboratory's data vs assigned values for the past six years; a graphical presentation of data from each laboratory's analysis of blind replicate samples over the past three years. Tabular data only are provided for α-carotene, trans β-carotene, β-cryptoxanthin, lutein, lycopene, retinyl palmitate, γ-tocopherol and zeaxanthin.

Table 1 provides a summary of interlaboratory data for retinol, α-tocopherol and β-carotene over the past three years. The mean relative standard deviation (RSD of retinol for **Core** laboratories (laboratories that have been involved in the QA program for more than two years) has averaged about 11% over the past three years with a range of 8.5-13.2%. The mean RSD for the **New** laboratories (program participants for less than two years) during the same period of studies is approximately 20%.

The mean RSD of α-tocopherol for **Core** laboratories has averaged 9.8% with a range of 8.6-12.0% over the past three years. During the same period, **New** laboratory RSD values have averaged about 30% with a range of approximately 7-55%.

The mean RSD for β-carotene of **Core** laboratories (using data for all sera with concentrations higher than 200 ng/mL) averaged 21% over the past nine Round Robin studies. The **New** laboratory mean RSD during this period was approximately 34%. These different levels of performance (for Core vs New Labs) document the impact of the QA program in improving the Quality of Fat-Soluble Vitamins measurements.

Tables 2 and 3 provide a listing of data submitted in Round Robins XXVII and XXVIII. A detailed discussion of data provided in these studies were distributed earlier. The "**Core Lab Trimmed Averages**" were used as Assigned Values for these samples. In Round Robin XXVII, the mean RSD for retinol of the **Trimmed Core** laboratories was approximately 6%, 7% for α-tocopherol, and 14% for β-carotene. The mean RSD for retinol and α-tocopherol of the **Trimmed Core** laboratories in Round Robin XXVIII was about 6% and approximately 14% for β-carotene.

Tables 4-20 provide a summary of data submitted for the most recent Round Robin (XXIX). Five serum samples (186-190) were distributed for analysis in Round Robin XXIX. Serum 189 and 190 were liquid-frozen samples; the remaining samples were lyophilized. All of these samples were distributed in previous Round Robin exercises. Agreement between values determined in Round Robin XXIX and previous Round Robins is shown graphically in Section 2C.

In Round Robin XXIX, forty-five laboratories submitted data for retinol: 23 **Core** labs and 22 **New** labs (6 with two-year participation, 5 with one- to two-year participation, and 11 participating for less than one year). The mean RSD for retinol of the **Core** laboratories is approximately 13% and about 18% for the **New** laboratories. The mean RSD of the **Trimmed Core** labs for retinol is 4.9%.

Forty-six laboratories submitted data for α-tocopherol in Round Robin XXIX: 26 **Core** labs and 20 **New** labs (6 two-year participants, 5 one- to two-year participants, and 9 less than one-year participants). The mean RSD for the **Core** laboratories is about 12%, while the **Trimmed Core** mean RSD is 6.2%. The mean RSD for the two-year participants is about 14%, 55% for the one- to two-year participants, and 34% for those laboratories that have participated for less than one year.

Thirty-six laboratories submitted data for β-carotene in Round Robin XXIX: 20 **Core** labs and 16 **New** labs (5 two-year participants, 4 one- to two-year participants, and 7 less than one-year participants. The mean RSD for β-carotene of the **Trimmed Core** laboratories is approximately 12%. The mean RSD of the two-year and one- to two-year participants is 34.5% and 67.3%, respectively. The mean RSD of the laboratories with less than one year participation is approximately 41%.

Tables 7-20 provide summaries of data submitted for other fat-soluble vitamins and carotenoid compounds in Round Robin XXIX. We will continue to improve the measurement quality of retinyl palmitate and additional carotenoid compounds.

Data for use in evaluating laboratory performance is provided to the right side of the Table. The "Core Lab" Trimmed Values were used as the assigned values. By convention, 0-5% bias from the assigned value represents **EXCEPTIONAL** performance, 6-10% **ACCEPTABLE** performance, 11-20% **MARGINAL** performance and >20% **POOR** performance relative to the current state-of-the-practice.

If labs have concerns regarding their performance or a lab was rated "U" based on the convention stated above, we suggest that they obtain a unit of SRM 968a and analyze all three levels. If, with minor method modifications, their measured values do not agree with the certified values, we suggest that they contact Mrs. Jeanice Brown Thomas at 301/975-3120 or Dr. Kathy Sharpless at 301/975-3121 for consultation. We are willing to provide in-house consultation (at the labs expense) if need be, but have found that most problems can be solved via telephone conversations.

For non-NCI funded labs, fees of $300 for US labs and $600 for non-US labs will be assessed for participating in the "Fat-Soluble Vitamins QA 1994" program. An invoice to that effect will be mailed to those laboratories.

The 1994 QA Program will consist of three round robin exercises for the analysis of fat-soluble vitamins and carotenoid compounds in serum, two studies for the analysis of ascorbic acid in serum, and one exercise for the analysis of fat-soluble vitamins and carotenoid compounds in food.

The first set of samples for the fat-soluble vitamins in serum analysis will be distributed the week of January 17 with results due March 19; written feed back will be provided to labs by April 25. The second set of samples will be shipped the week of April 25 with results due by June 14 and feedback to labs by July 25. The third set of samples will be shipped the week of July 25. Results will be due by August 30 so that we can discuss all three exercises at the QA Workshop. The actual date has not been set yet. Feedback will also be provided to those who are not able to attend the workshop.

The round robin study concerning the analysis of fat-soluble vitamins and carotenoid compounds in food will also be scheduled in April to coincide with the second fat-soluble vitamins in serum round robin study. The coordinator of this exercise is Dr. Kathy Sharpless (301/975-3121).

The first set of samples for the analysis of ascorbic acid in serum will be distributed in January or February. The second set will be distributed in June. This round robin study is being coordinated by Dr. Sam Margolis (301/975-3137).

Table 1a

ROUND ROBIN XXI

	SERUM # 144	SERUM # 145	RETINOL SERUM # 146	SERUM # 147
GRAND (34)	0.963	0.504	0.539	0.276
RSD	16.1	15.9	19.1	23.1
CORE (30)	0.963	0.494	0.520	0.261
RSD	9.0	11.9	10.9	11.0
NEW				
RSD				
ASSIGNED	0.958	0.490	0.514	0.262
RSD	6.5	7.8	10.0	9.7
PREVIOUS	0.921	0.465	0.515	0.259
DATE	1/88	1/90	5/90	1/90
a-TOCOPHEROL				
GRAND (35)	10.7	6.88	6.64	4.98
RSD	6.0	8.2	11.3	12.6
CORE (33)	10.8	6.92	6.69	5.03
RSD	8.0	8.2	11.4	12.5
NEW				
RSD				
ASSIGNED	10.7	6.91	6.59	4.88
RSD	6.0	3.5	6.7	8.4
PREVIOUS	10.5	6.68	6.65	4.83
DATE	1/88	1/90	5/90	1/90
b-CAROTENE				
GRAND (24)	0.836	1.144	0.236	0.450
RSD	30.5	27.6	65.6	27.3
CORE (21)	0.867	1.151	0.211	0.457
RSD	26.5	29.4	39.8	28.3
NEW				
RSD				
ASSIGNED	0.848	1.089	0.195	0.422
RSD	4.6	8.2	8.6	9.4
PREVIOUS	0.796	1.034	0.189	0.409
DATE	1/88	1/90	5/90	1/90

ROUND ROBIN XXII

	SERUM # 148	RETINOL SERUM # 149	SERUM # 150
GRAND (44)	0.210	0.510	0.680
RSD	42.6	33.0	38.2
CORE (31)	0.197	0.506	0.662
RSD	18.5	9.8	9.9
NEW (12)	0.245	0.521	0.729
RSD	65.7	61.7	68.4
ASSIGNED	0.186	0.489	0.659
RSD	5.4	5.0	7.1
PREVIOUS			
DATE			
a-TOCOPHEROL			
GRAND (44)	4.80	10.52	16.40
RSD	26.4	27.3	27.2
CORE (34)	4.79	10.35	16.32
RSD	10.5	9.8	9.0
NEW (10)	4.82	11.07	18.76
RSD	54.0	53.7	55.8
ASSIGNED	4.80	10.50	16.59
RSD	8.3	3.0	3.1
PREVIOUS			
DATE			
b-CAROTENE			
GRAND (33)	0.275	0.894	2.362
RSD	34.8	17.5	18.0
CORE (23)	0.292	0.891	2.339
RSD	34.6	13.6	14.4
NEW (10)	0.238	0.898	2.415
RSD	31.1	25.2	24.9
ASSIGNED	0.260	0.890	2.338
RSD	22.7	8.8	9.3
PREVIOUS			
DATE			

ROUND ROBIN XXIII

	SERUM # 155	RETINOL SERUM # 156	SERUM # 157	SERUM # 159
GRAND (44)	0.531	0.401	0.980	0.496
RSD	15.0	14.8	15.8	17.8
CORE (30)	0.538	0.402	1.004	0.506
RSD	12.2	10.2	13.0	9.9
NEW (14)	0.514	0.398	0.925	0.475
RSD	20.5	22.4	20.8	29.2
ASSIGNED	0.536	0.405	1.010	0.506
RSD	4.9	6.5	5.4	5.9
PREVIOUS				0.489
DATE				1/91
a-TOCOPHEROL				
GRAND (44)	7.52	10.01	6.30	10.51
RSD	12.9	14.4	14.0	15.0
CORE (32)	7.44	9.89	6.30	10.69
RSD	8.3	11.6	9.8	8.4
NEW (12)	7.71	10.27	6.30	10.05
RSD	21	20	22	26
ASSIGNED	7.55	10.16	6.28	10.50
RSD	4.9	5.4	5.4	3.9
PREVIOUS				10.5
DATE				1/91
b-CAROTENE				
GRAND (32)	0.378	0.823	0.139	0.898
RSD	52.7	29.9	199	36.0
CORE (20)	0.346	0.804	0.089	0.856
RSD	24.8	18.9	34.3	20.9
NEW (12)	0.426	0.854	0.221	0.965
RSD	71.2	42.1	203	49.2
ASSIGNED	0.371	0.822	0.091	0.879
RSD	13.6	15.9	19.3	12.4
PREVIOUS				0.890
DATE				5/91

Table 1b

ROUND ROBIN XXIV
RETINOL

	SAMPLE # 160	SAMPLE # 161	SAMPLE # 162	SAMPLE # 163
GRAND (42)	1.002	0.681	0.288	0.387
RSD	24.2	15.0	18.2	13.6
CORE (29)	1.012	0.676	0.293	0.388
RSD	11.2	7.7	7.0	7.9
NEW (13)	1.069	0.703	0.282	0.393
RSD	30.2	23.8	32.7	21.4
ASSIGNED	1.019	0.673	0.293	0.383
RSD	4.4	6.9	7.0	6.7
PREVIOUS	1.010	0.659	0.291	0.369
DATE	08/91	05/91	05/90	01/88

a-TOCOPHEROL

GRAND (41)	6.23	15.95	4.61	5.64
RSD	15.6	10.8	13.1	12.9
CORE (30)	6.24	16.12	4.63	5.66
RSD	14.0	7.4	11.9	9.2
NEW (11)	6.21	15.41	4.48	5.55
RSD	21.0	17.8	32.0	20.6
ASSIGNED	6.39	15.95	4.61	5.66
RSD	5.1	6.5	6.7	7.0
PREVIOUS	6.28	16.59	4.62	5.64
DATE	08/91	05/91	05/90	01/88

b-CAROTENE

GRAND (33)	0.100	2.205	1.016	0.183
RSD	51.2	32.9	22.0	21.5
CORE (21)	0.098	2.223	1.092	0.195
RSD	51.6	29.4	17.9	12.9
NEW (12)	0.109	2.17	0.861	0.156
RSD	53.1	43.0	22.1	33.3
ASSIGNED	0.090	2.212	1.073	0.195
RSD	11.0	9.1	7.9	12.9
PREVIOUS	0.091	2.338	1.145	0.202
DATE	08/91	05/91	05/90	01/88

ROUND ROBIN XXV
RETINOL

	SAMPLE # 164	SAMPLE # 165	SAMPLE # 166	SAMPLE # 167
GRAND (28)	1.074	0.895	0.546	0.202
RSD	10.2	11.5	12.2	20.2
CORE (23)	1.076	0.895	0.539	0.197
RSD	10.2	12.2	11.5	14.9
NEW (5)	1.037	0.865	0.560	0.224
RSD	13.1	13.2	19.0	35.2
ASSIGNED	1.085	0.872	0.525	0.194
RSD	6.2	6.6	4.1	6.3
PREVIOUS	1.022	0.846	0.515	0.186
DATE	07/88	01/90	05/90	05/91

a-TOCOPHEROL

GRAND (30)	9.70	9.82	4.61	5.64
RSD	13.3	9.0	13.1	12.9
CORE (24)	9.45	9.59	4.63	5.66
RSD	6.6	6.8	11.9	9.2
NEW (6)	10.61	10.66	7.60	5.51
RSD	24.4	11.8	22.2	21.8
ASSIGNED	9.38	9.59	6.36	4.66
RSD	5.6	5.5	7.2	6.8
PREVIOUS	9.39	9.62	6.65	4.80
DATE	07/88	01/90	05/90	05/91

b-CAROTENE

GRAND (27)	1.087	2.038	0.226	0.300
RSD	35.7	25.2	113	69.7
CORE (21)	0.998	1.999	0.172	0.264
RSD	17.3	13.5	16.8	16.6
NEW (6)	1.405	2.247	0.415	0.435
RSD	62.2	44.2	131	101
ASSIGNED	1.023	2.030	0.169	0.256
RSD	12.9	11.7	14.0	6.2
PREVIOUS	1.027	1.976	0.189	0.240
DATE	07/88	01/90	05/90	05/91

ROUND ROBIN XXVI
RETINOL

	SAMPLE # 168	SAMPLE # 169	SAMPLE # 170	SAMPLE # 171	SAMPLE # 172
GRAND (33)	0.549	0.644	0.669	0.547	0.670
RSD	10.6	10.7	6.7	7.0	6.8
CORE (26)	0.546	0.644	0.666	0.547	0.667
RSD	11.6	12.1	6.6	6.7	6.7
NEW (7)	0.559	0.648	0.680	0.548	0.680
RSD	7.9	4.7	7.2	8.7	7.5
ASSIGNED	0.546	0.639	0.657	0.538	0.662
RSD	4.6	7.3	5.2	4.9	5.6
PREVIOUS	0.553	0.627			
DATE	10/90	10/90			

a-TOCOPHEROL

GRAND (35)	10.59	9.82	6.25	4.96	6.18
RSD	9.8	8.3	10.1	11.5	9.6
CORE (28)	10.41	9.85	6.21	4.93	6.13
RSD	6.7	6.8	10.3	12.1	9.7
NEW (7)	11.24	9.70	6.39	5.08	6.39
RSD	11.6	6.6	9.7	9.5	9.2
ASSIGNED	10.33	9.83	6.23	6.03	6.13
RSD	4.6	6.1	6.9	9.7	6.8
PREVIOUS	10.46	9.65			
DATE	10/90	10/90			

b-CAROTENE

GRAND (30)	1.662	0.439	0.621	0.400	0.609
RSD	17.9	22.2	17.5	16.6	16.4
CORE (23)	1.710	0.447	0.642	0.416	0.623
RSD	16.6	23.9	17.4	14.6	15.3
NEW (7)	1.516	0.415	0.553	0.348	0.564
RSD	23.9	14.6	12.4	17.3	19.3
ASSIGNED	1.716	0.456	0.617	0.416	0.588
RSD	9.0	14.3	11.9	14.6	6.9
PREVIOUS	1.618	0.441			
DATE	10/90	10/90			

Table 1c

Round Robin XXVII Retinol	Sample # 173	Sample # 174	Sample # 175	Sample # 176	Sample # 177
Grand (38)	0.503	0.539	0.405	0.545	0.673
RSD	11.1	13.8	11.1	11.5	16.5
Core (27)	0.496	0.530	0.400	0.543	0.673
RSD	10.5	13.5	11.2	11.0	16.2
Assigned	0.502	0.542	0.394	0.541	0.671
RSD	5.1	5.7	6.2	6.2	6.3
Previous	0.489	0.536	0.405	0.538	0.659
Date	5/91	8/91	8/91	8/92	5/91
	0.506				0.673
	8/91				1/92
α-Tocopherol					
Grand (34)	10.53	7.37	9.93	4.87	15.74
RSD	9.7	12.6	9.7	12.6	8.5
Core (25)	10.55	7.35	9.98	4.82	15.74
RSD	7.1	11.1	7.6	12.8	8.5
Assigned	10.69	7.55	10.12	4.77	15.70
RSD	5.5	4.3	6.0	11.9	6.6
Previous	10.50	7.55	10.16	5.03	16.59
Date	5/91	8/91	8/91	8/92	5/91
	10.42				15.95
	8/91				1/92
β-Carotene					
Grand (33)	0.936	0.416	0.875	0.435	2.37
RSD	23.9	53.9	35.6	38.8	18.1
Core (24)	0.931	0.399	0.843	0.430	2.37
RSD	15.4	41.1	21.2	32.9	18.1
Assigned	0.909	0.368	0.844	0.414	2.37
RSD	6.8	16.1	15.2	15.1	18.1
Previous	0.890	0.371	0.822	0.416	2.34
Date	5/91	8/91	8/91	8/92	5/91
	0.879				2.21
	8/91				1/92

Round Robin XXVIII Retinol	Sample # 181	Sample # 182	Sample # 163	Sample # 184	Sample # 165
Grand (39)	0.494	0.543	0.558	0.362	0.555
RSD	13.6	16.9	17.0	19.7	14.1
Core (23)	0.484	0.540	0.554	0.353	0.545
RSD	10.7	8.5	8.9	10.2	11.2
Assigned	0.472	0.531	0.545	0.344	0.525
RSD	7.8	6.8	4.7	5.9	6.2
α-Tocopherol					
Grand (39)	6.86	5.38	10.99	4.41	5.38
RSD	16.6	16.0	14.8	24.8	18.4
Core (25)	7.00	5.41	11.24	4.44	5.50
RSD	8.0	7.5	7.0	14.7	9.8
Assigned	7.03	5.36	11.31	4.22	5.42
RSD	5.6	5.8	6.3	6.1	5.5
β-Carotene					
Grand (29)	0.119	0.441	0.372	0.352	0.436
RSD	100.4	22.0	20.7	17.7	20.8
Core (19)	0.087	0.430	0.371	0.362	0.446
RSD	26.1	15.2	16.6	16.6	20.8
Assigned	0.081	0.420	0.364	0.354	0.428
RSD	18.0	12.4	15.0	14.5	11.9

Round Robin XXIX Retinol	Sample # 186	Sample # 187	Sample # 188	Sample # 189	Sample # 190
Grand (45)	0.222	0.505	0.722	0.625	0.540
RSD	21.8	20.9	15.0	13.7	15.1
Core (23)	0.233	0.534	0.745	0.641	0.550
RSD	20.7	19.3	8.7	7.5	9.9
Assigned	0.227	0.467	0.734	0.636	0.542
RSD	7.6	3.8	4.4	4.1	4.5
Previous	0.226	0.485	0.738	0.627	0.553
Date	0.221	0.490	0.729	0.639	0.546
α-Tocopherol					
Grand (46)	3.54	6.55	11.18	9.25	10.11
RSD	23.8	24.4	22.4	22.5	22.6
Core (26)	3.72	6.98	11.70	9.7	10.60
RSD	10.1	15.9	10.3	12.4	11.2
Assigned	3.68	6.78	11.31	9.47	10.27
RSD	4.7	4.6	7.6	6.2	7.7
Previous	3.74	6.68	11.88	9.65	10.46
Date	3.71	6.91	11.56	9.83	10.33
β-Carotene					
Grand (36)	0.933	1.08	0.503	0.435	1.65
RSD	42.4	49.5	41.1	38.6	43.4
Core (20)	0.899	1.02	0.484	0.424	1.63
RSD	17.1	18.8	18.0	19.0	14.4
Assigned	0.862	1.04	0.782	0.438	1.58
RSD	11.8	15.8	10.8	13.0	9.1
Previous	0.974	1.04	0.524	0.441	1.62
Date	0.864	1.09	0.523	0.456	1.72

Round Robin XXIX

Table 4 Retinol Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.206	0.478	0.739	0.647	0.559
	0.215	0.463	0.732	0.594	0.508
	0.213	0.483	0.723	0.635	*0.431
	0.260	*0.598	*0.845	*0.745	*0.679
	0.243	0.493	0.697	*0.563	0.514
	0.218	0.466	0.726	0.592	0.510
	0.250	0.517	0.776	0.634	0.528
	0.230	0.489	0.749	0.642	0.551
	0.250	0.520	0.780	0.670	0.580
	0.210	0.468	0.730	0.633	0.542
	0.238	0.494	0.749	0.635	0.548
	0.206	0.467	0.674	0.595	0.525
	0.212	*0.685	0.713	0.602	0.550
	0.219	0.499	0.728	0.648	0.499
	*0.428	*0.894	0.716	0.682	0.563
	0.240	0.505	0.764	0.640	0.558
	0.201	0.455	0.657	0.710	0.626
	0.212	0.483	0.720	0.630	0.550
	0.238	0.506	0.767	0.652	0.551
	0.233	0.485	0.684	0.656	0.561
	0.242	*0.668	*0.967	*0.788	*0.689
	*0.154	0.458	*0.645	0.678	0.585
	0.238	0.498	0.797	0.628	0.521
	0.264	0.501	0.677	0.656	0.604
	0.250	0.550	0.830	0.660	0.520
	0.313	0.493	0.777	0.626	0.561
	0.238	0.498	0.724	0.616	0.521
	0.216	0.517	0.796	0.620	0.595
	0.196	0.469	0.621	0.619	0.496
	0.184	0.687	0.830	0.706	0.613
	0.161	0.363	0.536	0.553	0.519
	0.304	0.492	0.750	0.625	0.602
	0.188	0.451	0.734	0.586	0.502
	0.215	0.458	0.767	0.721	0.587
	0.170	0.336	0.570	0.460	0.377
	0.230	0.488	0.721	0.614	0.690
	0.227	0.512	0.755	0.648	0.530
	0.201	0.485	0.746	0.588	0.526
	0.228	0.488	0.746	0.634	0.542
	0.210	0.490	0.510	0.710	0.610
	0.079	0.150	0.221	0.182	0.165
	0.186		0.707	0.636	0.558
	0.200	0.500	0.720	0.630	0.550
	0.238	0.515	0.753	0.630	0.547
	0.212	0.448	0.710	0.571	0.477
	0.201	0.553	0.833	0.673	0.582
NIST 1	0.225	0.501	0.704	0.610	0.535
NIST 3	0.203	0.462	0.695	0.589	0.510
All Labs					
AVG (45)	0.222	0.505	0.722	0.625	0.540
SD	0.048	0.105	0.109	0.086	0.081
RSD	21.8	20.9	15.0	13.7	15.1
Core Labs (15-101;23)					
AVG	0.233	0.534	0.745	0.644	0.550
SD	0.048	0.103	0.064	0.048	0.054
RSD	20.7	19.3	8.7	7.5	9.9
(a) New Labs (104-115;6) 2 yr participation.					
AVG	0.233	0.536	0.763	0.641	0.551
SD	0.046	0.079	0.080	0.036	0.046
RSD	19.9	14.7	10.5	5.6	8.4
(b) New Labs (116-120;5) 1-2 yr participation.					
AVG	0.208	0.420	0.671	0.589	0.517
SD	0.058	0.067	0.109	0.096	0.089
RSD	27.8	15.9	16.3	16.3	17.3
) New Labs (122-132;11) Less than 1 yr participation.					
G	0.201	0.463	0.675	0.592	0.525
SD	0.044	0.113	0.169	0.141	0.131
RSD	21.6	24.4	25.1	23.8	25.0

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	-9.4	-1.9	0.7	1.7	3.1
	-5.4	-5.0	-0.2	-6.6	-6.3
	-6.3	-0.9	-1.5	-0.1	-20.5
	14.4	22.7	15.2	17.1	25.2
	6.9	1.2	-5.0	-11.5	-5.2
	-4.1	-4.4	-1.0	-6.9	-5.9
	10.0	6.1	5.8	-0.3	-2.6
	1.2	0.3	2.1	1.0	1.6
	10.0	6.7	6.3	5.4	7.0
	-7.6	-4.0	-0.5	-0.5	-0.0
	4.7	1.4	2.1	-0.1	1.1
	-9.4	-4.2	-8.1	-6.4	-3.2
	-6.7	40.6	-2.8	-5.3	1.4
	-3.7	2.4	-0.8	1.9	-8.0
	88.3	83.4	-2.4	7.2	3.8
	5.6	3.6	4.1	0.6	2.9
	-11.6	-6.6	-10.5	11.6	15.4
	-6.7	-0.9	-1.9	-0.9	1.4
	4.7	3.8	4.5	2.5	1.6
	2.5	-0.5	-6.8	3.2	3.5
	6.5	37.1	31.8	23.9	27.1
	-32.3	-6.0	-12.1	6.6	7.9
	4.7	2.2	8.6	-1.3	-3.9
	16.1	2.8	-7.7	3.2	11.4
	10.0	12.9	13.1	3.8	-4.1
	37.7	1.2	5.9	-1.6	3.5
	4.7	2.2	-1.3	-3.1	-3.9
	-5.0	6.1	8.5	-2.5	9.7
	-13.8	-3.8	-15.4	-2.7	-8.5
	-19.1	41.0	13.1	11.0	13.0
	-29.2	-25.5	-26.9	-13.0	-4.3
	33.7	1.0	2.2	-1.7	11.0
	-17.3	-7.5	0.0	-7.9	-7.4
	-5.4	-6.0	4.5	13.4	8.3
	-25.3	-31.1	-22.4	-27.7	-30.5
	1.2	0.1	-1.7	-3.5	27.2
	-0.1	5.1	2.9	1.9	-2.3
	-11.6	-0.5	1.7	-7.5	-3.0
	0.3	0.1	1.7	-0.3	-0.0
	-7.6	0.5	-30.5	11.6	12.5
	-65.2	-69.2	-69.9	-71.4	-69.6
	-18.2		-3.6	0.0	2.9
	-12.0	2.6	-1.9	-0.9	1.4
	4.7	5.7	2.6	-0.9	0.9
	-6.7	-8.1	-3.2	-10.2	-12.0
	-11.6	13.5	13.5	5.8	7.3
Core Labs Trimmed (15-101;23)					
AVG	0.227	0.487	0.734	0.636	0.542
SD	0.017	0.018	0.032	0.026	0.024
RSD	7.6	3.8	4.4	4.1	4.5
PREVIOUS VALUE	0.226	0.485	0.738	0.627	0.553
	0.221	0.490	0.729	0.639	0.546

* = Value removed for Core Lab Trimmed Average.

L = Late results not included in statistics.

Round Robin XXIX

Table 5 Alpha-Tocopherol Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	3.73	6.70	11.53	9.47	10.47
	3.64	6.58	11.64	9.60	10.16
	*3.23	6.24	10.81	9.56	10.64
	3.67	7.12	11.61	9.79	11.50
	3.58	6.56	10.93	8.40	9.43
	3.57	6.53	11.58	9.44	10.11
	3.50	6.40	10.40	8.90	9.50
	3.74	6.83	11.80	10.27	10.85
	3.86	7.07	12.60	10.06	11.28
	*4.36	*8.20	*13.53	*12.51	*13.55
	3.79	6.66	11.41	9.60	9.97
	3.83	6.69	12.62	9.56	10.26
	3.38	*9.29	11.24	9.73	10.12
	*3.16	*4.50	9.74	*6.69	8.90
	3.94	6.87	11.77	8.50	10.27
	3.67	6.84	12.19	9.53	10.18
	3.88	7.00	12.22	9.44	10.16
	3.87	7.24	11.26	9.81	10.64
	3.40	6.85	11.11	9.69	10.41
	3.48	6.37	11.90	9.23	9.40
	3.49	*5.95	10.87	9.03	10.01
	*3.10	*5.73	9.97	8.32	8.85
	3.77	6.92	10.29	10.26	11.58
	*4.25	*10.10	*13.90	*11.20	*12.40
	3.91	7.41	12.13	*11.35	11.70
	*4.84	*8.73	*15.19	*12.27	*13.34
	3.47	6.12	10.80	9.90	10.00
	4.10	6.80	10.60	9.40	10.50
	2.60	5.70	13.10	10.10	10.40
	2.75	6.60	13.70	9.91	10.03
	5.02	7.17	13.47	10.02	12.86
	2.89	5.88	10.41	8.86	9.52
	3.83	6.94	10.52	8.38	9.13
	2.88	5.22	8.78	9.31	10.65
	4.07	7.01	11.98	9.47	10.17
	2.95	6.37	10.65	8.10	8.64
	4.13	7.54	11.47	9.34	10.36
	0.13	0.22	0.43	0.36	0.36
	3.40	6.32	10.75	9.43	12.55
	3.86	6.24	11.68	9.33	10.01
	4.20	7.50	13.20	11.70	12.50
	0.46	0.84	1.34	1.12	1.24
	3.60		11.50	9.70	10.40
	3.66	7.31	11.91	10.43	11.16
	3.85	6.63	11.68	9.03	9.74
	4.17	6.48	10.13	9.16	9.16
	3.71	6.80	12.20	9.56	10.07
NIST 1	3.56	6.55	11.41	9.34	10.08
NIST 3	3.67	6.59	11.30	10.00	10.70
All Labs					
AVG (46)	3.54	6.55	11.16	9.25	10.11
SD	0.84	1.60	2.50	2.08	2.29
RSD	23.8	24.4	22.4	22.5	22.6
Core Labs (15-101;26)					
AVG	3.72	6.98	11.70	9.70	10.60
SD	0.37	1.11	1.20	1.20	1.18
RSD	10.1	15.9	10.3	12.4	11.2
(a) New Labs (104-115;6) 2 yr participation.					
AVG	3.53	6.51	11.97	9.45	10.41
SD	0.95	0.59	1.61	0.70	1.31
RSD	26.9	9.1	13.4	7.4	12.6
(b) New Labs (116-120;5) 1-2 yr participation.					
AVG	2.83	5.27	8.66	7.32	8.04
SD	1.63	2.95	4.76	3.93	4.36
RSD	57.4	56.0	54.9	53.7	54.3
New Labs (122-132;9) Less than 1 yr participation.					
AVG	3.43	6.02	10.49	8.83	9.65
SD	1.15	2.14	3.54	3.01	3.37
RSD	33.4	35.6	33.7	34.0	34.9

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	1.1	-1.2	1.9	0.0	2.0
	-1.2	-2.9	2.9	1.4	-1.1
	-12.3	-8.0	-4.4	0.9	3.6
	-0.4	5.0	2.6	3.4	12.0
	-2.8	-3.2	-3.4	-11.3	-8.2
	-3.2	-3.8	2.3	-0.3	-1.6
	-5.0	-5.6	-8.1	-6.0	-7.5
	1.5	0.7	4.3	8.4	5.6
	4.8	4.3	11.4	6.2	9.8
	18.3	21.0	19.6	32.1	31.9
	2.9	-1.8	0.9	1.4	-2.9
	3.9	-1.3	11.6	0.9	-0.1
	-8.3	37.0	-0.6	2.7	-1.5
	-14.2	-33.6	-13.9	-29.4	-13.4
	6.9	1.3	4.0	-10.3	-0.0
	-0.4	0.9	7.8	0.6	-0.9
	5.3	3.3	8.0	-0.3	-1.1
	5.1	6.9	-0.5	3.5	3.5
	-7.7	1.0	-1.8	2.3	1.3
	-5.6	-6.0	5.2	-2.6	-8.5
	-5.4	-12.2	-4.0	-4.7	-2.5
	-16.0	-15.4	-11.9	-12.1	-13.8
	2.3	2.1	-9.0	8.3	12.8
	15.3	49.0	22.9	18.2	20.7
	6.1	9.3	7.2	19.8	13.9
	31.4	28.8	34.3	29.5	29.8
	-5.8	-9.7	-4.5	4.5	-2.6
	11.3	0.3	-6.3	-0.8	2.2
	-29.4	-15.9	15.8	6.6	1.2
	-25.4	-2.6	21.1	4.6	-2.4
	36.2	5.8	19.1	5.8	25.2
	-21.6	-13.3	-8.0	-6.5	-7.3
	4.0	2.4	-7.0	-11.5	-11.1
	-21.9	-22.9	-22.4	-1.7	3.7
	10.5	3.4	5.9	-0.0	-1.0
	-19.9	-6.0	-5.9	-14.5	-15.9
	12.2	11.2	1.3	-1.4	0.8
	-96.6	-96.7	-96.2	-96.2	-96.5
	-7.7	-6.8	-5.0	-0.4	22.2
	4.8	-8.0	3.2	-1.5	-2.5
	14.0	10.6	16.7	23.5	21.7
	-87.7	-87.7	-88.2	-88.1	-88.0
	-2.3		1.7	2.4	1.2
	-0.7	7.8	5.3	10.1	8.6
	4.5	-2.2	3.2	-4.7	-5.2
	13.2	-4.4	-10.5	-3.3	-10.8
	0.7	0.4	7.8	0.9	-2.0
Core Labs Trimmed (15-101;26)					
AVG	3.68	6.78	11.31	9.47	10.27
SD	0.17	0.31	0.86	0.58	0.79
RSD	4.7	4.6	7.6	6.2	7.7
PREVIOUS					
VALUE	3.74	6.68	11.88	9.65	10.46
	3.71	6.91	11.56	9.83	10.33

* = Value removed for Core Lab Trimmed Average.

L = Late results not included in statistics.

Round Robin XXIX

Table 6 Total Beta-Carotene Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.958	1.078	0.533	0.449	1.689
	0.886	1.034	0.492	0.424	1.513
	0.800	1.070	0.408	0.533	1.660
	0.706	0.806	0.403	0.356	1.351
	0.933	1.044	0.529	0.443	1.659
	*1.349	1.355	*0.642	0.506	*2.118
	0.704	0.850	*0.243	*0.174	1.546
	*1.118	1.364	*0.618	0.503	*1.953
	0.937	1.082	0.530	0.482	1.732
	0.977	1.124	0.537	0.445	1.686
	0.854	*0.569	0.424	0.370	1.320
	0.920	0.950	0.470	0.400	1.520
	0.916	1.200	0.485	0.440	*2.070
	0.963	1.090	0.558	0.485	1.820
	0.985	0.985	0.520	0.420	1.570
	0.764	0.851	0.504	0.431	1.526
	0.801	0.914	0.456	0.382	1.463
	0.968	1.058	0.498	0.486	1.720
	0.786	1.050	0.462	0.467	1.400
	0.688	0.733	0.393	0.330	*1.230
	0.897	1.074	0.455	0.362	1.606
	0.757	0.842	0.380	0.359	1.364
	0.870	1.040	0.520	0.420	0.170
	0.378	0.984	0.466	0.393	1.342
	1.099	1.316	0.565	0.495	1.795
	0.447	0.523	0.288	0.268	1.126
	1.111	1.297	0.494	0.408	1.726
	0.984	1.134	0.489	0.334	1.794
	0.971	1.062	0.539	0.426	1.699
	1.020	1.135	0.547	0.502	1.750
	2.869	3.825	1.533	1.247	5.095
	0.930	1.090	0.505	0.433	1.928
	0.960	0.967	0.470	0.404	1.321
	1.058	1.352	0.619	0.565	2.111
	0.180	0.227	0.115	0.099	0.403
	1.070	1.150	0.560	0.490	1.650
	0.754	0.439	0.217	0.304	1.032
	0.913	0.990	0.484	0.390	1.717
NIST 1	0.962	1.210	0.559	0.495	1.600
NIST 3	0.885	0.934	0.476	0.399	1.500
All Labs					
AVG (36)	0.933	1.080	0.503	0.435	1.647
SD	0.396	0.534	0.208	0.168	0.715
RSD	42.4	49.5	41.4	38.6	43.4
Core Labs (15-101;20)					
AVG	0.899	1.017	0.484	0.424	1.632
SD	0.154	0.191	0.087	0.081	0.235
RSD	17.1	18.8	18.0	19.0	14.4
(a) New Labs (104-115;5) 2 yr participation.					
AVG	0.781	1.032	0.467	0.397	1.232
SD	0.351	0.321	0.106	0.082	0.654
RSD	44.9	31.1	22.8	20.7	53.1
(b) New Labs (116-120;4) 1-2 yr participation.					
AVG	1.461	1.789	0.777	0.627	2.585
SD	0.939	1.358	0.505	0.419	1.674
RSD	64.3	75.9	64.9	66.8	64.8
(c) New Labs (122-132;7) Less than 1 yr participation.					
AVG	0.838	0.888	0.424	0.384	1.452
SD	0.309	0.404	0.186	0.150	0.587
RSD	36.8	45.5	43.8	39.0	40.4

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	11.1	3.6	10.7	2.6	7.0
	2.7	-0.6	2.2	-3.1	-4.2
	-7.2	2.9	-15.3	21.8	5.1
	-18.1	-22.5	-16.3	-18.6	-14.4
	8.1	0.4	9.9	1.2	5.1
	56.4	30.3	33.3	15.6	34.2
	-18.4	-18.3	-49.5	-60.2	-2.1
	29.6	31.1	28.3	14.9	23.7
	8.7	4.0	10.1	10.2	9.7
	13.3	8.1	11.5	1.7	6.8
	-1.0	-45.3	-12.0	-15.4	-16.4
	6.7	-8.7	-2.4	-8.6	-3.7
	6.2	15.4	0.7	0.6	31.1
	11.7	4.8	15.9	10.8	15.3
	14.2	-5.3	8.0	-4.0	-0.6
	-11.4	-18.2	4.7	-1.5	-3.3
	-7.1	-12.1	-5.4	-12.7	-7.4
	12.3	1.7	3.4	11.1	8.9
	-8.9	1.0	-4.1	6.7	-11.3
	-20.2	-29.5	-18.4	-24.6	-22.1
	4.0	3.3	-5.5	-17.3	1.7
	-12.2	-19.0	-21.1	-18.0	-13.6
	0.9	-0.0	8.0	-4.0	-89.2
	-56.2	-5.4	-3.2	-10.2	-15.0
	27.4	26.5	17.3	13.1	13.7
	-48.2	-49.7	-40.2	-38.8	-28.7
	28.8	24.7	2.6	-6.8	9.3
	14.1	9.0	1.5	-23.7	13.6
	12.6	2.1	11.9	-2.6	7.6
	18.3	9.1	13.6	14.7	10.8
	232.7	267.8	218.3	185.0	222.7
	7.8	4.8	4.9	-1.0	22.1
	11.3	-7.0	-2.4	-7.7	-16.3
	22.7	30.0	28.5	29.1	33.7
	-79.1	-78.2	-76.1	-77.4	-74.5
	24.1	10.6	16.3	12.0	4.5
	-12.6	-57.8	-54.9	-30.5	-34.6
	5.9	-4.8	0.5	-10.9	8.8
Core Labs Trimmed(15-101;20)					
AVG	0.862	1.040	0.482	0.438	1.579
SD	0.102	0.164	0.052	0.057	0.144
RSD	11.8	15.8	10.8	13.0	9.1
PREVIOUS					
VALUE	0.974	1.038	0.524	0.441	1.618
	0.864	1.089	0.523	0.456	1.716

* = Value removed for Core Lab Trimmed Average.

L = Late results not included in statistics.

Round Robin XXIX
Table 7 Gamma Tocopherol Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.74	1.11	2.30	2.30	1.48
	0.78	1.02	2.39	2.36	1.43
	0.94	1.02	2.52	*2.64	1.46
	0.82	1.10	2.49	2.48	1.54
	0.84	1.10	2.40	2.41	1.50
	0.77	0.96	2.34	2.24	1.37
	0.52	1.00	*1.75	*1.75	*1.03
	0.75	*0.69	2.15	*1.87	*1.84
	0.83	0.89	2.47	2.37	1.46
	0.78	1.23	2.30	2.35	1.53
	0.60	1.07	2.48	2.31	1.49
	0.55	0.77	2.42	2.53	1.49
	0.93	1.10	2.50	2.50	1.55
	0.63	0.83	2.26	2.50	1.39
	*1.30	1.05	*2.69	2.16	1.49
	0.82	1.00	2.40	2.35	1.47
	0.71	0.90	2.24	2.26	1.75
	*0.10	*0.16	*0.32	*0.31	*0.21
		1.23	2.73	*2.69	1.66
NIST 1	0.63	0.85	2.23	2.04	1.25
NIST 3	0.73	0.94	2.32	2.33	1.45
All Lab					
AVG	0.74	0.94	2.25	2.21	1.42
SD	0.24	0.24	0.52	0.52	0.34
RSD	31.7	25.2	23.2	23.7	24.1

% Bias from Trimmed Core Lab Average.

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.3	10.4	-2.8	-2.3	-0.5
	5.8	1.6	0.9	0.2	-4.0
	27.5	1.6	6.4	12.1	-2.0
	11.0	9.8	5.0	5.3	3.6
	13.5	10.0	1.3	2.4	0.5
	4.5	-4.4	-1.2	-4.9	-8.0
	-29.5	-0.4	-26.1	-25.7	-30.8
	1.7	-31.5	-9.2	-20.6	23.6
	12.1	-11.2	4.3	0.8	-1.9
	5.1	22.5	-2.9	-0.3	2.7
	-18.3	6.6	4.7	-2.0	0.1
	-26.1	-22.9	2.2	7.4	0.1
	26.2	9.6	5.6	6.1	4.1
	-14.5	-17.3	-4.6	6.1	-6.7
	76.4	4.6	13.6	-8.3	0.1
	10.6	-0.7	1.4	-0.2	-1.6
	-3.7	-10.3	-5.4	-4.1	17.5
	-86.0	-84.6	-86.7	-87.0	-85.9
		22.4	15.2	14.3	11.7
Lab Trimmed					
AVG	0.74	1.00	2.37	2.36	1.49
SD	0.12	0.12	0.11	0.11	0.09
RSD	15.8	11.8	4.5	4.5	6.0

* = Value removed for Lab Trimmed Average.

Round Robin XXIX
Table 8 Trans Beta-Carotene Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	*0.028	*0.034	*0.020	*0.052	*0.076
	0.885	1.015	0.499	0.448	1.675
	0.919	1.064	0.509	0.421	1.619
	0.682	0.766	0.445	0.380	1.448
	0.685	0.679	0.344	0.282	1.256
	0.999	1.262	0.627	0.558	1.746
	0.960	1.076	0.525	0.472	1.677
NIST 1	0.939	1.160	0.538	0.470	1.540
NIST 3	0.803	0.855	0.443	0.374	1.450
AVG	0.855	0.977	0.492	0.427	1.570
SD	0.138	0.216	0.094	0.093	0.184
RSD	16.2	22.1	19.0	21.7	11.7

Round Robin XXIX
Table 9 Alpha-Carotene Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.045	0.037	0.023	0.060	0.108
	0.038	0.032	0.019	0.058	0.080
	0.061	0.044	0.025	0.099	0.153
	0.062	0.060	0.022	0.091	0.129
	0.050	0.046	0.019	0.073	0.101
	0.040	0.034	0.021	0.063	0.097
	0.051	0.024	0.025	0.079	0.118
	0.038	0.036		0.048	0.081
	0.052	0.041	0.024	0.070	0.111
	0.029	0.013	0.008	0.055	0.080
	0.039	0.033	0.019	0.061	0.101
	0.046	0.044	0.036	0.118	0.112
	0.036	0.030	0.024	0.063	0.092
	0.028	0.030	0.014	0.051	0.084
	0.020	0.020	0.020	0.090	0.150
	0.019			0.042	
		0.048	0.021	0.077	0.120
	0.047	0.038	0.027	0.077	0.127
	0.014	0.011	0.008	0.030	0.047
	0.033	0.025	0.014	0.041	0.080
	0.037	0.033	0.018	0.070	0.087
	0.023	0.020	0.015	0.041	0.063
	0.032			0.043	0.053
NIST 1	0.060	0.037	0.033	0.066	0.115
NIST 3	0.069	0.056	0.031	0.072	0.130
AVG	0.038	0.033	0.020	0.065	0.099
SD	0.013	0.012	0.006	0.021	0.028
RSD	34.0	35.9	32.1	32.6	28.3

Round Robin XXIX

Table 10 Retinyl Palmitate Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
				0.059	0.183
				0.092	0.295
				0.055	0.236
		0.052	0.015	0.087	0.227
				0.062	0.168
				0.084	0.276
	0.026	0.059	0.066	0.073	0.183
	0.163		0.020	0.066	0.279
				0.069	0.276
NIST 3				0.067	0.246
AVG	0.095	0.056	0.034	0.072	0.236
SD	0.097	0.005	0.028	0.013	0.049
RSD	102.5	8.9	83.5	18.2	20.6

Round Robin XXIX

Table 11 Lutein Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.040	0.111	0.072	0.108	0.133
	0.043	0.118	0.071	0.117	0.144
	0.042	0.136	0.074	0.126	0.140
	0.038	0.100	0.060	0.091	0.108
	0.060	0.090	0.120	0.180	0.230
	0.037	0.136	0.074	0.128	0.156
	0.013	0.048	0.027	0.042	0.050
	0.047	0.104	0.076	0.099	0.114
	0.059	0.156	0.108	0.216	0.255
	0.056	0.136	0.103	0.168	0.175
	0.036	0.105	0.064	0.097	0.116
	0.053	0.207	0.138	0.223	0.267
NIST 3	0.040	0.117	0.074	0.115	0.143
AVG	0.044	0.121	0.082	0.133	0.157
SD	0.013	0.039	0.030	0.054	0.065
RSD	29.6	32.3	36.5	40.5	41.0

Round Robin XXIX

Table 12 Lycopene (Total) Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.120	0.427	0.249	0.404	0.040
	0.082	0.339	0.195	0.319	0.300
	0.098	0.348	0.224	0.362	0.362
	0.095	0.429	0.266	0.466	0.448
	0.098	0.372	0.209	0.353	0.341
	0.158	0.321	0.288	0.491	0.498
	0.090	0.200	0.126	0.185	0.250
	0.091	0.350	0.223	0.375	0.349
	0.117	0.409	0.285	0.405	0.380
	0.088	0.320	0.196	0.332	0.321
	0.112	0.435	0.232	0.428	0.368
	0.217	0.287	0.218	0.300	0.361
	0.060	0.246	0.147	0.236	0.343
	0.080	0.330	0.200	0.370	0.390
	0.021	0.065	0.040	0.065	0.068
	0.122	0.722	0.404	0.570	0.630
	0.102	0.382	0.261	0.432	0.430
	0.034	0.131	0.093	0.152	0.171
	0.054	0.213	0.121	0.216	0.224
	0.082	0.073	0.178	0.311	0.293
	*0.005	*0.017	*0.011	*0.017	*0.019
	0.078	0.329	0.188	0.323	0.311
NIST 3	0.169	0.491	0.300	0.484	0.503
AVG	0.097	0.331	0.214	0.351	0.331
SD	0.043	0.147	0.078	0.117	0.138
RSD	43.9	44.4	36.4	33.3	41.8

Round Robin XXIX

Table 13 Zeaxanthin Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.013	0.031	0.025	0.039	0.045
	0.023	0.033	0.026	0.044	0.043
	0.024	0.029	0.028	0.025	0.025
	0.021	0.042	0.032	0.053	0.045
	0.002	0.017	0.010	0.012	0.020
	0.024	0.038	0.039	0.027	0.024
	0.019	0.027	0.031	0.048	0.048
	*0.180	*0.410	*0.289	*0.430	*0.536
NIST 3	0.026	0.045	0.039	0.053	0.055
AVG	0.018	0.031	0.027	0.035	0.036
SD	0.008	0.008	0.009	0.015	0.012
RSD	44.7	26.0	32.8	41.3	33.8

Round Robin XXIX
Table 14 Lutein + Zeaxanthin Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.065	0.158	0.102	0.159	0.187
	0.062	0.184	0.117	0.200	0.223
	0.103	0.257	0.153	0.246	0.263
	0.086	0.300	0.150	0.217	0.254
	0.071	0.174	0.110	0.174	0.195
	0.056	0.120	0.119	0.150	0.183
	0.069	0.182	0.117	0.190	0.226
AVG	0.073	0.196	0.124	0.191	0.219
SD	0.016	0.061	0.020	0.034	0.032
RSD	22.0	31.2	15.8	17.6	14.6

Round Robin XXIX
Table 15 Beta-Cryptoxanthin Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.042	0.120	0.037	0.098	0.127
	0.039	0.125	0.037	0.110	0.133
	0.048	0.102	0.045	0.102	0.134
	0.052	0.148	0.053	0.140	0.156
	0.051	0.175	0.056	0.159	0.183
	0.093	0.134	0.052	0.129	0.152
	0.034	0.107	0.033	0.100	0.115
	0.020	0.080	0.020	0.080	0.110
	0.024	0.067	0.024	0.061	0.073
	0.017	0.100	0.044	0.108	0.106
	0.039	0.125	0.041	0.103	0.130
	0.021	0.073	0.025	0.064	0.080
	0.029	0.089	0.022	0.093	0.116
	*0.960	0.135	0.046	0.120	0.146
	*0.003	0.011	0.004	0.010	0.012
		0.208		0.170	0.247
NIST 3	0.023	0.067	0.020	0.060	0.074
AVG	0.039	0.112	0.036	0.103	0.126
SD	0.020	0.046	0.015	0.039	0.051
RSD	51.2	40.7	40.6	37.7	40.3

Round Robin XXIX
Table 16 Trans-Lycopene Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.062	0.226	0.139	0.222	0.219
	0.074	0.339	0.222	0.321	0.333
	0.062	0.119	0.073	0.191	0.164
NIST 3	0.066	0.215	0.134	0.202	0.206
AVG	0.066	0.228	0.145	0.245	0.239
SD	0.007	0.110	0.075	0.068	0.086
RSD	10.5	48.3	51.6	27.8	36.1

Round Robin XXIX
Table 17 Trans-Lutein/Trans-Zeaxanthin Resul

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.074	0.163	0.133	0.216	0.223

Round Robin XXIX
Table 18 Trans-Alpha-Carotene Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
NIST 3	0.048	0.043	0.024	0.068	0.097

Round Robin XXIX
Table 19 Delta-Tocopherol Results

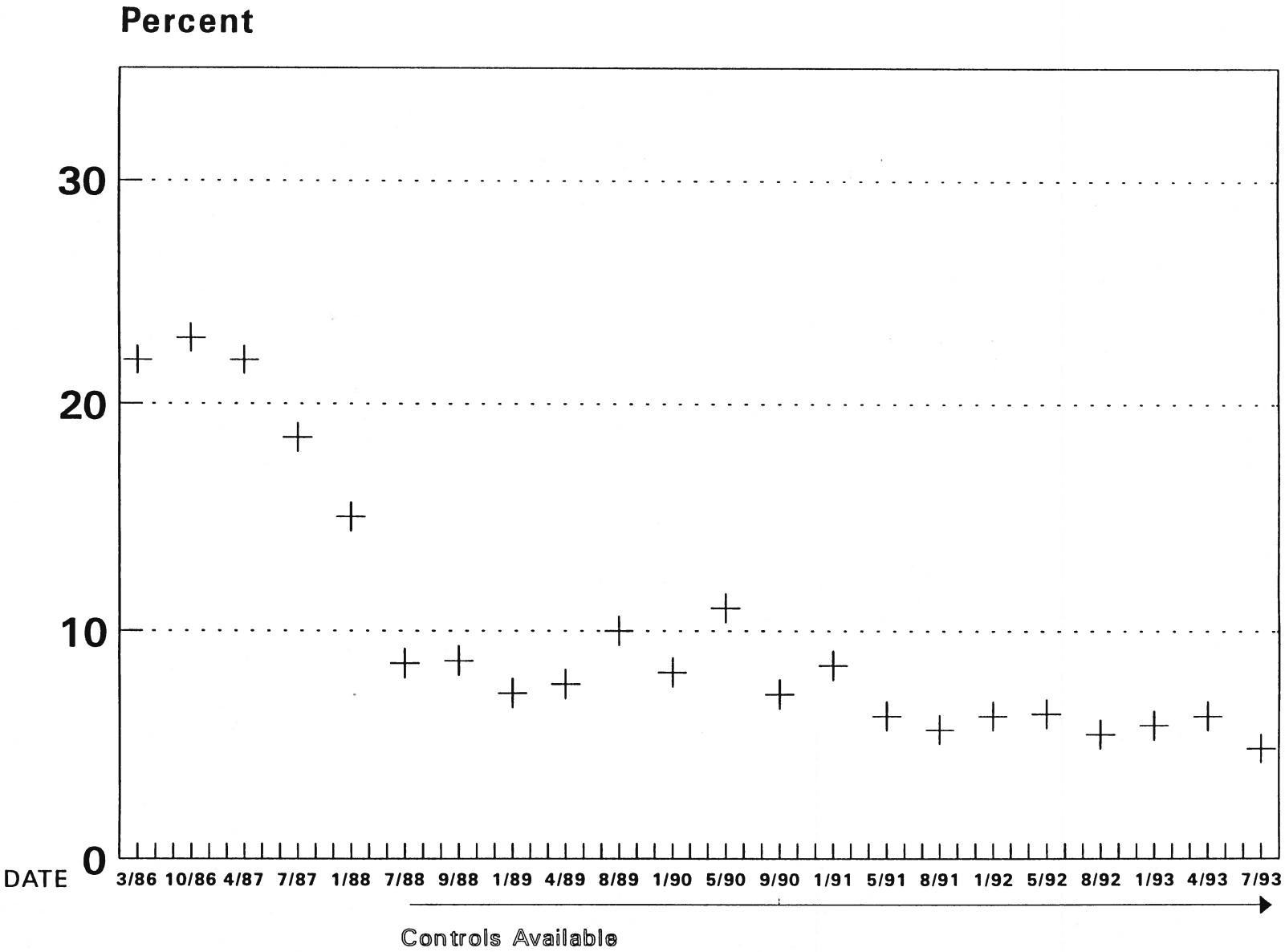
Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
NIST 3		0.109	0.142	0.104	0.076

Round Robin XXIX
Table 20 Cis-Lutein/Cis-Zeaxanthin Results

Lab#	Serum# 186	Serum# 187	Serum# 188	Serum# 189	Serum# 190
	0.027	0.077	0.063	0.118	0.131

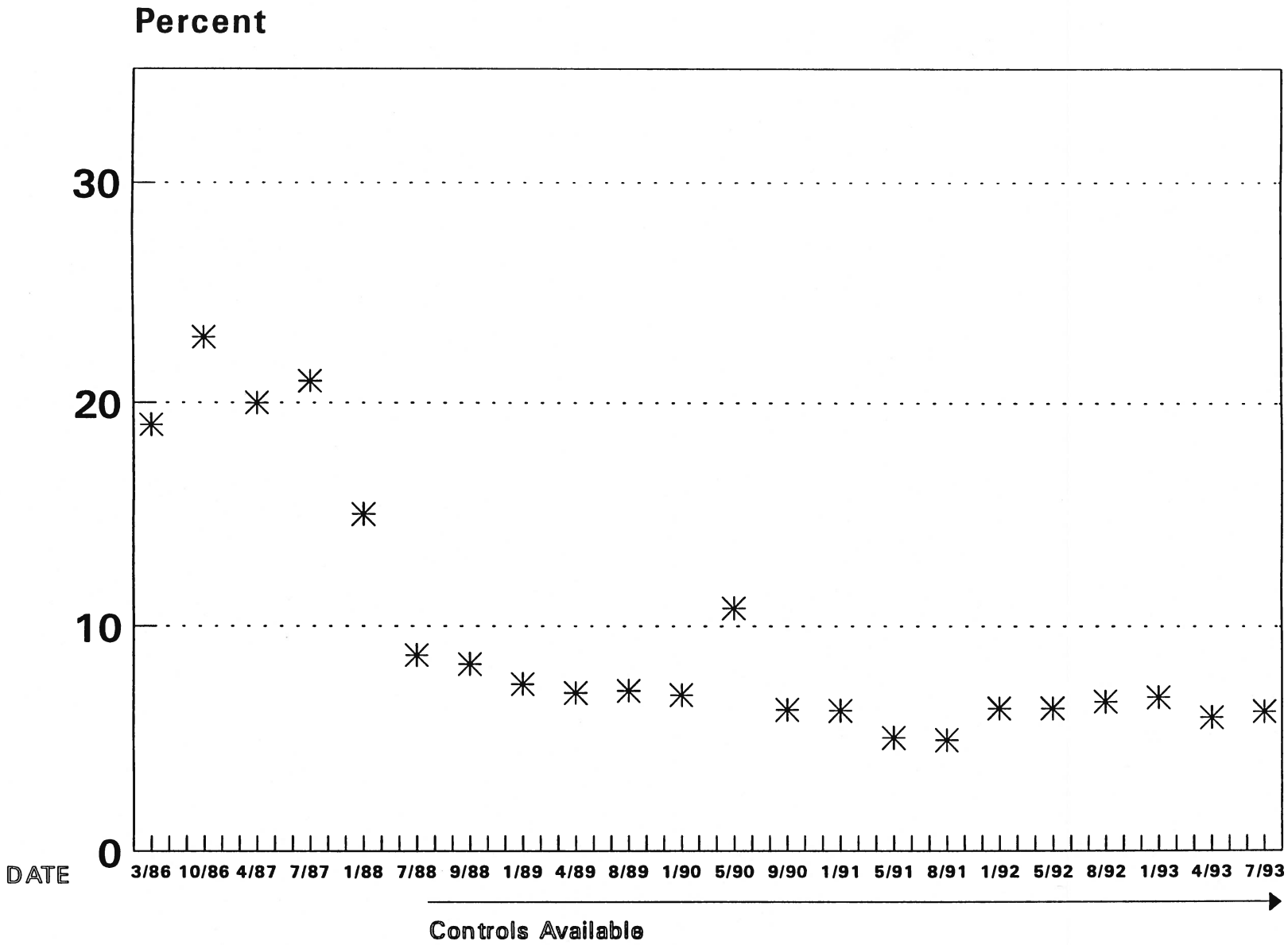
Interlaboratory Precision vs Time

Retinol



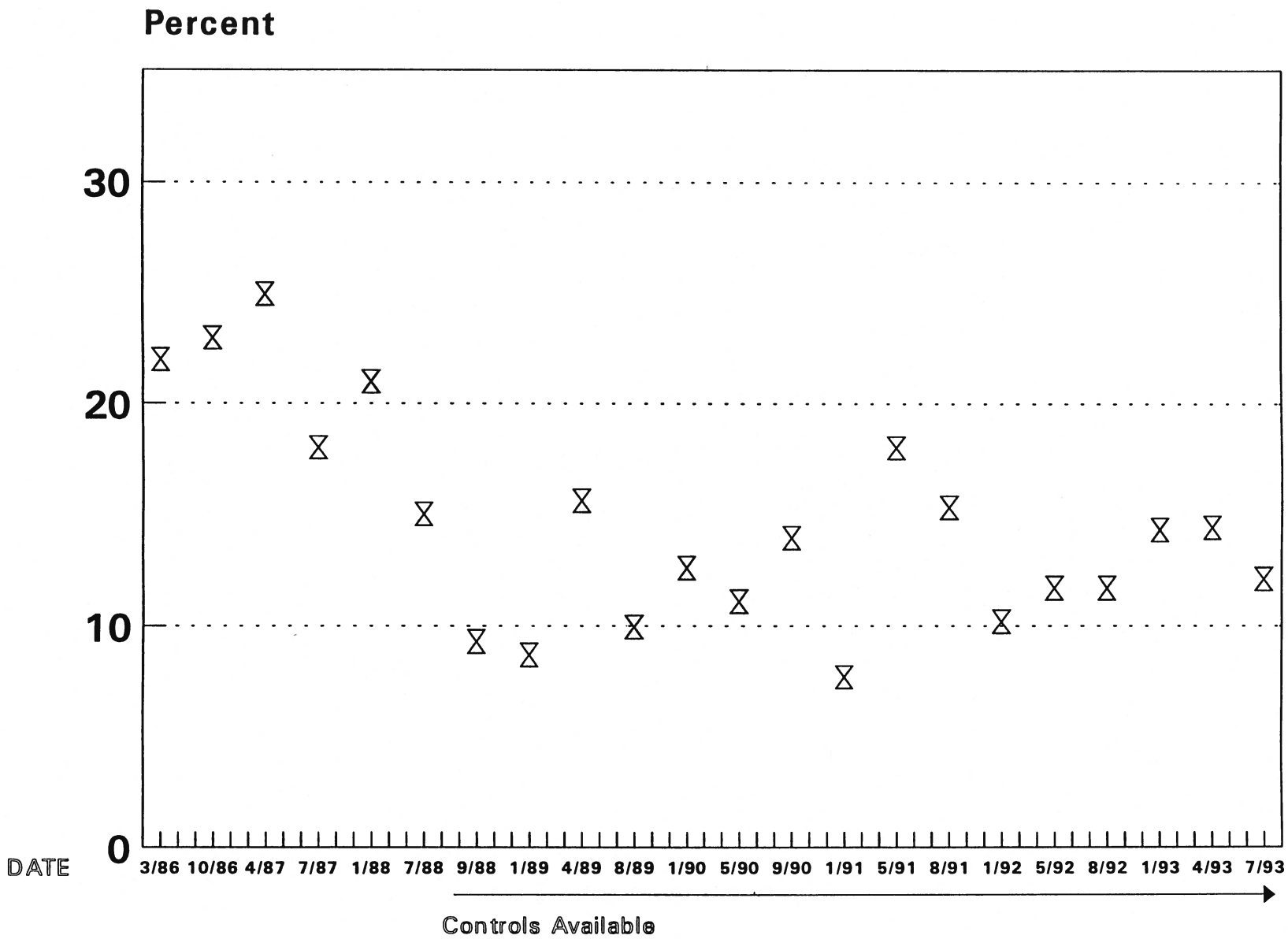
Interlaboratory Precision vs Time

Alpha-Tocopherol



Interlaboratory Precision vs Time

Beta-Carotene



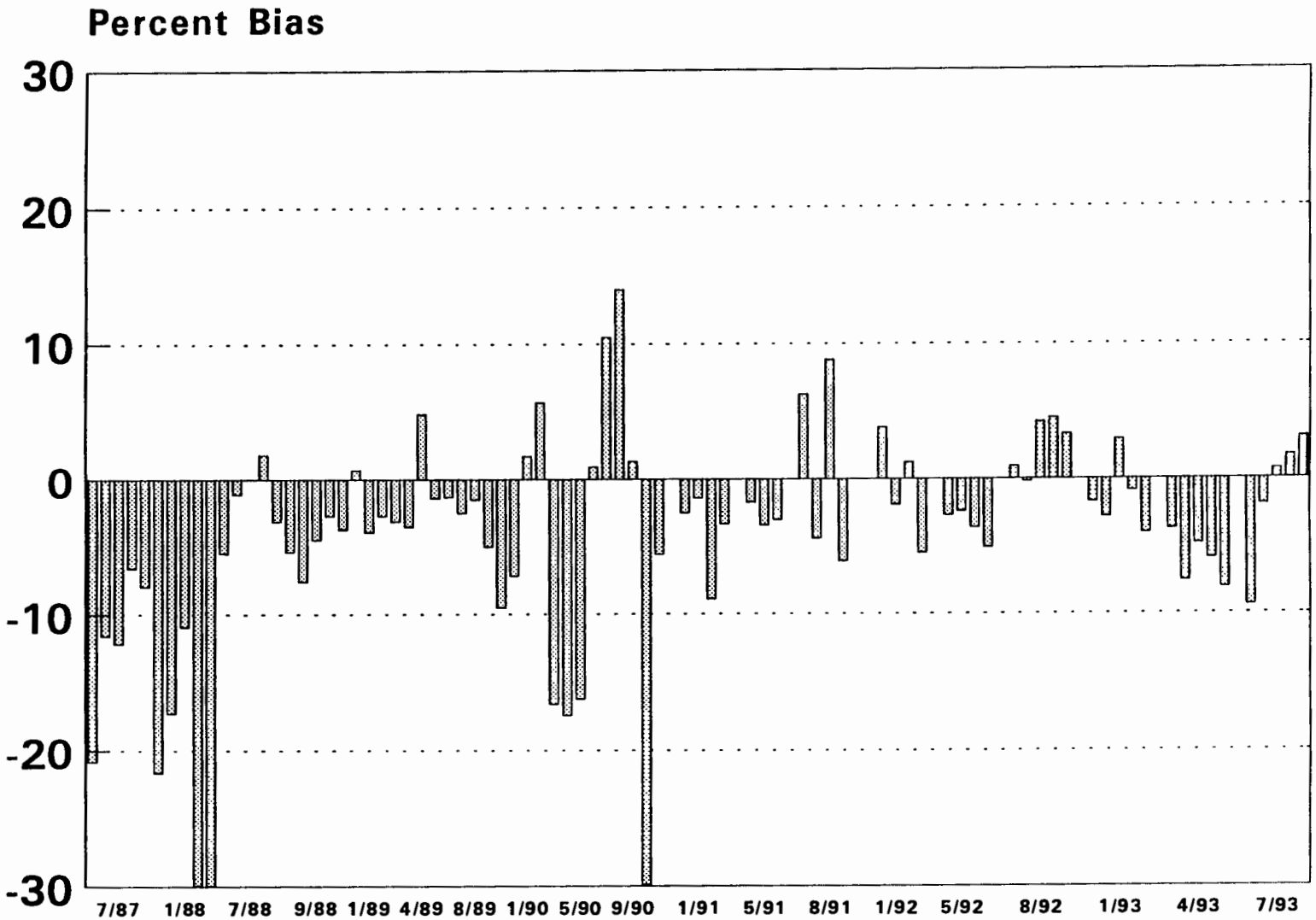
Appendix K. Representative "Individualized Report" for RR29

Each participant in RR29 received graphical summaries of their own measurement performance for total retinol, α-tocopherol, and/or total β-carotene. In RR29, two sets of graphs were prepared:

- "Percent Bias" relative to the "Trimmed Core Lab Average" for of the serum-based samples distributed from 7/1987 through 7/93.
- "Blind Duplicate Performance", documenting the history of the % Bias values for just the sera distributed in RR29.

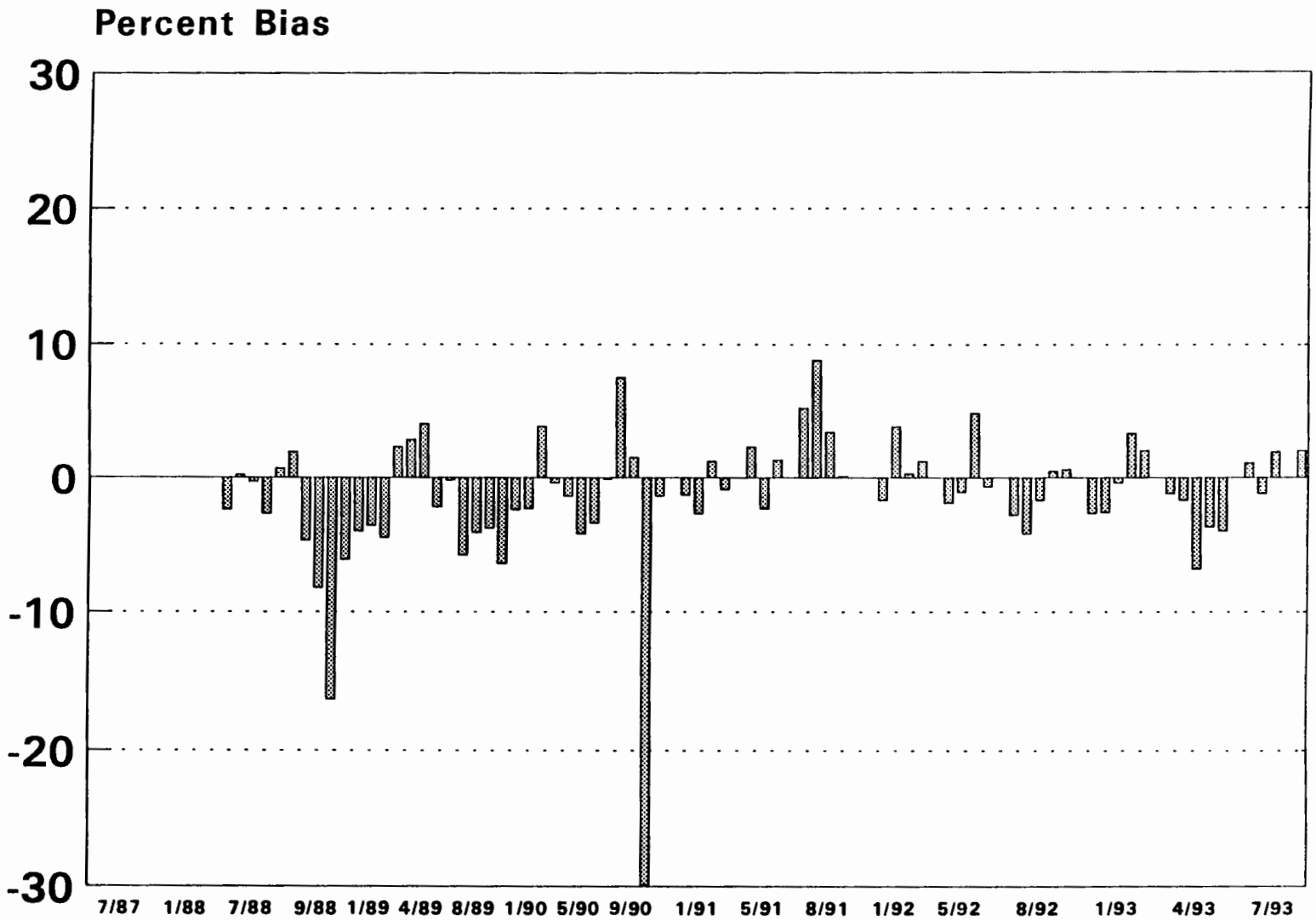
The following six pages constitute the individualized report for participant FSV-BY.

Laboratory FSV-BY
Retinol



% Bias from Assigned Values

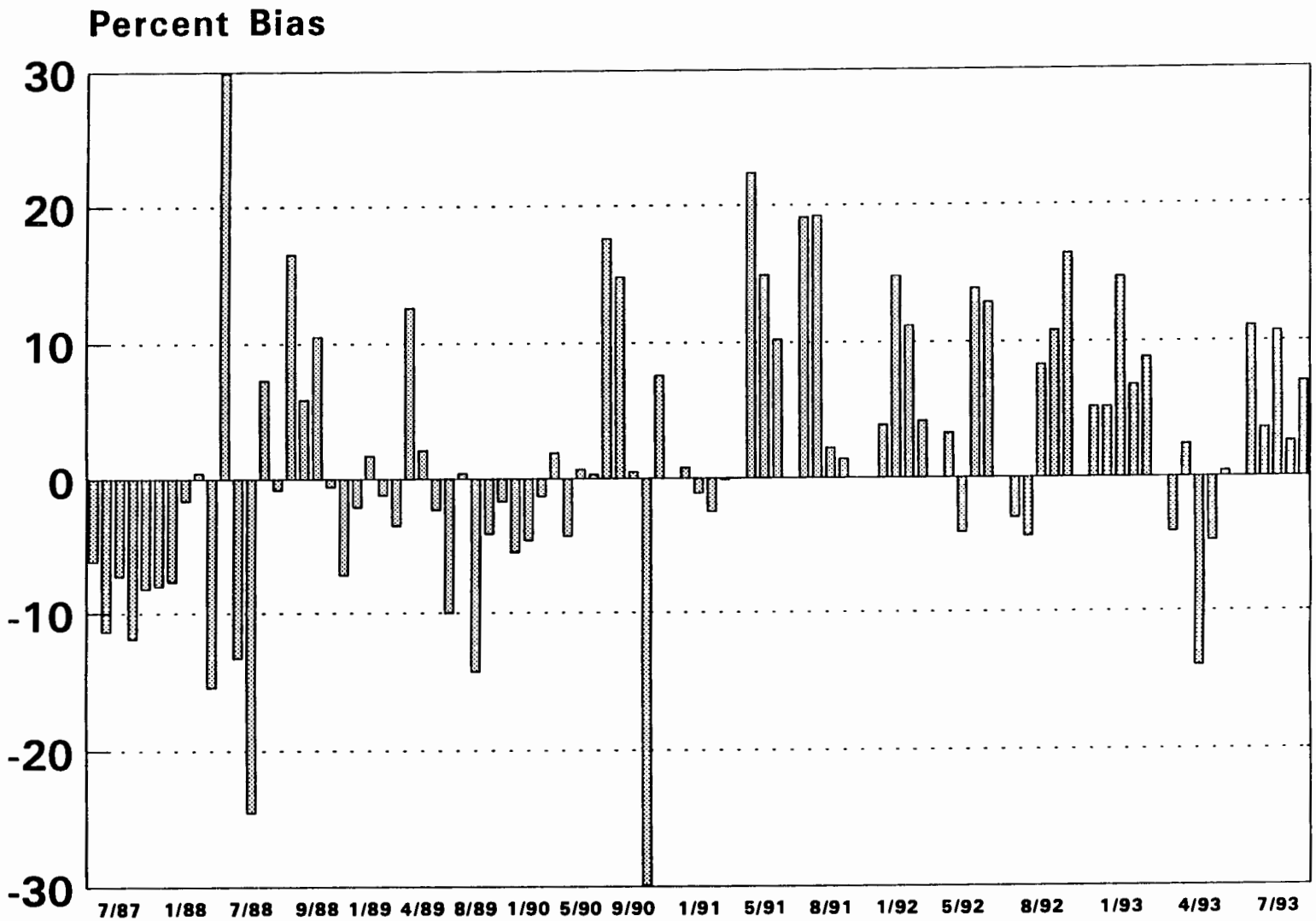
Laboratory FSV-BY
Alpha-Tocopherol



% Bias from Assigned Values

Laboratory FSV-BY

Total Beta-Carotene

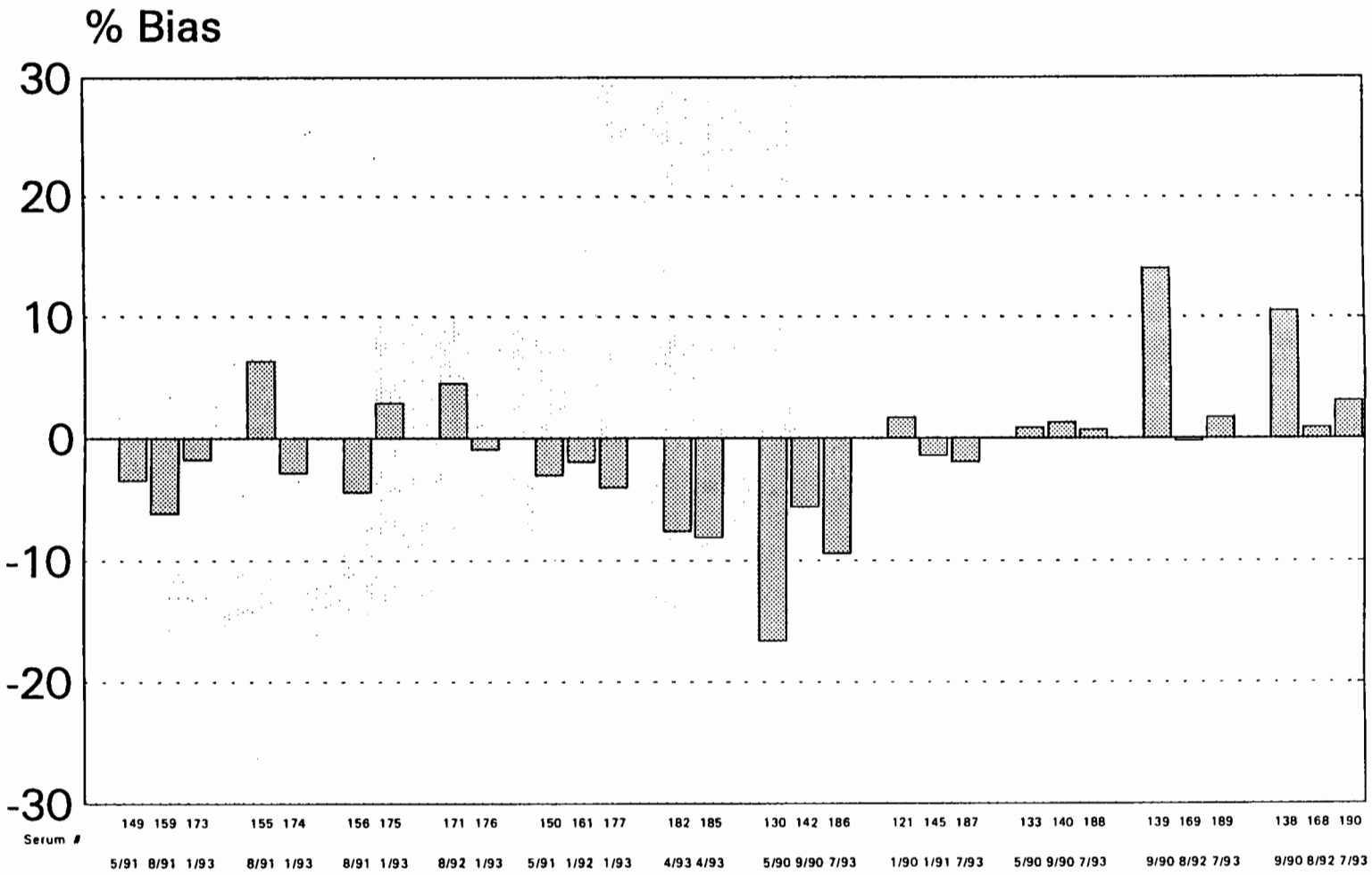


% Bias from Assigned Values

Laboratory FSV-BY

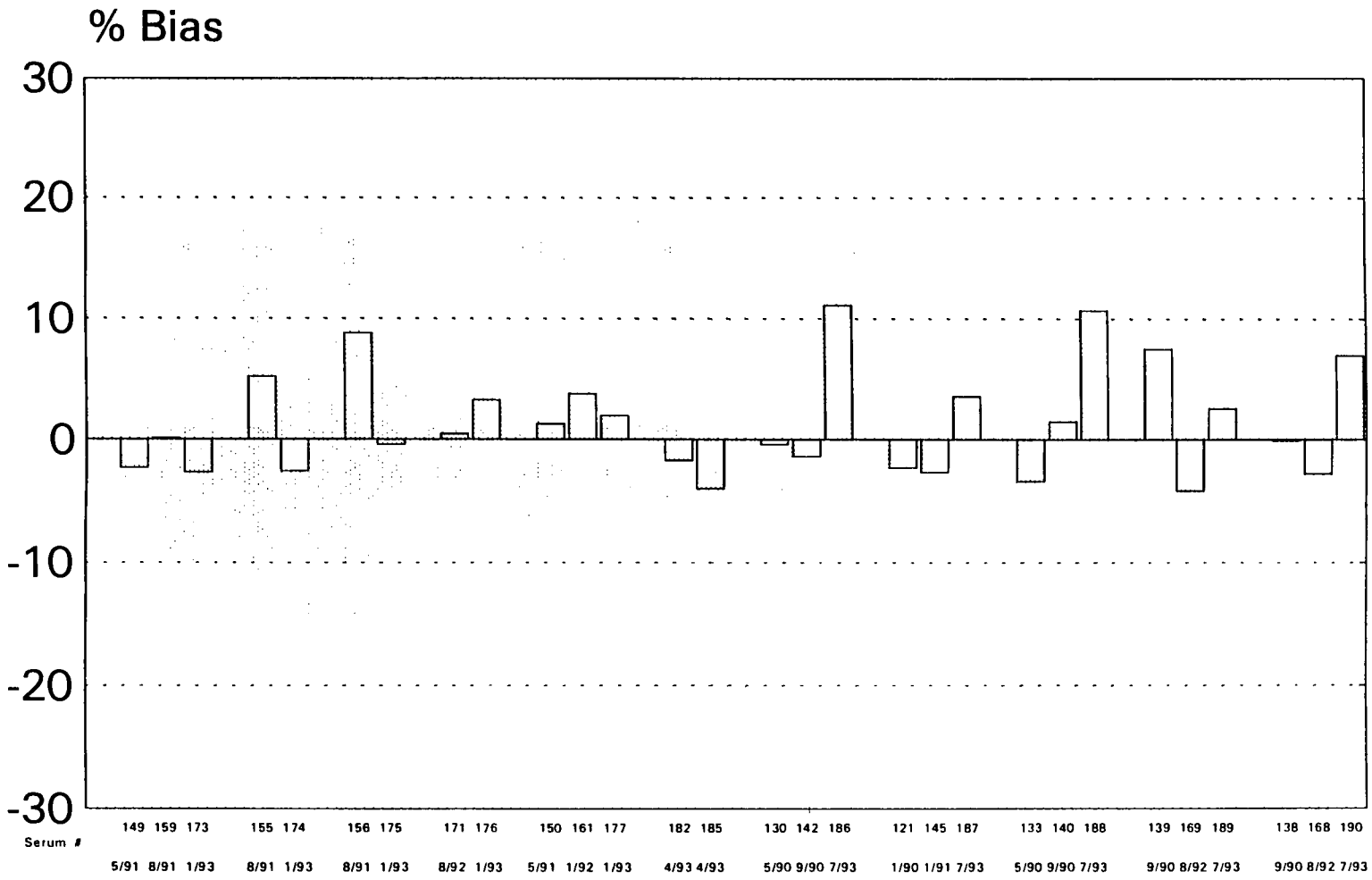
Blind Duplicate Performance

Retinol



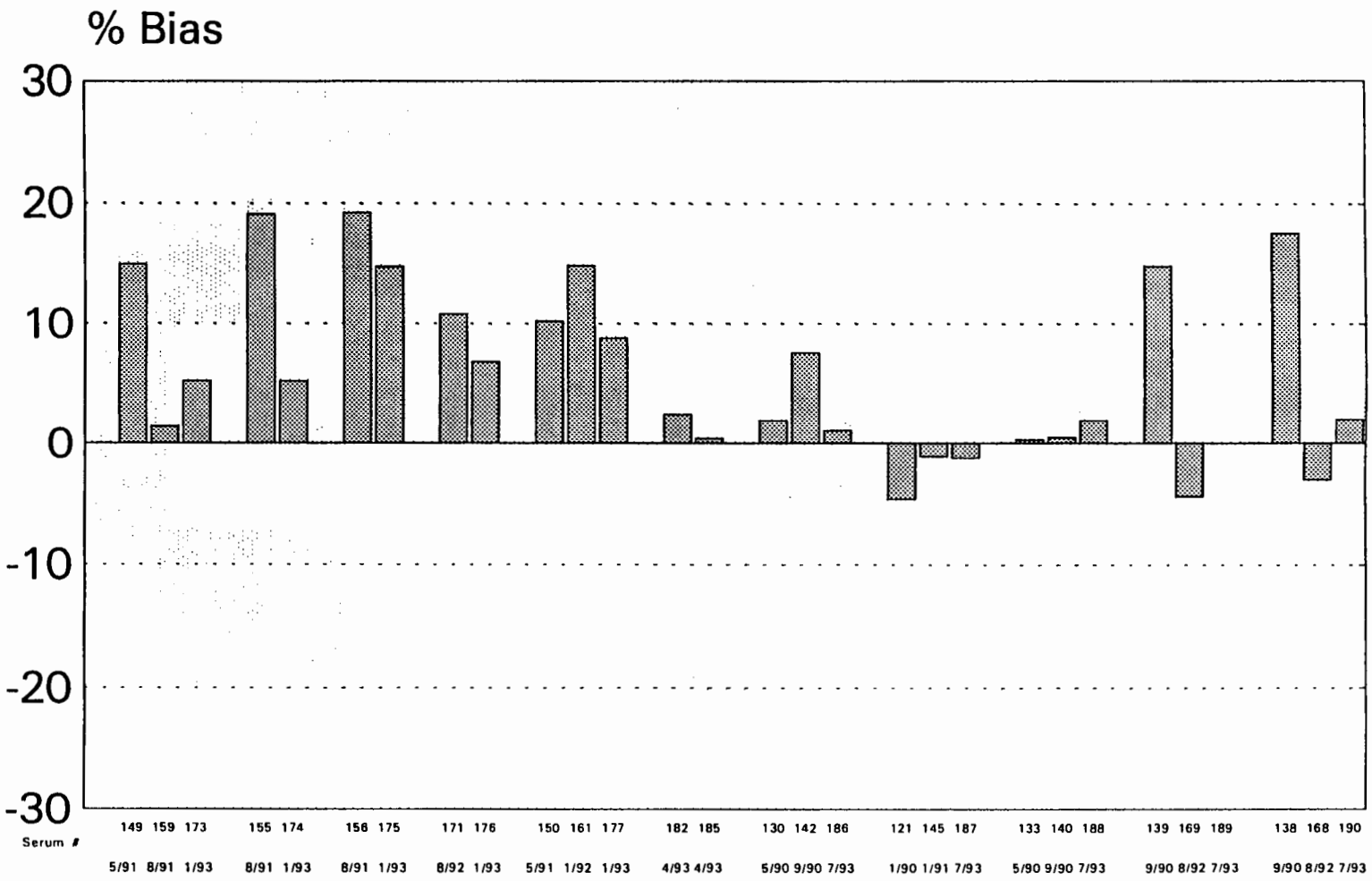
Laboratory FSV-BY

Blind Duplicate Performance
Alpha-Tocopherol



Laboratory FSV-BY

Blind Duplicate Performance
Total Beta-Carotene



Appendix L. Updated "All-Lab Report" for RR29

The following six pages are an updated version of an "All-Lab" report for RR29. This report has three parts:

- pages 1 to 4 list results for all analytes reported by at least twice, counting both participants and NIST analysts.
- page 5 lists values for all analytes reported by only once. This page also provides a legend for pages 1 to 4.
- page 6 summarizes each participants' performance for total retinol, α- and γ/β-tocopherol, and total β-carotene. These summaries are compatible with the percent bias evaluation advice given in the RR29 Report. However, the current bias summaries are estimated relative to the median of all reported values for each analyte in each serum rather than to the "Trimmed Core Lab Average" used in the original and detailed in Appendix J. These original reference values were estimated from on-time results of the more experienced participants, with subjective exclusion of results deemed non-representative.

To ensure confidentiality, the laboratory identifiers used in this "All-Lab Report" have been altered from those used in RR29. The only attributed results are those reported by NIST. The NIST results are not used in the assessment of the consensus summary results of the study.

Note: The analysts designated NISTa and NISTb in this updated All-Lab report are designated "NIST 1" and "NIST 3" in the Tables described in Appendix J.

Round Robin XXIX Laboratory Results

	Total Retinol, µg/mL					Retinyl Palmitate, µg/mL					α-Tocopherol, µg/mL					γ/β-Tocopherol, µg/mL				
Lab	186	187	188	189	190	186	187	188	189	190	186	187	188	189	190	186	187	188	189	190
FSV-BA	0.238	0.494	0.749	0.635	0.548	*nd*	0.052	0.015	0.087	0.227	3.79	6.66	11.41	9.60	9.97	0.837	1.104	2.40	2.41	1.50
FSV-BD	0.250	0.517	0.776	0.634	0.528						3.50	6.40	10.40	8.90	9.50					
FSV-BE	0.210	0.468	0.730	0.633	0.542						4.36	8.20	13.53	12.51	13.55	0.818	1.102	2.486	2.481	1.543
FSV-BF	0.230	0.489	0.749	0.642	0.551						3.74	6.83	11.80	10.27	10.85	0.940	1.020	2.520	2.640	1.460
FSV-BG	0.213	0.483	0.723	0.635	0.431				0.055	0.236	3.23	6.24	10.81	9.56	10.64					
FSV-BH	0.206	0.467	0.674	0.595	0.525	*nd*	*nd*	*nd*	0.062	0.168	3.83	6.69	12.62	9.56	10.26	0.770	0.960	2.34	2.24	1.37
FSV-BI	0.215	0.463	0.732	0.594	0.508	*nd*	*nd*	*nd*	0.092	0.295	3.64	6.58	11.64	9.60	10.16	0.780	1.020	2.390	2.360	1.430
FSV-BJ	0.240	0.505	0.764	0.640	0.558	*nd*	*nd*	*nd*	0.084	0.276	3.87	7.24	11.26	9.81	10.64	0.826	0.891	2.47	2.37	1.46
FSV-BK	0.201	0.455	0.657	0.710	0.626						3.40	6.85	11.11	9.69	10.41					
FSV-BL	0.428	0.894	0.716	0.682	0.563						3.88	7.00	12.22	9.44	10.16					
FSV-BM	0.186	*na*	0.707	0.636	0.558						3.60	*na*	11.50	9.70	10.40					
FSV-BN	0.216	0.517	0.796	0.620	0.595	0.163	*nd*	0.020	0.066	0.279	5.02	7.17	13.47	10.02	12.86					
FSV-BO	0.161	0.363	0.536	0.553	0.519						2.88	5.22	8.78	9.31	10.65					
FSV-BP	0.238	0.498	0.724	0.616	0.521						2.75	6.60	13.70	9.91	10.03					
FSV-BQ	0.201	0.485	0.746	0.588	0.526						3.86	6.24	11.68	9.33	10.01					
FSV-BR	0.227	0.512	0.755	0.648	0.530															
FSV-BT	0.215	0.458	0.767	0.721	0.587	*nd*	*nd*	*nd*	0.069	0.276	4.13	7.54	11.47	9.34	10.36	0.815	0.997	2.40	2.35	1.47
FSV-BY	0.206	0.478	0.739	0.647	0.559	*nd*	*nd*	*nd*	0.059	0.183	3.73	6.70	11.53	9.47	10.47	0.739	1.108	2.302	2.301	1.482
FSV-BZ											3.16	4.50	9.74	6.69	8.90	0.750	0.690	2.15	1.87	1.84
FSV-CA	0.243	0.493	0.697	0.563	0.514						3.58	6.56	10.93	8.40	9.43					
FSV-CB	0.313	0.493	0.777	0.626	0.561						2.60	5.70	13.10	10.10	10.40					
FSV-CG	0.079	0.150	0.221	0.182	0.165						0.46	0.84	1.34	1.12	1.24	0.100	0.160	0.32	0.31	0.21
FSV-CH	0.242	0.668	0.967	0.788	0.689						4.25	10.10	13.90	11.20	12.40	0.602	1.070	2.48	2.31	1.49
FSV-CJ	0.260	0.598	0.845	0.745	0.679						3.67	7.12	11.61	9.79	11.50					
FSV-CK	0.212	0.685	0.713	0.602	0.550						3.38	9.29	11.24	9.73	10.12	0.520	1.000	1.75	1.75	1.03
FSV-CM											3.67	6.84	12.19	9.53	10.18					
FSV-CO	0.218	0.466	0.726	0.592	0.510						3.57	6.53	11.58	9.44	10.11					
FSV-CP											3.10	5.73	9.97	8.32	8.85					
FSV-CQ	0.250	0.520	0.780	0.670	0.580						3.86	7.07	12.60	10.06	11.28					
FSV-CR	0.238	0.515	0.753	0.630	0.547						3.85	6.63	11.68	9.03	9.74					
FSV-CT	0.184	0.687	0.830	0.706	0.613						3.83	6.94	10.52	8.38	9.13					
FSV-CU	0.238	0.506	0.767	0.652	0.551	0.026	0.059	0.066	0.073	0.183	3.49	5.95	10.87	9.03	10.01					
FSV-CV	0.212	0.483	0.720	0.630	0.550						3.48	6.37	11.90	9.23	9.40	0.775	1.230	2.30	2.35	1.53
FSV-CX	0.250	0.550	0.830	0.660	0.520						4.10	6.80	10.60	9.40	10.50					
FSV-CY	0.219	0.499	0.728	0.648	0.499						3.94	6.87	11.77	8.50	10.27					
FSV-DJ	0.210	0.490	0.510	0.710	0.610						4.20	7.50	13.20	11.70	12.50					
FSV-DM	0.238	0.498	0.797	0.628	0.521						4.84	8.73	15.19	12.27	13.34					
FSV-DS	0.304	0.492	0.750	0.625	0.602						4.07	7.01	11.98	9.47	10.17					
FSV-DX	0.212	0.448	0.710	0.571	0.477						4.17	6.48	10.13	9.16	9.16					
FSV-EA	0.264	0.501	0.677	0.656	0.604						3.47	6.12	10.80	9.90	10.00	0.930	1.100	2.50	2.50	1.55
FSV-EB	0.233	0.485	0.684	0.656	0.561						3.77	6.92	10.29	10.26	11.58					
FSV-EC	0.170	0.336	0.570	0.460	0.377						0.13	0.22	0.43	0.36	0.36					
FSV-EI	0.196	0.469	0.621	0.619	0.496						2.89	5.88	10.41	8.86	9.52	0.630	0.830	2.26	2.50	1.39
FSV-EJ	0.154	0.458	0.645	0.678	0.585						3.91	7.41	12.13	11.35	11.70	0.545	0.774	2.42	2.53	1.49
FSV-EK	0.201	0.553	0.833	0.673	0.582						3.71	6.80	12.20	9.56	10.07	*nd*	1.229	2.73	2.69	1.66
FSV-EN	0.188	0.451	0.734	0.586	0.502						2.95	6.37	10.65	8.10	8.64	1.030	1.050	2.69	2.16	1.49
FSV-EX	0.200	0.500	0.720	0.630	0.550						3.66	7.31	11.91	10.43	11.16					
FSV-FC	0.230	0.488	0.721	0.614	0.690						3.40	6.32	10.75	9.43	12.55	0.710	0.900	2.24	2.26	1.75
FSV-FF	0.228	0.488	0.746	0.634	0.542															
n	46	45	46	46	46	2	2	3	9	9	47	46	47	47	47	18	19	19	19	19
Min	0.079	0.150	0.221	0.182	0.165	0.026	0.052	0.015	0.055	0.168	0.13	0.22	0.43	0.36	0.36	0.100	0.160	0.32	0.31	0.21
Mean	0.223	0.500	0.720	0.627	0.544	0.095	0.056	0.034	0.072	0.236	3.54	6.55	11.16	9.25	10.11	0.729	0.960	2.27	2.23	1.43
Max	0.428	0.894	0.967	0.788	0.690	0.163	0.059	0.066	0.092	0.295	5.02	10.10	15.19	12.51	13.55	1.030	1.230	2.73	2.69	1.84
SD	0.048	0.102	0.108	0.086	0.081	0.097	0.005	0.028	0.013	0.049	0.84	1.60	2.50	2.08	2.29	0.206	0.239	0.52	0.52	0.34
CV	22	20	15	14	15	103	9	84	18	21	24	24	22	22	23	28	25	23	23	24
NISTa	0.225	0.501	0.704	0.610	0.535						3.56	6.55	11.41	9.34	10.08	0.630	0.850	2.23	2.04	1.25
NISTb	0.203	0.462	0.695	0.589	0.510	*nd*	*nd*	*nd*	0.067	0.246	3.67	6.59	11.30	10.00	10.70	0.730	0.940	2.32	2.33	1.45
Median	0.217	0.492	0.731	0.634	0.550				0.069	0.236	3.67	6.69	11.53	9.53	10.18	0.773	1.020	2.40	2.35	1.49
eSD	0.031	0.034	0.050	0.033	0.045				0.015	0.064	0.36	0.56	1.07	0.56	0.70	0.094	0.125	0.15	0.19	0.08
eCV	14	7	7	5	8				21	27	10	8	9	6	7	12	12	6	8	5

L2

Round Robin XXIX Laboratory Results

	Total β-Carotene, µg/mL					trans-β-Carotene, µg/mL					Total cis-β-Carotene, µg/mL				
Lab	186	187	188	189	190	186	187	188	189	190	186	187	188	189	190
FSV-BA	0.937	1.082	0.530	0.482	1.732	0.885	1.015	0.499	0.448	1.675	*0.052*	*0.067*	*0.031*	*0.034*	*0.057*
FSV-BD															
FSV-BE	1.118	1.364	0.618	0.503	1.953										
FSV-BF	1.349	1.355	0.642	0.506	2.118										
FSV-BG	0.800	1.070	0.408	0.533	1.660										
FSV-BH	0.977	1.124	0.537	0.445	1.686	0.919	1.064	0.509	0.421	1.619	*0.058*	*0.060*	*0.028*	*0.024*	*0.067*
FSV-BI	0.886	1.034	0.492	0.424	1.513										
FSV-BJ	0.963	1.090	0.558	0.485	1.820										
FSV-BK															
FSV-BL															
FSV-BM															
FSV-BN	1.099	1.316	0.565	0.495	1.795	0.999	1.262	0.627	0.558	1.746	0.121	0.095	0.053	0.066	0.111
FSV-BO	0.984	1.134	0.489	0.334	1.794										
FSV-BP	0.378	0.984	0.466	0.393	1.342										
FSV-BQ	0.960	0.967	0.470	0.404	1.321										
FSV-BR															
FSV-BT	1.020	1.135	0.547	0.502	1.750	0.960	1.076	0.525	0.472	1.677	*0.060*	*0.059*	*0.022*	*0.030*	*0.073*
FSV-BY	0.958	1.078	0.533	0.449	1.689										
FSV-BZ	0.920	0.950	0.470	0.400	1.520										
FSV-CA															
FSV-CB	>0.685	>0.679	>0.344	>0.282	>1.256	0.685	0.679	0.344	0.282	1.256					
FSV-CG	0.180	0.227	0.115	0.099	0.403										
FSV-CH	0.786	1.050	0.462	0.467	1.400										
FSV-CJ	0.706	0.806	0.403	0.356	1.351	*0.678*	*0.772*	*0.383*	*0.304*	*1.275*	0.028	0.034	0.020	0.052	0.076
FSV-CK	0.854	0.569	0.424	0.370	1.320										
FSV-CM															
FSV-CO	0.933	1.044	0.529	0.443	1.659										
FSV-CP	0.801	0.914	0.456	0.382	1.463										
FSV-CQ	0.704	0.850	0.243	0.174	1.546										
FSV-CR															
FSV-CT	1.111	1.297	0.494	0.408	1.726										
FSV-CU	0.764	0.851	0.504	0.431	1.526	0.682	0.766	0.445	0.380	1.448	*0.082*	*0.085*	*0.059*	*0.051*	*0.078*
FSV-CV	0.985	0.985	0.520	0.420	1.570										
FSV-CX	0.870	1.040	0.520	0.420	0.170										
FSV-CY	0.916	1.200	0.485	0.440	2.070										
FSV-DJ															
FSV-DM	0.897	1.074	0.455	0.362	1.606										
FSV-DS	0.971	1.062	0.539	0.426	1.699										
FSV-DX	0.754	0.439	0.217	0.304	1.032										
FSV-EA	0.757	0.842	0.380	0.359	1.364										
FSV-EB	0.968	1.058	0.498	0.486	1.720										
FSV-EC	2.869	3.825	1.533	1.247	5.095										
FSV-EI	0.447	0.523	0.288	0.268	1.126										
FSV-EJ	0.688	0.733	0.393	0.330	1.230										
FSV-EK	0.913	0.990	0.484	0.390	1.717										
FSV-EN															
FSV-EX	1.070	1.150	0.560	0.490	1.650										
FSV-FC	0.930	1.090	0.505	0.433	1.928										
FSV-FF	1.058	1.352	0.619	0.565	2.111										
n	38	38	38	38	38	7	7	7	7	7	6	6	6	6	6
Min	0.180	0.227	0.115	0.099	0.170	0.678	0.679	0.344	0.282	1.256	0.028	0.034	0.020	0.024	0.057
Mean	0.928	1.070	0.499	0.432	1.636	0.830	0.948	0.476	0.409	1.528	0.067	0.067	0.036	0.043	0.077
Max	2.869	3.825	1.533	1.247	5.095	0.999	1.262	0.627	0.558	1.746	0.121	0.095	0.059	0.066	0.111
SD	0.386	0.521	0.204	0.164	0.697	0.143	0.212	0.095	0.096	0.202	0.032	0.021	0.016	0.016	0.018
CV	42	49	41	38	43	17	22	20	24	13	47	32	46	37	24
NISTa	0.962	1.210	0.559	0.495	1.600	0.939	1.160	0.538	0.470	1.540	*0.023*	*0.050*	*0.021*	*0.025*	*0.060*
NISTb	0.885	0.934	0.476	0.399	1.500	0.803	0.855	0.443	0.374	1.450	*0.082*	*0.079*	*0.033*	*0.025*	*0.050*
Median	0.925	1.054	0.493	0.425	1.655	0.885	1.015	0.499	0.421	1.619	0.059	0.064	0.030	0.043	0.075
eSD	0.162	0.136	0.062	0.087	0.228	0.169	0.360	0.080	0.076	0.188	0.022	0.019	0.013	0.016	0.008
eCV	18	13	13	20	14	19	35	16	18	12	38	30	43	38	11

L3

Round Robin XXIX Laboratory Results

	Total α-Carotene, µg/mL					Total Lycopene, µg/mL					trans-Lycopene, µg/mL					Total β-Cryptoxanthin, µg/mL				
Lab	186	187	188	189	190	186	187	188	189	190	186	187	188	189	190	186	187	188	189	190
FSV-BA	0.050	0.046	0.019	0.073	0.101						0.062	0.226	0.139	0.222	0.219	0.052	0.148	0.053	0.140	0.156
FSV-BD																				
FSV-BE	0.062	0.060	0.022	0.091	0.129															
FSV-BF	0.061	0.044	0.025	0.099	0.153	0.095	0.429	0.266	0.466	0.448										
FSV-BG																				
FSV-BH	0.040	0.034	0.021	0.063	0.097	0.098	0.372	0.209	0.353	0.341						0.051	0.175	0.056	0.159	0.183
FSV-BI	0.038	0.032	0.019	0.058	0.080	0.082	0.339	0.195	0.319	0.300						0.039	0.125	0.037	0.110	0.133
FSV-BJ	0.052	0.041	0.024	0.070	0.111	0.091	0.350	0.223	0.375	0.349										
FSV-BK																				
FSV-BL																				
FSV-BM																				
FSV-BN	0.047	0.038	0.027	0.077	0.127	0.102	0.382	0.261	0.432	0.430	0.074	0.339	0.222	0.321	0.333	0.039	0.125	0.041	0.103	0.130
FSV-BO	0.033	0.025	0.014	0.041	0.080	0.054	0.213	0.121	0.216	0.224						0.029	0.089	0.022	0.093	0.116
FSV-BP	*nd*	0.048	0.021	0.077	0.120	0.122	0.722	0.404	0.570	0.630						0.017	0.100	0.044	0.108	0.106
FSV-BQ																				
FSV-BR																				
FSV-BT	0.037	0.033	0.018	0.070	0.087	0.082	0.073	0.178	0.311	0.293						>0.096	>0.135	>0.046	>0.12	>0.146
FSV-BY	0.045	0.037	0.023	0.060	0.108	0.120	0.427	0.249	0.404	0.404						0.042	0.120	0.037	0.098	0.127
FSV-BZ	0.038	0.036	*nd*	0.048	0.081	0.090	0.200	0.126	0.185	0.250										
FSV-CA																				
FSV-CB	0.019	*nd*	*nd*	0.042	*nd*	0.021	0.065	0.040	0.065	0.068						0.024	0.067	0.024	0.061	0.073
FSV-CG	0.023	0.020	0.015	0.041	0.063	0.005	0.017	0.011	0.017	0.019						0.003	0.011	0.004	0.010	0.012
FSV-CH	0.046	0.044	0.036	0.118	0.112	0.112	0.435	0.232	0.428	0.368										
FSV-CJ						0.098	0.348	0.224	0.362	0.362						0.048	0.102	0.045	0.102	0.134
FSV-CK	0.051	0.024	0.025	0.079	0.118	0.158	0.321	0.288	0.491	0.498						0.093	0.134	0.052	0.129	0.152
FSV-CM																				
FSV-CO																				
FSV-CP	0.039	0.033	0.019	0.061	0.101	0.088	0.320	0.196	0.332	0.321						0.034	0.107	0.033	0.100	0.115
FSV-CQ																				
FSV-CR																				
FSV-CT																				
FSV-CU																				
FSV-CV	0.029	0.013	0.008	0.055	0.080	0.117	0.409	0.285	0.405	0.380										
FSV-CX	0.020	0.020	0.020	0.090	0.150	0.080	0.330	0.200	0.370	0.390						0.020	0.080	0.020	0.080	0.110
FSV-CY																				
FSV-DJ																				
FSV-DM																				
FSV-DS																				
FSV-DX	0.032	*nd*	*nd*	0.043	0.053						0.062	0.119	0.073	0.191	0.164					
FSV-EA	0.028	0.030	0.014	0.051	0.084	0.060	0.246	0.147	0.236	0.343										
FSV-EB																				
FSV-EC																				
FSV-EI	0.014	0.011	0.008	0.030	0.047	0.034	0.131	0.093	0.152	0.171						0.021	0.073	0.025	0.064	0.080
FSV-EJ	0.036	0.030	0.024	0.063	0.092	0.217	0.287	0.218	0.300	0.361										
FSV-EK						0.078	0.329	0.188	0.323	0.311						*nd*	0.208	*nd*	0.170	0.247
FSV-EN																				
FSV-EX																				
FSV-FC																				
FSV-FF																				
n	22	21	20	23	22	22	22	22	22	22	3	3	3	3	3	14	15	14	15	15
Min	0.014	0.011	0.008	0.030	0.047	0.005	0.017	0.011	0.017	0.019	0.062	0.119	0.073	0.191	0.164	0.003	0.011	0.004	0.010	0.012
Mean	0.038	0.033	0.020	0.065	0.099	0.091	0.307	0.198	0.323	0.330	0.066	0.228	0.145	0.245	0.239	0.037	0.111	0.035	0.102	0.125
Max	0.062	0.060	0.036	0.118	0.153	0.217	0.722	0.404	0.570	0.630	0.074	0.339	0.222	0.321	0.333	0.093	0.208	0.056	0.170	0.247
SD	0.013	0.012	0.006	0.021	0.028	0.045	0.154	0.087	0.135	0.133	0.007	0.110	0.075	0.068	0.086	0.022	0.047	0.015	0.040	0.052
CV	34	36	32	33	28	49	50	44	42	40	10	48	52	28	36	59	42	42	39	42
NISTa	0.060	0.037	0.033	0.066	0.115															
NISTb	0.069	0.056	0.031	0.072	0.130	0.169	0.491	0.300	0.484	0.503	0.066	0.215	0.134	0.202	0.206	0.023	0.067	0.020	0.060	0.074
Median	0.038	0.033	0.021	0.063	0.099	0.091	0.330	0.205	0.343	0.346						0.037	0.107	0.037	0.102	0.127
eSD	0.013	0.012	0.005	0.021	0.028	0.025	0.121	0.075	0.110	0.073						0.020	0.040	0.019	0.033	0.031
eCV	35	35	24	33	28	28	37	37	32	21						55	37	50	32	25

L4

Round Robin XXIX Laboratory Results

	Total Lutein, µg/mL					Total Zeaxanthin, µg/mL					Total Lutein&Zeaxanthin, µg/mL				
Lab	186	187	188	189	190	186	187	188	189	190	186	187	188	189	190
FSV-BA											0.103	0.257	0.153	0.246	0.263
FSV-BD															
FSV-BE															
FSV-BF															
FSV-BG															
FSV-BH	0.042	0.136	0.074	0.126	0.140	0.024	0.029	0.028	0.025	0.025	*0.066*	*0.165*	*0.102*	*0.151*	*0.165*
FSV-BI	0.043	0.118	0.071	0.117	0.144	0.023	0.033	0.026	0.044	0.043	*0.066*	*0.151*	*0.097*	*0.161*	*0.187*
FSV-BJ															
FSV-BK															
FSV-BL															
FSV-BM															
FSV-BN	0.037	0.136	0.074	0.128	0.156	0.021	0.042	0.032	0.053	0.045	0.069	0.182	0.117	0.190	0.226
FSV-BO	0.059	0.156	0.108	0.216	0.255										
FSV-BP															
FSV-BQ															
FSV-BR															
FSV-BT	>0.056	>0.136	>0.103	>0.168	>0.175	>0.019	>0.027	>0.031	>0.048	>0.048	*0.101*	*0.240*	*0.196*	*0.334*	*0.354*
FSV-BY	0.040	0.111	0.072	0.108	0.133	0.013	0.031	0.025	0.039	0.045	0.065	0.158	0.102	0.159	0.187
FSV-BZ	0.038	0.100	0.060	0.091	0.108										
FSV-CA															
FSV-CB											0.056	0.120	0.119	0.150	0.183
FSV-CG						0.180	0.410	0.289	0.430	0.536					
FSV-CH															
FSV-CJ											0.062	0.184	0.117	0.200	0.223
FSV-CK											0.086	0.300	0.150	0.217	0.254
FSV-CM															
FSV-CO															
FSV-CP											0.071	0.174	0.110	0.174	0.195
FSV-CQ															
FSV-CR															
FSV-CT	0.047	0.104	0.076	0.099	0.114	0.024	0.038	0.039	0.027	0.024	*0.071*	*0.142*	*0.115*	*0.126*	*0.138*
FSV-CU															
FSV-CV															
FSV-CX	0.060	0.090	0.120	0.180	0.230										
FSV-CY															
FSV-DJ															
FSV-DM															
FSV-DS															
FSV-DX	0.036	0.105	0.064	0.097	0.116										
FSV-EA															
FSV-EB															
FSV-EC															
FSV-EI	0.013	0.048	0.027	0.042	0.050	0.002	0.017	0.010	0.012	0.020	*0.015*	*0.065*	*0.037*	*0.054*	*0.070*
FSV-EJ															
FSV-EK	0.053	0.207	0.138	0.223	0.267										
FSV-EN															
FSV-EX															
FSV-FC															
FSV-FF															
n	11	11	11	11	11	7	7	7	7	7	12	12	12	12	12
Min	0.013	0.048	0.027	0.042	0.050	0.002	0.017	0.010	0.012	0.020	0.015	0.065	0.037	0.054	0.070
Mean	0.043	0.119	0.080	0.130	0.156	0.041	0.086	0.064	0.090	0.105	0.069	0.178	0.118	0.180	0.204
Max	0.060	0.207	0.138	0.223	0.267	0.180	0.410	0.289	0.430	0.536	0.103	0.300	0.196	0.334	0.354
SD	0.013	0.041	0.031	0.055	0.067	0.062	0.143	0.100	0.151	0.190	0.023	0.063	0.038	0.068	0.070
CV	30	34	38	43	43	151	167	155	167	180	33	35	32	38	34
NISTa															
NISTb	0.040	0.117	0.074	0.115	0.143	0.026	0.045	0.039	0.053	0.055	*0.066*	*0.162*	*0.113*	*0.168*	*0.198*
Median	0.042	0.111	0.074	0.117	0.140	0.023	0.033	0.028	0.039	0.043	0.068	0.169	0.116	0.168	0.191
eSD	0.007	0.031	0.015	0.030	0.039	0.003	0.007	0.006	0.021	0.027	0.007	0.034	0.021	0.041	0.050
eCV	18	28	20	25	28	13	22	21	53	62	10	20	18	24	26

L5

Round Robin XXIX Laboratory Results

Analytes Reported By One Laboratory

Values in µg/mL

Analyte	Code	186	187	188	189	190
δ-Tocopherol	NISTb	*nd*	0.109	0.142	0.104	0.076
trans-α-Carotene	NISTb	0.048	0.043	0.024	0.068	0.097
trans-β-Cryptoxanthin	FSV-BT	0.096	0.135	0.046	0.120	0.146
trans-Lutein	FSV-BT	0.056	0.136	0.103	0.168	0.175
trans-Zeaxanthin	FSV-BT	0.019	0.027	0.031	0.048	0.048
cis-Lutein&Zeaxanthin	FSV-BT	0.027	0.077	0.063	0.118	0.131
trans-Lutein&Zeaxanthin	FSV-BT	0.074	0.163	0.133	0.216	0.223

Legend

na	Not available for analysis
nd	Not detected (i.e., not reported or reported as '0', 'not determined', etc.)
>x	Value greater than x
italics	Value calculated from reported results
n	Number of non-NIST laboratories reporting quantitative results
Min	Minimum non-NIST reported value.
Mean	Average over all non-NIST reported values.
Max	Maximum non-NIST reported value.
SD	Standard deviation over all non-NIST values.
CV	Coefficient of Variation (% relative standard deviation): 100*SD/Mean
Median	Median over all non-NIST reported values
eSD	Robust estimate of SD based on the adjusted median absolute difference from the median (MADe)
eCV	Robust estimate of CV, 100*eSD/Median

Round Robin XXIX Laboratory Results

% Bias Summary

Lab	TR	aT	g/bT	bC
FSV-BA	2±4	0±2	4±4	6±5
FSV-BD	4±7	-6±2		
FSV-BE	-2±2	25±7	5±2	22±5
FSV-BF	2±3	4±3	7±10	30±10
FSV-BG	-5±9	-4±6		-1±17
FSV-BH	-6±1	3±4	-4±3	6±3
FSV-BI	-4±3	0±1	-1±2	-3±3
FSV-BJ	4±4	4±4	-1±7	9±5
FSV-BK	0±12	-1±4		
FSV-BL	37±48	3±3		
FSV-BM	-4±7	0±2		
FSV-BN	4±5	18±13		17±6
FSV-BO	-19±10	-13±13		0±13
FSV-BP	0±6	-1±16		-20±23
FSV-BQ	-4±4	-1±4		-7±9
FSV-BR	2±3			
FSV-BT	4±8	5±7	0±3	11±5
FSV-BY	-1±3	1±1	0±5	4±3
FSV-BZ		-21±10	-9±21	-6±4
FSV-CA	-2±9	-6±4		
FSV-CB	10±19	-4±17		-30±5
FSV-CG	-69±3	-88±0	-86±1	-78±2
FSV-CH	26±9	25±14	-3±11	-5±11
FSV-CJ	20±3	5±5		-20±3
FSV-CK	6±19	6±19	-24±12	-20±15
FSV-CM		2±2		
FSV-CO	-4±4	-1±1		2±3
FSV-CP		-14±1		-11±2
FSV-CQ	8±4	7±3		-32±22
FSV-CR	3±4	-1±4		
FSV-CT	12±19	-5±8		9±12
FSV-CU	4±4	-6±3		-8±10
FSV-CV	-1±1	-4±4	4±10	0±6
FSV-CX	8±9	1±7		-19±40
FSV-CY	-1±5	0±7		8±11
FSV-DJ	-2±17	17±5		
FSV-DM	3±6	31±1		-5±6
FSV-DS	10±17	4±5		4±4
FSV-DX	-7±5	-3±10		-40±17
FSV-EA	6±11	-4±5	9±7	-19±3
FSV-EB	1±5	3±9		5±6
FSV-EC	-27±5	-96±0		217±27
FSV-EI	-8±5	-11±6	-9±10	-43±9
FSV-EJ	-7±15	11±6	-9±17	-25±4
FSV-EK	6±8	2±3	15±4	-3±5
FSV-EN	-8±5	-12±6	8±16	
FSV-EX	-2±4	6±5		11±7
FSV-FC	5±12	1±13	-3±12	5±7
FSV-FF	1±3			26±7

Label	Definition
Lab	Participant code
TR	Total Retinol
aT	a-Tocopherol
g/bT	g/b-Tocopherol
bC	Total b-Carotene
% Bias	(Mean ± SD) of individual serum biases
Mean	Average of $(x_i\text{-Median}_i)/\text{Median}_i$
SD	Standard deviation of $(x_i\text{-Median}_i)/\text{Median}_i$
x_i	Result for analyte in serum_i
Median_i	Median of non-NIST results in serum_i

The original analysis listed % Bias for each result for each serum calculated relative to the "Trimmed Core Lab Average" of that analyte in the serum. The summary values reported here are the (arithmetic mean ± standard deviation) of each laboratory's reported results for the analyte estimated relative to each serum's median value.

Appendix M. Shipping Package Inserts for RR04

The following two items were included in each package shipped to a RR04 participant:

- Cover letter
- Report of Analysis datasheet

These items were attached to the shipping box.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

August 3, 1993

1~

2~

Dr. Margolis sent individual letters to invited study participants. The "~1" and "~2" were mail-merge commands for inserting a participant's name and address. This page was prepared from the original working draft.

Thank you for agreeing to measure the ascorbic acid in the accompanying samples. The samples which are in sealed ampoules were prepared by adding equal volumes of spiked human serum to 10% metaphosphoric acid (MPA). All samples have been stored at -70 °C and should be kept at this temperature. I have checked them for stability and the ascorbic acid appears sufficiently stable. If the samples arrive completely defrosted, please record the date of receipt and contact me immediately (301 / 975-3137).

You should find six ampoules in the shipping container. Each ampoule contains between 0.2 and 0.8 mg of ascorbic acid/dL of serum and each ampoule should be analyzed in duplicate by the method(s) used in your laboratory (preferably one measuring total ascorbic acid).

The samples should be defrosted by warming at 20 °C for not more than 10 min otherwise some oxidation of ascorbic acid may occur.

A report form is attached and I would appreciate it if you would make your measurements and return your results to me by **September 15, 1993**. Your results will be kept confidential. We will use these results in a study to demonstrate the comparative accuracy and precision of the laboratories currently measuring ascorbic acid. However, values will not be assigned to individual labs. If you wish to FAX your results, the number is (301) 926-8671. If you have any questions, I can be reached at (301) 975-3137.

Thank you for your assistance.

Sincerely,

Sam A. Margolis, Ph. D.
Research Chemist
Organic Analytical Research Division
Center for Analytical Chemisty

REPORT OF ANALYSIS

NAME:
ADDRESS:

Method of Analysis:

Date of Analysis:

Telephone Number:

FAX Number:

RESULTS (µg/mL)

SERUM 178, VIAL# _____

REPLICATE 1 _____ µg/mL
REPLICATE 2 _____ µg/mL

SERUM 178, VIAL# _____

REPLICATE 1 _____ µg/mL
REPLICATE 2 _____ µg/mL

SERUM 179B, VIAL# ____

REPLICATE 1 _____ µg/mL
REPLICATE 2 _____ µg/mL

SERUM 179B, VIAL# ____

REPLICATE 1 _____ µg/mL
REPLICATE 2 _____ µg/mL

SERUM 180, VIAL# _____

REPLICATE 1 _____ µg/mL
REPLICATE 2 _____ µg/mL

SERUM 180, VIAL# _____

REPLICATE 1 _____ µg/mL
REPLICATE 2 _____ µg/mL

Appendix N. Final Report for RR05

The following ten pages are the final report for RR05 as provided to all participants. This report contains:

- Cover letter and analysis of results.
- Table 1 "Results of the Round Robin Measurement of Ascorbic Acid in Human Plasma".
- Table 2 "NIST Results for the Measurement of AA in Human Plasma".
- Figure 1 "Box Plot of the Round Robin Results"
- Figure 2 "Distribution of the Round Robin Results for Lot 178"
- Figure 3 "Distribution of the Round Robin Results for Lot 179B"
- Figure 4 "Distribution of the Round Robin Results for Lot 180"
- A page intended to facilitate the participants' return of comments

A number of the results reported in the Tables were later revised to correct for miscommunication of the reporting units. Since the listed results do not necessarily represent measurement performance, the Lab identifiers used by Dr. Margolis have been redacted from these Tables rather than re-coded. The reporting unit confusion impacts some of the conclusions discussed in the cover letter. However, the results discussed in the Dr. Margolis's text have **not** been updated or corrected.

The "All Lab Report" in Appendix O lists the corrected results and provides more extensive statistical summaries.

UNITED STATES DEPARTMENT OF COMMERCE
National Institute of Standards and Technology
Gaithersburg, Maryland 20899-0001

January 27, 1994

The letter as distributed to participants has been lost. This version has been prepared from an extant draft.

Dear Colleague:

This report describes both the overall-group and your laboratory's performance in Round Robin IV for the measurement of ascorbic acid in human plasma. The study involve the duplicate analysis of four samples (two each from lots 178, 179B, and 180). Specifically, your package contains tabular presentations of all data submitted for ascorbic acid for Round Robin IV. Your results are designated "Data Set_#_" in the tables and figures.

Table 1 provides a summary of the data submitted by fourteen laboratories (the NIST data were not included in the statistical analysis). One laboratory submitted two sets of measurements, each done by a different method. As shown in Table 1, the percent Relative Standard Deviation (RSD) for all three lots ranged from 26.8 to 32.3. The intra-laboratory %RSD ranged from 3.6 to 9.6, indicating that the major source of variation was the interlaboratory variation. The box plot in Figure 1 is a graphic summary of the results. The minimum and maximum values for each lot are plotted as small solid circles, the two simple lines each span the next three “worst” above/below values and the center box contains the values from seven data sets. The NIST mean value for ascorbic acid (AA) + dehydro-AA are represented by a circle with a T inside and the NIST mean for reduced AA is represented by a R inside a circle. The horizontal line in the 50% boxes represents the median interlaboratory values which are slightly below the NIST values.

Figures 2 to 4 are plots of the distribution of the data points submitted by each laboratory for each sample lot. From these plots and the data in Table 1, it is apparent that the results obtained with the dinitrophenylhydrazine (DNPH) method (data sets 2 to 4), except for data set 3 lot 178, fall into a unique group of values which are higher than the NIST mean by approximately 10 to 25 %. Similarly all but one set of data obtained by LC methods are 5 to 15% below the NIST mean. Finally, one set of data (set 1) is exceptionally low. The high average mean of the DNPH measurements is not significant because of the wide distribution of values but it is consistent with previous round robins and suggests that the DNPH method may be positively biased. The basis of the distribution of the majority of the LC measurements below the NIST mean requires further evaluation along with the large variation in the results (%RSD = 27 to 32%). The observation that all of the gravimetrically added AA was accounted for (Table 2) also supports the need to continue these round robins in order to reduce the measurement variation.

The next set of samples, Round Robin V, will be shipped around the end of January or the early part of February. If you are interested in participating in Round Robin V, please indicate it on the enclosed sheet and return it via mail or FAX to:
Dr. Sam Margolis, NIST - Chemistry B156 Gaithersburg, MD 20899 (301)926-8671.

If you have any questions please contact me at (301)975-3137 or FAX at (301)926-8671.

Also on the enclosed sheet please indicate if you would like to participate in a one day workshop on the measurement of vitamin C to be held in conjunction with the Micronutrient Quality Assurance Workshop tentatively scheduled to be held at NIST in October 1994.

Sincerely,

Sam A. Margolis, Ph.D.
Research Chemist
Organic Analytical Research Division
Chemical Science and Technology Laboratory

Enclosures

Table 1. Results of the Round Robin Measurement of Ascorbic Acid in Human Plasma

Data Set[b]	Method	Ascorbic Acid (μmol/L Plasma)[a] Lot 178	Lot 179B	Lot 180
1	OPD	9.6 ± 0.1	38.6 ± 0.2	13.6 ± 0.1
2	DNPH	31.5 ± 5.9	180.6 ± 6.4	74.7 ± 12.2
3*	DNPH	23.7 ± 1.1	203.7 ± 7.8	46.1 ± 5.3
4	DNPH	39.3 ± 0.8	179.2 ± 1.0	56.1 ± 0.4
5	ENZ	23.9 ± 2.9	129.3 ± 1.5	38.0 ± 0.7
6	LC-EC	18.5 ± 0.7	120.2 ± 1.9	32.5 ± 1.3
7	LC-EC	19.6 ± 0	97.3 ± 2.7	29.1 ± 1.4
8*	LC-EC	23.3 ± 1.0	136.2 ± 3.9	41.8 ± 2.8
9	LC-EC	24.7 ± 1.8	155.8 ± 11.0	44.5 ± 3.1
10	LC-EC	22.0 ± 0.4	136.1 ± 3.8	38.3 ± 1.8
11	LC-EC	16.1 ± 6.1	139.2 ± 7.8	36.6 ± 8.0
12	LC-EC	24.1 ± 2.9	136.6 ± 6.3	39.2 ± 2.7
13	LC-EC	22.1 ± 0.5	128.9 ± 1.7	36.8 ± 0.7
14	LC-OPD	24.1 ± 1.43	149.3 ± 4.6	39.8 ± 2.1
15	DCIP	34.4 ± 2.3	137.4 ± 2.8	48.0 ± 2.3
MEAN		25.5 ± 8.2	144.5 ± 38.7	43.2 ± 13.9
SD		8.2	38.7	13.8
%RSD		32.3	26.8	32.1
NIST AA + DHAA	LC-EC	27.0 ± 0.5	154.4 ± 1.1[d]	42.7 ± 0.3
NIST AA	LC-EC	10.2 ± 0.4	67.2 ± 26.4[c]	15.1 ± 0.4

[a] Values represent the mean and SD of replicate measurements on two samples (total of 4 measurements).

[b] The Data Set numbers correspond to those in the figures 2-4 (Sets 3* and 8* were measured in the same laboratory).

[c] Values represent the mean and SD of measurements on five samples (total of 5 measurements).

[d] Vales represent the mean and SD of replicate measurements on five samples (total of 10 measurements).

Method Legend

OPD	Orthophenlyenediamine
DNPH	2,4-Dinitrophenylhydrazine
ENZ	Enzyme conversion (ascorbate oxidase)
LC-EC	Liquid chromatography with electrochemical detection
DCIP	2,6-dichlorophenolindophenol

Table 2. NIST Results for the Measurement of AA in Human Plasma

Lot No.	Ascorbic Acid (μmol/L) without DTT (AA)	with DTT (AA+DHAA)	Supplemented Amount
Plasma 1	5.1 ± 1.1 (4)[a]	11.5 ± 0.2 (4)	
178	10.2 ± 0.4 (4)	27.0 ± 0.5 (4)	15.8
179	12.1 ± 3.9 (10)	43.5 ± 1.5 (10)	32.1
180	15.1 ± 0.4 (4)	42.7 ± 0.3 (4)	31.6
Plasma 2	18.9 ± 6.5 (4)	52.2 ± 1.6 (4)	
179B	67.2 ± 26.4 (5)	154.4 ± 1.1 (10)	101.3

[a] The value in parentheses is the number of measurements made.

Figure 1. Box Plot of the Round Robin Results

Figure 2. Distribution of Round Robin Results for Lot 178

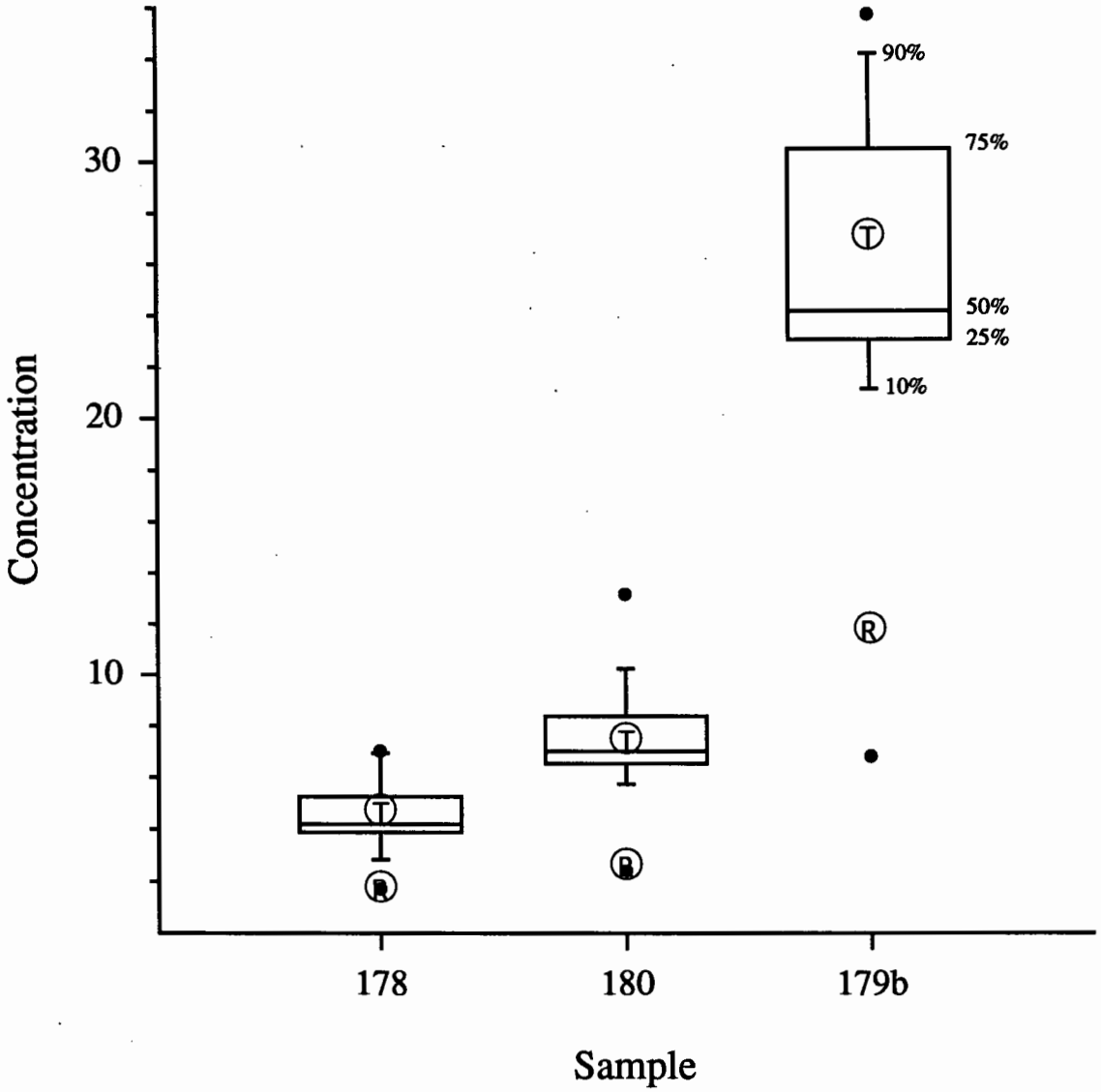
Figure 3. Distribution of Round Robin Results for Lot 179B

Figure 4. Distribution of Round Robin Results for Lot 180

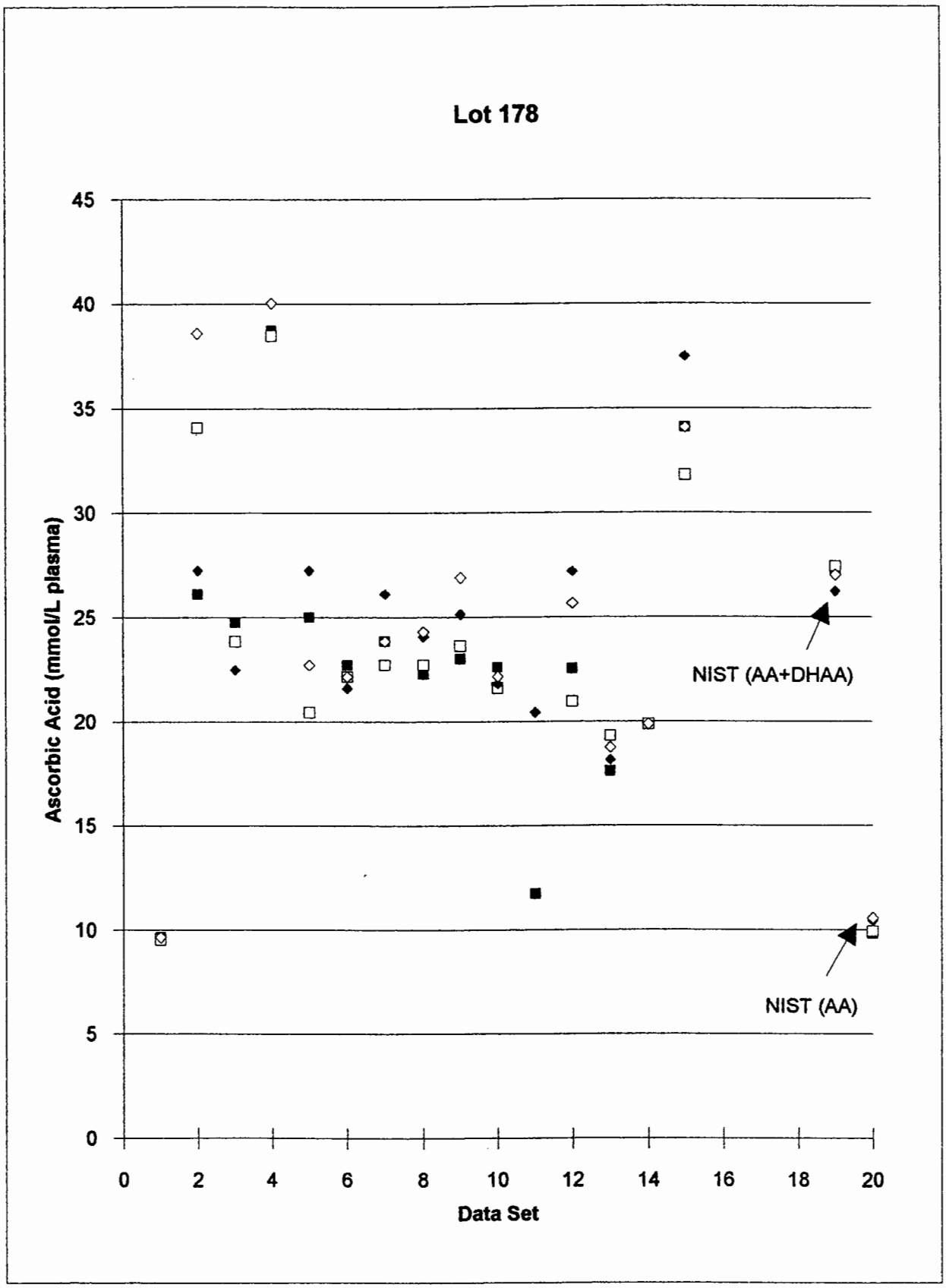
Key for Figures 2-4:

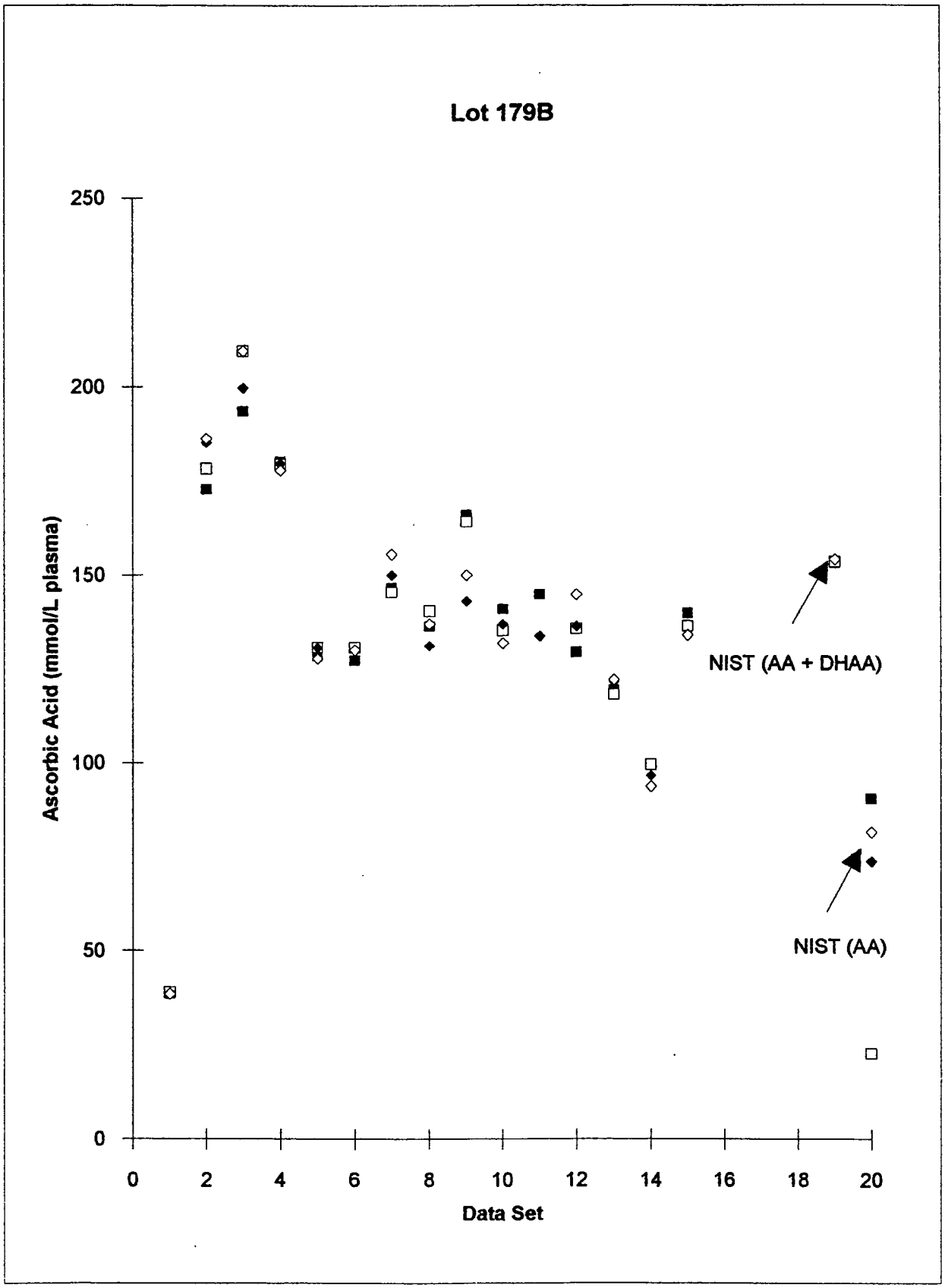
■ First Vial; First Measurement
♦ Second Vial; First Measurement
□ First Vial: Second Measurement
◊ Second Vial;Second Measurement

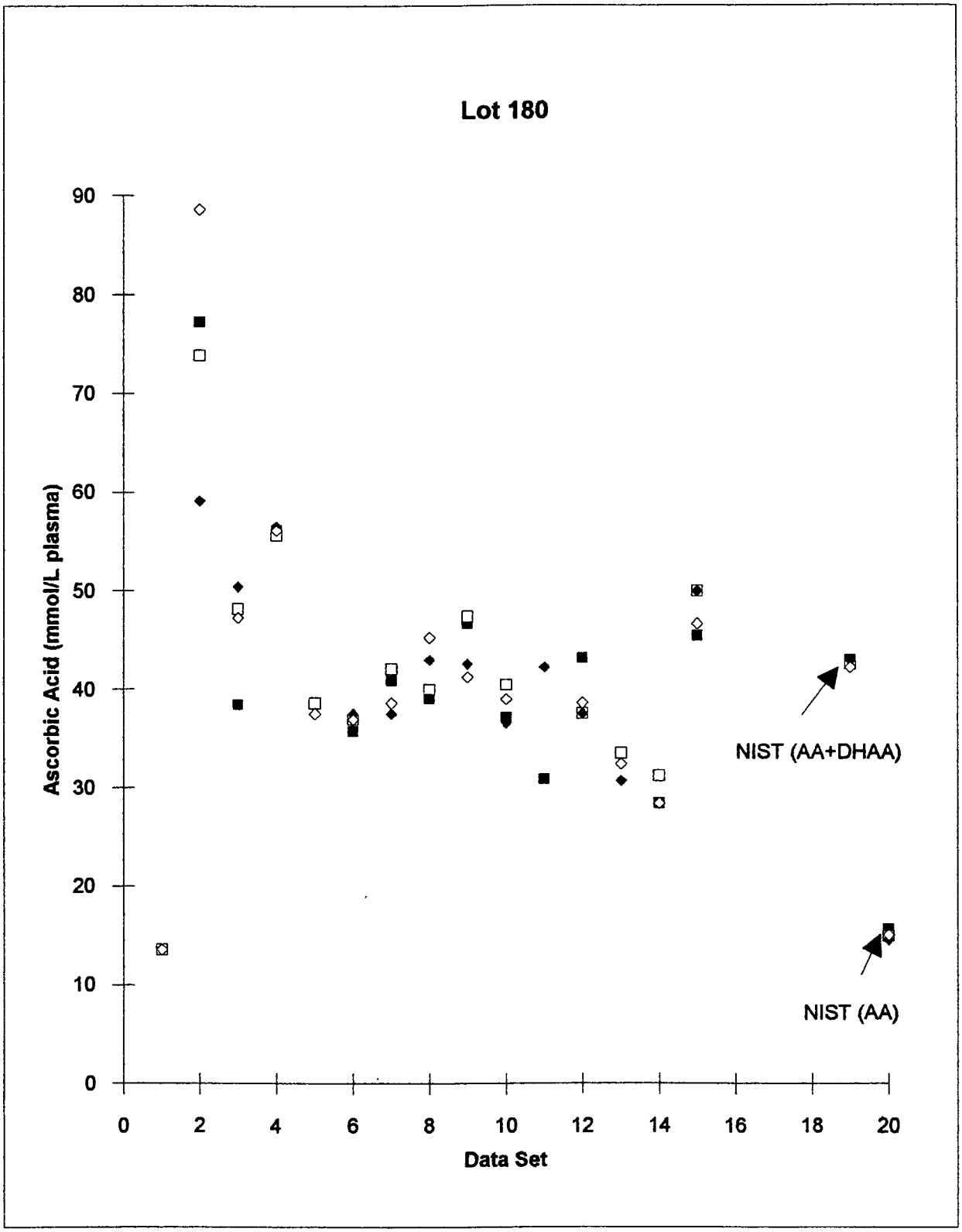
Data Set 19 are the NIST values for AA+DHAA
Data Set 20 are the NIST values for AA



Ascorbic Acid


Lot 178
Ascorbic Acid (mmol/L plasma)
45
40
35
30
25
20
15
10
5
0
0
2
4
6
8
10
12
14
16
18
20
Data Set
NIST (AA+DHAA)
NIST (AA)


Lot 179B
Ascorbic Acid (mmol/L plasma)
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
Data Set
NIST (AA + DHAA)
NIST (AA)


Lot 180
Ascorbic Acid (mmol/L plasma)
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Data Set
NIST (AA+DHAA)
NIST (AA)

NCI QUALITY ASSURANCE PROGRAM

To: Sam Margolis
NIST

Phone: (301) 975-3137
FAX: (301) 926-8671

From: Title~
Company~
Address~

Lab Number: Lab No.~

Dr. Margolis sent individual letters to invited study participants. The "Title~", "Company~", "Address~", and "Lab No.~" were mail-merge commands for inserting a participant's name, address, and laboratory code number.

Please Check Your Response:

I would like to participate in 1994 Vitamin C Round Robins V and VI. ☐ YES ☐ NO

I would like to attend the Vitamin C Workshop to be held in conjunction with the Micronutrient Workshop at NIST in 1994. ☐ YES ☐ NO

Appendix O. Updated "All-Lab Report" for VC-RR04

The following two pages are an updated "All-Lab Report" for RR04. This report contains the same information as originally provided to all participants, with the following exceptions:

- the participant identifiers (Lab) have been altered to ensure confidentiality of identification codes assigned to laboratories..
- the order in which the participant results are listed has been altered.
- results have been corrected and transformed to have units of µmol/L sample.
- additional summary statistics have been included.
- a Legend page has been added

Vitamin C Round Robin 4

			178, [TAA] μmol/mL					179B, [TAA] μmol/mL					180, [TAA] μmol/mL				
Lab	Date	Method	Mean	S_{dup}	S_{rep}	S_{het}	S_{tot}	Mean	S_{dup}	S_{rep}	S_{het}	S_{tot}	Mean	S_{dup}	S_{rep}	S_{het}	S_{tot}
VC-MA	16-Sep-93	HPLC-UV	11.1	0.2	0.2	0.1	0.2	64.4	0.0	1.0	0.0	1.0	18.4	0.3	0.3	0.2	0.4
VC-MB	24-Aug-93	AO	11.9	0.8	1.6	0.0	1.6	64.7	0.1	0.9	0.0	0.9	18.0	1.8	2.0	1.1	2.3
VC-MC	9-Sep-93	AO-OPD	11.7	0.6	0.3	0.6	0.7	101.5	1.1	4.7	0.0	4.7	23.0	2.0	2.6	0.8	2.7
VC-MD	9-Sep-93	HPLC-EC	11.7	0.6	0.1	0.6	0.6	68.1	1.5	1.8	0.8	2.0	20.9	1.6	0.6	1.5	1.7
VC-ME	24-Jan-94	24DNPH	12.8	0.2	0.2	0.1	0.2	66.5	1.3	2.0	0.0	2.0	20.7	0.0	0.0	0.0	0.0
VC-MV	13-Sep-93	HPLC-UV	9.9	0.0	0.0		0.0	48.6	1.5	0.7		0.7	14.5	0.5	0.7		0.7
VC-NB	7-Jan-94	HPLC-EC	12.1	1.6	0.3	1.6	1.6	87.5	1.3	1.3	0.9	1.6	22.0	0.8	1.6	0.0	1.6
VC-NC	13-Sep-93	HPLC-EC	19.6	0.6	0.2	0.6	0.6	89.6	0.4	0.5	0.1	0.5	28.0	0.1	0.2	0.1	0.2
VC-NG	14-Sep-93	HPLC-EC	12.3	1.0	0.5	0.9	1.0	77.9	6.5	1.8	6.4	6.6	22.2	1.8	0.4	1.8	1.8
VC-NN	3-Sep-93	24DNPH	15.8	1.0	3.5	0.0	3.5	90.3	3.6	1.4	3.5	3.8	37.3	0.6	7.4	0.0	7.4
VC-NP	12-Jan-94	HPLC-EC	11.2	1.4	0.1	1.4	1.4	63.4	0.3	0.8	0.0	0.8	20.1	0.0	0.1	0.0	0.1
VC-NS	15-Sep-93	HPLC-EC	12.1	0.6	0.6		0.6	74.7	2.4	1.4		1.4	19.9	1.2	0.4		0.4
VC-NT	23-Aug-93	HPLC-EC	4.8	0.0	0.0	0.0	0.0	19.3	0.2	0.3	0.0	0.3	6.8	0.0	0.1	0.0	0.1
VC-NW	21-Sep-93	HPLC-UV	9.2	0.0	0.4	0.0	0.4	60.1	1.1	0.3	1.1	1.1	16.3	0.7	0.4	0.6	0.8
NIST		HPLC-EC	13.5	0.2	0.2	0.2	0.3	77.2	0.5	0.0	0.5	0.5	21.3	0.1	0.2	0.0	0.2
		N	14					14					14				
		Min	4.8	0.0	0.0	0.0	0.0	19.3	0.0	0.3	0.0	0.3	6.8	0.0	0.0	0.0	0.0
		Median	11.8	0.6	0.3	0.4	0.6	67.3	1.2	1.2	0.1	1.3	20.4	0.7	0.4	0.1	0.7
		Max	19.6	1.6	3.5	1.6	3.5	101.5	6.5	4.7	6.4	6.6	37.3	2.0	7.4	1.8	7.4
		eSD	1.0					13.3					3.3				
		eCV	9					20					16				

O2

Datasets

Each participant typically reported two replicate measurements for each of two duplicate vials for each test sample. However, occasionally only one vial of each pair was evaluated or a single result was reported for each of the duplicate vials.

Legend

Lab	Laboratory Code
Date	Date that the results were received at NIST
Method	Type of assay
	AO — Ascorbate oxidase
	24DNPH — 2,4-Dinitrophenylhydrazine
	EC — Electrochemical detector
	HPLC — Liquid chromatography
	OPD — Orthophenlyenediamine
	UV — Ultraviolet absorbance
Mean	Mean of duplicate means
S_{dup}	Standard deviation of duplicate means
S_{rep}	Pooled standard deviation of replicates
S_{het}	Estimated sample heterogeneity, $\sqrt{\mathrm{MAX}\left(0, S_{dup}^2 - S_{het}^2\right)}$
S_{tot}	Estimated standard deviation of the mean, $\sqrt{\left(S_{dup}^2 + S_{rep}^2\right)/n}$, where n is the number of vials evaluated and is typically 2.
N	The number of participants
Min	Minimum value in the column
Median	Median value in the column
Max	Maximum value in the column
eSD	Adjusted median absolute deviation from the median (MADe)
eCV	Estimated coefficient of variation, 100*eSD/Median