Aquatic Toxicity of Common Household Chemicals and Storm-Water

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Abstract

Toxicity testing is a process by which environmental conditions can be evaluated. *Daphnia magna* is a standard test organisms to test aquatic environments. *Daphnia* are used because they are easily cultured in the lab and sensitive to a variety of contaminants and pollutants. Common contaminants such as rock salt and fertilizers were used in 24 hour acute toxicity tests. These chemicals are commonly used in urban and suburban environments without much thought of their environmental effects. *Daphnia* were acclimated to moderately hard water following USEPA guidelines prior to testing. Using the same water, chemicals were added at multiple concentrations and replicated three times at each level including an uncontaminated control. *Daphnia* were exposed for 24 hours while being monitored. Counts were done every couple of hours for living *Daphnia* and dead *Daphnia* were removed. Water test were done for dissolved oxygen, pH, conductivity, hardness and temperature to insure proper conditions. At the end of the test period, the percent mortality was determined and plotted against concentration.

Introduction

Many of the chemicals and waste that humans produce can adversely effect wildlife. One of the most impacted systems are aquatic freshwater systems. Water from land runoff, sewage discharge, industrial waste, atmospheric deposition, and many other sources can contaminate water and make it unsuitable for aquatic life. Many chemicals that are used on lawns, gardens or in agriculture have been determined to be toxic to aquatic life therefore application is not recommend near surface waters or prior to rainfall which could move the chemicals into the streams. Understanding the toxicity of various common chemicals and storm water will enable better decisions made on the use or avoidance of these chemicals in our lives.

Hypothesis

- Contaminate including pesticides, herbicides and salts, will have adverse effects on aquatic life

Objectives

1. Perform acute toxicity test on common chemicals and storm water effluent
2. Monitor water quality such as dissolved oxygen, conductivity, and pH

Methodology

Dilution Water
- Synthetic freshwater was made, using USEPA guidelines of "moderately hard" water
- pH:7.4-7.8, hardness: 80-100, alkalinity: 57-64
- Water was used in tank and as the dilution water for the testing solutions

Collection of Storm Water
- Water was collected at a point of interest during rain events.
- The rain event was at least 72 hours after the last event
- One liter samples were collected in clean plastic containers
- Samples were collected at storm drains

Preparation of Testing Water
- Dilutions (250 mL) were made at varying concentrations based on literature findings
- Approximately 50 mL of testing solution were added to each container

Preparation of Daphnia for Testing
- *Daphnia* they were acclimated to the synthetic freshwater for a minimum of 48 hours
- Microscope selection of *Daphnia* was used to identify full sized, non-pregnant Daphnia
- Ten *Daphnia* were transferred, by pipet, to each concentration testing container

Testing
- *Daphnia* were subjected to a 24 hour static toxicity test
- *Daphnia* were monitored every couple of hours for mortality
- Dead *Daphnia* were removed from the containers

Results & Discussion

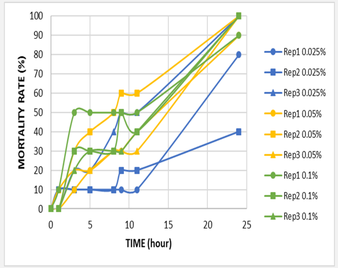

Figure 1: Mortality of *Daphnia* in Safer Pesticide Solutions in a 24 hour toxicity test

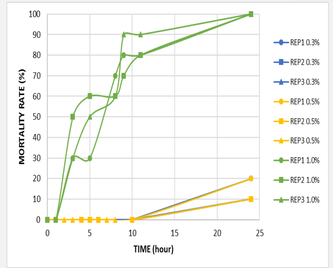

Figure 2: Mortality of *Daphnia* in Deicer (Brine) Solutions in a 24 hour toxicity test

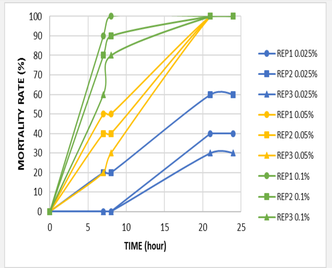

Figure 3: Mortality of *Daphnia* in Bayer Herbicide Solutions in a 24 hour toxicity test

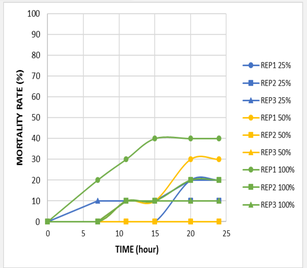

Figure 4: Mortality of *Daphnia* in Storm-water Solutions in a 24 hour toxicity test

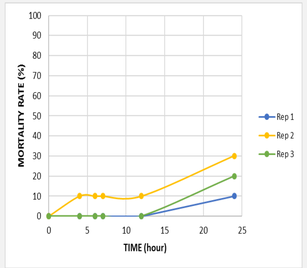

Figure 5: Mortality of *Daphnia* in Control Water in a 24 hour toxicity test

Table 1: Safer Water Chemical Analysis

Water	pH	Conductivity (uS/cm)	DO (mg/L)
Safer 0.025%	7.82	333	6.09
Safer 0.050%	7.43	340	6.09
Safer 0.100%	7.19	356	6.09

Table 2: Deicer (Brine) Water Chemical Analysis

Water	pH	Conductivity (uS/cm)	DO (mg/L)
Deicer 0.3%	7.10	1907	7.2
Deicer 0.5%	7.02	2910	7.2
Deicer 1.0%	7.00	5290	7.2

Table 3:Bayer Water Chemical Analysis

Water	pH	Conductivity (uS/cm)	DO (mg/L)
Bayer 0.025%	6.75	444	8.6
Bayer 0.050%	6.83	558	8.6
Bayer 0.100%	6.97	767	8.6

Table 4: Storm-Water Chemical Analysis

Water	pH	Conductivity (uS/cm)	DO (mg/L)
Storm-Water 25%	6.96	478	6.7
Storm-Water 50%	7.44	611	6.7
Storm-Water 100%	7.91	883	6.7

Table 5:Dilution Water Chemical Analysis

Water	pH	Conductivity (uS/cm)	DO (mg/L)
Dilution Water	8.0	327	8.75

Table 6: Toxicity Data

Literature cited toxicity data		Experimental toxicity data	
2,4-D 21-Day LC_{50}	25-643 mg/L	Bayer Herbicide 24-H LC_{50}	193 mg/L
Dicamba 48-H LC_{50}	1563 mg/L		
Quinclorac 48-H EC_{50}	113 mg/L		
Potassium salts of fatty acids 48-H LC_{50}	0.57 mg/L	Safer Insecticide 24-H LC_{50}	118.5 mg/L
Brine 48-H LC_{50}	1000 mg/L >100 mg/L	Deicer 24-H LC_{50}	773.4 mg/L
Brine 48-H EC_{50}, static	340.7-469.2 mg/L 52 mg/L ($CaCl_2$)		

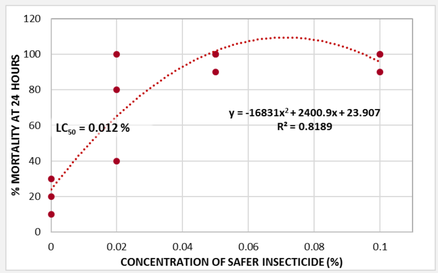

Figure 6: Calculated LC50 of *Daphnia* in Safer Pesticide Solutions

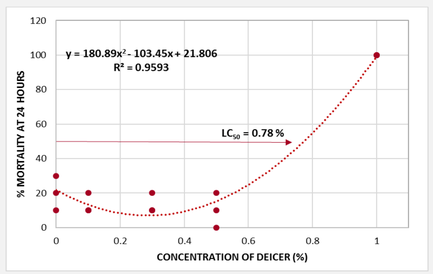

Figure 7: Calculated LC50 of *Daphnia* in Deicer (Brine) Solutions

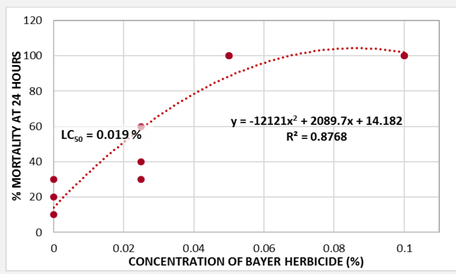

Figure 8: Calculated LC50 of *Daphnia* in Bayer Herbicide Solutions

- Safer is a insecticidal soap that uses potassium salts of fatty acids as the active ingredient.
- All concentrations of the insecticidal soap showed signs of toxicity to *Daphnia*.
- Insecticidal soaps are targeted to kill pest such as Aphids which come from the same phylum (Anthropoda) as *Daphnia*.
- Bayer is weed killer used to kill crabgrass, dandelions and clovers. It contains 2,4-D, dimethylamine salt (4.85%), Quinclorac (1.61%) and Dicamba dimethylamine salt (0.45%) as the active ingredients.
- Bayer pesticide had the highest *Daphnia* mortality for this toxicity test.
- Aqua Salina, a deicer/anti-icer is brine water formed from conventional wells.
- *Daphnia* were relatively resistant to the Deicer (brine) water with mortality not occurring until end of the 24 hours toxicity test.
- Hubbard Ohio storm-water was collected from a drain carrying suburban run-off. It did not show high amounts of toxicity.
- According to the calculated LC50 the Safer insecticide was the most toxic followed very closely by Bayer herbicide followed by the Deicer.
- All these solutions caused mortality at less than 1%.

Figure 9: *Daphnia* in testing jar

Figure 10: Products used for toxicity testing

Figure 11: *Daphnia* under microscope

Figure 12: Testing set up of container

Conclusion

Acute toxicity testing of *Daphnia magna* led to overall decline in health and resulted in mortality. There was higher decline of health and mortality in the low concentrations of both the pesticide and herbicide. Safer pesticide solution had the greatest toxicity at the lowest concentration. Even though Safer is a "green" insecticide it can still lead to adverse effect on aquatic organisms. These are only some of the household chemicals that enter aquatic systems through run off and can be detrimental to aquatic life. Such products should not be used around aquatic ecosystems.

References

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