



# Certificate of Analysis

## Certified Reference Material

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### VITB-1

#### Elevated-level Multivitamin Certified Reference Material for Minerals and Vitamins

VITB-1 is part of a suite of multivitamin Certified Reference Materials (CRMs) from the National Research Council of Canada (NRC). VITB-1 is an elevated-level multivitamin CRM that is certified for minerals and vitamins. Each unit of VITB-1 consists of 20 individually packed tablets. In conjunction with VITA-1, this CRM is intended for the calibration of procedures and the development of methods for the determination of minerals and vitamins in multivitamin materials or similar matrices.

The following tables show those constituents for which certified, reference and information values have been established for this elevated-level multivitamin certified reference material (CRM). The expanded uncertainty ( $U_{CRM}$ ) in the certified value is equal to  $U = ku_c$  where  $u_c$  is the combined standard uncertainty calculated according to the JCGM Guide [1] and  $k$  is the coverage factor. A coverage factor of two (2) was applied which corresponds to approx. 95 % confidence. It is intended that  $U_{CRM}$  accounts for every aspect that reasonably contributes to the uncertainty of the measurement. All values are expressed on the actual mass of the sample. No dry weight correction was performed.

**Table 1: Quantity values and expanded uncertainty ( $k = 2$ ) for elements and element species in VITB-1**

Element/compound	Mass fraction, mg/kg	Mass fraction, µg/tablet	Type of value
arsenic (b, c, e)	0.103 ± 0.026	0.269 ± 0.068	certified
boron (a, c, d)	163 ± 8	426 ± 23	certified
bromine (c)	0.35 ± 0.08	0.93 ± 0.21	reference
cadmium (a)	0.04	0.1	information
calcium (b, c, d, m)	57 100 ± 2400	149 400 ± 7100	certified
chlorine (c)	319 ± 42	835 ± 111	reference
chromium (a, c, d, m)	19.8 ± 1.2	51.7 ± 3.3	certified
chromium picolinate (as Cr) (f, m)	19 ± 0.8	49.8 ± 2.4	reference
cobalt (b, c)	0.97 ± 0.1	2.54 ± 0.27	certified
copper (a, c, d, m)	198 ± 10	518 ± 29	certified
iodine (c, m)	57 ± 16	150 ± 42	reference
iron (a, c, d, m)	7030 ± 120	18 410 ± 510	certified

Element/compound	Mass fraction, mg/kg	Mass fraction, µg/tablet	Type of value
lead (a, b, c)	0.108 ± 0.008	0.281 ± 0.022	certified
magnesium (b, c, d, m)	36 700 ± 1800	96 000 ± 5200	certified
manganese (b, c, d, m)	795 ± 34	2081 ± 100	certified
mercury (a, b)	< 0.004	< 0.010	certified
molybdenum (a, c, d)	35.9 ± 3.2	93.9 ± 8.6	certified
phosphorus (b, c, d)	37 500 ± 1600	98 100 ± 4700	certified
potassium (b, c, d, m)	24 400 ± 2800	63 900 ± 7500	certified
selenium (a, c, d)	8.2 ± 0.8	21.5 ± 2.1	certified
selenomethionine (as Se) (f)	6.6 ± 2.6	17.2 ± 6.8	reference
sodium (c)	1050	2880	information
strontium (c)	16	50	information
zinc (a, c, d, m)	4560 ± 360	11 930 ± 980	certified

**Table 2: Quantity values and expanded uncertainty ( $k = 2$ ) for vitamins in VITB-1**

Vitamin	Mass fraction, mg/kg	Mass fraction, µg/tablet	Type of value
<a href="#">ascorbic acid</a> (j, m)	22 410	57 310	information
<a href="#">alpha tocopherol</a> (k, m)	3580	8710	information
<a href="#">beta carotene</a> (j, m)	110	300	information
<a href="#">biotin</a> (h, l, m)	15.3 ± 1	40.1 ± 2.8	reference
<a href="#">cyanocobalamin</a> (f, g,h, l)	2.1 ± 0.6	5.4 ± 1.6	certified
<a href="#">ergocalciferol</a> (i)	0.13	0.33	information
<a href="#">folic acid</a> (h, l, m)	146 ± 16	381 ± 43	reference
<a href="#">lutein</a> (j)	1.6	4.1	information
<a href="#">niacinamide</a> (h, j, m)	7650 ± 420	20 030 ± 1190	reference
<a href="#">pantothenic acid</a> (h, j, m)	3830 ± 200	10 030 ± 570	reference
<a href="#">phyloquinone</a> (i, m)	11	26	information
<a href="#">pyridoxine HCl</a> (h, j, m)	890 ± 100	2320 ± 270	reference
<a href="#">retinol acetate</a> (i)	80	220	information
<a href="#">riboflavin</a> (h, j, m)	674 ± 30	1760 ± 90	reference
<a href="#">thiamine HCl</a> (h, j, m)	642 ± 64	1680 ± 170	reference

### Coding

The coding refers to the instrumental method of analyte determination.

- a** Isotope dilution inductively-coupled plasma mass spectrometry (ID-ICP-MS)
- b** Standard addition inductively-coupled plasma mass spectrometry (ICP-MS)
- c** Inductively-coupled plasma mass spectrometry (ICP-MS)

- d** Standard addition Inductively-coupled plasma atomic emission spectroscopy (ICP-AES)
- e** Hydride generation ICP-MS
- f** Standard addition liquid chromatography ICP-MS (LC-ICP-MS)
- g** Isotope dilution liquid chromatography-tandem mass spectrometry (ID-LC-MS/MS)
- h** Liquid chromatography-tandem mass spectrometry (LC-MS/MS)
- i** Liquid chromatography mass spectrometry (LC-MS)
- j** High-performance liquid chromatography ultraviolet detection (HPLC-UV)
- k** High-performance liquid chromatography fluorescence detection (HPLC-FLD)
- l** Microbiological assay
- m** Gravimetry

### **Certified values**

Certified values are considered to be those for which the NRC has the highest confidence in accuracy and that all known and suspected sources of bias have been taken into account and are reflected in the stated expanded uncertainties. Certified values are the best estimate of the true value and uncertainty.

### **Reference values**

Reference values are those for which insufficient data are available to provide a comprehensive estimate of uncertainty.

### **Information values**

Information values are those for which insufficient data are available to provide any estimate of uncertainty.

### **Intended use**

This CRM is not intended for human consumption; it is intended for the calibration of procedures and the development of methods for the determination of minerals and vitamins in multivitamin materials or similar matrices. A minimum sample mass of 2.62 g (one tablet) is recommended.

### **Storage**

It is recommended that VITB-1 to be stored in a dark, +4 °C temperature environment or lower and the trilaminate foil pouches opened immediately prior to use.

### **Instructions for use**

A unit of VITB-1 consists of a box with 20 tablets individually packaged in trilaminate foil pouches which serve as a barrier to the light and moisture. Trilaminate foil pouches should only be opened immediately prior to use. The CRM is sensitive to light, so caution should be taken to avoid any light exposure. Each tablet weighs approximately 2.62 g. The moisture content is estimated at 10 mg/g (26 mg per tablet). It should be noted that if the tablets are ground, the protective coating is fractured and the vitamins may degrade. In this case, sample must be analyzed immediately.

### **Preparation of material**

VITB-1 is an elevated-level multivitamin tablet that was prepared by a commercial manufacturer according to pharmaceutical standards. The material contains vitamins (both water soluble and fat soluble vitamins), dietary minerals and other nutritional elements and was pressed into

tablets, film-coated and individually packed in a trilaminate foil pouch. Each tablet is oval shaped with an average thickness of 11 mm.

### Stability

A short-term stability study was conducted using the isochronous approach to simulate potential elevated temperatures experienced during shipping. No measurable degradation was observed during this period. The long-term stability was initially assessed over a period of two years at storage conditions. No change in measured mass fraction was observed over this period as long as the material is stored in appropriate conditions. Uncertainty components for long and short-term stability were thus considered negligible and are thus not included in the uncertainty budget.

### Homogeneity

The material was tested for homogeneity at the NRC. Results from sub-samples (single tablets) were evaluated using DerSimonian-Laird random effects model and included in the calculation of the certified values [2].

### Uncertainty

Included in the overall combined uncertainty estimate ( $u_c$ ) are uncertainties in the batch characterization ( $u_{char}$ ), uncertainties related to possible between-tablet variation ( $u_{hom}$ ), and uncertainties related to inconsistency between the various measurement methods ( $u_{method}$ ). The latter is estimated as the heterogeneity in the random effects model fitted to the results of individual methods, also known as the dark uncertainty [3,4]. Expressed as standard uncertainties, these components are listed in Tables 3 and 4.

**Table 3: Uncertainty Components for VITB-1**

Element/compound	$u_c$ , mg/kg	$u_{char}$ , mg/kg	$u_{hom}$ , mg/kg	$u_{method}$ , mg/kg
arsenic	0.013	0.009	0.009	0
boron	4	3	3	0
bromine	0.04	0.03	0.03	0
calcium	1200	600	1000	0
chlorine	21	19	10	0
chromium	0.6	0.2	0.4	0.4
chromium picolinate (as Cr)	0.4	0.4	0	0
cobalt	0.05	0.03	0.03	0.02
copper	5	2	3	3
iodine	8	5	6	0
iron	60	40	40	0
lead	0.004	0.004	0.001	0
magnesium	900	500	500	600
manganese	17	10	12	6
molybdenum	1.6	0.6	1.4	0.5
phosphorous	800	400	400	600
potassium	1400	1200	500	500

Element/compound	$u_c$ , mg/kg	$u_{char}$ , mg/kg	$u_{hom}$ , mg/kg	$u_{method}$ , mg/kg
selenium	0.4	0.2	0.3	0
selenomethionine (as Se)	1.3	1.3	0.3	0
zinc	180	180	0	0

**Table 4: Uncertainty Components for VITB-1**

Vitamin	$u_c$ , mg/kg	$u_{char}$ , mg/kg	$u_{hom}$ , mg/kg	$u_{method}$ , mg/kg
biotin	0.5	0.3	0.4	0
cyanocobalamin	0.3	0.1	0.3	0.1
folic acid	8	4	4	6
niacinamide	210	100	180	0
pantothenic acid	100	70	70	0
pyridoxine HCl	50	10	20	50
riboflavin	15	5	14	4
thiamine HCl	32	11	13	27

### Metrological traceability

Results presented in this certificate are traceable to the SI through gravimetrically-prepared standards of established purity and international measurement intercomparisons. As such, VITB-1 serves as suitable reference materials for laboratory quality assurance programs, as outlined in ISO/IEC 17025.

### Quality Management System (ISO 17034, ISO/IEC 17025)

This material was produced in compliance with the NRC Metrology Quality Management System, which conforms to the requirements of ISO 17034 and ISO/IEC 17025. The Metrology Quality Management System supporting NRC Calibration and Measurement Capabilities, as listed in the *Bureau international des poids et mesures* (BIPM) Key Comparison Database ([kcdb.bipm.org/](http://kcdb.bipm.org/)), has been reviewed and approved under the authority of the Inter-American Metrology System (SIM) and found to be in compliance with the expectations of the *Comité international des poids et mesures* (CIPM) Mutual Recognition Arrangement. The SIM approval is available upon request.

### Updates

Users should ensure that the certificate they have is current. For updates, please refer to [doi.org/10.4224/crm.2018.vitb-1](https://doi.org/10.4224/crm.2018.vitb-1)

### References

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### Cited by

A list of scientific publications citing VITB-1 CRM can be found at [doi.org/10.4224/crm.2018.vitb-1](https://doi.org/10.4224/crm.2018.vitb-1)

### Authorship

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**VITB-1**

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**Approved by:**

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**This Certificate is only valid if the corresponding material was obtained directly from the NRC or an Authorized Reseller.**

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