

Investigation of the toxicity of bromate
on the embryo-larval development of
Japanese oyster (*Crassostrea gigas*)



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Approved by

01/11/2022

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Investigation of the toxicity of bromate on the embryo-larval development of Japanese oyster (*Crassostrea gigas*)

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1 Introduction

DHI has conducted a toxicity test assessing the effects of bromate on the embryo-larval development of the marine Japanese oyster (*Crassostrea gigas*) under static conditions. It allows the determination of the concentration levels that result in an abnormality in embryo-larval development. The test was performed according to DS/ISO 17244 "Water quality - Determination of the toxicity of water samples on the embryo-larval development of Japanese oyster (*Crassostrea gigas*) and mussel (*Mytilus edulis* or *Mytilus galloprovincialis*) /1/.

The exposure was performed from fertilized eggs to D larvae. This test aims at determining the No Effect Concentration (NOEC) level and the EC50 concentration, which results in abnormalities for 50 % of exposed larvae in 24 h for the Japanese oyster.

2 Test item

The purpose of the test was to investigate the toxicity of bromate (BrO_3^-), which will be formed if ozone treatment is installed at the treatment plant at Sjölanda (Malmö). DHI has therefore purchased 99.5% pure Sodium Bromate (NaBrO_3) from Sigma-Aldrich (Product No. 71325, Batch No. BCBX9200) for use in the test. The certificate of analysis and the safety data sheet is attached in Annex C.

Table 2.1 Information regarding the test item

Product Name:	Sodium Bromate
Purity	>= 99.5 % RT
Product Number:	71325
Batch Number:	BCBX9200
Brand:	Sigma-Aldrich
CAS Number:	7789-38-0
Formula:	NaBrO_3
Formula Weight:	150.89
Quality Release Date:	03 AUG 2018
Recommended Retest Date:	JAN 2023

3 Test method

3.1 Test solution

A stock solution of sodium bromate (NaBrO_3) was prepared by dissolving 236 mg in 500 mL of filtered natural seawater with a salinity of 32 PSU. This stock solution corresponds to 400 mg bromate/L. The dilution series was prepared by adding the appropriate amounts of stock solution to 300 mL of filtered sea water.

3.2 Test organism

Crassostrea gigas was purchased from Guernsey Sea Farms Ltd., Guernsey. The oysters were ready for spawning as soon as they arrived in the laboratory. The oysters were used directly after arrival and were therefore stored at 20°C until use.

Gametes from the oysters can be obtained by use of different methods according to the ISO standard. In this study the gametes were stripped from the gonads directly by opening the Oysters and inserting a clean, Pasteur pipette into the gonad to a depth of 1 mm to 2 mm and the eggs or sperm were collected. The gametes were transferred to separate volumes of seawater and held at $24\text{ °C} \pm 2\text{ °C}$ (preferably 25 °C).

A part of the initial egg suspension was diluted in seawater. The egg density was evaluated by counting the solution several times in a stereo microscope. The initial solution was then adjusted to obtain a final density in the test replicates between 20 000 and 50 000 eggs/L. Fertilization was carried out by adding a few millimetres of a dense suspension of sperm in the beaker containing the eggs (oocytes).

The content of the beaker was homogenized by gently shaking the beaker (every 1 min to 2 min) in order to avoid polyspermy. A sample was taken from the beaker to check the fertilization rate (each egg shall be surrounded by six to 10 spermatozoa which can be observed on an equatorial plan). The fertilization rate should have reached 90 % to perform the inoculation.

From 15 min to 20 min post fertilization, the fertilized eggs were quickly inoculated in the test solutions resulting in 20 000 to 50 000 eggs/L. The test vials were incubated under the conditions described in Table 3.1 for $24\text{ h} \pm 2\text{ h}$.

After the incubation period, glutaraldehyde, was added to each test vessel to fix and preserve the larvae. The observations of the larvae can then be carried out immediately or up to several weeks later if the test vials are kept hermetically sealed at the ambient temperature of the laboratory. The observations were carried out by taking the appropriate volumes (e.g., 5 x 1 mL) out of a homogeneous test suspension and using a stereoscopic inverted light microscope fitted with a magnification of at least 200x, but preferably 400x.

100 individuals per replicate were counted. The number of abnormal or dead larvae and the "D-Shaped" (see Figure 3.1) normal larvae were registered. Larvae are considered abnormal if they present at least one of the following anomalies (photos available in ISO 17244):

- shell abnormality: concave or convex hinge, irregular edge (a hinge is considered abnormal if it can be considered that it is not functional);
- mantle abnormality: mantle retracted between the shell's valves or hypertrophied which can go as far as expulsion (the larvae are then categorized as dead);

- segmentation abnormalities: blockage of the embryogenesis;
- empty shell: dead larva.

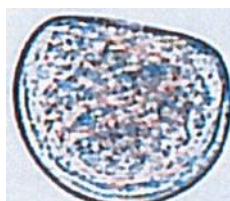


Figure 3.1 Oyster normal D larvae

Table 3.1 Summary of test conditions in the ISO 17244 test with Pacific oyster (*Crassostrea gigas*).

Test guideline	ISO 17244 /1/
Test organism	Japanese oyster (also named Pacific oyster) (<i>Crassostrea gigas</i>)
Test organism source	Guernsey Sea Farms Ltd., Guernsey
Test organism life stage	Fertilized eggs
Test concentrations	0; 10; 20; 40; 80;160 and 320 mg/L
Test duration	24 ± 2 hours
Test container	20-mL glass vials with 10 mL test solution
Replicates	• 5-10 × laboratory control • 3 × test concentration
Test organisms per replicate	100 organisms per replicate is counted
Endpoint	The number of D larvae and abnormal larvae are counted. Toxicity is expressed as the percentage of abnormal larvae versus the D-shaped normal larvae at the end of the experiment (raw percentage, RPA) and transformed into a net percentage of abnormal larvae (NPA) (see section 5).
Laboratory control medium	Natural seawater (salinity 32 PSU) collected at an unpolluted site in the North Sea and then filtered through Millipore filters (10; 5.0; 0.5 and 0.22 µm). The sea water is checked for toxicity towards Acartia eggs and N+P are measured before the sea water is used at DHI.
Food regime	No food during testing.
Photoperiod	Total darkness
Temperature	24 ± 2°C
Initial pH	In the laboratory control medium: 8.0 ± 0.3
Validity criteria	The average rate of D larvae in the laboratory controls must be ≥80%

Reference test	Verification of organism sensitivity with copper sulphate pentahydrate (CuSO₄·5H₂O). The test concentrations are included in the range 0 µg/L to 100 µg/L of CuSO₄·5H₂O, or 0 µg/L to 25 µg/L expressed as copper. The value of EC₅₀ should be between 4 µg/L and 16 µg/L expressed as total copper. Dilution series for reference test: 1.5; 3.0; 6.0; 12 and 24 µg Cu/L
----------------	--

4 Chemical analysis

Duplicate samples for chemical analysis were collected from each test concentration and the control at the initiation of the test, and at the termination of the test.

The samples were collected in 60-mL PE bottles containing NaOH and EDTA for conservation, samples were stored at 4 ± 2.0°C. The concentration was measured in the highest and the lowest concentration at the beginning and the end of the test.

5 Statistical analysis

Toxicity was expressed as the percentage of abnormal larvae versus the D-shaped normal larvae at the end of the experiment (raw percentage, RPA) and transformed into a net percentage of abnormal larvae (NPA):

$$RPA = [(number\ of\ abnormal\ larvae)/(total\ number\ of\ larvae)] \times 100$$

$$NPA [(test\ RPA - control\ RPA)/(100 - control\ RPA)] \times 100$$

The statistical analyses were performed using the free software R /1/. The corresponding packages used for the different analysis are described in Section 8, References.

The LOEC/NOEC values were determined by use of the Dunnett's test /3/. The NOEC value ($p > 0.05$) was determined as the highest tested concentration, at which no significant negative effect was observed compared with the control. The LOEC ($p < 0.05$) is the concentration just above the NOEC.

To comply with the conditions of the Dunnett's test, the normality of the data was assessed but only by a visual description using a boxplot /4/. The variance was analysed with a Levene's test /5/.

A Probit analysis was conducted to estimate the EC values. The EC values were calculated to attain the closest possible curve fit.

6 Results

6.1 Results from chemical analysis

The samples were shipped cold to the analytical laboratory, ALS Scandinavia AB, Danderyd, Sweden.

Verification of the test item stability in the test system was verified by analysing the lowest and the highest test concentration at test start and termination) (Table 6.1 and Annex B). The stability was satisfactory and therefore no more samples were analysed.

Table 6.1 Results from chemical analysis

Nominal concentration		Actual measured concentration of bromate (BrO_3^-)		
NaBrO_3 mg/L	BrO_3^- mg/L	Test start (T=0)	Test end (T=24h)	Average
11.8	10	10.6	10.8	10.7
377.6	320	305	300	302.5

6.2 Ecotoxicological results

The primary data are presented in Appendix A. The results of this test are summarized below.

Significant effects on the observed percentage of abnormal larvae after exposure to bromate were observed (Table 6.2) at the two highest concentrations. NOEC and LOEC values are thus estimated to be 80 mg bromate/L and 160 mg bromate/L, respectively.

An EC50 value of 188 mg bromate/L was calculated.

Table 6.2 Oyster larval development after exposure to sodium bromate.

Concentration	Percent abnormal (average)	Std. dev. (%)
BrO_3^- mg/L		
Control	14	3.2
10	15	3.2
20	13	3.6
40	17	3.1
80	18	2.0
160	31	4.9
320	100	0.6

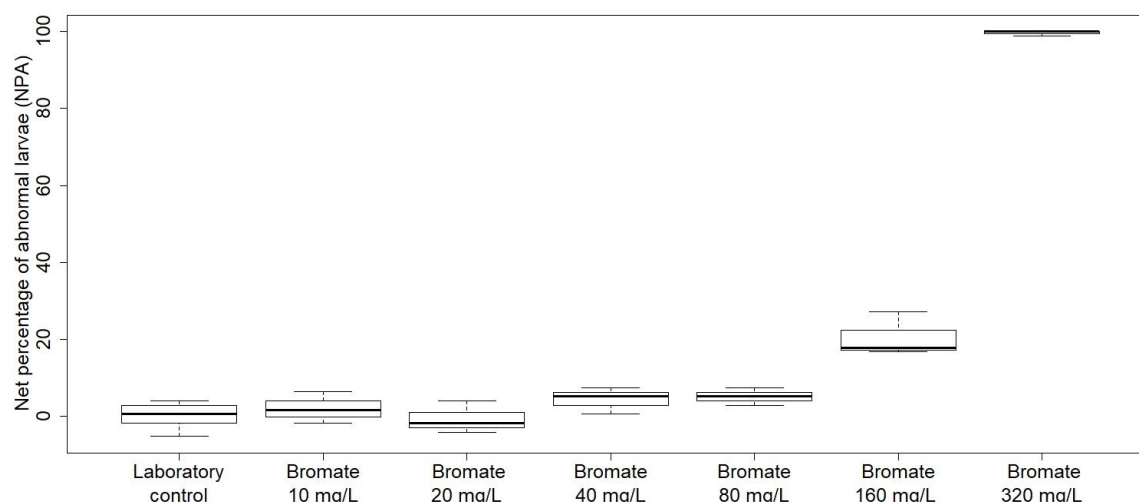


Figure 6.1 Boxplot of the net percentage of abnormal larvae (NPA) after exposure to sodium bromate

7 Conclusion

The validity criterion was fulfilled, and the stability of the test item was satisfactory.

The EC50 with the reference substance was 17.5 (16.2-18.8) $\mu\text{g Cu/L}$, which is very close to the required range of 4 $\mu\text{g/L}$ to 16 $\mu\text{g/L}$ expressed as total copper according to the guideline. The EC50 with the reference substance was 17.5 $\mu\text{g Cu/L}$ which is very close to the required range of 4 $\mu\text{g/L}$ to 16 $\mu\text{g/L}$ expressed as total copper according to the standard. The EC50 value is dependant of how the effect is calculated. If calculated as the raw percentage, the EC50 is calculated as 16 mg/L. Therefore, the results obtained with the test substance Bromate is considered acceptable.

Table 7.1 Results of the Oyster larval development toxicity test after exposure to sodium bromate

Endpoint	NOEC	LOEC	EC50
Embryo-larval development	80 mg bromate/L	160 mg bromate/L	208 (191-226) mg bromate/L

8 References

- /1/ DS/ISO 17244 "Water quality - Determination of the toxicity of water samples on the embryo-larval development of Japanese oyster (*Crassostrea gigas*) and mussel (*Mytilus edulis* or *Mytilus galloprovincialis*). First edition. 2015.09.15.
- /2/ R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <http://www.R-project.org/>.
- /3/ Frank Bretz, Torsten Hothorn and Peter Westfall (2010) (Dunnnett's test), Multiple Comparisons Using R, CRC Press, Boca Raton.
- /4/ Fox, J. (2005) The R Commander: A Basic Statistics Graphical User Interface to R. Journal of Statistical Software, 14(9): 1–42

- /5/ Fox, J. and Weisberg, S. (2011) *An R Companion to Applied Regression*, Second Edition, Sage.
- /6/ Ritz, C (2010). Towards a unified approach to dose-response modelling in ecotoxicology. *Environmental Toxicology & Chemistry*, 29, 220–229.

APPENDICES

APPENDIX A

Raw data and statistical evaluation

A Raw data toxicity test

A.1.1 Primary data toxicity test

Table A 1 Raw data generated in the toxicity test with NaBrO₃.

Concentration BrO ₃ ⁻ (mg/l)		Total abnormal larvae	Total D-larvae	Total number	Percent abnormal larvae
0	A	-	-	-	-
0	B	17	83	100	17
0	C	14	86	100	14
0	D	16	84	100	16
0	E	12	88	100	12
0	F	9	91	100	9
10	A	15	85	100	15
10	B	12	88	100	12
10	C	19	81	100	19
20	A	12	88	100	12
20	B	10	90	100	10
20	C	17	83	100	17
40	A	18	82	100	18
40	B	14	86	100	14
40	C	20	80	100	20
80	A	18	82	100	18
80	B	16	84	100	16
80	C	20	80	100	20
160	A	29	71	100	29
160	B	37	63	100	37
160	C	28	72	100	28
320	A	100	0	100	100
320	B	99	1	100	99
320	C	100	0	100	100

Table A 2 pH, oxygen and salinity

Test concentration BrO ₃ ⁻ (mg/l)	Date: 09.02.2022 t = 0			Date: 10.02.2022 t = 24h		
	% O ₂	‰ sal.	pH	% O ₂	‰ sal.	pH
Control	100	31.9	7.9	100	31.9	8.0
10	100	31.9	7.9	100	31.9	8.1
20	100	31.9	7.9	100	31.9	8.1
40	100	31.9	7.9	100	31.9	8.1
80	100	31.9	7.9	100	31.9	8.1
160	100	32.0	7.9	100	32.0	8.1
320	100	32.0	7.9	100	32.0	8.0

A.2 Statistical analysis

A.2.1 Determination of NOEC and LOEC for the effect on the larvae abnormality

Table A 3 Experimental data of the abnormal larvae (%)

Replicate No.	Laboratory control	10 mg/L (BrO ₃ ⁻)	20 mg/L (BrO ₃ ⁻)	40 mg/L (BrO ₃ ⁻)	80 mg/L (BrO ₃ ⁻)	160 mg/L (BrO ₃ ⁻)	320 mg/L (BrO ₃ ⁻)
1	17	15	12	18	18	29	100
2	14	12	10	14	16	37	99
3	16	19	17	20	20	28	100
4	12	-	-	-	-	-	-
5	9	-	-	-	-	-	-
Count	5	3	3	3	3	3	3
Mean	14	15	13	17	18	31	100

- Dunnett's test

Dunnett's test tests the null hypothesis that the averages of each test group are not different from the control group.

Table A 4 Multiple comparisons of means: Dunnett's contrasts.

Mean Comparisons	Estimate	Std. Error	t value	Pr(> t)	Significance ¹⁾
1-Bromate-10mg/L - 0-Bromate-0mg/L == 0	2.00	2.74	0.73	0.957	
2-Bromate-20mg/L - 0-Bromate-0mg/L == 0	-0.73	2.74	-0.27	1	
3-Bromate-40mg/L - 0-Bromate-0mg/L == 0	4.33	2.74	1.58	0.482	
4-Bromate-80mg/L - 0-Bromate-0mg/L == 0	5.10	2.74	1.86	0.325	
5-Bromate-160mg/L - 0-Bromate-0mg/L == 0	20.53	2.74	7.49	<0.001	***
6-Bromate-320mg/L - 0-Bromate-0mg/L == 0	99.60	2.74	36.35	<0.001	***

1) Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p values reported - single-step method)

The two highest concentrations were significantly different from the control group.

Table A 5 Endpoint: estimations NOEC and LOEC.

Endpoint	NOEC	LOEC	Unit
Embryo-larval development	80	160	mg/L (BrO ₃ ⁻)

A.2.1 Results of the Probit analysis

The ECx values were estimated by use of the probit analysis.

Table A 6 ECx estimates, Probit analysis with R (W2.3 {drc}) /6/ of the embryo-larval development

ECx	Bromate concentration mg/L	Std. Error	95% confidence interval	
			Lower	Upper
EC05	115	7.7	99	131
EC10	136	6.3	123	149
EC25	171	5.1	160	181
EC50	208	8.3	191	226

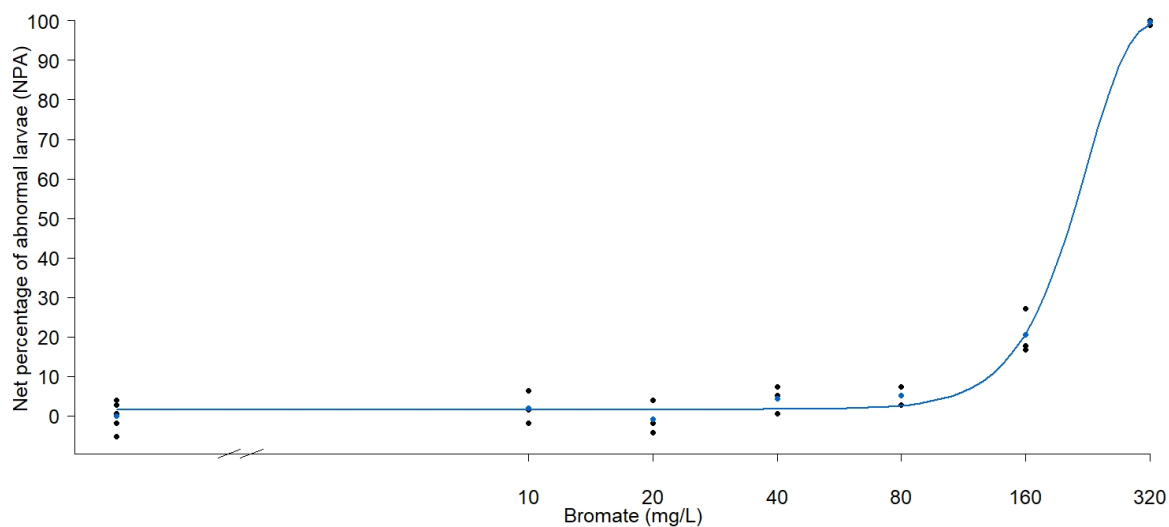


Figure A.1 Effect of bromate on the net percentage of abnormal larvae. In blue, the dose response curve established by use of the free software R, (W2.3 {drc}). The blue points correspond to the average NPA of each concentration. The black points correspond to the NPA of each replicate.

Table A 7 Embryo-larval development endpoint, estimations of EC10, EC50, Probit analysis.

Endpoint	EC10	EC50	Unit
Embryo-larval development	136 (123-149)	208 (191-226)	mg/L (BrO_3^-)

A.3 Validity criterion

The average ratio of D larvae in the laboratory controls was 86% and therefore the validity criterion of $\geq 80\%$ was fulfilled.

B Raw data toxicity test with reference test

B.1 Primary data toxicity test

Table B.1 Raw data generated in the toxicity test with CuSO₄·5H₂O.

Concentration CuSO ₄ ·5H ₂ O as µg Cu/l		Total abnormal larvae	Total D-larvae	Total number	Percent abnormal larvae
0	A	-	-	-	-
0	B	17	83	100	17
0	C	14	86	100	14
0	D	16	84	100	16
0	E	12	88	100	12
0	F	9	91	100	9
1.5	A	21	79	100	21
1.5	B	16	84	100	16
1.5	C	14	86	100	14
3	A	25	75	100	25
3	B	17	83	100	17
3	C	22	78	100	22
6	A	26	74	100	26
6	B	20	80	100	20
6	C	18	82	100	18
12	A	28	72	100	28
12	B	25	75	100	25
12	C	24	76	100	24
24	A	80	20	100	80
24	B	85	15	100	85
24	C	80	20	100	80

Table B.2 pH, oxygen and salinity

Test concentration (µg/l)	Date: 09.02.2022 t = 0			Date: 10.02.2022 t = 24h		
	% O ₂	‰ sal.	pH	% O ₂	‰ sal.	pH
0	100	31.9	7.9	100	31.9	8.0
1.5	100	32.0	7.9	100	32.0	8.1
3	100	32.0	7.9	100	32.0	8.1
6	100	31.9	7.9	100	31.9	8.1
12	100	32.0	8.0	100	32.0	8.1
24	100	31.9	8.0	100	32.0	8.1

B.2 Statistical analysis

B.2.1 Determination of NOEC and LOEC for the effect on the larvae abnormality

Table B.3 Experimental data of the abnormal larvae (%)

Replicate No.	Laboratory control	1.5 µg Cu/L	3 µg Cu/L	6 µg Cu/L	12 µg Cu/L	24 µg Cu/L
1	17	21	25	26	28	80
2	14	16	17	20	25	85
3	16	14	22	18	24	80
4	12	-	-	-	-	-
5	9	-	-	-	-	-
Count	5	3	3	3	3	3
Mean	14	17	21	21	26	82

- Dunnett's test

Dunnett's test tests the null hypothesis that the averages of each test group are not different from the control group.

Table B.4 Multiple comparisons of means: Dunnett's contrasts.

Mean Comparisons	Estimate	Std. Error	t value	Pr(> t)	Significance ¹⁾
1 - Copper-1.5-µg/L - Copper-0-µg/L == 0	3.97	2.858	1.39	0.56	
2 - Copper-3.0-µg/L - Copper-0-µg/L == 0	8.93	2.858	3.13	0.03	*
3 - Copper-6.0-µg/L - Copper-0-µg/L == 0	8.97	2.858	3.14	0.03	*
4 - Copper-12-µg/L - Copper-0-µg/L == 0	13.97	2.858	4.89	0.00	**
5 - Copper-24-µg/L - Copper-0-µg/L == 0	78.80	2.858	27.57	<0.001	***

1) Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 (Adjusted p values reported - single-step method)

All exposure groups, except from the lowest, were significantly different from the control group.

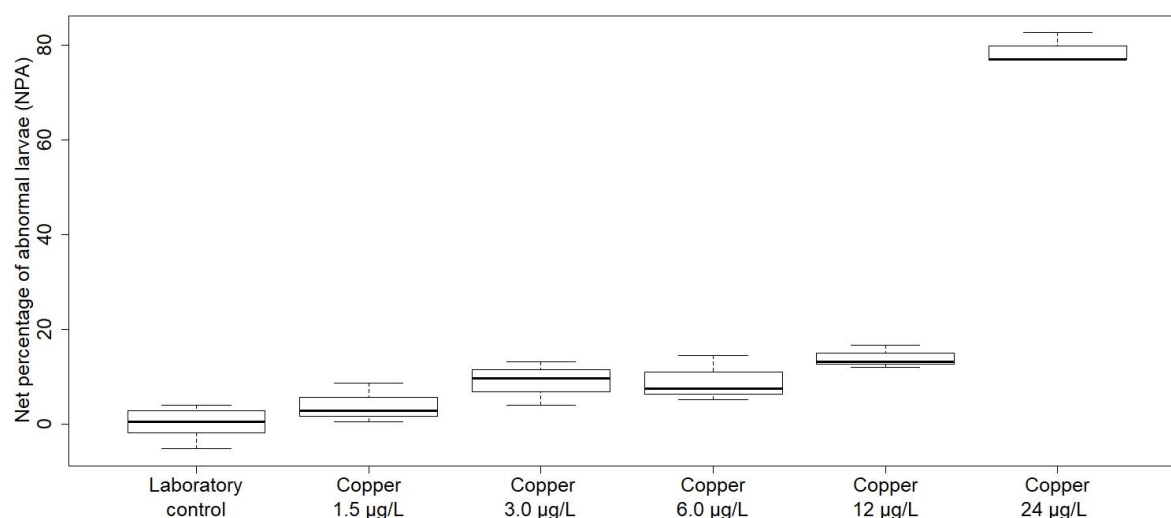


Figure 8.2 Observed net percentage of abnormal larvae (NPA) after exposure to copper.

Table B.5 Endpoint: estimations of EC50, NOEC and LOEC

Endpoint	NOEC	LOEC	EC50	Unit
Embryo-larval development	1.5	3.0	17.5 (16.2-18.8)	µg Cu/L

B.3 Validity criteria and performance evaluation

The average ratio of D larvae in the laboratory controls was 86% and therefore the validity criterion of $\geq 80\%$ was fulfilled.

The EC50 with the reference substance was $17.5 \mu\text{g Cu/L}$ which is very close to the required range of $4 \mu\text{g/L}$ to $16 \mu\text{g/L}$ expressed as total copper according to the standard. The EC50 value is dependant of how the effect is calculated. If calculated as the raw percentage, the EC50 is calculated as 16 mg/L . Therefore the results from the test is considered acceptable.

APPENDIX B– Chemical analysis

Results from chemical analyses

C Results from chemical analyses



Analyscertifikat

Ordernummer	: ST2204603	Sida	: 1 av 3
Kund	: DHI A/S	Projekt	: Project 11827338
Kontaktperson	: Anja Kamper	Beställningsnummer	: Andreas Sjölin/VA
Adress	: Agern allé 5 2970 Hørsholm Danmark	Provtagare	: JAB
E-post	: aka@dhigroup.com	Provtagningspunkt	: ----
Telefon	: ----	Ankomstdatum, prover	: 2022-02-18 10:50
C-O-C-nummer	: ----	Analys påbörjad	: 2022-02-22
(eller Orderblankett-num mer)		Utfärdad	: 2022-02-23 14:28
Offertnummer	: ST2021SE-NIR-SWE0001 (OF210090)	Antal ankomna prover	: 4
		Antal analyserade prover	: 4

Generell kommentar

Denna rapport får endast återges i sin helhet, om inte utfärdande laboratorium i förväg skriftligen godkänt annat. Resultatet gäller endast materialet såsom det har mottagits, identifierats och testats. Laboratoriet tar inget ansvar för information i denna rapport som har lämnats av kunden, eller resultat som kan ha påverkats av sådan information. Beträffande laboratoriets ansvar i samband med uppdrag, se vår webbplats www.alsglobal.se

Signatur	Position
Niels-Kristian Terkildsen	Laboratoriechef



Laboratorium	: ALS Scandinavia AB	hemsida	: www.alsglobal.se
Adress	: Rinkebyvägen 19C 182 36 Danderyd Sverige	E-post	: info.ta@alsglobal.com
		Telefon	: +46 8 5277 5200

Sida : 2 av 3
 Ordernummer : ST2204603
 Kund : DHI A/S



Analysresultat

Matris: HAVSVATTEN		Provbeteckning	Oyster larvae test, 10 A mg/L, T=0 09/02-2022					
		Laboratoriets provnummer	JAB					
		Provtagningsdatum / tid	ST2204603-001					
			2022-02-09					
Parameter	Resultat	MU	Enhet	LOR	Analyspaket	Metod	Utf.	
Oorganiska parametrar								
bromater	10600	± 2110	µg/L	5.0	Bromat	W-OXY-IC	PR	

Matris: HAVSVATTEN		Provbeteckning	Oyster larvæ test, 320 A mg/L, T=0 09/02-2022					
		Laboratoriets provnummer	JAB					
		Provtagningsdatum / tid	ST2204603-002					
			2022-02-09					
Parameter	Resultat	MU	Enhet	LOR	Analyspaket	Metod	Utf.	
Oorganiska parametrar								
bromat	305000	± 60900	µg/L	5.0	Bromat	W-OXY-IC	PR	

Matris: HAVSVATTEN		Provbeteckning	Oyster larvea test, 10 A mg/L, T=24 10/02-2022						
		Laboratoriets provnummer	JAB						
		Provtagningsdatum / tid	ST2204603-003						
			2022-02-09						
Parameter		Resultat	MU	Enhet	LOR	Analyspaket		Metod	Utf.
Oorganiska parametrar									
bromater		10800	± 2170	µg/L	5.0	Bromat		W-OXY-IC	PR

Matris: HAVSVATTEN		Provbeteckning	Oyster larva test, 320 A mg/L, T=24 10/02-2022					
		Laboratoriets provnummer	JAB					
		Provtagningsdatum / tid	ST2204603-004					
			2022-02-09					
Parameter	Resultat	MU	Enhet	LOR	Analyspaket	Metod	Utf.	
Oorganiska parametrar								
bromat	300000	± 60100	µg/L	5.0	Bromat	W-OXY-IC	PR	

Metodsammanfattningar

Analysmetoder	Metod
W-OXY-IC	Bestämning av löst bromat, klorat och klorit enligt metod baserad på CSN EN ISO 15061, CSN EN ISO 10304-4. Mätning utförd med jonkromatografi. Bestämning av summan klorat och klorit genom beräkning från uppmätta värden.

Sida : 3 av 3
 Ordernummer : ST2204603
 Kund : DHI A/S



Nyckel: LOR = Den rapporteringsgräns (LOR) som anges är standard för respektive parameter i metoden. Rapporteringsgränsen kan påverkas vid t.ex. spädning p.g.a. matrisstörningar, begränsad provmängd eller låg torrsbstanshalt.
 MU = Mätosäkerhet
 * = Asterisk efter resultatet visar på ej ackrediterat test, gäller både egna lab och underleverantör

Mätosäkerhet:

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data- Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.
Mätosäkerhet anges endast för detekterade ämnen med halter över rapporteringsgränsen.
Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

Utförande laboratorium (teknisk enhet inom ALS Scandinavia eller anlitat laboratorium (underleverantör)).

	Utf.
PR	Analys utförd av ALS Czech Republic s.r.o Prag, Na Harfe 336/9 Prag Tjeckien 190 00 Ackrediterad av: CAI Ackrediteringsnummer: 1163

APPENDIX C – CoA

Identification of test item (CoA)

D Identification of test item (CoA)

Certificate of Analysis

Product Name: SODIUM BROMATE
puriss. p.a., >= 99.5 % RT
Product Number: 71325
Batch Number: BCBX9200
Brand: Sigma-Aldrich
CAS Number: 7789-38-0
Formula: NaBrO₃
Formula Weight: 150.89
Quality Release Date: 03 AUG 2018
Recommended Retest Date: JAN 2023

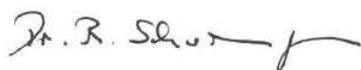
TEST	SPECIFICATION	RESULT
APPEARANCE (COLOR)	COLORLESS OR WHITE	WHITE
APPEARANCE (FORM)	POWDER OR CRYSTALS	CRYSTALS
REDOX TITRATION	99.5 - 101.0 %	100.0 %
REDOXTITRATION (METHOD)	IODOMETRIC	IODOMETRIC
SOLUBILITY (COLOR)	COLORLESS	COLORLESS
SOLUBILITY (TURBIDITY)	CLEAR	CLEAR
SOLUBILITY (METHOD)	0.5G IN 10ML WATER	0.5G IN 10ML WATER
PH	5.0 - 9.0 (50 MG/ML H ₂ O, 25C)	6.3
METAL TRACE ANALYSIS (ICP)	CORRESPONDS TO REQUIREMENTS	PASSED
CALCIUM (ICP)	≤ 10 MG/KG	< 10 MG/KG
CADMIUM (ICP)	≤ 5 MG/KG	< 5 MG/KG
COBALT (ICP)	≤ 5 MG/KG	< 5 MG/KG
CHROMIUM (ICP)	≤ 5 MG/KG	< 5 MG/KG
COPPER (ICP)	≤ 5 MG/KG	< 5 MG/KG
IRON (ICP)	≤ 5 MG/KG	< 5 MG/KG
POTASSIUM (ICP)	≤ 100 MG/KG	< 100 MG/KG
MAGNESIUM (ICP)	≤ 5 MG/KG	< 5 MG/KG
MANGANESE (ICP)	≤ 5 MG/KG	< 5 MG/KG
NICKEL (ICP)	≤ 5 MG/KG	< 5 MG/KG
LEAD (ICP)	≤ 5 MG/KG	< 5 MG/KG
ZINC (ICP)	≤ 5 MG/KG	< 5 MG/KG

SIGMA-ALDRICH®

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Email USA: techserv@sial.com Outside USA: eurtechserv@sial.com

Certificate of Analysis

BROMIDE (BR)	≤ 500 MG/KG	< 500 MG/KG
TOTAL NITROGEN	≤ 50 MG/KG	45 MG/KG
SULFATE (SO₄)	≤ 500 MG/KG	< 500 MG/KG



Dr. Reinhold Schwenninger
Quality Assurance
Buchs, Switzerland

Sigma-Aldrich warrants that at the time of the quality release or subsequent retest date this product conformed to the information contained in this publication. The current specification sheet may be available at Sigma-Aldrich.com. For further inquiries, please contact Technical Service. Purchaser must determine the suitability of the product for its particular use. See reverse side of invoice or packing slip for additional terms and conditions of sale.