

Alternatives to Animal Testing for Chemical Risk Assessment

A Defra LINK Project

Project no. LK0984

NON POLAR NARCOSIS QSAR FOR *TETRAHYMENA PYRIFORMIS*

M8 Development of *in silico* models for “non-reactive” toxicity

Prepared by:

Fania Bajot
School of Pharmacy and Chemistry,
Liverpool John Moores University,
Byrom Street, Liverpool, L3 3AF, England
F.Bajot@ljmu.ac.uk

This project was sponsored by Defra through the Sustainable Arable Link Programme

September 2009

www.inchemicotox.org

1 Aim of this Document

This document provides supporting information related to the non polar narcosis QSAR for *Tetrahymena pyriformis* acute toxicity reported in the framework of the Defra LINK LK0984 project. This QSAR is related to Milestones 8 Development of *in silico* models for “non-reactive” toxicity. The QSAR model presented in this document is available on <http://www.inchemicotox.org/>.

The following documentation has been generated using the QSAR Model Reporting Format (QMRF) available at JRC, <http://qsardb.jrc.ec.europa.eu/qmrf/>.

2. QSAR Abstract

A dataset of 87 chemicals previously identified as non polar narcotics to *Tetrahymena pyriformis* has been used to develop a non polar narcosis QSAR model [1] (Equation 1). The non polar narcosis mechanism of action has often been shown to be related to the lipophilicity of chemicals.

Linear regression analysis was applied to relate the acute toxicity (IGC50) to *Tetrahymena pyriformis* to the logarithm of octanol-water partition coefficient (log P). The following model was obtained:

$$\log (1/\text{IGC50})= 0.83 \log P - 2.07 \quad \text{Equation 1}$$

$$n=87; q^2=0.95; r^2=0.96; s=0.27; F=1895$$

Where IGC50 is 50% inhibitory growth the concentration (moles per litre), n is the number of compounds, q^2 is the cross-validated coefficient of determination, r^2 is the square of the correlation coefficient, s is the standard deviation and F is the Fisher statistics.



3. Reference

1. Ellison, C. M.; Cronin, M. T. D.; Madden, J. C.; Schultz, T. W. Definition of the structural domain of the baseline non-polar narcosis model for *Tetrahymena pyriformis*. *SAR and QSAR in Environmental Research* **2008**, 19, 751-783.

Disclaimer and Important Legal Notice:

Every attempt is made to ensure the accuracy of the information, data, models, ITS, case studies and all other content on this web-site and reported within this project. However, the members of the consortium cannot be held responsible for any errors or incorrect conclusions or inferences drawn from this information and these data.

The content of the InChemicoTox web site reflects only the views of members of the consortium. Neither the Consortium (partners and / or contractors and / or sub-contractors) nor Defra are liable for any use that may be made of the information contained herein.

	QMRF identifier (JRC Inventory): To be entered by JRC	
	QMRF Title: Non polar narcosis QSAR for <i>tetrahymena pyriformis</i> acute toxicity	
	Printing Date: 22-Sep-2009	

1. QSAR identifier

1.1. QSAR identifier (title):

Non polar narcosis QSAR for *tetrahymena pyriformis* acute toxicity

1.2. Other related models:

None

1.3. Software coding the model:

2. General information

2.1. Date of QMRF:

07th of September 2009

2.2. QMRF author(s) and contact details:

[1] Fania Bajot Liverpool John Moores University f.bajot@ljmu.ac.uk

[2] Mark Cronin Liverpool John Moores University + 44 151 231 2402
m . t . c r o n i n @ l j m u . a c . u k
<http://www.staff.livjm.ac.uk/phamcron/qsar/qsar1.htm>

2.3. Date of QMRF update(s):

2.4. QMRF update(s):

2.5. Model developer(s) and contact details:

[1] C.M. Ellison Liverpool John Moores University

[2] Mark Cronin Liverpool John Moores University + 44 151 231 2402
m . t . c r o n i n @ l j m u . a c . u k
<http://www.staff.livjm.ac.uk/phamcron/qsar/qsar1.htm>

2.6. Date of model development and/or publication:

07th of September 2009

2.7. Reference(s) to main scientific papers and/or software package:

C.M. Ellison, M.T.D. Cronin, J.C. Madden and T.W. Schultz. Definition of the structural domain of the baseline non-polar narcosis model for *Tetrahymena pyriformis*. SAR and QSAR in Environmental Research 19: 751–783

2.8. Availability of information about the model:

The model is non-proprietary. Information on the algorithm and training set is publicly available.

2.9. Availability of another QMRF for exactly the same model:

None

3. Defining the endpoint - OECD Principle 1

3.1. Species:

Tetrahymena pyriformis

3.2. Endpoint:

3. Ecotoxic effects 3.3. Acute toxicity to fish (lethality)

3.3. Comment on endpoint:

3.4. Endpoint units:

Moles per litre

3.5. Dependent variable:

50% inhibitory growth concentration (IGC50) (moles per litre) were logarithmically transformed (to base 10) and multiplied by minus 1

3.6. Experimental protocol:

Toxicity data were measured according to: I. Kahn and al. Altern. Lab. Anim. 35 (2007), pp. 15–24.

3.7. Endpoint data quality and variability:

4. Defining the algorithm - OECD Principle 2

4.1. Type of model:

QSAR

4.2. Explicit algorithm:

Linear regression analysis

$$\log (1/\text{IGC50}) = 0.825 \log P - 2.07$$

4.3. Descriptors in the model:

log P dimensionless logarithm of octanol-water partition coefficient

4.4. Descriptor selection:

One descriptor (log P) chosen empirically from a knowledge of mechanism of action

4.5. Algorithm and descriptor generation:

log P was calculated from SMILES string

4.6. Software name and version for descriptor generation:

KOWWIN v1.67

KOWWIN is part of EPISuite software

Available for download from
<http://www.epa.gov/oppt/exposure/pubs/episuite.htm>
<http://www.epa.gov/oppt/exposure/pubs/episuite.htm>

4.7. Descriptors/Chemicals ratio:

1 descriptor / 87 chemicals

5. Defining the applicability domain - OECD Principle 3

5.1. Description of the applicability domain of the model:

Applicability domain covers a log P range from -0.78 to 5.75. The acute toxicity values (negative logarithm of molar value) ranged from -2.51 to 1.67.

The compounds selected have been identified as non-polar narcotics to fish. i.e. they are non-reactive and cause lethality by accumulation at cellular membranes. They are characterised by being simple organic compounds including alkyl, halogen and ketone substituted mono-aromatic and (fully saturated) alkyl compound.

5.2.Method used to assess the applicability domain:

None

5.3.Software name and version for applicability domain assessment:

5.4.Limits of applicability:

Non-polar narcosis mechanism of acute fish toxicity.

6.Internal validation - OECD Principle 4

6.1.Availability of the training set:

Yes

6.2.Available information for the training set:

CAS RN:Yes

Chemical Name:Yes

Smiles:Yes

Formula:No

INChI:No

MOL file:No

6.3.Data for each descriptor variable for the training set:

All

6.4.Data for the dependent variable for the training set:

All

6.5.Other information about the training set:

87 simple organic compounds including alkyl, halogen and keto

6.6.Pre-processing of data before modelling:

None

6.7.Statistics for goodness-of-fit:

r^2 adjusted for degrees of freedom = 0.957

standard error = 0.270

Fishers statistic = 1895

6.8.Robustness - Statistics obtained by leave-one-out cross-validation:

leave-one-out cross validated r^2 =0.954

6.9.Robustness - Statistics obtained by leave-many-out cross-validation:

6.10.Robustness - Statistics obtained by Y-scrambling:

6.11.Robustness - Statistics obtained by bootstrap:

6.12.Robustness - Statistics obtained by other methods:

7.External validation - OECD Principle 4

7.1.Availability of the external validation set:

No

7.2.Available information for the external validation set:

CAS RN:No

Chemical Name:No

Smiles:No

Formula:No

INChI:No

MOL file:No

7.3.Data for each descriptor variable for the external validation set:

No

7.4.Data for the dependent variable for the external validation set:

No

7.5.Other information about the external validation set:

7.6.Experimental design of test set:

7.7.Predictivity - Statistics obtained by external validation:

7.8.Predictivity - Assessment of the external validation set:

7.9.Comments on the external validation of the model:

8.Providing a mechanistic interpretation - OECD Principle 5

8.1.Mechanistic basis of the model:

All compounds are considered to act by non-polar narcosis. This is well established for non-reactive compounds. Acute lethality is brought about by accumulation in cellular membranes causing their disruption

and ultimately death of the organism. The ability of the compound to accumulate in a cellular membrane is thought to be related to its intrinsic hydrophobicity. Hydrophobicity of these compounds is modelled

by log P.

8.2.A priori or a posteriori mechanistic interpretation:

As stated in Section 8.1, hydrophobicity is related to log P and is known to the controlling factor in the acute lethal toxicity of non-polar narcotic compounds. Compounds in this data set were selected a priori

on the basis that they acted as non-polar narcotics.

8.3.Other information about the mechanistic interpretation:

9.Miscellaneous information

9.1.Comments:

This model is related to a large number of models for non-polar narcosis (also termed baseline or minimum toxicity) for acute fish toxicity.

9.2.Bibliography:

9.3.Supporting information:

Training set(s) Test set(s) Supporting information

10.Summary (JRC Inventory)

10.1.QMRF number:

To be entered by JRC

10.2.Publication date:

To be entered by JRC

10.3.Keywords:

To be entered by JRC

10.4.Comments:
To be entered by JRC