AOAC SMPR® 2025.003

Standard Method Performance Requirements (SMPRs®) for Determination of Selected Trace Elements in Food and Beverages

Intended Use: Surveillance and Monitoring by Trained Technicians

Purpose

What: AOAC *Standard Method Performance Requirements* (SMPRs®) are voluntary consensus standards developed in accordance with the AOAC policy, "AOAC Due Process for Development of AOAC Non-Method Consensus Standards and Documents." SMPRs describe a scientific community's recommended minimum method performance characteristics and analytical requirements for a specific method-related intended use.

Who: Drafted by AOAC working groups, SMPRs are adopted by AOAC by a consensus of stakeholders affiliated with its integrated science programs and projects which are composed of volunteer subject matter experts representing academia, government, industry, and nonprofit sectors from around the world.

Use: AOAC SMPRs are used in the AOAC core science programs as a resource for AOAC method experts, including expert review panels (ERPs), in the evaluation of validation study data for methods submitted to the AOAC *Official Methods of Analysis*℠ and AOAC *Performance Tested Methods*℠ programs. AOAC SMPRs also may be used to provide acceptance criteria for the verification of methods and serve as a resource to guide method development and optimization.

1 Applicability

Quantification of total concentration of elements listed in Table 1 with priority given to a variety of food and beverage matrix categories (including infant formula), and multi-element methods. Some of the elements in the infant formula matrix category are addressed by other SMPRs and are specified in Table 1. Elements in addition to those in Table 1 may be included.

2 Analytical Technique

Inductively coupled plasma-based mass spectrometry (ICP-MS) or alternative technique that meets performance requirements.

3 Definitions

Limit of quantitation (LOQ).—Minimum concentration or mass of analyte in a given matrix that can be reported as a quantitative result.

Recovery.—Fraction or percentage of naturally present or spiked analyte that is recovered when test sample is analyzed using the entire method.

Repeatability.—Variation arising when all efforts are made to keep conditions constant by using the same instrument and operator, and repeating during a short time period. Expressed as the repeatability standard deviation (SD_r); or % repeatability relative standard deviation ($\%RSD_r$).

Reproducibility.—Standard deviation or relative standard deviation calculated from among-laboratory data. Expressed as the reproducibility standard deviation (SD_R); or % reproducibility relative standard deviation ($\%RSD_R$).

Total acid extractable.—Elemental concentration that can be extracted under an acid digestion environment using a single acid or combination of acids such as HNO_3, HCl plus H_2O_2. For food and beverage samples, the use of HF is not required in this definition of 'total acid extractable.'

4 Method Performance Requirements

Multiple elements are listed in Tables 1 and 2; while preference will be given to methods with more elements, it is not necessary for a submitted method to contain all the elements.

LOQ and performances for all elements are listed and derived from various sources, including regulatory limits (current and potential), CODEX requirements and guidance, and generally recognized instrument/method performance. While it is desirable that submitted methods be able to meet the listed LOQs and performances, failure to meet a listed LOQ or performances does not preclude a method from consideration.

Only recovery, repeatability, and reproducibility criteria above the corresponding LOQs for each element need be satisfied. For example, criteria at <10 µg/kg does not need to be evaluated for Zn as the LOQ is 500 µg/kg. *See* Tables 1 and 2.

5 System Suitability Tests and/or Analytical Quality Control

Suitable methods will include processed blank check samples, and second source check standards at the lowest point and/or mid-range point of the analytical range.

Table 1. Elements and their target limits of quantitation

Element	CAS No.	LOQ, µg/kg
Aluminum	7429-20-5	300
Antimony	744-36-0	2 (in liquid matrices); 40 (in solid matrices)
Barium	744-39-3	100
Chromium[a]	7440-47-3	8
Cobalt	7440-48-4	20
Copper[b]	7440-50-8	10
Manganese[b]	7439-96-5	10
Molybdenum[a]	7439-98-7	20
Nickel	7440-02-0	50
Selenium[a]	7782-49-2	10 (in liquid matrices); 100 (in solid matrices)
Silver	7440-22-4	10
Thallium	7440-28-0	5
Tin	7440-31-5	30
Vanadium	7440-62-2	30
Zinc[b]	7440-66-6	500

[a] Total chromium (Cr), molybdenum (Mo), and selenium (Se) in all forms of infant, adult, and/or pediatric formula (powders, ready-to-feed liquids, and liquid concentrates) are addressed by AOAC SMPR 2011.009. AOAC **2011.19** (ICP-MS) is the corresponding AOAC Final Action *Official Method*℠ that meets AOAC SMPR 2011.009.

[b] Copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) are trace elements in all forms of infant, adult, and/or pediatric formula (powders, ready-to-feed liquids, and liquid concentrates) and are addressed by AOAC SMPR 2014.004. AOAC **2015.06** (ICP-MS) and AOAC **2011.14** (ICP-AES) are the corresponding AOAC Final Action *Official Methods*℠ that meet AOAC SMPR 2014.004.

Table 2. Recovery, repeatability, and reproducibility

	Concentration, µg/kg		
Parameter	<0	10 to <100	≥100
Recovery, %	40–120	60–115	80–110
Repeatability, %	≤30	≤21	≤15
Reproducibility, %	≤44	≤32	≤22

6 Reference Material(s)

A certified reference material should be used when available. Alternatively, internally produced reference materials may be used until a reference material for a specific representative commodity is made available by an internationally recognized organization, such as Institute for Reference Materials Measurements (IRMM) or U.S. National Institute of Standards and Technology (NIST).

"Annex E: AOAC Method Accuracy Review" and "Annex F: Development and Use of In-House Reference Materials" in "Appendix F: Guidelines for *Standard Method Performance Requirements*," *Official Methods of Analysis of AOAC INTERNATIONAL* (2023) 22nd Ed., AOAC INTERNATIONAL, Rockville, MD, USA. Available at: https://doi.org/10.1093/9780197610145.005.006

7 Validation Guidance

Recommended level of validation:

Official Methods of Analysis℠.—All submitted methods must be accompanied by validation data upon which the AOAC ERP can undertake a comprehensive review. A minimum of a complete single-laboratory validation (SLV) is required for AOAC First Action status. However, method reproducibility will be required for any method to attain AOAC Final Action status. The method performance parameters may be required or expected depending upon the nature of the analytes, matrices, and techniques pertinent to the method. Use the information in this SMPR to support the minimum necessary types of method validation data collection required.

Additional information on other validation parameters may be found in "Appendix F: Guidelines for *Standard Method Performance Requirements*" of the *Official Methods of Analysis of AOAC INTERNATIONAL.* AOAC guidelines containing information on acceptable experimental designs used to collect this data may be found in the appendices of the *Official Methods of Analysis of AOAC INTERNATIONAL*, available at: https://doi.org/10.1093/9780197610145.005.006.

Also available <USP233>.

8 Maximum Time-to-Result

None.

Approved by stakeholders associated with AOAC Trace Elements Program. Final version: December 9, 2025. Effective date: November 14, 2025