

Certificate of analysis

Certified reference material code: CRM-00-YTX

Name: Certified Reference Material of Yessotoxin di-sodium salt

Batch: 23-001

Description: This Certified Reference Material (CRM) is a solution of Yessotoxin di-sodium salt (CAS Number 112574-50-2) in methanolic solution.

Intended use: Calibration of equipment or a measurement procedure. Establishing metrological traceability. Method validation. Quality control of a measurement or measurement procedure. For laboratory use only.

Certified values and uncertainties: The certified concentration given below is based on results obtained from the gravimetric preparation of this solution previous quantity determination by ^1H -qNMR in Varian WB 500 MHz equipment (Universidad de Santiago de Compostela).

Concentration of Yessotoxin di-sodium salt and analogues (95% Confidence Interval)	$(7.10 \pm 0.48) \mu\text{mol} / \text{kg}$
	$(8.42 \pm 0.57) \mu\text{g} / \text{g}$

NOTE: In order to perform the analysis, it should be noted that the certificate value corresponds to the sum of Yessotoxin di-sodium salt and minor analogues concentration and therefore the sum of the areas of the chromatographic signals should be considered. See #Non-certified and non-accredited data section of this certificate.

The starting material is measured by ^1H -qNMR against a Benzoic acid certified reference material followed by gravimetric preparation using high precision balances calibrated with SI-traceable weights. Consequently, the quantified values are traceable to the International System of Units (SI) via an unbroken chain of comparisons through validated methodology.

Homogeneity was evaluated by analysis of variance on 2% of stratified randomly selected ampoules over the entire batch (6 replicate analyses per ampoule). A possible heterogeneity is hidden by the method repeatability. Therefore, a maximum possible heterogeneity was calculated as u_{bb} , 1.28%. The Stability studies after storage of selected units were performed at -20°C for a storage time of 12 months. Using the data from the long-term study, the uncertainty due to possible degradation was calculated as u_{lts} , 1.34%. Both studies were verified against an independently prepared calibration solution.

The components of Standard Uncertainty include related uncertainties due to characterization, heterogeneity, long term instability, short term instability (dispatch), and bulk assay, Table 1. The results are expressed as the certified value $\pm$ the expanded uncertainty (calculated by combination of the squared contribution values). Estimated expanded uncertainty with a coverage factor $k = 2$, corresponding to a level of confidence of about 95 %, as defined in the Guide to the expression of uncertainty in measurement, ISO33405.

The certificate is a summary of an extensive program of work involving selection and purification of the material, assessing its suitability and measuring the properties to be certified.

Expiration of Certification: *This certificate of CRM-00-YTX, 23-001 batch is valid 12 months after purchase date within the measurement uncertainties specified, provided the CRM is handled and stored in accordance with the instructions given in this certificate. This validity may be extended if further evidence of stability becomes available.*



CRM-00-YTX, 23-001,
rev.2, 12/01/2026

F-01-08 Edición 6 Página 1 de 5

Maintenance of Certification: The material will be subjected to regular Laboratorio Cifga stability monitoring programme to control its further stability over the period of its certification. If substantive changes occur that affect the certification before the expiration date, Laboratorio Cifga will notify the purchaser.

Instructions for proper handling use: This material contains toxic material, and should be handled with care. Read MSDS before using. Material Safety Data sheet for information regarding CRM-00-YTX is enclosed in the package. Use proper disposal methods.

Before opening an ampoule, it must be guaranteed that the content is a liquid and properly mixed to ensure homogeneity. Sample aliquots for analysis should be handled at 15°C to 25°C immediately after opening the ampoules and should be processed without delay for the certified value to be valid within the stated uncertainty. Ampoule should not remain open longer than five minutes due to solvent volatility and air contamination.

Storage conditions: The original sealed ampoules should be stored at temperatures below/at -20 °C (freezer) until use. Unopened ampoules should be stored upright under normal laboratory conditions inside the original container supplied.

Source and Preparation of Material: Yessotoxin di-sodium salt was isolated from large scale culture of *Protoceratium reticulatum* and purified via preparative HPLC chromatography system. After purification, identity of the material was confirmed by ¹H-NMR and UPLC-MS/MS, Figures 1 and 2. Finally, 0.5 mL aliquots of YTX solution were dispensed into 2-mL amber argon-filled glass ampoules, which were then flame sealed.

#Non-certified and non-accredited data:

Taking into account the density of methanol at 20 °C ($\rho^{20} = 0.7915 \text{ g/mL}$), non-certified volumetric concentration values are:

Concentration of Yessotoxin di-sodium salt (95% Confidence Interval)	(5.62 ± 0.38) µM
	(6.67 ± 0.45) µg / mL

Concentration of YTX and impurities are neglected in order to apply solution density value.

Purity analysis was performed by combining ¹H-qNMR and UPLC MS/MS, ≥ 97 % (molar ratio purity). Percentage values not certified. No purity correction over certified concentration should be done.

Additional low amounts of YTX tentative analogues quantified out from principal component are presented, see #Table 2.

Additional lectures:

1. UNE-EN ISO 17034 *General Requirements for the competence of reference material producers*.
2. ISO 33405 *Reference materials - Approaches for characterization and assessment of homogeneity and stability*.



Figures

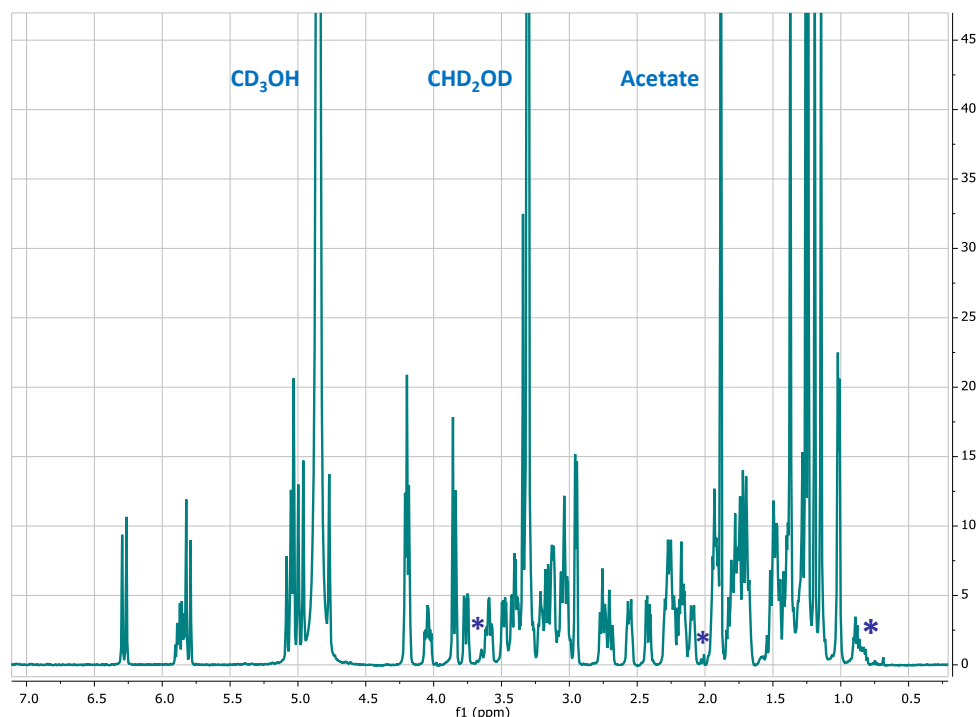


Figure 1. ^1H -NMR spectrum of YTX solution, Varian 500 MHz WB, 6 mM of YTX in CD_3OD used in preparation of CRM-00-YTX batch 23-001. No identified impurities are highlighted (*). As the structure of these impurities is not known, their exact amount cannot be calculated. Because the impurities usually are smaller molecules (otherwise, more NMR signals would arise), it can be estimated from the corresponding integrals, but this purity is not relative to close-related impurities to Yessotoxin analogues.

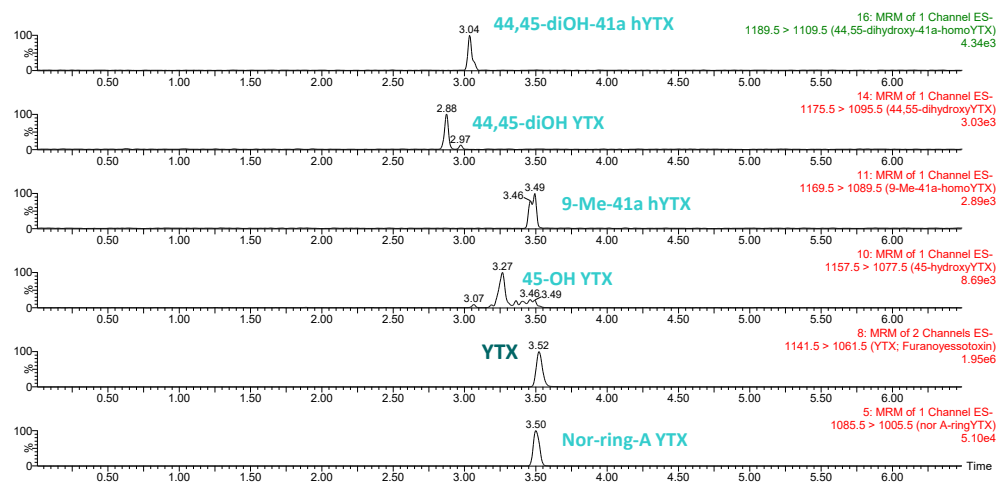


Figure 2. Analysis of the CRM-00-YTX (23-001) by UPLC-MS/MS. Conditions: ACQUITY UPLC BEH C18 1.7 μm , 100x2.1 mm, UPLC column. Elution conditions, gradient mode with mobile phases: (A) Water and (B) Aqueous 95% acetonitrile, both with 5 mM ammonium acetate, pH = 6.85; Gradient: 0.00 min 20% B; 1.00 min 20% B; 4.00 min 90% B; 5.00 min 90% B; 5.10 min 20% B; 6.50 min 20% B; flow rate: 0.50 mL/min. Temperature: 35 °C. MS detector: Waters XEVO TQ MS using the typical MRM transitions of Yessotoxin tentative analogues.



Table 1. Uncertainties contribution for the certification of CRM-00-YTX (23-001). *Char*: qNMR quantification; *ba*: bulk assay; *bb*: homogeneity test; *lts*: long term stability test; *sts*: short term stability test.

Uncertainty contribution parameter	Uncertainty values
	Yessotoxin di-sodium salt*
$u_{char}/\%$	2.49
$u_{ba}/\%$	0.60
$u_{bb}/\%$	1.28
$u_{lts}/\%$	1.34
$u_{sts}/\%$	1.29
Expanded uncertainty ($k=2$) / %	6.82

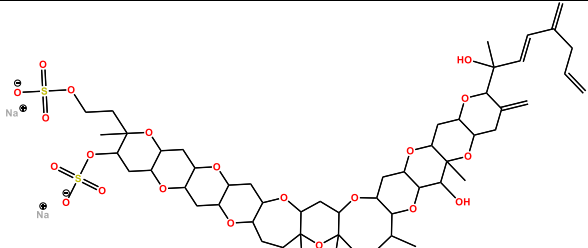
Short-term stability study. The uncertainty due to transport instability was estimated from the test for slope significance at 40°C. The results indicated continued stability, no change is expected in the property values of the CRM. The combined uncertainty budget of the assigned value was upgraded to incorporate short-term stability at 40°C for 9 days.

* Yessotoxin di-sodium salt and isomers detected have been quantified jointly.

#Table 2. Non-certified reference values of impurities concentration (µM) determined by UPLC MS/MS. Assigned analogues entries for compounds must be regarded as tentative according to MRM transitions agree. Assumption of equimolar response at sulphate loss MRM was used. Estimated uncertainty corresponds to a level of confidence in terms of one standard deviation. *Tentative analogue assignment.

Toxin	Concentration / µM	%
YTX	5.62 ± 0.35	$\geq 97 \%$
32-arabinoside-YTX*	-	0.02 %
Nor-ring-A-YTX*	0.11 ± 0.05	1.9 %
9-Me-41a-homoYTX*	-	0.05 %
45-hydroxy-YTX*	-	0.03 %
44,45-dihydroxy-41a-homoYTX*	-	0.2 %

Table 3. Molecular information.

Name	Yessotoxin di-sodium salt
CAS NUMBER	112514-54-2 (for component yessotoxin di acid form)
Molecular formula	$C_{55}H_{80}O_{21}S_2Na_2$
Molecular Weight	$1187.3 \text{ g} \cdot \text{mol}^{-1}$
Monoisotopic molecular weight	$1186.4 \text{ g} \cdot \text{mol}^{-1}$
2D structure	



Inquiries concerning this Reference Material should be directed to:

Laboratorio CIFGA S.A.

Rua do Vidro 117D, Parcelas 3-6

27003 • Lugo • Spain

Tel. 0034 982 816 715

E-mail: info@cifga.com

RM PRODUCER'S APPROVING OFFICER:

Certification Manager: Álvaro Antelo

This Certificate is only valid if the product was obtained directly from Laboratorio CIFGA S.A. or one of our authorized distributors.

Certificate Revision History:

October, 27th 2023 (Original certificate issue date, revision 1).

January, 12th 2026. Address update. Revised and added associated uncertainties following additional testing. Minor typographical errors (*certificate rev. 2*).

NOTE: This certificate of analysis shall not be reproduced, except in full, without written approval of Laboratorio CIFGA S.A.



CRM-00-YTX, 23-001,
rev.2, 12/01/2026

F-01-08 Edición 6 Página 5 de 5

The marked activities (#) are not
covered by ENAC accreditation