



# Certificate of Analysis

## Certified Reference Material

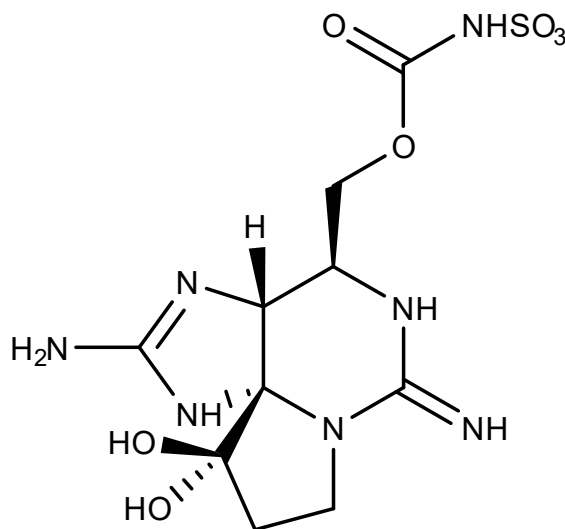
### CRM-GTX5-d (Lot# 20191024)

#### Certified Calibration Solution for Gonyautoxin-5

Gonyautoxin-5 (GTX5) is a saxitoxin analogue [1] found in both marine microalgae [2] and freshwater cyanobacteria [3]. CRM-GTX5-d is a certified calibration solution of GTX5 in dilute acetic acid (pH 5), designed to aid in the identification and quantitation of GTX5. This is a replacement calibration solution for CRM-GTX5-c.

**Table 1:** Certified concentration and uncertainty for CRM-GTX5-d.

Compound	$\mu\text{mol/L}$ (15 - 30 °C)
GTX5	$53.6 \pm 2.9$



#### Gonyautoxin-5 (GTX5)

CAS registry No.: 64296-25-9 (free base)

InChIKey: JKKCSFJSULZNDN-HGRQIUPRSA-N (free base)

Molecular formula: C<sub>10</sub>H<sub>17</sub>N<sub>7</sub>O<sub>7</sub>S<sub>1</sub>

Molecular weight: 379.35 g/mol

Period of validity: 1 year from date of sale

Storage conditions: -12 °C or below

## Intended Use

CRM-GTX5-d is a certified calibration solution designed for analytical method development and accurate quantitation of GTX5. The concentration is suitable for preparing a dilution series for calibration of instruments such as liquid chromatography with detection by pre/post-column oxidation-fluorescence (LC-ox-FLD) or mass spectrometry (LC-MS), as well as for spiking control samples for recovery experiments.

## Instructions for Storage and Use

To ensure the stability of CRM-GTX5-d, ampoules should be stored at -12 °C or below.

Prior to opening, each ampoule should be allowed to warm to room temperature and the contents thoroughly mixed. The ampoule should be opened at the pre-scored mark. Calibrated volumetric equipment should be used for accurate transfer. An increase in concentration due to evaporation of solvent will occur if the solution is left opened for more than a few minutes. It is recommended that the CRM should not be evaporated to dryness because of the potential for losses. *Note:* The volume of the solution is not certified. Only the concentration is certified. Therefore, the entire contents of the ampoule should not simply be transferred to a volumetric flask and diluted to volume.

## Preparation of CRM-GTX5-d

N-sulfocarbamoyl-gonyautoxin-3 (C2) was isolated from a large-scale laboratory culture of *Alexandrium tamarense*, chemically converted to GTX5, then purified by several chromatographic steps [4]. The structure and purity of GTX5 was confirmed by LC-MS/MS [5,6] (Figures 1 and 2) and <sup>1</sup>H NMR. A measured accurate *m/z* of 380.0984 ( $\Delta = 0.2$  ppm for C<sub>10</sub>H<sub>18</sub>N<sub>7</sub>O<sub>7</sub>S<sub>1</sub><sup>+</sup>) was obtained for the [M+H]<sup>+</sup> ion of GTX5 (free base) using LC-high resolution MS (LC-HRMS). Purity was further assessed by LC-MS, LC-ox-FLD [7] (Figure 3), capillary electrophoresis with UV (CE-UV) [8] and liquid chromatography with chemiluminescence nitrogen detection (LC-CLND) [9].

The stock solution was prepared by diluting the purified GTX5 in H<sub>2</sub>O for quantitation using <sup>1</sup>H-NMR (qNMR) [10]. The CRM-GTX5-d solution was prepared by making an accurate dilution of the stock solution in degassed deionized water adjusted to pH 5 with acetic acid. Aliquots were dispensed into clean argon-filled amber glass ampoules and immediately flame-sealed. Each ampoule contains approximately 0.5 mL of solution.

## Analytical Methods and Value Assignment

The certified value for CRM-GTX5-d (Table 1) is based on results obtained at the NRC using three analytical methods: qNMR using potassium hydrogen phthalate (NIST SRM 84L) for calibration, and LC-CLND and LC-ox-FLD using NRC CRM-GTX5-c for calibration.

## Homogeneity

A representative number of CRM-GTX5-d ampoules were selected from across the fill series and GTX5 response was measured by LC-ox-FLD. No heterogeneity was observed.

## Stability

A one year stability study performed on CRM-GTX5-c demonstrated good stability for GTX5 in aqueous acetic acid (pH 5) stored in sealed ampoules at temperatures of -12 °C or below.

## Uncertainty

All reasonable sources of error related to the characterization of CRM-GTX5-d were considered and measured. The overall uncertainty estimate ( $U_{CRM}$ ) includes uncertainties associated with batch characterization ( $u_{char}$ ) and instability during storage ( $u_{stab}$ ) [11-14]. These components are listed in Table 2, and are combined and expanded as follows:

$$U_{CRM} = k\sqrt{u_{char}^2 + u_{hom}^2 + u_{stab}^2}$$

where  $k$  is the coverage factor for a 95% confidence level ( $= 2$ ).

**Table 2:** Uncertainty components for the certified value of CRM-GTX5-d.

Uncertainties	Relative*
$u_{char}$	0.026
$u_{hom}$	negligible
$u_{stab}$	0.008

\*Relative to concentration shown in Table 1.

## Safety Instructions

If sufficient quantities are ingested, GTX5 and related toxins can cause paralysis and even death. Only qualified personnel should handle the solution and appropriate disposal methods should be used. Suitable personal protective equipment should be used when opening the ampoule in the event the glass shatters. A safety data sheet (SDS) is available for CRM-GTX5-d.

## Period of Validity

If stored unopened at the recommended storage condition of  $-12\text{ }^{\circ}\text{C}$  or below, the certified concentration of CRM-GTX5-d is valid for 1 year from the date of sale.

## Metrological Traceability

Results presented in this certificate are traceable to the SI (*Système international d'unités*) through gravimetrically prepared standards of a NIST potassium hydrogen phthalate certified reference material (NIST SRM 84L), and a certified reference material for GTX5 (NRC CRM-GTX5-c).

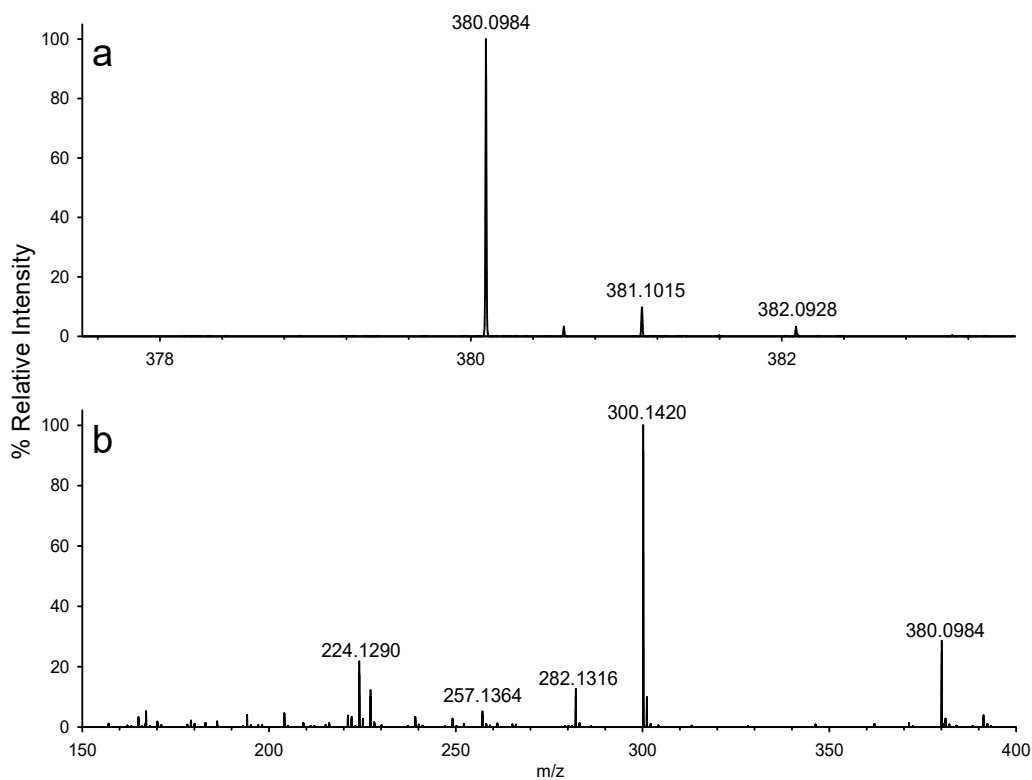
## Quality Management System (ISO 17034, ISO/IEC 17025)

This material was produced in compliance with the National Research Council of Canada (NRC) Metrology Quality Management System, which conforms to the requirements of ISO 17034 and ISO/IEC 17025.

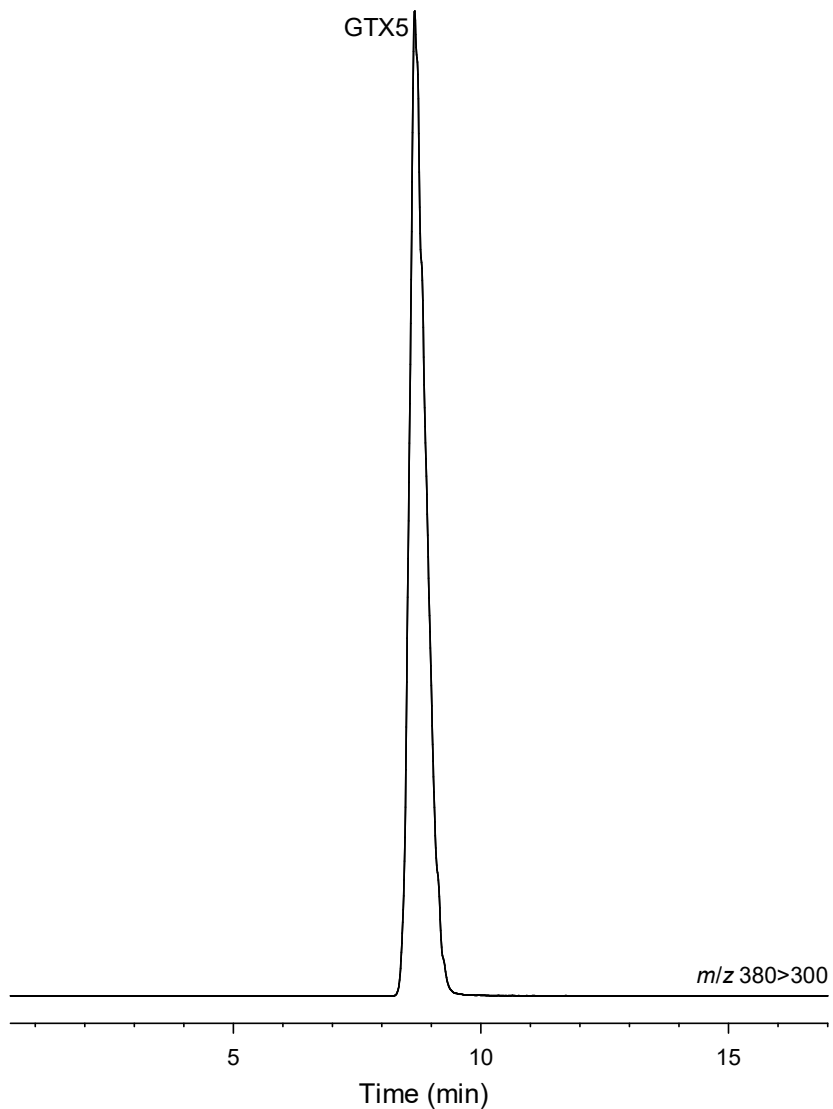
The Metrology Quality Management System supporting the NRC Calibration and Measurement Capabilities, as listed in the *Bureau international des poids et mesures* (BIPM) Key Comparison Database (<http://kcdb.bipm.org/>), has been reviewed and approved under the authority of the Inter-American Metrology 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.

## References

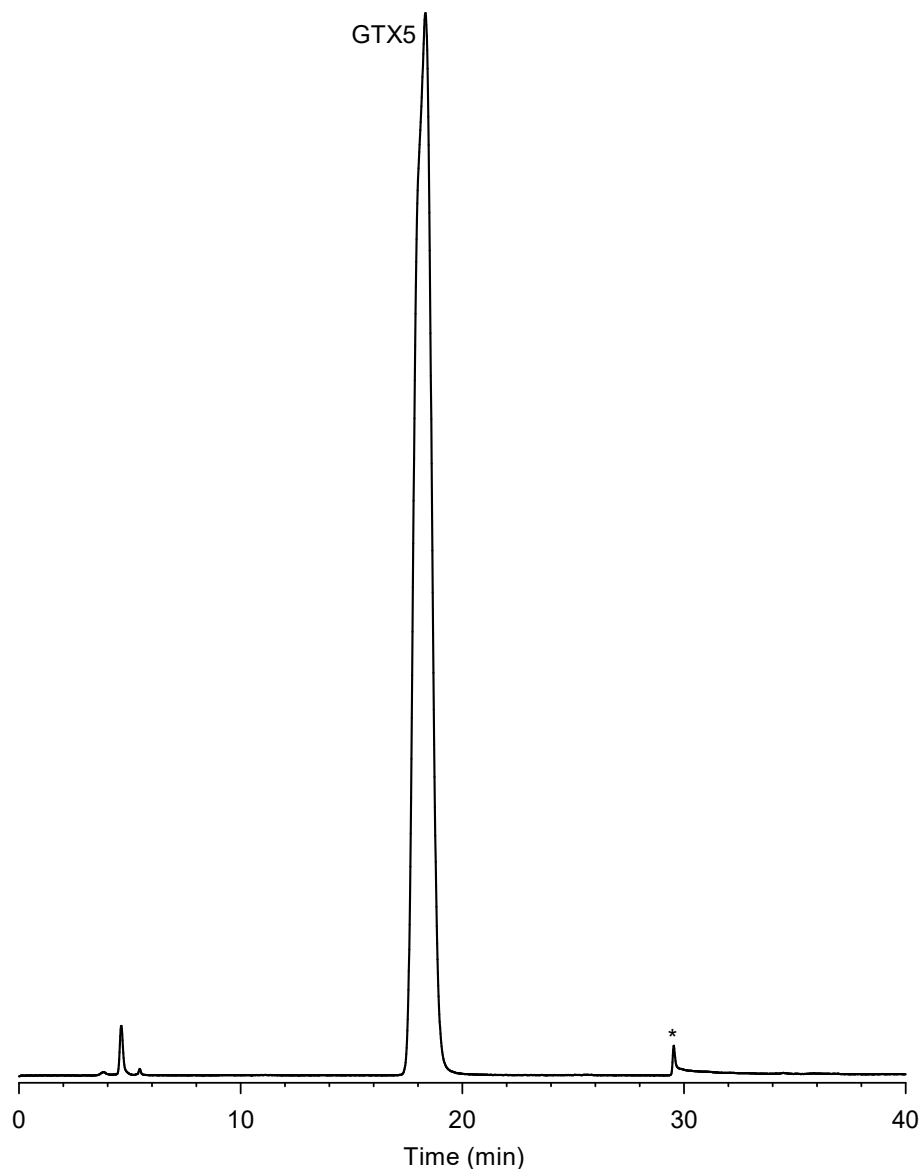
1. Hall S, Strichartz GR, Moczydlowski E, Ravindran A, Reichardt PB (1990). The saxitoxins: sources, chemistry, and pharmacology. In: Hall S and Strichartz GR (Eds) *Marine Toxins. ACS Symposium Series* 418: 29-65. Washington DC, *Am Chem Soc*.
2. Shumway SE (1990). A review of the effects of algal blooms on shellfish and aquaculture. *J. World Aquacult Soc* 21 (2): 65-104.
3. D'Agostino PM, Boundy MJ, Harwood TD, Carmichael WW, Neilan BA, Wood SA (2019). Re-evaluation of paralytic shellfish toxin profiles in cyanobacteria using hydrophilic interaction liquid chromatography-tandem mass spectrometry. *Toxicon* 158: 1-7.
4. Laycock MV, Thibault P, Ayer SW, Walter JA (1994). Isolation and purification procedures for the preparation of paralytic shellfish poisoning toxin standards. *Nat Toxins* 2: 175-183.
5. Dell'Aversano C, Hess P, Quilliam MA (2005). Hydrophilic interaction liquid chromatography-mass spectrometry for the analysis of paralytic shellfish poisoning (PSP) toxins. *J Chromatogr A* 1081: 190-201.
6. Thomas K, Beach DG, Reeves KL, Gibbs RS, Kerrin ES, McCarron P, Quilliam MA (2017). Hydrophilic interaction liquid chromatography-tandem mass spectrometry for quantitation of paralytic shellfish toxins: validation and application to reference materials. *Anal Bioanal Chem* 409: 5675-5687.
7. Anon. AOAC Official Method 2011.02. Paralytic shellfish toxins in mussels, clams, oysters, and scallops; post-column oxidation (PCOX) method (2009). *Official Methods of Analysis* 18th Ed. AOAC International, Gaithersburg, MD.
8. Thibault P, Pleasance S, Laycock MV (1991). Analysis of paralytic shellfish poisons by capillary electrophoresis. *J Chromatogr A* 542: 483-501.
9. Thomas K, Wechsler D, Chen YM, Crain S, Quilliam MA (2016). Analysis of natural toxins by liquid chromatography-chemiluminescence nitrogen detection and application to the preparation of certified reference materials. *J AOAC Int* 99: 1173-1184.
10. Burton IW, Quilliam MA, Walter JA (2005). Quantitative  $^1\text{H}$  NMR with external standards: use in preparation of calibration solutions for algal toxins and other natural products. *Anal Chem* 77: 3123-3131.
11. Pauwels J, Lamberty A, Schimmel H (2000). Evaluation of uncertainty of reference materials. *Accred Qual Assur* 5: 95-99.
12. Pauwels J, Lamberty A, Schimmel H (1998). The determination of the uncertainty of reference materials certified by laboratory intercomparison. *Accred Qual Assur* 3: 180-184.
13. Ellison SLR, Burke S, Walker RF, Heydorn K, Mansson M, Pauwels J, Wegscheider W, te Nijenhuis B (2001). Uncertainty for reference materials certified by interlaboratory study: Recommendations of an international study group. *Accred Qual Assur* 6: 274-277.
14. Evaluation of measurement data – Supplement 1 to the “Guide to the expression of uncertainty in measurement” (GUM) – Propagation of distributions using a Monte Carlo method. JCGM 101:2008, [www.bipm.org](http://www.bipm.org).



**Figure 1:** Full scan (a) and collision induced dissociation (MS/MS) (b) LC-HRMS spectra of GTX5 used for CRM-GTX5-d analyzed on a Thermo QExactive-HF mass spectrometer equipped with a heated electrospray ionization probe. Data was collected in positive mode with a 2500 V spray voltage, +275 °C capillary temperature, and a +375 °C heater temperature. Full scan data was acquired with a resolution setting of 60 000. MS/MS data was acquired in parallel reaction monitoring scan mode with a resolution setting of 60 000 and a normalized collision energy of 30 V.



**Figure 2:** LC-MS/MS analysis of diluted stock solution for CRM-GTX5-d using selected reaction monitoring on an Agilent 1290 LC connected to a Sciex 5500 QTRAP MS with electrospray ionization. Chromatographic conditions: Toso-Haas Amide-80 column (250 mm × 2 mm, 5 μm) at +40 °C; mobile phase: 60% acetonitrile in water with 2 mM ammonium formate and 3.6 mM formic acid, 0.3 mL/min; injection volume: 0.5 μL. MS conditions: collision energy +20 V; declustering potential +100 V, and source temperature of +275 °C.



**Figure 3:** LC-ox-FLD analysis of CRM-GTX5-d. Conditions: Zorbax Bonus-RP column (250 mm × 4.6 mm i.d., 5 μm) at +35 °C; mobile phase: 5.5 mM ammonium phosphate with 11 mM sodium heptane sulfonate in water (pH 7.1) with a step at 23 minutes to 16.5 mM ammonium phosphate with 11 mM sodium heptane sulfonate in water (pH 7.1) with 9% acetonitrile: 0.8 mL/min; injection volume 25 μL; post-column oxidation: 0.4 mL/min 5 mM periodic acid in 100 mM sodium phosphate at pH 7.8 with reaction coil at +80 °C; effluent acidified with 0.4 mL/min 0.75 M nitric acid; detection: fluorescence with excitation at 330 nm and emission at 390 nm (\* indicates step gradient peak).

## Acknowledgements

The following staff members at the NRC contributed to the production and certification of CRM-GTX5-d: Beach D, Crain S, Giddings S, Gray T, Hogenbom J, LeBlanc P, McCarron P, Mudge E, Perez Calderon RA, Rafuse C, Rajotte I, Reeves K, Thomas K and Wright E.

### This document should be cited as:

Reeves K, Thomas K, Crain S, McCarron P "CRM-GTX5-d, a certified calibration solution reference material for Gonyautoxin-5", Biotoxin Metrology Technical Report CRM-GTX5-d-20191024, National Research Council Canada, Halifax.

DOI <https://doi.org/10.4224/crm.2020.gtx5-d.20191024>

*Date of issue: August 2020*

*Document version: 20220221*

*Revised: December 2020 (DOI added), February 2022 (editorial updates)*

Approved by:



Pearse McCarron, Ph.D.  
Team Leader, Biotoxin Metrology

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

### Comments, information and inquiries should be addressed to:

National Research Council Canada  
1411 Oxford Street  
Halifax, Nova Scotia B3H 3Z1  
Canada

**Telephone:** 1-902-426-8281

**Fax:** 1-902-426-5426

**Email:** [CRM-MRCHalifax@nrc-cnrc.gc.ca](mailto:CRM-MRCHalifax@nrc-cnrc.gc.ca)