



National Institute of Standards & Technology

Reference Material 8416

Microcrystalline Cellulose

Agriculture Canada

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This Reference Material (RM) is intended for use in evaluating analytical methods and instruments used for the determination of minor and trace constituent elements in food, agricultural, and biological materials containing low elemental concentrations. RM 8416 was prepared and characterized by the Centre for Land and Biological Resources Research (CLBRR), Agriculture Canada, who is the sole authority for the information provided in this report including best estimate and other technical information. RM 8416 consists of 35 g of dry powdered microcrystalline cellulose packaged in a glass bottle.

Material Application: This material, together with other food-type RMs issued by NIST covers a wide range of natural matrix compositions and elemental concentrations. By providing concentration values for a wide range of constituent elements of nutritional, toxicological, and environmental significance, RM 8416 is expected to be useful in assessing the role of nutrients in health and disease, establishing dietary requirements for nutrients, accumulating accurate baseline concentration data for nutrients and contaminants, and monitoring foods for nutrients and contaminants.

It is conceivable that some elemental contamination may have been picked up during preparation, processing and handling, and also that alterations of original chemical composition of the bulk starting material may have resulted from differential sieving of components with differing compositions. Hence, this material cannot be taken as strictly containing solely natural, physiological concentrations of inorganic constituent elements. It can, however, be considered to reflect a food product taken through preparation/processing, not unlike food materials processed commercially or in the analytical laboratory. This RM can thus be used for data quality control (DQC) in the analysis of such processed materials and can additionally be considered for DQC of methods measuring total concentrations of elements in food products with natural, uncontaminated, physiological element levels.

The material was prepared at Agriculture Canada under the direction of Milan Ihnat, Centre for Land and Biological Resources Research (CLBRR), who also coordinated the interlaboratory analytical campaign to characterize the material and performed evaluations/calculations of analytical data to arrive at best estimate and informational elemental concentration values. The former Engineering and Statistical Research Centre, Agriculture Canada, kindly constructed the blender.

Statistical support, design, and consultation with computations for homogeneity estimates as well as best estimate and informational concentration values were provided by M.S. Wolynetz, Statistical Research Section, Research Program Service, Agriculture Canada.

Support in the issuance of this RM was coordinated through the NIST Standard Reference Materials Program by W.R. Wolf, NIST Research Associate, U.S. Department of Agriculture, R. Alvarez, (retired) and T.E. Gills.

Gaithersburg, MD 20899
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Recommended Procedures for Use: RM 8416 should be kept at room temperature in its original bottle tightly-capped and not exposed to intense direct light or ultraviolet radiation. Prior to each use, contents of the bottle should be well mixed by gentle shaking and rolling of the container. A recommended minimum subsample weight of 0.5 g should be taken for analysis. Moisture content should be determined on a separate subsample for conversion of analytical results to a dry weight basis. The recommended method of drying to relate analytical results to the best estimate values listed in Table 1 is drying for 4 h in an air oven at 85 °C. Analyses reported in Table 1 represent total concentrations of elements in this RM. Dissolution procedures should be capable of rendering a completely dissolved sample appropriate to the method and should be designed to avoid losses of elements by volatilization or by retention on decomposition and processing containers and measuring equipment. Analytical methods should be capable of measuring total levels of analytes for comparison with best estimate values.

Preparation: The source of material for Reference Material 8416 was Avicel microcrystalline cellulose, type PH 101 obtained from FMC Corp., Dorval, Quebec, Canada. Lot analysis was 98.4% cellulose, not more than 0.001% heavy metals, with nominally 50 μm particle size. All preparatory work following acquisition of the commercial product was performed at the facilities of Agriculture Canada, Ottawa. [1] The dry bulk powder was sterilized with cobalt-60 gamma radiation to 2.0 megarads by Atomic Energy of Canada Ltd. All subsequent processing was performed in a moderately clean room using plastic equipment. There was no need for additional reduction of particle size as the starting material consisted of very fine particles. Material sieving was through nylon monofilament sieve cloths supported in high density white polyethylene holders. Pairs of sieves with openings of approximately 150 μm /20 μm were used to yield a suitable narrow middle cuts constituting the RM. This fraction was blended in a polymethylmethacrylate V-configuration blender and packaged into clean 150 mL brim capacity, clear glass bottles with triseal (polyethylene)-lined white polypropylene screw caps. A total of 144 randomly selected units was segregated for physical and chemical characterization.

Assessment of Homogeneity: Homogeneity testing was performed on randomly selected units for 4 elements by application of a high precision analytical method in one laboratory. Subsamples of 1.6-10 g each, taken from a total of six units, were analyzed by R.W. Dabeka, Health and Welfare Canada, for cadmium, cobalt, nickel, and lead by precise and reliable graphite furnace atomic absorption spectrometric methods following acid digestion and separation/preconcentration of the analytes using coprecipitation with ammonium pyrrolidine dithiocarbamate (all four elements) and additionally with palladium/ascorbic acid for lead. [2-4] Fluoride was determined by the same analyst in 0.1 g subsamples from six units by an acid-facilitated microdiffusion-ion specific electrode method [5] but concentrations were too low to permit firm homogeneity estimates. In addition, the extensive set of analytical results obtained from a large number of analysts participating in the interlaboratory characterization campaign was assessed to provide homogeneity estimates for other elements. [6] This material generally exhibits excellent homogeneity and uncertainties associated with best estimate values reported in Table 1 include effects of material inhomogeneity.

Best Estimate Values for Constituent Elements: The population of analytical information from cooperating analysts, acknowledged at the end of the report, using a wide variety of analytical methods was assessed using technical and statistical criteria as well as judgment to arrive at best estimate values and associated uncertainties listed in Table 1. These values, not certified by NIST, are based on results generally obtained by at least two, but typically several, independent, reliable analytical methods. Concentration estimates for 16 other elements, are provided in Table 2 as information values only, as they are based on results of limited determinations or only one analytical method.

Chemical Characterization: Chemical analyses to establish best estimate concentrations were conducted in an interlaboratory cooperative characterization campaign involving the initiating laboratory and a large number of selected expert analysts in other laboratories. A wide range of independent analytical methods listed in Table 3 was applied to provide analytical results for a large number of nutritionally, toxicologically and environmentally pertinent elements. Typically, analyses were performed by each participant on duplicate subsamples from randomly selected (usually four) units of material using subsample weights and methods left to the discretion of the analyst. Subsample sizes ranged from 0.001 to 10 g, typically 1 g. Elemental determinations were performed on "as received" material, with conversion of results to a dry matter basis using moisture values determined on separate 2 g subsamples by the procedure specified in this report. Analytical results obtained by the Health and Welfare Canada laboratory during homogeneity testing and analysis served a dual role of providing information for homogeneity assessment and quantitation.

This Report of Investigation, prepared by Milan Ihnat, is contribution No. 92-181 from CLBRR, Research Branch, Agriculture Canada.

Table 1. Best Estimate Concentrations of Constituent Elements

Minor and Trace Constituents

<u>Element</u>	<u>Content and uncertainty mg/kg(a)</u>		<u>Methods(b)</u>
Nitrogen	200	± 200	I01
Chlorine	80	± 50	D01, F02, K02, K03
Aluminum	3.7	± 1.2	A05, D01
Nickel	0.05	± 0.05	A14, A16, C03, H01
Copper	0.015	± 0.012	C06, D03, H01
Molybdenum	0.01	± 0.01	C06, C07, D03, F01, H06
Lead	0.006	± 0.005	A16, H01
Selenium	0.002	± 0.002	C04, G01
Cobalt	0.0017	± 0.0007	A16, D02, H01
Cadmium	0.0002	± 0.0002	A16, H01

(a) Best estimate values, mg/kg (ppm), are based on the dry material, dried according to instructions in this report and are equally-weighted means of results from generally at least two, but typically several, different analytical methods applied by analysts in different laboratories. The exception to the approach involving at least two independently different analytical methods for establishing best estimate values for this RM is the acceptance of data for N by a single reliable Kjeldahl method, applied with suitable quality control. Uncertainties are imprecision estimates expressed either as a 95% confidence interval or as an interval (Cd, Cl, Co, Cu, Mo, N, Ni, Pb, Se) based on the entire range of accepted results for a single future determination, based on a sample weight of at least 0.5 g. These uncertainties, based on among-method and laboratory, among-unit and within-unit estimates of variances, include measures of analytical method and laboratory imprecisions and biases and material inhomogeneity.

(b) Analytical method codes and descriptions are provided in Table 3.

Table 2. Information Concentrations of Constituent Elements

<u>Element</u>	<u>Estimated content mg/kg(a)</u>	<u>Methods(b)</u>
Arsenic	0.001	A11, D03
Barium	0.1	B02, C03
Boron	0.2	B02
Calcium	5	B02, D01
Chromium	0.05	B02, D02
Fluorine	0.005	H04
Iodine	0.01	F01
Iron	2	B02, D02
Manganese	0.03	C03, D01
Mercury	0.0002	A10
Phosphorus	7	B02, F01
Sodium	7	D01
Sulfur	10	F03, J04
Strontium	0.02	B02, C03
Vanadium	0.02	B02, D01
Zinc	0.1	C03, H01

(a) These analytical values, on a dry matter basis, are estimates given strictly for information only as they are based on results of limited determinations or only one method; no uncertainties are provided. Use of this RM to quantitatively monitor method performance for elements other than those with best estimate concentration values in Table 1 is not warranted.

(b) Analytical method codes and descriptions are provided in Table 3.

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Table 3. Analytical Methods Used to Determine Best Estimate and Information Concentration Values(a)

<u>Analytical Method</u>	<u>Code</u>	<u>Elements Determined</u>
Closed vessel acid digestion electrothermal atomic absorption spectrometry	A05	Al
Closed vessel acid digestion cold vapor atomic absorption spectrometry with preconcentration	A10	(Hg)
Closed vessel acid digestion hydride generation atomic absorption spectrometry with preconcentration	A11	(As)
Acid digestion solvent extraction flame atomic absorption spectrometry	A14	Ni
Acid digestion coprecipitation electrothermal atomic absorption spectrometry	A16	Cd, Co, Ni, Pb
Acid digestion inductively coupled plasma atomic emission spectrometry	B02	(B), (Ba), (Ca), (Cr), (Fe) (P), (Sr), (V)
Closed vessel acid digestion isotope dilution inductively coupled plasma mass spectrometry	C03	(Ba), (Mn), Ni, (Sr), (Zn)
Acid digestion dry ashing hydride generation isotope dilution inductively coupled plasma mass spectrometry	C04	Se
Acid digestion isotope dilution inductively coupled plasma mass spectrometry	C06	Cu, Mo
Dry ashing inductively coupled plasma mass spectrometry	C07	Mo
Instrumental neutron activation analysis	D01	Al, (Ca), Cl, (Mn), (Na) (V)
Instrumental neutron activation analysis with acid digestion	D02	Co, (Cr), (Fe)
Neutron activation analysis with radiochemical separation	D03	(As), Cu, Mo

Acid digestion light absorption spectrometry	F01	(I), Mo, (P)
Dry ashing light absorption spectrometry	F02	Cl
Digestion light absorption spectrometry	F03	(S)
Acid digestion fluorometry	G01	Se
Closed vessel acid digestion anodic stripping voltametry	H01	Cd, Co, Cu, Ni, Pb, (Zn)
Extraction ion selective electrode	H04	(F)
Dry ashing catalytic adsorption polarography	H06	Mo
Kjeldahl method for nitrogen -volumetry	I01	N
Combustion elemental analysis -fluorometry	J04	(S)
Dry ashing volumetry	K02	Cl
Combustion volumetry	K03	Cl

(a) Letter codes refer to classes of similar methods; number codes refer to specific variants. Elements in parentheses have only information values in this RM.

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