



Certificate of Analysis

Standard Reference Material[®] 927e

Bovine Serum Albumin (7 % Solution)

(Total Protein Standard)

This Standard Reference Material (SRM) is intended primarily for use in the standardization of procedures employed in clinical analyses for total serum protein, for critical evaluation of daily working standards used in these procedures, and as a reference standard for assays of total protein by colorimetric methods. This SRM is a solution (mass fraction 7 %) of known protein concentration and purity. The protein content of this SRM was determined using the biuret reference method [1] that is recommended for use in standardizing laboratory-prepared protein solutions and “normal” serum pools. Such standardized “normal” sera could then be used to calibrate refractometers or other instruments for serum protein estimations. SRM 927e may also be used for other procedures, such as gel diffusion, amino acid analysis, electrophoresis, nitrogen assays, or other tests that require well-characterized protein for calibration or evaluation. A unit of SRM 927e consists of 10 ampoules, each containing approximately 2.2 mL of solution.

In addition to the measurements using the biuret method, NIST made measurements of the bovine serum albumin (BSA) concentration using amino acid analysis. The results from the two approaches are reported as follows: 1) certified BSA concentration by amino acid analysis and 2) reference BSA concentration by the biuret method.

Certified Concentration Value: The certified concentration value for BSA as determined by amino acid analyses is provided in Table 1. A NIST certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or taken into account [2]. The certified value for BSA concentration is based upon the results from isotope dilution liquid chromatography/tandem mass spectrometry (ID-LC/MS/MS) [3].

Reference Values: The reference BSA concentration determined using the biuret method is provided in Table 2. The biuret reference method [1] was employed to determine the BSA concentration in SRM 927e using SRM 927d as an external standard. Reference values are noncertified values that are the best estimate of the true values based on available data; however, the values do not meet the NIST criteria for certification and are provided with associated uncertainties that may reflect only measurement precision, may not include all sources of uncertainty, or may reflect a lack of sufficient statistical agreement among multiple analytical methods [2]. Reference values are provided in Table 3 for additional properties including density and relative average molecular mass as determined using electrospray ionization mass spectrometry.

Expiration of Certification: The certification of **SRM 927e** is valid, within the measurement uncertainty specified, until **28 February 2024**, provided the SRM is handled and in accordance with instructions given in this certificate (see “Instructions for Storage and Use”). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

Maintenance of SRM Certification: NIST will monitor this SRM over the period of its certification. If substantive technical changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

Overall direction and coordination of technical measurements leading to the certification were performed by K.W. Phinney and D.M. Bunk of the NIST Biomolecular Measurement Division.

Statistical analysis was provided by N.F. Zhang of the NIST Statistical Engineering Division.

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Certificate Revision History on Last Page

Steven J. Choquette, Director
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Acquisition of the material was performed by K.W. Phinney. Certification measurements were performed by M.S. Lowenthal, A.B. Green, and D.M. Bunk of the NIST Biomolecular Measurement Division.

Support aspects involved with the certification and issuance of this SRM were coordinated through the NIST Office of Reference Materials.

NOTICE AND WARNINGs TO USERS

Warning: SRM 927e IS INTENDED FOR RESEARCH USE. The blood used in the preparation of SRM 927e Bovine Serum Albumin (7 % Solution) was collected from cattle sourced in the United States. Only blood from cattle/carcasses that have passed ante-mortem and post-mortem U.S. Department of Agriculture (USDA) Food Safety Inspection Service (FSIS) inspection was used. This material has not come from cattle that have been in a herd in which a case of Bovine Spongiform Encephalopathy (BSE) has appeared, and the product does not contain, and is not derived from, specified risk material as defined in Commission Decision 97/534/EC. No bovine blood was used from tuberculosis and/or brucellosis reactors. No bovine blood was used from animals subject to emergency slaughter or identified as U.S. Suspect. There were no additives to the pooled serum prior to protein purification.

INSTRUCTIONS FOR STORAGE AND USE

Storage: This SRM is supplied to the user in sealed ampoules. The SRM should be stored in a refrigerator at a temperature between 2 °C and 8 °C. The ampoules should not be frozen because of possible breakage of ampoules during the thawing process.

Instructions for Use: Once an ampoule is opened, the solution should be used promptly. Any unused solution in opened ampoules should be discarded.

Preparation of Dilutions: Protein solutions of lower concentration may be prepared by transferring the appropriate aliquot to a volumetric flask and diluting to volume. Diluents are not furnished with the SRM; an aqueous sodium chloride diluent, such as a solution having a concentration of 0.15 mol/L, may be used. Caution should be taken when performing dilutions greater 100-fold due to the potential for protein loss (possibly due to protein absorption on laboratory equipment).

Inappropriate Uses: This SRM is not intended to be used as a standard for dye-binding tests as the dye-binding characteristics of BSA will likely be dissimilar to other proteins being assayed. Additionally, this SRM is not intended for checking pre-calibrated refractometers, for immunochemical methods, or as an additive for bilirubin standardization.

SOURCE, PREPARATION, AND ANALYSIS⁽¹⁾

Source and Preparation: SRM 927e was prepared by Aalto Scientific (Carlsbad, CA). The bovine serum was produced for manufacture into products for pharmaceutical use at USDA Establishment #245-J. The BSA for this SRM was dissolved in 0.02 mol/L sodium chloride and the pH adjusted to 6.5-6.8 with 1.0 mol/L sodium hydroxide. The material was sterilized by membrane filtration and tested for sterility by approved methods [4].

Analysis: All analyses in the value assignment of SRM 927e were performed at NIST.

Measurement of BSA concentration by amino acid analysis (ID-LC/MS/MS): The amino acid analysis method involved isotope dilution liquid chromatography/tandem mass spectrometry (ID-LC/MS/MS) [3]. Diluted samples of SRM 927e and 927d (as a control) were combined with isotope-labeled analogs of phenylalanine, proline, isoleucine, leucine, and valine and were hydrolyzed with vapor-phase hydrochloric acid (HCl) for 48 h at approximately 115 °C in sealed vials. After hydrolysis, the samples were lyophilized and then reconstituted with 0.1 mL/L formic acid in water. Amino acids were separated using gradient-elution mixed-mode chromatography on a reverse-phase analytical column with embedded acidic ion-pairing groups. Measurements were performed on a triple quadrupole mass spectrometer, monitoring specific transitions for each amino acid. The measurements were calibrated using solutions prepared from purified amino acid standards whose purity was assessed at NIST. Data were collected for phenylalanine, proline, isoleucine, leucine and valine. Based upon the known amino acid sequence for BSA, the concentration of BSA was calculated from the concentrations determined for each of the amino acids.

⁽¹⁾ Certain commercial equipment, instruments, or materials are identified in this certificate 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.

Measurement of BSA concentration (biuret): The reference BSA concentration was measured using the biuret reference method for total serum protein [1]. The measurements involve a direct comparison between the current SRM 927e and previously issued SRM 927d and were performed by spectrophotometry.

Additional analyses: Density measurement was performed gravimetrically [5]. Relative average molecular mass was determined using liquid chromatography/mass spectrometry (LC/MS). Measurements were performed on a time-of-flight mass spectrometer operated in the positive ion mode and coupled to a nanoflow LC with a commercial C18 column. Gradient elution using 0.1 mL/L trifluoroacetic acid in water and in acetonitrile was used. Horse myoglobin was used for mass calibration of the mass spectrometer. The relative average molecular masses of the four major forms of BSA found in SRM 927e are shown in Table 3 in decreasing order of abundance. The previous issue, SRM 927d had a similar range of molecular masses.

Homogeneity Analysis: The homogeneity assessment was made at the time the certification analyses were performed. A stratified sampling plan was devised to test for homogeneity across the lot of ampoules. There was no apparent trend in the data when plotted against the sequence in which the ampoules were prepared.

Certified Value: The measurand is the total concentration of bovine serum albumin. Metrological traceability is to the SI derived units for mass concentration (expressed as of grams per liter). The uncertainty provided with the measured BSA certified concentration value is an expanded uncertainty about the mean to cover the measurand with approximately 95 % confidence, consistent with the ISO/JCGM Guide [6]. The expanded uncertainty is calculated as $U = ku_c$, where u_c is the combined uncertainty, and k is a coverage factor corresponding to approximately 95 % confidence for this analyte [6]. For the certified value shown below, $k = 2$.

Table 1. Certified Bovine Serum Albumin Concentration by Amino Acid Analysis

BSA Concentration: 67.38 g/L \pm 1.38 g/L

Reference Value: The reference value in Table 2 is based specifically on the biuret reference method. The measurand is the bovine serum albumin concentration as determined using the biuret method. Metrological traceability is to the SI derived units for mass concentration (expressed as of grams per liter). The uncertainty provided with the reference value in Table 2 is an expanded uncertainty about the mean to cover the measurand with approximately 95 % confidence; it incorporates Type B uncertainty components related to the analyses, consistent with the ISO/JCGM Guide and with its Supplement 1 [6,7]. The expanded uncertainty is calculated as $U = ku_c$, where u_c is the combined uncertainty and k is a coverage factor corresponding to approximately 95 % confidence for this analyte [6]. For the reference value shown in Table 2, $k = 2$.

Table 2. Reference Bovine Serum Albumin Concentration by the Biuret Method

BSA Concentration: 69.58 g/L \pm 1.30 g/L

Additional Reference Values: The reference values are based on the method used for each measurand as described above. Metrological traceability of the density value is to the SI units for grams per milliliter. The uncertainty provided with each reference value in Table 3 is an expanded uncertainty about the mean to cover the measurand with approximately 95 % confidence. The expanded uncertainty is calculated as $U = ku_c$, where u_c is the combined uncertainty and k is a coverage factor corresponding to approximately 95 % confidence for each analyte [6]. For the reference values shown in Table 3, $k = 2$.

Table 3. Additional Reference Values for Properties of SRM 927e

Density ^(a) (g/mL)
1.0182 ± 0.0002
Relative Average Molecular Mass of the Major Molecular Forms of BSA ^(b) (unitless)
66 431.3 ± 0.9
66 548.9 ± 0.8
66 458 ± 1
66 590 ± 6

^(a) The uncertainty of the solution density in determining the expanded uncertainty of the BSA concentration is negligible when compared to the analytical variation.

^(b) Decreasing order of abundance.

Additional Information: The theoretical relative average molecular mass of BSA was calculated to be 66 398.1. The calculation of the average relative molecular mass of BSA is based on the reported amino acid sequence [8]:

	10	20	25	30	40	50	60
	MKWVTFISLL	LLFSSAYSRG	VFRRDTHKSE	IAHRFKDLGE	EHFKGLVLIA	FSQYLQQCPF	
	70	80	90	100	110	120	
	DEHVKLVNEL	TEFAKTCVAD	ESHAGCEKSL	HTLFGDELCK	VASLRETYGD	MADCCEKQEP	
	130	140	150	160	170	180	
	ERNECFLSHK	DDSPDLPKLK	PDPNTLCDEF	KADEKKFWGK	YLYEIARRHP	YFYAPELLYY	
	190	200	210	220	230	240	
	ANKYNGVFQE	CCQAEDKGAC	LLPKIETMRE	KVLASSARQR	LRCASIQKFG	ERALKAWSVA	
	250	260	270	280	290	300	
	RLSQKFPKAE	FVEVTKLVTD	LTKVHKECCH	GDLLECADDR	ADLAKYICDN	QDTISSKLKE	
	310	320	330	340	350	360	
	CCDKPLLEKS	HCIAEVEKDA	IPENLPPLTA	DFAEDKDVCK	NYQEAKDAFL	GSFLYEYSRR	
	370	380	390	400	410	420	
	HPEYAVSVLL	RLAKEYEATL	EECCAADDPH	ACYSTVFDKL	KHLVDEPQNL	IKQNCDFEKF	
	430	440	450	460	470	480	
	LGEYGFQNAL	IVRYTRKVPQ	VSTPTLVEVS	RSLGKVGTRC	CTKPESERMP	CTEDYLSLIL	
	490	500	510	520	530	540	
	NRLCVLHEKT	PVSEKVTKCC	TESLVNRRPC	FSALTPDETY	VPKAFDEKLF	TFHADICTLP	
	550	560	570	580	590	600	
	DTEKQIKKQT	ALVELLKHKP	KATEEQKQTV	MENFVAFVDK	CCAADDKEAC	FAVEGPKLIV	
	607						
	STQTALA						

The sequence of the mature protein is not expected to include the signal peptide and propeptide, which would have been removed as part of normal post-translational processing. Therefore, the sequence of BSA starts at amino acid 25 in the sequence above and ends are amino acid 607 as indicated by the bold text. BSA also contains 17 disulfide bonds. It has been reported [8] that disulfides are present between cysteine residues 77-86, 99-115, 114-125, 147-192, 191-200, 223-269, 268-276, 288-302, 301-312, 339-384, 383-392, 415-461, 460-471, 484-500, 499-510, 537-582, and 581-590.

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Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail srminfo@nist.gov; or via the Internet at <https://www.nist.gov/srm>.