The 96-hr LC_{50} and Uptake of Sodium Tellurite in goldfish (*Carrasius auratus*)

by

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ABSTRACT

There is no information regarding toxicity of tellurium in fish. This research used goldfish (Carassius auratus) as an animal model, and sodium tellurite (Na_2TeO_3) as the form of tellurium to tested. Acute 96-hr LC_{50} and 15-day uptake tests with tellurium were conducted in a static test system. The 96-hr LC_{50} for sodium tellurite was 785.8 mg/L (ppm) (using the trimmed Spearman-Karber method). After 15 days, the uptake of sodium tellurite into muscle did not reach steady state. In conclusion, sodium tellurite at low concentrations is not harmful to goldfish in the short term.

DECLARATION

I hereby declare that this thesis was done by me, Henneke Pangkey, graduate student at Lakehead University, and supervised by Dr. Walter T. Momot, Alasdair D. Smith, MSc., and Dr. R. Omeljaniuk, Department of Biology, Lakehead University. This thesis represent original research. I do hope that this information will prove useful for whoever that loves nature.

Henneke Pangkey

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I. Introduction and literature review

Tellurium is one of the rare earth metals. It is found in many types of ore deposits (Stone and Carbon, 1961; Trush, 1968; Snell and Ettre, 1973; Considine and Considine, 1984). Tellurium was named by the Austrian chemist, M.H. Klaproth, this name derived from the Latin word tellus meaning "earth" (Cooper, 1971). There are no ore deposits exclusively mined for tellurium; rather, its recovery is usually linked with the production of copper, lead, and gold. In Indonesia, tellurium is deposited in silver-gold veins which occur in rock formations of tertiary geological age (Foster, 1984, and Boyle, 1987).

Previously, tellurium and its compounds had no industrial importance but now have become important for the development of the metallurgical, chemical, and electrical technology. Metallurgical needs consume an estimated 55% of the world demand for tellurium. Chemical needs account for 25% of world demand. Electrical use accounts for 15% of world demand, and for other applications (5%), tellurium is used as a pigment to produce various colors in glass and ceramics (Gardener, 1991). The major refined tellurium producers are Belgium, Canada, Japan, and the USA. Average annual western world production of tellurium is approximately 200 metric tons (SDTA, 1989).

Many properties of tellurium have been reported such as: chemical properties (Dutton, 1971); and Zingaro and Irgolic, 1971), physical properties (Becker and Johnson, 1971), analytical chemistry (Chakrabarti, 1967; Snerne and Brooks, 1972; Gornostaeva

and Pronin, 1974), metabolic and biochemical effects, and natural occurence (Carapella, 1971), industrial production and utilization patterns (Champness, 1971; Nachtman, 1971; and Aborn, 1971), environmental exposure levels, and concentrations in foods and in human tissues (Fishbein, 1977).

Some toxicological properties have also been reported. These studies indicate that tellurium can be a toxic element (Valkonen and Salvolainen, 1985; and Williams and Dusenbery, 1990). Acute tellurium poisoning in mammals produces: a garlic odor in the breath; a deep black coloration in tissues; paralysis of the central nervous system; restlesness; tremors; diminished reflexes; convulsions; somnolence; unconsciousness; cessation of respiration; and finally, death from asphyxia (Devlin, 1975).

Resently, many studies of tellurium poisoning and deficiency have been described in microorganisms, plants, mammals, bird, and humans. Taylor et al. (1988) found that tellurium decreased the resistance of Eschericia coli. In plants, according to Al Attar et al. (1988), who studied the effect of both selenium and tellurium in Lolium perenne showed selenium and tellurium treatments did have an effect on the elemental composition of plants. Furthermore, Johnson et al. (1988) investigated the toxicity of tellurium in mammals. Pregnant rats were fed a diet containing 0; 30; 300; 3000; and 15,000 ppm of tellurium on days 6 through 15 of gestation, and artificially inseminated rabbits were fed a diet containing 0; 17.5; 175; 1750; 5250 ppm of tellurium during days 6 through 18 of gestation. The result showed that exposure of these

pregnant rats and rabbits to tellurium had no effect upon reproduction. Moreover, Srivastava et al. (1987) found the 48-h LD_{75} of tellurium in rats was 2.25 - 30 ppm by injection. When fed to Peking ducks, 500 - 1000 ppm on tellurium tetrachloride in food was acutely toxic with markedly reduced growth and heavy mortality during the second week.

Tellurium can accumulate in the body of mammals. DeMeio and Henriques (1947) found in experiments with rats, rabbits, and dogs that the ammount excreted in 24 hr by the respiratory tract was less than 0.1 % of the amount injected (0.1 - 0.5 mg tellurium per kg as Na_2TeO_3), and the total amount of tellurium exreted in urine 5 - 6 days was 20 %.

In man, a garlic odor of the breath and sweat is a sensitive and characteristic indication of the absorption of tellurium into the body (Cerwenka and Cooper, 1960). It was found that 0.5 microgram of tellurium dioxide given by mouth imparted a pronounced garlic odor to the breath for thirty hours beginning an hour and a quarter after intake. Fifteen milligrams produced a garlic odor for 237 days (Cooper, 1971). Ingestion of 45 microgram of tellurium as sodium tellurate produced a detectable tellurium breath for three weeks (Frost and Ingvoldstat). The fatal dosage to humans of tellurium was estimated to be about two grams (Keall et al., 1946). This was discovered when sodium tellurite was mistakenly added by catheter into the ureter of a patient in place of sodium iodide. The symptons produced were garlic breath, cyanosis, pain in the loins, some nausea and vomiting, followed by

stuppor, loss of consciousness, and death within six hours. Autopsy findings were: deposition of black tellurium in the mucosa of the ureter and congestion of the lungs, spleen, kidneys, and most markedly, the liver. Thus, the toxicity of tellurium varies in different organisms depending in the length of exposure to tellurium, the exact chemical formulation employed, the method of exposure, and duration of exposure.

Among the tellurium compounds, hydrogen telluride, tellurium hexafluoride, tellurium dioxide, tellurous and telluric acids, sodium and potasium tellurites and tellurates are of greatest interest in toxicological study (Vouk, 1977). Acute toxicity tests in mammals showed that the tellurites were more toxic than the tellurates (Muehlberger and Schrenk, 1928). De Meio (1946) stated that the toxicity of sodium tellurite is ten times greater than the toxicity of sodium tellurate. Therefore, this research I chose sodium tellurite.

However, no data are known concerning the toxic effects of tellurium on fish. The purpose of this research is to determine the LC_{50} and uptake of the tellurium compound, sodium tellurite (Na_2TeO_3), in the goldfish, Carrasius auratus. The LC_{50} is the concentration of toxicant estimated to produce 50% mortality of a test population over a specified time period (TCMTTAO, 1975). There are several reasons for selecting goldfish as the test animal. First, goldfish have an adaptibility to environmental temperatures ranging from 5 °C to 35 °C (Levy and Gucinski, 1964), thus, it is good to use goldfish in this research as a

representative of warm water fish. Second, one of the most popular fish cultured in Indonesia is the common carp (Cyprinus carpio). Goldfish belong to the same family as common carp and therefore, I used goldfish as representative of common carp.

II. Materials and methods

II.1. Water supply

In this experiment, I used Lake Superior dechlorinated water. Water quality analyse were performed by the Northwestern Regional laboratory, Ontario Ministry of the Environment and Norlab Environmental Services Inc. The physical and chemical characteristics are shown in Table 1 (ATRG, 1988). Analyse are stated in mg/L (ppm) for conventional parameters such as conductivity, pH, turbidity, etc., and ug/L (ppb) for metals.

II.2. Test fish

Goldfish (weight wet 7.6 $\pm$ 1.2 g) were obtained from Grassyfork Fisheries Co. Inc., Martinsville, Indiana, USA., and acclimated for about two weeks at a temperature of 21.6 $\pm$ 0.2 °C. All fish were hand fed daily with dry pellets (Trout pellet number 5 from Martins Feed Mill, Elmira, Ontario) at 1% of body weight, and were maintained in a static condition. Fish deaths during the first 48 h after arrival were 6% of the total. According to Parrish (1985), not more than 10% of test fish should die during a 48 h period. Fish were not fed one day prior to testing. All fish used for the test appeared healthy. The LC_{50} test used 140 goldfish, and the uptake test used 84 goldfish.

Table 1: Physical/chemical characteristics of the Lake Superior water supply (ATRG, LU, 1988).

Parameter	mean ± s.d.
conductivity (umhos/cm)	101.375 ± 2.3867
pH (pH units)	6.950 ± 0.3505
turbidity (turbidity units)	0.533 ± 0.1041
alkalinity as $CaCO_3$	44.875 ± 3.8336
hardness as $CaCO_3$	48.000 ± 2.1381
total phophorus	0.005 ± 0.0014
sulphate	3.125 ± 0.9910
chloride	3.125 ± 0.3536
ammonia nitrogen	0.069 ± 0.0586
kjeldahl nitrogen	0.221 ± 0.0811
nitrites	0.002 ± 0.0012
nitrates	0.138 ± 0.0585
ug/L	
copper	0.005 ± 0.0042
zinc	0.007 ± 0.0031
iron	0.054 ± 0.0348
lead	0.004 ± 0.0023
cadmium	0.001
nickel	0.003 ± 0.0018
chromium	0.013 ± 0.0075
free chloride	not detectable

II.3. Exposure tanks

For the acute test, fourteen 10 L exposure tanks were used, while eight 15 L exposure tanks were used for the uptake test. The control test tanks were arranged separately from other exposure tanks to avoid contamination. Before being used all tanks were washed with detergent and rinsed twice with 5% HNO_3, and finally rinsed three times with dechlorinated water. Every tank was aerated.

II.4. Concentration gradients

The concentrations of sodium tellurite in the LC_{50} test were 1600, 800, 400, 200, 100,and 50 ppm. Sodium tellurite was obtained from Pfaltz and Bauer Inc., Waterbury, USA.

In the uptake test, the concentrations of sodium tellurite used were: 60, 30, and 15 ppb.

II.5. Acute testing

The acute LC_{50} test was conducted as a static test utilizing 48-hour solution renewal. Fish were exposed for ninety-six hours at a temperature of 21 °C. Tests were performed in duplicate and employed ten fish per test. The water was aerated during the test, dissolved oxygen and pH were analysed with an ORION 940 A Ion Analyser, and conductivity determined by a Cole-Palmer Model 4070 conductivity meter. These parameters were measured daily. Water samples were taken at the end of the test and sodium tellurite was analysed by using hydride generation atomic absorption

spectrometry. Data were statistically calculated using the trimmed Spearman-Karber method (Hamilton et al., 1977).

II.6. Uptake testing

The uptake test was conducted in a 24-hour renewable static system in 15 L-exposure tanks. Fish were exposed for 15 days at three concentrations of sodium tellurite (60, 30, and 15 ppb plus control). Each test level employed 21 fish. All fish were fed during the test at 1% of body weight and all tanks were cleaned daily to avoid the accumulation of food that was not eaten.

Water quality such as dissolved oxygen, pH, temperature and conductivity were measured every 24 hours. Water samples were taken every other day and sodium tellurite was analysed by hydride generation atomic absorption spectrometry.

Fish samples were taken every two days (three fish at each concentration). Fish were anesthetized using MS-222 and frozen until analysed. The MS-222 dose used was a 0.2% stock solution of the foregoing compound made up of 0.1 gm in 500 mL of water was diluted six times for use according to Lagler (1977). The estimate for the rate of uptake (K_1) was calculated using the equation below (Hamelink, 1977; and Spacie and Hamelink, 1985):

$$\frac{C_1}{C_2} = \frac{1 - \exp(-K_2 t_1)}{1 - \exp(-K_2 t_2)}$$

$$K_1 = \frac{(C/t + K_2 C)}{C_w}$$

where:

$C_1;C_2$: concentrations of the chemical in fish

K_2 : the rate of depuration

$t_1;t_2$: time exposure in hours

K_1 : the rate of uptake

C_w : concentration of the chemical in water

III. Analytical chemistry

The concentration of sodium tellurite in the water samples was determined by employing a hydride vapour generator coupled with an atomic absorption spectrophotometry unit. The following outline summarizes the extraction procedure for recovering sodium tellurite from water: 1) A ten mL water sample, ten mL concentrated HCl, and 0.4 mL of 2% potassium persulphate were placed into a glass tube with a screw top lid. 2) the reagent blank tubes consisted of ten mL DDW (Deionized distilled water), plus ten mL of concentrated HCl and 0.4 mL of 2% potassium persulphate solution. 3) one ppb digested standard was prepared by adding 0.1 mL of the stock tellurium solution to a 100 mL volumetric flask and brought up to volume with 50% concentration HCl:DDW. Twenty mL of this solution was pipetted into a tube marked 1 ppb. The fifteen ppb digested standard was prepared by adding 0.75 mL of the stock tellurium solution to a 50 mL volumetric flask and brought up to volume with 50% concentration HCl:DDW. Twenty mL of this solution was pipetted into a tube marked 15 ppb, then added to 0.4 mL of the potassium persulphate solution. 4) All tubes were capped and mixed well by inversion. The tubes, with caps loosened, were placed in a boiling water bath for 20 minutes, then cooled. Sodium tellurite concentration was measured with the hydride vapour generation-atomic absorption spectrophotometry.

The determination of sodium tellurite in fish muscle tissue employed a wet digestion method with H_3PO_4, HNO_3, and H_2O_2. The following procedure (Reamer and Veillon, 1981) was used: 1) 0.5

g tissue from the epaxial muscle was weighed out into a tube, 5 mL HNO_3 was added, as was 1 mL H_3PO_4. The mixture was allowed to stand overnight. 2) The solution (from point 1) was boiled until all N_2 fumes were gone, then cooled. 3) H_2O_2 was added dropwise until the solution in every tube was clear. 4) The sample was then concentrated by boiling down to 2 mL, and cooled. 5) Five mL of 6M HCl was added, and the solution was then heated at 95 °C for 30 minutes. 6) The solution was cooled, brought up to 25 mL final volume and mixed well. The mixture was then measured by hydride vapour generation atomic absorption spectrophotometry.

IV. Results

IV.1. Chemical analysis results

IV.1.1. Water chemistry

The mean and standard deviation for temperature, pH, dissolved oxygen, and conductivity measured during the LC_{50} were 21.6 ± 0.04 °C, 7.8 ± 0.7, 7.4 ± 0.2 mg/L, and 380.7 ± 333.1 umhos/cm, respectively (Table 2). During the uptake test, they were 23.6 ± 0.05 °C, 7.0 ± 0.09, 7.2 ± 0.09 mg/L, and 92.6 ± 2.19 umhos/cm,respectively (Table 3).

IV.1.2. Sodium tellurite determinations

The mean and standard deviation for sodium tellurite concentrations in water for the LC_{50} test were: control, 0.0 ± 0.0 ppm; tank 1, 47.2 ± 13.6 ppm; tank 2, 111.5 ± 15.0 ppm; tank 3, 259.5 ± 35.1 ppm; tank 4, 462.0 ± 15.8 ppm; tank 5, 1188.0 ± 21.2 ppm; and tank 6, 1848.0 ± 47.8 ppm (Table 4). The mean and standard deviation of sodium tellurite concentrations in water for the uptake test were: control, 0.0 ± 0.0 ppb; tank 1, 19.78 ± 3.1 ppb; tank 2, 36.19 ± 8.6 ppb; and for tank 3, 73.05 ± 6.9 ppb (Table 5).

Table 2 : The mean and standard deviation of temperature, pH, dissolved oxygen, and conductivity for the 96-hr LC_{50} test with goldfish.

Na_2TeO_3 (ppm)	Temperature (°C)	pH (pH units)	DO (mg/L)	Conductivity (umhos/cm)
0	21.5 ± 0.2	7.0 ± 0.1	7.2 ± 0.2	95.6 ± 6.6
0	21.6 ± 0.1	7.0 ± 0.1	7.0 ± 0.1	99.6 ± 3.0
50	21.6 ± 0.2	7.0 ± 0.1	7.5 ± 0.1	145.5 ± 2.3
50	21.6 ± 0.2	7.4 ± 0.3	7.6 ± 0.1	145.4 ± 2.7
100	21.6 ± 0.2	7.4 ± 0.2	7.3 ± 0.3	193.8 ± 2.9
100	21.6 ± 0.2	7.4 ± 0.1	7.3 ± 0.1	197.8 ± 2.5
200	21.6 ± 0.2	7.5 ± 0.1	7.5 ± 0.1	277.6 ± 9.4
200	21.6 ± 0.2	7.5 ± 0.1	7.5 ± 0.1	279.0 ± 5.6
400	21.6 ± 0.2	8.1 ± 0.2	7.7 ± 0.2	481.2 ± 2.7
400	21.6 ± 0.2	8.0 ± 0.2	7.5 ± 0.2	478.6 ± 2.4
800	21.6 ± 0.2	8.5 ± 0.2	7.8 ± 0.1	886.2 ± 7.2
800	21.6 ± 0.2	8.8 ± 0.1	7.5 ± 0.04	882.4 ± 8.6
1600	21.5 ± 0.2	8.8 ± 0.2	7.1 ± 0.1	985.0 ± 5.7
1600	21.5 ± 0.1	8.8 ± 0.2	7.2 ± 0.2	980.6 ± 7.7

Table 3: The mean and standard deviation of temperature, pH, dissolved oxygen, and conductivity (N=3) for the sodium tellurite uptake test with goldfish.

Na_2TeO_3 (ppb)	Temperature (°C)	pH (pH units)	DO (mg/L)	Conductivity (umhos/cm)
0	23.7 ± 0.1	6.9 ± 0.1	7.1 ± 0.1	89.8 ± 1.4
15	23.6 ± 0.2	7.0 ± 0.1	7.3 ± 0.1	92.2 ± 1.8
30	23.6 ± 0.1	7.1 ± 0.1	7.2 ± 0.2	93.7 ± 1.1
60	23.6 ± 0.2	7.1 ± 0.1	7.1 ± 0.1	94.9 ± 1.0

Table 4 : The mean and standard deviation for sodium tellurite concentration in water samples from the 96-hr LC_{50} test with goldfish.

Tank	Concentration (ppm)
Control	0.0 ± 0.0
1	47.2 ± 13.6
2	111.5 ± 15.0
3	259.0 ± 35.1
4	462.0 ± 15.8
5	1188.0 ± 21.2
6	1848.0 ± 47.8

Table 5: The mean and standard deviation for sodium tellurite concentration in water samples from the sodium tellurite uptake test with goldfish.

Tank	concentration (ppb)
control	0.0 ± 0.0
1	19.78 ± 3.1
2	36.19 ± 8.6
3	73.05 ± 6.9

IV.2. The 96-hr LC_{50} test results

The static test utilizing measured concentrations (47.2, 111.5, 259.0, 1188.0, and 1848.0 ppm) of sodium tellurite yielded a 96-hour LC_{50} for goldfish of 785.8 ppm, with 95% confidence limits of 558.8 to 892.1 ppm (Fig.1) according to the trimmed Spearman-Karber analysis (Hamilton et al., 1977). In concentrations 0, 47.2, 111.5, and 259.0 ppm of sodium tellurite there were no dead fish, in 462.0 ppm at 96-hr there were three dead fish, in 1188.0 ppm and 1848.0 ppm at the end of the test the number of dead fish was thirteen and twenty, respectively (Fig.2).

IV.3. The uptake test result

After two weeks, the uptake of sodium tellurite in goldfish had not reached steady state (Fig.3). The concentrations of sodium tellurite in goldfish determined from epaxial muscle are presented in Table 6.

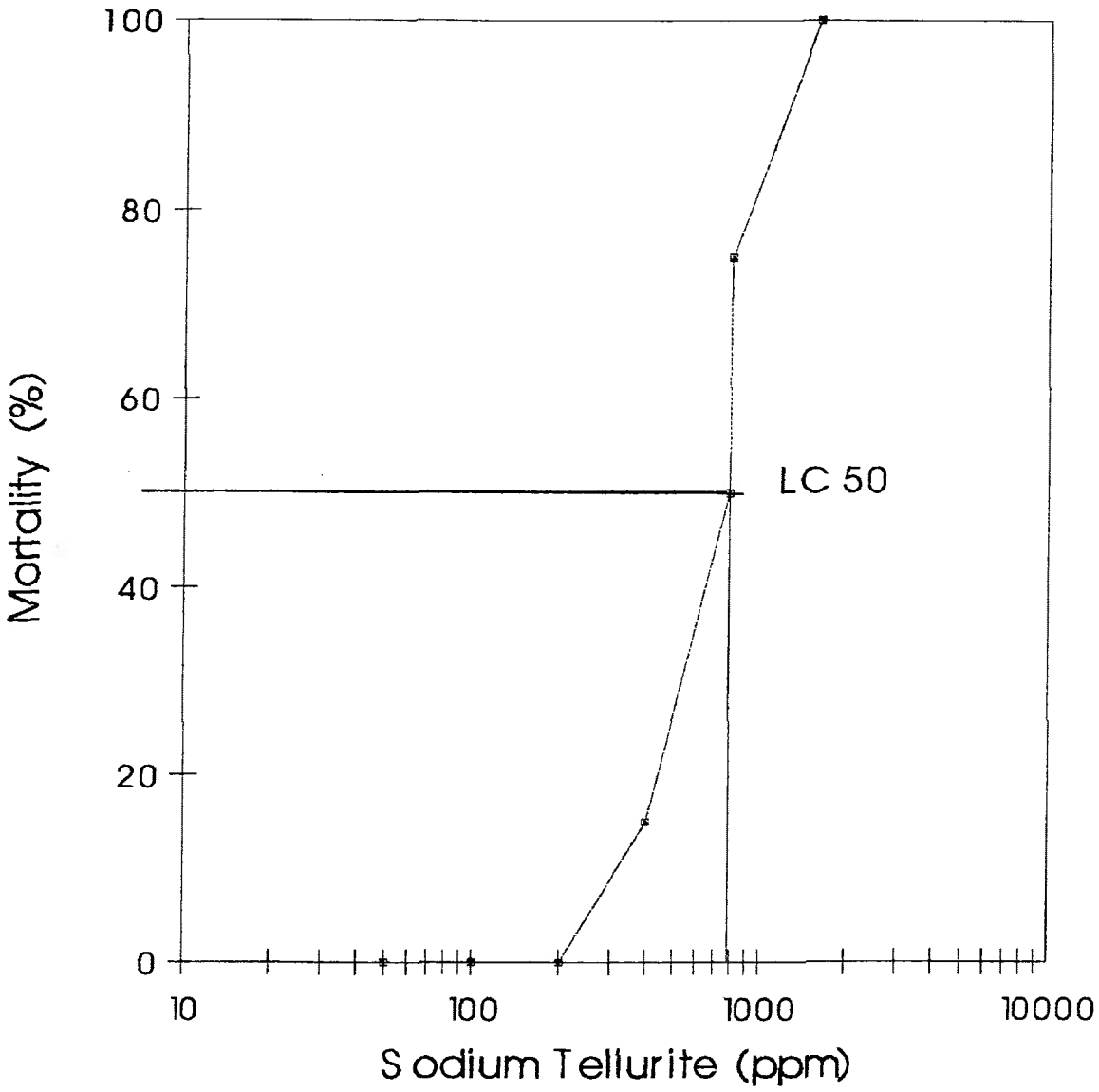

Figure 1:

Relationship between the percentage of mortality observed at 96 hours and the concentration of sodium tellurite

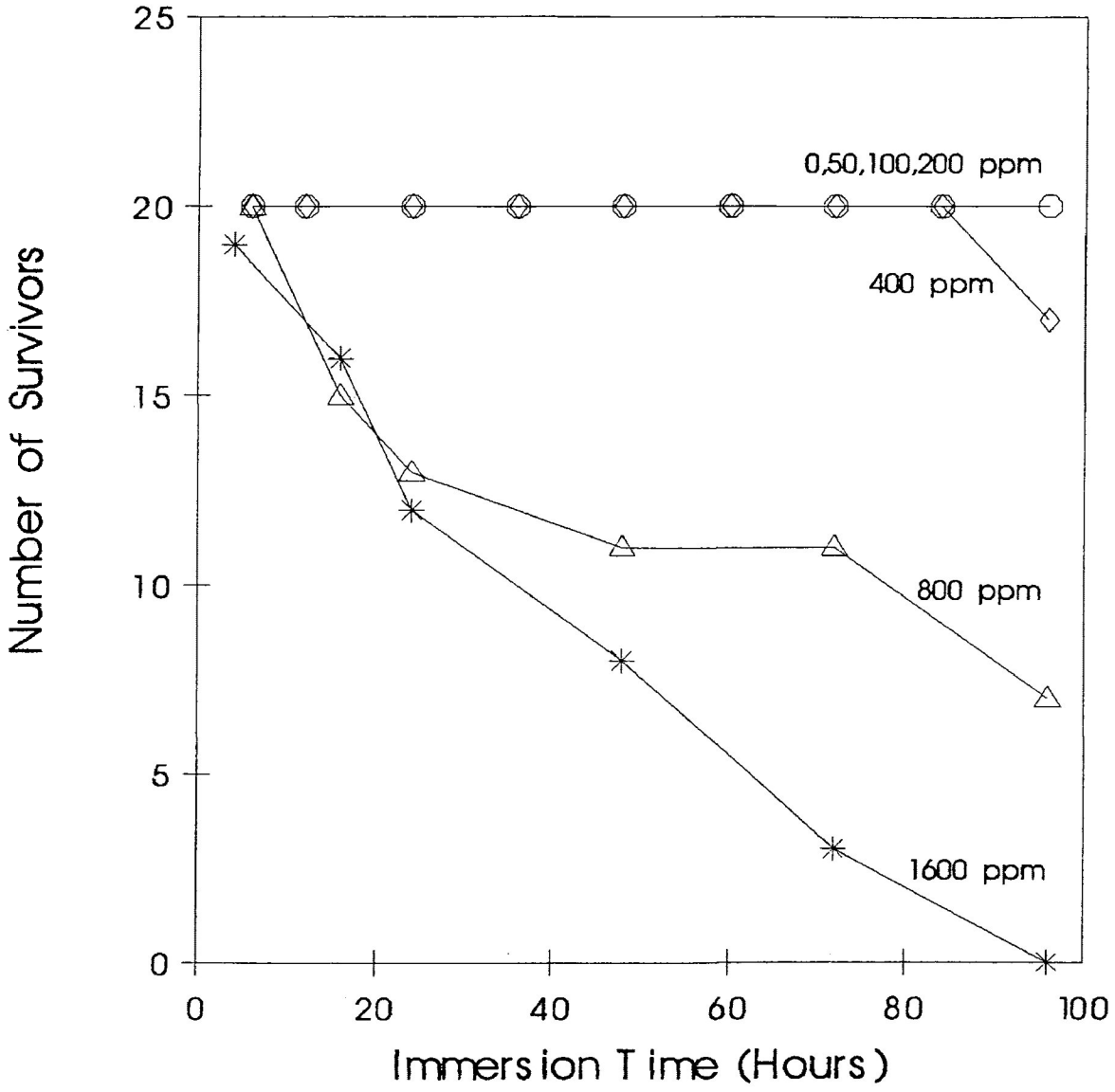

Figure 2:

Time - course of goldfish mortality during immersion in sodium tellurite

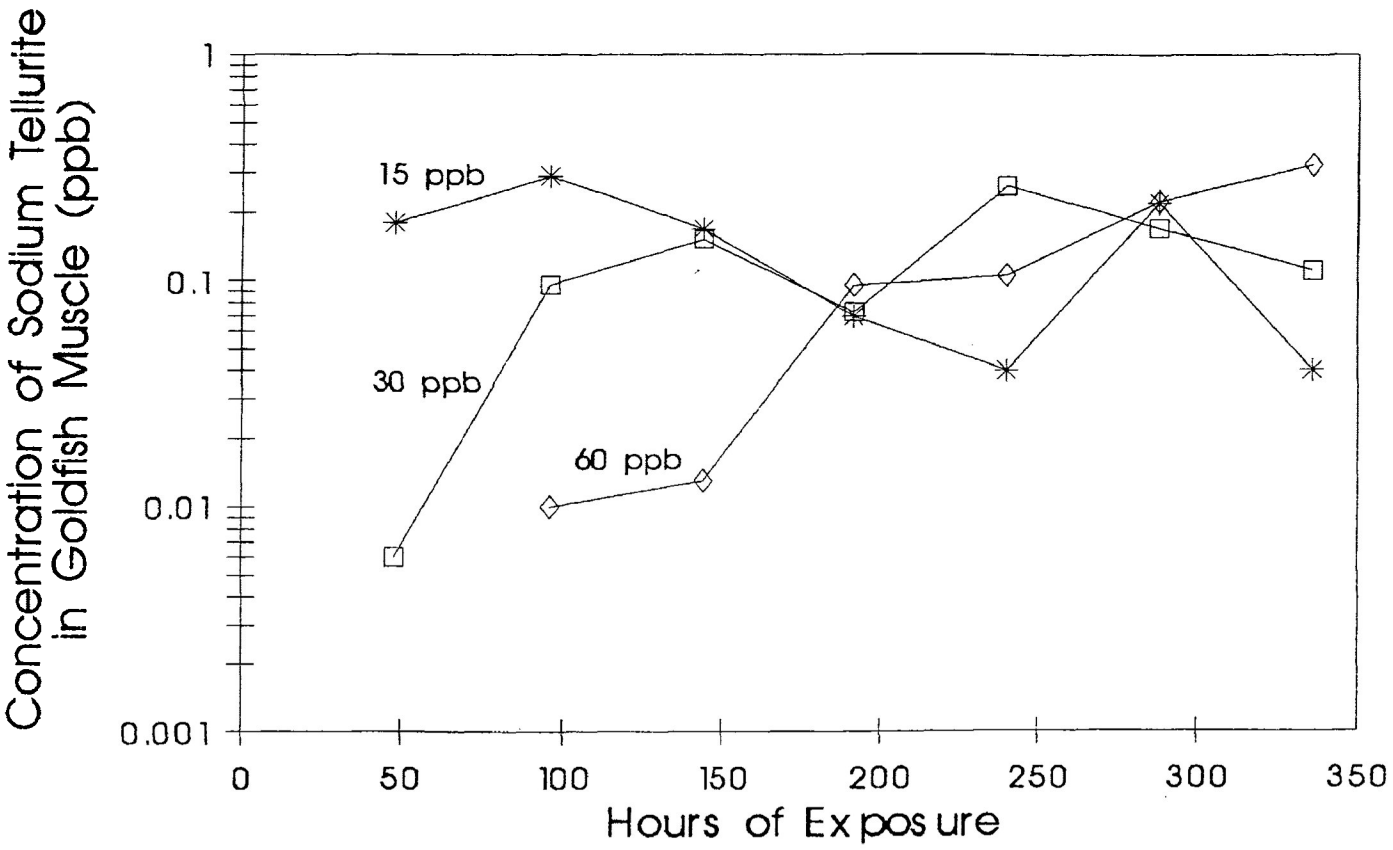

Figure 3:

Log tissue levels of sodium tellurite at three exposure concentration in goldfish over a 15-day period

Table 6: Sodium tellurite concentrations in goldfish muscle for 15 days.

Time (hrs)	Concentrations (ppb/.5 g) 15	30	60
48	0.12;0.21;0.21	0.0 ;0.02;0.0	0.0 ;0.0 ;0.0
96	0.27;0.30;0.30	0.1 ;0.07;0.12	0.0 ;0.02;0.01
144	0.20;0.18;0.13	0.19;0.26;0.01	0.02;0.0 ;0.02
192	0.12;0.02;0.07	0.11;0.09;0.02	0.10;0.13;0.10
240	0.07;0.01;0.04	0.41;0.21;0.23	0.11;0.14;0.14
288	0.13;0.38;0.15	0.22;0.17;0.17	0.30;0.28;0.31
336	0.09;0.0 ;0.04	0.08;0.1 ;0.15	0.29;0.36;0.32

V. Discussion and conclusion

There is no previous information regarding the toxicity of tellurium to fish. This experiment demonstrated that sodium tellurite when compared to other metal toxicity is only slightly toxic to goldfish (Table 7). The 96-hr LC_{50} was 785.8 ppm. In comparison, selenium, a closely related chemical, provides quite different results. Weir and Hine (1970) found that the LC_{50} for selenium in goldfish was 7.9 - 17.0 ppm. Furthermore studies with selenium in other fish such as fathead minnow (Pimephales promelas) fry and bluegill (Lepomis macrochirus) juveniles, revealed the 96-hr LC_{50} of selenium dioxide ranged from 2.9 - 40.0 ppm (Cardwell et al., 1976). For rainbow trout (Oncorhynchus mykiss) the 96-hr LC_{50} of sodium selenite averaged 6.5 - 8.1 ppm (Hodson et al., 1980). One of the reasons why tellurium has a different 96-hr LC_{50} compared to selenium and other metals maybe because of the difference in the permeability of the gill to tellurium in fish. Another reason maybe that tellurium is just not as toxic as other metals at the site of toxic action.

In this study, to determine the final tellurium uptake by the goldfish would have required additional time. It is possible that use of a continuous-flow biassay system, coupled with maintenance of known toxicant concentrations, for a sufficiently long period would produce the changes in slope necessary to determine final maximum uptake rates. By looking at 15, 30, and 60 ppb separate-

Table 7: The LC_{50} of several metals for goldfish (Weir and Hine,1970).

Metals	!	LC_{50} (ppm)
Mercury		0.75 - 0.90
Selenium		7.90 - 17.00
Arsenic		24.60 - 41.60
Lead		100.00 - 121.00

ly in Table 6, we can see there is a tendency for the uptake of tellurium in the muscle of goldfish to increase as the concentration goes up. The phenomena of 15 and 30 ppb being greater than 60 ppb was puzzling. After initial rapid uptake, the concentrations decreased at 15 and 30 ppb (Table 6), while at 60 ppb there was no uptake for 48 hrs, then the uptake increased (Table 6). It would seem that at concentrations below 30 ppb the fish are able to eliminate a portion of the tellurium. However, at 60 ppb tellurium begins to accumulate in the tissue suggesting that depuration is not sufficient to lower tellurium concentration at concentrations above this level. If the length of exposure had been extended, we might be able to discern trends within each uptake pattern. Surely, there was no problem with the solubility of this compound in the water, because the analysis of water sample proved that there was enough sodium tellurite present for exposure to the goldfish. Thus, the problem lies between the concentration of this compound and the specific physiological adjustment to this compound by the goldfish itself. In other words, the variability seen in all three curves at steady-state may be due to the fact that the exposure concentrations changed each time they were renewed in the static-renewal test procedure or that complexation was different at the different concentrations of tellurite in the exposure water. A flow-through test procedure might have eliminated a lot of the variability seen in the data. Further research is neccessary to resolve this problem. At 60 ppb, obviously, the muscle steadily takes up the sodium tellurite.

However, the result showed that there was no uptake until after 48 hours. The reason for the lag in the 60 ppb curve prior to 200 hr is unknown, but it could be damage to the gill surface or excessive binding to mucous, which set up a repulsion of similarly charged ions. In comparison, the uptake rate of selenium in rainbow trout reached equilibrium at about 100 h^{-1} at selenium concentrations of 0.01 ppm, 0.1 ppm, and 0.4 ppm. The study showed that the equilibrium level was almost reached only after four weeks of continuous exposure (Nielsen and Nielsen, 1978) indicating that an equal amount of time might be neccessary for tellurium.

Measurement of conductivity in the LC_{50} test produced a slightly different results, for example in 111.5 ppm of sodium tellurite, the conductivity was 195.8 $\pm$ 2.8 uhmos/cm, and in 259.0 ppm of sodium tellurite, the conductivity was 278.3 $\pm$ 0.9 umhos/cm. This was because of the salt form of the tellurium compound that we used. There were also a slight difference in pH in LC_{50} test among the concentration levels, and this could have possibly increased the toxicity of sodium tellurite to goldfish. Sorensen et al. (1983a, and b) found that the changing pH in water lead to a greater solubility of selenates and the bioaccumulation of selenium in fish.

In conclusion, exposure of goldfish to sodium tellurite in this study showed that sodium tellurite is not harmful for the goldfish at low concentrations (the 96-hr LC_{50} of sodium tellurite was 785.8 ppm). However since there is no previous information

regarding the toxicity of this compound to fish additional studies with this metal would be of value.

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