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Static Acute Toxicity of Sodium Bromide to Fathead Minnows*

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This study was the first phase of a research program designed to examine the dynamics of sodium bromide uptake, biotransformation, and depuration in fish. This investigation was designed to determine the acute static toxicity of sodium bromide to the test species, Pimephales promelas Rafinesque. These data were used to select exposure levels for later long-term sodium bromide exposures.

MATERIALS

Test Material. The NaBr used was analyzed 99.9% pure from Lot 09049, Halogens Research, Michigan Division, The Dow Chemical Company, Midland, MI.

Dilution Water. Lake Huron water which had been passed through a carbon contactor and ultraviolet light sterilizer was used. Detailed analyses of this dilution water are given in Tables 1 and 2 (HUNEMORDER 1979).

Fish. Fathead minnows (original stock from U.S. EPA Laboratory, Duluth, MN) were hatched and reared in the Environmental Sciences Research (ESR) Laboratory. These animals were reared at 25 + 2°C until about 60 days of age (subadults) and then slowly (≤1°C/day) acclimated to 12 + 1°C. Typical holding and rearing conditions were 16 h light/day photoperiod at 215-2044 lux and a water flow rate >2 L/min. Fish were fed once or twice daily, ad libitum. The specially formulated diet mix is shown in Table 3 (MEHRLE 1976).

METHODS

A range-finding test was run in which two fish were placed in 1 L of each of seven widely varying concentrations of NaBr at 12 + 1°C. This test indicated the LC50 was between 10,000-20,000 mg/L.

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TABLE 1. CARBON FILTERED RAW LAKE HURON WATER ANALYSES

Date	pH	Conductivity µmhos/cm	Hardness mg/L as $CaCO_3$	Alkalinity mg/L as $CaCO_3$
4/5/79	7.7	158	110	79
5/29/79	7.7	200	134	85
7/2/79	7.7	190	110	87
7/18/79	7.6	200	95	77
9/10/79	7.9	188	103	86
10/12/79	8.0	198	102	78
11/20/79	8.1	185	105	80
1/7/80	7.8	155	97	80

TABLE 2. CARBON FILTERED RAW LAKE HURON WATER ANALYSES

Chemical Quality	mg/L
Alkylbenzene sulfonate	ND (0.1)
Arsenic	ND (0.001)
Barium	ND (1)
Cadmium	ND (0.01)
Calcium	26
Chloride	9.9
Chromium	ND (0.05)
Copper	ND (0.01)
Cyanide	ND (0.01)
Fluoride	0.09
Iron	0.01
Lead	ND (0.05)
Magnesium	7
Manganese	ND (0.05)
Mercury	ND (0.005)
Nitrate	0.20
Phenols	ND (0.001)
Polychlorinated Biphenyls	ND (0.010×10^{-3})
Selenium	ND (0.01)
Silver	ND (0.05)
Sulfate	19
Total Filterable Residue	146
Zinc	ND (0.5)

ND = Parameter was not detected followed by minimum detectable amount in parentheses.

TABLE 3. FORMULATED SYNTHETIC DIET

Dry synthetic diet contains:

28%	casein	- 280 g per kg dry mix
15%	gelatin	- 150 g per kg mix
28%	dextrin	- 280 g per kg mix
4%	mineral mix	- 40 g per kg mix
9%	vitamin mix	- 90 g per kg mix
11%	corn oil	- 110 g per kg mix
5%	salmon oil	- 50 g per kg mix

Mix for 15 minutes and package.

Mix equal weights of dry mix and dechlorinated Lake Huron water and refrigerate.

This was followed by a definitive test (THE DOW CHEMICAL COMPANY 1978) in which the concentrations of NaBr were set close together using a 90% dilution factor, with concentrations ranging from 8,610-20,000 mg/L. For this test, ten fish were placed in 8 L of dilution water for 24 h with aeration. After 24 h, aeration was discontinued and toxicant added with 2 L of water to bring the total volume to 10 L in each vessel at the start of the test. Fish were exposed for 96 h at 12 $\pm$ 1 C with effects recorded and dead animals removed every 24 h. No food was provided during the test. The 16-h photoperiod was also used in the testing area at 915-1345 lux cool white fluorescent illumination. Death was confirmed by absence of opercular movement and lack of response to prodding. Measurement of surviving fish at test conclusion showed the average standard length and weight to be 26.8 mm and 0.285 g.

Statistical Calculations. The results from toxicity tests were used to calculate the LC50 value, i.e., the toxicant concentration which would kill 50% of the test organisms in a specified time period. This was done using a computer program of Finney's method of probit analysis (FINNEY 1952), Thompson's method of moving averages (THOMPSON 1947), and the binomial method (STEEL et al. 1960). The 95% confidence interval (a range within which there is 95% probability the real LC50 value lies) was also determined. Probit results are considered the most accurate (PARK 1979), and are reported when data fulfilled the probit program requirements. Otherwise, LC50's calculated by moving average are reported.

RESULTS AND DISCUSSION

The acute toxicity of sodium bromide to the fathead minnow is summarized below:

Exposure Period (Hours)	LC50 (mg/L)	Method of Calculation
24	18,441 (17,879-19,140)*	Moving Avg.
48	17,757 (16,929-18,668)	Probit
72	17,019 (16,084-18,137)	Probit
96	16,479 (15,614-17,428)	Probit

The moving average value for the 24-h LC50 is reported because the data did not fulfill the requirement for the probit analysis which requires at least two partial kills to achieve statistically valid results. There was a sufficient range of mortality during the remainder of the test to perform valid probit analyses.

Sodium bromide has a low toxicity to fathead minnows that is similar to that of sodium chloride. The 96-h LC50 for sodium chloride on fathead minnows has been reported by our laboratory as 10,610 (10,423-10,846) mg/L (BARTLETT 1978). This is 0.181 (0.178-0.185) moles per L or 0.362 (0.356-0.370) ionic equivalents per L. The 96-h LC50 value for sodium bromide of 16,479 (15,614-17,428) mg/L is 0.160 (0.152-0.169) moles per L or 0.320 (0.304-0.338) ionic equivalents per L. These toxicity values are close but still significantly different at P= 0.05 because of no overlap on the 95% confidence interval.

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*95% confidence intervals

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