NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
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Standard Reference Material® 1568c
Rice Flour
CERTIFICATE OF ANALYSIS

Purpose: The certified values delivered by this Standard Reference Material (SRM) are intended for validating methods for determining elements and arsenic species in rice flour and similar matrices. The certified values can be used for quality assurance, such as when assigning values to in-house control materials.

Description: A unit of SRM 1568c consists of one bottle containing approximately 50 g of material. The bottle is sealed inside an aluminized pouch.

Certified Values: These values are metrologically traceable to the International System of Units (SI) derived unit for mass fraction, expressed as milligrams per kilogram on a dry-mass basis [1,2]. The certified values for elements and arsenic species in SRM 1568c are provided in the tables below.

Table 1. Certified Mass Fraction Values (Dry-Mass Basis) for Elements in SRM 1568c

Element	Mass Fraction[(a)] (mg/kg)	Element	Mass Fraction[(a)] (mg/kg)
Arsenic (As)	0.367 ± 0.015	Mercury (Hg)	0.001 785 ± 0.000 050
Cadmium (Cd)	0.009 89 ± 0.000 40	Molybdenum (Mo)	0.638 ± 0.021
Calcium (Ca)	102.3 ± 15.8	Potassium (K)	3110 ± 353
Copper (Cu)	3.06 ± 0.18	Selenium (Se)	0.064 7 ± 0.002 3
Iron (Fe)	13.0 ± 1.5	Sodium (Na)	15.9 ± 1.6
Lead (Pb)	0.016 8 ± 0.003 7	Strontium (Sr)	0.483 ± 0.010
Magnesium (Mg)	1462 ± 210	Sulfur (S)	1155.5 ± 8.4
Manganese (Mn)	30.92 ± 0.22	Zinc (Zn)	23.45 ± 0.16

[(a)] Values are expressed as $x \pm U_{95\%}(x)$, where x is the certified value and $U_{95\%}(x)$ is the expanded uncertainty of the certified value. The true value of the analyte lies within the interval $x \pm U_{95\%}(x)$ with 95 % confidence. To propagate this uncertainty, treat the certified value as a normally distributed random variable with mean x and standard deviation $U_{95\%}(x)/2$ [3–5].

Table 2. Certified Mass Fraction Values (Dry-Mass Basis) for Arsenic Species in SRM 1568c

Element	Mass Fraction[(a)] (mg/kg)
Inorganic Arsenic (iAs)	0.166 6 ± 0.004 9
Dimethylarsinic acid (DMA)	0.182 9 ± 0.002 3
Monomethylarsonic acid (MMA)	0.011 0 ± 0.000 5

[(a)] Values are expressed as $x \pm U_{95\%}(x)$, where x is the certified value, $U_{95\%}(x)$ is the expanded uncertainty of the certified value, and coverage factor is $k = 2$ [3–5].

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Non-Certified Values: Non-certified values are provided in Appendix A.

Additional Information: Methods used for the analysis of SRM 1568c and additional information are provided in Appendix B. Full details on the production, analysis, and statistical evaluation of SRM 1568c are provided in NIST Special Publication 260-229 [6].

Period of Validity: The certified values delivered by SRM 1568c are valid within the measurement uncertainty specified until **30 March 2032.** The certified values are nullified if the SRM is stored or used improperly, damaged, contaminated, or otherwise modified.

Maintenance of Certified Values: NIST will monitor this SRM over the period of its validity. If substantive technical changes occur that affect the certification, NIST will issue an amended certificate through the NIST SRM website (https://www.nist.gov/srm). Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

Safety: SRM 1568c IS INTENDED FOR RESEARCH USE; not for human consumption. Consult the Safety Data Sheet (SDS) for hazard information.

Storage: Unopened bottles of SRM 1568c should be stored at room temperature (20 °C ± 5 °C). Assigned mass fractions values from a previously opened bottle are valid until the material reaches its expiration date, provided that the open bottle is re-capped and stored at room temperature (20 °C ± 5 °C).

Use: Before use, the contents of the bottle should be mixed thoroughly. Allow the contents to settle for one minute prior to opening to minimize the loss of fine particles. To relate analytical determinations to the certified values in this Certificate of Analysis, test portions of the material equal to or greater than 0.5 g for Ca, Cu, Cd, Fe, Hg, Pb, Mg, Mn, P, K, Na, Sr, Zn, iAs, DMA, and MMA; equal to or greater than 0.75 g for S; and equal to or greater than 0.25 g for As, Br, Mo, and Se should be used. Test portions should be analyzed as received and results converted to a dry-mass basis by determining moisture content (described below) on separate test portions.

Determination of Moisture: All assigned values were determined on an as-received basis and converted to a dry-mass basis using a conversion factor that is the inverse of the dry-mass proportion. The dry-mass proportion of (0.903 7 ± 0.001 1) gram dry-mass per gram as-received mass was determined by averaging results obtained at NIST by using (1) drying over magnesium perchlorate in a desiccator at room temperature for 28 days; and (2) drying in a forced-air oven at 90 °C for 4 hours. The uncertainty on the dry-mass proportion is an expanded uncertainty ($k = 2$) to represent a 95 % level of confidence. A relative uncertainty component for the conversion factor (0.1 %) obtained from the moisture measurements is incorporated in the uncertainties of the certified and non-certified values.

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[3] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement*; (GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (JCGM) (2008); available at https://www.bipm.org/en/committees/jc/jcgm/publications (accessed Mar 2026); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at https://www.nist.gov/pml/nist-technical-note-1297 (accessed Mar 2026).

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[8] Barber, C.A.; Burdette, C.Q.; Hayes, H.V.; Johnson, M.E.; Kotoski, S.P.; Murray, J.A.; Phillips, M.M.; Rimmer, C.A.; Wood, L.J.; Yarberry, A.J. *Health Assessment Measurements Quality Assurance Program: Exercise 6 Final Report*; NIST Interagency Report (NIST IR) 8343 (2021). available at https://nvlpubs.nist.gov/nistpubs/ir/2021/NIST.IR.8394.pdf (accessed Mar 2026).

If you use this SRM in published work, please reference:

Wood LJ, Barber CA, Bryan Sallee CE, Johnson ME, Kotoski S, Long SE, Narukawa T, Paul RL, Sharp N, Sieber JR, Vega Martinez MI, Yen JH, Yu LL (2025) Certification of Standard Reference Material® 1568c Rice Flour. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (NIST SP) 260-229r1. https://doi.org/10.6028/NIST.SP.260-229r1

Certificate Revision History: 27 March 2026 (Upgraded arsenic species mass fraction values from non-certified values to certified values; editorial changes); **14 October 2022** (Original certificate date).

Certain commercial equipment, instruments, or materials may be identified in this Certificate of Analysis to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, MD 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

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APPENDIX A

Non-Certified Values: Non-certified values are suitable for use in method development, method harmonization, and process control but do not provide metrological traceability to the International System of Units (SI) or other higher-order reference system [1]. Non-certified mass fraction values for additional elements, proximates, and calories in SRM 1568c, reported on a dry-mass basis, are provided in Table A1, A2, and A3.

Table A1. Non-Certified Mass Fraction Values for Elements in SRM 1568c

Element	Mass Fraction[(a)] (mg/kg)
Aluminium (Al)	2.91 ± 0.62
Bromine (Br)	0.968 0 ± 0.009 5
Chlorine (Cl)	292.1 ± 5.9
Phosphorus (P)	4300 ± 1200
Rubidium (Rb)	8.89 ± 0.30

[(a)] Values are expressed as $x \pm U95\%(x)$, where x is the estimated value and $U95\%(x)$ is the expanded uncertainty of the value. The method-specific value of the analyte lies within the interval $x \pm U95\%(x)$ with 95 % confidence. For purposes of harmonization and process control, the imprecision and homogeneity components of uncertainty can be propagated by treating the non-certified value as a normally distributed random variable with mean x and standard deviation $U_{95\%}(x)/2$ [3–5].

Table A2. Non-Certified Mass Fraction Values for Proximates in SRM 1568c

Analyte	Mass Fraction[(a)] (g/100 g)
Ash	1.367 ± 0.048
Protein	8.87 ± 0.15
Carbohydrates	84.28 ± 0.71
Fat	3.33 ± 0.21
Solids	88.82 ± 0.54

[(a)] Values are expressed as $x \pm 2u(x)$, where x is the non-certified value and $u(x)$ is the standard uncertainty of the non-certified value. While the best estimate of each measurand lies within the interval $x \pm 2u(x)$, not all components of uncertainty have been considered. For purposes of harmonization and process control, the components of uncertainty can be propagated as $u(x)/x$ relative standard deviations [3–5].

Table A3. Non-Certified Value for Calories in SRM 1568c

Analyte	Energy[(a)] (kcal/100 g)
Calories	407 ± 14

[(a)] Values are expressed as $x \pm 2u(x)$, where x is the non-certified value and $u(x)$ is the standard uncertainty of the non-certified value. While the best estimate of each measurand lies within the interval $x \pm 2u(x)$, not all components of uncertainty have been considered. For purposes of harmonization and process control, the components of uncertainty can be propagated as $u(x)/x$ relative standard deviations [3–5].

Period of Validity: The non-certified values are valid within the measurement uncertainty specified until **30 March 2032.** The value assignments are nullified if the material is stored or used improperly, damaged, contaminated, or otherwise modified.

Maintenance of Non-Certified Values: NIST will monitor this material to the end of its period of validity. If substantive technical changes occur that affect the non-certified values during this period, NIST will update this Certificate of Analysis. Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

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APPENDIX B

Material Acquisition and Preparation: A total mass of 88 kg of brown rice flour was purchased from several commercially available products. Blending and bottling were done at NIST, Gaithersburg, MD. All 88 kg of rice flour was double blended for 30 minutes using a ceramic lined cone blender. Bottling was done under an environmental hood with a dust collector using a (polytetrafluoroethylene) PTFE lined hopper and trough. Fifty grams of material were placed into pre-washed amber glass bottles. After packaging, the material was irradiated by Neutron Products, Inc. (Dickerson, MD) by ^{60}Co to an absorbed dose of 6.0 kGy to 8.6 kGy.

Analysis: Value assignment of the mass fractions of elements, proximates, and calories in SRM 1568c was based on the combination of measurements made by NIST and by collaborating laboratories, where available. The analytical methods used for elemental determinations are outlined in Table B1 [6].

Analyses by Collaborating Laboratories: The National Metrology Institute of Japan (NMIJ) collaborated by measuring arsenic species in SRM 1568c. Analysts at many collaborating laboratories analyzed SRM 1568c as part of NIST Health Assessment Measurements Quality Assurance Program (HAMQAP) Exercises 5 and 6 [7–8]. HAMQAP Collaborating laboratories were asked to use their in-house analytical methods to make measurements on SRM 1568c. Details for collaborating laboratory measurements of SRM 1568c are provided in NIST Special Publication 260-229 [6]; and HAMQAP Exercise 5 [7] and Exercise 6 [8] Final Reports.

Table B1. Analytical Methods Used for Elemental Determinations

Element	NIST Methods[(a)]	NMIJ Methods[(a)]	HAMQAP Methods[(a)]
Aluminum (Al)	ICP-MS		
Arsenic (As)	ICP-MS, INAA		ICP-OES, ICP-MS
Inorganic Arsenic (iAs)	LC-ICP-MS	HPLC-ICP-MS	
Dimethylarsinic Acid (DMA)	LC-ICP-MS	HPLC-ICP-MS	
Monomethylarsonic Acid (MMA)	LC-ICP-MS	HPLC-ICP-MS	
Bromine (Br)	INAA		
Cadmium (Cd)	ICP-MS		AAS, ICP-MS, ICP-OES, ID ICP-MS
Calcium (Ca)	ICP-OES, WDXRF		ICP-MS, ICP-OES, ID ICP-MS
Chlorine (Cl)	WDXRF		
Copper (Cu)	ICP-OES, WDXRF		
Iron (Fe)	ICP-OES, WDXRF		ICP-MS, ICP-OES, ID ICP-MS
Lead (Pb)	ICP-MS		ICP-MS, ICP-OES, ID ICP-MS
Magnesium (Mg)	ICP-OES, WDXRF		
Manganese (Mn)	ICP-OES, WDXRF		
Mercury (Hg)	ID-CV-ICP-MS		
Molybdenum (Mo)	ICP-MS, INAA		
Phosphorus (P)	ICP-OES, WDXRF		
Potassium (K)	ICP-OES, WDXRF		ICP-MS, ICP-OES, ID ICP-MS
Rubidium (Rb)	ICP-MS		
Selenium (Se)	ICP-MS, INAA		
Strontium (Sr)	ICP-OES, ICP-MS		
Sodium (Na)	ICP-OES		ICP-MS, ICP-OES
Sulfur (S)	TNPGAA, WDXRF		
Zinc (Zn)	ICP-OES, WDXRF		

[(a)] Not all participants in the HAMQAP exercises reported the method they used.

Methods

AAS	Atomic absorption spectroscopy
HPLC-ICP-MS	High-performance liquid chromatography inductively coupled plasma mass spectrometry
ICP-MS	Inductively coupled plasma mass spectrometry
ICP-OES	Inductively coupled plasma optical emission spectrometry
ID-CV-ICP-MS	Isotope dilution cold vapor inductively coupled plasma mass spectrometry
ID ICP-MS	Isotope dilution inductively coupled plasma mass spectrometry
INAA	Instrumental neutron activation analysis
LC-ICP-MS	Liquid chromatography inductively coupled plasma mass spectrometry
TNPGAA	Thermal neutron prompt gamma-ray activation analysis
WDXRF	Wavelength dispersive X-ray fluorescence spectrometry

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